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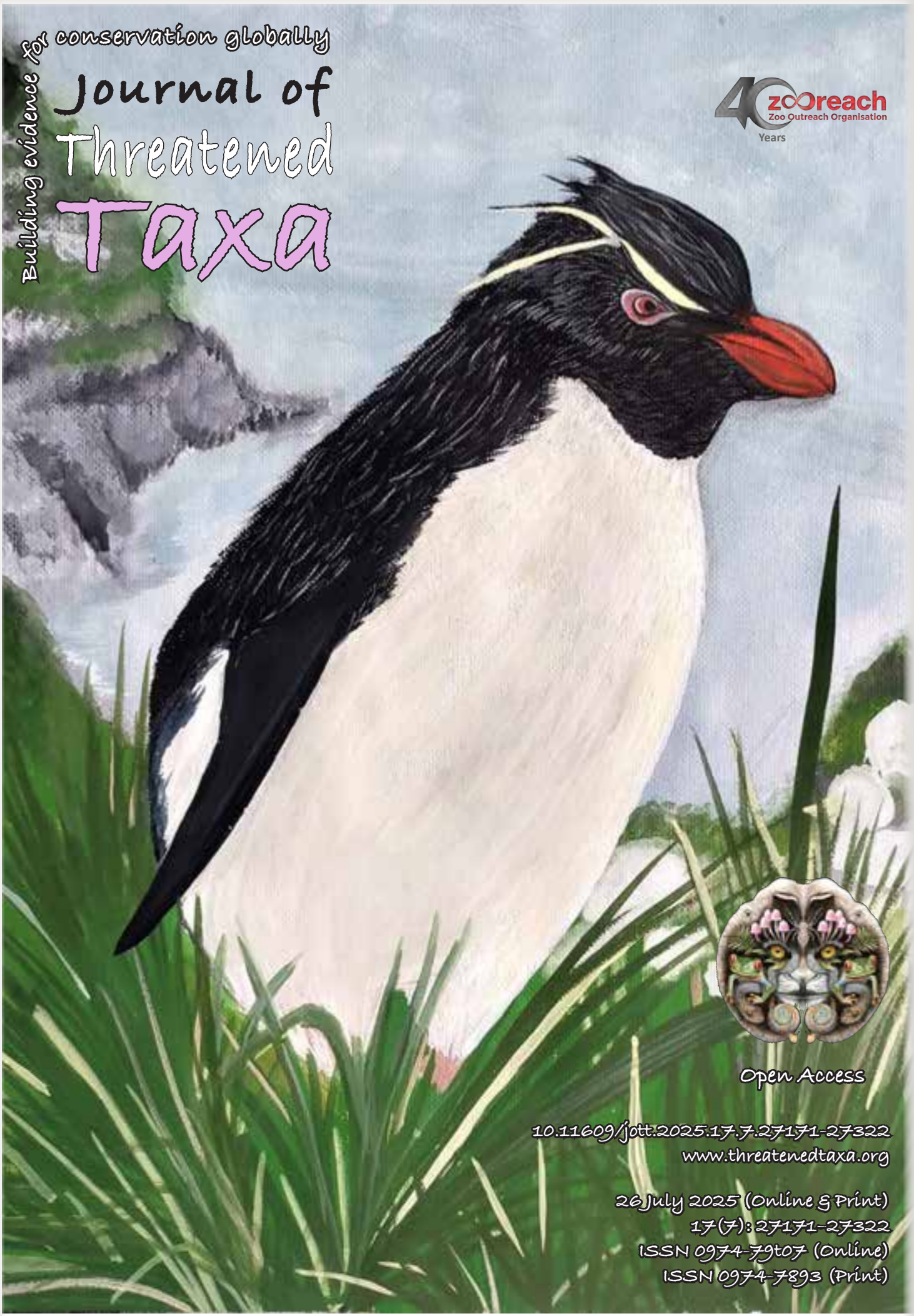

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continued on the back inside cover

Cover: A Southern Rockhopper Penguin *Eudyptes chrysocome* stands on Tussock Grass on Westpoint Island. Painted in poster colors, this artwork is a reproduction of a photograph by Phillip Colla. Thanks to the photographer for the original image. © Pooja Patil.

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ARTICLE

Two new species of bush frogs (Anura: Rhacophoridae: *Raorchestes*) from Meghalaya, northeastern India

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Abstract: The genus *Raorchestes* Biju et al., 2010 represents one of the most diverse lineages within the family Rhacophoridae, with its members characterized by small size, absence of vomerine teeth, direct development, and distinctive digital discs with circum-marginal grooves. Despite its location in the Indo-Burma biodiversity hotspot, the amphibian diversity of Meghalaya remains underexplored. In this study, we describe two new species, *Raorchestes jakoid* sp. nov. and *Raorchestes jadoh* sp. nov., from the Khasi Hills of Meghalaya, based on an integrative approach combining morphological, bioacoustic, and molecular data (16S rRNA). Additionally, we provide new records and supplementary descriptions for three species: *R. kempiae*, *R. garo*, and *R. asakgrensis*, thereby improving our understanding of their intraspecific variation and distribution. Phylogenetic analyses confirm the placement of the new species within the *Raorchestes parvulus* species complex. The new species are distinguished by a suite of morphological traits, unique call structures, and genetic divergence from congeners. Notably, both new species were discovered in secondary habitats near human settlements, suggesting ecological tolerance yet raising concerns about their long-term survival amid rapid habitat loss. The elevational distribution of the species studied ranges from 235 m to 1,655 m, with a concentration between 1,000–1,600 m, highlighting patterns of elevational partitioning and habitat specialization. Our findings add to the growing evidence of high cryptic diversity in the region and underscore the urgent need for targeted herpetofaunal surveys and conservation actions in Northeast India.

Keywords: 16SrRNA, acoustic, biodiversity, conservation, endemism, Indo-Burma biodiversity hotspot, morphology, *parvulus* complex, systematics, taxonomy.

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Competing interests: The authors declare no competing interests.

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Author contributions: HW—conceptualization, paper writing, collection of specimens, field study and data gathering; JP—paper writing and phylogenetic analysis; HTL—provided morphological data; MD—laboratory work and paper writing.

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INTRODUCTION

The genus *Raorchestes* Biju et al., 2010 is one of the most diverse in the family Rhacophoridae (Vijayakumar et al. 2014), currently comprising 80 recognized species (Biju & Bossuyt 2009; Frost 2025). The distribution of *Raorchestes* spans a wide geographical range, from southern and northeastern India to Nepal, extending through Myanmar, Thailand, Laos, and southern China, reaching Vietnam, Cambodia, and western Malaysia (Frost 2025). These small frogs are characterized by their unique morphological traits, including an adult snout-vent length between 15–45 mm and the absence of vomerine teeth. Notably, all documented species undergo direct development, with eggs hatching directly into froglets, bypassing the free-swimming tadpole stage. Additionally, the genus is distinguished by the expanded tips at its fingers, and toes, each ending in discs with circum-marginal grooves (Biju et al. 2010; Seshadri et al. 2012; Wu et al. 2021).

Meghalaya, a state in northeastern India, lies within the Indo-Burma biodiversity hotspot, a region renowned for its remarkable species richness and high levels of endemism (Myers et al. 2000). Despite its ecological significance, much of Meghalaya's amphibian diversity remains underexplored, with many species still awaiting formal description. Recent studies describing new amphibian taxa points to the rich and underexplored amphibian diversity of Meghalaya (Mathew & Sen 2007, 2009, 2010a, 2010b; Das et al. 2010; Mahony et al. 2011, 2013, 2018; Purkayastha & Matsui 2012; Kamei et al. 2013; Saikia et al. 2023; Naveen et al. 2024, 2025).

Among the Rhacophoridae of Meghalaya, species within the genus *Raorchestes* are unique in exhibiting direct development. In contrast, all other rhacophorid genera recorded from the region (e.g., *Rhacophorus*, *Polypedates*, *Kurixalus*, & *Chirixalus*) undergo an indirect development cycle, with a prominent free-swimming aquatic tadpole stage following hatching. Additionally, members of the genus *Raorchestes* possess rudimentary toe webbing. In comparison, species of other rhacophorid genera exhibit moderate to extensive toe webbing. Based on morphology, bioacoustic and genetics (16S rRNA), herein, two new species of *Raorchestes* belonging to the *Raorchestes parvulus* species complex were described (Garg et al. 2021) along with additional data on the newly described *R. asakgrensis* Naveen, Chandramouli, Babu, Ryndongsngi, Karunakaran & Kumara 2024, and of redescribed *R. garo* (Boulenger, 1919), and *R. kempiae* (Boulenger, 1919) from the subtropical forests of Meghalaya. Naveen et al. (2025) synonymised two nominal taxa *Philautus namdaphaensis* Sarkar & Sanyal, 1985 and *P. manipurensis* Mathew & Sen, 2009 under *R. kempiae*. These newly described and redescribed species significantly enhance the known diversity within the genus, offering fresh insights into the biogeography of *Raorchestes,* and contributing to the broader understanding of amphibian diversity in this ecologically rich but understudied region.

MATERIALS AND METHODS

Field sampling

Fieldwork was carried out in different parts of Meghalaya where specimens were observed and collected (Figure 1), including Mawpat, South West Khasi Hills (25.359° N, 91.255° E, elevation 1,355 m) for ADBUHW0154, Mawsynram, East Khasi Hills (25.296° N, 91.585° E, elevation 1,445 m) for ADBUHW0141, Lawbah, East Khasi Hills (25.247° N, 91.580° E, elevation 815 m) for ADBUHW0143, ADBUHW0145, and ADBUHW0144, Langtor, Eastern West Khasi Hills (25.533° N, 91.586° E, elevation 1,655 m) for ADBUHW0124 and ADBUHW0123, Laittyra, East Khasi Hills (25.222° N, 91.742° E, elevation 755 m) for ADBUHW0052, Mawiong Nongkhlaw, Eastern West Khasi Hills (25.690° N, 91.641° E, elevation 875 m) for ADBUHW0049, Umdein, West Khasi Hills (25.637° N, 91.047° E, elevation 445 m) for ADBUHW0119, Lailad, Nongkhyllem, Ribhoi (25.897° N, 91.775° E, elevation 235 m) for ADBUHW0116, and Tura, West Garo Hills (25.519° N, 90.210° E, elevation 375 m) for ADBUHW0169, and ADBUHW0170 between 2022 and 2024.

The research was conducted under the permission of the Principal Chief Conservator of Forests, Wildlife and Chief Wildlife Warden, Meghalaya (Memo. No. FWC/Research/115/2790–2796, Memo. No. FWC/Research/115/1653–1661 & Memo. No. FWC/Research/115/1134–1142). The study used randomized walks (Lambert 1984) and visual encounter surveys (Crump & Scott 1994) on different sites. The frogs were located and recorded by paying attention to the male frogs' calls. The frogs were photo-documented using Canon EOS M50 Mark II. Collected frogs were euthanized using lignocaine (2%), preserved in 10% formaldehyde solution, and deposited in the Assam Don Bosco University.

Morphological Study

The measurements were made using a vernier calliper to the nearest 0.01 mm. Different morphometric

characters and descriptions were considered following Watters et al. (2016). The morphological characters include: head width (HW); snout-vent length (SVL); tibia length (TL); interorbital distance (IOD); head length (HL); eye diameter (ED); internarial distance (IND); eye–nostril distance (EN); snout length (SL); snout–nostril length (NS); foot length (FL); tympanum diameter (TD); thigh length (THL); hand length (HAL); forearm length (FLL); upper eyelid width (UEW); tarsus length (TSL); mandible to eye distance (MBE); upper arm length (UAL); horizontal tympanic annulus diameter (TAD); mandible–nostril distance (MN); hindlimb–length (HLL); lower arm length (LAL); body width (BW); snout–urostyle length (SUL); finger I length (Fin1L); finger II length (Fin2L); finger III length (Fin3L); finger IV length (Fin4L); finger I disk width (Fin1DW); finger II disk width (Fin2DW); finger III disk width (Fin3DW); finger IV disk width (Fin4DW); finger IV width (Fin4W); toe I length (Toe1L); toe II length (Toe2L); toe III length (Toe3L); toe IV length (Toe4L); toe V length (Toe5L); and toe IV disk width (Toe4DW). For morphological comparison, we used raw measurements. We compared these measurements with the members of *Raorchestes parvulus* complex (Garg et al. 2021; Naveen et al. 2024, 2025): *Raorchestes kempiae*, and *Raorchestes garo*.

Bioacoustics recording and analyses

The calls were captured in real–time using BOYA BY–DMR7 unidirectional handheld microphones (WAV format, 24–bit) and SONY ICD–PX470 stereo digital voice recorders (MP3 format, 256 kbps) between 1600 h and 2300 h. The distance between the recording equipment and the calling males was maintained at 30–150 cm, except few which are present at the top of big trees, with recording levels adjusted before each session (Prasad et al. 2020). The acoustic properties of the different species were analyzed using Raven Pro 1.6. For calls, we analyzed the temporal variables like the number of notes per call, note duration, duration of the silent interval between notes, call duration, duration of the silent intervals between the calls, and call repetition rate. The spectral variables include the dominant frequency. Descriptive statistics like mean, standard deviation, range, and coefficient of variance were computed using Microsoft Excel 2010.

Genetic study: Genomic DNA isolation from 10 samples of *Raorchestes* spp. (ADBUHW0049, ADBUHW0052, ADBUHW0116, ADBUHW0124, ADBUHW0141, ADBUHW0143, ADBUHW0145, ADBUHW0154, ADBUHW0169, ADBUHW0170) was done using Phenol: Chloroform: Isoamyl alcohol method, followed by 0.8% agarose gel electrophoresis, and visualized under UV light using Biorad Gel Imazer Gel Documentation Unit. The 16S rRNA gene were amplified using gene- primers pair AH-16S_S 5'- CGC CTG TTT ACC AAA AAC ATC GCC T-3' and AH-16S_R 5'- TGC GCT GTT ATC CCY RGG GTA ACT-3' following Caranza & Arnold (2006). Comparative genetic data from members of *Raorchestes parvulus* group were download from GenBank and were used in construction of phylogenetic tree (Table 2). Sequence alignment was done using MUSCLE (Edgar 2004) in MEGA7 (Tamura & Nei 1993; Kumar et al. 2016) with default parameter settings (max 2072 bp). Maximum likelihood (ML) phylogenetic tree was reconstructed using unpartitioned dataset in IQ-TREE (Nguyen et al. 2015) with the substitution model TIM2+F+R2 selected based on the BIC scores by Model Finder (Kalyaanamoorthy et al. 2017). The ML analysis was run with an ultrafast bootstrap option (Minh et al. 2013) for 1,000 iterations to assess clade support. The uncorrected pairwise p-distance was calculated in MEGA7 (Kumar et al. 2016) with pairwise deletions of missing data and gaps.

RESULTS

Based on 16S rRNA data generated, the species studied were seen to be members of the *Raorchestes parvulus* species group (Garg et al. 2021; Image 1; Supplement Table 1). The specimens ADBUHW0049 (PQ492285), ADBUHW0052 (PQ492286), and ADBUHW0145 (PQ492281) were seen to form a sister clade with *R. kempiae* differing by an uncorrected p-distance of 0.000–0.006 (0.6%). Specimens, ADBUHW0141 (PQ492279) and ADBUHW0154 (PQ492282) were seen to form a sister taxon *to R. garo*, differing by an uncorrected p-distance of 0.000.

ADBUHW0116 (PQ492287), ADBUHW0169 (PQ492283), and ADBUHW0170 (PQ492284) were seen to be sister taxa to *R. asakgrensis*, differing from each other with an uncorrected p-distance of 0.000–0.015 (0.15%).

Furthermore, specimen ADBUHW0124 (PQ492288) was seen to be sister taxon to *R. shillongensis*, differing by an uncorrected p-distance of 0.034 (3.4%), and ADBUHW0143 (PQ492280) was seen to be sister to *R. rezakhani*, differing by an uncorrected p-distance of 0.058 (5.8%) to 0.061 (6.1%).

Systematics

***Raorchestes kempiae* (Boulenger, 1919)**

(Images 2 & 3; Tables 1 & 3)

Referred materials

ADBUHW0049, adult male collected from Mawiong Nongkhlaw, Eastern West Khasi Hills, Meghalaya, India (25.690° N, 91.641° E, elevation 875 m on 30 August 2023 at around 1845 h by Holiness Warjri and Rijessing Warjri.

ADBUHW0052 adult male collected from Laittyra, East Khasi Hills, Meghalaya, India 25.222° N, 91.742° E, elevation 755 m) on 7 August 2023 at around 1930 h by Holiness Warjri and Rijessing Warjri.

ADBUHW0145, adult male collected from Lawbah, East Khasi Hills, Meghalaya, India (25.247° N, 91.580° E, elevation 815 m) on 6 August 2024 at around 1750 h by Holiness Warjri and Rijessing Warjri.

Diagnostic characters

The species is allocated to the genus *Raorchestes* because of small size (adult SVL ranging from 15–45 mm) and absence of vomerine teeth; a large, transparent gular pouch visible during calls; in males, tips of all fingers and toes expanded into discs with circum-marginal grooves (Biju et al. 2010; Wu et al. 2021). *Raorchestes kempiae* is characterised by: webbing formula (I 1–2 II 2–1 III 1–3.5 IV 3–2 V); inner palmar tubercle absent and outer palmar tubercle with round shape; tibio-tarsal articulation reaching the eye when hindlimb is stretched alongside body (whereas Boulenger (1919) mentioned of tibio-tarsal articulation reaching the anterior border of an eye); nuptial pad present; inner metatarsal tubercle oval (IMT/Toe4L 0.09 mm long), outer metatarsal tubercle absent; upper part of body with small warts.

Color in life (Image 2)

Dorsal color beige, with or without an hour glass shaped marking; finger discs and toe discs greyish; dorsal surface of the hindlimb and forelimb with more or less dark crossbars; supratympanic fold dark brown; iris light golden; ventral surface creamy white with many white spots.

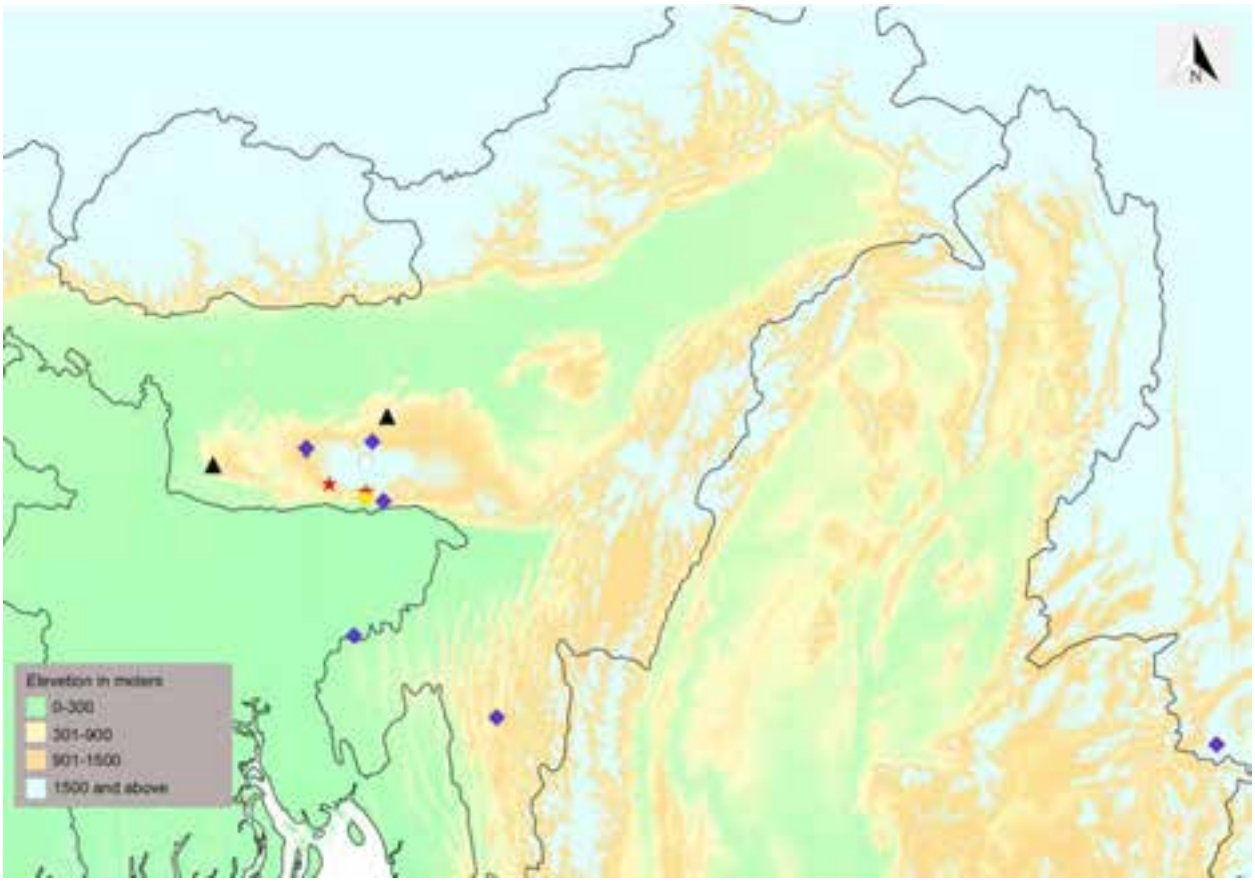

Figure 1. An elevation map showing distribution of *Raorchestes garo* (red star), *Raorchestes jakoid* sp. nov. (yellow circle), *Raorchestes jadoh* sp. nov. (white square), *Raorchestes asakgrensis* (black triangle), and *Raorchestes* cf. *kempiae* (blue diamond).

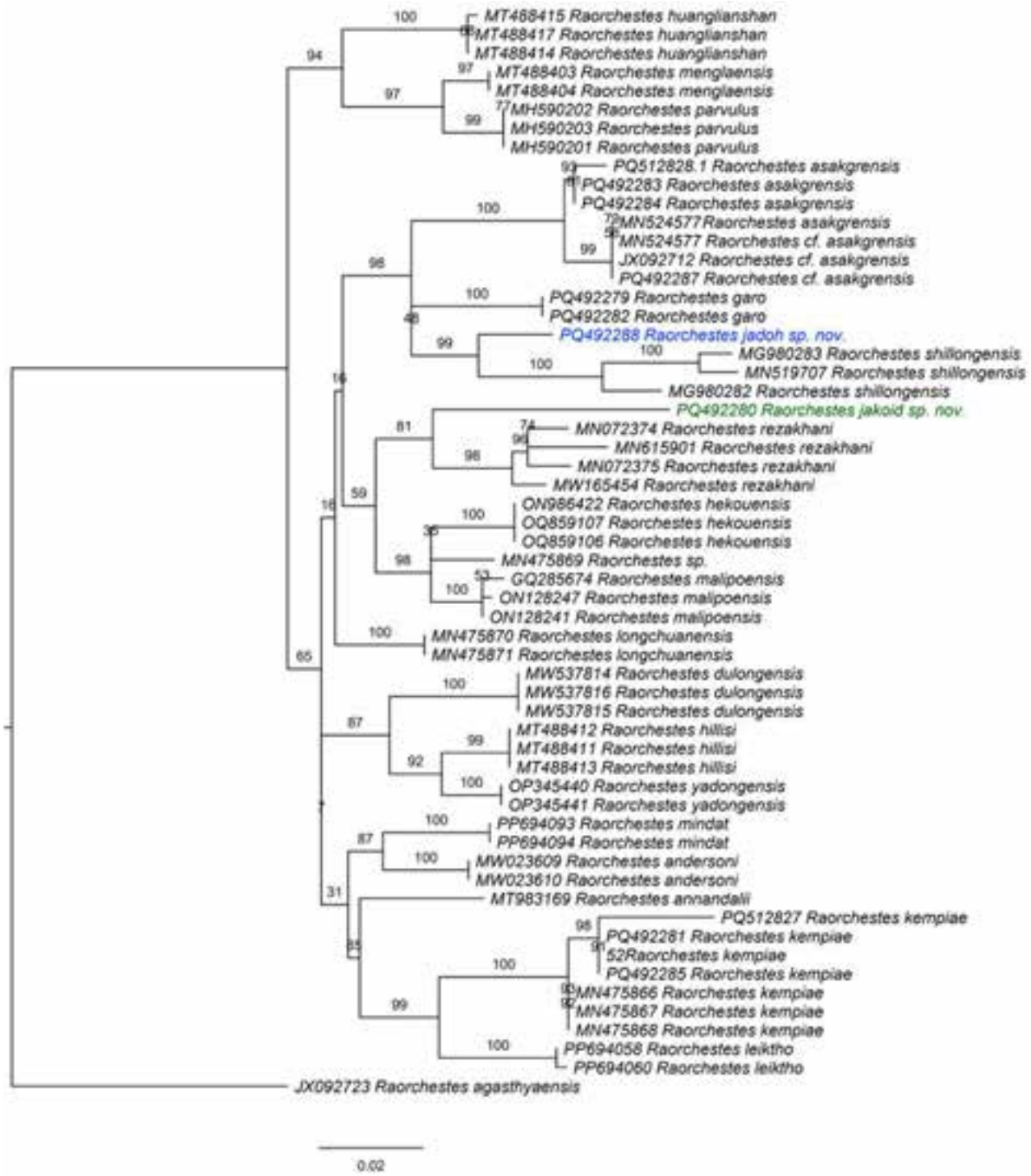

Image 1. Maximum likelihood phylogeny of frogs in the genus *Raorchestes*; numbers at nodes represent bootstrap support (Preceding the species name is NCBI accession number).

Advertisement calls: (Image 3; Table 3)

Ten advertisement calls were analyzed from two individuals having SVL of 23.6 and 24.4 mm. The calling position from the ground was observed to be 20–400 cm. When recording, calling males were sitting on trees and grasses near human settlements and calls were recorded between 1625 h and 1800 h on 7 August 2023. The ambient air temperature was 26°C and the relative humidity was 99%.

The advertisement call had a mean duration of 0.37

Image 2. Live image of *Raorchestes kempiae* from Meghalaya, India.: A—Lawbah, East Khasi Hills | B—Mawiong, Eastern West Khasi Hills | C—Laittyra, East Khasi Hills. © Holiness Warjri.

± 0.05 seconds, with a mean inter−call interval of 1.32 ± 0.11 seconds, and an average call repetition rate of 2.73 ± 0.33 calls per minute. Each call contained an average of 2.0 ± 0.0 notes, with a note duration of 0.12 ± 0.008 seconds and a mean inter-note interval of 0.06 ± 0.007 seconds. The mean dominant frequency of the call was 2.73 ± 0.03 kHz, ranging 2.72−2.81 kHz, with a coefficient of variation of 1.09.

***Raorchestes garo* (Boulenger, 1919)**
(Images 3 & 4; Tables 1 & 3)

Referred materials

ADBUHW0154 adult male collected from Mawpat, South West Khasi Hills, Meghalaya, India (25.359^0 N, 91.255^0 E, elevation 1,355 m) on 17 July 2024 at around 1830 h by Holiness Warjri and Rijessing Warjri.

ADBUHW0141 adult male collected from Mawsynram, East Khasi Hills, Meghalaya, India (25.296^0 N, 91.585^0 E, elevation 1,445 m) on 6 July 2024 at around 1910 h by Holiness Warjri and Rijessing Warjri.

Diagnostic characters: *Raorchestes garo* is characterised by small body size (maximum SVL 22.7 mm), vomerine teeth absent, males possess a transparent gular pouch which is visible when calling, and tips of all fingers and toes expanded into discs with circum-marginal grooves. Tympanum may be distinct or hidden. Boulenger (1919) and Naveen et al. (2024) mentioned of distinct tympanum, whereas the specimens reported in this study (ADBUHW0141 and ADBUHW0154) have a indistinct tympanum; webbing between fingers absent; relative finger lengths: I < II < IV < III, relative toe lengths: I < II < III < V < IV; webbing formula for toe is: I 1−1 II 1−1 III 3−3 IV 3−2.5 V; inner palmar tubercle absent and outer palmar tubercle present with round shape; tibiotarsal articulation reaching the posterior border of an eye when hindlimb is stretched alongside body (whereas Boulenger (1919) mentioned tibio-tarsal articulation reaching the anterior border of an eye); nuptial pad present and whitish in color; inner metatarsal tubercle oval (IMT/Toe4L 0.07 mm long), outer metatarsal tubercle absent; dark brown

Table 1. Morphometric data of *Raorchestes garo, R. jakoid* sp. nov., *R. jadoh* sp. nov., *R. asakgrensis*, and *R. kempiae* from Meghalaya, India.

	ADBUHW0154	ADBUHW0141	ADBUHW0143	ADBUHW0144	ADBUHW0123	ADBUHW0124	ADBUHW0169	ADBUHW0170	ADBUHW0116	ADBUHW0049	ADBUHW0052	ADBUHW0145
Species	*R. garo*		*R. jakoid* sp. nov.		*R. jadoh* sp. nov.		*R. asakgrensis*			*R. kempiae*		
SVL	22.47	22.75	18.47	21.6	14.01	13.68	21.57	23.35	18.08	22.96	24.4	23.62
SUL	21.41	18.11	16.5	20.13	13.24	13	20.52	22.93	16.41	21.64	23.07	22.1
BW	7.21	7.11	7.4	7.51	7.2	7.33	8.53	10.38	7.35	8.59	9.1	9.7
HW	5.79	7.67	7.05	7.52	6.02	5.43	8.35	9.21	6.42	8.87	8.56	8.8
HL	3.95	5.34	5.2	6.11	4.01	3.91	6.54	7.68	5.26	7.13	8.97	7.22
IOD	2.18	2.68	2.19	1.7	2.12	2.1	2.21	2.05	2.13	2.61	2.33	2.79
IND	2.8	1.52	2.12	2.1	1.97	1.85	1.84	2.01	1.98	2.67	3.15	1.89
UEW	1.51	1.81	1.63	1.75	1.51	1.46	1.94	2	1.52	2.06	1.74	1.78
ED	1.68	2.51	1.79	1.8	1.71	1.69	2.24	2.6	1.82	3.21	2.77	2.64
EN	1.71	2.61	1.7	1.89	1.71	1.69	2.24	2.94	1.6	2.48	2	2.53
SL	2.9	3.41	2.4	2.45	2.9	2.87	3.24	4.32	2.78	3.64	4	3.41
NS	0.91	1.41	1.45	1.28	0.9	0.89	1.99	1.71	2.6	1.86	2.01	1.61
TD	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct
TAD	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct
MBE	1.31	1.31	1.07	1.45	1.21	1.25	1.74	2.17	1.04	2.42	2.04	1.41
MN	3.06	3.58	4.41	5.45	2.91	3.01	4.63	4.88	4.27	5.69	5.05	6.01
FLL	3.49	4.79	4.22	4.29	3.42	3.41	3.72	4.92	4.12	5.33	5.15	5.73
UAL	4.12	4.41	3.09	3.33	4.15	4.11	3.8	3.73	3.08	3.96	3.49	3.25
LAL	7.11	9.11	11.45	12	7.11	7.15	14.33	4.66	11.29	11.04	10.87	10.01
HAL	4.45	5.65	4.85	4.91	4.61	4.5	5.68	6.09	4.78	7.37	7.87	7.19
HLL	19.05	24.01	23.5	23.16	18.61	19.02	32.03	34.97	23.5	33.77	36.47	31.21
THL	6.75	9.19	7.75	8.16	6.75	6.7	11.51	10.8	8.07	12.11	10.71	11.1
TL	7.16	10.11	8.4	10.62	8.11	7.1	11.49	12.91	8.43	11.58	12.23	14.23
TSL	4.08	6.61	3.69	5.49	4.09	4.02	7.49	6.73	3.88	6.53	6.52	5.98
FL	6.04	8.11	7.35	8.11	6.05	6.03	8.58	9.47	7.36	9.38	8.91	9.53
Fin1L	1.61	4.25	2.93	3.18	1.43	1.66	2.45	2.1	2.25	3.12	4.33	3.01
Fin2L	2.1	5.35	3.55	4.11	2	2.11	3.19	3.92	3.65	4.69	5.23	4.15
Fin3L	4.14	6.41	5.35	6.45	4.12	4.15	5.87	6.1	5.3	7.51	7.4	6.94
Fin4L	3.61	5.99	4.28	4.5	4.62	3.59	4.63	5.2	4.22	5.48	6.45	5.73

Table 1. cont.

	ADBUHW0154	ADBUHW0141	ADBUHW0143	ADBUHW0144	ADBUHW0123	ADBUHW0124	ADBUHW0169	ADBUHW0170	ADBUHW0116	ADBUHW0049	ADBUHW0052	ADBUHW0145
Species	*R. garo*		*R. jakoid* sp. nov.		*R. jadoh* sp. nov.		*R. asakgrensis*			*R. kempiae*		
Fin1DW	0.33	0.46	0.32	0.44	0.33	0.39	0.36	0.44	0.49	0.53	0.61	0.45
Fin2DW	0.61	0.86	0.86	0.89	0.62	0.65	0.81	0.82	0.85	0.93	1.12	0.91
Fin3DW	1.19	0.97	1.2	1.61	1.36	1.29	1.25	1.25	1.14	1.42	1.48	1.45
Fin4DW	0.81	0.88	0.92	0.99	0.99	0.68	0.87	0.84	0.9	1.44	1.48	1.16
Fin4W	0.25	0.56	0.59	0.91	0.21	0.25	0.72	0.87	0.58	0.6	1	0.58
Toe1L	1.31	2.99	2.4	2.91	1.21	1.26	2.3	3.65	2.41	3.29	2.85	3.59
Toe2L	3.39	2.11	3.45	2.48	3.18	2.42	3.1	2.97	2.4	5.55	4.97	4.22
Toe3L	5.19	5.2	5.6	6.78	6	6.11	6.33	6.7	5.49	7.27	6.68	5.99
Toe4L	6.19	7.11	7.5	7.69	6.01	6.45	8.85	9.16	7.41	9.19	9.52	9.52
Toe5L	6.19	6.99	6.7	6.9	5	5.12	7.54	7.36	6.55	8.03	7.32	7.81
Toe4DW	0.87	1.2	0.98	1.03	0.83	0.86	1.12	1.4	0.94	1.41	1.4	1.29

interorbital triangle between eyes interorbital distance larger than eye horizontal diameter; upper part with small warts.

Color in life (Image 4)

Dorsal color beige, with a faint) (shaped marking; finger discs and toe discs greyish; dorsal surface of the hindlimb and forelimb with more or less dark crossbars; supratympanic fold dark brown; crotch with distinct black patches; iris golden brown; ventral surface creamy white with many white spots.

Advertisement calls: (Image 3; Table 3)

A total of 10 advertisement calls were analysed from 2 individuals having SVL of 22.5 and 22.8 mm. The calling position from the ground is observed to be between 50–500 cm. The calling males were observed and recorded between 1830 h and 2125 h on 17 July 2024 with most calls originating from bushes in dense forest areas and near human settlements. The ambient air temperature during the recordings was 24°C, with a relative humidity of 89 %. The advertisement calls analyzed had a mean duration of 0.03 ± 0.005 seconds, with a mean inter-call interval of 2.26 ± 0.18 seconds, and an average call repetition rate of 35.28 ± 6.15 calls per minute. Each call consisted of a single note, meaning the note duration was identical to the call duration, and the inter-note interval matched the inter-call interval. The mean dominant frequency of the call was 2.93 ± 0.04 kHz, with a frequency range of 2.91–3.00 kHz. The coefficient of variation was 1.35.

***Raorchestes asakgrensis* Naveen, Chandramouli & Babu, 2024**

(Images 3 & 5; Tables 1 & 3)

Referred materials

ADBUHW0170 adult male collected from Tura, West Garo Hills, Meghalaya, India (25.519^0 N, 90.210^0 E, elevation 375 m) on 22 July 2024 at around 1830 h by Holiness Warjri and Rijessing Warjri.

Two adult males, ADBUHW0169 and ADBUHW0116 were collected. ADBUHW0169 was collected from the same locality and had the same information as the holotype, and ADBUHW0116 was collected from Lailad, Nongkhyllem, Ribhoi (25.897^{0}N, 91.775^{0}E, elevation 235 m) on 27 April 2024 at around 1800 h by Holiness Warjri and Ibankershisha Dkhar.

Diagnostic characters

Raorchestes asakgrensis is characterised by: very

Table 2. GenBank accession of 16s rRNA gene for species used to construct maximum likelihood phylogenetic tree.

Species	Locality	Voucher specimen	GenBank accession No
Raorchestes andersoni	Medog, Tibet, China	KIZ 014104	MW023610
Raorchestes andersoni	Medog, Tibet, China	KIZ YPX16167	MW023609
Raorchestes annandalii	Nepal	CDZMTU419	MT983169
Raorchestes asakgrensis	Tura, West Garo Hills, Meghalaya	ADBUHW0169	PQ492283
Raorchestes asakgrensis	Tura, West Garo Hills, Meghalaya	ADBUHW0170	PQ492284
Raorchestes asakgrensis	Lailad, Nongkhyllem, Ribhoi, Meghalaya	ADBUHW0116	PQ492287
Raorchestes asakgrensis	Nongkhyllem, Meghalaya	ZSIS-M7	MN524577
Raorchestes asakgrensis.	NA	CESF420	JX092712.1
Raorchestes asakgrensis.	Asakgre Community Reserve, Garo Hills, Meghalaya, India	SACON VA 805	PQ512828
Raorchestes cf. *parvulus*	Gunung Jerai, Kedah, Malaysia	LSUHC 10473	MH590203
Raorchestes cf. *parvulus*	Pulau Langkawi, Kedah, Malaysia	LSUHC 7596	MH590202
Raorchestes cf. *parvulus*	Gunung Stong, Kelantan, Malaysia	LSUHC 11118	MH590201
Raorchestes dulongensis	Qinlangdang Village, Yunnan, China	KIZ 035125	MW537815
Raorchestes dulongensis	Qinlangdang Village, Yunnan, China	KIZ 035082	MW537814
Raorchestes dulongensis	Qinlangdang Village, Yunnan, China	KIZ 035126	MW537816
Raorchestes garo	Mawpat, South West Khasi Hills, Meghalaya	ADBUHW0154	PQ492282
Raorchestes garo	Mawsynram, East Khasi Hills, Meghalaya	ADBUHW0141	PQ492279
Raorchestes garo	Daribokgre Community Reserve, East Garo Hills, Meghalaya, India	SACON VA 809	PQ585812
Raorchestes hekouensis	Hekou, Yunnan, China	GXNU YU000536	OQ859106
Raorchestes hekouensis	Hekou, Yunnan, China	GXNU YU000537	OQ859107
Raorchestes hekouensis	Hekou, Yunnan, China	GXNU YU000160	ON986422
Raorchestes hillisi	Xiding, Yunnan, China	MT488411	MT488411
Raorchestes hillisi	Xiding, Yunnan, China	CIB 116329	MT488412
Raorchestes hillisi	Xiding, Yunnan, China	CIB 116330	MT488413
Raorchestes huanglianshan	Mt. Huanglian, Lvchun, Yunnan, China	CIB 116365	MT488414
Raorchestes huanglianshan	Mt. Huanglian, Lvchun, Yunnan, China	CIB 116353	MT488415
Raorchestes huanglianshan	Mt. Huanglian, Lvchun, Yunnan, China	CIB 116354	MT488417
Raorchestes jadoh sp. nov.	Langtor, Eastern West Khasi Hills, Meghalaya	ADBUHW0124	PQ492288
Raorchestes jakoid sp. nov.	Lawbah, East Khasi Hills, Meghalaya	ADBUHW0143	PQ492280
Raorchestes kempiae	Mikadogre Community Reserve	SACON VA 806	PQ512827
Raorchestes kempiae	Mawiong Nongkhlaw, Eastern West Khasi Hills, Meghalaya	ADBUHW0049	PQ492285
Raorchestes kempiae	Laittyra, East Khasi Hills, Meghalaya	ADBUHW0052	PQ492286
Raorchestes kempiae	Lawbah, East Khasi Hills, Meghalaya	ADBUHW0145	PQ492281
Raorchestes kempiae	Cangyuan, Yunnan, China	KIZ 015855	MN475866
Raorchestes kempiae	Cangyuan, Yunnan, China	KIZ 015856	MN475867
Raorchestes kempiae	Cangyuan, Yunnan, China	KIZ 015857	MN475868
Raorchestes leiktho	Near Leiktho, Hp-an District, Kayin State, Myanmar	SMF 106284	PP694058
Raorchestes leiktho	Near Leiktho, Hp-an District, Kayin State, Myanmar	SMF 106234	PP694060
Raorchestes longchuanensis	Gongdong, Longchuan county, Yunnan, China	KIZ 048492	MN475871
Raorchestes longchuanensis	Gongdong, Longchuan county, Yunnan, China	KIZ 048468	MN475870
Raorchestes malipoensis	Malipo, Yunnan, China	SWFU 3110	ON128247
Raorchestes malipoensis	Malipo, Yunnan, China	SWFU 3111	ON128241
Raorchestes malipoensis	Pac Ban, Tuyen Quan, Vietnam	ROM30288	GQ285674
Raorchestes menglaensis	Zhushihe, Mengla, Yunnan, China	CIB 116338	MT488403
Raorchestes menglaensis	Zhushihe, Mengla, Yunnan, China	CIB 116340	MT488404
Raorchestes mindat	Ovatmataung National Park, Kanpetlet township, Mindat District, Chin State, Myanmar	CAS 234782	PP694093
Raorchestes mindat	Ovatmataung National Park, Kanpetlet township, Mindat District, Chin State, Myanmar	CAS 234783	PP694094
Raorchestes rezakhani	Maulovibazar, Bangladesh	JnUZool-A0319	MN072374
Raorchestes rezakhani	Maulovibazar, Bangladesh	JnUZool-A0419	MN072375
Raorchestes rezakhani	Maulovibazar, Bangladesh	JnUZool-A0619	MN615901
Raorchestes rezakhani	Bangladesh	A0619	MW165454
Raorchestes shillongensis	Shilong, meghalaya, India	ZSIS-M1	MN519707
Raorchestes shillongensis	Malki forest, Shilong, meghalaya, India	R2	MG980283
Raorchestes shillongensis	Risa forest, Shilong, meghalaya, India	R1	MG980282
Raorchestes sp.	Tam Dao, Vinh Phu, Vietnam	ROM30298	MN475869
Raorchestes yadongensis	Yadong, Xizang, China	YBU 21222	OP345440
Raorchestes yadongensis	Yadong, Xizang, China	YBU 21223	OP345441
Nasutixalus jerdonii	Meriema, Nagaland, India	SDBDU 2007.060	KU170003

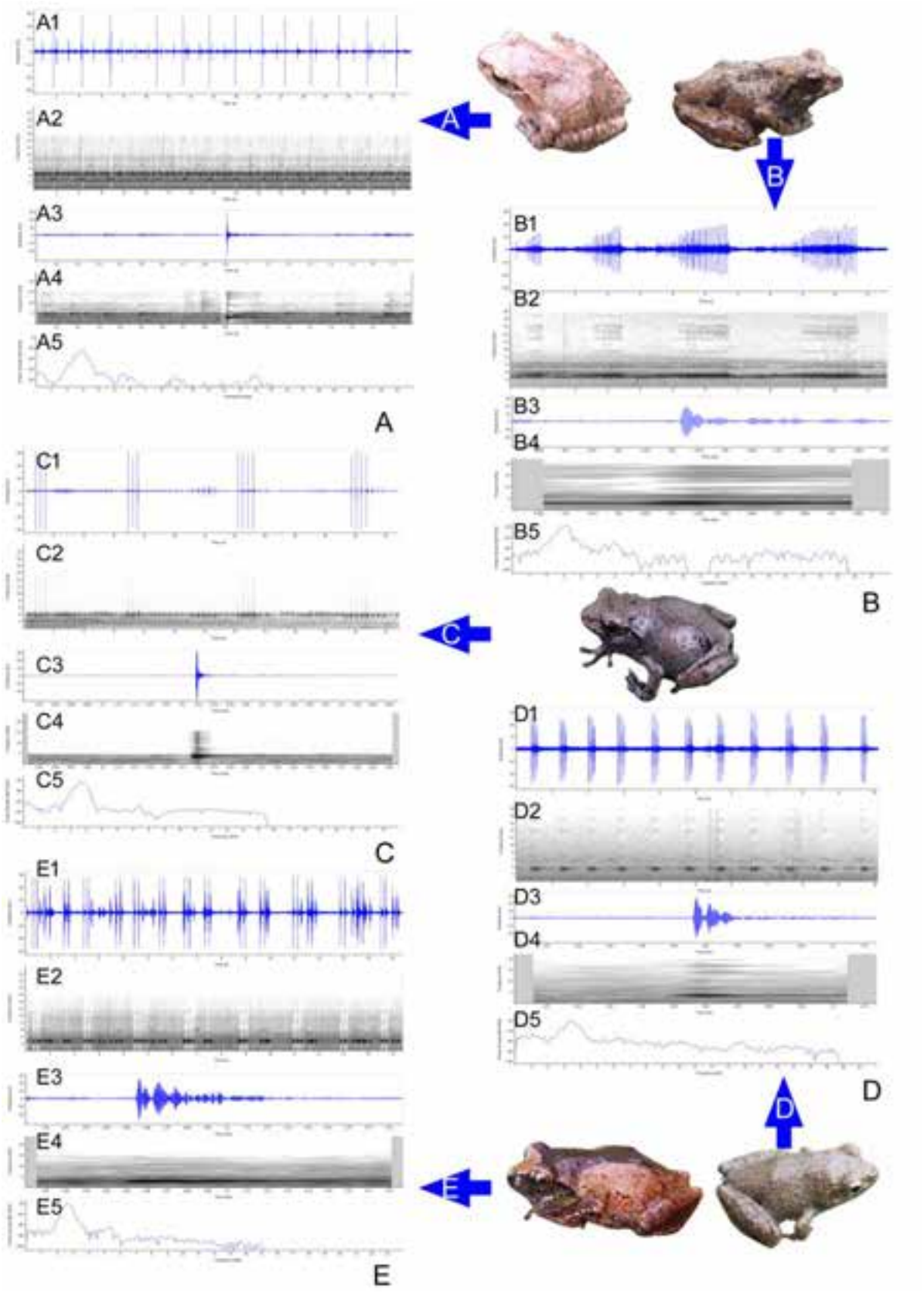

Image 3. Advertisement calls: 1—Oscillogram of call | 2—Spectrogram of call | 3—Oscillogram of single note | 4—Spectrogram of single note | 5—Power spectrum (Window type-Blackman, 3dB Filter Bandwith-150 Hz)] of A—*Raorchestes garo* | B—*Raorchestes jakoid* sp. nov. | C—*Raorchestes jadoh* sp. nov. | D—*Raorchestes asakgrensis* | E—*Raorchestes kempiae* from Meghalaya, India.

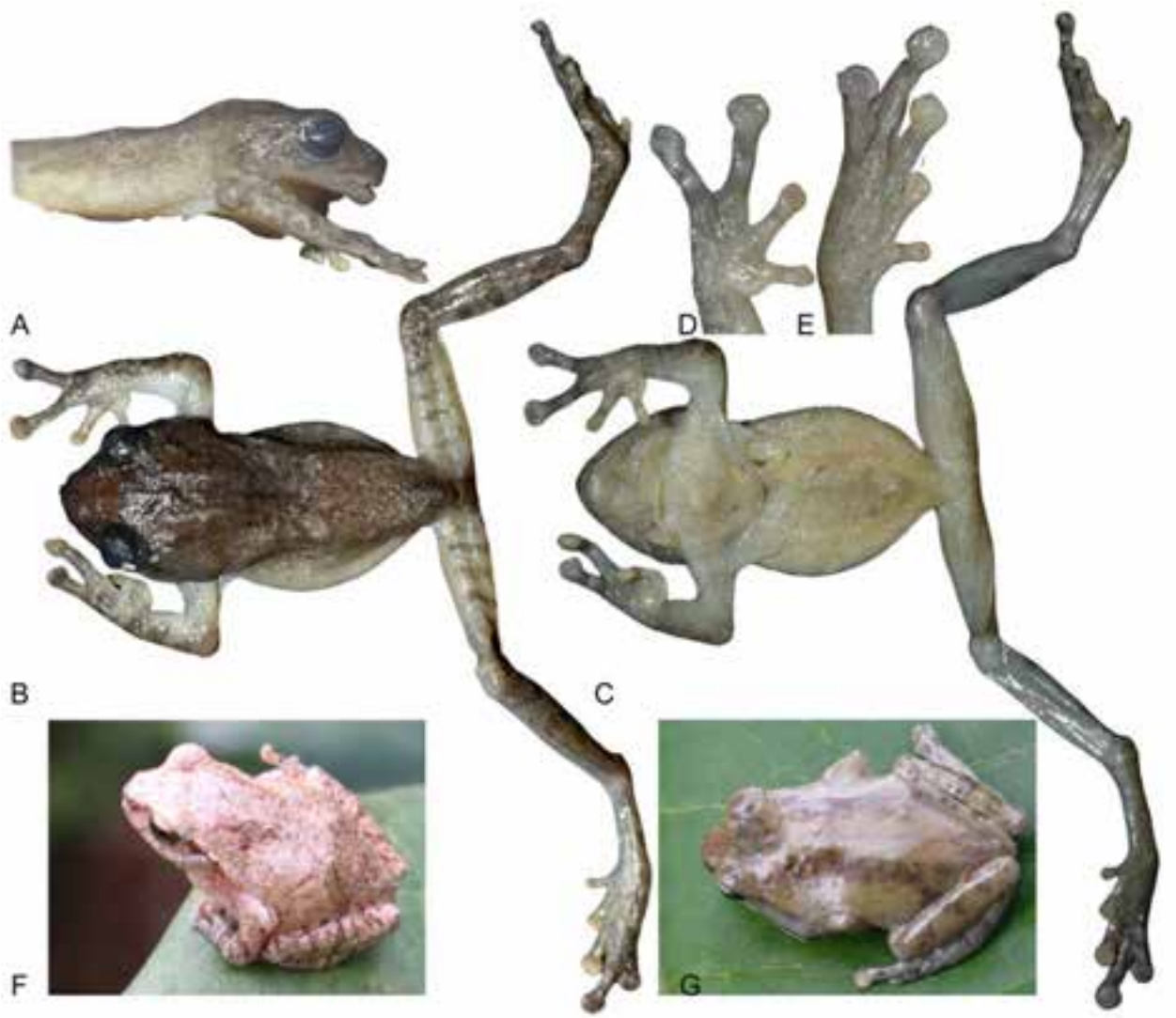

Image 4. *Raorchestes garo* from Meghalaya, India: A—Lateral aspect | B—Dorsal aspect | C—Ventral aspect | D—Manus | E—Pes | F&G—Live specimens. © Holiness Warjri.

small body size with maximum SVL of 23.35 mm; head wider than long; tympanum may be distinct or hidden. Rudimentary webbing between toes present, webbing formulaI I 1–2 II 2–2 III 2–3.5 IV 3.3–2 V; relative finger lengths: I < II < IV < III, relative toe lengths: I < II < III < V < IV; inner palmar tubercle absent and outer palmar tubercle present with round shape; tibio-tarsal articulation reaches anterior border of an eye when hindlimb is stretched alongside of body; nuptial pad distinct; inner metatarsal tubercle oval (IMT/Toe4L 0.08 mm long), outer metatarsal tubercle absent; interorbital distance larger than eye horizontal diameter.

Color in life (Image 5)

Dorsal color light to dark brown, with no cross bars on the body; finger discs and toe discs light orange and greyish; dorsal surface of the hindlimb and forelimb with more or less dark crossbars; supratympanic fold black; iris light brown.

Advertisement calls: (Image 3; Table 3)

Fifteen advertisement calls were analyzed from three individuals having SVLs of 18.1, 21.6, and 23.4 mm. The calling position from the ground is observed to be 50–900 cm. The calling males were observed and recorded from trees and grasses near human settlements between 1745 h and 2100 h on 12 August 2023. The ambient air temperature was 28°C and the relative humidity was 99%.

The advertisement call had a mean duration of 0.24 ± 0.02 seconds, with a mean inter–call interval of 0.62 ± 0.09 seconds and an average call repetition rate of 4.17

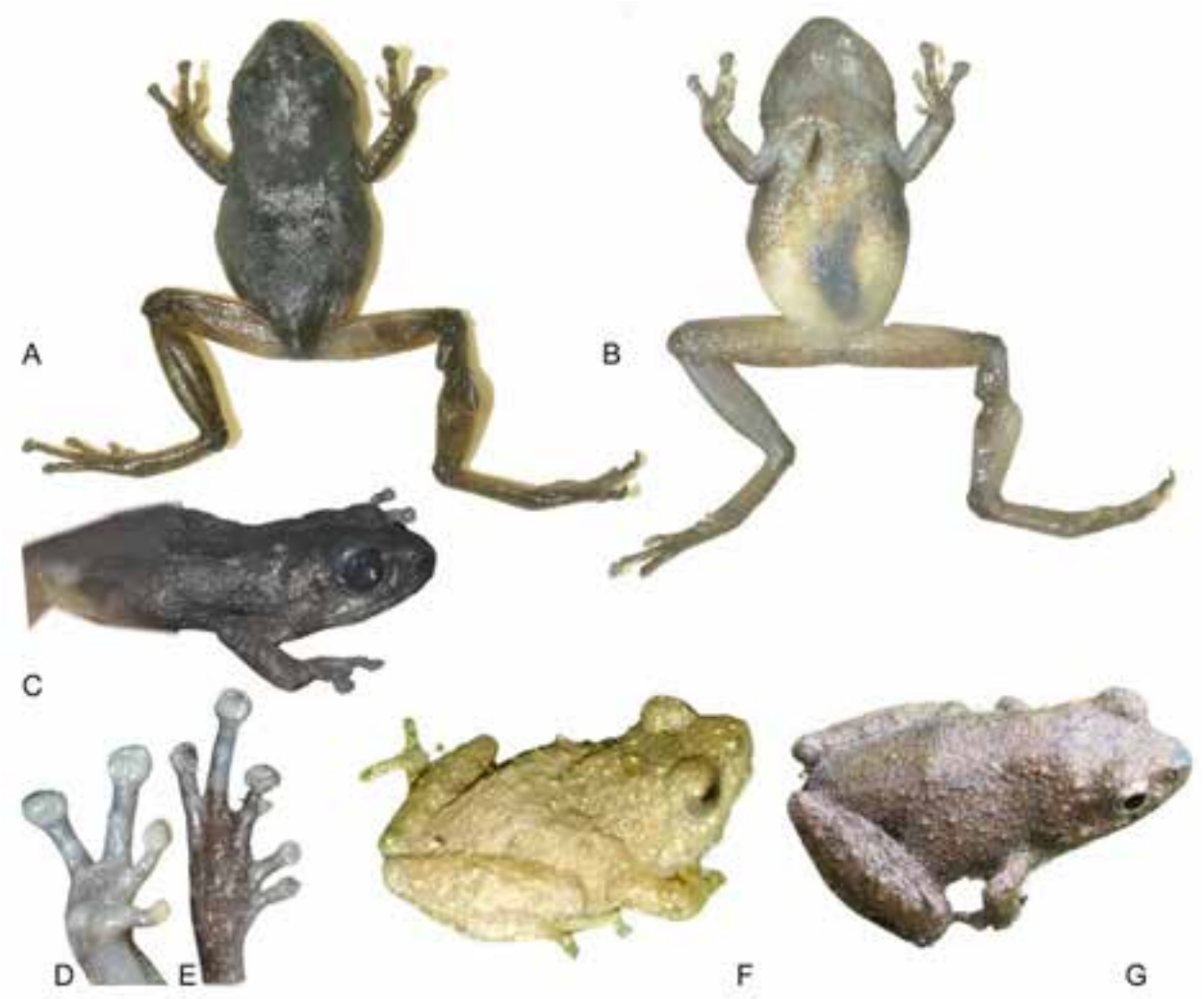

Image 5. *Raorchestes asakgrensis* from Meghalaya, India: A—Dorsal aspect | B—Ventral aspect | C—Lateral aspect | D—Manus | E—Pes | F&G—Live specimens. © Holiness Warjri.

± 0.40 calls per minute. Each call contained an average of 4.0 ± 0.0 notes, with a mean note duration of 0.02 ± 0.003 seconds and a mean inter-note interval of 0.03 ± 0.003 seconds. The call's mean dominant frequency was 3.39 ± 0.04 kHz, ranging 3.36–3.45 kHz, with a coefficient of variation of 0.

***Raorchestes jakoid* sp. nov.**

(Image 3 & 6; Table 1, 3 & 4)

urn:lsid:zoobank.org:act:3240A3E3-FF1C-428C-86D0-E6712B4645CC

Holotype

ADBUHW0143 adult male collected from Lawbah, East Khasi Hills, Meghalaya, India (25.247^0 N, 91.580^0 E, elevation 815 m) on 6 July 2024 at around 1800 h by Holiness Warjri and Rijessing Warjri.

Paratype

ADBUHW0144 an adult male, other data same as holotype.

Etymology

The specific epithet 'jakoid' is derived from the Khasi word for "frog" (jakoid), used by the indigenous Khasi people of Meghalaya, northeastern India. The name is treated as a noun in apposition. This nomenclature honours the rich linguistic and cultural heritage of the Khasi community, and emphasizes the importance of local traditional knowledge in the discovery, and conservation of biodiversity in the Khasi Hills.

Diagnostic characters

While the developmental mode of the newly described species, *Raorchestes jakoid* sp. nov., remains

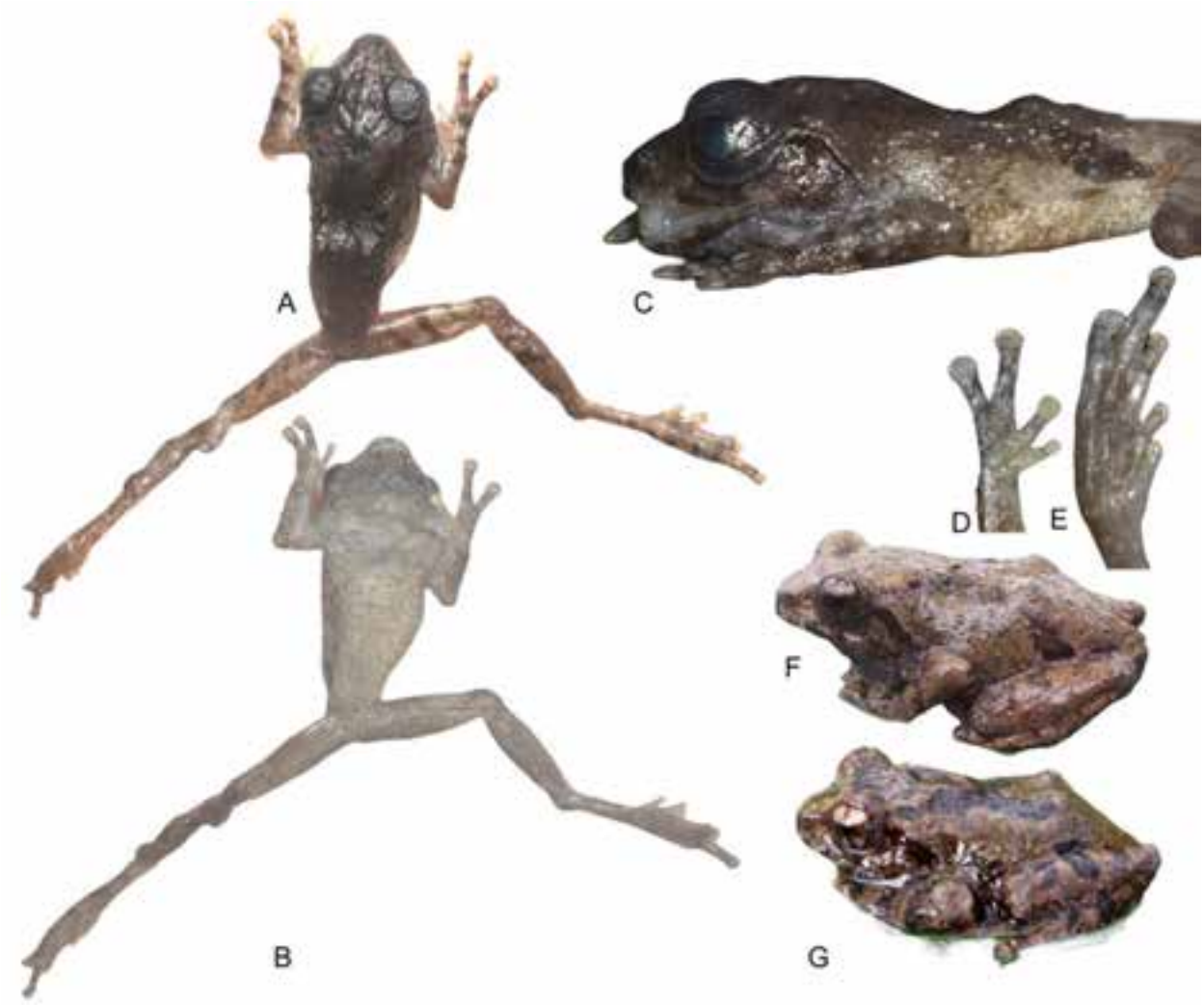

Image 6. *Raorchestes jakoid* sp. nov. from Meghalaya, India [Holotype (ADBUHW0143)]: A—Dorsal aspect | B—Ventral aspect | C—Lateral aspect | D—Manus | E—Pes | F&G—Live specimens. © Holiness Warjri.

uncertain, its placement within the genus *Raorchestes* is supported by the following combination of characteristics: small body size, vomerine teeth absent, male possesses transparent gular pouch which is visible when calling, and tips of all fingers & toes expanded into discs with circum-marginal grooves. The new species is distinguished from relevant congeners by phylogenetic position, by call analysis based on parameters like dominant frequency, call duration, inter-call interval, call repetition rate, number of note, note duration, and inter-note interval, and by the combination of the following morphological characteristics: small body size with SVL of 18.47–21.6 mm; head wider than long; tympanum indistinct, supratympanic fold distinct; tongue pyriform, and notched posteriorly; webbing between fingers absent; rudimentary webbing between toes present; relative finger lengths: I < II < IV < III, relative toe lengths: I < II < III < V < IV; inner palmar tubercle absent and outer palmar tubercle present with round shape; tibiotarsal articulation reaching posterior border of an eye when hindlimb is stretched alongside of body; nuptial pad distinctly whitish in colour; inner metatarsal tubercle oval (IMT/Toe4L 0.07 long), outer metatarsal tubercle absent; body surface slightly rough and has")(" shaped marking; interorbital distance larger than eye horizontal diameter; upper parts with very small warts.

Description of the holotype

(Measurement in mm, Table 1) ADBUHW0143 adult male. Body size is small (SVL 18.47). Head is wider than long (HW/HL 1.36); top of the head is relatively flat; snout is slightly rounded and longer than eye diameter

(SL/ED 1.34); tympanum indistinct; supratympanic fold distinct; canthus rostralis rounded; internarial distance smaller than interorbital distance (IOD/IND 1.03); nostril is positioned slightly closer to the tip of the snout than to the front corner of the eyes (EN/NS 1.17); tongue pyriform and notched posteriorly; vomerine teeth absent; eye diameter small (ED 1.79) and a large external single subgular vocal sac present.

Forelimbs robust; lower arm is longer than the upper arm (LAL/UAL 3.71). Relative finger lengths: I < II < IV < III; tips of all four fingers expanded into discs in which the disc size is I<II<IV<III; webbing between fingers absent; circum-marginal grooves present; outer metacarpal tubercle distinct and rounded; inner metacarpal tubercle indistinct; no webbing between fingers; small nuptial pad present on the dorsal side of the first finger, whitish.

Hindlimb long (23.5); tibia length is longer than foot length (TL/FL 1.14); relative toe lengths: I < II < III < V < IV; tips of toes with discs and smaller than finger discs; rudimentary webbing between toes present (I 1−1 II 1−2.5 III 2−3 IV 3−1 V); inner metatarsal tubercle oval; outer metatarsal tubercle absent; tibio-tarsal articulation reaching the posterior border of an eye when hindlimb is stretched alongside body.

Dorsum is rough with small warts while the ventral regions are granular, the dorsal surface of the head, forelimb, and hindlimb are covered with very small granules. On the ventral side of digits rounded subarticular tubercles having different sizes are present. Relative size of 0.15 (third subarticular tubercles of Fin 3/Fin 3L) is recorded. Surfaces of hands and toes are granular.

Color in life (Image 6)

Dorsal colour light brown, with a black ")(" shaped marking; finger discs and toe discs light orange and greyish; dorsal surface of the hindlimb and forelimb with more or less dark crossbars; supratympanic fold black; iris light brown. The groin is dark and has less visible bands on the upper part of the thigh.

Advertisement calls (Image 3, Table 3)

The calls of two individuals having SVL of 18.5 and 21.6 mm were observed and recorded from small bushes at 1820−2040 h on 6 July 2024. The calling position from the ground is observed to be 100−350 cm. The ambient air temperature was 27°C and the relative humidity was 89%.

The advertisement call had a mean duration of 1.37 ± 0.93 seconds, with a mean inter-call interval of 1.17 ± 0.19 seconds, and an average call repetition rate of 1.07 ± 0.64 calls per minute. Each call contained an average of 17.0 ± 13.31 notes, with the mean note duration being 0.03 ± 0.003 seconds and the mean inter−note interval at 0.04 ± 0.005 seconds. The call's mean dominant frequency was 3.19 ± 0.0 kHz, with a coefficient of variation of 0.

Comparison (see Table 4)

Raorchestes jakoid sp. nov. differs from *R. andersoni* (Ahl, 1927) by 1) tympanum indistinct vs. tympanum distinct in *R. andersoni*; 2) rudimentary webbing between the toes vs. feebly webbed in *R. andersoni*; 3) inner palmar tubercle absent vs. present in *R. andersoni*; 4) outer palmar tubercle present vs. absent in *R. andersoni.*

Raorchestes jakoid sp. nov. differs from *R. annandalii* (Boulenger, 1906) by 1) tympanum indistinct vs. tympanum just distinguishable in *R. annandalii*; 2) rudimentary webbing between the toes vs. webbed at the base of the toe in *R. annandalii*; 3) tibiotarsal articulation reaches the posterior border of the eye vs. the eye in *R. annandalii*; 4) dorsum with small warts vs. smooth in *R. annandalii*; 5) inner palmar tubercle absent vs. present *R. annandalii*; 6) outer palmar tubercle present vs. absent *R. annandalii.*

Raorchestes jakoid sp. nov. differs from *R. dulongensis* Wu, Liu, Gao, Wang, Li, Zhou, Yuan & Che 2021 by 1) SVL of 18.47−21.6 mm vs. 15.0−19.0 mm in *R. dulongensis*; 2) tympanum indistinct vs. tympanum distinct in *R. dulongensis*; 3) nuptial pad present vs. absent in *R. dulongensis*; 4) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. dulongensis*; 5) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. dulongensis*; 6) inner palmar tubercle absent vs. present in *R. dulongensis.*

Raorchestes jakoid sp. nov. differs from *R. hekouensis* Du, Xu, Liu & Yu, 2024 by 1) SVL of 18.47−21.6 mm vs. 16.1–17.5 mm in *R. hekouensis*; 2) tympanum indistinct vs. distinct in *R. hekouensis*; 3) inner palmar tubercle absent vs. present in *R. hekouensis*; 4) outer palmar tubercle present vs. absent in *R. hekouensis*; 5) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. hekouensis.*

Raorchestes jakoid sp. nov. differs from *R. hillisi* Jiang Ren, Guo, Wang & Li 2020 by 1) SVL of 18.47−21.6 mm vs. 15.9−17.7 mm in *R. hillisi*; 2) tympanum indistinct vs. tympanum distinct in *R. hillisi*; 2) webbing formula of I 1−1 II 1−2.5 III 2−3 IV 3−1 V vs. I 1−1 II 1−2.5 III 1−2.5 IV 2.5−1 V of *R. hillisi*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the eye in *R. hillisi*; 4) outer palmar present vs. absent in *R. hillisi.*

Raorchestes jakoid sp. nov. differs from *R. huanglianshan* Jiang, Wang, Ren, and Li 2020 by 1) SVL of

18.47–21.6 mm vs. 17.0–19.6 mm in *R. huanglianshan*; 2) tympanum indistinct vs. distinct in *R. huanglianshan*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the eye in *R. huanglianshan*; 4) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 1–1 II 1–2 III 1–2 IV 2–1 V of *R. huanglianshan*.

Raorchestes jakoid sp. nov. differs from *R. longchuanensis* Yang & Li 1978 by 1) SVL of 18.47–21.6 mm vs. 21.4–23.9 mm in *R. longchuanensis*; 2) tympanum indistinct vs. tympanum distinct in *R. longchuanensis*; 3) inner palmar tubercle absent vs. present in *R. longchuanensis*; 4) relative toe length, I<II<III<V<IV vs. I<II<III ≈ V<IV in *R. longchuanensis.*

Raorchestes jakoid sp. nov. differs from *R. malipoensis* Huang, Liu, Du, Bernstein, Liu, Yang, Yu & Wu 2023 by 1) SVL of 18.47–21.6 mm vs. 14.6–17.7mm in *R. malipoensis*; 2) tympanum indistinct vs. distinct and small in *R. malipoensis*; 3) outer palmar tubercle present vs. absent in *R. malipoensis*; 4) inner metatarsal tubercle oval vs. round in *R. malipoensis*; 5) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. malipoensis*; 6) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. malipoensis*; 7) nuptial pad present vs. absent in *R. malipoensis*; 8) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 2–2 II 2–2 III 2–3 IV 3–2 V of *R. malipoensis*.

Raorchestes jakoid sp. nov. differs from *R. meglaensis* (Kou, 1990) by 1) SVL of 18.47–21.6 mm vs. 16.6–21.6 mm in *R. meglaensis*; 2) inner palmar tubercle absent vs. present in *R. meglaensis*; 3) outer metatarsal tubercle absent vs. present in *R. meglaensis*; 4) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. meglaensis*; 5) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. meglaensis*; 6) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 1–1 II 1–2 III 1–2.5 IV 2.5–1 V of *R. meglaensis.*

Raorchestes jakoid sp. nov. differs from *R. parvulus* (Boulenger, 1893) by 1) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 2–2 II 1.5–3.25 III 2–3.5 IV 3.25–2 V of *R. parvulus*; 2) inner metatarsal tubercle oval vs. small in *R. parvulus*; 3) nuptial pad present vs. absent in *R. parvulus*; 5) inner palmar tubercle absent vs. present in *R. parvulus.*

Raorchestes jakoid sp. nov. differs from *R. rezakhani* Al-Razi, Maria & Muzaffar, 2020 by 1) SVL of 18.47–21.6 mm vs. 18.85–20.90 mm in *R. rezakhani*; 2) supratympanic fold distinct vs. weakly distinct in *R. rezakhani*; 3) nuptial pad present vs. absent in *R. rezakhani*; 4) outer palmar tubercle present vs. absent in *R. rezakhani*; 5) inner metatarsal tubercle present vs. absent in *R. rezakhani*; 5) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. rezakhani*; 6) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 2–2 II 1.75–2 III 1.5–3 IV 2.75–2 V of *R. rezakhani*.

Raorchestes jakoid sp. nov. differs from *R. yadongensis* Zhang, Shu, Liu, Dong & Guo 2022 by 1) SVL of 18.47–21.6 mm vs. 17.8–24.1 mm in *R. yadongensis*; 2) tympanum indistinct vs. distinct in *R. yadongensis*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the snout in *R. yadongensis.*

Raorchestes jakoid sp. nov. differs from *R. mindat* Köhler, Dost, Than, Ohler, Thammachoti Charunrochana, Chuaynkern, Chuaynkern, and Geiss, 2025 by 1) SVL of 18.47–21.6 mm vs. 16.75–18.36 mm in *R. mindat*; 2) inner palmar tubercle absent vs. present in *R. mindat*; 3) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. II 2–3.5 III 2+–3.5 IV 3.25–2 V of *R. mindat.*

Raorchestes jakoid sp. nov. differs from *R. leiktho* Köhler, Dost, Than, Ohler, Thammachoti Charunrochana, Chuaynkern, Chuaynkern, and Geiss, 2025 by 1) SVL of 18.47–21.6 mm vs. 15.72–15.80 mm in *R. leiktho*; 2) supratympanic fold distinct vs. indistinct in *R. leiktho*; 3) inner palmar tubercle absent vs. present in *R. leiktho*; 4) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. III 2–3.5 IV 3.33–2 V of *R. leiktho.*

Furthermore, the new species differs from members of *R. parvulus* species complex, and other bush frogs of Meghalaya as follows:

Raorchestes jakoid sp. nov. differs from *R. garo* by 1) tympanum indistinct vs. tympanum distinct in *R. garo*; 2) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 1–1 II 1–1 III 3–3 IV 3–2.5 V of *R. garo*; 3) dorsum with small warts vs. smooth in *R. garo.*

Raorchestes jakoid sp. nov. differs from *R. kempiae* by 1) SVL of 18.47–21.6 mm vs. 22.96–24.4 mm in *R. kempiae*; 2) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 1–2 II 2–1 III 1.1–3.5 IV 3–2 V in *R. kempiae*.

Raorchestes jakoid sp. nov. differs from *R. shillongensis* (Pillai and Chanda, 1973) by 1) SVL of 18.47–21.6 mm vs. SVL of 10–20 mm of *R. shillongensis*; 2) inner metatarsal tubercle present and oval vs. indistinct in *R. shillongensis*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the tympanic region *R*. shillongensis.

Raorchestes jakoid sp. nov. differs from *R. asakgrensis* by 1) SVL of 18.47–21.6 mm vs. SVL of 18.0–23.35 mm of R. *asakgrensis*; 2) tympanum indistinct vs. distinct in *R. asakgrensis*; 3) webbing formula of I 1–1 II 1–2.5 III 2–3 IV 3–1 V vs. I 1–2 II 2–2 III 2–3.5 IV 3.33–2 V in *R. asakgrensis*

***Raorchestes jadoh* sp. nov.**

(Image 3 & 7; Table 1, 3 & 4)

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Holotype

ADBUHW0124 adult male collected from Langtor, eastern West Khasi Hills, Meghalaya, India (25.533° N, 91.586° E, elevation 1655 m) on 10 May 2024 at around 19:00 h by Holiness Warjri and Rijessing Warjri.

Paratype

ADBUHW0123 an adult male, other data same as holotype.

Etymology

The specific epithet 'jadoh' is derived from the name of a traditional rice and meat dish that is integral to the cuisine and cultural identity of the Khasi people of Meghalaya, northeastern India. The name is used here as a noun in apposition. This naming celebrates Khasi heritage and underscores the connection between local biodiversity and indigenous cultural practices.

Diagnostic characters

While the developmental mode of the newly described species, *Raorchestes jadoh* sp. nov., remains uncertain, its placement within the genus *Raorchestes* is supported by the following combination of characteristics: small body size, vomerine teeth absent, male possess transparent gular pouch which is visible when calling, and tips of all fingers and toes expanded into discs with circum-marginal grooves. The new species is distinguished from relevant congeners by phylogenetic position, by call analysis based on

Image 7. *Raorchestes jadoh* sp. nov. from Meghalaya, India [Holotype (ADBUHW0124)]: A—Dorsal aspect | B—Ventral aspect | C—Lateral aspect | D—Manus | E—Pes | F&G—Live specimens. © Holiness Warjri.

the parameters dominant frequency, call duration, inter-call interval, call repetition rate, number of note, note duration, and inter-note interval, and by the combination of the following morphological characters: very small body size with SVL of 13.68–14.01 mm; head wider than long; tympanum indistinct, supratympanic fold distinct; tongue pyriform and notched posteriorly, webbing between fingers absent; rudimentary webbing between toes present; relative finger lengths: I < II < IV < III, relative toe lengths: I < II < III < V < IV; inner palmar tubercle absent and outer palmar tubercle present with round shape; tibiotarsal articulation reaching posterior border of an eye when hindlimb is stretched alongside of body; nuptial pad present; inner metatarsal tubercle round (IMT/Toe4L 0.08 mm long), outer metatarsal tubercle absent; interorbital distance larger than eye horizontal diameter; upper part with small warts and six fairly distinct warts on the body towards the posterior of the eyes.

Description of the holotype (Measurements in mm, Table 1)

ADBUHW0124 adult male. Body size is very small (SVL 13.68). ADBUHW0124 Head is wider than long (HW/HL 1.39); top of the head is relatively flat; snout is slightly rounded; snout is longer than eye diameter (SL/ED 1.70); tympanum indistinct; supratympanic fold distinct; canthus rostralis rounded; internarial distance smaller than interorbital distance (IOD/IND 1.14); nostril is positioned slightly closer to the tip of the snout than to the front corner of the eyes (EN/NS 1.90); tongue pyriform and notched posteriorly; vomerine teeth absent; eye diameter small (ED 1.69) and a large external single subgular vocal sac present.

Forelimbs robust; lower arm is longer than the upper arm (LAL/UAL 1.74). Relative finger lengths: I < II < IV < III; tips of all four fingers expanded into discs in which the disc size is I<II<IV<III; webbing between fingers absent; circum–marginal grooves present; outer metacarpal tubercle distinct and rounded; inner metacarpal tubercle indistinct; no webbing between fingers; small nuptial pad present on the dorsal side of the first finger, whitish.

Hindlimb long (19.02); tibia length is longer than foot length (TL/FL 1.18); relative toe lengths: I < II < III < V < IV; tips of toes with discs, smaller than finger discs; rudimentary webbing between toes present (I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V); inner metatarsal tubercle round; outer metatarsal tubercle absent; tibiotarsal articulation reaching the posterior border of an eye when hindlimb is stretched alongside body.

Dorsum has small warts and six fairly distinct warts on the body towards the posterior of the eyes. At the same time, the ventral regions are granular the dorsal surface of the head, forelimb, and hindlimb are covered with very small granules; under the digits rounded subarticular tubercles having different sizes are present. Relative size of 0.10 (Third subarticular tubercles of Fin 3/Fin 3L) is recorded; surfaces of palm and sole are granular.

Color in life (Image 7)

Dorsal color light brown, with a black ")(" shaped marking; finger discs and toe discs light orange and greyish; dorsal surface of the hindlimb and forelimb with more or less dark crossbars; supratympanic fold black; iris light brown. The groin is dark and the rear part of the thigh has dark bands.

Advertisement calls: (Image 3; Table 3)

10 advertisement calls were analysed from two individuals having SVL of 13.7 and 14.0 mm. The calling males were observed and recorded from trees & bushes at 1800–2100 h on 17 July 2024. The calling position from the ground is observed to be 20–150 cm. The ambient air temperature at the time of recording was 24°C, with a relative humidity of 89%.

The advertisement call exhibited a mean duration of 0.93 ± 0.22 seconds, with a mean inter-call interval of 6.17 ± 0.54 seconds and an average call repetition rate of 1.12 ± 0.27 calls per minute. Each call contained an average of 3.5 ± 0.58 notes, with the mean note duration being 0.02 ± 0.003 seconds and the mean inter–note interval of 0.30 ± 0.01 seconds. The mean dominant frequency of the call was 3.66 ± 1.32 kHz, ranging 3.56–3.84 kHz, with a coefficient of variation of 3.63.

Comparison: (see Table 4)

Raorchestes jadoh sp. nov. differs from *R. andersoni* by 1) tympanum indistinct vs. tympanum distinct in *R. andersoni*; 2) rudimentary webbing between the toes vs. feebly webbed in *R. andersoni*; 3) inner palmar tubercle absent vs. present in *R. andersoni*; 6) outer palmar tubercle present vs. absent in *R. andersoni.*

Raorchestes jadoh sp. nov. differs from *R. annandalii* by 1) tympanum indistinct vs. tympanum just distinguishable in *R. annandalii*; 2) rudimentary webbing between the toes vs. webbed at the base of the toe in *R. annandalii*; 3) tibio-tarsal articulation reaches the posterior border of the eye vs. the eye in *R. annandalii*; 4) dorsum with small warts vs. smooth in *R. annandalii*; 5) inner palmar tubercle absent vs. present in *R. annandalii*; 6) outer palmar tubercle present vs. absent

in *R. annandalii.*

Raorchestes jadoh sp. nov. differs from *R. dulongensis* by 1) SVL of 13.68–14.01 mm vs. 15.0–19.0 mm in *R. dulongensis*; 2) tympanum indistinct vs. tympanum distinct in *R. dulongensis*; 3) nuptial pad present vs. absent in *R. dulongensis*; 4) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. dulongensis*; 5) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. dulongensis*; 6) inner palmar tubercle absent vs. present in in *R. dulongensis.*

Raorchestes jadoh sp. nov. differs from *R. hekouensis* by 1) SVL of 13.68–14.01 mm vs. 16.1–17.5 mm in *R. hekouensis*; 2) tympanum indistinct vs. distinct in *R. hekouensis*; 3) inner palmar absent vs. present in *R. hekouensis*; 4) outer palmar tubercle present vs. absent in *R. hekouensis*; 5) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. hekouensis*

Raorchestes jadoh sp. nov. differs from *R. hillisi* by 1) SVL of 13.68–14.01 mm vs. 15.9–17.7 mm in *R. hillisi*; 2) tympanum indistinct vs. tympanum distinct in *R. hillisi*; 2) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. I 1–2 II 1–2.5 III 1–2.5 IV 2.5–1 V of *R. hillisi*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the eye in *R. hillisi*; 4) outer metacarpal present vs. absent in *R. hillisi.*

Raorchestes jadoh sp. nov. differs from *R. huanglianshan* by 1) SVL of 13.68–14.01 mm vs. 17.0–19.6 mm in *R. huanglianshan*; 2) tympanum indistinct vs. distinct in *R. huanglianshan*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the eye in *R. huanglianshan*; 4) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. I 1–1 II 1–2 III 1–2 IV 2–1 V of *R. huanglianshan*.

Raorchestes jadoh sp. nov. differs from *R. longchuanensis* by 1) SVL of 13.68–14.01 mm vs. 21.4–23.9 mm in *R. longchuanensis*; 2) tympanum indistinct vs. tympanum distinct in *R. longchuanensis*; 3) inner palmar tubercle absent vs. present in *R. longchuanensis*; 4) relative toe length, I<II<III<V<IV vs. I<II<III ≈ V<IV in *R. longchuanensis.*

Raorchestes jadoh sp. nov. differs from *R. malipoensis* by 1) SVL of 13.68–14.01 mm vs. 14.6–17.7mm in *R. malipoensis*; 2) tympanum indistinct vs. distinctively small in *R. malipoensis*; 3) outer palmar tubercle present vs. absent in *R. malipoensis*; 4) inner metatarsal tubercle round vs. round in *R. malipoensis*; 5) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. malipoensis*; 6) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. malipoensis*; *7)* nuptial pad present vs. absent in *R. malipoensis*; 8) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. I 2–2 II 2–2 III 2–3 IV 3–2 V of *R. malipoensis.*

Raorchestes jadoh sp. nov. differs from *R. meglaensis* by 1) SVL of 13.68–14.01 mm vs. 16.6–21.6 mm in *R. meglaensis*; 2) inner palmar tubercle absent vs. present in *R. meglaensis*; 3) outer metatarsal tubercle absent vs. present in *R. meglaensis*; 4) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. meglaensis*; 5) tibiotarsal articulation reaches posterior border of the eye vs. anterior of the eye in *R. meglaensis*; 6) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. I 1–2 II 1–2 III 1–2.5 IV 2.5–1 V of *R. meglaensis.*

Raorchestes jadoh sp. nov. differs from *R. parvulus* by 1) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. I 2–2 II 1.5–3.25 III 2–3.5 IV 3.25–2 V of *R. parvulus*; 2) inner metatarsal tubercle round vs. small in *R. parvulus*; 3) nuptial pad present vs. absent in *R. parvulus*; 5) inner palmar tubercle absent vs. present in *R. parvulus.*

Raorchestes jadoh sp. nov. differs from *R. rezakhani* by 1) SVL of 13.68–14.01 mm vs. 18.85–20.90 mm in *R. rezakhani*; 2) supratympanic fold distinct vs. weakly distinct in *R. rezakhani*; 3) nuptial pad present vs. absent in *R. rezakhani*; 4) outer palmar tubercle present vs. absent in *R. rezakhani*; 5) inner metatarsal tubercle present vs. absent in *R. rezakhani*; 5) relative toe length, I<II<III<V<IV vs. I<II<V<III<IV in *R. rezakhani*.

Raorchestes jadoh sp. nov. differs from *R. yadongensis* by 1) SVL of 13.68–14.01 mm vs. 17.8–24.1 mm in *R. yadongensis*; 2) tympanum indistinct vs. distinct in *R. yadongensis*; 3) tibiotarsal articulation reaches posterior border of the eye vs. the snout in *R. yadongensis.*

Raorchestes jadoh sp. nov. differs from *R. mindat* by 1) SVL of 13.68–14.01 mm vs. 16.75–18.36 mm in *R. mindat*; 2) inner palmar tubercle absent vs. present in *R. mindat*; 3) inner metatarsal tubercle oval vs. rounded in *R. mindat*; 4) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. II 2–3.5 III 2+–3.5 IV 3.25–2 V of *R. mindat.*

Raorchestes jadoh sp. nov. differs from *R. leiktho* by 1) SVL of 13.68–14.01 mm vs. 15.72–15.80 mm in *R. leiktho*; 2) supratympanic fold distinct vs. indistinct in *R. leiktho*; 3) inner palmar tubercle absent vs. present in *R. leiktho*; 4) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. III 2–3.5 IV 3.33–2 V of *R. leiktho.*

Furthermore, the new species differs from members of *R. parvulus* species complex and other bush frogs of Meghalaya as follows

Raorchestes jadoh sp. nov. differs from *R. garo* by 1) tympanum indistinct vs. tympanum distinct or hidden in *R. garo*; 2) inner metatarsal present vs. indistinct in *R. garo*; 3) webbing formula of I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V vs. I 1–1 II 1–1 III 3–3 IV 3–2.5 V in *R. garo*; 3) tibiotarsal

articulation reaches the posterior border of the eye vs. the anterior of the eye to the snout in *R. garo*; 4) dorsum with small warts vs. smooth in *R. garo.*

Raorchestes jadoh sp. nov. differs from *R. kempiae* by 1) tibiotarsal articulation which reaches the posterior border of the eyes vs. the eye to the snout in *R. kempiae*; 2) webbing formula of I 1−1 II 1−1.5 III 1−3.5 IV 3−1 V vs. I 1−2 II 2−1 III 1−3.5 IV 3−2 V in *R. kempiae*

Raorchestes jadoh sp. nov. differs from *R. shillongensis* by 1) SVL of 13.68−14.01 mm vs. SVL of 10−20 mm of *R. shillongensis*; 2) Inner metatarsal tubercle present and round vs. indistinct in *R. shillongensis*; 3) rudimentary webbing between the toe vs. indistinct rudimentary webbing present between the fourth and fifth toe in *R. shillongensis*; 4) tibiotarsal articulation reaches posterior border of the eye vs. the tympanic region *R. shillongensis.*

Raorchestes jadoh sp. nov. differs from *R. asakgrensis* by 1) SVL of 13.68−14.01 mm vs. SVL of 18.0–23.35 mm of *R. asakgrensis*; 2) tympanum indistinct vs. distinct in *R. asakgrensis*; 3) webbing formula of I 1−1 II 1−1.5 III 1−3.5 IV 3−1 V vs. I 1−2 II 2−2 III 2−3.5 IV 3.33−2 V in *R. asakgrensis*.

Raorchestes jadoh sp. nov. differs from *Raorchestes jakoid* sp. nov. by 1) SVL of 13.68−14.01 mm vs. 18.47–21.6 mm of *R. jakoid*; 2) inner metatarsal tubercle round vs. oval of *R. jakoid*; 3) upper part with small warts and six fairly distinct warts on the body towards the posterior of the eyes vs. small warts randomly distributed in *R. jakoid*; 4) webbing formula of I 1−1 II 1−1.5 III 1−3.5 IV 3−1 V vs. I 1−1 II 1−2.5 III 2−3 IV 3−1 V in *R. jakoid*; 5) call duration of 0.93 ± 0.22 seconds vs. 1.37 ± 0.93 seconds of *R. jakoid*; 6) a mean inter−call interval of 6.17 ± 0.54 seconds vs. 1.17 ± 0.19 seconds of *R. jakoid*; 7) an average call repetition rate of 1.12 ± 0.27 vs. 1.07 ± 0.64 calls per minute of *R. jakoid*; 8) 3.5 ± 0.58 notes vs. 17.0 ± 13.31 notes of *R. jakoid*; 9) note duration 0.02 ± 0.003 seconds vs. 0.03 ± 0.003 seconds of *R. jakoid*; 10) inter note interval of 0.30 ± 0.01 seconds vs. 0.04 ± 0.005 seconds of *R. jakoid*; 11) dominant frequency of 3.66 ± 1.32 kHz vs. 3.19 ± 0.0 kHz of *R. jakoid*; 12) coefficient of variation 3.63 vs. 0 of *R. jakoid.*

DISCUSSION

Prior to this study, the bush frog diversity in Meghalaya was represented by only five species: *R. kempiae*, *R. garo*, *R. annandalii*, *R. shillongensis,* and *R. asakrensis* (Frost 2025). The discovery of two new species from the *R. parvulus* species complex significantly expands the known diversity of bush frogs in this region, highlighting Meghalaya as a hotspot for amphibian speciation. These findings underscore the critical role that northeastern India plays in amphibian biodiversity within the Indo-Burma region, an area known for its complex biogeography and high endemism (Myers et al. 2000).

In this study, in addition to the new species, an additional description for *Raorchestes kempiae, Raorchestes garo*, and *Raorchestes asakgrensis* was given. In *R. kempiae*, the tibiotarsal articulation reaches the eye when the hindlimb is stretched alongside the body, whereas Boulenger (1919) previously described it as reaching the anterior border of the eye. In *R. garo*, tympanum visibility varies. While Boulenger (1919) and Naveen et al. (2024) reported a small and fairly distinct tympanum, the specimens examined in this study exhibit an indistinct tympanum. Additionally, the tibiotarsal articulation extends to the posterior border of the eye when the hindlimb is stretched alongside the body, differing from Boulenger's (1919) observation that it reaches the anterior border of the eye. Similarly, in *R. asakgrensis*, Naveen et al. (2024) documented a fairly visible tympanum, whereas the specimens analyzed in this study exhibit an indistinct tympanum. These variations in morphological characteristics contribute to a deeper understanding of intraspecific variation and potential taxonomic divergence within the genus *Raorchestes*. A recent study on *Raorchestes* of this region also revealed taxonomic inflation as two nominal taxa *Philautus namdaphaensis* and *P. manipurensis* were synonymised under *R. kempiae*, highlighting at the importance of redefining earlier-existing nominal taxa, as a prerequisite to identify new taxa (Naveen et al. 2025).

The distribution of the *Raorchestes* species across a wide range of altitudes, from 200 m (*R. asakgrensis*) to 1800 m (*R. jadoh* sp. nov.), provides valuable insights into habitat specialization and elevational partitioning within the genus. Most species diversity was concentrated between an elevation of 1,000 m and 1,600 m, a pattern observed in other amphibian taxa, where mid-elevation zones provide optimal microhabitats for species diversification (Rahbek 1995; Wu et al. 2021). This concentration of diversity at intermediate elevations is likely driven by the interaction of favourable temperature, humidity, and vegetation cover, which create stable environmental conditions necessary for the persistence of species with specific ecological requirements.

Interestingly, all new species were found in disturbed or secondary habitats near human settlements,

Table 3. Acoustic data of studied species of *Raorchestes* from Meghalaya. India.

Species	Calling position from the ground (cm)	Call Properties						
		Call Duration (s) ±SD (min–max) CV	Inter-call interval (s) ±SD (min–max) CV	Number of notes per call ±SD (min–max) CV	Note duration(s) ±SD (min–max) CV	Call Repetition Rate(calls/min) ±SD (min–max) CV	Inter-note interval(s) ±SD (min–max) CV	Dominant Frequency(kHz)±SD (min–max) CV
Raorchestes garo	50–500	0.03±0.005 (0.02–0.04) 18.2	2.26±0.18 (1.86–2.49) 7.8	1.0±0.0 (1.0–1.0) 0	0.03±0.005 (0.02–0.04) 18.2	35.28±6.15 (25.32–45.66) 17.4	2.26±0.18 (1.86–2.49) 7.8	2.93±0.04 (2.91–3) 1.35
Raorchestes asakgrensis	50–900	0.24±0.02 (0.21–0.28) 10.0	0.62±0.09 (0.5–0.8) 15.3	4.0±0.0 (4.0–4.0) 0	0.02±0.003 (0.02–0.03) 16.7	4.17±0.40 (3.6–4.9) 9.60	0.03±0.003 (0.03–0.04) 10.3	3.39±0.04(3.36–3.45) 0
Raorchestes kempiae	20–400	0.37±0.05 (0.30–0.43) 12.4	1.32±0.11 (1.16–1.46) 8.5	2.0±0.0 (2.0–2.0) 0	0.12±0.008 (0.11–0.13) 6.9	2.73±0.33 (2.32–3.31) 12.3	0.06±0.007 (0.04–0.07) 11.8	2.73±0.03(2.72–2.81) 1.09
Raorchestes jakoid **sp. nov.**	100–350	1.37±0.93 (0.55–2.81) 68.0	1.17±0.19 (0.94–1.51) 15.8	17.0±3.31 (5.0–35.0) 78.3	0.03±0.003 (0.02–0.03) 10.6	1.07±0.64 (0.36–1.81) 59.5	0.04±0.005 (0.03–0.04) 12.4	3.19±0.0
Raorchestes jadoh **sp. nov.**	20–150	0.93±0.22 (0.74–1.13) 23.6	6.17±0.54 (5.36–6.49) 8.8	3.5±0.58 (3.0–4.0) 16.5	0.02±0.003 (0.02–0.03) 12.9	1.12±0.27 (0.89–1.35) 23.6	0.30±0.01 (0.29–0.31) 13.3	3.66±1.32(3.56–3.84) 3.63

suggesting a degree of ecological tolerance. However, this apparent adaptability should not be interpreted as resilience to environmental changes, particularly in a region where habitat degradation from deforestation and agricultural expansion is accelerating. The persistence of these species in human-modified landscapes raises concerns about their long-term survival, given the growing anthropogenic pressures on Meghalaya's forests, wherein over the last 15 years there has been a 6% loss of forest cover in the West Khasi Hills District (Lyngdoh & Lyngdoh 2023).

The broad distribution of *R. asakgrensis* across disparate localities, including localities such as Tura and Lailad, Nongkhyllem, suggests that this species has a wider ecological niche than its congeners. This is in contrast to the more restricted ranges of the other species described in this study, which were confined to higher elevations. The aerial distance between populations of *R. asakgrensis* (approximately 170 km) may indicate either high dispersal ability or the existence of suitable but underexplored habitats between these regions, such as the Garbhanga Reserve Forest and adjacent areas of Assam. Similar patterns of species dispersal across fragmented landscapes have been reported in other *Raorchestes* species complexes, where geographic isolation and habitat fragmentation contribute to both speciation and range limitation (Vijayakumar et al. 2014; Wu et al. 2019).

The onset of calling activity for all species during the late dry season and the early monsoon (April–August) reflects a reproductive strategy synchronized with the arrival of rainfall, a pattern consistent with other *Raorchestes* species across their range (Biju et al. 2010; Vijayakumar et al. 2016). The behaviour of calling males, typically occupying small shrubs and bushes between 1–3 m in height, is a well-documented trait in the genus. The calls of *R. asakgrensis* were notably recorded at higher canopies (up to 9 m), particularly in Lailad, Nongkhyllem. This canopy-calling behaviour may represent a unique adaptation to its low-elevation, forested habitat, distinguishing it from its higher-elevation congeners.

Meghalaya is home to around 70 species of amphibians (including the present finding) of which around 20 (29%) species were discovered or recorded in the current millennium (since the year 2000), highlighting the importance of the study of amphibians in the landscape of Meghalaya in specific and northeastern India in general. Describing new taxa not only highlights diversity but also helps update conservation criteria. An example of the high rate of cryptic diversity is

Table 4. A comparative table of member species of *Raorchestes parvulus* species group and species of bush frogs found in northeastern India.

Character	*R. dulongensis*	*R. meglaensis*	*R. longchuanensis*	*R. parvulus*	*R. malipoensis*	*R. rezakhani*	*R. hillisi*	*R. huanglianshan*	*R. shillongensis*	*R. annandali*	*R. andersoni*	*R. garo*
SVL of male (mm)	15.0–19.0	16.6–21.6	21.4–23.9	NA	14.6-17.7	18.85–20.90	15.9–17.7	17.0–19.6	10–20	16.0	24.0	22.47–23.8
Tympanum	Distinct	Indistinct	Distinct	Hidden	Distinct	Indistinct	Distinct	Distinct	Indistinct	Just distinguish-able	Distinct	Distinct or hidden
Supratympanic fold	Distinct	NA	NA	NA	Distinct	Weakly distinct	Distinct	Distinct	Distinct	NA	NA	Distinct
Nuptial pad	Absent	Present, white	Present	Absent	Present	Absent	Present	Present	NA	NA	NA	Present
Inner palmer tubercle	Present	Present	Present	Present	Absent	Absent	Indistinct	NA	NA	Present	Present	Absent
Outer palmar tubercle	Present	Present	Present	Present	Absent	Absent	Indistinct	NA	NA	Absent	Absent	Present
Inner metatarsal tubercle	Present	Present	Present	Present	Present, round	Absent	Present, Oval		Absent	Absent	Present	Present
Outer metatarsal tubercle	Absent	Present	Absent	Absent	Absent	Absent	Absent	NA	Absent	Absent	Absent	Absent
Toe web	Rudimentary webbing between toes	Toes are partially webbed (II 1 – 2 III 1 – 21/2 IV 21/2 – 1 V)	Toes are partially webbed	Webbed at the base	Rudimentary (I 2 – 2 II 2 – 2 III 2 – 3 IV 3 – 2 V)	Moderate webbing (I2 – 2 II 1¾ – 2 III 1½ – 3 IV 2¾ – 2 V)	No web between toe I and toe II, web rudimen-tary between other toes (II 1 – 2 III 1–21/2 IV 21/2 – 1 V)	Rudimentary web on toes (II 1 – 2 III 1 – 2 – IV 2 – 1 V)	Indistinct rudiment of web present between the fourth and fifth toe	Webbed at the base	Feebly webbed	Webbed at the base (I 1–1 II 1–1 III 3–3 IV 3–2.5 V)
Relative toe length	I < II < V < III < IV	I<II<III ≈ V<IV, or I<II<III<V<IV	I<II<III ≈ V<IV	I<II< III <V<IV	I<II<V<III<IV	I < II < V < III < IV	I < II < III < V < IV	I < II < III < V < IV	I < II < III < V < IV	I < II < III < V < IV	I < II < III = V < IV	I < II < III < V < IV
Tibiotarsal articulation	Reaches anterior of the eye.	NA	NA	Reaches posterior border of the eye.	Reaches anterior border of the eye.	NA	Reaches the eye	Reaches the eye	Reaches the tympanic region	Reaches the eye	Reaches the eye	Reaches the posterior and above the eye
Dorsal surface	Distinct “) (”-shaped dark marking	Rough with small warts, dark butterfly-shaped spot on the back	Scattered small warts and "X" shaped markings	Curved dark band on each side of the back	X-shaped marking on the dorsal surface	“)-(“ or “) (“ shaped blackish mark on the dorsal surface	An indistinct “) (” shaped dark brown blotch on fore part of back.	An indistinct “X” shaped brown blotch on back.	"V" shaped broad light band on the back	Dorsal surface is smooth	Scattered tubercles on the dorsal surface	Dorsal surface is covered with hourglass-shaped blotch covering the head from between the eyes and the back

Table 4 cont. A comparative table of member species of *Raorchestes parvulus* species group and species of bush frogs found in northeastern India.

Character	*P. kempiae*	*R. hekouensis*	*R. yadongensis*	*R. asakgrensis*	*R. mindat*	*R. leiktho*	*R. jakoid* sp. nov.	*R. jadoh* sp. nov.
SVL of male (mm)	22.96 –24.4	16.1–17.5	17.8–24.1	18.0–23.35	16.75–18.36	15.72–15.80	18.47–21.6	13.68– 14.01
Tympanum	Hidden	Distinct	Distinct	Indistinct	Indistinct	Indistinct	Indistinct	Indistinct
Supratympanic fold	Distinct	NA	NA	Distinct	Distinct	Indistinct	Distinct	Distinct
Nuptial pad	Present	Present	Present	Present	Present	Present	Present, whitish	Present
Inner palmer tubercle	Absent	Present	NA	Absent	Present	Present	Absent	Absent
Outer palmar tubercle	Present	Indistinct	NA	Present	Present	Present	Present	Present
Inner metatarsal tubercle	Present	Present, oval	Present	Present, oval	Present, rounded	Present, oval	Present, Oval	Present, round
Outer metatarsal tubercle	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Toe web	Webbed at the base (I 1-2 II 2-1 III 1-3.51 IV 31-2 V)	Rudimentary webbing on toes	Rudimentary webbing	Rudimentary webbing (I 1–2 II 2–2 III 2–3.5 IV 3.33–2 V)	Webbing between toes 1 and 2 vestigial, other rudimentary (II 2–3.5 III 2+–3.5 IV 3.25–2 V)	Webbing between toes 1 and 2 absent, other rudimentary (III 2–3.5 IV 3.33–2 V)	Rudimentary webbing (I 1–1 II 1–2.5 III 2–23 IV 23–1 V)	Rudimentary webbing (I 1–1 II 1–1.5 III 1–3.5 IV 3–1 V)
Relative toe length	I < II < III < V < IV	I < II < III < V < IV	I< II < III < V < IV	I < II < III < V < IV	I < II < III < V < IV	I < II < III < V < IV	I < II < III < V < IV	I < II < III < V < IV
Tibiotarsal articulation	Reaches the eye or the snout	Reaches the anterior of an eye	Reaches the tip of snout.	Reaches anterior border of an eye	Reaches level of posterior margin of the eye	Reaches level of mid eye	Reaches posterior border of the eye.	Reaches posterior border of the eye.
Dorsal surface	Dorsal surface rough with granules with or without hour glass shaped marking	Distinct X-shaped dark brown marking on back		Upper parts with small wartsand with or without ") (" shaped marking.	Body surface with X-shaped markings		Body surface slightly rough with very small warts and has") (" shaped marking	Upper part with small warts and six fairly distinct warts on the body towards the posterior of the eyes. Body also has ")(" shaped marking

Cyrtodactylus khasiensis (Jerdon, 1870) which was thought to be a single species with a distribution of whole of northeastern India and adjacent Myanmar. Current studies (mostly since 2018) have pointed to the fact that *Cyrtodactylus khasiensis* is a species complex currently represented by 35 species of which 26 are endemic to India (Boruah et al. 2024). Most of these species are now found to be point endemic and loss or fragmentation of a small patch of habitat may exterminate the species as a whole (Purkayastha et al. 2020, 2021, 2022; Bohra et al. 2022; Lalremsanga et al. 2022, 2023) Thus, describing such cryptic species has a very important local as well as global conservation implications.

REFERENCES

Biju, S.D. & F. Bossuyt (2009). Systematics and phylogeny of *Philautus* Gistel, 1848 (Anura, Rhacophoridae) in the Western Ghats of India, with descriptions of 12 new species. *Zoological Journal of the Linnean Society* 155(2): 374–444.

Biju, S.D., Y. Shouche, A. Dubois, S.K. Dutta & F. Bossuyt (2010). A ground-dwelling rhacophorid frog from the highest mountain peak of the Western Ghats of India. *Current Science* 98(8): 1119–1125.

Bohra, S.C., H.T. Zonunsanga, M. Das, J. Purkayastha, L. Biakzuala & H.T. Lalremsanga (2022). Morphological and molecular phylogenetic data reveal another new species of bent-toed gecko (*Cyrtodactylus* Gray: Squamata: Gekkonidae) from Mizoram, India. *Journal of Natural History* 56(41–44): 1585–1608. https://doi.org/10.1080/00222933.2022.2119178

Boruah, B., S. Narayanan, N.A. Aravind, S. Lalronunga, V. Deepak & A. Das (2024). Description of six new species of *Cyrtodactylus* Gray (Squamata: Gekkonidae) from northeastern India. *Vertebrate Zoology* 74: 453–486. https://doi.org/10.3897/vz.74.e124752

Boulenger, G.A. (1893). Concluding report on the reptiles and batrachians obtained in Burma by Signor L. Fea dealing with the collection made in Pegu and the Karin Hills in 1887–88. *Annali del Museo civico di storia natural di Genova* 13(Series 2): 304–307.

Boulenger, G.A. (1906). Description of two new Indian frogs. *Journal of the Asiatic Society of Bengal* 2(2): 385–386.

Boulenger, G.A. (1919). Descriptions of three new batrachians from the Garo Hills, Assam. *Records of the Zoological Survey of India* 16: 207–208.

Carranza, S. & E.N. Arnold (2006). Systematics, biogeography, and evolution of *Hemidactylus* geckos (Reptilia: Gekkonidae) elucidated using mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution* 38(2): 531–545. https://doi.org/10.1016/j.ympev.2005.07.012

Crump, M.L. & N.J. Scott, Jr. (1994) Visual encounter surveys, pp. 84–92. In: Heyer, W.R., M.A. Donnelly, R.W. Mcdiarmid, L.C. Hayek & M.S. Foster (ed.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press, Washington, DC, 361 pp.

Das, I., R.K.L. Tron, D. Rangad & R.N.K. Hooroo (2010). A new species of *Leptolalax* (Anura: Megophryidae) from the sacred groves of Mawphlang, Meghalaya, northeastern India. *Zootaxa* 2339: 44–56.

Du, L., Y. Xu, S. Liu & G. Yu (2024). A new species of *Raorchestes* (Anura, Rhacophoridae) from Yunnan Province, China. *ZooKeys* 1192: 213–235. https://doi.org/10.3897/zookeys.1192.106013

Edgar, R.C. (2004). MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* 32(5): 1792–1797. https://doi.org/10.1093/nar/gkh340

Frost, D.R. (2025). Amphibian Species of the World: an Online Reference Version 6.2 (20 July 2025). https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA. https://doi.org/10.5531/db.vz.0001

Garg, S., R. Suyesh, S. Das, M.A. Bee & S.D. Biju (2021). An integrative approach to infer systematic relationships and define species groups in the shrub frog genus *Raorchestes*, with description of five new species from the Western Ghats, India. *PeerJ* 9(e10791): 1–78. https://doi.org/10.7717/peerj.10791

Huang, J., X.L. Liu, L. Du, J.M. Bernstein, S. Liu, Y. Yang, G. Yu & Z. Wu (2023). A new species of bush frog (Anura, Rhacophoridae, *Raorchestes*) from southeastern Yunnan, China. *ZooKeys* 1151: 47–65. https://doi.org/10.3897/zookeys.1151.95616

Jiang, K., J. Ren, J. Wang J. Guo, Z. Wang, Y. Liu, D. Jiang & J. Li (2020). Taxonomic revision of *Raorchestes menglaensis* (Kou, 1990) (Amphibia: Anura), with descriptions of two new species from Yunnan, China. *Asian Herpetological Research* 11(4): 263–281. https://doi.org/10.3897/zookeys.1151.95616

Kalyaanamoorthy, S., B.Q. Minh, T.K. Wong, A.V. Haeseler & L.S. Jermiin (2017). ModelFinder: fast model selection for accurate phylogenetic estimates. *Nature Methods* 14(6): 587–589. https://doi.org/10.1038/nmeth.4285

Kamei, R.G., D.J. Gower, M. Wilkinson & S.D. Biju (2013). Systematics of the caecilian family *Chikilidae* (Amphibia: Gymnophiona) with the description of three new species of *Chikila* from northeast India. *Zootaxa* 3666: 401–435. https://doi.org/10.11646/zootaxa.3666.4.1

Kumar, S., G. Stecher & K. Tamura (2016). MEGA7: molecular evolutionary genetics analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution* 33(7): 1870–1874. https://doi.org/10.1093/molbev/msw054

Lalremsanga, H.T., H. Chinliansiama, S.C. Bohra, L. Biakzuala, M. Vabeiryureilai, L. Muansanga, F. Malsawmdawngliana, G.Z. Hmar, H.T. Decemson, V. Siammawii, M. Das & J. Purkayastha (2022). A new Bent-toed Gecko (*Cyrtodactylus* Gray: Squamata: Gekkonidae) from the state of Mizoram, India. *Zootaxa* 5093(4): 465–482. https://doi.org/10.11646/zootaxa.5093.4.5

Lalremsanga, H.T., Z. Colney, M. Vabeiryureilai, M. Vabeiryureilai, F. Malsawmdawngliana, S.C. Bohra, L. Biakzuala, L. Muansanga, M. Das & J. Purkayastha (2023). It's all in the name: Naming another *Cyrtodactylus* Gray (Squamata: Gekkonidae) from northern Mizoram, northeast India. *Zootaxa* 5369(4): 553–575. https://doi.org/10.11646/zootaxa.5369.4.5

Lambert, M.R.K. (1984). Amphibians and reptiles, pp. 205–227. In: *Sahara Desert. Key Environments.* Cloudsley-Thompson J.L. Pergamon Press, London, 348 pp.

Lyngdoh, E.M. & A.T.G. Lyngdoh (2023). Environmental degradation in West Khasi Hills District, Meghalaya. *International Journal of Ecology and Environmental Sciences* 49: 411–416. https://doi.org/10.55863/ijees.2023.2748

Mahony, S., S. Sengupta, R.G. Kamei & S.D. Biju (2011). A new low-altitude species of *Megophrys* Kuhl and van Hasselt (Amphibia: Megophryidae) from Assam, Northeast India. Zootaxa 3059: 36–46. https://doi.org/10.11646/zootaxa.3059.1.2

Mahony, S., E.C. Teeling & S.D. Biju (2013). Three new species of horned frogs, *Megophrys* (Amphibia: Megophryidae), from northeast India, with a resolution to the identity of *Megophrys boettgeri* populations reported from the region. *Zootaxa* 3722: 143–169. http://doi.org/10.11646/zootaxa.3722.2.2

Mahony, S., R.G. Kamei, E.C. Teeling & S.D. Biju (2018). Cryptic diversity within the *Megophrys major* species group (Amphibia: Megophryidae) of the Asian Horned Frogs: Phylogenetic perspectives and a taxonomic revision of South Asian taxa, with descriptions of four new species. *Zootaxa* 4523: 1–96. https://doi.org/10.11646/zootaxa.4523.1.1

Mathew, R. & N. Sen (2007). Description of two new species of *Xenophrys* (Amphibia: Anura: Megophryidae) from north-east India. *Cobra* 1(2): 18–28.

Mathew, R. & N. Sen (2009). Studies on little known amphibians of Northeast India. *Records of the Zoological Survey of India*. *Occasional Papers* 293: 1–64.

Mathew, R. & N. Sen (2009). Studies on caecilians (Amphibia: Gymnophiona: Ichthyophiidae) of North East India with description of three new species of *Ichthyophis* from Garo Hills, Meghalaya and additional information on *Ichthyophis garoensis* Pillai & Ravichandran, 1999. *Records of the Zoological Survey of India*. Occasional Papers 309: 1–56.

Mathew, R. & N. Sen (2010a). *Pictorial Guide to the Amphibians of Northeast India*. Records of the Zoological Survey of India, 144 pp.

Mathew, R. & N. Sen (2010b). Description of a new species of *Leptobrachium* Tschudi, 1838 (Amphibia: Anura: Megophryidae) from Meghalaya, India. *Records of the Zoological Survey of India* 109: 91–108.

Minh, B.Q., M.A.T. Nguyen & A. von Haeseler (2013). Ultrafast approximation for phylogenetic bootstrap. *Molecular Biology and Evolution* 30(5): 1188–1195. https://doi.org/10.1093/molbev/mst024

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca & J. Kent (2000). Biodiversity hotspots for conservation priorities. *Nature* 403(6772): 853–858. https://doi.org/10.1038/35002501

Naveen, R.S., S.R. Chandramouli, S. Babu, A.M. Ryndongsngi, P.V. Karunakaran & H.N. Kumara (2024). Rediscovery and redescription of *Ixalus garo* Boulenger, 1919, and *Ixalus kempiae* Boulenger, 1919, with a reassessment of the taxonomic status of *Raorchestes cangyuanensis* Wu, Suwannapoom, Xu, Murphy & Che, 2019, and the description of a new species from the Garo Hills of Meghalaya. *Herpetozoa* 37: 359–372. https://doi.org/10.3897/herpetozoa.37.e122825

Naveen R.S., K.P. Nath, H.T. Lalremsanga, K. Deuti, H. Decemson, L. Muansanga, M. Vabeiryureilai, F. Malsawmdawngliana, H. Warjri & J. Purkayastha (2025). A Bush Frog with multiple names: new populations of *Raorchestes kempiae* (Boulenger, 1919) and reassessment of the taxonomic status of *Philautus namdaphaensis* (Sarkar & Sanyal, 1985) and *Raorchestes manipurensis* (Mathew & Sen 2009). *Journal of Asia-Pacific Biodiversity* 18(Pre-proof): 000-000. https://doi.org/10.1016/j.japb.2025.05.003

Nguyen, L.T., H.A. Schmidt, A. von Haeseler & B.Q. Minh (2015). IQ-TREE: a fast and effective stochastic algorithm for estimating maximum-likelihood phylogenies. *Molecular Biology and Evolution* 32(1): 268–274. https://doi.org/10.1093/molbev/msu300

Pillai, R.S. & S.K. Chanda (1973). *Philautus shillongensis*, a new

frog (Ranidae) from Meghalaya, India. *Proceedings of the Indian Academy of Sciences* 78(1): 30–36.

Prasad, V.K., K.B. Gautam & S.K. Gupta (2020). Identification of anuran species diversity of the Panna Tiger Reserve, Central India, using an integrated approach. *Zootaxa* 4851(3): 450–476. https://doi.org/10.11646/zootaxa.4851.3.2

Purkayastha, J. & M. Matsui (2012). A new species of *Fejervarya* (Anura: Dicroglossidae) from Mawphlang, northeastern India. *Asian Herpetological Research* 3: 31–37. https://doi.org/10.3724/SP.J.1245.2012.00031

Purkayastha, J., H.T. Lalremsanga, B. Litho, Y.S. Rathee, S.C. Bohra, V. Mathipi, L. Biakzuala & L. Muansanga (2022). Two new *Cyrtodactylus* (Squamata, Gekkonidae) from Northeast India. *European Journal of Taxonomy* 794: 111–139. https://doi.org/10.5852/ejt.2022.794.1659

Purkayastha, J., H.T. Lalremsanga, S.C. Bohra, L. Biakzuala, H.T. Decemson, L. Muansanga, M. Vabeiryureilai, S. Chauhan & Y.S. Rathee (2021). Four new Bent-toed Geckos *Cyrtodactylus* (Gray: Squamata: Gekkonidae) from northeast India. *Zootaxa* 4980(1): 451–489. https://doi.org/10.11646/zootaxa.4980.3.2

Purkayastha, J., M. Das, S.C. Bohra, A.M. Bauer & I. Agarwal (2020). Another new *Cyrtodactylus* (Squamata: Gekkonidae) from Guwahati, Assam, India. *Zootaxa* 4732(3): 375–392. https://doi.org/10.11646/zootaxa.4732.3.2

Rahbek, C. (1995). The elevational gradient of species richness: a uniform pattern? *Ecography* 18(2): 200–205.

Saikia, B., B. Sinha, A. Shabnam & K.P. Dinesh (2023). Description of a new species of *Amolops* Cope (Anura: Ranidae) from a cave ecosystem in Meghalaya, northeast India. *Journal of Animal Diversity* 5: 36–54. https://doi.org/10.61186/JAD.5.1.36

Sarkar, A.K. & D.P. Sanyal (1985). Amphibia. *Records of the Zoological Survey of India* 82: 285–295.

Seshadri, K.S., K.V. Gururaja & N.A. Aravind (2012). A new species of *Raorchestes* (Amphibia: Anura: Rhacophoridae) from mid-elevation evergreen forests of the southern Western Ghats, India. *Zootaxa* 3410(1): 19–34. https://doi.org/10.11646/zootaxa.3410.1.2

Tamura, K. & M. Nei (1993). Estimation of the number of nucleotide substitutions in the control region of mitochondrial DNA in humans and chimpanzees. *Molecular Biology and Evolution* 10(3): 512–526. https://doi.org/10.1093/oxfordjournals.molbev.a040023

Vijayakumar, S.P., K.P. Dinesh, M.V. Prabhu & K. Shanker (2014). Lineage delimitation and description of nine new species of Bush Frogs (Anura: *Raorchestes*, Rhacophoridae) from the Western Ghats Escarpment. *Zootaxa* 3893(4): 451–488. https://doi.org/10.11646/zootaxa.3893.4.1

Vijayakumar, S.P., R.C. Menezes, A. Jayarajan & K. Shanker (2014). Glaciations, gradients, and geography: multiple drivers of diversification of Bush Frogs in the Western Ghats Escarpment. *Proceedings of the Royal Society B: Biological Sciences* 283(1836): 20161011. https://doi.org/10.1098/rspb.2016.1011

Watters, J.L., S.T. Cummings, R.L. Flanagan & C.D. Siler (2016). Review of morphometric measurements used in anuran species descriptions and recommendations for a standardized approach. *Zootaxa* 4072(4): 477–495. https://doi.org/10.11646/zootaxa.4072.4.6

Wu, Y., C. Suwannapoom, Y. Xu, J. Chen, J. Jin, H. Chen, R.W. Murphy & J. Che (2019). Description of a new species of *Raorchestes* (Anura: Rhacophoridae) from southwestern China. *Zoological Research* 40(6): 558–563. https://doi.org/10.11646/zootaxa.4941.2.5

Wu, Y., S. Liu, W. Gao, Y. Wang, Y. Li, W. Zhou, Z. Yuan & J. Che (2021). Description of a new species of Bush Frog *Raorchestes* from northwestern Yunnan, China. *Zootaxa* 4941(2): 284–300. https://doi.org/10.11646/zootaxa.4941.2.5

Supplement Table 1. Uncorrected pdistance (16s rRNA) amongst the members of *Raorchestes parvulus* species group (Preceding the species name is the GenBank accession number).

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Khasi: Ka jait jakoid *Raorchestes* Biju et al. (2020), kadei kawei na ki jait jakoid ba bun jait hapoh ka longiing Rhacophoridae, ha kaba ki dkhot jong ka ki long ki ba rit, kim don ia ki bniat vomerine, ka jingroi kam da donkam ban heh sha ki dohlun, bad ki don ki tduh kti ba iar. Ka Meghalaya, wat la ka don ha ka jaka ba bun jait ki jingthaw ba im ba ki khot ka Indo-Burma, hynrei ka jingwadbniah ia ka jingbun ki mrad ba im lang ha um bad ha ryngkew (amphibians) ka dang duna. Ha kane ka jingpule, ngin batai ia ki ar tylli ki jait jakoid kiba thymmai, kata u *Raorchestes jakoid* sp. nov. bad u *Raorchestes jadoh* sp. nov., na ki lum khasi jong ka jylla Meghalaya, ba la pynshong nongrim ha ka jing pule kaba pyniasoh lang ia ki jingtip ba iadei bad ka dur ka dar, ka sur pah, bad ki gene (16S rRNA). Nalor kata, ngi ai ki jingbatai ba thymmai naka bynta ki lai tylli kiwei pat ki jakoid kata u *R. kempiae*, u *R. garo*, bad u *R. asakgrensis*, da kaba pynjanai ia ka jingsngewthuh jong ngi shaphang jong ki. Ka jingpeit bniah ia ka jinglong jingman jong kine ki jakoid ka pynskhem ia ka jingbuh ia ki hapoh ka kynhun ba la khot ka *Raorchestes parvulus*. Ia kine ki jakoid ba thymmai la shem hajan ki jaka basah ki briew bad kane ka pyni ia ka jing lah jong ki ban im ha kino kino ki jaka, hynrei ka don ruh ka jingsngewkhia shaphang ka jingim slem jong ki hapdeng ka jingduh stet ia ka jaka shong jaka sah jong ki. La shem ia ki hapdeng ka jing jrong kaba 235m haduh 1,655 m bad kham bun hapdeng ka 1,000-1,600 m. Kine ki jinglap jong ngi ki pyni ia ka jingbun ki mrad kiba pher ha kane ka jaka bad ka donkam kyrkieh ban pynneh pynsah iaki jait mrad ba la khot ha ka phareng herpetofauana, ha ka thain shatei lammihngi jong ka ri India.

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ARTICLE

Cataloguing biodiversity of freshwater communities in two lakes of Gadchiroli area of central India using environmental DNA analysis

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Abstract: We investigated eukaryote biodiversity in two freshwater lakes in the Aashti area of Gadchiroli in central India, using next-generation sequencing-based technology. In this preliminary study, we analyzed four water samples using metabarcoding of the 18s V6 region of mitochondrial DNA, and detected >500 operational taxonomic units (OTUs). We detected algae, dinoflagellates, rotifers, ciliates, and metazoan species and our results indicate that algae and rotifers were the most abundant groups in these lakes.

Keywords: 18S DNA barcoding, alpha diversity, beta diversity, biodiversity, environmental parameters, freshwater ecology, phytoplankton, zooplankton.

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Author contributions: MS, PC, MSP involved in the designing experiments, conduct of experiments, data analysis and manuscript writing. All authors have read and approved the final manuscript.

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INTRODUCTION

Phototrophic algae, heterotrophic protists, rotifers, crustaceans, dinoflagellates, and diatoms usually dominate the freshwater microscopic eukaryotic communities (Manabe et al. 1994; Nishikawa et al. 2010), and play a crucial role in governing the biogeochemical cycles in the lotic and lentic waterbodies (Allan 1976; Gannon & Stemberg 1978). Phytoplankton and zooplankton play essential roles in C and N cycles, and enhance the stability of aquatic ecosystems (Steinberg et al. 2008). Zooplankton directly feeds on phytoplankton and thus contributes to the inhibition of the eutrophic conditions in lakes (Cottenie et al. 2003; Kohout & Fott 2006; Schou et al. 2009). Similarly, many zooplankton are sensitive to anthropogenic stressors, and thus can serve as useful biological indicators of environmental stressors (Beaugrand et al. 2002; Grosjean et al. 2004; Blanco-Bercial & Bucklin 2016). Marine, wetland, and freshwater ecosystems are facing various threats to their stability, including toxicant pollution, nutrient influx, land use, and climate change. It is known that these human activities change the biogeochemical cycles, which in turn change the types of species that live in freshwater ecosystems, and how those ecosystems work (Baldwin et al. 2014; Drake 2014). Anthropogenic activities significantly altered the population dynamics and biodiversity of aquatic habitats (Sala et al. 2000). Conservation efforts are hampered by a lack of detailed information on biodiversity and the rates of species extinction in freshwater ecosystems (Ricciardi & Rasmussen 1999; Pimm et al. 2014). Therefore, protecting the aquatic ecosystems and their biodiversity is of prime importance, and concentrated efforts are required to conserve these precious ecosystems. In this context, documenting the true biodiversity in various ecosystems is essential.

Several studies on cataloguing phytoplankton and zooplankton diversity are available in the literature (Banse 1995; Nogueira 2001; Branco et al. 2002; Neves et al. 2003; Whitman et al 2004; Mageed 2007; Frutos et al. 2009; Suresh et al. 2011; Vanderploeg et al. 2012; Paturej et al. 2017; Gao et al. 2019; Li et al. 2019). Plankton diversity of different aquatic ecosystems has been identified using DNA barcoding (Amaral-Zettler et al. 2009; Bucklin et al. 2019; Machida et al. 2009; Tang et al. 2012; Hadziavdic et al. 2014; Djurhuus et al. 2018; Wangensteen et al. 2018; Berry et al. 2019). Traditional taxonomic methods have been used by Indian researchers to record the different aquatic communities in a number of freshwater habitats (Madhupratap et al. 1981; Mishra et al. 1993; Jha & Barat 2003; Kiran et al. 2007; Kumar et al. 2011; Harney et al. 2013; Smitha et al. 2013; Jyotibabu et al. 2018; Bhattacharya et al. 2015; Manickam et al. 2018). The limitations of traditional taxonomic methods in identifying microscopic forms have hindered the complete elucidation of the true plankton diversity in these freshwater lakes and ponds. Recently, few studies employed DNA barcoding to explore plankton biodiversity (Nair et al. 2015; Govender et al. 2022). Few studies have used metagenomics to identify diversity in freshwater lakes in India. These observations suggest a need for comprehensive studies to identify the biodiversity in freshwater ecosystems of central India. In the current study we used environmental DNA barcoding to catalogue eukaryote diversity in two freshwater lakes from the Gadchiroli area of central India.

MATERIALS AND METHODS

Sampling sites

Two lakes, Chandankhedi Lake 1 (ASL1, 19.709° N & 79.826° E) and Chandankhedi Lake 2 (ASL2, 19.726° N & 79.833° E), are situated near Chandankhedi Village, Ashti area, Gadchiroli District, Maharashtra State of India (Figure 1). The ASL1 and ASL2 are not included in any area that is reserved for biodiversity conservation or privately owned, so no specific permissions were required to conduct the sample collection. The current study did not collect or include any species listed as endangered or protected in species lists. Since the schedule species list of animals does not include the organisms in the plankton sample, no ethical committee approval was required. We followed the collection procedures as outlined in the literature (Harris et al. 2000).

Water samples

We collected a one-liter water sample from three different depths near the lake's periphery (littoral zone) and inside the lake (limnetic zone) in sterile collection bottles and processed it within a day. The three samples collected from the periphery (littoral zone) of each lake were combined and labeled as ASL1P, and ASL2P. Similarly three samples from the interior (limnetic zone) of each lake were combined and labeled as ASL1I, and ASL2I. A total of four samples ASL1P, ASL2P, ASL1I, and ASL2I were processed for metagenomics analysis. Chemical parameters estimated for water samples included hydrogen ion concentration (pH) and total dissolved solids (TDS), recorded using portable meters (Amstat, USA). Other chemical parameters were estimated in

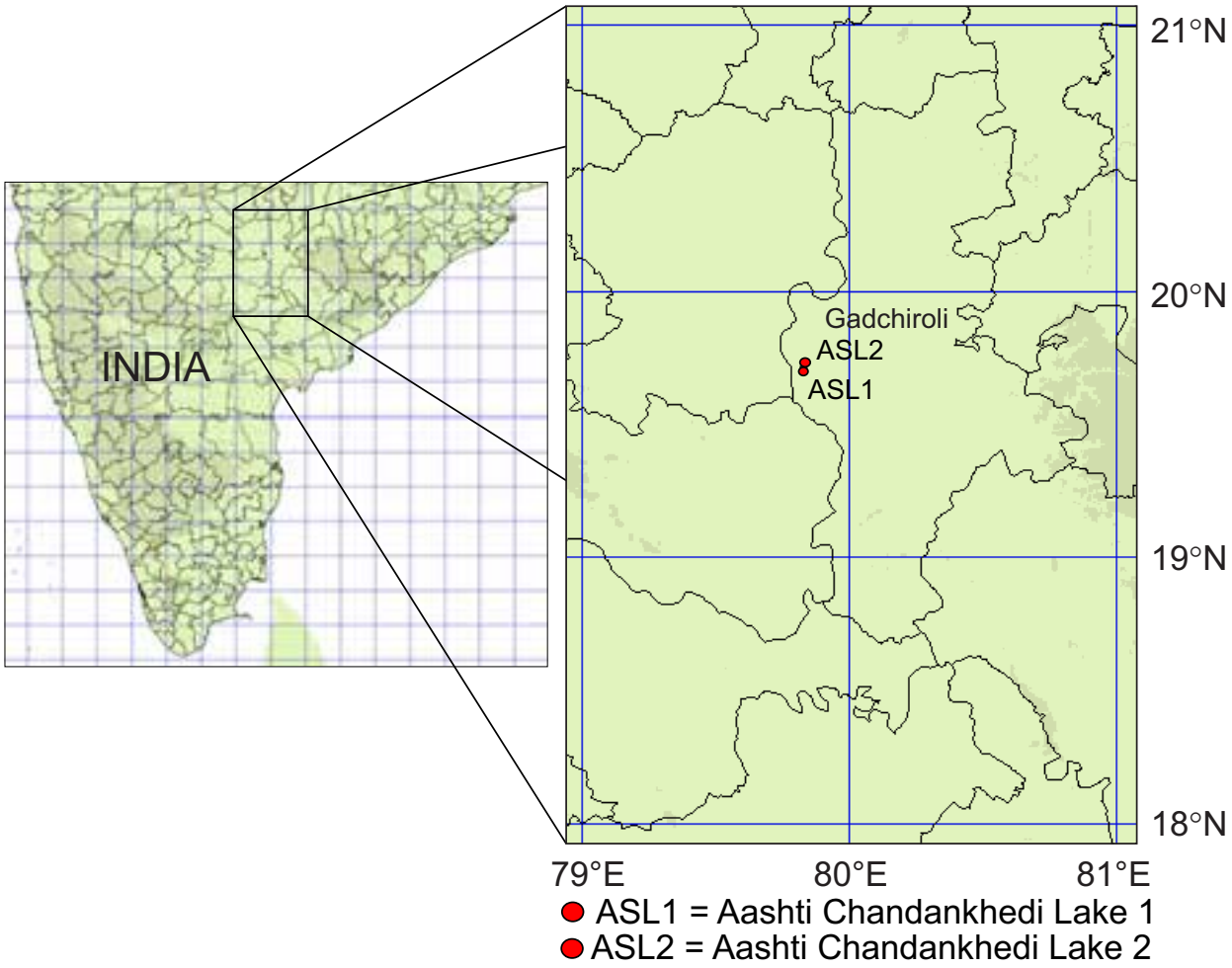

Figure 1. Collection sites: Chandankhedi, Aashti Lake 1 (ASL1), and Chandankhedi, Aashti Lake 2 (ASL2).

the laboratory using standard protocols (APHA 2008). Winkler's method was used to measure dissolved oxygen (DO), and titrimetric methods to measure free CO_2 and total hardness. We estimated total alkalinity using titrimetric methods by combining two values: free CO_2 (carbonate alkalinity) and bicarbonate alkalinity, measured with phenolphthalein, and methyl orange indicators, respectively, and titrating the water sample against N/50 sulphuric acid.

DNA extraction

DNA extraction from the collected samples: ASL1 P (littoral zone) and ASL1 I (limnetic zone) from Chandankhedi Lake 1, and ASL2P (littoral zone) and ASL2I (limnetic zone) from Chandankhedi Lake 2 was performed using the DNA Easy Power Water DNA Isolation Kit (Qiagen, USA). DNA isolation was carried out according to the manufacturers' protocol. The genomic DNA was checked on a 1% agarose gel for the presence of a single intact band. Further, 1 µL of each sample was loaded in a microvolume spectrophotometer for determining the A260/280 ratio (Denovix, USA). The DNA was quantified using a QuantiFluor® ONE dsDNA System (Promega, USA).

Amplification of the 18S rRNA gene and subsequent Illumina sequencing

The amplicon sequencing protocol targeting the V4 region of the 18S gene was used to prepare the sequencing libraries for metagenomics analysis. DNA amplicon libraries were generated according to the guidelines provided by Illumina (http://www.illumina.com). The forward and reverse primers, possessing adapter amplicon lengths compliant with Illumina standards, were produced, and utilized for amplification. The PCR reactions were conducted under these conditions: initial denaturation at 95°C for 15 minutes, followed by 35 cycles consisting of denaturation at 95°C for 45 seconds, annealing at 60°C for 45 seconds, and extension at 72°C for one minute.

The amplification concluded with a final extension phase at 72°C for 10 minutes. The PCR products were purified with a column-based purification kit (Promega, USA), analyzed via gel electrophoresis to confirm size, and quality, and quantified using a QuantiFluor® ONE dsDNA System (Promega, USA). Indexing PCR, ampure bead purification, equimolar pooling, and sequencing on the Illumina 250 PE platform were conducted at the FirstBase DNA Sequencing Service in Malaysia. Libraries were sequenced utilizing the paired-end Illumina 250 PE platform to provide 250 bp paired-end raw reads. The paired-end reads of each sample were cleaned by removing the barcodes and primer sequences, and were merged using FLASH (V1.2.7) (Lozupone et al. 2007). We performed quality cleanup on the raw tags using specific filtering parameters, resulting in high-quality clean tags (Avershina et al. 2013, Qiime (V1.7.0); Magali et al. 2013). The chimeric sequences were eliminated to get high-quality tags for bioinformatics and taxonomic research (Edger et al. 2011).

OTU cluster and taxonomic annotation

Sequence analysis was carried out using all the effective tags employing the Uparse software (Uparse v7.0.1090, Magoč et al. 2011). Sequences having more than 97% similarity were considered as the same OTUs. A representative sequence for each OTU was checked for further annotation. Sequence analysis was carried out using the Qiime RDP method (Version 1.7.0, http://qiime.org/scripts/assign_taxonomy.html; Bokulich et al. 2013). The Silva database (http://www.arb-silva.de; Caporaso et al. 2010) was used for species annotation (Threshold: 0.6~1). Sequences were aligned using MUSCLE (Version 3.8.31, http://www.drive5.com/muscle; Edgar 2013) to obtain phylogenetic relationships. We selected the top 100 genera to understand the phylogenetic relationships. OTU abundance was normalized using a standard of sequence number equivalent to the sample with the least sequences. We performed subsequent analyses of alpha diversity and beta diversity using the normalized data.

Statistical analysis

Alpha diversity indices, observed species, Shannon, ACE, Chao1, Simpson, and good coverage, were calculated using QIIME (Version 1.7.0). We calculated beta diversity on both weighted and unweighted UniFrac using the QIIME software (Version 1.7.0). A square matrix of "dissimilarity" or "distance" was calculated and used for non-metric multidimensional scaling (NMDS) analysis, and principal coordinate analysis (PCoA). AMOVA was estimated by mothur using the amova function. Canonical correspondence analysis (CCA) was performed to understand whether there was any relationship between OTU and the chemical parameters. A scatter plot was graphed to understand the contribution of each CCA axis. The significance of canonical correlations was tested at two levels using 999 permutations (Legendre & Legendre 1998). The significance of the trace value was estimated to test the overall null hypothesis that there is no correlation between the environmental parameters and the species occurrence, and (2) the significance of individual canonical eigenvalues was tested with the same null hypothesis but against the alternate hypothesis that a given eigenvalue explains more of the variation of species occurrence than matrices with permuted rows would.

RESULTS

Assignment of Molecular Operational Taxonomic Units (OTUs)

We generated and sequenced amplicons of the 18S small subunit rRNA gene for each sample. A total of 1,105,618 DNA sequences were generated. After quality control and removal of chimeras, 994,568 good-quality sequences remained (Table 1). The average read length for the sequencing reads was 311 bp. Using a 97% similarity cut-off, the clean read tags were clustered into a total of 642 OTUs. We recorded a total of 568 OTUs in Chandankhedi Lake 1 (ASL1) and 437 OTUs in Chandankhedi Lake 2 (ASL2) (Figure 2 A, Supplementary Information S1). All four samples shared 189 OTUs, while the ASL1 sample had the highest number of unique OTUs (Figure 2B). The ASL1 sample displayed the highest number of unique OTUs (Figure 2B). Of the observed OTUs from two lakes, only 163 were identified at the species level. Arthropoda was the most abundant group, and Rotifera was the second most abundant taxon (Figure 3A). The least diverse taxonomic group was Euglenozoa. Maxillopoda, Monogononta, Chrysophyceae, and Intramacronucleata were the most dominant classes, whereas Calanoida, Cyclopoida, Flosculariaceae, and Ploimida were the most abundant orders in ASL1, and ASL2 (Figure 3B). Calanoida, Cyclopoida, Flosculariacea, and Ploimida were the most dominant families, whereas *Calanoida, Cyclopoida, Flosculariacea,* and *Ploimida were the* most abundant genera (Figure 3C). *Mesocyclops dissimilis, Ptygura libera, Vallisneria natans, Filinia longiseta, Limnias ceratophylli, Nymphoides peltata, Sphaerastrum fockii, and Collotheca campanulata were*

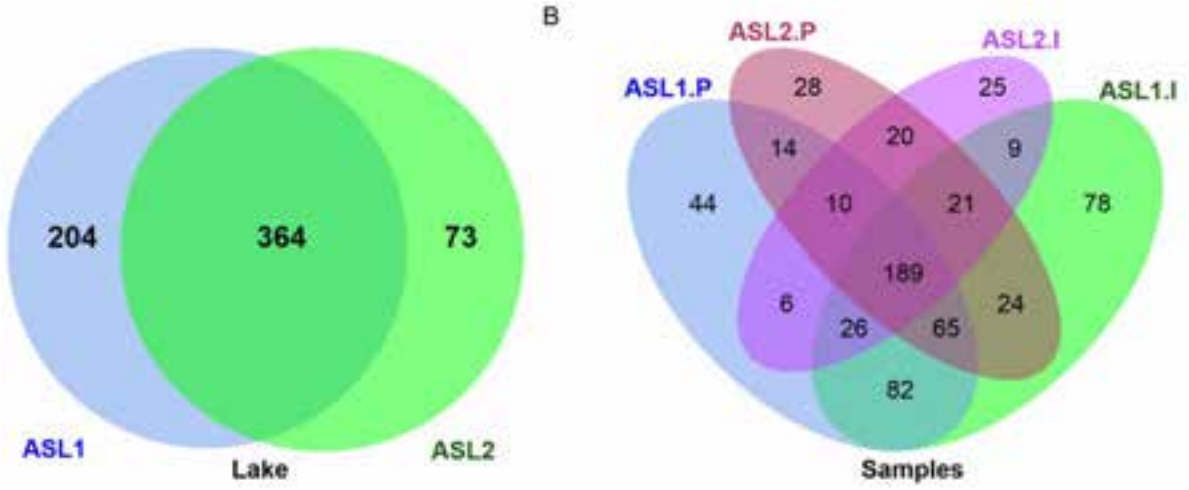

Figure 2. Biodiversity of Chandankhedi, Aashti lakes: A—Venn diagrams illustrating the number of common and unique OTU between Chandankhedi, Aashti Lake 1 (ASL1), and Chandankhedi, Aashti Lake 2 (ASL2) | B—Venn diagrams illustrating the number of common and unique OTU between four samples (ASL1.I, ASL1.P, ASL2.I, and ASL2.P).

Table 1. QC statistics of ASL1 and ASL2 samples.

Sample name	Raw PE(#)	Raw Tags(#)	Clean Tags(#)	Effective Tags(#)	Taxon Tag	Average length (nt)	OUT number	Species	Effective %
ASL1.I	284,836	275,043	273,629	262,811	261716	311	513	494	92.27
ASL1.P	271,293	263,039	261,914	245,710	244777	311	460	436	90.57
ASL2.I	272,095	262,053	260,807	235,995	234697	311	339	306	86.73
ASL2.P	277,394	266,638	265,350	250,052	249131	311	400	371	90.14

the most common species.

Alpha and beta diversity

Alpha and beta diversity analyses of ASL1 and ASL2 sequence reads revealed rich taxonomic diversity and dominance of a few species (Figure. 4, Supplementary Information S2). Shannon's index ranges from 1–1.5, indicating high species richness in the samples collected from these lakes (Figure 4A). Interestingly, samples from ASL1.P (D = 0.296), ASL1.I (D = 0.32), ASL2.P (D = 0.209), and ASL2.I (D = 0.193) showed higher dominance among fewer groups (Figure 4B). The ACE analysis showed that the lake samples had a lot of different species (Figure 4C), and the Chao-1 analysis predicted that these samples would have between 337 and 511 different species (Figure 4D). Alpha diversity indices such as the Shannon index, evenness, and Margalef index were not significantly different between the ASL1 and SL2 lake samples (Mann-Whitney *U* test *P* >0.05 for each comparison). Interestingly, the Simpson index showed a significant difference between ASL1 and ASL2 (Mann-Whitney *U* test, *P* <0.05). Beta diversity analysis indicated that the composition of species in these two lakes is significantly different (Figure 4E; nMDS Stress <0.001). A species accumulation curve showed the presence of 642 OTUs in these lake samples (Figure 4F). The analysis of molecular variance (AMOVA) revealed no significant difference in molecular variance between the samples collected from ASL1 and ASL2 lakes (Fs = 6.72682, p = 0.342).

Correlation between species composition and biochemical characteristics of lakes

The composition and biodiversity of eukaryotes were significantly different among the two lakes (Figure 2). NMDS analysis indicated that biological diversity in these two lakes clearly discriminated from each other (Figure 4E, Trace p <0.01). Proportions of Rotifera, Ochrophyta, Ciliophora, Cryptomycota, Diatomea, Chlorophyta, Phragmoplastophyta, and Peronosporomycetes differed significantly among water bodies. Canonical correspondence analysis suggested that there was a strong correlation between chemical parameters and species occurrence (Figure 5, trace = 0.00087, P = 0.039). The first two axes, which together explained 93.8% of the total inertia, were significant,

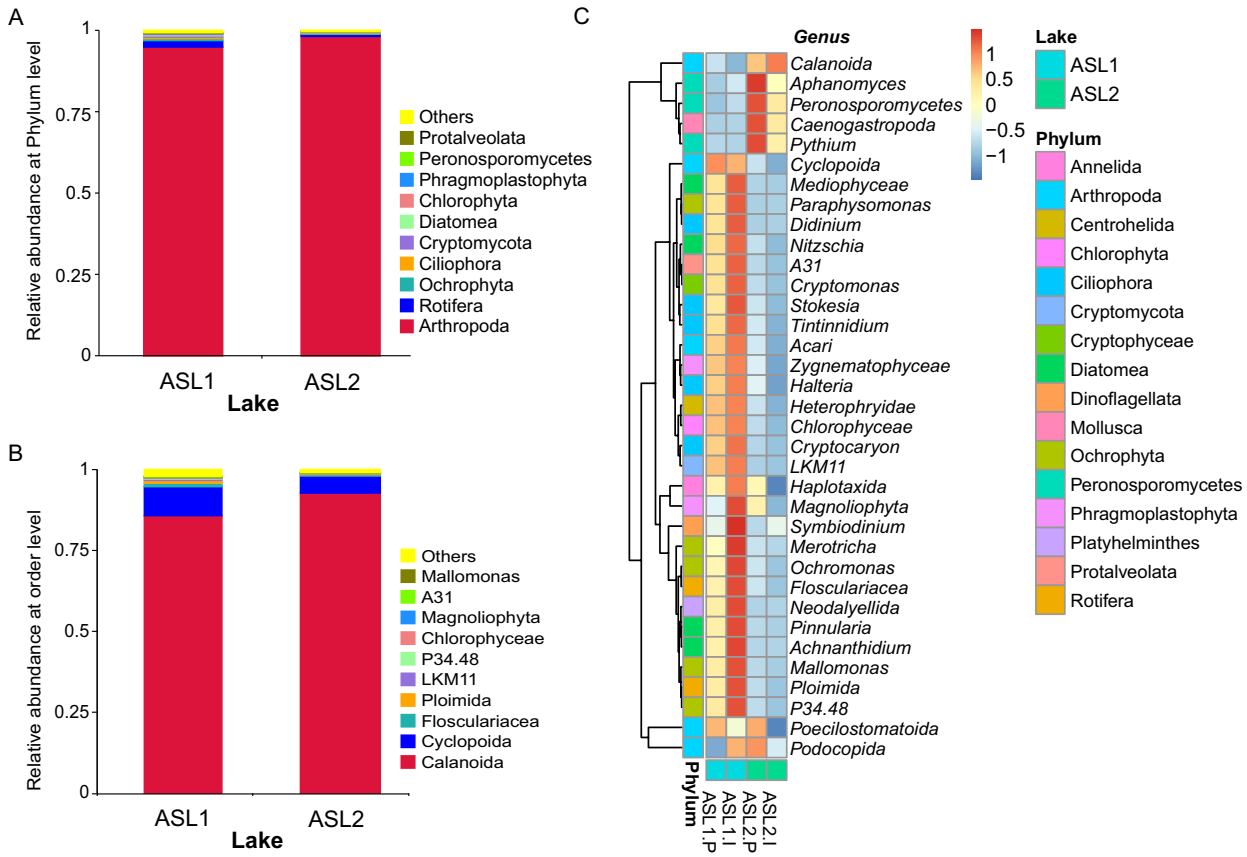

Figure 3. Species composition in Chandankhedi, Aashti Lake 1 (ASL1), and Chandankhedi, Aashti Lake 2 (ASL2): A—Relative abundance of OUT at phylum level | B—Relative abundance of OUT at order level | C—Taxonomic abundance cluster heatmap at genus level: According to abundance information of top 35 genus of all samples, the heatmap was drawn. Sample name on the X-axis and the Y-axis represents the genus. The absolute value of 'z' represents the distance between the raw score and the mean of the standard deviation. 'Z' is negative when the raw score is below the mean, and vice versa.

and depicted the relationship between chemical parameters, and species occurrence. Most species were clustered around the origin of both axes, indicating that they had no particular preference for chemical parameters. Interestingly, only a few species showed a correlation with the chemical parameters of water. For instance, *Bryometopus atypicus, Chloromonas oogama, Malassezia globosa,* and *Cyanophora paradoxa* had preferences for relatively higher values of TDS. *Cloeon durani, Chironomus tentans, Dinobryon sp.,* and *Pinnularia sp.* showed preference for relatively higher values of total hardness, chloride, and dissolved CO2. *Pseudorhizidium endosporangiatum, Trochilia petrani, Furgasonia blochmanni,* and *Pseudocharaciopsis ovalis* showed preference for higher values of dissolved oxygen, and *Ochromonas sphaerocystis, Gieysztoria sp., Linostomella sp.,* and *Chlamydopodium starrii* showed preference for higher values of alkalinity, and salinity.

The evolutionary tree of the top 100 genera

Of the observed OTUs from two lakes, 169 OUT could be identified at genera level. Out of 169 identified genera, the top 100 were used for phylogenetic analysis (Figure 6; Supplementary Information S1). Phylogenetic analysis revealed that more than 90% of OUT reads accounted for five phyla (Calanoida, Cyclopoida, Ploimida, Flosculariacea, Philodinia), suggesting the dominance of a few phyla in ASL1, and ASL2 lakes.

DISCUSSION

Aquatic fauna of freshwater lakes plays a fundamental role in the food web and provides important information about the state of the water body (Manabe et al. 1994; Nishikawa et al. 2010). Several studies have looked at the variety of phytoplankton and zooplankton in freshwater, estuarine, and marine water bodies around the world (Banse 1995; Nogueira 2001; Branco et al.

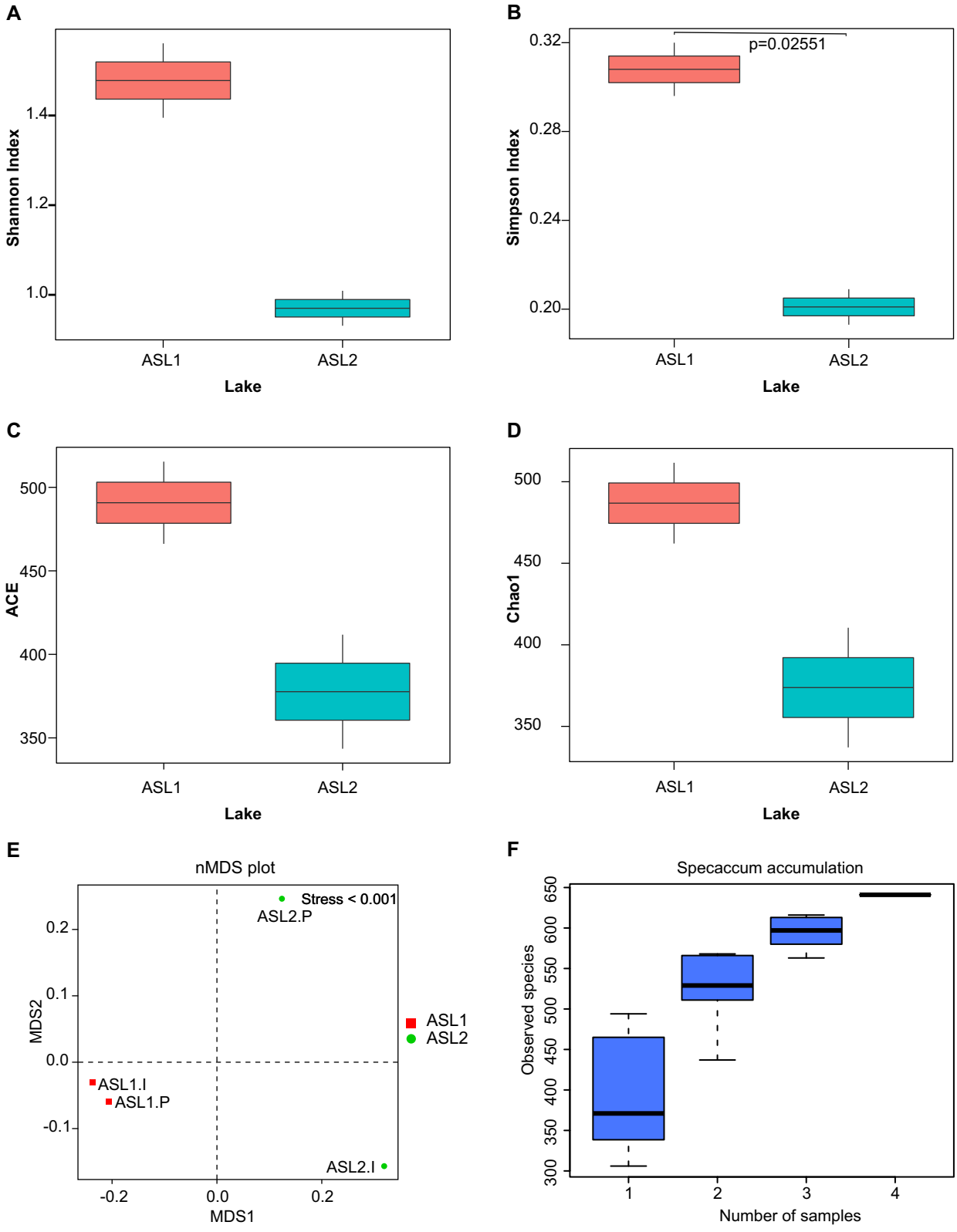

Figure 4. Alpha, beta, and gamma diversity indices: Alpha diversity box plots | A—Shanon index | B—Simpson Index | C—ACE | D—Chao1, Beta diversity plot | E—n MDS plot and gamma diversity plot | F—Species accumulation.

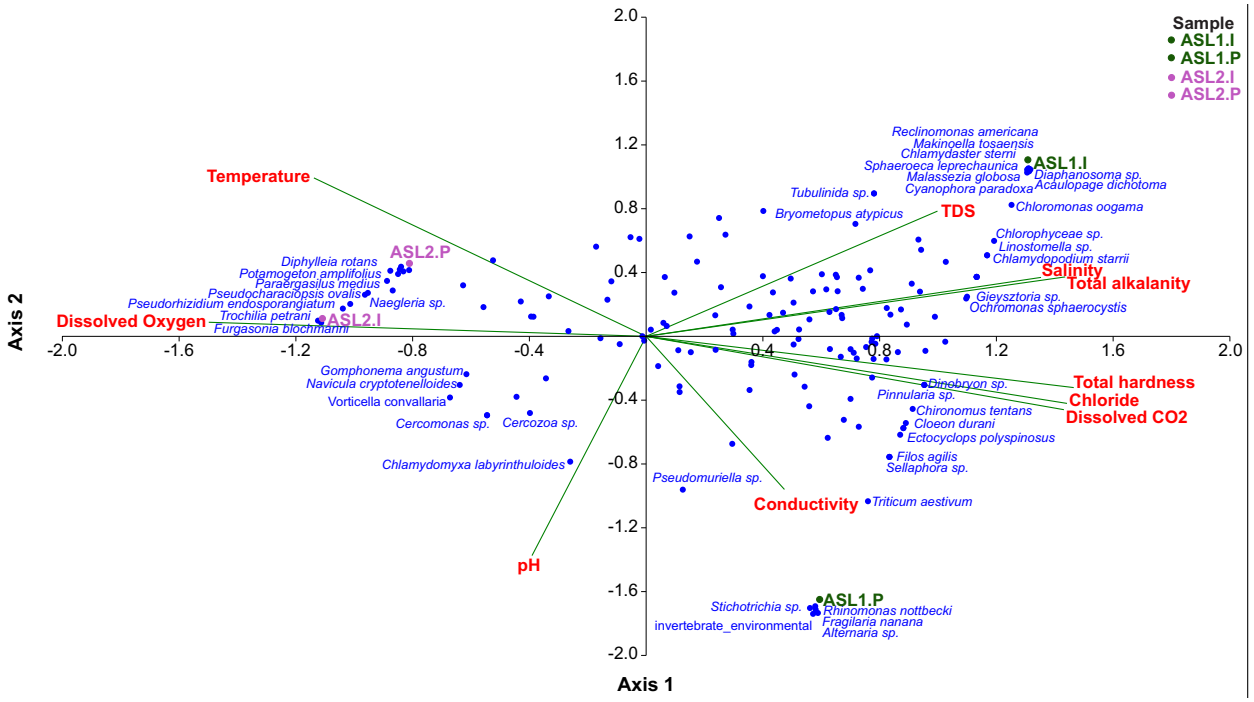

Figure 5. Canonical correspondence analysis (CCA) ordination plot for species composition, samples, and environmental variables.

2002; Neves et al. 2003; Whiteman et al. 2004; Mageed 2007; Frutos et al. 2009; Suresh et al. 2011; Vanderploeg et al. 2012; Paturej et al. 2017; Gao et al. 2019; Li et al. 2019). Several studies in India have catalogued the biodiversity of phytoplankton and zooplankton in rivers, estuaries, and marine habitats (Madhupratap et al. 1981; Mishra et al. 1993; Jha & Barat 2003; Kiran et al. 2007; Kumar et al. 2011; Harney et al. 2013; Smitha et al. 2013; Jyothibabu et al. 2015; Manickam et al. 2018; Bhattacharya et al. 2015). Taxonomic studies of these bodies of water showed that they were home to protozoa, rotifers, copepods, cladocera, ciliophora, and meroplanktons. Similarly, genetic analysis studies also documented the presence of several zooplankton and phytoplankton species in rivers and lakes of India (Nair et al. 2015; Govender et al. 2022).

The main goal of this study was to obtain taxonomic and genetic data for eukaryotes in two freshwater lakes in the Aashti area of Gadchiroli, Maharashtra. The metagenomic analysis of the lakes suggested the presence of a rich eukaryotic community structure. The universality of 18S primers and sample collection methods played a crucial role in documenting the true diversity of the aquatic forms present in the two lakes, ASL1 and ASL2. Rotifera, Cladocera, and Maxillopoda, along with other aquatic organisms, including aquatic Phragmoplastophyta, Platyhelminthes, Ochrophyta, Holozoa, Gastrotricha, Diatoms, Protista, Nematoda, Ciliophora, Diatomea, and Chlorophyta, were predominant in the sampling sites. *Eudiaptomus environmental, Mesocyclops dissimilis, Arthropoda environmental, Neoergasilus japonicus, Microcyclops varicans,* and *Unionicola foili* comprised over 90% of the total numbers of OUT (Figure 6). Rofifers, *Ptygura libera, Filinia longiseta, Limnias ceratophylli,* and *Collotheca campanulata* were abundant in these two lakes. *Vallisneria natans, Nymphoides peltata*, and *Chlamydomonas reinhardtii* dominated the plant species. Diatoms such as *Achnanthidium saprophilum* and *Urosolenia eriensis* were present in good numbers in these two lakes (Figure 6). Although DNA metabarcoding identified more than 600 OTUs in the current study, only 163 OTUs could be identified at the species level. Chao-1 analysis suggested that more than 600 species might be present in the study area. The results obtained in the current study suggest that the ASL1 and ASL2 lakes have high species diversity with a complex community structure (supplementary information, Table S1 and Figure 2), and in-depth taxonomic analysis is required to uncover the true diversity in these two lakes.

Maxillopoda has been considered a bioindicator of environmental fluctuation and ecosystem dynamics (Campos et al. 2017; Jyothibabu et al. 2018). On the other hand, Cyclopoida are capable of surviving in different habitats and maintaining their population size in hostile conditions as well (Paffenhoffer 1993). In these two lakes,

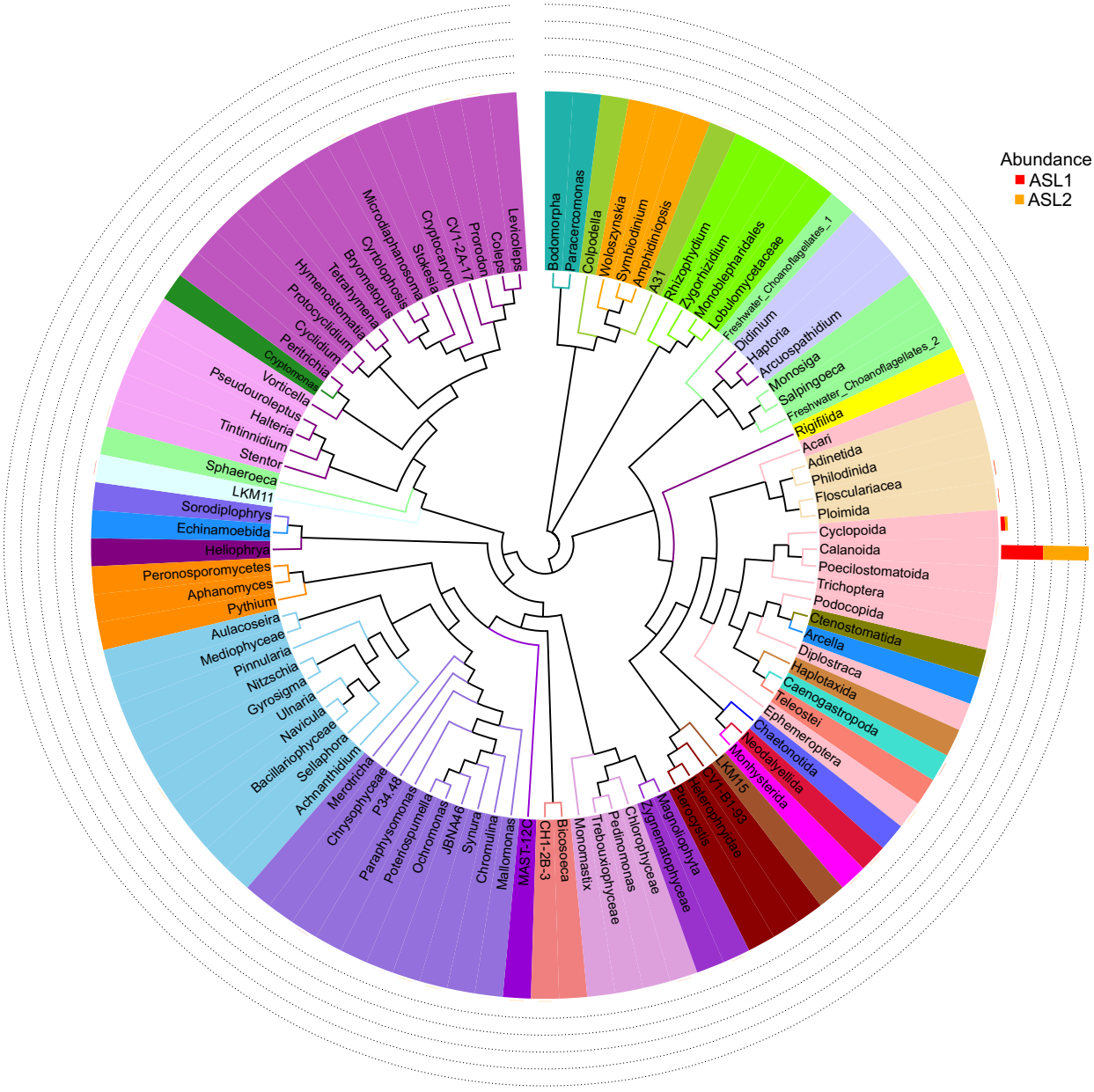

Figure 6. The phylogenetic relationship of genus: the top 100 genera were selected and the evolutionary tree was drawn using the aligned representative sequences. Different colours of the branches represent different phyla. Relative abundance of each genus in each group was displayed outside the circle and different colours represent different groups.

ASL1 and ASL2, Maxillopoda, Calanoida, and Cyclopoida were abundantly present. These observations suggest that these two lakes are experiencing fewer threats from anthropogenic activities. Although the plankton fauna has been recorded from a wide range of environmental conditions, environmental factors such as pH, dissolved oxygen, salinity, and temperature play an important role in determining the accumulation of species (Ahmad et al. 2012). Few species exhibit a profound response to a given factor, while others do not demonstrate any significant response (Figure 5). The results obtained in the current study indicated that environmental variables, dissolved CO_2, total hardness, chloride concentration, TDS, and oxygen concentration have a significant role in determining the species composition.

It has been well documented that temperature plays a crucial role in determining the diversity and abundance of plankton communities. The results obtained in the current study suggest that temperature might not be influencing the species diversity in these two lakes, ASL1

and ASL2 (Figure 5). *Bryometopus atypicus, Chloromonas oogama, Malassezia globosa,* and *Cyanophora paradoxa* showed preference for relatively higher values of TDS. On the other hand, *Cloeon durani, Chironomus tentans, Dinobryon sp,.* and *Pinnularia sp.* showed preference for higher values of total hardness, chloride, and dissolved CO_2. *Pseudorhizidium endosporangiatum, Trochilia petrani, Furgasonia blochmanni,* and *Pseudocharaciopsis ovalis* prefer higher values of dissolved oxygen for survival in lake environments. On the other hand, *Ochromonas sphaerocystis, Gieysztoria sp., Linostomella sp.,* and *Chlamydopodium starrii* showed affinity for higher values of alkalinity, and salinity. The observations corroborate the results obtained in the earlier studies.

The use of the Illumina platform enabled us to detect several operational taxonomic units (OTUs) of eukaryotes using environmental DNA, even though they are available in low abundance in samples. The outcome of this study revealed that we have significantly underestimated plankton diversity in the past due to too much reliance on traditional microscopy-based methods. The results obtained in this study are preliminary in nature and require further investigation.

REFERENCES

Ahmad, U., S. Parveen, H.R.A. Mola, H.A. Kabir & A.H. Ganai (2012). Zooplankton population in relation to physico-chemical parameters of Lal Diggi pond in Aligarh, India. *Journal of Environmental Biology* 33(6): 1015.

Allan, J.D. (1976). Life history patterns in zooplankton. *The American Naturalist* 110: 165–180. https://doi.org/10.1086/283056

Amaral-Zettler, L.A., E.A. McCliment, H.W. Ducklow & S.M. Huse (2009). A method for studying protistan diversity using massively parallel sequencing of V9 hypervariable regions of small-subunit ribosomal RNA genes. *Plos One* 4: e6372. https://doi.org/10.1371/journal.pone.0006372

APHA (2008). *Standard Methods for Examination of Water and Waste Water, 21st Edition*. American Public Health Association, Washington, DC, USA, 1288 pp.

Avershina, E., T. Frisli & K. Rudi (2013). De-novo semi-alignment of 16S rRNA Gene characterization of next generation sequencing data. *Microbes and Environments* 28(2): 211–216. https://doi.org/https://doi.org/10.1264/jsme2.me12157

Baldwin, A., H.K. Jensen & M. Schoenfeldt (2014). Warming increases plant biomass and reduces diversity across continents, latitudes, and species migration scenarios in experimental wetland communities. *Global Change Biology* 20: 835–850. https://doi.org/https://doi.org/10.1111/gcb.2014.20.issue-3

Banse, K. (1995). Zooplankton: pivotal role in the control of ocean production: I. Biomass and production. *ICES Journal of Marine Science* 52: 265–277. https://doi.org/10.1016/1054-3139(95)80043-3

Beaugrand, G., P.C. Reid, F. Ibanez, J.A. Lindley & M. Edwards (2002). Reorganization of North Atlantic marine copepod biodiversity and climate. *Science* 296: 1692–1694. https://doi.org/https://doi.org/10.1126/science.1071329

Berry, T.E., B.J. Saunders, M.L. Coghlan, M. Stat, S. Jarman, A.J. Richardson, C.H. Davies, O. Berry, E.S. Harvey & M. Bunce (2019). Marine environmental DNA biomonitoring reveals seasonal patterns in biodiversity and identifies ecosystem responses to anomalous climatic events. *PLOS Genetics* 15: e1007943. https://doi.org/10.1371/journal.pgen.1007943

Bhattacharya, B.D., J.S. Hwang, S.K. Sarkar, D. Rakhsit, K. Murugan & T. Li-Chun (2015). Community structure of mesozoo-plankton in coastal waters of Sundarban mangrove wetland, India: a multivariate approach. *Journal of Marine Systems* 141: 112–121. https://doi.org/10.1016/j.jmarsys.2014.08.018

Blanco-Bercial, L. & A. Bucklin (2016). New view of population genetics of zooplankton: RAD-seq analysis reveals population structure of the North Atlantic planktonic copepod Centropagestypicus. *Molecular Ecology* 25: 1566–1580. https://doi.org/10.1111/mec.2016.25.issue-7

Bokulich, N.A., S. Subramanian, J.J. Faith, D. Gevers, J.I. Gordan, R. Knight, D.A. Mills & J.G. Caporaso (2013). Quality-filtering vastly improves diversity estimates from Illumina amplicon sequencing. *Nature Methods* 10(1): 57–59. https://doi.org/10.1038/nmeth.2276

Branco, C.W., M.I.A. Rocha, G.F. Pinto, G.A. Gomara, G. Alves & R.D. Filippo (2002). Limnological features of Funil Reservoir (RJ, Brazil) and indicator properties of rotifers and cladocerans of the zooplankton community. *Lakes & Reservoirs: Research & Management* 7: 87–92. https://doi.org/10.1046/j.1440-169X.2002.00177.x

Bucklin, A., H.D. Yeh, J.M. Questel, D.E. Richardson, B. Reese, N.J. Copley & P.H. Wiebe (2019). Time-series metabarcoding analysis of zooplankton diversity of the NW Atlantic continental shelf. *ICES Journal of Marine Science* 76: 1162–1176. https://doi.org/10.1093/icesjms/fsz021

Campos, C.C., T.M. Garcia, S. Neumann-Leitao & M.O. Soares (2017). Ecological indicators and functional groups of copepod assemblages. *Ecological Indicators* 83: 416–426. https://doi.org/https://doi.org/10.1016/ jecolind.2017.08.018

Caporaso, J.G., J. Kuczynski, J. Stombaugh, K. Bittinger, F.D. Bushman, E.K. Costello, N. Fierer, A.G. Peña, J.K. Goodrich, J.I. Gordon & G.A. Huttley (2010). QIIME allows analysis of high-throughput community sequencing data. *Nature Methods* 7(5): 335–336. https://doi.org/10.1038/nmeth.f.303

Cottenie, K., E. Michels, N. Nuytten & L.D. Meester (2003). Zooplankton metacommunity structure: Regional vs. local processes in highly interconnected ponds. *Ecology* 84: 991–1000. https://doi.org/10.1890/0012-9658(2003)084[0991:ZMSRVL]2.0.CO;2

Djurhuus, A., K. Pitz, N.A. Sawaya, J. Rojas-Marquez, B. Michaud, E. Montes, F. Muller-Karger & M. Breitbart (2018). Evaluation of marine zooplankton community structure through environmental DNA metabarcoding. *Limnology and Oceanography: Methods* 16: 209–221.

Drake, B.G. (2014). Rising sea level, temperature, and precipitation impact plant and ecosystem responses to elevated CO2 on a Chesapeake Bay wetland: review of a 28-year study. *Global Change Biology* 20: 3329–3343. https://doi.org/10.1111/gcb.12631

Edgar, R.C. (2013). UPARSE: highly accurate OTU sequences from microbial amplicon reads. *Nature Methods* 10: 996–998. https://doi.org/10.1038/nmeth.2604

Edgar, R., C.B.J. Haas, J.C. Clemente, C. Quince & R. Knight (2011). UCHIME improves sensitivity and speed of chimera detection. *Bioinformatics* 27: 2194–2200. https://doi.org/10.1093/bioinformatics/btr 381

Frutos, S.M., P.D. Neiff & J.J. Neiff (2009). Zooplankton abundance and species diversity in two lakes with different trophic states (Corrientes, Argentina). *Acta Limnologica Brasiliensia* 21(3): 367–375.

Gannon, J.E. & R.S. Stemberger (1978). Zooplankton (especially crustaceans and rotifers) as indicators of water quality. *Transactions of the American Microscopical Society* 1: 6–35.

Gao, Y., Q. Yang, H. Li, X. Wang & A. Zhan (2019). Anthropogenic pollutant-driven geographical distribution of mesozooplankton communities in estuarine areas of the Bohai Sea, China. *Scientific Reports* 9: 1–12. https://doi.org/10.1038/s41598-018-37186-2

Govender, A., J.C. Groeneveld, S.P. Singh & S. Willows-Munro (2022).

Metabarcoding of zooplankton confirms southwards dispersal of decapod crustacean species in the western Indian Ocean. *African Journal of Marine Science* 44(3): 279–289. https://doi.org/10.2989/1814232X.2022.2108144

Grosjean, P., M. Picheral, C. Warembourg & G. Gorsky (2004). Enumeration, measurement, and identification of net zooplankton samples using the ZOOSCAN digital imaging system. *Ices Journal of Marine Science* 61: 518–525. https://doi.org/10.1016/j.icesjms.2004.03.012

Hadziavdic, K., K. Lekang, A. Lanzen, I. Jonassen, E.M. Thompson & C. Troedsson (2014). Characterization of the 18S rRNA gene for designing universal eukaryote specific primers. *Plos One* 9: e87624. https://doi.org/10.1371/journal.pone.0087624

Harney, N.V., A.A. Dhamani & R.J. Andrew (2013). Seasonal variations in the physico-chemical parameters of Pindavani pond of central India. *Science Weekly* 1(6): 1–8.

Harris, R., P.H. Wiebe, J. Lenz, H.R. Skjoldal & M. Huntley (2000). *ICES Zooplankton Methodology Manual*. Academic Press, San Diego, 684 pp.

Jha, P. & S. Barat (2003). Hydrobiological study of Lake Mirik in Darjeeling, Himalaya. *Journal of Environmental Biology* 24(3): 339–344.

Jyothibabu, R., L. Jagadeesan, C. Karnan, N. Arunpandi, R.S. Pandiyarajan & K.K. Balachandran (2018). Ecological indications of copepods to oxygen-deficient near-shore waters. *Ecological Indicators* 93: 73–90. https://doi.org/10.1016/j.ecolind.2018.04.069

Kiran, B.R., E.T. Puttaiah & D. Kamath (2007). Diversity and seasonal fluctuation of zooplankton in fish pond of Bhadra fish farm, Karnataka. *Zoo's Print Journal* 22(12): 2935–2936. https://doi.org/https://doi.org/10.11609/JoTT.ZPJ.1464.2935-6

Kohout, L. & J. Fott (2006). Restoration of zooplankton in a small acidified mountain lake (Plesne Lake, Bohemian Forest) by reintroduction of key species. *Biologia* 61: S477–S483. https://doi.org/10.2478/s11756-007-0065-9

Kumar, C.S. & P. Perumal (2011). Hydrobiological Investigations in Ayyampattinam Coast (Southeast Coast of India) with Special Reference to Zooplankton. *Asian Journal of Biological Sciences* 4(1): 25–34.

Legendre, P. & L. Legendre (1998). *Numerical Ecology. Second Edition*. Elsevier Sciences, Amsterdam, 853 pp.

Li, C., W. Feng, H. Chen, X. Li, F. Song, W. Guo, J.P. Giesy & F. Sun (2019). Temporal variation in zooplankton and phytoplankton community species composition and the affecting factors in Lake Taihua large freshwater lake in China. *Environmental Pollution* 245: 1050–1057. https://doi.org/10.1016/j.envpol.2018.11.007

Lozupone, C.A., M. Hamady, S. Kelley & R. Knight (2007). Quantitative and qualitative β diversity measures lead to different insights into factors that structure microbial communities. *Applied And Environmental Microbiology* 73(5): 1576–1585.

Machida, R.J., Y. Hashiguchi, M. Nishida & S. Nishida (2009). Zooplankton diversity analysis through single-gene sequencing of a community sample. *BMC Genomics* 10: 438. https://doi.org/10.1186/1471-2164-10-438

Madhupratap, M., C.T. Achuthankutty, S.R.S. Nair & V.R. Nair (1981). Zooplankton abundance of the Andaman Sea. *Indian Journal of Marine Sciences* 10: 258–261. http://drs.nio.org/drs/handle/2264/6781

Magali, N.R., O.T. Burton, P. Wise, H. Oettgen, S.K. Mazmanion & T.A. Chatila (2013). A microbiota signature associated with experimental food allergy promotes allergic sensitization and anaphylaxis. *The Journal of Allergy and Clinical Immunology* 131(1): 201–212.

Mageed, A.A. (2007). Distribution and long-term historical changes of zooplankton assemblages in Lake Manzala (south Mediterranean Sea, Egypt). *Egyptian Journal of Aquatic Research* 33: 183–192.

Magoc, T. & S.L. Salzberg (2011). FLASH: fast length adjustment of short reads to improve genome assemblies. *Bioinformatics* 27(21): 2957–2963. https://doi.org/10.1093/bioinformatics/btr507

Manabe, T., M. Tanda, Y. Hori, S. Nagai & Y. Nakamura (1994). Changes in eutrophication and phytoplankton in Harima-Nada — Results of environmental monitoring for 20 years. *Bulletin on Coastal Oceanography* 31: 169–181.

Manickam, N., P.S. Bhavan, P. Santhanam, R. Bhuvaneswari, T. Muralisankar, V. Srinivasan, A. Asaikuttti, G. Rajkumar, R. Udayasuriyan & M. Karthik (2018). Impact of seasonal changes in zooplankton biodiversity in Ukkadam Lake, Coimbatore, Tamil Nadu, India, and potential future implications of climate change. *The Journal of Basic and Applied Zoology* 79: 15. https://doi.org/10.1186/s41936-018-0029-3

Mishra, S., D. Panda & R.C. Panigrahy (1993). Physico-chemical characteristics of the bahuda estuary (Orissa), East coast of India. Indian Journal of Marine Sciences 22: 75–77.

Nair, V.R., F.X. Kidangan, R.G. Prabhu, A. Bucklin & S. Nair (2015). DNA barcode of Chaetognatha from Indian Waters. *Indian Journal of Geo-Marine Science* 44(9): 1366–1376.

Nandy, T. & S. Mandal (2020). Unravelling the spatio-temporal variation of zooplankton community from the river Matla in the Sundarbans Estuarine System, India. *Oceanologia* 62: 326–346. https://doi.org/10.1016/j.oceano.2020.03.005

Neves, I., O. Rocha, K. Roche & A. Pinto (2003). Zooplankton community structure of two marginal lakes of the river Cuiabá (Mato Grosso, Brazil) with analysis of Rotifera and Cladocera diversity. *Brazilian Journal of Biology* 63: 329–343.

Nishikawa, T., Y. Hori, S. Nagai, K. Miyahara, Y. Nakamura, K. Harada, M. Tanda, T. Manabe & K. Tada (2010). Nutrient and phytoplankton dynamics in Harima-Nada, eastern Seto Inland Sea, Japan during a 35-year period from 1973 to 2007. *Estuaries & Coasts* 33: 417–427. https://doi.org/10.1007/s12237-009-9198-0

Nogueira, M.G (2001). Zooplankton composition, dominance and abundance as indicators of environmental compartmentalization in Jurumirim Reservoir (Paranapanema River), São Paulo, Brazil. *Hydrobiologia* 455: 1–18. https://doi.org/10.1023/A:1011946708757

Paffenhoffer, G. (1993). On the ecology of marine cyclopoid copepods (Crustacea, Copepoda). *Journal of Plankton Research* 15(1): 37–55. https://doi.org/10.1093/plankt/15.1.37

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

Putuej, E., A. Gutkowska, J. Koszałka & M. Bowszys (2017). Effect of physicochemical parameters on zooplankton in the brackish, coastal Vistula Lagoon. *Oceanologia* 59: 49–56. https://doi.org/10.1016/j.oceano.2016.08.001

Ricciardi, A. & J. Rasmussen (1999). Extinction rates of North American freshwater fauna. *Conservation Biology* 13(5): 1220–1222. https://doi.org/10.1046/j.1523-1739.1999.98380.x

Sala, O.E., F.S. Chapin, J.J. Armesto, E. Berlow, J. Bloomfield, R. Dirzo, E. Huber-Sanwald, L.F. Huenneke, R.B. Jackson, A. Kinzig, R. Leemans, D.M. Lodge, H.A. Mooney, M. Oesterheld, N.L. Poff, M.T. Sykes, B.H. Walker, M. Walker & D.H. Wall (2000). Global biodiversity scenarios for the year 2100. *Science* 287: 1770–1774. https://doi.org/10.1126/science.287.5459.1770

Schou, M.O., C. Risholt, T.L. Lauridsen, M. Sondergaard, P. Gronkjaer, L. Jacobsen, S. Berg, C. Skov, S. Brucet & E. Jeppesen (2009). Restoring lakes by using artificial plant beds: Habitat selection of zooplankton in a clear and a turbid shallow lake. Freshwater Biology 54: 1520–1531. https://doi.org/https://doi.org/10.1111/j.1365-2427.2009.02189.x

Smitha, S., P. Shivashankar & G.V. Venkataramana (2013). Zooplankton diversity of Chikkadevarayana Canal in relation to physico-chemical characteristics. *Journal of Environmental Biology* 34: 819–824.

Steinberg, D.K., B.V. Mooy, K. Buessler & P. Boyd (2008) Bacterial vs. Zooplankton control of sinking particle flux in the ocean's twilight zone. *Limnology and Oceanography* 53: 1327–1338. https://doi.org/10.4319/lo.2008.53.4.1327

Suresh, S., S. Thirumala & H.B. Ravind (2011). Zooplankton diversity and its relationship with physicochemical parameters in Kundavada

Lake, of Davangere District, Karnataka, India. *ProEnvironment Promediu* 4(7): 56–59.

Tang, C.Q., F. Leasi, U. Obertegger, A. Kieneke, T.G. Barraclough & D. Fontaneto (2012). The widely used small subunit 18S rDNA molecule greatly underestimates true diversity in biodiversity surveys of the meiofauna. *Proceedings of the National Academy of Sciences* 109: 16208–16212. https://doi.org/10.1073/pnas.1209160109

Vanderploeg, H.A., S.A. Pothoven, G.L. Fahnenstiel, J.F. Cavaletto, J.R. Liebig, C.A. Stow, T.F. Nalepa, C.P. Madenjian & D.B. Bunnell (2012). Seasonal zooplankton dynamics in Lake Michigan: disentangling impacts of resource limitation, ecosystem engineering, and predation during a critical ecosystem transition. *Journal of Great Lakes Research* 38: 336–352. https://doi.org/10.1016/j.jglr.2012.02.005

Wangensteen, O.S., C. Palacín, M. Guardiola & X. Turon (2018). DNA metabarcoding of littoral hard-bottom communities: high diversity and database gaps revealed by two molecular markers. *PeerJ* 6: e4705. https://doi.org/10.7717/peerj.4705

Whitman, R.L., M.B. Nevers, M.L. Goodrich, P.C. Murphy & B.M. Davis (2004). Characterization of Lake Michigan coastal lakes using zooplankton assemblages. *Ecological Indicators* 4: 277–286. https://doi.org/10.1016/j.ecolind.2004.08.001

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ARTICLE

Additions to the Agaricales of Kolhapur District, Maharashtra, India

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Abstract: This paper is a part of the series dealing with taxonomy of members of Agaricales from Kolhapur District. In the present investigation 10 species belonging to order Agaricales—*Agrocybe pediades*, *Amanita manicata*, *Bolbitius coprophilus*, *Entoloma serrulatum*, *E. theekshnagandhum*, *Hymenopellis radicata*, *Macrocybe gigantea*, *Schizophyllum commune*, *Termitomyces heimii*, *T. microcarpus*—have been elaborated, of which *A. manicata*, *B. coprophilus, E. serrulatum*, *E. theekshnagandhum*, *M. gigantea* have been reported for the first time from Maharashtra State.

Keywords: Basidiomycota, edible mushrooms, fungal diversity, fungal ecology, macrofungi, new records, taxonomy, Western Ghats, wild mushroom.

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Author contributions: ARP—served as the principal investigator of the study and contributed significantly to the writing and formatting of the manuscript. SIB—was responsible for the collection, identification, and description of the mushroom species, and also assisted in the writing and formatting of the manuscript.

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INTRODUCTION

Agaricales Underw. is the largest order in Agaricomycetes comprise of total eight suborders, 46 families, 482 genera, and more than 40,000 species. Previously, based on the phylogenetic studies Agaricales was divided into seven suborders, viz., *Agaricineae* Aime et al., *Pluteineae* Aime et al., *Tricholomatineae* Aime et al., *Marasmiineae* Aime et al., *Schizophyllineae* Aime et al., *Pleurotineae* Aime et al., and *Hygrophorineae* Aime et al. with one more addition of suborder *Clavariineae* Olariaga by Olariaga et al. in 2020 (Wang et al. 2023). Most species in the Agaricales form mushrooms with gilled hymenophore, pileus, and stipe which play various roles as decomposers, symbionts, and pathogens, helping to maintain the ecosystem. Most species belonging to this order consumed as foods and rich in nutrient supplements and medicines. Taxonomy of the order Agaricales has much debate on identifying species. Traditionally species belonging to the order identified based on their macroscopic and microscopic characteristics, however sometimes these characteristics are often not sufficient to identify Agaricales specimens to the species level. Nowadays, DNA sequence–based classification and identification are now being widely used to overcome the limitations of morphology-based identification (Yoo et al. 2022). Indian Agaricales were first reviewed by Sathe & Rahalkar (1978) and Manjula (1983) who provided a very exhaustive list of agaricoid and boletoid fungi from India and Nepal (Gogoi & Parkash 2015).

Maharashtra is the third largest state of India next to Rajasthan and Madhya Pradesh covering an area of 307,713 km^2. The state lies at 18.96^0 N, 72.82^0 E and altitude ranges 0–1,800 m. The state has ample forest area which occupies approximately one fifth of the state confined to the Western Ghats and eastern Vidarbha region with an annual rain fall of about 4,000 mm in the western region of Western Ghats and about 700–1,250 mm in Vidarbha region (Senthilarasu 2014).

Mycologists paid little attention to the diversity of mushrooms found in Maharashtra. The diversity of mushrooms from Maharashtra was mainly contributed by Blatter (1911), Parandekar (1964), Trivedi (1972), Sathe & Rahalkar (1975, 1976), Narendra & Rao (1976), Thite et al. (1976), Chavan & Barge (1977), Patil & Thite (1977, 1978), Sathe & Sasangan (1977, 1978), Patil (1978), Patil et al. (1979), Sathe & Kulkarni (1979), Sathe & Deshpande (1979, 1980a,b, 1982), Manjula (1983), Bhide et al. (1987), Kulkarni (1990, 1992), Hedawoo & Mohite (2008), Hedawoo (2010), and Senthilarasu (2014).

A detailed checklist of gilled mushrooms from Maharashtra was provided by Senthilarasu (2014), in which 178 species in 68 genera belonging to 23 families and five orders, viz., Agaricales, Boletales, Cantharellales, Polyporales, and Russulales have been reported. Most of the species diversity was published between 1901 and 1992. Since then, there was no report on the taxonomy and diversity of gilled fungi occurring in Maharashtra (Senthilarasu 2014). Borkar et al. (2015) studied Mushroom diversity of Konkan region of Maharashtra and described 21 species belonging to the order Agaricales. Patil & Bornak (2022, 2023) studied diversity of Agaricales from Kolhapur District, Maharashtra and listed 14 species of which one species is new to India and three species are new to Maharashtra State. This paper is the continuation of Agaricales diversity from Kolhapur District.

MATERIAL AND METHODS

Study area

Kolhapur lies in the south-west between 15.716–17.166^0 N and 73.666–74.700^0 E. As a part of Western Ghats, Kolhapur district has ample biodiversity having tropical climate with high rainfall and warm summers. The monsoon rains are due to winds from the southwest as well as north-east with the maximum rainfall of (6,000 mm) in the west to minimum (600 mm) in the east. The district is rich in vegetation cover. The total forest cover in the district is 1,672 km^2, out of which 563 km^2 is reserve forest and 417 km^2 is protected forest. Total forest area is about 22% of the total geographic area of the district. There are three main types of forests: a) subtropical evergreen, b) moist deciduous and semievergreen, and c) dry deciduous forest (Patil & Bornak 2023).

Collection and identification

Frequent trips were made to various localities of Kolhapur district between 2020 and 2023. All the species were collected during the monsoon season. Healthy specimens at different stages of development were collected. Field photographs were taken with the help of Xiaomi Redmi Note 5 Pro and OnePlus 9RT mobile camera to note colour, size, shape, and habitat whereas, odour and other ecological characters were noted down in the field notebook. Microscopic observations of fresh fruiting bodies were done using 1.5% Phloxine B stain and Lawrence and Mayo N-300M research microscope. Dry and wet (70% ethanol) preservation techniques

have been used for collected specimens.

RESULTS

Agrocybe pediades
(Image 1a–h)

(Pers.: Fr.) Fayod in *Ann. Sci. Nat. Bot. Ser*. 79: 359, 1889.

Fruiting body small to medium; **Pileus** up to 1–3 cm in diam., convex, ex-umbonate; surface pale brownish to yellowish-brown, moist, smooth, hygrophanous; margin regular, not splitting at maturity, non-striate; flesh thin, 0.2 cm thick, pale; taste and odour mild. **Lamellae** broadly adnate to sub-decurrent, ventricose, sub-distant to distant, moderately broad, pale brown. **Spore print** dark brown. **Stipe** 3–6 × 0.3 cm, central, cylindrical, slightly bulbous at base, solid, pale brown to brown, with granular texture, shiny. **Basidiospores** 10.2–14.5 × 6.6–9.2 µm, ellipsoidal, with a truncate germ pore, thick–walled, smooth; **Basidia** 22–26.8 × 7.8–10.2 µm, clavate, 4-spored, hyaline, lamella edge sterile. **Cheilocystidia** 16.8–33.5 × 6.6–9 µm, polymorphic, cylindrical, lageniform, thin–walled, hyaline, some with granular apices. **Pleurocystidia** absent. Clamp connections present throughout.

Collections examined

India, Maharashtra, Kolhapur, Bhudargad, Bhendvade, Gadhinglaj–Gargoti Road, (16.309^0 N, 74.181^0 E), on soil mixed in rice husk, gregarious, in cluster, 14.vi.2020, Bornak, S.I. & Patil, A.R. (Y20V1C3); Gaganbawda, Kolhapur–Gaganbawda Road, (16°33’26”N-73°51’11”E), on littered soil, gregarious, 26.vi.2020, Bornak, S.I. (Y20C4V4); Karvir, Rajaram College Campus, (16.686^0 N, 74.256^0 E), on humid soil, in cluster, 12.vii.2020, Bornak, S.I. (Y20V10C3); Karvir, Rajarshi Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur campus (16.687^0 N, 74.261^0 E), on soil, in pair, 07.vii.2022, Bornak, S.I, (Y22V3C9); Karvir, Rajaram College Campus, (16.687^0 N, 74.257^0 E), on soil, under *Gliricidia sepium* tree, in a cluster, 09.vii.2023. Bornak, S.I. (Y23V1C5).

Remarks

Agrocybe pediades, an edible mushroom recognized by its name ‘Common field cap’, is growing gregariously in grassy fields, on lawns, and pasture lands. *A. pediades* is recognized by the smooth pileus surface, which is brownish-yellow with some reddish shades, appendiculate pileal margin and powdery squamulose stipe with scattered remnants of evanescent annulus (Kaur et al. 2014). It is common and distributed worldwide and seems to be a problematic species. Many authors designate several species to *A. pediades* based on morphological characters such as pileus colour, viscidity, amount of veil, shape of pileus, spore size, although morphological studies have demonstrated most species to be synonymous or varieties within *A. pediades* (Niveiro et al. 2020). *A. pediades* is highly prized due to its edibility. The known Indian distribution of this species is Kerala, some parts of northern India and Punjab (Kaur et al. 2014). From Maharashtra this species has been reported from Pune (Senthilarasu 2014).

***Amanita manicata* (Berk. & Broome) Pegler**
(Image 2a–h)

Kew Bull., Addit. Ser. 12: 216 (1986).

Pileus 6–10 cm, fleshy, initially hemispherical, then convex to completely flat, whitish to creamy white, wrapped in a general grainy-greasy veil, the ochraceous orange colour that covers it entirely when young, but subsequently thins out in patches, leaving the underlying parts uncovered and clear. Margin smooth, not striated, strongly appended by triangular flap like remnants of the partial veil, then completely naked at maturity. **Lamellae** adnate to adnexed, low and only slightly ventricose, crowded, white to whitish pink, up to 10 mm broad with short lamellulae. **Stipe** 7–16 × 0.8–1.6 cm, cylindrical, solid, typically sinuous in the median part with rounded base, sub–clavate. Smooth above the ring, below entirely covered by ochre-orange coloured, large, fibrillose-hairy scales. Stipe is concolourous with the pileus surface. Flesh white, 1 cm thick, with strong unpleasant odour. **Basidiospores** 5.6–8.0 × 5.0–7.8 µm, globose to sub-globose, few broadly ellipsoidal, amyloid, smooth. **Basidia** 40–56 × 9–11 µm, tetrasporic cylindrical-clavate. **Cheilocystidia** and **pleurocystidia** absent.

Collection examined

India, Maharashtra, Kolhapur, Rajarshi Chhatrapati Shahu Maharaj College of Agriculture (16.684^0 N, 74.261^0 E), on ground, alone, scattered, 07.vii.2022, Bornak, S.I. (Y22V4C1)

Remarks

A. manicata can be easily recognized by its yellowish-brown to pale tawny brown pileus covering with floccoso-verrucose to felty squamules; margin appendiculates with large floccose fragments which hang down up to 2 cm; the cylindrical stipe covering with tawny brown floccoso-squamose which becomes more intense and

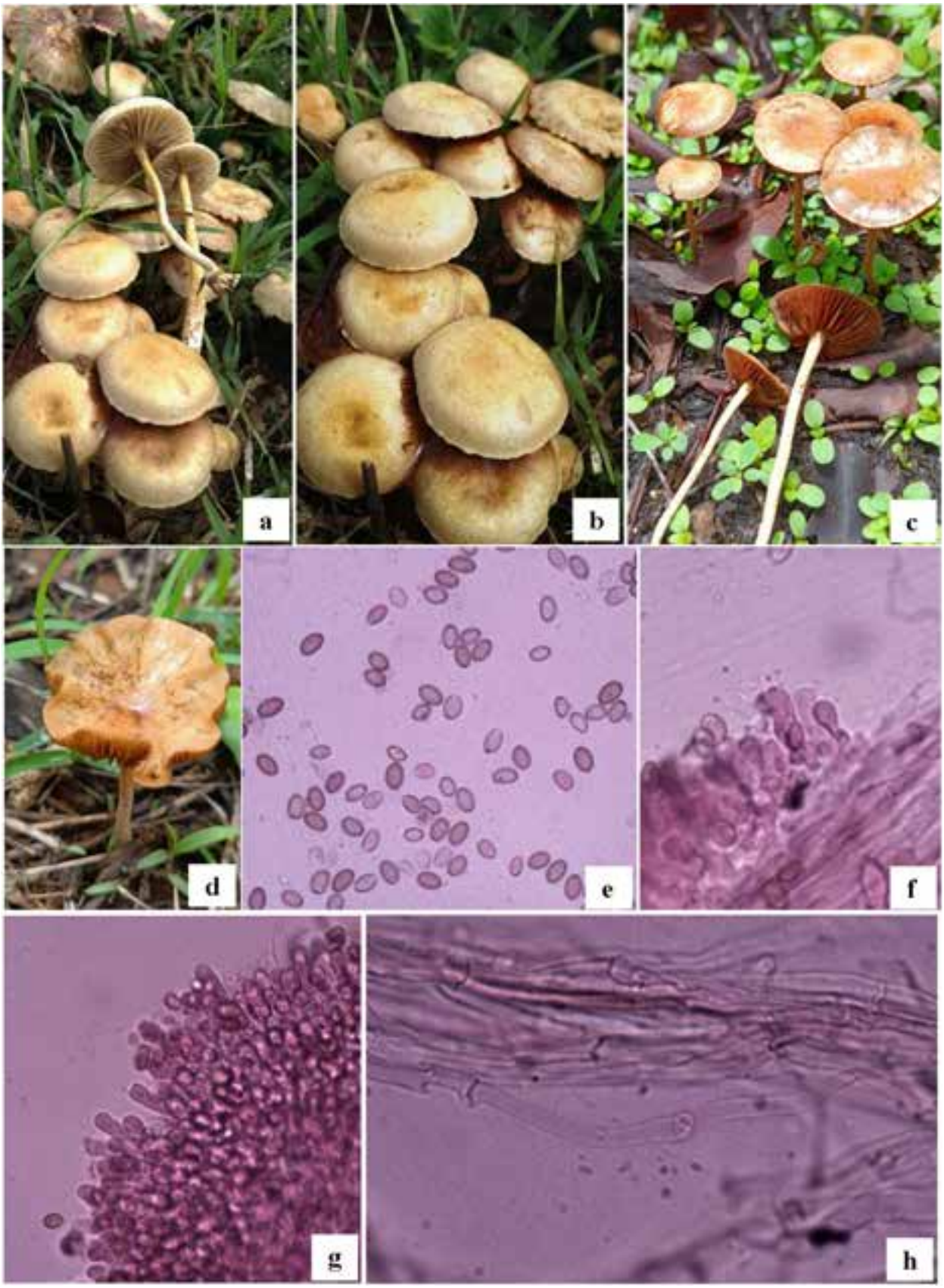

Image 1. *Agrocybe pediades* (Pers.: Fr.) Fayod.: a–d—Basidiomes in their natural habitat | e—Basidiospores 40x | f–g—Basidia with basidioles 40x | h—Pileipellis hyphae with clamp connections 40x. © Sushant Ishwar Bornak.

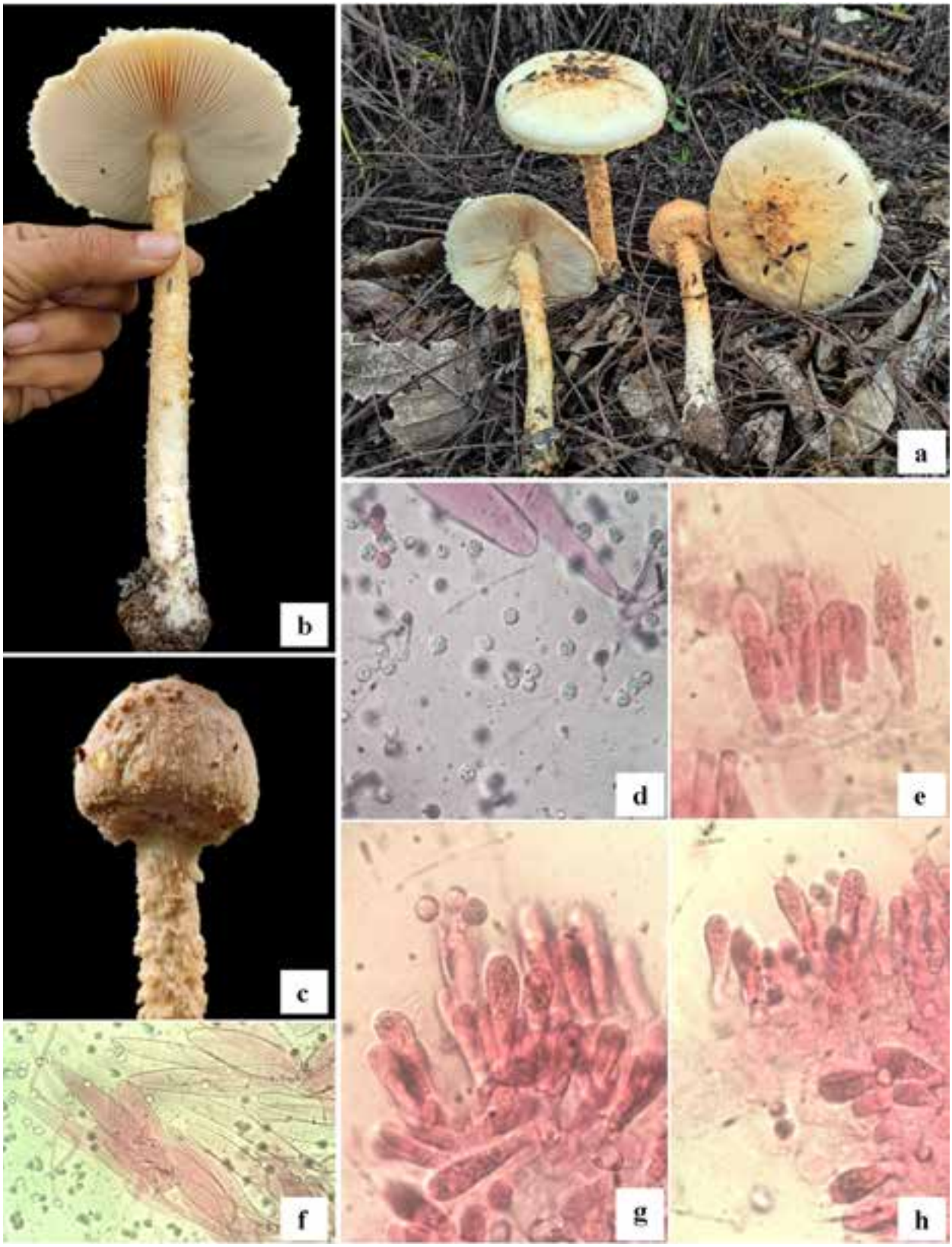

Image 2. ***Amanita manicata*** **(Berk. & Broome) Pegler: a–c—Basidiomes in their natural habitat | d—Basidiospores 40x | e—Basidia 40x | f—Pileipellis 40x | g–h—Basidia with basidioles 40x. © Sushant Ishwar Bornak.**

thicker as upwards; the cream to whitish or pinkish tint lamellae; the subglobose and amyloid basidiospores (Liu et al. 2022) This species has been described from Karnataka, India (Kantharaja & Krishnappa 2022). This is the first report from Maharashtra State.

***Bolbitius coprophilus* (Peck) Hongo**
(Image 3a–i)

Mem. Fac. Lib. Arts Educ., Shiga University, Nat. Sci. 9: 82, 1959.

Fruiting body small to medium, 3–20 cm in height. **Pileus** 2.5–6 cm in diam., campanulate when young, conical at maturity, becoming applanate; umbonate, umbo broad, reddish-brown to pale brown to brown; slightly pinkish when young, surface viscid, smooth, fragile, margin irregular, pellucid, striate, splitting at maturity; flesh thin; **Lamellae** free, unequal, crowded, narrow to moderately broad, white to pale yellow when young, grayish-brown to brown at maturity, fragile; gill edges curled with age. **Stipe** central, 3–18 × 0.4–0.6 cm broad, tubular, with slightly swollen base, hollow, surface pale yellow, unchanging, with pinkish excludes on surface when mature, pruinose–fibrillose, delicate, shiny, silky. **Basidiospores** 10.5–16 × 8–10 mm, ellipsoidal to ovate, truncated by a broad germ pore, thick-walled, smooth, yellowish-brown. **Basidia** 18–30 × 9.5–14.8 mm, clavate to cylindrico-clavate, thin walled, 2–4 spored; **Lamella edges** sterile. **Cheilocystidia** 25–35.5 × 7.6–18.5 mm, cylindrical, clavate-vesiculose, thin-walled, hyaline. **Pleurocystidia** not observed. **Pileipellis** hymeniform, 18–45 × 8–12 mm, inflated, clavate, thin walled, hyaline; clamp connections absent.

Collection examined

India, Maharashtra, Kolhapur, Karvir, Parite, Kolhapur–Radhanagari road (16.542^0 N, 74.115^0 E), on rice husk, alone, solitary, scattered, 16.vii.2023, Bornak, S.I. (Y23V6C3).

Remarks

B. coprophilus is characterized by a broad pileus which is pale with a distinct pinkish tinge and a pileal shape that varies from convex or campanulate when young and flat at maturity; the gills are free and non-deliquescent and the basidiospores are ellipsoid to ovoid. This species prefers to grow on organic substrates that are rich in nutrients, such as dung or compost (Usman et al. 2022). *B. coprophilus* was originally described from North America by Hongo in 1959. After that several investigations were made from various regions of the world viz. dung heaps in New York; wheat fields in England; horse and deer dung mixed with straw in Denmark, Italy; scattered on cow dung, compost, and rice straw in Singapore; compost and wheat straw in Argentina, Europe, and Poland; horse dung in France and Austria; straw, dung, and compost in Russia (Usman et al. 2022). *B. coprophilus* has been previously reported from India on elephant dung in Kerala (Thomas et al. 2001; Manimohan et al. 2007) and from Punjab by Amandeep et al. (2013). There is no report of this species from Maharashtra state. Thus, this is a first report from Maharashtra State.

***Entoloma serrulatum* (Fr.) Hesler**
(Image 4a–e)

Beih. Nova Hedwigia 21: 140 (1967).

Fruit body small to medium; **Pileus** 0.8–5 cm, dark bluish-purple, velvety when young becoming greyish-blue on maturity, silky, convex, centrally depressed when mature with incurved margin. **Lamellae** creamish-pink to pale blue, adnate, narrow and moderately crowded. **Stipe** 1.5–4.5 × 0.2–0.5 cm, bluish-grey, base cream, central, cylindrical, smooth, hollow. **Basidiospores** 7–11 × 5.8–7.5 µm, hyaline, angular, pentagonal. **Basidia** 26–34 × 9–11 µm, clavate, 4- spored. **Cheilocystidia** 35–60 × 8–11.5 µm; cylindric with clavate to subclavate apices. Lamellar edge sterile. **Clamp connections** absent.

Collections examined

India, Maharashtra, Kolhapur, Panhala, Pombare (16°43’05”N-73°54’09”E), on soil, under the trunk of *Acacia mearnsii* De Wild. tree, solitary or in pair, 16.vii.2020, Bornak, S.I. (Y20V15C4); Panhala, Padsali (16.589^0 N, 73.867^0 E), amongst decaying leaf litter, solitary, scattered, 24.vi.2021, Bornak, S.I. & Patil, Y.S. (Y21V3C4).

Remarks

Entoloma serrulatum can be recognized by the dark blue cap, squamous pileal surface in the center and bluish lamellae with a dark margin. Microscopically basidiospores measure 9–13 × 6–9 µm and the pileal surface is composed of a cutis with pileocystidis forming a transition between cutis and trichoderm, sometimes almost hymeniform. *E. serrulatum* has a wide geographic distribution, occurring in Europe, South America, North America, Asia, and Brazil (Karstedt 2010).

This species has been previously reported from Kerala (Farook et al. 2013) and southwestern India (Pavithra et al. 2016). Jagadish et al. (2019) showed that the species *E. serrulatum* along with 20 other species have ectomycorrhizal assemblage in the vicinity

Image 3. ***Bolbitius coprophilus*** **(Peck) Hongo.: a–g—Basidiomes in their natural habitat | h—Basidiospores 40x | i—Pileipellis 40x. © Sushant Ishwar Bornak.**

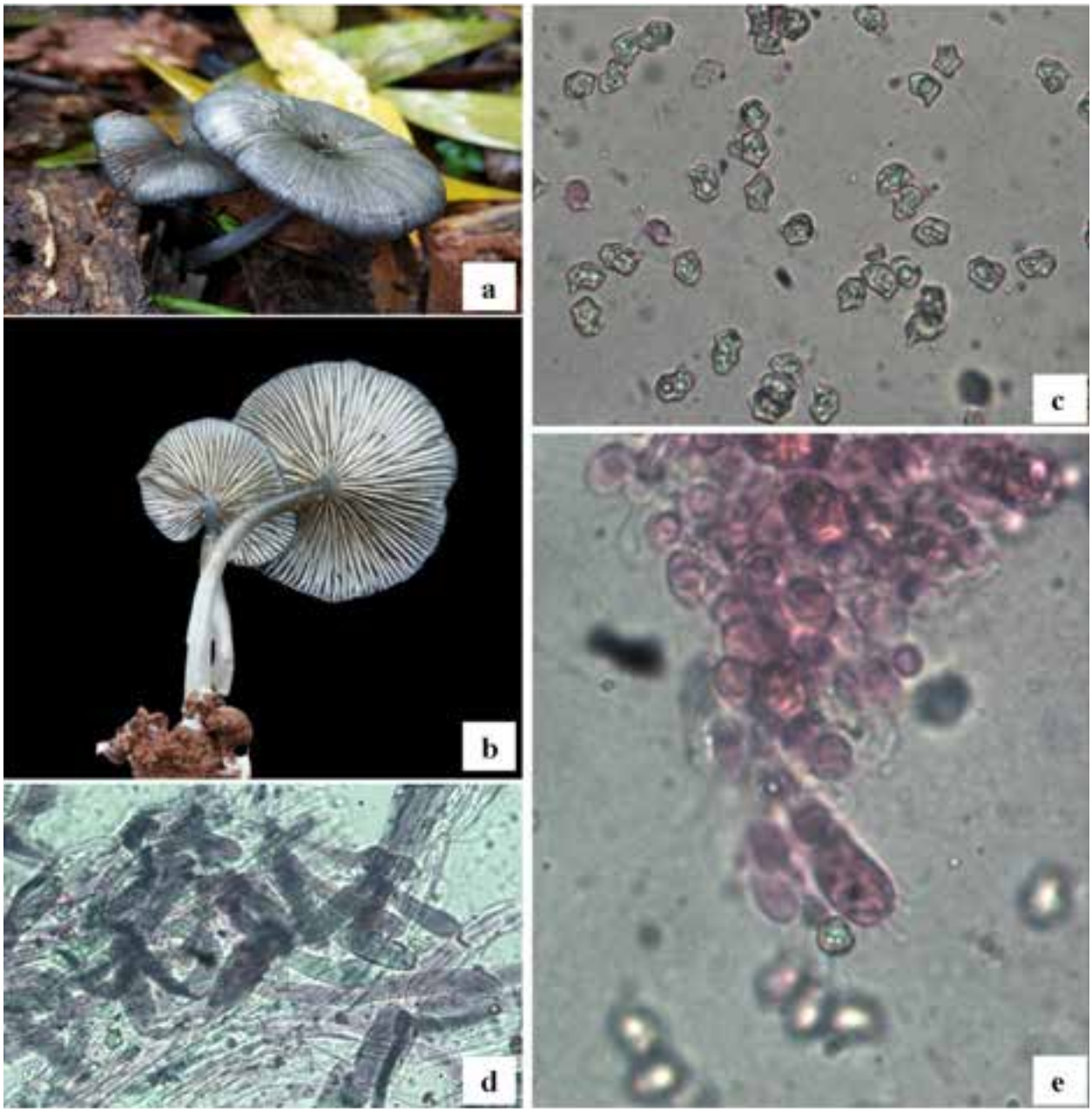

Image 4. ***Entoloma serrulatum*** **(Fr.) Hesler: a–b—Basidiomes in their natural habitat | c—Basidiospores 40x | d—Pileipellis 40x | e—Basidia with basidioles 40x. © Sushant Ishwar Bornak.**

of *Anacardium occidentale* from the Arabian Sea coast near Mangalore City, Karnataka State. This species is the first record from Maharashtra State.

Entoloma theekshnagandhum **Manim., A.V. Joseph & Leelav.**
(Image 5a–h)

Mycol. Res. 99(9): 1088 (1995).

Fruiting body small to medium. **Pileus** 2–4 cm in diameter, convex, centrally depressed cap; surface white to yellowish white, pale greenish-white when young, glabrous, smooth, pellucid–striate; margin regular. **Lamellae** adnate to sub-decurrent, white to yellowish-white, with lamellulae. **Stipe** 3–7 × 0.2–0.5 cm; central or slightly eccentric, cylindric, sometimes compressed, hollow; yellowish-white, pruinose at apex, glabrous towards base. **Odour** very strong, unpleasant; taste unpleasant. **Basidiospores** 7–9 × 6.8–8.2 µm, quadrate or pentagonal. **Basidia** 23–39 × 8–13 µm, clavate with four sterigmata. Lamella edge sterile. **Cheilocystidia**

18–65 × 6.5–22 µm, copious, lageniform, clavate to obclavate, cylindrical, hyaline. **Pleurocystidia** not observed. **Caulocystidia** 32–70 × 10–18 µm, similar to cheilocystidia. Spore print pale pink to orange white.

Collections examined

India, Maharashtra, Kolhapur, Panhala, Pombare (16.689^0 N, 73.906^0 E), on soil, solitary, scattered, 16.vii.2020, Bornak, S.I. (Y20V15C3); Shahuwadi, Nandari (16.098^0 N, 73.835^0 E), on soil, single, 05.viii.2021, Bornak, S.I. & Patil, Y.S. (Y21V7C6).

Remarks

This species was first described by Manimohan and Leelavathy (1988) as *Alboleptonia graveolens*. Later, the name was changed to *Entoloma theekshnagandhum* (Manimohan et al. 1995). The species can be easily recognized by its robust, whitish, omphalinoid basidiomes; the strong, unpleasant odour, quadrate spores, versiform cheilocystidia and the darkening nature of the basidiomes upon drying, development of a yellow colour when the fresh basidiomes are bruised (Manimohan et al. 1995). The species has been reported from several places of Kerala (Manimohan & Leelavathy 1988; Manimohan et al. 1995), Karnataka (Karun & Sridhar 2016) and Hollongapar Gibbon Wildlife Sanctuary, Assam (Gogoi & Parkash 2015). Diversity of genus *Entoloma* is not well studied in Maharashtra state. So far only *E. brassicolens, E. byssisedum, E. ochrospora, E. strictius*, *E. roseoflavum* have been reported from Maharashtra State (Senthilarasu 2014; Borkar et al. 2015). *E. theekshnagandhum* is the first report from Maharashtra State.

***Hymenopellis radicata* (Relhan) R.H.Petersen**
(Image 6 a–j)

Petersen & Hughes, *Nova Hedwigia*, Beih. 137: 202 (2010).

Fruiting body medium**; Pileus** 2.5–9cm, initially convex, then flattened-convex to flat, with wide low and obtuse umbo; margin thin, regular, acute, smooth, a little wavy; smooth cuticle when young, sooner or later radially wrinkled, glabrous, opaque with dry weather, viscous when humid; pale brown, hazel, ochraceus, whitish at times, darker at the centre; **Lamellae** of spaced gills, adnate or rounded, ventricose, wide, interspersed with numerous lamellulae of various length; the colour is white, the thread is entire and just stains brown when ripe; **Stipe** 5–16(20) × 0.5–1.5 cm, slender, long, cylindrical, with the enlarged base continuing in the soil under in the form of long root, rigid, fibrous, tough, full, at times twisted; surface finely floccose, longitudinally fibrillar, white at the apex, darkens gradually towards the base, where it has a colouration more or less similar to that of the cap; **Basidiospores** 15–18 × 8–10 µm; widely ellipsoidal, elongated–ovoid, smooth, guttulous; **Basidia** 45–55 × 10–15 µm; cylindrical, clavate, tetrasporic, with clamp connections; **Cheilocystidia** 12–35 µm; clavate, ventricose, smooth; **Pleurocystidia** 22–35 µm; widely clavate, widely rounded, truncated at the apex; **Annulus** absent. **Spore print** white.

Collections examined

India, Maharashtra, Kolhapur, Bhudargad, Bediv (16.211^0 N, 74.163^0 E), on ground, alone, solitary, 14.vi.2020, Bornak S.I. (Y20V2C12); Shahuwadi, Ambeshwar Devrai, (16.974^0 N, 74.801^0 E), on soil, alone, solitary, 19.vi.2020, Bornak S.I. (Y20V4C26); Kalammawadi Road, Radhanagari, (16.404^{0}N, 74.018^{0}E), on soil, single, 16.vii.2023, Bornak, S.I. (Y23V4C4).

Remarks

The type species of *Hymenopellis* is *H. radicata* described in 1786 under the name *Agaricus radicatus. H. radicata* is an edible species and can be cultivated commercially which *contains bioactive compound lectin which is antifungal, mucidin which is antioxidative, anti-inflammatory and shows lung-protective effects and some polysaccharides which are antifungal in nature* (Niego et al. 2021). The species is cosmopolitan. In *Maharashtra this species has been reported from Karnala, Thungareshwar, Lonavala, and Bhimashankar.*

***Macrocybe gigantea* (Massee) Pegler & Lodgel.**
(Image 7a–g)

Mycologia, 1998

Pileus 8–35 cm across, convex to flat, white, grayish-white, cream white, paler towards margin, glabrous and silky smooth, margin entire and incurved, expands when mature, often cracking. **Lamellae** notched, crowded, pale white to straw yellow, many tiers of lamellulae. **Stipe** 10–40 × 4–6 cm, central, solid, concolorous with pileus, fibrillose. **Basidiospores** 4.8–6.6 × 3.2–4.2 µm, ovate to ellipsoidal, hyaline, thin walled, smooth. **Basidia** 23–26.5 × 5.8–8.8 µm, four spored, clavate to sub-cylindrical, hyaline, oil droplets prominent, basal clamp connections present. **Cystidia** absent. **Lamellar** edges fertile. **Hymenophoral** trama regular, made up of thin-walled parallel hyphae. Pileipellis a cutis of narrow hyphae 4–8 µm in diameter, hyaline in 5% KOH, **clamp connections** present. Spore print white. **Odour** and taste

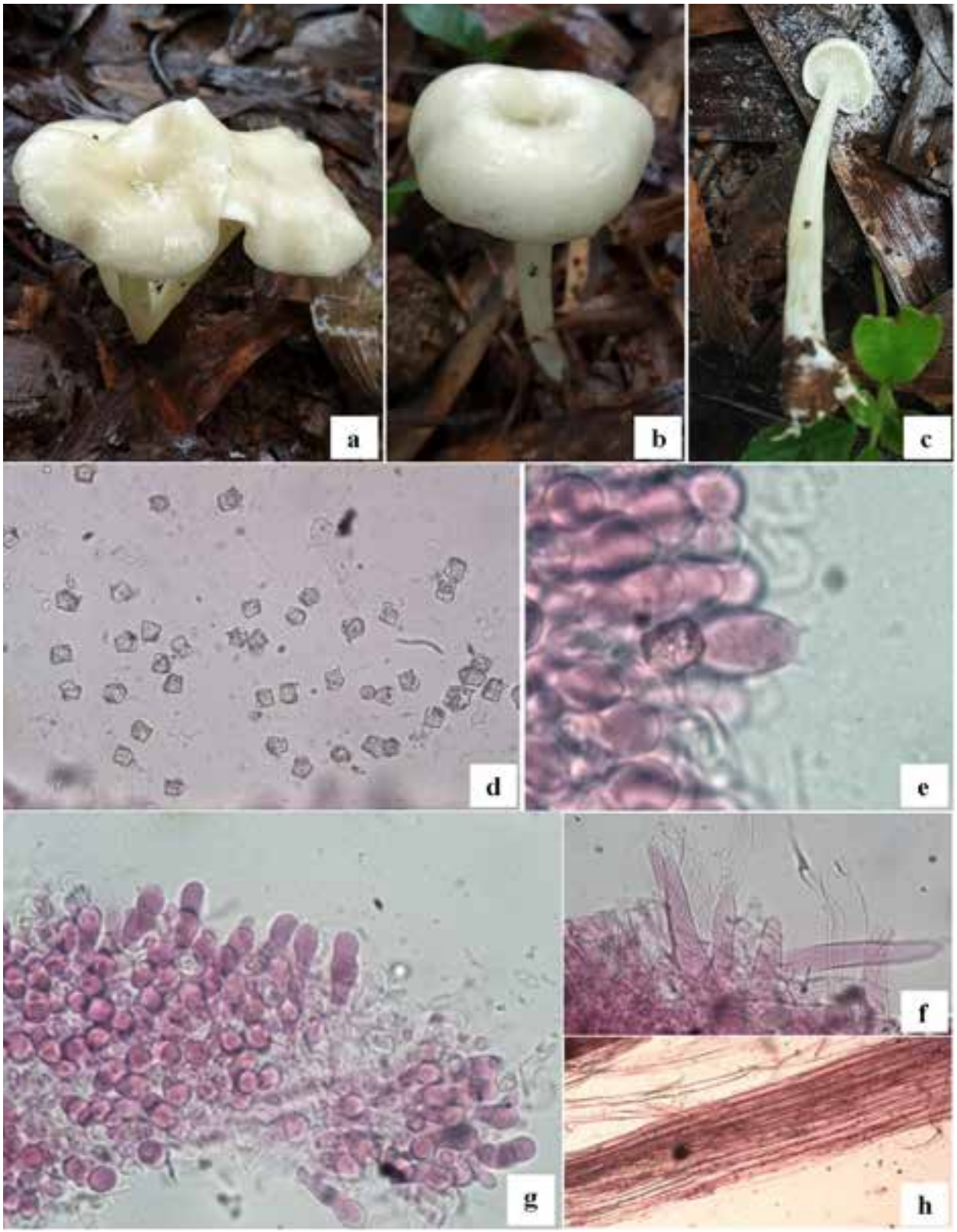

Image 5. ***Entoloma theekshnagandhum*** **Manim., A.V.Joseph & Leelav.: a–c—Basidiomes in their natural habitat | d—Basidiospores 40x | e—Basidia 40x | f—Pileipellis 40x | g—Basidioles 40x | h—Stiptipellis 40x. © Sushant Ishwar Bornak.**

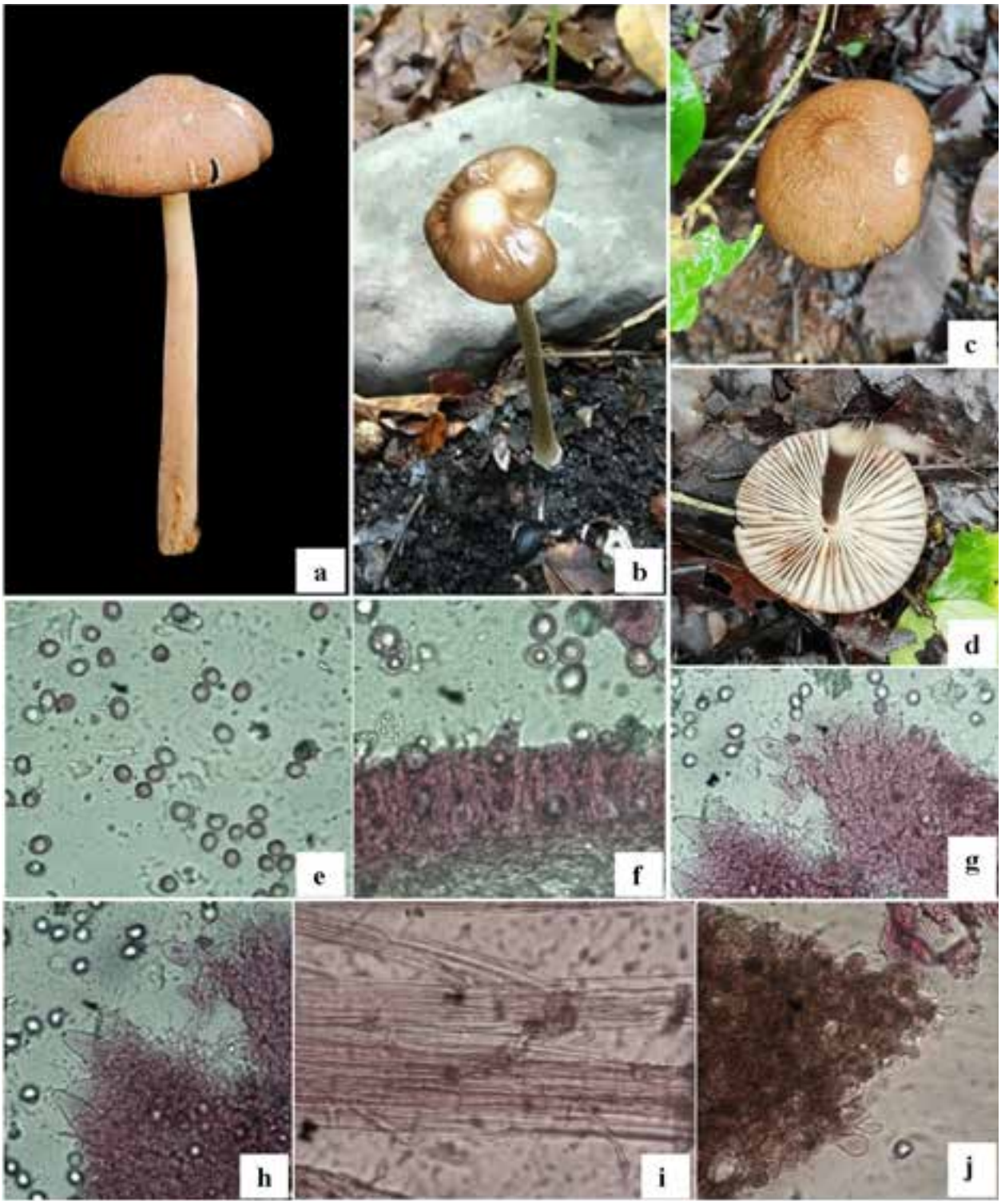

Image 6. *Hymenopellis radicata* (Relhan) R.H.Petersen: a–d—Basidiomes in their natural habitat | e—Basidiospores 40x | f—Basidia with basidioles 40x | g–h—Cheilocyctidia 40x | i—Stipetipellis 40x | j—Pileipellis 40x. © Sushant Ishwar Bornak.

not recorded.

Collections examined

India, Maharashtra, Kolhapur, Karvir, Samrat Nagar, (16.680^0 N – 74.243^0 E) on soil, in cluster, gregarious, 22.vi.2020, Bornak, S.I. & Patil, Y.S. (Y20V3C1); Shivaji University Campus (16.677^0 N, 74.254^0 E), on soil, solitary or scattered, 19.vii.2022, Bornak, S.I. & Patil, Y.S.

(Y22V6C1).

Remarks

Macrocybe gigantea was previously known as *Tricholoma giganteum* reported for the first time from West Bengal, India (Pegler et al. 1998). This species belongs to the family Tricholomataceae. *Macrocybe* species are characterized by white, cream to greyish, or ochraceous, and convex, umbonate to depressed pileus. The genus *Macrocybe* has been considered as *Tricholoma*. Later, it was segregated from *Tricholoma* and ranked as a genus using distinct morphological and molecular characteristics (Razaq et al. 2016). *Macrocybe* species are widely distributed in tropical regions from various parts of the world (Pegler et al.1998). The genus shows similar characters with *Calocybe*, both having conspicuous large basidiomata. However, *Macrocybe* species differs from *Calocybe* in lacking siderophilous granulation in the basidia and molecular characteristics. *M. gigantea* is an edible species with many varieties recognized and is cultivated in the wild tropical and subtropical regions of the world. It has a sweet taste and is rich in nutritive components such as proteins, polysaccharides, fat, amino acids, and many mineral elements (Galappaththi et al. 2022). Due to these nutritional and therapeutic attributes, it could be advantageous to grow this fungus at industrial scale for maximum benefits. *M. gigantea* can meet the demand of food for growing population due to both nutritional and therapeutic peculiarities. However, in wild form, there is a chance of radioactive contamination, which can be overcome by the cultivation under controlled conditions. (Ghafoor et al. 2022). *M. gigantea* is distributed only in the Asian countries such as China, India, Nepal, and Pakistan and there is no other report of this species from the western Hemisphere. (Razaq et al. 2016). In India, this species has been previously reported from Kerala, Karnataka, and West Bengal. This is the first report from Maharashtra State.

***Schizophyllum commune* Fr.**
(Image 8a–i)

Observ. mycol. (Havniae) **1**: 103 (1815).

Fruiting body small. **Pileus** 1–4.5 cm diam., thin, fan–shaped, shell like, in group or sessile or rudimentary stem, soft when fresh, leathery when dry; margin involute, lobed, wavy; whitish-grayish with hairy or velvety surface, greyish-brown towards the margin. **Lamellae** decurrent, unequal, narrow, split along the edge, distant, whitish to cream then pale grey–brown. **Stipe** rudimentary or absent, lateral. Flesh very tough, thin, pinkish. **Basidiospores** 4.3–6.2 × 1.8–2.2 µm, smooth, hyaline, subcylindrical. **Basidia** 16–22 × 3.8–6.2 µm, tightly clavate, 4-spored.

Collections examined

India, Maharashtra, Kolhapur, Bhudargad, Bhendvade, Gadhinglaj–Gargoti Road, (16°24'13"N-74°22'11"E), on dead wood, in cluster, 14.vi.2020., Bornak, S.I. & Patil, A.R. (Y20V1C7); Shahuwadi, Amba, Ambeshwar Devrai, (16.341^0 N, 73.845^0 E), on dead wood, in group, 19.vi.2020, Bornak, S.I. (Y20V6C6); Panhala, Pombare (16.721^0 N, 73.889^0 E), on unknown living tree trunk, gregarious, scattered, 20.vi.2021, Bornak, S.I., Biranje, S.S. & Patil, Y.S. (Y21V4C9); Panhala, Padasali (16.703^0 N, 73.672^0 E), on dead wood, in cluster, 24.vi.2021, Bornak, S.I. (Y21V3C8); Bhudargad, Pal, Pal Devrai (16.371^0 N, 74.190^0 E), on unknown wood, gregarious, scattered, 22.viii.2022, Bornak, S.I., Patil, Y.S. & Biranje, S.S. (Y22V9C5); Karvir, Parite, Kolhapur-Radhanagari road, (16.539^0 N, 74.105^0 E), on wood, gregarious, scattered, 16.vii.2023, Bornak, S.I. (Y23V6C6); Karvir, Rajaram College Campus, (16.686^0 N, 74.259^0 E), on dead wood, in cluster, 24.vii.2023, Bornak, S.I. (Y23V5C1).

Remarks

Schizophyllum commune is saprobic on dead wood or occasionally parasitic on living wood; growing alone, gregarious, sometimes clustered; on decaying hardwood sticks and logs grows throughout year. This species is widely distributed in North America, South America, Europe, Asia, Africa, Ireland, and Great Britain, Bay area, India. *S. commune* is a wood decaying fungus that causes a white rot, by using enzymes to decay. The lignin and cellulose left behind on the decaying wood is white. There are also reports of this species being found in humans and other animals. This fungus is known to cause a human mycoses in a few cases involving immune incompetent people, brain abscess especially in children. This is also an edible species and is a very good source of protein, vitamins, lipids and minerals and widely consumed in many parts of world. In northeastern India it is a traditional food species (Verma & Verma 2017). This species has been a reported from Mahabaleshwar and Mulashi, Maharashtra (Senthilarasu 2014). This is a first report from the study area.

***Termitomyces heimii* Natarajan**
(Image 9 a–j)

Mycologia 71 (4): 853 (1979).

Pileus 5–11 cm diam., surface smooth, convex to planoconvex, when young prominently sub-umbonate,

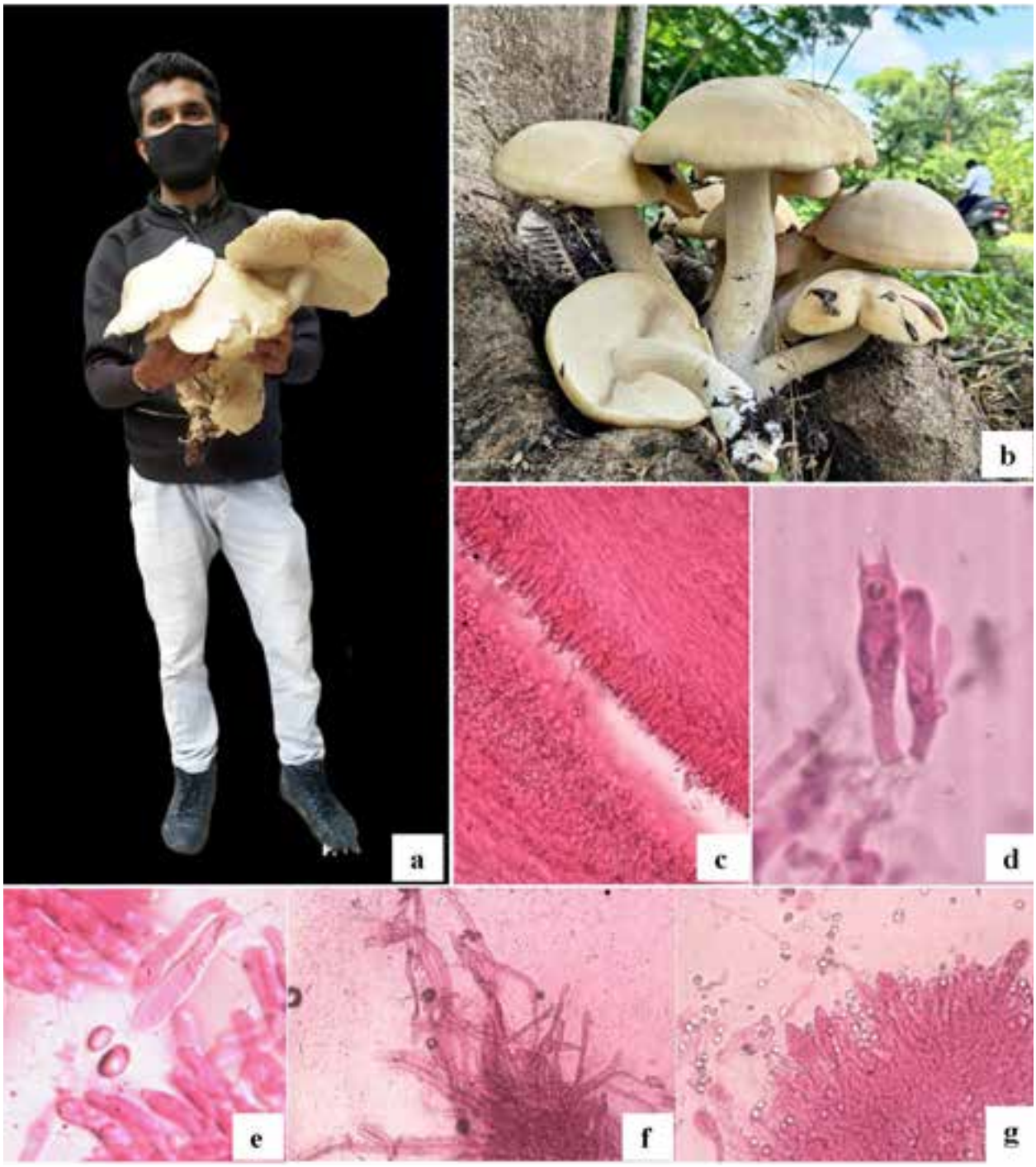

Image 7. *Macrocybe gigantea* (Massee) Pegler & Lodgel.: a—Fruiting body | b—Basidiomes in their natural habitat | c—Lamellae margin 10x | d—Basidia 40x | e—Basidia with basidioles 40x | f—Pileipellis 40x | g—Cheilocystidia 40x. © Sushant Ishwar Bornak.

margin incurved, white, striate with greyish to greyish-brown umbo, splits when mature. **Context** fleshy, white. **Lamellae** free, crowded, white, becoming pink, up to 6–8 mm broad, margin serrate, lamellulae present. **Stipe** 13–18 cm long and 1.5–2 cm wide, white, surface smooth, cylindrical, solid, with a thick annulus, pseudorhiza present, 13–20 cm below the ground level. **Pileal** surface an epicutis hyphae 4–5 µm wide. **Hymenophoral trama** regular, thin–walled parallel hyphae, 10–12 µm wide. **Basidia** clavate, 16.5–20.8 × 5.7–7.0 µm, with four sterigmata. **Pleurocystidia** broadly clavate, 44 × 17 µm. **Cheilocystidia** not observed. **Basidiopores** 7.2–8.5 ×

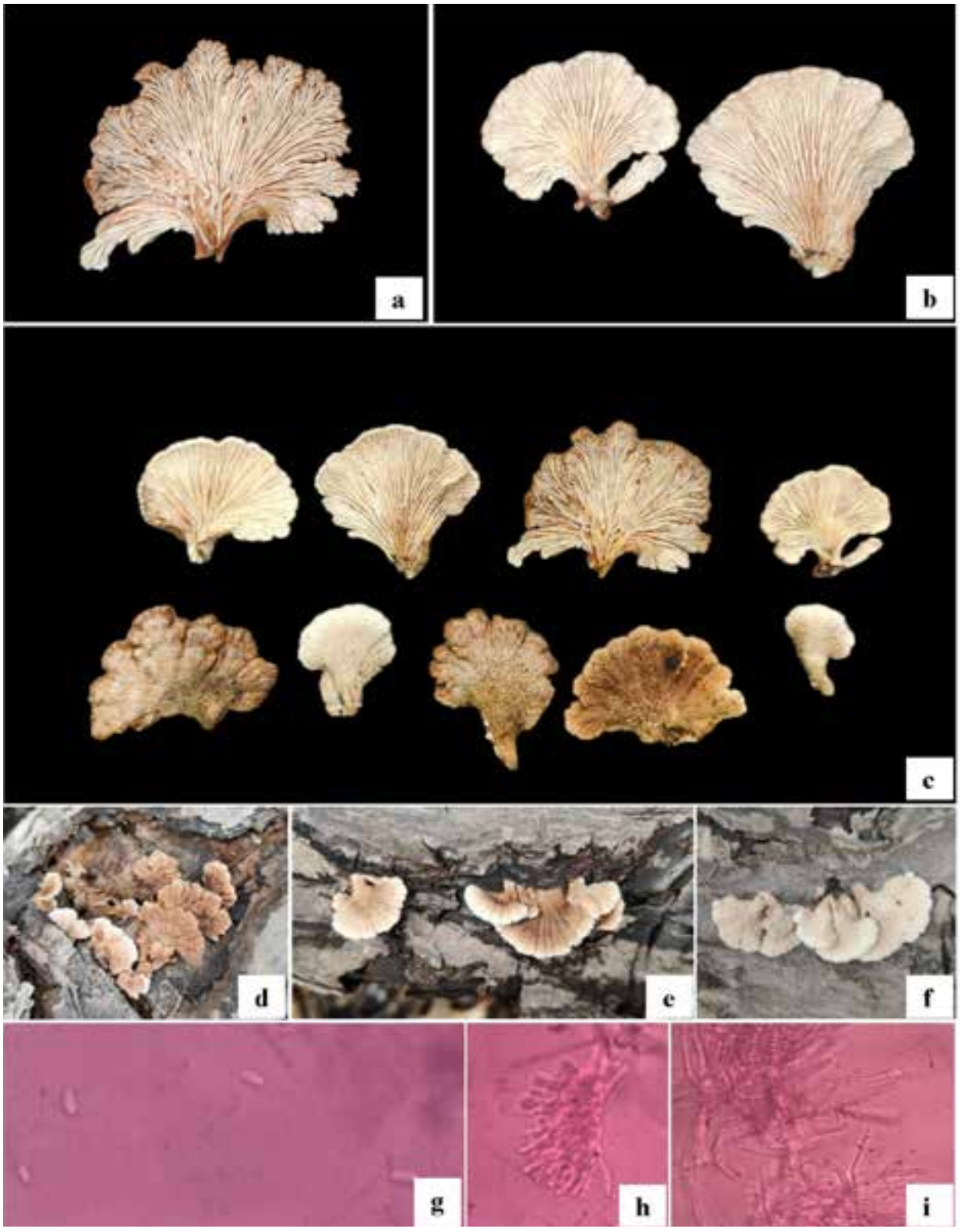

Image 8. ***Schizophyllum commune*** **Fr.: a–f—Basidiomata and basidiomes in their natural habitat | g—Basidiospores 40x | h—Basidia with basidioles 40x | i—Pileipellis 40x. © Sushant Ishwar Bornak.**

4.0–5.4 µm, ellipsoid, smooth, hyaline, nonamyloid. **Clamp connections** absent. **Spore deposit** pink**.**

Collection examined

India, Maharashtra, Kolhapur, Jyotiba (16.787^0 N, 74.176^0 E), on open ground, gregarious, scattered, 19.vii.2022, Bornak, S.I. & Subhedar, V. (Y20V10C1).

Remarks

The diagnostic feature of this species is the large, white, smooth, sub-umbonate pileus and smooth annulate stipe with a long pseudorrhiza. Other large annulate species of *Termitomyces* differ from this significantly. In *T. eurrhizus* (Berk.) Heim, the fruit bodies are larger, the pseudorhiza black and the viscid pileus surface dark gray brown to fuliginous; the perforatorium is pointed. In *T. lanatus* Heim the pileus is covered by a thick grayish woolly veil and the annulus and stipe are covered with woolly scales. In *T. striatus* (Beeli) Heim the pileus is ochraceous to gray brown and distinctly striate (Natarajan 1979).

T. heimii has ethno-medicinal importance as it can be used in treatment for fever, cold, and fungal infections, used in blood tonics during wound healing and blood coagulation, syrup is used for jaundice and diarrhea and also shows antimicrobial, anticancer, and antioxidant properties. Water soluble solvents of *T. heimii* shows antimicrobial activity against *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas* sp., *Staphylococcus aureus*, and *Streptococcus pyogenes* (Paloi et al. 2023). The species has been reported from Maharashtra (Borkar et al. 2015).

***Termitomyces microcarpus* (Berk. & Broome) R.Heim (Image 10a–e)**

Arch. Mus. Hist. Nat. Paris, ser. 6 18: 128 (1942).

Fruiting body small to medium. **Pileus** 1.5–3 cm, at first companulate becoming e×panded convex on maturity with shield-shaped acute umbo, margins splitting at maturity, pale to creamish-white, yellowish-white, smooth, silky, shiny, viscid or slimy when wet. **Lamellae** free to adnexed, narrow, less crowded, with lamellulae, cream turns into light brown on maturity. **Stipe** 3.2–8 × 0.1–0.3 cm, creamish, central, cylindrical, thin, fibrillose, smooth, silky, hollow and tapering towards the base, devoid of annulus and without pseudorhiza. **Basidiospores** 5.0–7.2 × 3.4–4.5 µm, hyaline, ovoid to broadly ellipsoid, thin walled. **Basidia** 11.6−16.2 × 4.3–6.6 µm, with four sterigmata.

Collection examined

India, Maharashtra, Kolhapur, Shahuwadi, Amba, (16.942^0 N, 73.791^0 E), on soil, in cluster, gregarious, 30.vi.2023, Bornak, S.I. & Vedpathak, M.A. (Y23V4C3).

Remarks

T. microcarpus is closely related to *T. medius* in shape of pileus as well as umbo, but *T. microcarpus* differs for being devoid of pseudorhiza. In India along with *T. heimii, T. microcarpus* was used to alleviate fever, colds, and fungal infections (Nhi et al. 2022). This is an edible species and can be used to treat gonorrhea (Pavithra et al. 2017). Despite of all this species has ample medicinal usage, viz, lowers the total serum cholesterol, LDL–cholesterol and triglycerides in rats, used in wound healing, used in treatment of diarrhoea, muscular pain, delivery pain, stomachache, laziness, stiffness of joints, cough/cold, venereal diseases, used for fever treatment and bone strengthening (Kumari et al. 2022).

The species has many vernacular names, viz: Katola kum/Akki kum, Nuchikum, Pullaekum, Uei Chhatu, Choto karane, (Kerala and Karnataka); Bhat Pihari, (Nei kalan, Ari Kumizh, Arishi Kalan (Tamil Nadu); Bada bali chatu (Odisha); Jhari chewn, Mulchewn (Uttrakhand); Kanki Phutu, Chowk Phutu, Chapat phutu (Chattisgarh); Shiti or Shitol olamis (Goa); Inyak (Arunachal Pradesh); Balu khukhdi (Jharkhand); Mikhumu khapolok (Tripura); Bhatoli, Mohtran (Himachal Pradesh) (Kumari et al. 2022). The previous reports of *T. microcarpus* are from Karnataka, Kerala, Tamil Nadu and Pune in Maharashtra (Pavithra et al. 2017).

DISCUSSION

In the present investigation 10 species belonging to eight genera and eight families from order Agaricales have been enumerated. Among these, five species have been described for the first time from Maharashtra State. *Agrocybe pediades*, *Hymenopellis radicata*, *Macrocybe gigantea*, *Schizophyllum commune*, *Termitomyces heimii* and *T. microcarpus* are edible and *Entoloma serrulatum* is a poisonous species (Ediriweera et al. 2015; Razaq et al. 2016; Mishra et al. 2021; Niego et al. 2021).

The edible species such as *M. gigantea* and *S. commune*, which are used in traditional dishes in some parts of India, are commonly distributed in Kolhapur District. In addition to their edibility, species such as *A. pediades*, *H. radicata*, *T. heimii*, and *T. microcarpus* are also known for their medicinal properties. These fungi exhibit a wide range of bioactivities including antimicrobial,

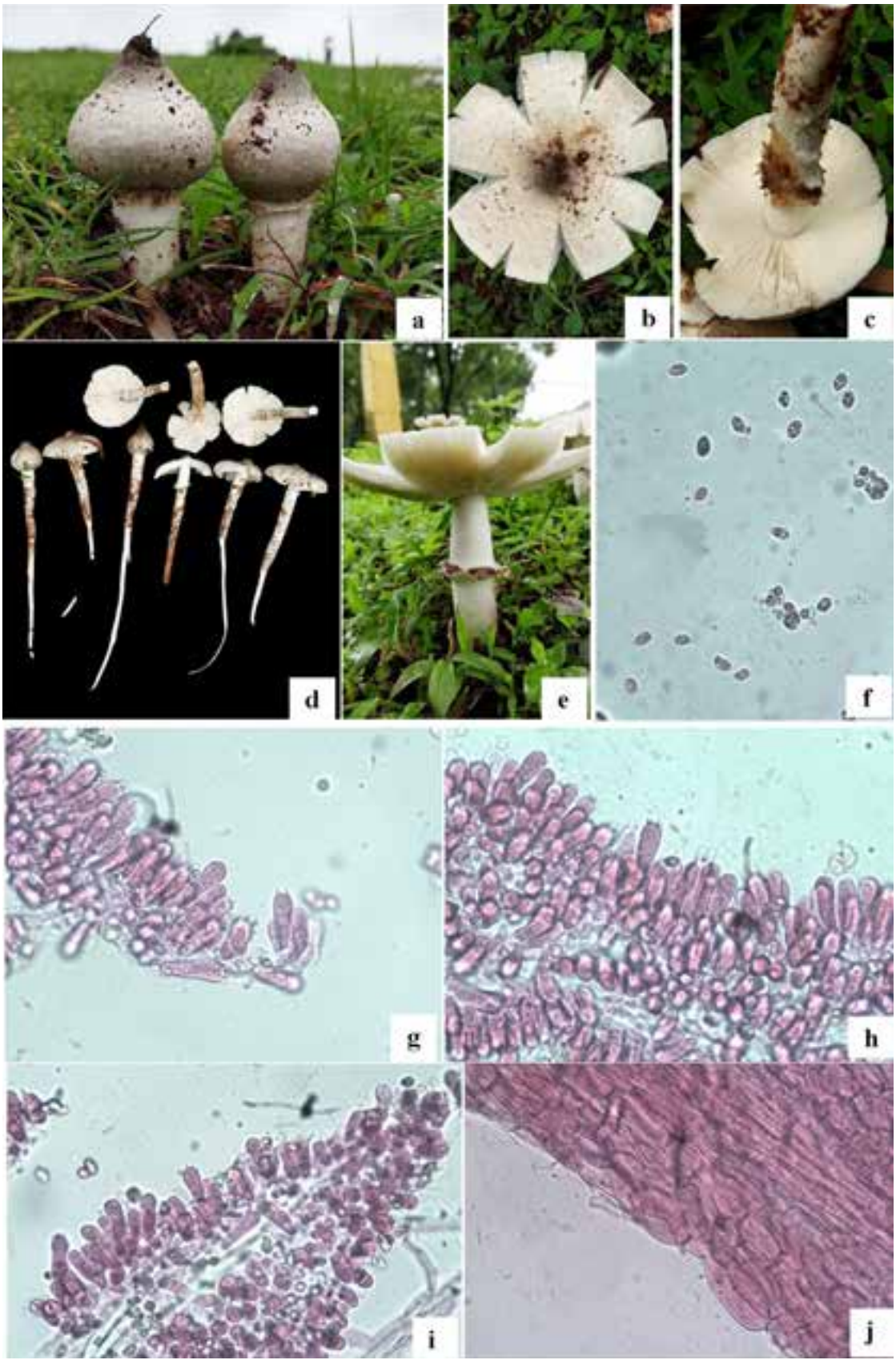

Image 9. *Termitomyces heimii* Natarajan: a–e—Basidiomata and basidiomes in their natural habitat | f—Basidiospores 40x | g–i—Basidia with basidioles 40x | j—Pileipellis 40x. © Sushant Ishwar Bornak.

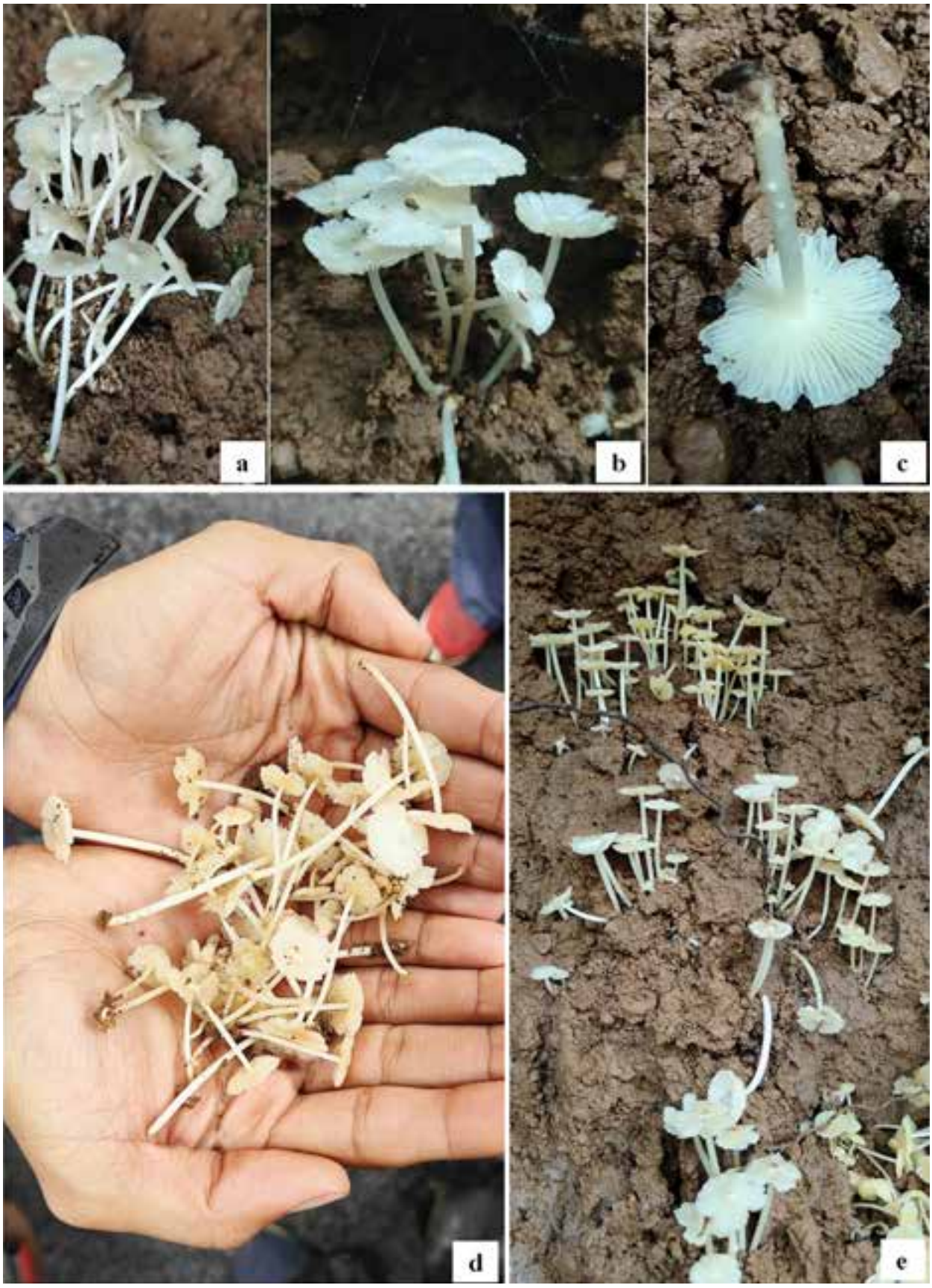

Image 10. ***Termitomyces microcarpus*** **(Berk. & Broome) R.Heim.: a–e—Basidiomes in their natural habitat. © Sushant Ishwar Bornak.**

antiviral, antifungal, antioxidant, anti-inflammatory, anticancer, wound-healing, and lung-protective effects. Such therapeutic potential is attributed to the presence of various bioactive compounds, emphasizing the nutritional and pharmacological significance of wild mushrooms in rural communities.

In rural areas of Kolhapur District, *Termitomyces* and *Pleurotus* species are among the most commonly consumed wild edible mushrooms during the monsoon season. *Termitomyces* species are typically found in forested regions and near agricultural lands, often associated with termite mounds. These mushrooms are relatively easy to recognize due to their long, slender pseudorhiza extending into the soil, a distinguishing characteristic in most species, except *Termitomyces microcarpus*, which lacks a prominent pseudorhiza. Similarly, *Pleurotus* species are widely collected and consumed across various parts of the district. Members of this genus can be identified by their fan-shaped pileus, lateral or absent stipe, and often white to off-white basidiocarps. Despite the familiarity of these genera to local populations, accurate mushroom identification remains a challenging task. Distinguishing between edible and toxic species based solely on macroscopic features can be unreliable and may pose significant health risks. Therefore, while some genera may have recognizable traits, caution and expert verification are essential for safe wild mushroom consumption.

REFERENCES

Amandeep, K., N.S. Atri & K. Munruchi (2013). Diversity of species of the genus *Bolbitius* (Bolbitiaceae, Agaricales) collected on dung from Punjab, India. *Mycosphere* 4(6): 1053–1064. https://doi.org/10.5943/mycosphere/4/6/3

Bhide, V.P., A. Pande, A.V. Sathe, V.G. Rao & P.G. Patwardhan (1987). *Fungi of Maharashtra (Supplement–I).* Maharashtra Association for the Cultivation of Science, Research Institute, Pune, 146 pp.

Blatter, E. (1911). A list of Indian fungi, chiefly of the Bombay Presidency, with the description of two new species. *Journal of Bombay Natural History Society* 21: 146–152.

Borkar, P., A. Doshi & S. Navathe (2015). Mushroom diversity of Konkan region of Maharashtra, India. *Journal of Threatened Taxa* 7(10): 7625–7640. https://doi.org/10.11609/JoTT.o4283.7625–40

Chavan, P.B. & S.N. Barge (1977). Some fleshy fungi from Maharashtra. *Botanique* 8: 124–128.

Ediriweera, S., R. Wijesundera, C. Nanayakkara & W. Ovdsj (2015). Comparative study of growth and yield of edible mushrooms, *Schizophyllum commune* Fr., *Auricularia polytricha* (Mont.) Sacc. and *Lentinus squarrosulus* Mont. on lignocellulosic substrates. *Mycosphere* 6(6): 760–765. https://doi.org/10.5943/mycosphere/6/6/10

Farook, V.A., S.S. Khan & P. Manimohan (2013). A checklist of Agarics (gilled mushrooms) of Kerala State, India. *Mycosphere* 4(1): 97–131. https://doi.org/10.5943/mycosphere/4/1/6

Galappaththi, M.C.A., Y. Lu, S.C. Karunarathna, N. Wijewardena, A. Karunarathna, M. Gamage & A.N. Ediriweera (2022). First successful cultivation and nutritional composition of *Macrocybe gigantea* in Sri Lanka. *MycoAsia* 2022/07. https://doi.org/10.59265/mycoasia.2022-07

Ghafoor, A., A.R. Niazi & N.-u.-S. Afshan (2022). Domestication and element analysis of the giant edible *Macrocybe gigantea* from Pakistan. *Journal of Applied Botany and Food Quality* 95: 167–173. https://doi.org/10.5073/JABFQ.2022.095.021

Gogoi, G. & V. Parkash (2015). A checklist of gilled mushrooms (Basidiomycota: Agaricomycetes) with diversity analysis in Hollongapar Gibbon Wildlife Sanctuary, Assam, India. *Journal of Threatened Taxa* 7(15): 8272–8287. https://doi.org/10.11609/jott.1770.7.15.8272–8287

Hedawoo, G.B. & P.U. Mohite (2008). Some wild edible mushrooms from Melghat Tiger Reserve Forest and Amravati Region. *Bioscience Biotechnology Research Communications* 1(2): 163–167.

Hedawoo, G.B. (2010). Wild mushroom flora from Amravati Regoin, Maharastra, India. *Journal of Mycology and Plant Pathology* 40(3): 441–444.

Jagadish, B.R., K.R. Sridhar & H.R. Dattaraj (2019). Macrofungal assemblage with two tree species in scrub jungles of south–west India. *Studies in Fungi* 4(1): 72–82. https://doi.org/10.5943/sif/4/1/10

Kantharaja, R. & M. Krishnappa (2022). Amanitaceous fungi of central Western Ghats: taxonomy, phylogeny, and six new reports to Indian mycobiota. *Journal of Threatened Taxa* 14(4): 20890–20902. https://doi.org/10.11609/jott.7801.14.4.20890–20902

Karstedt, F. (2010). *Entolomataceaeemáreas de Mata Atlântica da regiãometropolitana de São Paulo,* SP. 186 f. Dissertação (MestradoemBiodiversidade Vegetal e MeioAmbiente). Instituto de Botânica, Secretaria de Estado de MeioAmbiente, São Paulo.

Karun, N.C. & K.R. Sridhar (2016). Spatial and temporal diversity of macrofungi in the western Ghat forests of India. *Applied Ecology and Environmental Research* 14(2): 1–21. https://doi.org/10.15666/aeer/1402_001021

Kaur, A., N.S. Atri & M. Kaur (2014). Diversity of coprophilous species of *Panaeolus* (Psathyrellaceae, Agaricales) from Punjab, India. *Biodiversitas* 15: 115–130.

Kaur, A., N.S. Atri & M. Kaur (2014). Taxonomic study on species of *Agrocybe* (Strophariaceae, Agaricales) collected on dung from Punjab, India. *KAVAKA* 43: 46–49.

Kulkarni, S.M. (1990). Contribution to lignicolous Basidiomycetes flora of S.W. India – II. *Geobios New Reports India* 9(1): 14–17.

Kulkarni, S.M. (1992). *Amanita konkanensis*: a new species of Agaricales. *Biovigyanam* 18(1): 56– 58.

Liu, Y.S., J. Kumla, N. Suwannarach, P. Sysouphanthong & S. Lumyong (2022). Three species of *Amanita* section *Lepidella* (Amanitaceae, Agaricales) from northern Thailand. *Phytotaxa* 570(1): 016–028. https://doi.org/10.11646/phytotaxa.570.1.2

Manimohan, P. & K.M. Leelavathy (1988). Two new species of *Alboleplonia* (Agaricales, Entolornataceae) from southern India. *Transactions of the British Mycological Society* 91: 710–712.

Manimohan, P., A.V. Joseph & K.M. Leelavathy (1995). The genus *Entoloma* in Kerala State, India. *Mycological Research* 99: 1083–1097.

Manimohan, P., K.A. Thomas & V.S. Nisha (2007). Agarics on elephant dung in Kerala State, India. *Mycotaxon* 99(1): 147–158.

Kumari, B., V.P. Sharma, A. Barh & N.S. Atri (2022). The genus *Termitomyces*- An appraisal of some basic and applied aspects from India. *Current Research in Environmental & Applied Mycology* 12(1): 102–124. https://doi.org/10.5943/cream/12/1/9

Manjula, B. (1983). A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. In: Proceedings of Indian Academy of Sciences (Plant Science) 92(2): 81–213.

Mishra, A.K., S. Mishra, S. Rathore, V. Naik, S. Patil & S. Kumar (2021). Wild mushroom diversity of Rairangpur Forest Division, Odisha, India and its medicinal uses. *European Journal of Medicinal Plants* 32(9): 19–27. https://doi.org/10.9734/EJMP/2021/v32i930415

Narendra, D.V. & V.G. Rao (1976). Studies into coprophilous fungi of Maharashtra, India-V. *Nova Hedwigia* 27: 631–645.

Natarajan, K. (1979). South Indian Agaricales V: *Termitomyces heimii*. *Mycologia* 71(4): 853–855. https://doi.org/10.2307/3759201

Nhi, N.T.N., D.T Khang & T.N. Dung (2022). *Termitomyces* mushroom extracts and its biological activities. *Food Science Technology Campinas* 42: 1–7. https://doi.org/10.1590/fst.125921

Niego, A.G., O. Raspé, N. Thongklang, R. Charoensup, S. Lumyong, M. Stadler & K.D. Hyde (2021). Taxonomy, diversity and cultivation of the oudemansielloid / xeruloid taxa *Hymenopellis*, *Mucidula, Oudemansiella,* and *Xerula* with respect to their bioactivities: a review. *J Fungi* 137(1): 51. https://doi.org/10.3390/jof7010051

Niveiro, N., M. Uhart & E. Albertó (2020). Revision of the genera *Agrocybe* and *Cyclocybe* (Strophariaceae, Agaricales, Basidiomycota) in Argentina. *Rodriguésia* 71: 1–26. https://doi.org/10.1590/2175-7860202071038

Olariaga, I., S. Huhtinen, T. Læssøe, J.H. Petersen & K. Hansen (2020). Phylogenetic origins and family classification of typhuloid fungi, with emphasis on *Ceratellopsis*, *Macrotyphula* and *Typhula* (Basidiomycota). *Stud Mycology* 96: 155–184. https://doi.org/10.1016/j.simyco.2020.05.003

Paloi, S., J. Kumla, B.P. Paloi, S. Srinuanpan, S. Hoijang, S.C. Karunarathna, K. Acharya, N. Suwannarach & S. Lumyong (2023). Termite mushrooms (*Termitomyces*), a potential source of nutrients and bioactive compounds exhibiting human health benefits: a review. *Journal of Fungi* 9(1): 112. https://doi.org/10.3390/jof9010112

Parandekar, S.A. (1964). A contribution to the fungi of Maharashtra. *Journal of University of Poona, Science & Technology Sections* 26: 57–65.

Patil, A.R. & S.I. Bornak (2022). First report of *Gymnopilus ochraceus* Høil. 1998 (Agaricomycetes: Agaricales: Hymenogastraceae) from India and determination of bioactive components. *Journal of Threatened Taxa* 14(10): 22021–22025. https://doi.org/10.11609/jott.7881.14.10.22021–22025

Patil, A.R. & S.I. Bornak (2023). Diversity of Agaricales from Kolhapur District, Maharashtra, India-I. *KAVAKA* 59(2): 92–103. https://doi.org/10.36460/Kavaka/59/2/2023/92–103

Patil, M.S. & A.N. Thite (1977). Fungal flora of Radhanagri, Kolhapur. *Journal of Shivaji University (Science)* 17: 149–162.

Patil, M.S. & A.N. Thite (1978). Fungal flora of Amboli (Ratnagiri). *Journal of Shivaji Univesity (Science)* 18: 219–224.

Patil, M.S. (1978). Some fleshy fungi from Maharashtra - III. *Indian Phytopathology* 31: 32–35.

Patil, S.D., L.N. Nair & B.P. Kapandis (1979). Studies on fleshy fungi of Western India. *Journal of University of Poona, Science & Technology* 52: 349–354.

Pavithra, M., K.R. Sridhar & A.A. Greeshma (2017). Macrofungi in two botanical gardens in southwestern India. *Journal of Threatened Taxa* 9(3): 9962–9970. https://doi.org/10.11609/jott.2747.9.3.9962–9970

Pavithra, M., K.R. Sridhar, A.A. Greeshma & N.C. Karun (2016). Spatial and temporal heterogeneity of macrofungi in the protected forests of southern India. *International Journal of Agricultural Technology* 12(1): 105–124.

Pegler, D.N., D.J. Lodge & K.K Nakasone (1998). The pantropical genus *Macrocybe* gen. nov. *Mycologia* 90: 494–504.

Razaq, A., R. Nawaz & A.N. Khalid (2016). An Asian edible mushroom, *Macrocybe gigantea*: its distribution and ITS-rDNA based phylogeny. *Mycosphere* 7: 525–530. https://doi.org/10.5943/mycosphere/7/4/11

Sathe, A.V. & S.M. Kulkarni (1979). A new species of *Entoloma* from India. *Current Science* 48(23): 1042–1043.

Sathe, A.V. & K.C. Sasangan (1977). Agaricales from South West India - III. *Biovigyanam* 3(1): 119– 121.

Sathe, A.V. & K.C. Sasangan (1978). A new species of *Lepista* from south west India. *Current Science* 47(19): 739–740.

Sathe, A.V. & S. Deshpande (1979). *Chlorolepiota* - a new genus of Agaricales (Mushrooms) from India. *Current Science* 48(15): 693–695.

Sathe, A.V. & S. Deshpande (1980a). A new species of *Pholiota* from India. *Current Science* 49(13): 517–518.

Sathe, A.V. & S. Deshpande (1980b). Agaricales (Mushrooms) of Maharashtra State. In: Agaricales (Mushrooms) of south west India. Maharashtra Association for the Cultivation of Science, Research Institute, Pune 9–42.

Sathe, A.V. & S. Deshpande (1982). Agaricales of Maharashtra. In: Advances in Mycology & Plant Pathology: Proceeding[s] of the National Symposium Held at Calcutta on 22nd, 23rd September, 1979, eds. S.B. Chattopadhyay & N. Samajpati, Oxford & IBH Publishing Company 81–88.

Sathe, A.V. & S.R. Rahalkar (1975). Agaricales from south west India - I. *Biovigyanam* 1(1): 75–78.

Sathe, A.V. & S.R. Rahalkar (1976). Proceedings of Symposium on Survey and Cultivation of edible mushrooms in India, Reg. Research Laboratory, Srinagar 77–80.

Senthilarasu, G. (2014). Diversity of agarics (gilled mushrooms) of Maharashtra, India. *Current Research in Environmental & Applied Mycology* 4(1): 58–78. https://doi.org/10.5943/cream/4/1/5

Thite, A.N., M.S. Patil & T.N. More (1976). Some fleshy fungi from Maharashtra. *Botanique* 7(2&3): 77–88.

Thomas, K.A., A. Hausknecht & P. Manimohan (2001). Bolbitiaceae of Kerala State, India: new species and new and noteworthy records. *ÖsterreichischeZeitschrift für Pilzkunde* 10: 87–114.

Trivedi, T.K. (1972). Agaricales of Nagpur–I. *Botanique* 3(1): 53–59.

Usman, M., A.N. Awan, N. Yousaf, G. Murtaza, M. Hanif & A.N. Khalid (2022). First records of *Bolbitius coprophilus* (Agaricales, Bolbitiaceae) from Pakistan. *Check List* 18(3): 525–533. https://doi.org/10.15560/18.3.525

Verma, R.K. & P. Verma (2017). Diversity of macro–fungi in central India–VI: *Schizophyllum commune. Van Sangyan* (4)7:15–23

Wang, G.S., Q. Cai, Y.J. Hao,

T. Bau, Z.H. Chen, M.X. Li, N. David, N. Kraisitudomsook & Z.L. Yang (2023). Phylogenetic and taxonomic updates of Agaricales, with an emphasis on Tricholomopsis. *Mycology* 15(2): 1–30 . https://doi.org/10.1080/21501203.2023.2263031

Yoo, S., Y. Cho, J.S. Kim, M. Kim & Y.W. Lim (2022). Fourteen Unrecorded Species of Agaricales Underw. (Agaricomycetes, Basidiomycota) from the Republic of Korea. *Mycobiology* 50(4): 219–230. https://doi.org/10.1080/12298093.2022.2097364

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COMMUNICATION

First camera-trap records of Dhole *Cuon alpinus* (Pallas, 1811) (Mammalia: Canidae) and Spotted Linsang *Prionodon pardicolor* (Hodgson, 1841) (Mammalia: Carnivora: Prionodontidae) in Makalu Barun National Park, Nepal

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Abstract: The Dhole *Cuon alpinus* and Spotted Linsang *Prionodon pardicolor* are two elusive carnivores inhabiting the forests of southern and southeastern Asia. Despite their ecological roles and conservation significance, both species remain under-researched, particularly in Nepal. From 2019 to 2024, a biodiversity survey using 10 camera traps in the Barun Valley of Makalu Barun National Park (over 5,508 camera-days) provided the first photographic evidence of both species from the region. A solitary Dhole was recorded at two stations on three independent events in the lower subalpine zones. Spotted Linsangs were captured at four stations on 12 independent events in the sub-tropical and temperate zones. These findings highlight the importance of Barun Valley as a significant habitat for rare mammals and highlight the need for systematic surveys to understand their distribution, threats, and conservation needs.

Keywords: Asian Wild Dog, Barun Valley, camera trapping, eastern Himalaya, high-elevation biodiversity, Makalu Barun National Park, photographic evidence, rare mammals.

Nepali: वनकुकुर र सिलु बिरालो दक्षिण तथा दक्षिणपूर्वी एसियाका जंगलहरूमा पाइने दुर्लभ मांसाहारी स्तनधारी प्रजातिहरू हुन्। यिनीहरूको पारिस्थितिक भूमिका तथा संरक्षण महत्व भए पनि, विशेषतः नेपालमा यिनीहरू सम्बन्धी वैज्ञानिक अध्ययन न्यून रहेको छ। सन् २०१९ देखि २०२४ सम्म मकालु-वरुण राष्ट्रिय निकुञ्जको वरुण उपत्यकामा १० वटा क्यामेरा ट्र्याप प्रयोग गरी जैविक विविधता सर्वेक्षण गरिएको थियो, जसमा जम्मा ५,५०८ भन्दा बढी क्यामेरा-दिन संकलन गरिएको थियो। उक्त सर्वेक्षणमा प्राप्त वन कुकुर र सिलु बिरालोका तस्वीरहरू मकालु-वरुण राष्ट्रिय निकुञ्ज क्षेत्रबाट पहिलो पटक भेटिएको फोटोग्राफिक प्रमाण हुन्। वनकुकुर ठण्डा समशीतोष्ण जलवायु भएका मकालु-बरुण राष्ट्रिय निकुञ्ज क्षेत्रमा राखिएका दुई क्यामेरा ट्र्याप स्टेशनहरूमा तीनवटा स्वतन्त्र क्यामरा ट्र्याप फोटोहरूमा रेकर्ड गरियो। त्यसैगरी, सिलु बिरालो न्यानो तथा ठण्डा समशीतोष्ण क्षेत्रका राखिएका चारवटा ट्र्याप स्टेशनहरूमा जम्मा १२ वटा स्वतन्त्र क्यामरा ट्र्याप फोटोहरूमा रेकर्ड गरिएको थियो। यी नतिजाहरुले वरुण उपत्यका दुर्लभ मांसाहारी स्तनधारीहरूको महत्वपूर्ण बासस्थान भएको पुष्टि गर्छ। साथै, यस्ता प्रजातिहरूको वितरण, जोखिम कारकहरू र संरक्षणका आवश्यकताहरू बुझ्न दीर्घकालीन तथा व्यवस्थित अध्ययन आवश्यक रहेको स्पष्ट देखिन्छ।

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INTRODUCTION

The eastern Himalaya are known for their unique biodiversity and rich ecosystems. The region is home to many of the worlds' most iconic species, like Tiger *Panthera tigris*, Elephant *Elephas maximus*, Red Panda *Ailurus fulgens*, Snow Leopard *Panthera uncia*, Clouded Leopard *Neofelis nebulosa*, Dhole *Cuon alpinus* (WWF 2024). The Dhole, or Asiatic Wild Dog, is one of Asia's most widely distributed carnivores, found across southern and southeastern Asia. The Dhole has been classified as 'Endangered' on the IUCN Red List (IUCN 2015) and is severely limited in its range due to various threats, such as habitat destruction, and persecution (Kamler et al. 2015; Wolf & Ripple 2017). In Nepal, where the population is estimated to be fewer than 500 individuals (Jnawali et al. 2011), research on its status and ecology is scarce (Thapa et al. 2013). The Spotted Linsang *Prionodon pardicolor*, a nocturnal and arboreal carnivore, is one of Asia's least studied species (van Rompaey 1995). This species is classified as 'Least Concern' globally (IUCN 2015), yet it is one of 27 protected priority mammal's species in Nepal and is considered nationally Endangered due to a small population of approximately 100 individuals (Jnawali et al. 2011). Despite its national importance, the Least Concern or non-flagship species receives limited attention and is often overlooked in research and conservation initiatives due to funding constraints in Nepal (Katuwal et al. 2017; Basnet & Rai 2020). Furthermore, research on both the Spotted Linsang and the Dhole in remote areas, like the Barun Valley of Makalu Barun National Park (MBNP), remains scarce, despite their conservation importance.

This study provides the first photographic evidence of Dhole and the Spotted Linsang in Makalu Barun National Park, extending their known ranges, and offering new insights into their distribution and ecological roles within this biodiversity hotspot. This study also assesses the implications of these findings for the conservation status of these species in Nepal. By addressing gaps in knowledge about their presence and ecology, this research provides valuable insights towards more focused, extensive surveys, and the need for targeted conservation efforts to protect these two species and their fragile alpine habitats.

MATERIALS AND METHODS

Makalu Barun National Park is located in eastern Nepal, east of the Everest region, and is renowned for its exceptional topographical, and ecological diversity. It is the world's only protected area with an elevation range exceeding 8,000 m, from 435 m at the base to 8,463 m at the summit of Mt. Makalu. The park's varied altitude, combined with heavy monsoon rains, creates a complex range of microhabitats that support rich biodiversity. MBNP is home to 3,128 species of flowering plants, 315 species of butterfly, 43 reptiles, 16 amphibians, 78 fish species, 440 bird species, and 88 mammal species (Jha 2003). This study was conducted along the Barun Valley, which extends from the Makalu Glacier to Barun Dovan, Arun and Barun confluence (Image 1). This area is part of the Barun Biomeridian Research Project (The East Foundation & Future Generation University 2021), which monitors the biodiversity along a transect around 27 km, encompasses nine distinct vegetation zones, ranging from lower subtropical to nival zones, running through the valley. Four main ecozones have been identified in the Barun Valley (Dobremez & Shakya 1975; Olson et al. 2004). These areas feature pristine, dense forests that provide ideal habitats for a variety of species, including those of conservation concern. The climate in the study area is characterized by a strong seasonality, with a wet monsoon period from June to September, which contributes to the high annual rainfall, and a dry winter season from October to March, with snowfall in the peak winter.

As part of a pilot project, ten camera traps (Browning Strike Force BTC-5HDP) were deployed at ten sampling locations between April 2019 and March 2024, covering an elevation range of 1,975–3,793 m. Sampling locations were selected along an elevation gradient to represent a range of habitats within the Barun Valley, ensuring that the study captured a broad spectrum of species across different ecozones. Camera trap locations were focused on areas where wildlife trails or corridors were prominent, as these locations were expected to maximize wildlife detections. The camera traps were mounted 45–60 cm above ground level to ensure optimal detection of terrestrial wildlife while minimizing the likelihood of damage from environmental factors. In alpine zones, the cameras were positioned higher, at 60–90 cm, to prevent snow accumulation, and potential trap malfunctions due to snowfall. The cameras were set to operate 24 h a day, with each trap taking a single photograph per trigger to conserve battery life, and maximize the duration of fieldwork. These traps were checked every three months to replace memory cards and batteries. Species identification was conducted through photographic evidence, and any unidentified images were cross-checked with wildlife experts.

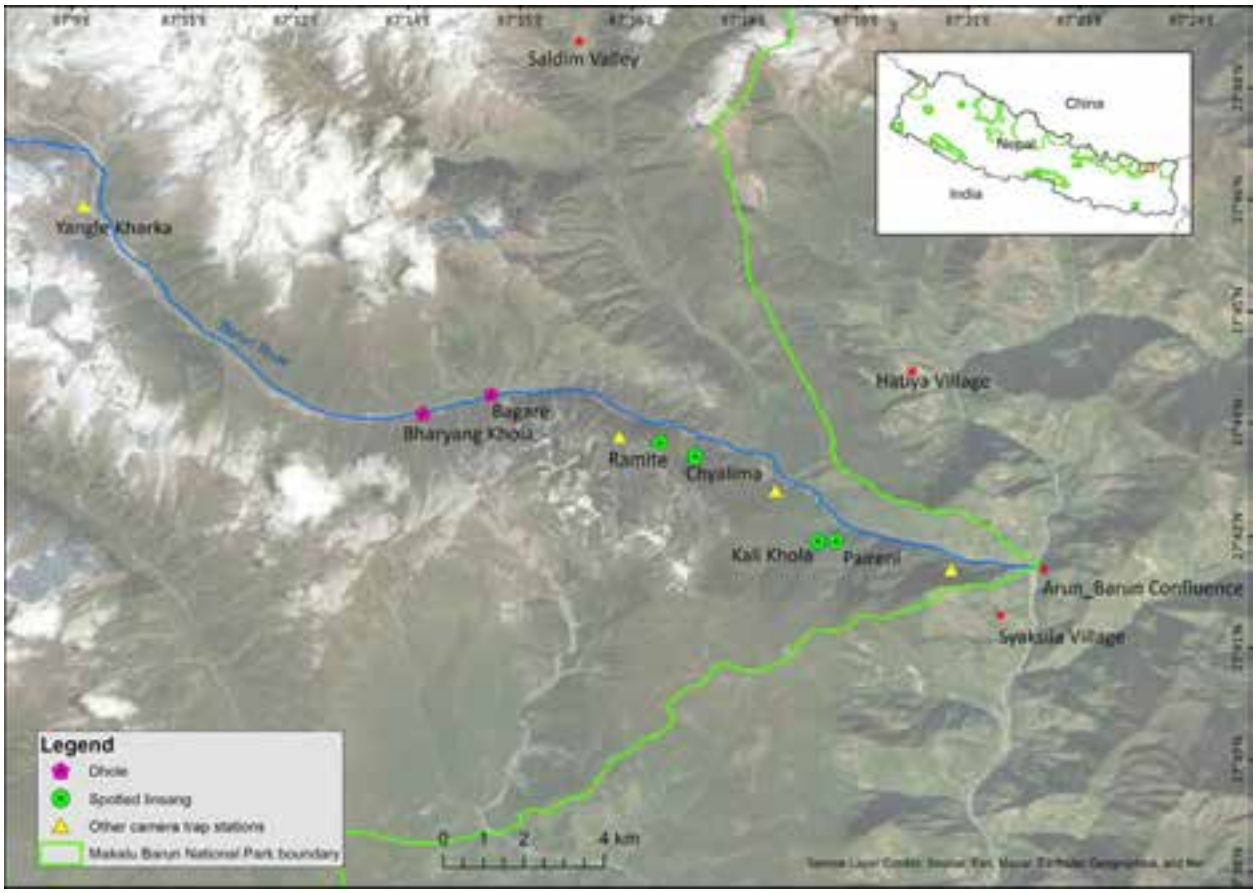

Image 1. The Barun Valley camera trap stations, where Dhole and Spotted Linsang were photographed within the Makalu Barun National Park area. The inset shows the location of the protected areas of Nepal (green boundaries).

RESULTS

This study completed a total sampling effort of 5,508 camera-days, resulting in 38,075 photographs, capturing 30 mammal species. Among these, a solitary Dhole was photographed on three independent events at two stations: Bharyang Khola (3,064 m) and Bagare (2,910 m). The relative abundance of Dhole was 0.054 per 100 trap nights (Image 1, Table 1). The first photograph was taken in November 2021, followed by two additional captures in March 2022 and August 2022 (Image 2). Both stations, located approximately 30 m from the Barun River, are characterized by dense Rhododendron and bamboo forests. All Dhole photographs were captured during daylight hours, indicating diurnal activity in the area. In addition to the Dhole, 14 other mammal species were recorded at these two stations, including prey species and potential competitors of the Dhole (Table 1).

he Spotted Linsang was photographed in 12 independent events at four stations located in the upper subtropical and temperate zones: Kali Khola (2,043 m), Ramite Danda (2,867 m), Chyalima (2,428 m), and Paireni (2,071 m) (Image 1, Image 3). The relative abundance of Spotted Linsang was 0.21 per 100 trap nights. This species was recorded at Kali Khola in dense mixed forests dominated by *Acer* and *Quercus* species, while Acer, rhododendron, and malingo forests were prevalent at the Ramite Danda station (Image 3). Additionally, Chyalima station featured malingo-Acer forests, whereas Rhododendron and *Quercus lamellosa* were the dominant species at Paireni station. All stations had good ground cover, composed of fern species. Temporal patterns revealed that the Spotted Linsang is nocturnal, with all photographs taken between 1945 h and 0439 h, most frequently during the early morning hours (0000–0359 h). Seasonal variations in detection were observed, with three events in July, two in May, and one event each in other months, except for February, August, October, and November, when the species was not recorded.

Table 1. Dhole, Spotted Linsang and other mammalian species detected in camera trap locations. * indicates the date of unusual timestamp due to snowfall in the region.

Species	Dhole	Spotted Linsang
Stations	Bagare and Bharyang Khola	Ramite Danda, Chylima, Kali Khola, and Paireni Ukalo
No. of photos	3	24
Date and time	15.xi.2020 at 1432 h, March 2022 at mid-day*, 24.viii.2022 at 1547 h	06.ix.2018 at 0230 h, 09.v.2021 at 0327 h, 22.v.2021 at 0245 h, 14.vi.2021 at 2032 h, 10.vii.2021 at 0202 h, 10.vii.2021 at 1957 h, 31.iii.2022 at 0150 h, 23.iv.2022 at 2112 h, 01.v.2022 at 2351 h, 13.vii.2022 at 0325 h, 30.xii.2022 at 0439 h, and 30.i.2024 at 2148 h
Terrain	Steep slope	Steep slope
Activity pattern	Trotting	Stalking, Ambush hunting
Other mammals captured in at these stations	Himalayan Musk deer, Himalayan Black Bear, Leopard, Leopard Cat, Yellow-throated Marten, Red Panda, Nepal Gray Langur, Assamese Macaque, Mainland Serow, Himalayan Goral, Himalayan Tahr, squirrel species, bat species and rodent species.	Asian Golden Cat, Assamese Macaque, Clouded Leopard, Himalayan Black Bear, Himalayan Goral, Himalayan Tahr, Indian Hare, Leopard Cat, Mainland Serow, Masked Palm Civet, Nepal Gray Langur, Northern Red Muntjac, Orange-bellied Himalayan Squirrel, Particolored Flying Squirrel, Red Fox, Red Giant Flying Squirrel, Royle's Pika, Siberian Weasel, Wild Boar, Yellow-bellied Weasel, Yellow-throated Marten, Rodent spp. and Bat spp.

Image 2. Solitary Dhole photographed two locations at Barun Valley: 1—Bharyang Khola at 1547 h on 24 August 2022 and Bagare | 2–3—on March 2022 & 24 August 2022 at 1547 h. © Barun Bio-meridian Research Project/Future Generation University/Department of National Park and Wildlife Conservation.

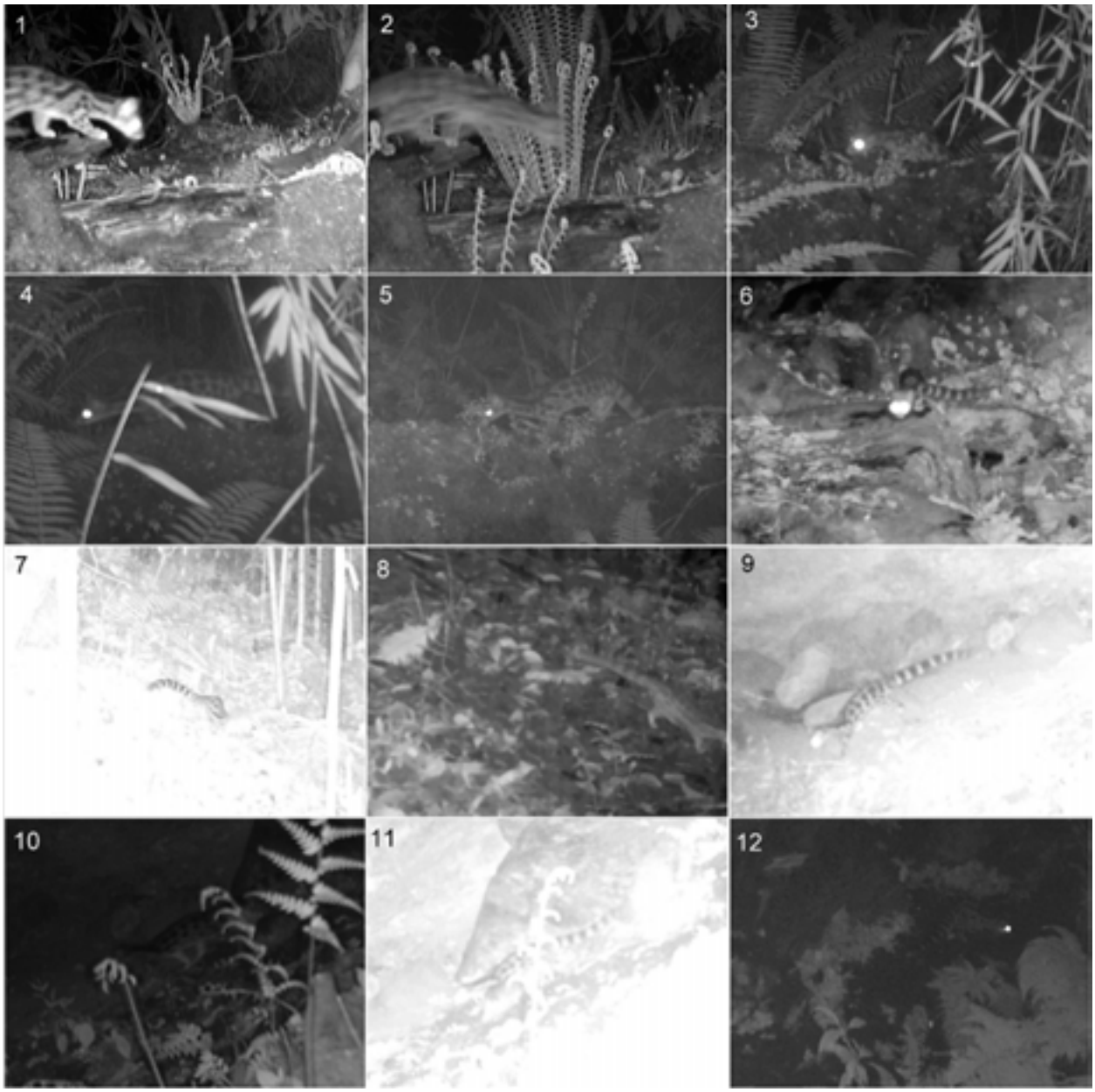

Image 3. Spotted Linsang photographed at various locations in Barun Valley: 1–5—Ramite Danda | 6—Paireni Ukalo | 7–8—Chyalima | 9–12—Kali Khola, Barun Valley. © Barun Bio-meridian Research Project/Future Generation University/ Department of National Park and Wildlife Conservation.

DISCUSSION

This study provides the first photographic evidence of the Dhole in Makalu Barun National Park. Although Ghimirey et al. (2024) confirmed Dhole's presence at 12 sites across Nepal, including Makalu Barun National Park, their findings were based on Byers et al. (2014). Similarly, previous records, such as those by Jha (2003), relied on anecdotal evidence. Dholes, as apex predators, play a vital role in shaping ecosystems by regulating prey populations, and maintaining trophic balance (Beschta & Ripple 2009). They are considered a keystone species in Bhutan (Thinley et al. 2021), and their conservation is crucial in pristine habitats, such as Makalu Barun National Park. The park's subalpine forests, rich in Dhole's prey species, including Himalayan Serow *Capricornis sumatraensis*, Himalayan Tahr *Hemitragus jemlahicus*, Himalayan Goral *Naemorhedus goral*, Assamese Macaque *Macaca assamensis*, and Nepal Grey Langur *Semnopithecus schistaceus*, provide an ideal habitat for Dholes. This abundance of prey aligns with findings from the eastern Himalaya, where Himalayan Serow, Himalayan Tahr, and

Himalayan Goral were found to constitute 98.7% of the Dhole's diet (Bashir et al. 2013), further highlighting the suitability of Makalu Barun National Park for sustaining this apex predator. Furthermore, the valley's diverse carnivores and omnivores, including Leopard *Panthera pardus*, Clouded Leopard, Himalayan Black Bear *Ursus thibetanus*, Leopard Cat *Prionailurus bengalensis*, Asiatic Golden Cat *Catopuma temminckii*, Red Panda *Ailurus fulgens*, and Yellow-throated Marten *Martes flavigula*, further underscore the complex predator-prey dynamics within the park. Despite these favourable ecological conditions, Dholes face significant threats. Prey depletion and competition with other carnivores (Karanth et al. 2004; Andheria et al. 2007; Kamler et al. 2015) challenge their survival. While they are not heavily targeted by illegal wildlife trade (Velho et al. 2012), conflicts with locals due to over livestock predation often result in retaliatory killings, as observed in Bardia National Park, and Kanchenjunga Conservation Area (Khatiwada et al. 2011; Yadav et al. 2019). In the Barun Valley, local herders occasionally report cattle predation by Dholes, but sightings have become rare in recent years despite the species once being abundant (Dukpa Thikepa Bhote pers. comm. 23.xii.2023). This emphasizes the need for conservation efforts that prioritize mitigating human-wildlife negative interactions and creating safe habitats to support Dhole population recovery within the park.

This study provides the first photographic evidence of the Spotted Linsang in Makalu Barun National Park, marking only the fifth confirmed photographic record for Nepal in recent years. Other photographic records from the Annapurna Conservation Area (Ghimirey et al. 2018), Kanchenjunga Conservation Area (Lama et al. 2024), Tinjure Milke Jallajale area (Rai et al. 2018), and Khotang and Bhojpur districts (Baral et al. 2025) highlight its elusive nature and rarity). In Nepal, records of this species have relied entirely on non-invasive camera trapping surveys due to the difficulty of obtaining direct sightings or identifying it from indirect evidence (Duckworth et al. 2016).

The Spotted Linsang was found to be nocturnal, with all 24 photographs taken between 1945 h and 0439 h, consistent with previous records from other regions (Ghimirey et al. 2018; Lama et al. 2024; Baral et al. 2025), which further complicates efforts to study the species. Our records of 12 independent events, obtained with a limited number of camera traps, indicates that Barun Valley is a key habitat for this elusive species. The Spotted Linsang in Barun Valley was recorded at elevations between 2,043 and 2,867 m, consistent with ranges reported in recent studies. Baral et al. (2025), however, documented the species at 3,228 m in Salpasilicho, Bhojpur, which may represent the highest elevation record for Nepal, although it remains below the global maximum of 3,308 m (Jennings & Veron 2015; Duckworth 2016). The habitat at Ramite Danda station resembles Annapurna Conservation Area, with ground cover dominated by ferns (Ghimirey et al. 2018). In contrast, lowland records from Chitwan National Park were in riverine forests, dense grasslands, and Sal *Shorea robusta* forests (Sunquist 1982), highlighting the species' habitat adaptability, although it appears to have a preference for evergreen forests (Jennings & Veron 2015). Information on the diet of the Spotted Linsang is limited, but its dental morphology suggests a preference for smaller prey (Jennings & Veron 2015). In Vietnam, stomach analyses of six individuals revealed remains of rodents, frogs, and snakes (Davis 1958). In the study area, rodents, shrews, and Orange-bellied Himalayan Squirrels were commonly observed at stations where Spotted Linsangs were recorded, indicating they may serve as potential prey species.

This study highlights the importance of Barun Valley as an important habitat for both the Dhole and the Spotted Linsang. Due to resource limitations and geographic challenges, only ten camera trap stations were established, with just two located in alpine areas, which are key habitats for these species. This limited sampling effort likely reduced the chances of capturing a broader range of species and encounters, particularly for more elusive carnivores. The study focused on overall biodiversity rather than targeting these two species specifically, which may have affected the depth of the findings. A more focused, extensive survey would likely yield more comprehensive information, improving the understanding of these species' distribution, behaviour, and ecological roles.

REFERENCES

Andheria, A.P., K.U. Karanth & N.S. Kumar (2007). Diet and prey profiles of three sympatric large carnivores in Bandipur Tiger Reserve, India. Journal of Zoology 273: 169–175.

Asiatic Wild Dog | CITES (2021). Convention on International Trade in Endangered Species of Wild Fauna and Flora. https://cites.org/eng/gallery/species/mammal/Asiatic_wilddog.html. Accessed on 07.iv.2025.

Bashir, T., T. Bhattacharya, K. Poudyal, M. Roy & S. Sathyakumar (2014). Precarious status of the Endangered Dhole *Cuon alpinus* in the high elevation eastern Himalayan habitats of Khangchendzonga biosphere reserve, Sikkim, India. *Oryx* 48: 125–132. https://doi.org/10.1017/S003060531200049X

Baral, B., D.R. Basnet & J. Rai (2025). First record of Spotted Linsang *Prionodon pardicolor* (Hodgson, 1841) (Mammalia: Carnivora: Prionodontidae) with photographic evidence in Khotang and Bhojpur, Eastern Nepal. Nepalese Journal of Zoology 9: 76–79. https://doi.org/10.3126/njz.v9i1.81405

Basnet, H. & A. Rai (2020). An update on the distribution of Yellow-throated Marten *Martes flavigula* in Nepal. *Nepalese Journal of Zoology* 4: 147–151. https://doi.org/10.3126/njz.v4i2.33907

Beschta, R.L. & W.J. Ripple (2009). Large predators and trophic cascades in terrestrial ecosystems of the western United States. *Biological Conservation* 142: 2401–2414. https://doi.org/10.1016/j.biocon.2009.06.015

Byers, A.C., E.A. Byers & D. Thapa (2014). Conservation and restoration of alpine ecosystems in the Upper Barun Valley, Makalu-Barun National Park, Nepal. Final report submitted to National Geographic Society. The Mountain Institute, Washington, DC, USA.

Davis, D.D. (1958). Mammals of the Kelabit Plateau, northern Sarawak. *Fieldiana Zoology* 39: 119–147. https://doi.org/10.5962/bhl.title.3475

Dobremez, J.F. & P.R. Shakya (1975). Carte Ecologique du Nepal. IV. Region Biratnagar - Kanchenjunga 1:250,000. *Documents De Cartographie Ecologique* vol. XVI: 33–48.

Duckworth, J.W., M. Lau, A. Choudhury, W. Chutipong, R.J. Timmins, D.H.A. Willcox, B. Chan, B. Long & S. Roberton (2016). *Prionodon pardicolor*. The IUCN Red List of Threatened Species 2016: e.T41706A45219917. https://doi.org/10.2305/IUCN.UK.2016-1.RLTS.T41706A45219917.en. Accessed on 7.iv.2025.

Ghimirey, Y., R. Acharya, K. Yadav, J. Rai, R. Baral, U. Neupane, B. Basnet, M. Gilbert, S. Poudel & B.J. van Rensburg (2024). Challenges and possible conservation implications of recolonizing Dholes *Cuon alpinus* in Nepal. *Oryx* 58: 378–386. https://doi.org/10.1017/S003060532300073X

Ghimirey, Y., K. Yadav, J. Rai, R. Prasai, P. Rana & R. Acharya (2018). First verifiable record of Spotted Linsang *Prionodon pardicolor* from Nepal since the nineteenth century. *Small Mammal Conservation* 56: 48–53.

Jennings, A.P. & G. Veron (2015). Predicted distributions, niche comparisons, and conservation status of the Spotted Linsang *Prionodon pardicolor* and Banded Linsang *Prionodon linsang*. *Mammal Research* 60: 107–116. https://doi.org/10.1007/s13364-014-0204-y

Jha, S.G. (2003). Linkages between biological and cultural diversity for participatory management: Nepal's experiences with Makalu-Barun National Park and Buffer Zone. *Journal of National Science Foundation Sri Lanka* 31: 41–56. https://doi.org/10.4038/jnsfsr.v31i1-2.3022

Jnawali, S.R., H.S. Baral, S. Lee, K.P. Acharya, G.P. Upadhyay, M. Pandey, R. Shrestha, D. Joshi, B.R. Lamichhane, J. Griffiths & A. Khatiwada (2011). *The Status of Nepal Mammals: The National Red List Series*. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal, 226 pp.

Kamler, J.F., N. Songsasen, K. Jenks, A. Srivathsa, L. Sheng & K. Kunkel (2015). *Cuon alpinus.* The IUCN Red List of Threatened Species 2015: e.T5953A72477893. https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T5953A72477893.en. Accessed on 7.iv.2025.

Katuwal, H.B., H.P. Sharma, P.J.L. Shaner, R. Gurung, V. Thapa, T.G. Magar, T.B. Gurung, K. Parajuli, M.B. Gurung, H. Basnet, S. Koirala, M.S. Ghimire, S. Yadav, J.L. Belant & K. Shah (2018). Updating spatial information of 27 mammal species in Nepal. *The Journal of Animal & Plant Sciences* 28: 1735–1745.

Karanth, K.U., J.D. Nichols, N.S. Kumar, W.A. Link & J.E. Hines (2004). Tigers and their prey: predicting carnivore densities from prey abundance. *Proceedings of the National Academy of Sciences of the United States of America*, 101: 4854–4858. https://doi.org/10.1073/pnas.0306210101

Khatiwada, A.P., K.D. Awasthi, N.P. Gautam, S.R. Jnawali, N. Subedi & A. Aryal (2011). The pack hunter (Dhole): Received little scientific attention. *The Initiation* 4: 8–13. https://doi.org/10.3126/init.v4i0.5531

Lama, S.T., K.A. Bugler, J.G. Ross & A.M. Paterson (2024). Diversity of mammalian species in the Kangchenjunga Landscape of eastern Nepal. *European Journal of Wildlife Research* 70: 1–16. https://doi.org/10.1007/s10344-024-01869-1

Olson, D.M., E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'Amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wettengel, P. Hedao & K.R. Kassem (2004). Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience* 51: 933–938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Rai, J., K. Yadav, Y. Ghimirey, S. G.C, R. Acharya, K. Thapa, L.P. Poudyal & N. Singh (2018). Small Carnivores in Tinjure-Milke -Jaljale, Eastern Nepal. Friends of Nature, Nepal and Rufford Small Grants, UK, 20 pp.

Sunquist, M.E. (1982). Incidental observations of Spotted Linsang *Prionodon pardicolor*. *Journal of the Bombay Natural History Society* 79: 185.

Thapa, K., M.J. Kelly, J.B. Karki & N. Subedi (2013). First camera trap record of pack hunting Dholes in Chitwan National Park, Nepal. *Canid Biology and Conservation* 16: 4–7.

The East Foundation and Future Generation University (2021). Barun Biomeridian Research Project. Future Generation University, West Virginia, USA, 49pp.

Thinley, P., R. Rajaratnam, J.F. Kamler & C. Wangmo (2021). Conserving an endangered canid: assessing distribution, habitat protection, and connectivity for the Dhole *Cuon alpinus* in Bhutan. *Frontiers in Conservation Science* 2: 1–11. https://doi.org/10.3389/fcosc.2021.654976

van Rompaey, H. (1995). The Spotted Linsang, *Prionodon pardicolor*. *Small Carnivore Conservation* 13: 10–13.

Velho, N., K.K. Karanth & W.F. Laurance (2012). Hunting: A serious and understudied threat in India, a globally significant conservation region. *Biological Conservation* 148: 210–215. https://doi.org/10.1016/j.biocon.2012.01.022

Wolf, C. & W.J. Ripple (2016). Prey depletion as a threat to the world's large carnivores. *Royal Society Open Science* 3: 160252. https://doi.org/10.1098/rsos.160252

WWF (2024). Eastern Himalayas. Accessed on 26.xi.2024. https://www.worldwildlife.org/places/eastern-himalayas

Yadav, S.K., B.R. Lamichhane, N. Subedi, R.K. Thapa, L.P. Poudyal & B.R. Dahal (2019). Dhole *Cuon alpinus* (Mammalia: Carnivora: Canidae) rediscovered in Bardia National Park, Nepal. *Journal of Threatened Taxa* 11(12): 14582–14586. https://doi.org/10.11609/jott.4714.11.12.14582-14586

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OPEN ACCESS

COMMUNICATION

Redescription of a leaf-footed bug *Homoeocerus glossatus* Ahmad & Perveen (Heteroptera: Coreidae) from Dhule, Maharashtra, India

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Abstract: We redescribe *Homoeocerus glossatus* Ahmad & Perveen, 1994 based on specimens from Navadevi, Shirpur (District Dhule, Maharashtra), collected in August 2024, with detailed digital illustrations of morphology, including genitalia, improving the limited original description. We also record host plant of the species to be *Milletia pinnata* (L.) Panigrahi, Fabaceae. This species was originally described based on specimens collected from Kerala, southern India and deposited in 'National Museum of Natural History', Washington DC, USA, but was not included in the recent checklist of Coreoidea of India. Although not recorded again from any part of India, after original description, this species has now been noted from Maharashtra, from places such as Dhule and Pune for the first time, based on previous collections.

Keywords: Coreinae, Homoeocerini, host plant, malabar, morphology, *Pongamia*, range extension, true bugs.

Editor: Anonymity requested.

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Author contributions: Jadhav collected the specimens, helped in dissection, photography, preparation of manuscript, and preparation of illustrations. All authors wrote the manuscript.

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INTRODUCTION

Genus *Homoeocerus*, Burmeister (1835) is distributed in the Ethiopian, Eastern Palearctic, and Oriental regions. Distant listed about 43 species while compiling Fauna of British India volumes and also commented on 3–4 doubtful species (Distant 1902, 1908, 1918). Many of these species mentioned by Distant are described from places which are no longer part of the present Indian territory. In fact, Distant listed or described all the species under the genus *Homoeocerus* and treated many genera like *Prismatocerus* and *Tliponius* as synonyms under *Homoeocerus*. Many of these genera are resurrected and the various included species, their known localities, their synonyms, and relevant literature, have been detailed in Coreoidea Species File (CoreoideaSF Team 2025, Coreoidea Species File Online Version). Prabakar (2013) published a list of coreids and their distribution in India. This list does not include all the species known from India, as indicated earlier (Jadhav et al. 2021); the species *H. glossatus,* which is redescribed here, is also not listed by Prabakar (2013). A complete checklist of Coreoidea of India needs to be compiled.

A few specimens of *Homoeocerus* collected from Navadevi, Shirpur (Dhule, Maharashtra), in August 2024, and some previous collections with one of us (HVG), were identified as *Homoeocerus glossatus* Ahmad & Perveen, 1994 on the basis of key and description given by Perveen (1991, unpublished PhD thesis) and Ahmad & Perveen (1994).

We are redescribing the species *H. glossatus* with several digital colour illustrations of morphology, including that of male, and female genitalia, because the original description provided only a few line drawings.

MATERIALS AND METHODS

Specimens were collected from Navadevi, Shirpur, Dhule District (Maharashtra, India) by hand picking from its host plant *Milletia pinnata* (locally called as 'Karanj'). Male and female specimens were collected from the same population, although mating was not observed. Specimens were preserved in 70% alcohol and brought to Modern College, Pune for further study. Detailed methods for study are outlined earlier in Jadhav et al. (2021). For scanning electron microscopy (SEM), parts of specimen were cleaned with absolute alcohol, dried thoroughly and mounted on stub with conducting carbon tape, coated with platinum at a thickness of about 10 nm, scanned and photographed using a JEOL JSM-6360A analytical scanning electron microscope.

Material studied: Two females and one male from Shirpur, Dhule (coll.: D. Jadhav, August 2024) and one female, from Savitribai Phule Pune University Campus (coll.: D. Jadhav, February 2025). Previously collected material: one female from Pune University campus (November 2009), on *Millettia*; one female, Vellayani, Kerala (coll.: Rajan, February 2017); one female Amba valley (Student coll., November 2017); one female, Shirur, (coll.: B. Sarode; September 2017); one male, Tamhini , Mulshi, Pune (Student coll.: August 2017).

RESULTS

Taxonomy

Family Coreidae Leach, 1815
Subfamily Coreinae Leach, 1815
Tribe Homoeocerini Amyot & Serville, 1843
Genus *Homoeocerus* Burmeister, 1835
Species *Homoeocerus glossatus* Ahmad & Perveen,1994
Taxonomical placement follows Coreoidea Species File online version.

Redescription

Size, colouration, and vestiture

Elongate bug of about 18 mm, male slightly smaller, and slender than female. Legs slender, short; none of the femora swollen or with spines underneath; hind femora not passing apex of abdomen.

Overall ochraceous, dorsally blackly punctate, with magenta tinge on antennae, pronotum, scutellum, abdominal tergites, clavus, and corium. Ventrally uniformly pale yellow. Antennae with II and III antennomeres slightly fuscus at apex while IV antennomere pale in basal half and fuscus in apical half. Older specimens are faded and show only slight tinge of reddish or magenta colouration while fresh specimens show darker magenta colouration. Fine, short, sparse, adpressed setae present all over body. Head with black setigerous granules in anterior half. Antennae also with fine black setigerous granules (Image 3A,B), except fourth segment which has only fine, short setae. Eyes pale brown (appear whitish in older specimens), ocelli reddish. Labium pale with its tip black. Pronotum with broadly pale lateral margin and one longitudinal, median levigate pale line (Image 1A). Corium with one large and one small pale yellow levigate spots on inner margin, close to membrane (these spots very indistinct in some specimens after drying); scattered setigerous granules also present on corium (Image 3B,C). Membrane

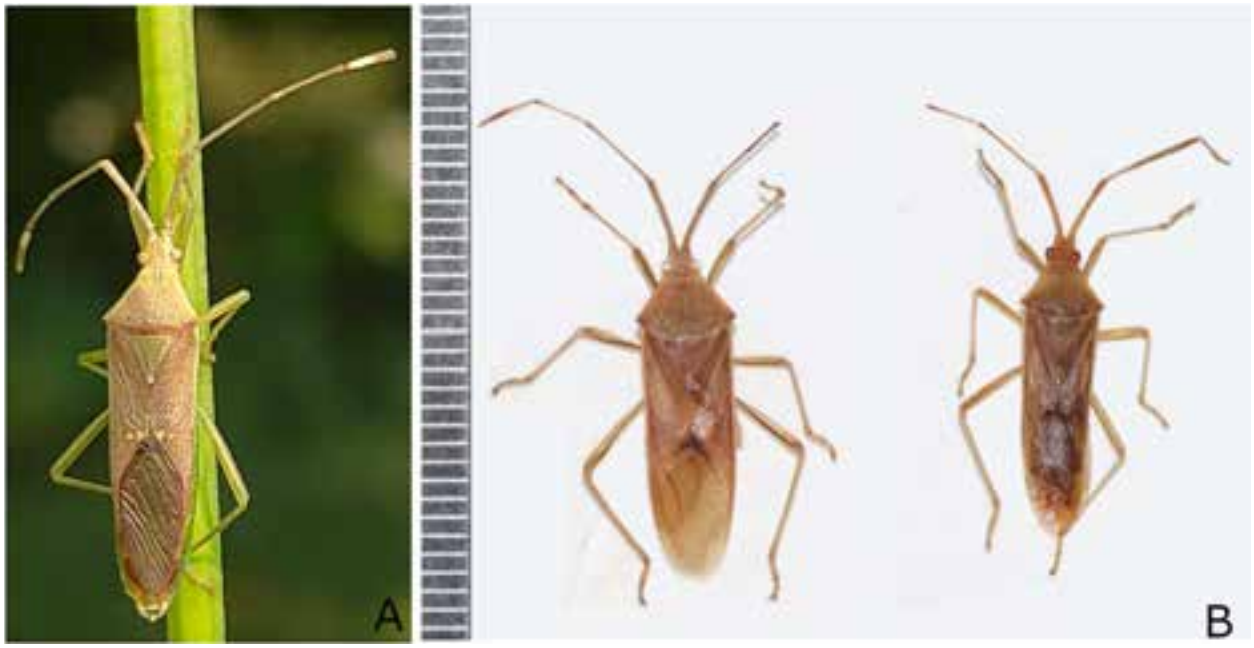

Image 1. *Homoeocerus glossatus*: A—Dorsal habitus, live bug | B—dry mounted female (on left) and male (scale in mm). © D.R. Jadhav.

translucent with multiple parallel veins, its basal angle fuscus (Image 1). Abdomen dorsally partly ochraceous with large patches of bilaterally symmetrical magenta patches on all tergites (Image 4D), ventrally ochraceous; spiracles either black or dark brown (Image 2C).

All legs uniformly pale cream, with fine punctures, and translucent, sparse, adpressed setae on femora; setae on tibia longer, darker, and denser in distal third portion. Tarsal segments densely setose with dark setae dorsally and pale setae ventrally. Claw tips black.

Structure

Head

Broader than long due to large eyes. Shape more or less rectangular, excluding eyes. Antenniferous tubercles large, situated anteriorly on either side of clypeus. Dorsally clypeus visible only as small triangle. A short, median, longitudinal sulcus present behind base of clypeus but not continued behind between eyes. Eyes large, globose, situated close to anterior border of pronotum. Ocelli slightly bulging, closer to eyes than to each other. Antennae long, first segment (scape) stout, second (pedicel), and third slender, fourth spindle shaped, and slightly thicker (Image 1A,B; 2A). Labium short, passing fore coxae; bucculae short (Image 2B).

Thorax

Pronotum rhomboidal, more than two and half times broad at humeral angles than at anterior angles, much broader than long, slightly declivous; pronotal surface densely and coarsely punctured, especially posterior to calli; anterior angles subacute, anterolateral margin straight, not crenulate; anterior margin slightly concave behind head; humeral angles slightly laterally produced, prominent but subacute; posterolateral margin gently sinuate, posterior margin straight over scutellum. Callar region of pronotum slightly depressed, more wrinkled than remaining part. Prosternum medially smooth, sulcate; mesosternum medially smooth, shallowly sulcate; metasternum medially smooth, convex; pro-, meso- and metapleural areas coarsely, and densely punctured (Image 2A, B). Metathoracic scent gland opening with elongate peritreme, anterior projection rounded, posterior projection subacute; evaporatorium small (Image 2C,D). Scutellum triangular, densely, and coarsely punctured, slightly longer than broad, with acute apex. Hemelytra with clavus showing almost similar punctures; corium also coarsely punctured but punctures slightly less dense in basal half than in distal half, its veins prominent; membrane with typical parallel veins.

Pre-genital abdomen

Dorsally connexivum well-marked from adjacent tergites, not covered over fully by hemelytra. Ventrally connexivum not well-marked from adjacent sternites, very finely wrinkled but without distinct punctures. In male as well as in female, abdomen gradually narrowed

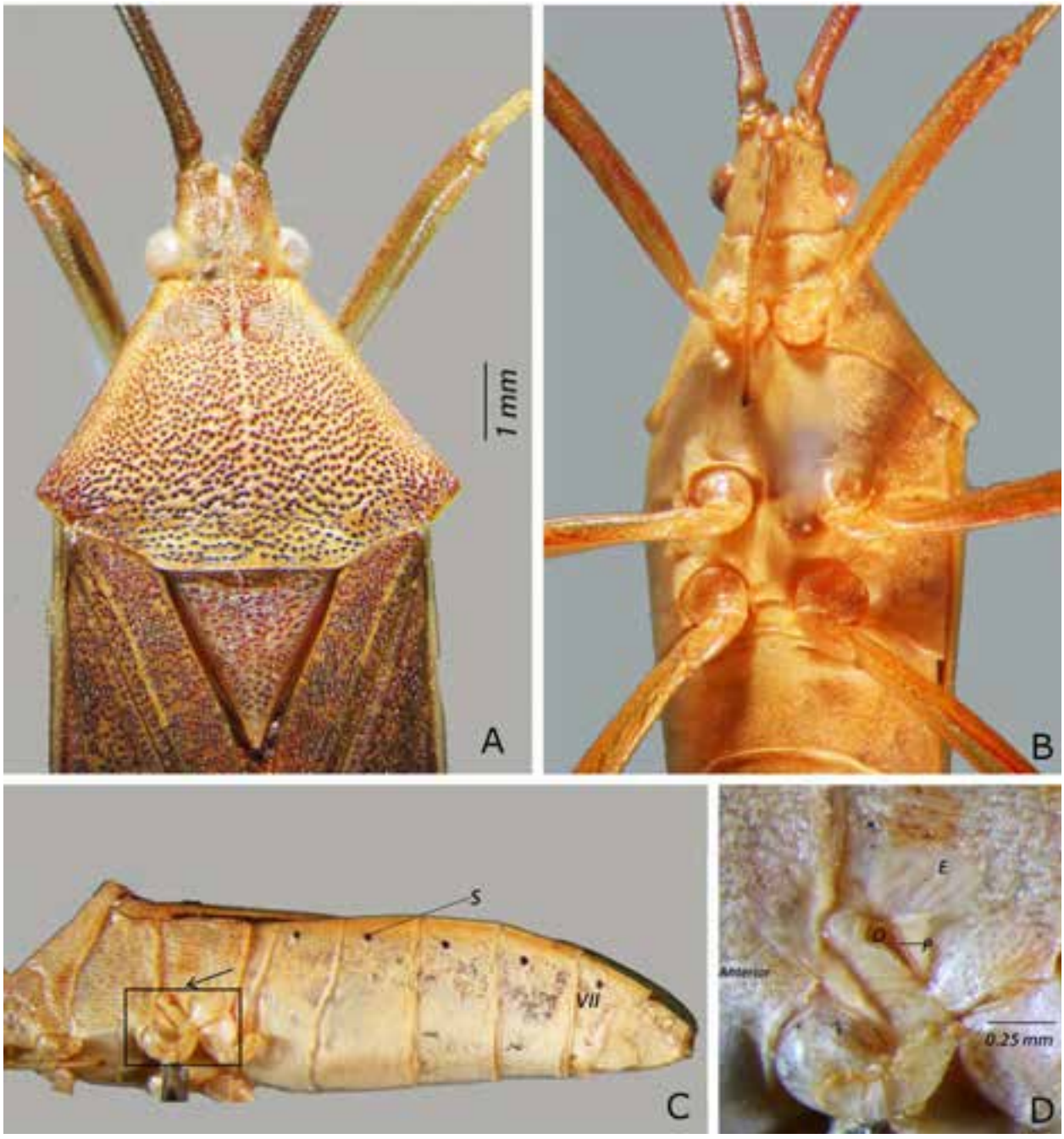

Image 2. *Homoeocerus glossatus* structure: A—head and thorax, dorsal view | B—head and thorax, ventral view | C—thorax and abdomen, lateral view. Inset marking metathoracic scent gland opening and surrounding area: S—spiracle | D—inset of C, details. Abbreviations: O—opening of gland | P—peritreme | E—evaporatory area. © H.V. Ghate.

from sixth segment to apex, segmental boundaries distinct. Spiracles slightly closer to anterior margin than lateral margin of segment.

Genital segments in male and female

Ventral side of abdomen in male and female are illustrated (Image 4A–C). In male, seventh sternite is deeply emarginate; pygophore, with its tongue like posterior process which can be seen in ventral (Image 4C,5A) and posterior view; eighth sternum is not visible. Hemelytra almost completely cover pygophore. Sometimes pygophore protrudes out automatically during preservation and hence it may be partly seen from dorsal side.

Detached pygophore is broadly oval, cup-like, ventrally convex, and dorsally flattened, gradually

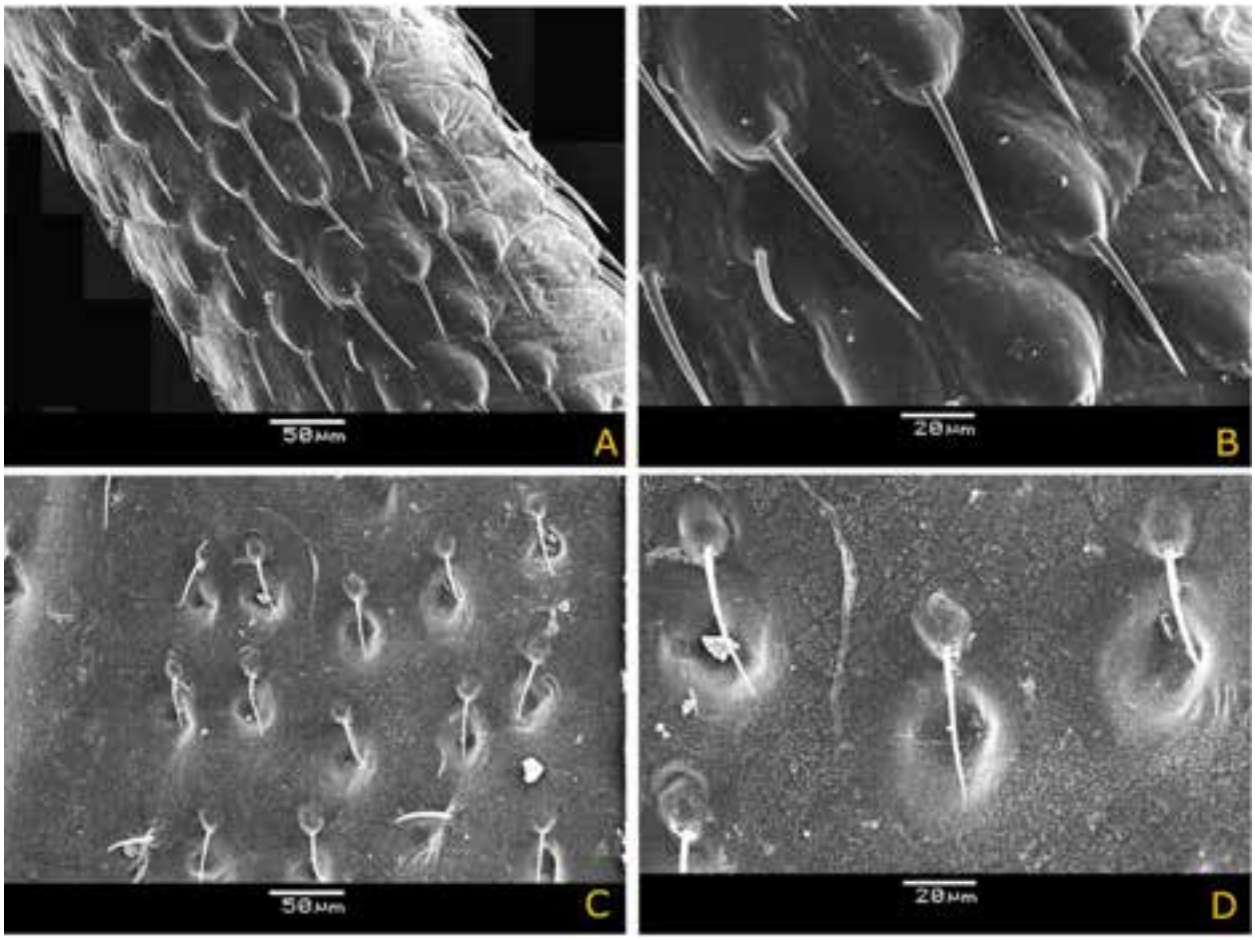

Image 3. *Homoeocerus glossatus* structure: A&B—SEM view of setae on first antennomere | C&D—SEM view of setae on corium. © H.V. Ghate.

narrowed posteriorly, its distal opening dorsal; posteroventral margin with tongue like median projection (TP) and 1+1 subacute or rounded, lateral projections; entire ventral surface and rim with moderately long, moderately dense, setae (Image 5B,C,D). Dorsally pygophore with basal membranous area which includes two sclerotized lateral patches (SP), one on either side of midline; dorsal bridge (DB) narrow, anterior to these patches (Image 5B). Phallus with well-developed articulatory apparatus, phallotheca and conjunctiva membranous (Image 5E). There is one sclerotized appendage at base of vesica dorsolaterally, with one long acute process. There is one pair of sclerotized ventral processes and pair of lateral, elongate, partially sclerotized processes. Boundaries of all the processes of conjunctiva are not clear due to unsuccessful inflation of aedeagus.

Female terminalia, as seen in ventral view, show seventh sternum slightly depressed in posterior half, with its posterior margin sinuate, and medially cleft in distal one fifth up to triangular plica; first, large, and triangular gonocoxa (or valvifer) 8 (gx8) is situated just behind the sinuate border of seventh sternum; laterotergites 8 (lt8) with its spiracle and laterotergites 9 (lt9), are seen laterally (Image 4A,B); wide, oval opening of tenth segment (=proctiger) is seen apically. Removal of tergites show the relation of different parts of female genitalia in dorsal view: the spermatheca with tubular seminal receptacle, tightly coiled part, large ampulla, and also very long spermathecal duct, as shown here; different parts, such as: ring sclerites (RS), laterotergites (lt), and valvifers or gonocoxae (gx) are also shown here (Image 6A). Separated gonocoxae eight and nine, along with associated valvulae or gonapophyses (gp8 and gp9) are illustrated (Image 6B), note setose margin of gonapophyses, and spiracle on eighth laterotergite.

Measurements (M/F) in mm (1 male / 1 female).

Total length – 16/18.5. Head length mediodorsally – 1.5/1.5; head width at eye – 2/2; head width between eyes – 1/1.05; antenna: first segment – 3.5/3.5; second segment – 4.5/4.5; third segment – abnormal/2.75;

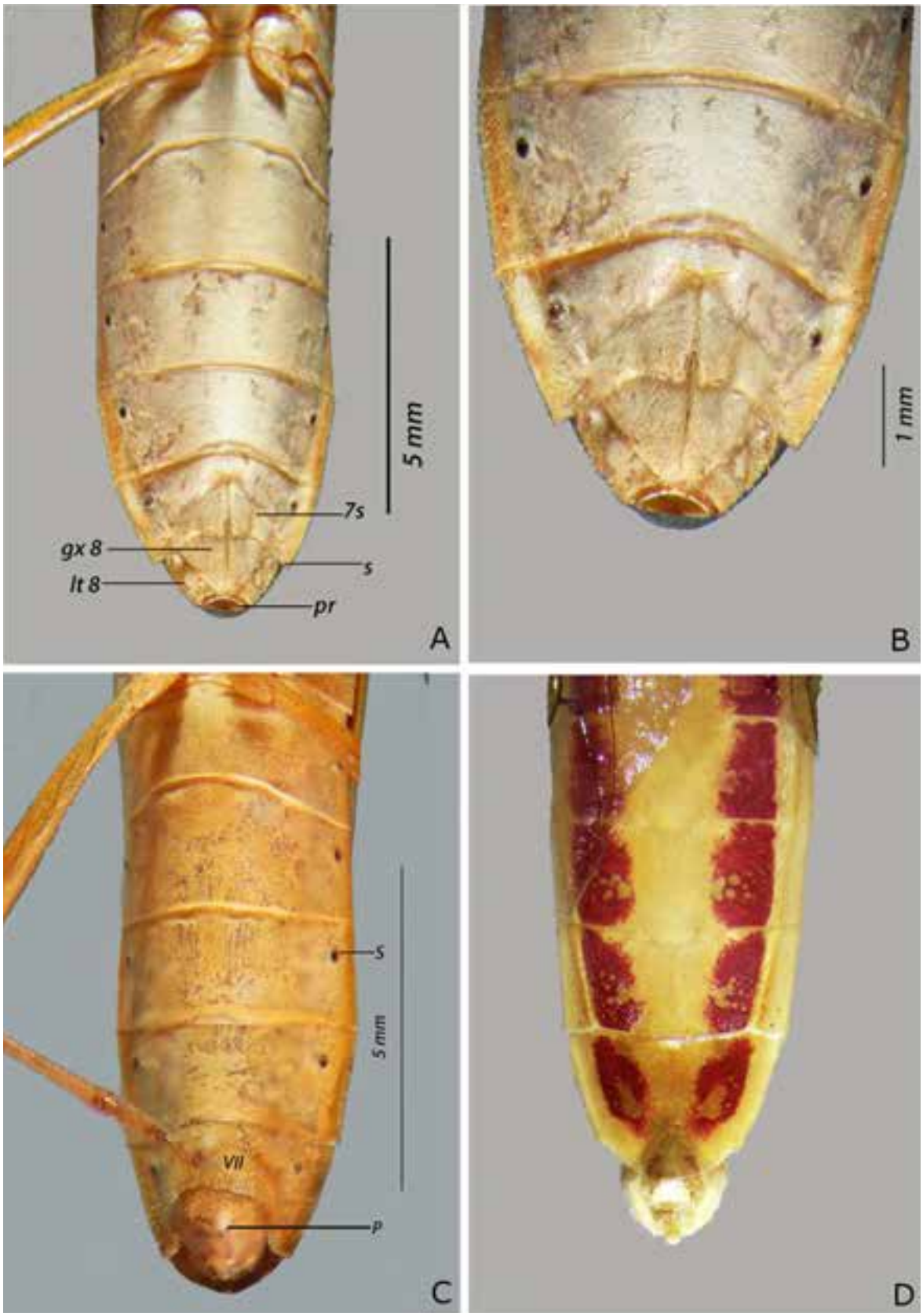

Image 4. ***Homoeocerus glossatus*** **abdomen: A&B—female abdomen, ventral view | C—male abdomen, ventral view | D—male abdomen, dorsal view. Abbreviations: gx8—gonocoxae 8 | lt8—laterotergite 8 | 7s—seventh sternum of female | S—spiracle | PR—proctiger | VII—seventh sternum male | P—pygophore or ninth segment. © H.V. Ghate.**

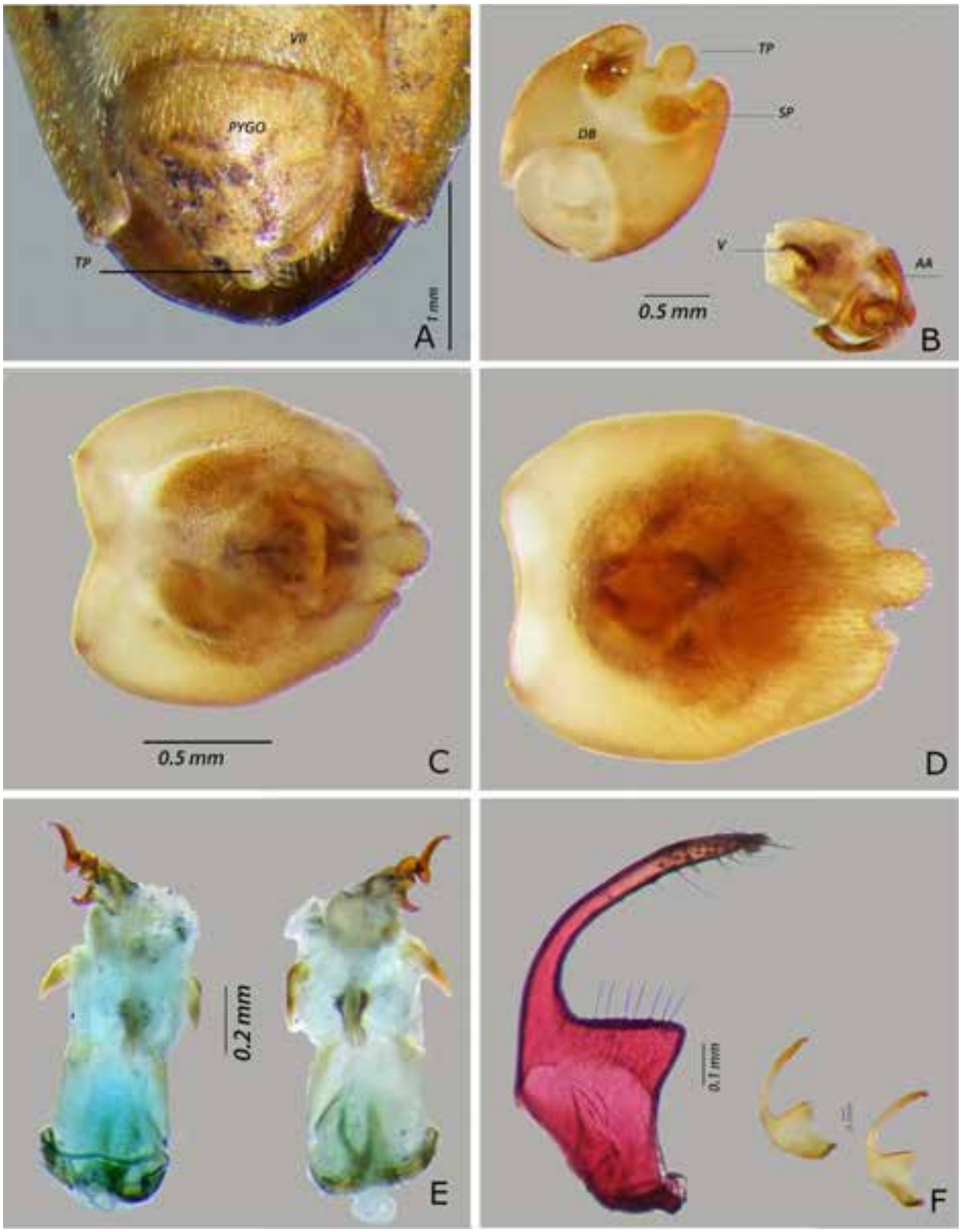

Image 5. ***Homoeocerus glossatus*** **male genitalia: A—pygophore in situ, ventral view | B—empty pygophore and uneverted phallus, dorsal view | C&D—KOH treated pygophore in dorsal and ventral view, respectively | E—everted phallus in dorsal (on left) and ventral view | F—parameres, inset parameres in two different views with setae removed. Abbreviations: PYGO—pygophore | TP—tongue like process | SP—sclerotised parts | V—vesica | AA—articulatory apparatus. © H.V. Ghate**

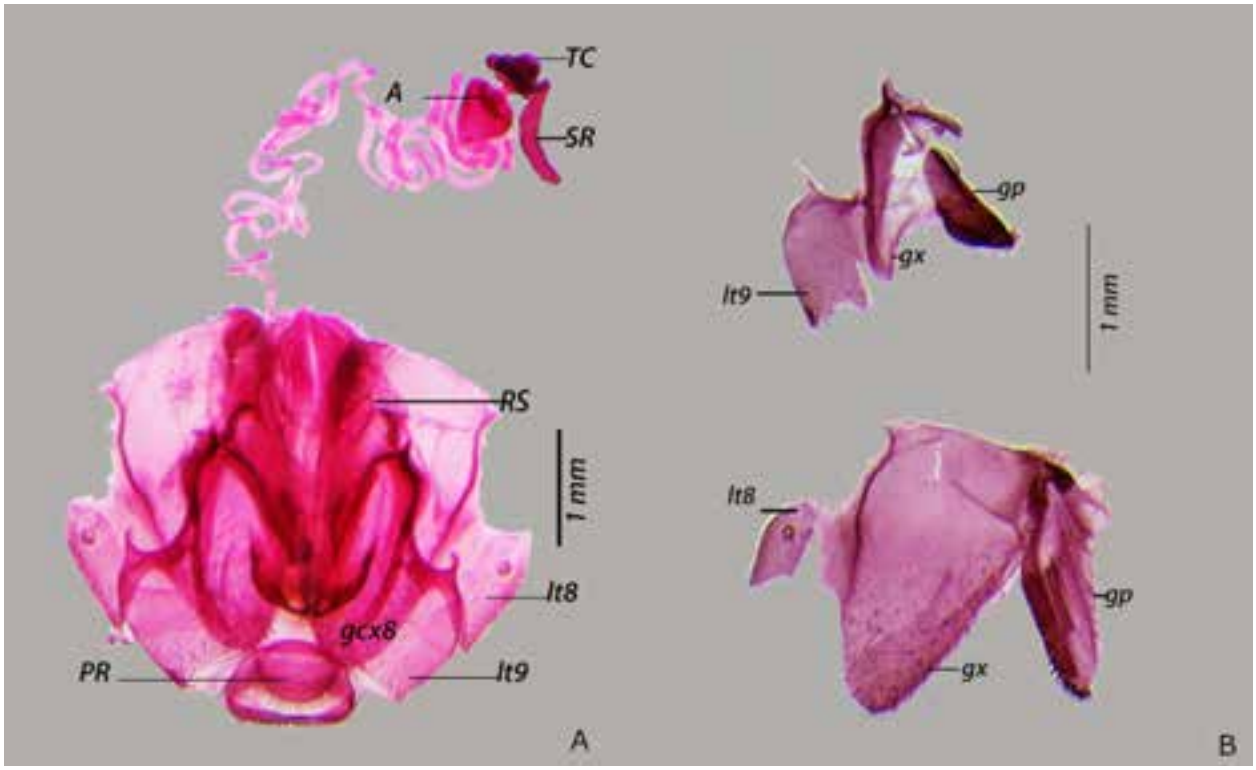

Image 6. ***Homoeocerus glossatus*** **female genitalia: A—female genitalia in dorsal view | B—dissected laterotergites, gonocoxae 8 & 9 along with associated gonapophyses. Abbreviations: A—ampulla | RS—ring sclerite | lt8 & lt9—laterotergites 8 & 9 | gx—gonocoxa | gp—gonapophyses | PR—proctiger | SR—seminal receptacle | TC—tightly coiled duct. © H.V. Ghate.**

fourth segment – abnormal/3; labium: first segment – 0.75/0.75; second segment- 0.75/0.75; third segment – 1/1; fourth segment – 1.12/1.12; pronotum breadth at anterior angles – 1.6/1.75; pronotum width at humeral angles – 4.55/5.25; median length of pronotum – 3.5/3.75; scutellum width at base – 2.1/2mm; scutellum median length – 2.25/2.3; hemelytra total length–13 /14; legs: fore coxa – 0.5/0.35; fore femur – 4.5/3.75; fore tibia – 3.5/3.6; tarsus with claw – 2/2.25; mid coxa – 0.5/0.75; mid femur – 4/4.25; mid tibia – 3.75/4.1; tarsus with claw – 2/2; hind coxa – 0.75/0.5; hind femur – 5.5/6.5; hind tibia – 5.5/5.9; tarsus with claw – 2.25/2.5.

DISCUSSION

Ahmad & Perveen (1994) described *Homoeocerus glossatus* based on seven specimens collected by P. S. Nathan from 'Malabar, Malayan Forest, 100 ft', southern India, in September 1952 (Male holotype deposited at National Museum of National History, Washington DC); one female, with the same collection details, was designated as allotype; in addition, five more females (paratypes?) collected from 'Charangade, 3500 ft' (Nilgiri Hills part, Tamil Nadu), southern India, in 1950, were also studied by them. We also studied a female specimen collected from Vellayani, Kerala, and it is identical.

Our male as well as female specimens, including structure of their genitalia, completely match with the original description, and illustrations given by Perveen (1991), and Ahmad & Perveen (1994), and so there is no doubt about the identity of the species. The original description is supplied with a few line drawings, here we are providing many additional details of morphology with several digital photographs; for example, the female genitalia are only illustrated as a gross (undissected) ventral view of apex of abdomen while we are presenting a complete in situ view of female genitalia as well as details of gonocoxae (= valvifers), and gonapophyses (= valvulae) after dissection. Spermatheca is also fully illustrated with its long duct. Kumar (1965) illustrated similar and comparable structures, giving details of dissected female genitalia in Homoeocerini, in two related species: 1) *Homoeocerus lacertosus* Distant [= *Homoeocerus* (*Anacanthocoris*) *lacertosus* Distant, 1889] and 2) *Anacanthocoris striicornis* Scott (= *Homoeocerus* (*Anacanthocoris*) *striicornis* Scott, 1874); Kumar (1965) erroneously treated that under Dasynini

(although initial list in the same paper included it correctly under Homoeocerini) (CoreoideaSF Team 2025).

This species was named as *H. glossatus* because of tongue like projection of the posteroventral margin of the pygophore, as has been shown here in several illustrations. Features of phallus, parameres, and female terminalia are also matching with figures given by the original authors. The spermatheca is typically of 'A III types' with a long spermathecal duct, as illustrated for Coreinae / Homoeocerini, in a comprehensive work on Coreidae spermatheca (Pluot-Sigwalt & Moulet 2020).

Our specimens come from more northern places as compared to the type locality -Kerala ('Malabar', old name for the major part of the coast of present Kerala, in Western Ghats; exact locality is not given in original paper). The presence of this species in Maharashtra is a considerable northward extension of the species, and it is from areas that are very wet (Mulshi) or relatively semi-arid (Dhule) or intermediate (Pune) in climatic conditions. It is quite likely that the species is more wide-spread in Maharashtra and elsewhere, as is evident from material studied. Perveen (1991) and Ahmad & Perveen (1994) did not mention the host plant. All of the specimens in Shirpur (coll. D. Jadhav) were found to be associated with *Milletia pinnata* (former name *Pongamia pinnata*, locally known as *Karanj*, in Marathi); host plants for other specimens/places were not recorded, however, a female collected in Pune also was also associated with *Milletia*. Fabaceae plants are known to attract some other *Homoeocerus* species as well (Hemant Ghate, unpublished data). This is also the first report of the species after its original description. A lack of surveys and taxonomic expertise has affected work on Coreoidea as well as other Heteroptera.

Perveen (1991) studied tribe Homoeocerini from Indian subcontinent and presented detailed and a well-illustrated work on various species of *Homoeocerus*. There are only a few recent papers giving details of morphology of Indian Coreoidea, and especially *Homoeocerus*, from India. A PhD thesis by Gupta (2012), includes description of morphology (including genitalia) of ten species of *Homoeocerus* from Punjab (India), along with photos, but *H. glossatus* was not included in that study.

Various species included under *Homoeocerus* in Distant's fauna volumes (cited above) are very briefly described or redescribed. It is often difficult to identify them due to lack of: a) recent keys, b) detailed redescriptions / illustrations and c) knowledge about within-species variations. Although redescription of some of the Indian species has been done earlier by Perveen (1991) in her PhD thesis, much additional work is necessary.

REFERENCES

Amyot, C.J.B. & A. Serville (1843). *Histoire Naturelle des Insectes Hemipteres*. Librairie Encyclopedique de Roret, Paris, 675 pp.

Ahmad I. & R. Perveen (1994). A revision of squash bug subgroup *Lacertosus* Distant of the genus *Homoeocerus* Burmeister (Hemiptera: Coreidae) with new record and description of new species from Indo-Pakistan subcontinent. *Proceedings of Pakistan Congress of Zoology* 14: 157–169

Burmeister, H. (1835). *Handbuch der Entomologie.* Zweiter Band, Besondere Entomologie, Rhynchota. Berlin, 400 pp.

CoreoideaSF Team (2025). Coreoidea Species File Online. Version 5.0/5.0. Available from: http://Coreoidea.SpeciesFile.org. Accessed on vi 2025

Distant, W.L. (1902). *The Fauna of British India including Ceylon and Burma*. Rhynchota Vol. I (Heteroptera). Taylor and Francis, London, 438 pp.

Distant, W.L. (1908). *The Fauna of British India including Ceylon and Burma.* Rhynchota Vol. IV (Homoptera and Appendix). Taylor and Francis, London, 501 pp.

Distant, W.L. (1918). *The Fauna of British India including Ceylon and Burma.* Rhynchota Vol. VII (Homoptera: Appendix; Heteroptera: Addenda). Taylor and Francis, London, 210 pp.

Gupta, R. (2012) Taxonomic studies on families Coreidae and Lygaeidae (Hemiptera: Heteroptera) from North India, supplemented with rapid markers. Unpublished PhD thesis submitted to the Punjabi University, Patiala, 361 pp + 731 figs. http://hdl.handle.net/10603/10215

Jadhav, D.R., R.R. Khairnar, B.V. Sarode, S.S. Boyane & H.V. Ghate (2021). Redescription of the bug *Aschistocoris brevicornis* (Heteroptera: Coreidae) and first report on its life history from northern Maharashtra, India. *Journal of Threatened Taxa* 13(3): 17930–17938. https://doi.org/10.11609/jott.6763.13.3.17930-17938

Kumar, R. (1965). Aspects of the morphology of Coreoidea and their value in its higher classification. *Proceedings of the Royal Society of Queensland* LXXVI (3): 27–91.

Leach, W.E. (1815). Entomology, Hemiptera, pp. 57–192. In: Brewster, D. (ed). *Edinburgh Encyclopedia - Vol. 9*. Edinburg, Scotland, 384 pp.

Perveen, R. (1991). Taxonomic study of tribe Homoeocerini Amyot & Serville (Heteroptera: Coreidae) from Indo-Pakistan Subcontinent. (Unpublished PhD Thesis submitted to the University of Karachi, Pakistan), 406 pp.

Pluot-Sigwalt, D. & P. Moulet (2020). Morphological types of spermatheca in Coreidae: bearing on intra-familial classification and tribal-groupings (Hemiptera: Heteroptera). *Zootaxa* 4834(4): 451–501. https://doi.org/10.11646/zootaxa.4834.4.1

Prabakar, D. (2013). The biogeographical distribution of species of the superfamily Coreoidea : Hemiptera in India. *Records of the Zoological Survey of India* 113(4): 103–128. https://doi.org/10.26515/rzsi/v113/i4/2013/121746

Scott, J. (1874). On a collection of Hemiptera Heteroptera from Japan. Descriptions of various new genera and species. *The Annals and Magazine of Natural History* 14(4th series): 360–365

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COMMUNICATION

Diet composition of three syntopic, ecologically divergent frogs (*Euphlyctis*, *Minervarya*, *Polypedates*) from paddy fields of Kohima, Nagaland, India

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Abstract: Monitoring indicator species like amphibians is crucial to assess habitat health. The diet of 129 anurans belonging to the three most abundant species found in the paddy fields of Kohima district in Nagaland, northeastern India—the aquatic *Euphlyctis adolfi,* the terrestrial *Minervarya nepalensis* and the arboreal *Polypedates himalayensis*—was studied. Results revealed 302 intact prey items belonging to 11 prey categories, gleaned through the stomach-flushing method. While Coleoptera was the most abundant prey found in all three species; Clitellata (terrestrial earthworms), Diptera, and Orthoptera were also important prey items. The high degree of overlap in the dietary niche of the three species despite their diverged microhabitat associations, could be the result of abundant prey items and the segregation of microhabitats. Lastly, as these frogs share a common prey base, they evidently segregate their foraging microhabitats to avoid competition.

Keywords: Aquatic, arboreal, class, index of relative importance, northeastern India, order, terrestrial.

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Author contributions: First author (TC) collected the diet content from the field and identified the diet content for analysis and drafted the manuscript. Corresponding author (SK) supervised the work, checked the manuscript and communicated it to the journal.

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INTRODUCTION

Anurans (frogs & toads) are the most diverse order of amphibians and are ecological indicator species that require close monitoring (AmphibiaWeb 2025). India is home to a vast number of little-known, threatened, and endemic amphibians, despite harbouring a very high human population and this is particularly true for the northeastern India that is one of the country's three biodiversity hotspots (Dinesh et al. 2024). The Kohima District of Nagaland has a hilly terrain and very less naturally occurring standing water. Rice terrace cultivation is a widely practiced form of agriculture in this region. Paddy fields serve as crucial habitats for anurans, providing essential standing water for breeding and supporting tadpole development, especially in regions with limited natural aquatic environments (Elphick 2000). Despite the high anuran diversity in this region (Talukdar & Sengupta 2020), a comprehensive literature review revealed only three published studies on the diet of adult anurans in northeastern India, indicating a significant research gap in this area (Chanda 1993; Ao et al. 2001; Sarkar & Dey 2022). Despite the reduced habitat heterogeneity in paddy fields, resilient generalist species inhabit these fields (Piatti et al. 2010). Paddy fields serve as surrogate habitats for aquatic species (Elphick 2000), including anurans from surrounding areas (Seshadri et al. 2020).

While some taxa demonstrate a restricted trophic niche, relying on a limited range of prey items, others exhibit a broader diet, consuming a diverse assemblage of prey organisms. Primarily, anurans feed on arthropods and they can be important pest control agents in agro-ecosystems (Khatiwada et al. 2016). Anurans play a crucial role in the food chain due to the diet they consume and also because they are prey to animals in the higher trophic levels. Niche overlap does not equate to an increase in competition among species when there are enough resources for all species (Pianka 1974). Niche partitioning studies can give insights into a community's species diversity, abundance, and distribution (Toft 1985). Information on diet helps in the understanding of ecology, natural history (Donnelly 1991), niche partitioning (Toft 1985), and community structure (Toft 1980). The present study focussed on the following two parameters: (i) to assess the composition of anurans in paddy fields; (ii) to compare the diet of the three most abundant species observed in the local paddy fields, with respect to three syntopic, ecologically-dissimilar frog species.

MATERIALS AND METHODS

Study species

Three co-occurring or syntopic frog species that have divergent habitat utilisation patterns were chosen for the study. They were: the aquatic skittering frog *Euphlyctis adolfi* (Günther, 1860), the terrestrial cricket frog *Minervarya nepalensis* (Dubois, 1975) and the arboreal tree frog *Polypedates himalayensis* (Annandale, 1912). These species depend on stagnant water for breeding and other vital life processes including metamorphosis (Chanda 2002). These species use the water from embankments for breeding during summer. While *E. adolfi* primarily inhabits water, *M. nepalensis*, and *P. himalayensis* occur primarily in the periphery of embankments on land, and on vegetation, respectively. For taxonomic definitions of the studied frog species see Sanchez et al. (2018), Saikia et al. (2020), and Dufresnes et al. (2022).

Study sites

Six paddy fields, one each from five villages and one sub-urban locality in Kohima District, Nagaland, were surveyed. The six paddy fields were located in Nehrema Village, Kohima Town, Viswema Village, Jotsoma Village, Khonoma Village, and Dzüleke Village. The closest paddy fields were 2.46 km apart.

Sampling

Sampling was carried out from March to June, i.e., pre-monsoon to monsoon during 2021–2022. Stomach-flushing was done following Solé et al. (2005) immediately after capture of each individual frog from 1800 h to 2100 h. Following the stomach-flushing, all individuals were released back into the environment. Each stomach was flushed thrice. The stomach content was stored in 70% ethanol in screw cap vials. Diet content of 129 individuals of anurans belonging to three species- *Euphlyctis adolfi* (n = 45), *Minervarya nepalensis* (n = 51), and *Polypedates himalayensis* (n = 33) were examined during the study. Diet contents were identified up to the order level under a dissecting microscope. Partially digested food items, stones, and plant materials were categorized as miscellaneous and were not considered for analysis. A significant amount of diet contents observed was either partially digested or partially eaten; hence, intact bodies of prey items were a representation of the total prey consumed. Identification keys for diet contents were taken from Gibb & Oseto (2006). Prey items were measured with Mitutoyo 505–730 dial calipers (0.02 mm accuracy). Data analysis was

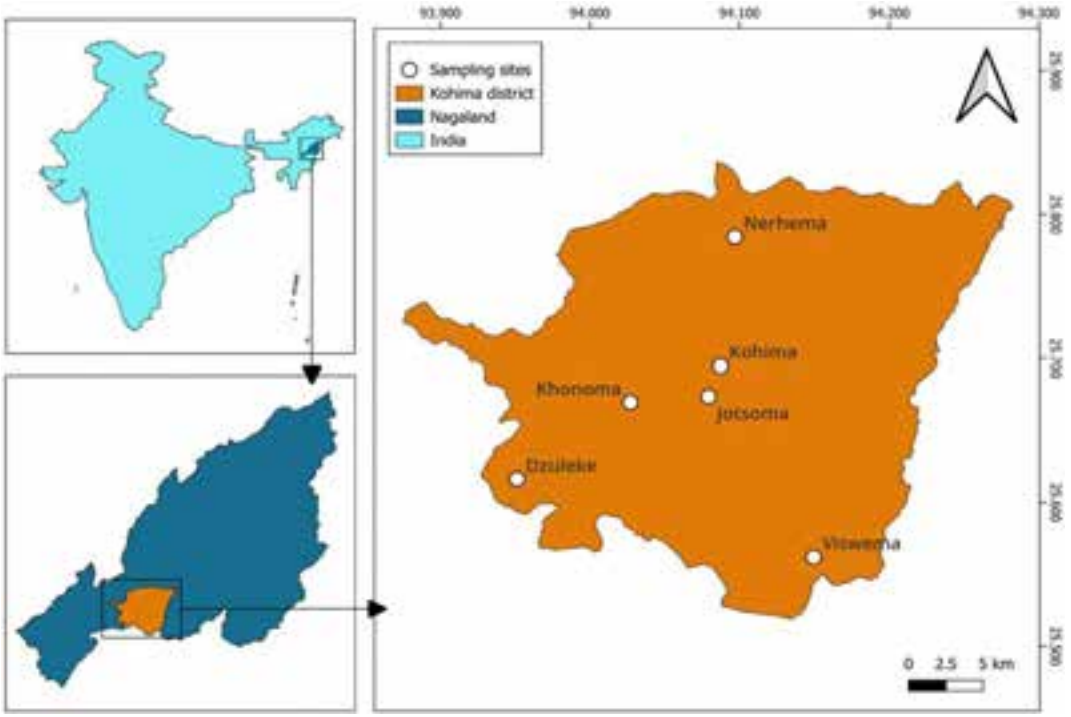

Figure 1. Map showing the study sites in Kohima District, Nagaland, northeastern India.

done using MS Excel and RStudio.

Data analysis

Vacuity index was measured as the proportion of empty stomachs to the total number of individuals of each species sampled. The volume of prey items was calculated using the formula for ellipsoid bodies (Colli & Zamboni 1999):

$$V = \frac{4}{3}\pi\left(\frac{L}{2}\right)\left(\frac{W}{2}\right)^2$$

Where, V is the volume, L is the length, and W is the width of a prey item.

The importance of diet contents was determined by ranking them using the index of relative importance (IRI) (Pinkas 1971):

$$IRI = (N + V)F$$

Where IRI = index of relative importance, N = numerical percentage, V = volumetric percentage, and F = frequency of occurrence percentage. Trophic niche breadth was calculated using the pliang non-Wiener index (Shannon & Weaver 1949):

$$H' = \sum P_i log\ (P_i)$$

Where H' is the Shannon-Weaver index, p_i is the proportion of individuals found to consume prey *i.* The H' value was standardized using the evenness index (Shannon & Weaver 1949):

$$J' = \frac{H'}{ln(n)}$$

Where J' is the measure of evenness and n is the number of species. Species were paired to calculate niche breadth by following Pianka's niche breadth formula:

$$O_{jk} = \frac{\sum_i^n p_{ij}p_{ik}}{\sqrt{\sum_i^n p_{ij}^2 \sum_i^n p_{ik}^2}}$$

Where $\hat{O}_{jk}$ is Pianka's measure of niche overlap, $\hat{P}_{ij}$ is the proportion of i^{th} resource used by j^{th} species and $\hat{P}_{ik}$ is the proportion of i^{th} resource used by k^{th} species.

RESULTS

Out of the 169 individual anurans belonging to the three species that were examined, 129 individuals contained food items in their stomachs. A total of 302 intact prey items were recovered which belonged to three classes (Insecta, Clitellata and Malacostraca) and 11 categories (Araneae, Coleoptera, Diptera, Orthoptera, Blattodea, Hemiptera, Lepidoptera (larva), Hymeniptera, Trichoptera, Clitellata, Decapoda), respectively. It was observed that several individuals had empty stomachs: 21 individuals of *Minervarya nepalensis* (vacuity index

= 29.58%), 14 individuals of *Euphlyctis adolfi* (vacuity index = 23.73%), and five individuals of *Polypedates himalayensis* (vacuity index = 13.16%). Partially digested prey was observed in several individuals of anurans while intact prey was relatively fewer. Results showed that *E. adolfi* consumed prey of eight categories while *M. nepalensis* and *P. himalayensis* consumed prey of nine categories, respectively. Statistical analysis revealed that the difference in the total number of prey consumed among the species was not significant (Kruskal-Wallis chi-squared = 2, df = 2, p = 0.3679).

Euphlyctis adolfi consumed the highest number of prey followed by *P. himalayensis* and *M. nepalensis*. *Polypedates himalayensis* on average consumed the highest number of prey per individual (Table 1). There was a statistically significant difference between the total number of prey consumed by the individuals of the three species (Kruskal-Wallis test = 28.232, df = 2, p <0.05). Coleoptera was the most common prey item in all the three species (relative occurrence: 34.88% relative occurrence in *E. adolfi*, 32% in *M. nepalensis* and 48.98% in *P. himalayensis*).

Table 1. Average prey consumed per individual of each species.

Frog species	No. of anurans	No. of prey (n)	Mean	SD
E. adolfi	45	129	2.867	2.06
M. nepalensis	51	75	1.471	1.17
P. himalayensis	33	98	2.97	1.49

Table 2. Niche breadth values measured with Shannon-Weaver index and evenness measure.

Frog species	H'	J'
M. nepalensis	1.87	0.851
E. adolfi	1.67	0.805
P. himalayensis	1.59	0.722

Table 3. Niche overlap values measured with Pianka's measure.

Frog species	*M. nepalensis*	*E. adolfi*	*P. himalayensis*
M. nepalensis	1	0.728	0.949
E. adolfi	0.728	1	0.765
P. himalayensis	0.949	0.765	1

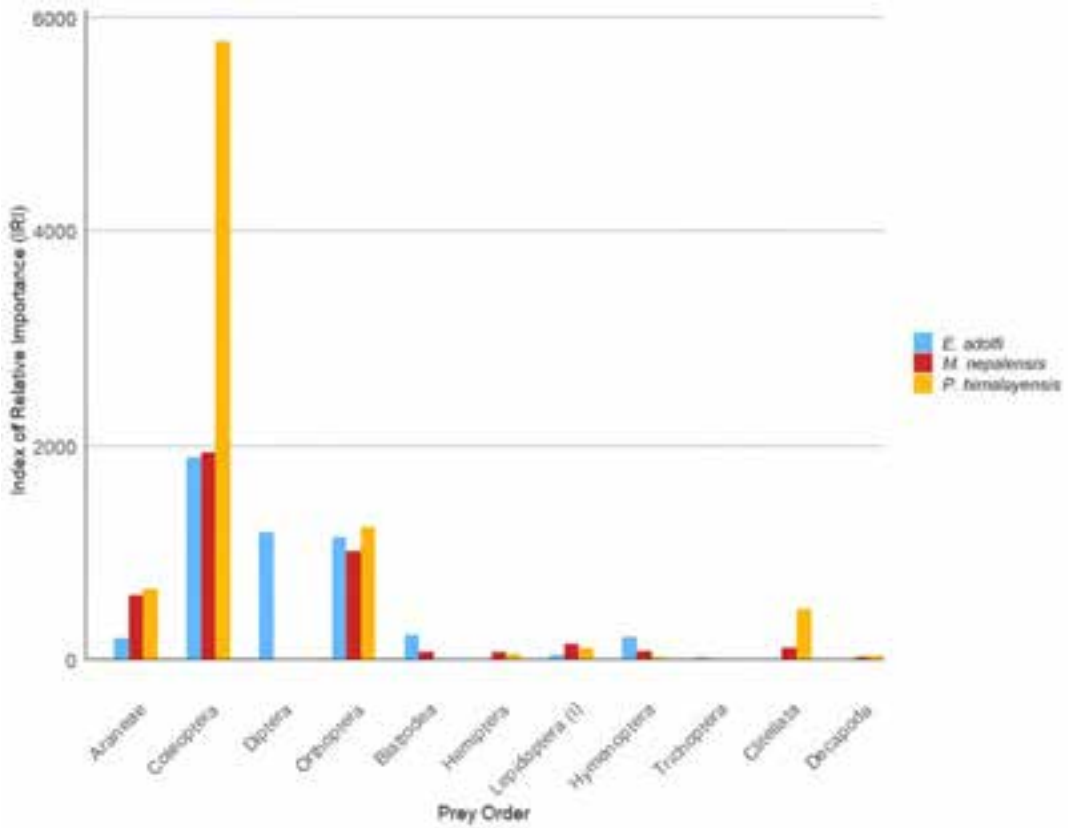

Figure 2. Index of relative importance values across prey orders of *Euphlyctis adolfi*, *Minervarya nepalensis* and *Polypedates himalayensis*.

Niche breadth and niche overlap

Dietary niche breadth was broadest in *M. nepalensis* and narrowest in *P. himalayensis* (Table 2). Niche overlap was highest between *M. nepalensis* and *P. himalayensis* and lowest between *M. nepalensis* and *E. adolfi* (Table 3). There was a high degree of overlap in the dietary niche of the three species.

Index of relative importance

Coleoptera (beetles) were the most abundant prey order found to be consumed by all three species studied. Prey categories Coleoptera, Orthoptera, and Clitellata were the highest contributors to the IRI value by volume for *M. nepalensis* (Table 5). In *P. himalayensis*, the diet volume was contributed mostly by class Clitellata (terrestrial earthworms) (Table 6). On the other hand, the largest volume contributors to the diet of *E. adolfi* were the orthopterans (Table 4). For all three species, coleopterans had the highest score for the Index of Relative Importance (IRI). Other important prey orders for *E. adolfi* were Diptera and Orthoptera. Orthoptera and Araneae were the highest contributors to IRI values in both *M. nepalensis* and *P. himalayensis.* The total prey volume was the highest in *E. adolfi* (568.36 cm^3, n = 45), while *M. nepalensis*, and *P. himalayensis* had similar volume (189.95 cm^3, n = 51 and 276.41 cm^3, n = 33, respectively).

DISCUSSION

Each of the three studied species have wide distribution across northeastern India (Chanda 2002; Ao et al. 2003; Dinesh et al. 2024) and was found to be the most abundant species in paddy field habitats in the studied areas. Due to their resilience and generalist behaviour, these species can thrive in this altered habitat. Other co-occurring species, viz., *Hyla annectans, Duttaphrynus melanostictus, Microhyla* sp., *Zhangixalus burmanus*, and *Zhangixalus smaragdinus* were excluded from this study due to small sample size present in our observations.

The vacuity index reveals a relatively high proportion of individuals with empty stomachs. A similar study found that anurans feed at a lower intensity during drier periods (Das 1996a). The high degree of dietary niche overlap is attributable to the similarity of IRI ratings of prey items among the three species. Coleoptera was the most important prey order according to the IRI values across all species. Diptera and Orthoptera ranked second and third in IRI values for *E. adolfi* respectively; while Orthoptera and Araneae ranked second and third

Table 4. Index of relative importance and its variables for *Euphlyctis adolfi*.

Prey Order / Class	Volume (%)	Frequency (%)	Number (%)	IRI
Araneae	3.19	15.56	9.30	194.38
Coleoptera	9.41	42.22	34.88	1870.27
Diptera	6.74	31.11	30.23	1150.36
Orthoptera	42.20	20	9.30	1030.05
Blattodea	28.96	11.11	4.65	373.50
Hemiptera	0	0	0	0
Lepidoptera (larva)	5.94	4.44	2.33	36.73
Hymenoptera	3.05	13.33	6.98	133.68
Trichoptera	0.50	6.67	2.33	18.83
Clitellata	0	0	0	0
Decapoda	0	0	0	0

Table 5. Index of relative importance and its variables for *Minervarya nepalensis*.

Prey Order / Class	Volume (%)	Frequency (%)	Number (%)	IRI
Araneae	12.41	19.61	17.33	583.29
Coleoptera	22.07	35.29	32.00	1908.42
Diptera	0	0	0	0
Orthoptera	20.62	25.49	20.00	1035.47
Blattodea	4.55	7.84	5.33	77.53
Hemiptera	8.30	5.88	4.00	72.35
Lepidoptera (larva)	6.25	7.84	9.33	122.21
Hymenoptera	0.85	9.80	6.67	73.69
Trichoptera	0	0	0	0
Clitellata	23.14	3.92	2.67	101.20
Decapoda	3.54	3.92	2.67	24.34

Table 6. Index of relative importance and its variables for *Polypedates himalayensis*.

Prey Order / Class	Volume (%)	Frequency (%)	Number (%)	IRI
Araneae	7.53	30.30	13.27	630.21
Coleoptera	29.69	72.73	48.98	5721.20
Diptera	0	0	0	0
Orthoptera	13.72	39.39	17.35	1223.66
Blattodea	0.98	3.03	1.02	6.05
Hemiptera	3.76	6.06	4.08	47.50
Lepidoptera (larva)	4.83	9.09	6.12	99.53
Hymenoptera	0.28	6.06	3.06	20.24
Trichoptera	0	0	0	0
Clitellata	30.18	12.12	4.08	415.30
Decapoda	9.05	6.06	2.04	67.22

in IRI values for *M. nepalensis* and *P. himalayensis*, respectively. Clitellata was absent in the diet of *E. adolfi* owing to the anuran's aquatic habitat. Though *P. himalayensis* is a tree frog, it is often observed on the ground in paddy fields during the breeding period. We have observed that they consume prey of Clitellata (terrestrial earthworms) during this period.

Das (1996) reported that the related, peninsular Indian species *P. maculatus* feeds both on ground and trees and classified it as a terrestrial feeder. *Polypedates himalayensis* have been reported to deposit eggs on forest floors. Individuals of this species were observed calling from holes in the ground and paddy fields (Rangad et al. 2012), indicating that this species spends its breeding period on ground, descending from the nearby bushes. Therefore, niche overlap values indicate a high degree of overlap in the diet of these anurans. Diptera and Trichoptera were found only in *E. adolfi* while Clitellata, Hemiptera, and Decapoda were found only in *M. nepalensis* and *P. himalayensis.* The decapod prey items observed were freshwater shrimps.

Although several studies have reported the presence of stones and plant materials in the diet of anurans, the cause for ingesting such materials has not been ascertained (Modak et al. 2018; Bahuguna et al. 2019). The presence of such materials may be attributed to accidental ingestion. This study also reveals that all the three observed species lack specialization in the food intake and are hence considered generalists in their feeding habit. Previous studies on *E. adolfi* also reported that coleopterans occupied the highest volume percentage amongst all arthropod prey items consumed (Das & Coe 1994; Das 1996b).

It was observed that although there is a high dietary niche overlap among the species, the three species occupied different microhabitats, thus minimizing the chances of competition between species. *E. adolfi* individuals were primarily observed swimming or floating on water. *Polypedates himalayensis* were recorded from microhabitats with less water, such as wet soil, and moist edges of embankments within paddy fields. *Minervarya nepalensis* individuals were observed to be wide-ranging, their microhabitats overlapping between *E. adolfi,* and *P. himalayensis*. Within the embankments, *M. nepalensis* was seen at the edges and did not swim / float unless while escaping from the observer.

CONCLUSION

In this study eight species of anurans were recorded from paddy fields; out of which three were studied for their diet preferences. The study site has a hilly terrain with several torrential streams. The landscape has limited areas of wetland habitats, which make paddy fields a vital refuge for anurans as they require wetlands for breeding, larval development, and a source of food for both adults, and tadpoles. While some species may use the paddy field areas for breeding only, the studied species have been found outside their breeding period in this habitat. This indicates that these three species are resilient generalists (Piatti et al. 2010). Among the three species, *E. adolfi* was the only species that had been studied previously (Das & Coe 1994). The present study revealed a high degree of overlap of prey among the three species with a low number of ingested prey.

The niche overlap and coexistence of the species suggest two hypotheses. Firstly, the interspecific competition caused by the niche overlap is not enough to drive any species to competitive exclusion due to the abundance of prey base. Secondly, the existing competition has not lasted long enough for species to evolve different diets. These have been supported by Pianka (1974) and Piatti & Souza (2011). Although the dietary niche overlap is high among the species, the overall niche may be differentiated according to observations in microhabitat usage. Future studies are recommended to include prey diversity studies and extend the sampling period through the monsoon to the post-monsoon seasons. To determine the overall niche differentiation among these three syntopic frog species, we suggest the inclusion of other niche dimensions such as aural niche, in addition to spatial, and trophic niches studied here.

REFERENCES

Ao, M., S. Bordoloi & A. Dutta (2001). Food and feeding behaviour of *Hyla annectans* (Jerdon, 1870) in Nagaland, India. *Zoos' Print Journal* 16: 535–536. https://doi.org/10.11609/JoTT.ZPJ.16.7.535-6

AmphibiaWeb (2025). University of California, Berkeley, California. https://amphibiaweb.org Accessed 15.iii.2025.

Bahuguna, V., A. Chowdhary, S. Singh & S. Bahuguna (2019). A food spectrum analysis of three bufonid species (Anura: Bufonidae) from Uttarakhand region of the western Himalaya, India. *Journal of Threatened Taxa* 11(13): 14663–14671. https://doi.org/10.11609/jott.4335.11.13.14663-14671

Chanda, S. (1993). Food and Feeding habits of some Amphibian species of northeast India. *Records of the Zoological Survey of India* 93: 15. https://doi.org/10.26515/rzsi/v93/i1-2/1993/160858

Chanda, S.K. (2002). *Handbook. Indian Amphibians*. Zoological Survey of India, Calcutta, India, 335 pp.

Colli, G.R. & D.S. Zamboni (1999). Ecology of the Worm-Lizard *Amphisbaena alba* in the Cerrado of Central Brazil. *Copeia* 1999(3): 733–742. https://doi.org/10.2307/1447606

Das, I. (1996a). Folivory and seasonal changes in diet in *Rana hexadactyla* (Anura: Ranidae). *Journal of Zoology* 238(4): 785–794. https://doi.org/10.1111/j.1469-7998.1996.tb05430.x

Das, I. (1996b). Resource use and foraging tactics in a south Indian

amphibian community. *Journal of South Asian Natural History* 2(1): 30.

Das, I. & M. Coe (1994). Dental morphology and diet in anuran amphibians from south India. *Journal of Zoology* 233: 417–427. https://doi.org/10.1111/j.1469-7998.1994.tb05274.x

Dinesh, K.P., K. Deuti & B. Saikia (2024). *Checklist of Fauna of India: Animalia, Chordata, Amphibia*. E-checklist. Publications of the Zoological Survey of India, 21 pp.

Donnelly, M. (1991). Feeding Patterns of the Strawberry Poison Frog, *Dendrobates pumilio* (Anura: Dendrobatidae). *Copeia* 1991: 723. https://doi.org/10.2307/1446399

Dufresnes, C., S. Mahony, V.K. Prasad, R.G. Kamei, R. Masroor, M.A. Khan, A.M. Al-Johany, K.B. Gautam, S.K. Gupta, L.J. Borkin, D.A. Melnikov, J.M. Rosanov, D.V. Skorinov, A. Borzée, D. Jablonski & S.N. Litvinchuk (2022). Shedding light on taxonomic chaos: Diversity and distribution of South Asian skipper frogs (Anura, Dicroglossidae, *Euphlyctis*). *Systematics and Biodiversity* 20(2102686): 1–25. https://doi.org/10.1080/14772000.2022.2102686

Elphick, C. (2000). Functional Equivalency between Rice Fields and Seminatural Wetland Habitats. *Conservation Biology* 14: 181–191. https://doi.org/10.1046/j.1523-1739.2000.98314.x

Gibb, T. & C. Oseto (2006). *Arthropod Collection and Identification Field and Laboratory Techniques*. Elsevier Academic Press, Amsterdam, Boston, 311 pp.

Khatiwada, J.R., S. Ghimire, S. Paudel Khatiwada, B. Paudel, R. Bischof, J. Jiang & T. Haugaasen (2016). Frogs as potential biological control agents in the rice fields of Chitwan, Nepal. *Agriculture, Ecosystems & Environment* 230: 307–314. https://doi.org/10.1016/j.agee.2016.06.025

Modak, N., H. Chunekar & A. Padhye (2018). Life History of Western Ghats endemic and threatened Anuran – Matheran Leaping Frog, (*Indirana leithii*) with notes on its feeding preferences. *Journal of Natural History* 52: 27–28. https://doi.org/10.1080/00222933.2018.1488008

Pianka, E. (1974). Niche Overlap and Diffuse Competition. *Proceedings of the National Academy of Sciences of the United States of America* 71: 2141–2145. https://doi.org/10.1073/pnas.71.5.2141

Piatti, L. & F. Souza (2011). Diet and resource partitioning among anurans in irrigated rice fields in Pantanal, Brazil. *Brazilian Journal of Biology = Revista Brasleira de Biologia* 71: 653–661. https://doi.org/10.1590/S1519-69842011000400009

Piatti, L., F. Souza & P.L. Filho (2010). Anuran assemblage in a rice field agroecosystem in the Pantanal of central Brazil. *Journal of Natural History* 44: 1215–1224. https://doi.org/10.1080/00222930903499804

Pinkas, L. (1971). Food habits of albacore, bluefin tuna, and bonito in California waters. *Fish Bulletin U.S.* 152: 1–139.

Rangad, D., R.K.L. Tron & R.N.K. Hooroo (2012). Geographic distribution: *Polypedates himalayensis. Herpetological Review* 43(4): 614.

Saikia, B., A. Bora, B. Sinha & J. Purkayastha (2020). A note on the type locality of Himalayan Treefrog, *Polypedates himalayensis* (Annandale, 1912) (Anura: Rhacophoridae). *Reptiles & Amphibians* 27: 517–518.

Sanchez, E., S.D. Biju, M.M. Islam, M.K. Hasan, A. Ohler, M. Vences & A. Kurabayashi (2018). Phylogeny and classification of fejervaryan frogs (Anura: Dicroglossidae). *Salamandra* 54: 109–116.

Sarkar, S. & M. Dey (2022). Feeding Selectivity in Anuran Species from a Tea Cultivation Area of Barak Valley, Assam, India. *Russian Journal of Herpetology* 29: 127–136. https://doi.org/10.30906/1026-2296-2022-29-3-127-136

Seshadri, K.S., J. Allwin, S. Karimbumkara & G. Tg (2020). Anuran assemblage and its trophic relations in rice-paddy fields of South India. *Journal of Natural History* 54: 2745–2762. https://doi.org/10.1080/00222933.2020.1867772

Shannon, C. & W. Weaver (1949). *The Mathematical Theory of Communication*. Univ. Illinois Press, Urbana, 117 pp.

Solé, M., O. Beckmann, B. Pelz, A. Kwet & W. Engels (2005). Stomach-flushing for diet analysis in anurans: An improved protocol evaluated in a case study in Araucaria forests, southern Brazil. *Studies on Neotropical Fauna and Environment* 40: 23–28. https://doi.org/10.1080/01650520400025704

Talukdar, S. & S. Sengupta (2020). Edible frog species of Nagaland. *Journal of Environmental Biology* 41(4): 927–930.

Toft, C.A. (1980). Feeding ecology of thirteen syntopic species of anurans in a seasonal tropical environment. *Oecologia* 45(1): 131–141. https://doi.org/10.1007/BF00346717

Toft, C.A. (1985). Resource partitioning in amphibians and reptiles. *Copeia* 1985(1): 1–21. https://doi.org/10.2307/1444785

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REVIEW

A checklist of avifauna of Telengana, India

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Abstract: The avifaunal diversity of Telangana is in the process of being comprehensively documented. Due to the lack of a consolidated database, many doubtful avian species have found their way into various checklists published periodically. This checklist includes bird species currently investigated through field surveys or known to occur from literature within the boundaries of Telangana. This checklist encompasses accepted common names, scientific names along with their authorities, vernacular name, IUCN conservation status, and their listing under the Indian Wildlife Protection Act. The avifaunal richness of Telangana is represented by 452 species belonging to 24 orders and 82 families. It is noteworthy that two species, the Great Indian Bustard *Ardeotis nigriceps* (Vigors, 1831) and Jerdon's Courser *Rhinoptilus bitorquatus* (Blyth, 1848), are considered locally extinct from the state.

Keywords: Avian diversity, birds, database, IUCN Red List status, new records, rare birds, threatened birds, vernacular name, Wildlife (Protection) Act.

Telugu: తెలంగాణలో పక్షి వైవిధ్యం సమగ్రంగా నమోదు చేసే ప్రక్రియలో ఉంది. ఏకీకృత డేటాబేస్ లేకపోవడం వల్ల, అనేక సందేహాస్పద పక్షి జాతులు అనేక చెక్‌లిస్ట్‌లలో చేర్చబడ్డాయి. ఈ చెక్‌లిస్ట్‌లో ప్రస్తుతం సర్వేల ద్వారా పరిశోధించబడిన లేదా తెలంగాణ సరిహద్దుల్లోని సాహిత్యం నుండి సంభవించినట్లు తెలిసిన పక్షి జాతులు ఉన్నాయి. ఈ సమీక్ష సర్వేల ద్వారా లేదా సాహిత్యం నుండి తెలంగాణలో ప్రస్తుతం సంభవించే పక్షి జాతుల జాబితాను అందిస్తుంది. ఈ చెక్‌లిస్ట్‌లో పక్షుల సాధారణ పేర్లు, శాస్త్రీయ పేర్లతో పాటు స్థానిక పేరు, IUCN పరిరక్షణ మరియు భారతీయ వన్యప్రాణుల రక్షణ చట్టం వివరాలు అందించబడ్డాయి. తెలంగాణలో పక్షి వైవిధ్యం 452 జాతులు (24 ఆర్డర్‌లు మరియు 82 కుటుంబాలకు) చెందినవి. గ్రేట్ ఇండియన్ బస్టర్డ్ ఆర్డియోటిస్ నైగ్రిసెప్స్ (వైగర్స్, 1831) మరియు జెర్డాన్స్ కోర్సర్ రైనోప్టిలస్ బిటోర్క్వాటస్ (బ్లైత్, 1848) అనే రెండు జాతులు రాష్ట్రం నుండి స్థానికంగా అంతరించిపోయినట్లు పరిగణించబడటం గమనార్హం.

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INTRODUCTION

Telangana, located on the Deccan Plateau in the south-central part of peninsular India, was previously part of the united Andhra Pradesh from 1956 to 2014. Prior to that, it was a significant part of the Hyderabad State from 1948 to 1956, and the State of Hyderabad from 1724 to 1948 (Srinivasulu & Kumar 2022). Covering an area of 122,077 km^2, Telangana is situated between 15.835–19.917 ^{0}N and 77.238–81.307 ^{0}E. The state is traversed by two major rivers, Godavari and Krishna, along with their numerous tributaries. The Hyderabad State Ornithological Survey, conducted by Dr. Sálim Ali in two spells (between October to December 1931, and Late February to April 1932) covering 15 major collection locations, and numerous sites enroute these. The Hyderabad State Ornithological Survey, the first of its kind in the country, conducted by Dr. Sálim Ali (in two spells between October to December 1931 and Late February to April 1932) covered 15 major collection locations (many of which are in the present day Telangana) and numerous sites enroute these locations (Ali & Whistler 1933a,b,c, 1934a,b; Ali 1939). Majumdar (1984) studied the 103 species of birds collected in January and February 1978 from four locations in the erstwhile Adilabad District. Taher & Pittie (1989, 1996) compiled a checklist of birds of Andhra Pradesh, which remained as one of the important sources of information on species diversity for a very long time.

Many researchers have documented bird diversity in protected areas of Telangana (Rao et al. 1997; Kumar & Choudhury 1999; Srinivasulu & Nagulu 2002; Srinivasulu 2004a, 2006; Prasad et al. 2014; Sailu & Swamy 2020), wetland ecosystems (Srinivasulu et al. 1997; Srinivasulu & Srinivasulu 2000, 2010; Srinivasulu 2013; Taher 2015; Sivakumar et al. 2021), forested tracts (Nagulu et al. 1998), urban, and rural areas (Srinivasulu & Srinivasulu 2001; Srinivasulu & Sreekar 2012; Swamy et al. 2016). Very few ecological studies on birds have been conducted, and among them are the works of Rao et al. (1998a,b), Srinivasulu et al. (1998), and Srinivasulu & Srinivasulu (1999a). Numerous reports on sightings of rare and elusive bird species from the region were published on a regular basis and include those of Taher & Pittie (1983), Taher (1985), Pittie (1987), Pittie et al. (1998a,b, 2005), Kannaiah & Ganesh (1990), Kumar (1990), Pittie & Mathew (1994, 2001), Hash et al. (1996), Srinivasulu & Srinivasulu (1999b), Srinivasulu et al. (1997, 2001), Srinivasulu & Rao (2000), Taher & Ramakrishnan (2001), Srinivasulu (2004b), Pittie & Ulla (2006), Narayanan & Manchi (2008), Sreekar & Ram (2010), Sreekar et al. (2010a,b), Taher et al. (2011, 2017), Srinivasan et al. (2012), Singh (2015), Jha (2016, 2021), Shah (2016), Hanumanthu (2020), Jha & Vasudevan (2020), Peters & Vinay (2020), Srikanth et al. (2020), Chakravarty (2021), Manoj & Dey (2021), Reddy & Ramachandran (2023).

A recent report on birds of Telangana by Sailu et al. (2021) lists 380 species belonging to 22 orders and 82 families. This number is an under-representation of the actual avian diversity of Telangana, as their work primarily relied on historical records and limited field surveys. Owing to erroneous sighting records published in literature or included in online databases (such as eBird and India Biodiversity Portal), numerous dubious species have been included in this study. Through this concise report, we endeavor to furnish an updated checklist of avian species presently recognized as occurring within Telangana. Our checklist aims to serve as a foundational reference, facilitating further research, and documentation efforts directed towards the region's rich, and diverse bird life. This research addresses this knowledge gap by documenting previously unreported species and providing updated distribution data, thereby contributing to a more complete understanding of Telangana's avifaunal richness.

METHODS

For the current checklist, a comprehensive exploration of peer-reviewed literature on avifauna reported from Telangana was conducted. Historical records were sourced from published survey reports, particularly those of Salim Ali (covering southern and eastern Telangana, including Hyderabad environs) and Nitin Majumdar (focusing on Utnoor and its environs in Kawal Wildlife Sanctuary). While physical verification of museum specimens was not conducted due to logistical constraints, reliance was placed on the published documentation of these collections. Literature selection followed strict criteria, including verification of species identification through photographic evidence where available, cross-referencing of unusual records, and validation of observation localities within current Telangana boundaries.

Additionally, we utilized data from field surveys conducted by us in various regions of Telangana (Figure 1) since 1995, including Protected Areas, waterbodies, known bird-diverse locations, and in cities, towns, and other locations. The common and scientific names follow Clements et al. (2024). Species abundance was classified into three categories (common, uncommon, and rare)

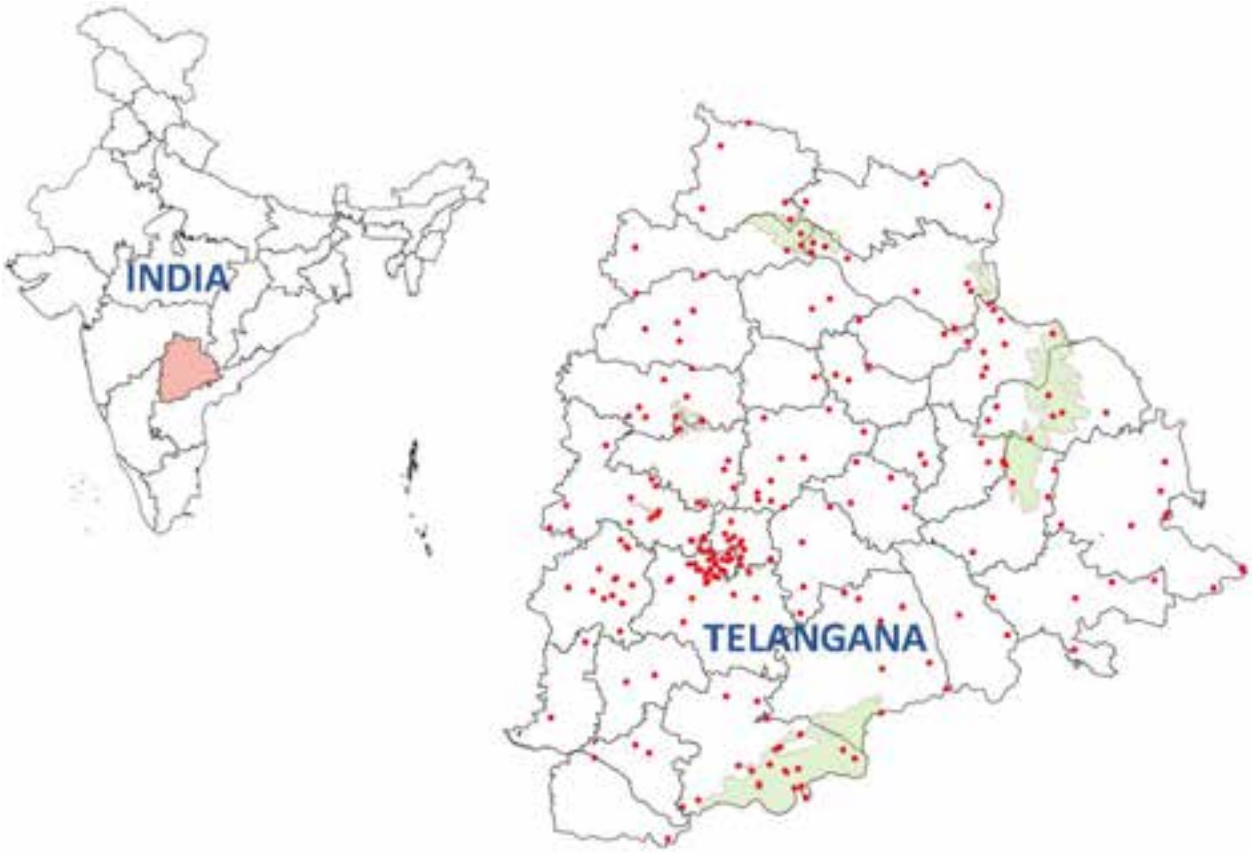

Figure 1. Protected areas (light green shaded) and locations (red circles) where the bird surveys were carried out in Telangana, India.

based on a combined assessment of two data sources: (1) qualitative descriptions from published literature and historical records and (2) sighting frequency data from the field surveys. Species were categorized as 'common' if they were consistently reported in literature and regularly encountered during surveys (observed in >60% of survey occasions). 'Uncommon' species were those with occasional mentions in literature and moderate detection rates (observed in 30–60% of survey occasions). Species were classified as 'rare' if they were sparsely documented in literature and infrequently encountered during surveys (observed in <30% of survey occasions). This dual approach of incorporating both historical records and contemporary field data provides a more robust assessment of species abundance patterns in the region. Explanations for the removal of taxa previously reported in the literature were included.

RESULTS AND DISCUSSION

In this checklist, 452 species of avifauna belonging to 24 orders and 82 families (Table 1; Figure 2; Images 1–215) are listed as present in Telangana. Of this diversity, most species have been found to be common (339 species, 75.5%), followed by uncommon (78 species, 17.37%), and rare (35 species, 7.79%).

Rare species

Brief accounts of rare species of birds in Telangana are provided below. These species often act as indicators of ecosystem health and habitat specificity, providing valuable insights into the region's biodiversity significance. Many of these species are of high conservation value, either due to their restricted distribution, specific habitat requirements, or threatened status. Documentating and establishing the baseline occurrence data of rare species in Telangana is essential for future monitoring efforts and conservation planning, especially in regions under pressure from rapid urbanization, and landscape modifications leading to alteration of natural habitats. Some of these species may be naturally rare in the region due to being at the edge of their distribution range, while others may have become rare due to anthropogenic pressures.

Greylag Goose *Anser anser*—Very few sightings

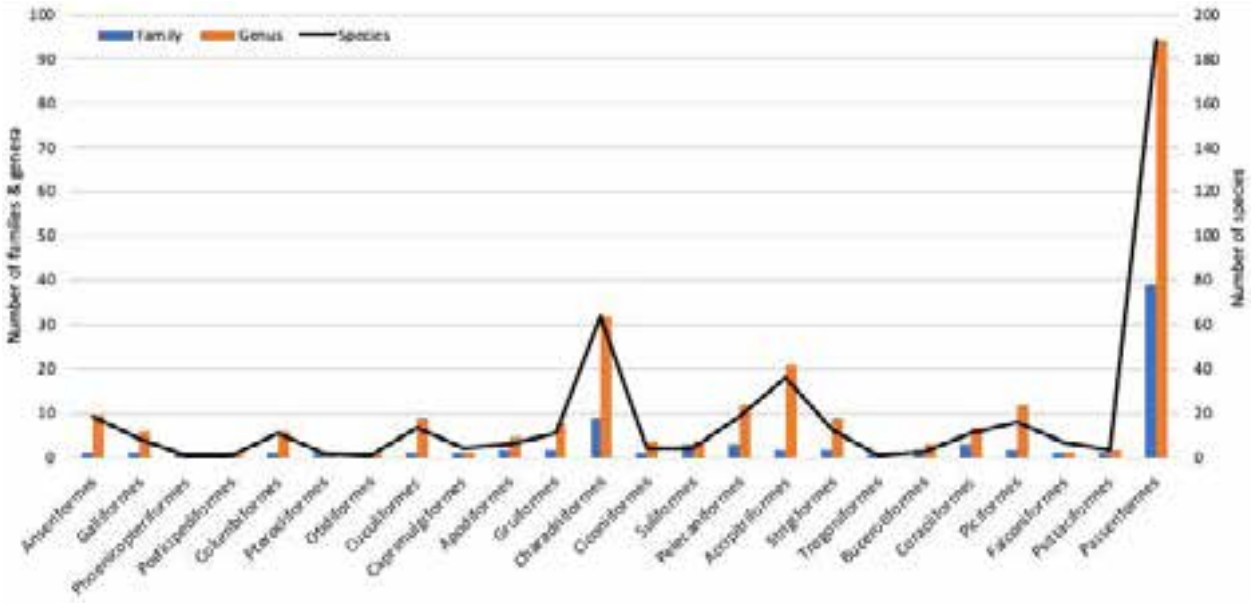

Figure 2. Species, genus, and family diversity of birds in different orders in Telangana, India.

from Komaram Bheem Asifabad and Nizamabad districts (present study).

Common Shelduck *Tadorna tadorna*—A single sighting from Hussain Sagar, Hyderabad district (present study).

Red Spurfowl *Galloperdix lunulata*—Reported from northeastern Telangana and southern Telangana. Observed and reported less than 10 times (present study).

Thick-billed Green-Pigeon *Treron curvirostra*—Only from Pakhal Wildlife Sanctuary, sighted in December 2018 (present study).

Lesser Florican *Sypheotides indicus*—Reported from Osman Sagar Lake, Ranga Reddy District, and Shamirpet Lake, Hyderabad (present study).

Watercock *Gallicrex cinerea*—Reported occasionally from different water bodies (present study).

Common Crane *Grus grus*—Reported from Sangareddy and Nizamabad Districts.

Demoiselle Crane *Anthropoides virgo*—5,000 individuals were reported at Singur in 1987. Recently, confirmed sightings at Singur Reservoir, Medak District (present study).

Great Thick-knee *Esacus recurvirostris*—Reported from near Singur Dam, Medak District (present study).

Grey-headed Lapwing *Vanellus cinereus*—A passage migrant, cyclone-dependent; once reported from Hussain Sagar, Hyderabad District (Sreekar & Ram 2010).

Spur-winged Lapwing *Vanellus spinosus*—Two individuals sighted at Ammavaripet Lake, Warangal District in March 2024. First record of this species from India (present study).

Ruddy Turnstone *Arenaria interpres*—A passage migrant reported from Ameenpur Lake, Sangareddy district (present study).

Red Phalarope *Phalaropus fulicarius*—Reported from Osman Sagar Lake, Ranga Reddy District and Kodakanchi Lake, Sangareddy District (present study).

Small Buttonquail *Turnix sylvaticus*—Reported from Osman Sagar Lake, Ranga Reddy District (present study).

Slender-billed Gull *Chroicocephalus genei*—Reported only once from Ameenpur Lake, Sangareddy District (present study).

Lesser Black-backed Gull *Larus fuscus*—Reported only once from Ameenpur Lake, Sangareddy District (present study).

Indian Skimmer *Rynchops albicollis*—Reported once from Manjeera Wildlife Sanctuary, Sangareddy District (Prasad et al. 2014), and recently from lower Manair Reservoir, Karimnagar District (present study).

Sooty Tern *Onychoprion fuscatus*—Reported only once from Kotepally Reservoir, Vikarabad District (Taher et al. 2011).

White-winged Tern *Chlidonias leucopterus*—Reported from Osman Sagar Lake, Ranga Reddy district and Ammavaripet Lake, Warangal District (present study).

Lesser Frigatebird *Fregata ariel*—A Pelagic bird, cyclone-dependent; reported only twice from Osman Sagar Lake, Rangareddy District and Ameenpur Lake,

Sangareddy District (present study).

Western Reef Egret *Egretta gularis*—Reported at Manjeera Wildlife Sanctuary and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) campus, Sangareddy District (present study).

European Honey-buzzard *Pernis apivorus*—Reported only once from Damarkunta - Vasaalamarri Road, Yadadri Bhuvangiri District in November 2021 (present study).

Black Baza *Aviceda leuphotes*—A passage migrant; sighted in Amrabad region, Nagarkurnool District (present study).

Jerdon's Baza *Aviceda jerdoni*—Reported only once from Dantepally Cheruvu, Medak District in February 2011 (Srinivasan et al. 2012).

Indian Vulture *Gyps indicus*—Reported regularly, but in few numbers, at Palarapugutta cliff, Penchikalpet in Komaram Bheem Asifabad District (Stotrabhashyam et al. 2015).

Imperial Eagle *Aquila heliaca*—Reported only once from Nizamabad District in January 2020 (present study).

Brown Wood-Owl *Strix leptogrammica*—Reported only from Bhadradri Kothagudem District (present study).

Amur Paradise-Flycatcher *Terpsiphone incei*—Reported only from Gubbala Mangamma Temple area, Bhadradri Kothagudem District in March 2022 (present study).

Black-crested Bulbul *Rubigula flaviventris*—Reported only from Bhadradri Kothagudem District (present study).

Pied Thrush *Geokichla wardii*—A passage migrant, reported twice from Umamaheshwaram forest, Nagarkurnool District in October 2022 and Bheemunipadam Waterfalls, Mahabubabad District in April 2024 (present study).

Scaly Thrush *Geokichla dauma*—A passage migrant, reported twice from Bheemunipadam Waterfalls, Mahabubabad District in December 2024 and April 2025 (present study).

Little Pied Flycatcher *Ficedula westermanni*—Reported twice, in 1987 from Narsapur forest area, Medak District, and in 1989 from Anantagiri forest, Vikarabad District. This species has not been sighted since 1989.

Loten's Sunbird *Cinnyris lotenius*—Reported from Bhadradri Kothagudem and Nagarkurnool districts (present study).

Crimson Sunbird *Aethopyga siparaja*—Reported only from Bhadradri Kothagudem District (present study).

Little Spiderhunter *Arachnothera longirostra*—Reported from Kawal Tiger Reserve, Mancherial District (Srinivasulu 2004) and Bhadradri Kothagudem District (present study).

Long-billed Pipit *Anthus similis*—Reported in November and December 2023 from Yenkathala grassland, Vikarabad District (present study).

Most species in the checklist are resident breeders (209 species, 46.54%), followed by winter migrants (176 species, 39.19%), residents (species whose breeding status is not known) (41 species, 9.13%), seasonal migrants (17 species, 3.78%), and vagrants (nine species, 2.0%). Of the 452 bird species recorded from Telangana, 410 species (91.31%) are classified as 'Least Concern' (LC) according to the IUCN Red List of Threatened Species. The remaining species include 21 'Near Threatened' (NT) species (4.67%), nine 'Vulnerable' (VU) species (2%), five 'Endangered' (EN) species (1.11%), and two 'Critically Endangered' (CR) species (0.44%). Five species (1.11%) currently fall under the 'Not Evaluated' (NE) category in the IUCN Red List. This assessment reflects the global conservation status of bird species that occur within Telangana.

The Critically Endangered bird species of Telangana are Lesser Florican *Sypheotides indicus* (Hari Krishna Adepu, pers. comm.) and Indian Vulture *Gyps indicus* (Umapathy et al. 2009; Stotrabhashyam et al. 2015). The Lesser Florican *Sypheotides indicus* historically inhabited the region's grassland patches (locally known as 'chelkalu'). In the past three decades, sightings have declined dramatically, with only two recent observations recorded near large lake banks. Similarly, the Indian Vulture *Gyps indicus* formerly maintained breeding colonies on the rocky ledges of Palarathi Gutta near Bejjur, Sirpur-Kaghaznagar. Their breeding activities have ceased following the destruction of nesting ledges due to natural causes, and sightings have become increasingly rare. The critical status of these species in Telangana is further exacerbated by ongoing habitat degradation, particularly due to land conversion for real estate development, and natural deterioration of their specific habitat requirements. These species serve as indicators of the urgent need for targeted conservation efforts in the region's grassland and rocky cliff habitats.

The Endangered species are Lesser Sand-Plover *Charadrius mongolus* (present study), Indian Skimmer *Rynchops albicollis* (Prasad et al. 2014, present study), Black-bellied Tern *Sterna acuticauda* (present study), Egyptian Vulture *Neophron percnopterus* (present study), and Steppe Eagle *Aquila nipalensis* (present study). The Vulnerable species are Common Pochard

Table 1. Checklist of birds of Telangana, India.
Key: Res—Resident | Res, Br—Resident Breeder | SM—Seasonal Migrant | WM—Winter Migrant | V—Vagrant | LC—Least Concern | NT—Near Threatened | VU—Vulnerable | EN—Endangered | CR—Critically Endangered | NE—Not Evaluated | IWPA—Indian Wildlife Protection Act: I—Schedule I | II—Schedule II.

	English name	Species	Authority	Vernacular name	Status	Abundance	IUCN Red List Status	IWPA
I. Order Anseriformes								
1. Family Anatidae								
1	Fulvous Whistling-Duck	*Dendrocygna bicolor*	(Vieillot, 1816)	Eela-vese Pedda Chiluva	WM	Common	LC	I
2	Lesser Whistling-Duck	*Dendrocygna javanica*	(Horsfield, 1821)	Eela-vese Chinna Chiluva	Res, Br	Common	LC	II
3	Greylag Goose	*Anser anser*	(Linnaeus, 1758)	Erra-kalla Pedda Bathu	WM	Rare	LC	II
4	Bar-headed Goose	*Anser indicus*	(Latham, 1790)	Tella Pedda Bathu	WM	Common	LC	II
5	Knob-billed Duck	*Sarkidiornis melanotos*	(Pennant, 1769)	Juttu Chiluva	Res, Br	Common	LC	II
6	Ruddy Shelduck	*Tadorna ferruginea*	(Pallas, 1764)	Bapana Bathu	WM	Common	LC	
7	Common Shelduck	*Tadorna tadorna*	(Linnaeus, 1758)	Erra Chiluva	WM	Rare	LC	II
8	Cotton Pygmy-Goose	*Nettapus coromandelianus*	(Gmelin, 1789)	Doodhi Chiluva	Res, Br	Common	LC	I
9	Garganey	*Spatula querquedula*	(Linnaeus, 1758)	Cheruvu Bathu	WM	Common	LC	II
10	Northern Shoveler	*Spatula clypeata*	(Linnaeus, 1758)	Chamcha-moothi Bathu	WM	Common	LC	II
11	Gadwall	*Mareca strepera*	(Linnaeus, 1758)	Ella-reppala Bathu	WM	Common	LC	II
12	Eurasian Wigeon	*Mareca penelope*	(Linnaeus, 1758)	Namam Bathu	WM	Common	LC	II
13	Indian Spot-billed Duck	*Anas poecilorhyncha*	Forster, 1781	Mukku-chukka Bathu	Res, Br	Common	LC	II
14	Northern Pintail	*Anas acuta*	Linnaeus, 1758	Soodhi-thoka Bathu	WM	Common	LC	II
15	Common Teal	*Anas crecca*	Linnaeus, 1758	Parja	WM	Common	LC	II
16	Red-crested Pochard	*Netta rufina*	(Pallas, 1773)	Erra-tala Chiluva	WM	Common	LC	II
17	Common Pochard	*Aythya ferina*	(Linnaeus, 1758)	Boodida-rangu-rekka Chiluva	WM	Common	VU	I
18	Ferruginous Duck	*Aythya nyroca*	(Güldenstädt, 1770)	Tella-kanti Chiluva	WM	Common	NT	II
19	Tufted Duck	*Aythya fuligula*	(Linnaeus, 1758)	Nalla-turai Chiluva	WM	Common	LC	
II. Order Galliformes								
2. Family Phasianidae								
20	Indian Peafowl	*Pavo cristatus*	Linnaeus, 1758	Nemali	Res, Br	Common	LC	I
21	Red Spurfowl	*Galloperdix spadicea*	(Gmelin, 1789)	Erra Kodi	Res, Br	Rare	LC	II
22	Painted Spurfowl	*Galloperdix lunulata*	(Valenciennes, 1825)	Jitha Kodi	Res, Br	Common	LC	II
23	Rain Quail	*Coturnix coromandelica*	(Gmelin, 1789)	Nalla-boora Elise	WM	Common	LC	II
24	Jungle Bush-Quail	*Perdicula asiatica*	(Latham, 1790)	Adavi Poda Elise	Res, Br	Common	LC	II
25	Rock Bush-Quail	*Perdicula argoondah*	(Sykes, 1832)	Rathi Poda Elise	Res, Br	Common	LC	II
26	Painted Francolin	*Francolinus pictus*	(Jardine & Selby, 1828)	Kakera Kamju	Res, Br	Common	LC	II
27	Grey Francolin	*Ortygornis pondicerianus*	(Gmelin, 1789)	Boodida-rangu Kamju	Res, Br	Common	LC	II
28	Grey Junglefowl	*Gallus sonneratii*	Temminck, 1813	Tella Adavi Kodi	Res, Br	Common	LC	I
III. Order Phoenicopteriformes								
3. Family Phoenicopteridae								
29	Greater Flamingo	*Phoenicopterus roseus*	Pallas, 1811	Rajahamsa	Res, Br	Common	LC	II
IV. Order Podicepiformes								
4. Family Podicepidae								
30	Little Grebe	*Tachybaptus ruficollis*	(Pallas, 1764)	China-munugudi Kodi	Res, Br	Common	LC	II
V. Order Columbiformes								
5. Family Columbidae								
31	Rock Pigeon	*Columba livia*	Gmelin, 1789	Gaddi Pavuramu	Res, Br	Common	LC	
32	Oriental Turtle-Dove	*Streptopelia orientalis*	(Latham, 1790)	Erra Poda-guvva	Res, Br	Common	LC	II

	English name	Species	Authority	Vernacular name	Status	Abundance	IUCN Red List Status	IWPA
33	Eurasian Collared-Dove	*Streptopelia decaocto*	(Frivaldszky, 1838)	Pedda Bella Guvva	Res, Br	Common	LC	II
34	Red Collared-Dove	*Streptopelia tranquebarica*	(Hermann, 1804)	Erra Guvva	Res, Br	Common	LC	II
35	Spotted Dove	*Spilopelia chinensis*	(Scopoli, 1786)	Chukkala Guvva	Res, Br	Common	LC	II
36	Laughing Dove	*Spilopelia senegalensis*	(Linnaeus, 1766)	Sovatha Guvva	Res, Br	Common	LC	II
37	Asian Emerald Dove	*Chalcophaps indica*	(Linnaeus, 1758)	Andi Bella Guvva	Res, Br	Common	LC	II
38	Orange-breasted Green-Pigeon	*Treron bicinctus*	(Jerdon, 1840)	Pasupu-paccha Pavuramu	Res, Br	Common	LC	II
39	Thick-billed Green-Pigeon	*Treron curvirostra*	(Gmelin, 1789)	Pedda-mukku Pavuramu	WM	Rare	LC	II
40	Yellow-footed Green-Pigeon	*Treron phoenicopterus*	(Latham, 1790)	Paccha Guvva	Res, Br	Common	LC	II
41	Green Imperial-Pigeon	*Ducula aenea*	(Linnaeus, 1766)	Kakarani Guvva	Res, Br	Common	NT	II
VI. Order Pterocliformes								
6. Family Pteroclidae								
42	Chestnut-bellied Sandgrouse	*Pterocles exustus*	Temminck, 1825	Jamb-polanki	Res, Br	Common	LC	II
43	Painted Sandgrouse	*Pterocles indicus*	(Gmelin, 1789)	Konda Jamb-polanki	Res, Br	Common	LC	II
VII. Order Otidiformes								
7. Family Otididae								
44	Lesser Florican	*Sypheotides indicus*	(Miller, 1782)	Nela Nemali	WM	Rare	CR	I
VIII. Order Cuculiformes								
8. Family Cuculidae								
45	Greater Coucal	*Centropus sinensis*	(Stephens, 1815)	Pedda Jamudu-kaki	Res, Br	Common	LC	II
46	Sirkeer Malkoha	*Taccocua leschenaultii*	Lesson, 1830	Sirkeer-kaki	Res, Br	Common	LC	II
47	Blue-faced Malkoha	*Phaenicophaeus viridirostris*	(Jerdon, 1840)	Vamana-kaki	Res, Br	Common	LC	II
48	Green-billed Malkoha	*Phaenicophaeus tristis*	(Lesson, 1830)	Paccha-mukku Vamana-kaki	Res, Br	Common	LC	II
49	Pied Cuckoo	*Clamator jacobinus*	(Boddaert, 1783)	Gola Kokila	SM	Common	LC	II
50	Asian Koel	*Eudynamys scolopaceus*	(Linnaeus, 1758)	Koyila	Res, Br	Common	LC	II
51	Banded Bay Cuckoo	*Cacomantis sonneratii*	(Latham, 1790)	Basha Kathi Pitta	Res	Common	LC	II
52	Grey-bellied Cuckoo	*Cacomantis passerinus*	(Vahl, 1797)	Boodida-rangu-potta Kokila	Res, Br	Common	LC	II
53	Fork-tailed Drongo-Cuckoo	*Surniculus dicruroides*	(Hodgson, 1839)	Aithrintha Kokila	Res	Common	LC	II
54	Large Hawk-Cuckoo	*Hierococcyx sparverioides*	(Vigors, 1832)	Pedda Kathi Pitta	WM	Common	LC	II
55	Common Hawk-Cuckoo	*Hierococcyx varius*	(Vahl, 1797)	Chinna Kathi Pitta	Res, Br	Common	LC	II
56	Lesser Cuckoo	*Cuculus poliocephalus*	Latham, 1790	Chinna Kokila	WM	Uncommon	LC	II
57	Indian Cuckoo	*Cuculus micropterus*	Gould, 1838	Desiya Kokila	Res	Common	LC	II
58	Common Cuckoo	*Cuculus canorus*	Linnaeus, 1758	Eurasia Kokila	SM	Common	LC	II
IX. Order Caprimulgiformes								
9. Family Caprimulgidae								
59	Jungle Nightjar	*Caprimulgus indicus*	Latham, 1790	Boodida-rangu Reyi-pitta	Res, Br	Common	LC	II
60	Large-tailed Nightjar	*Caprimulgus macrurus*	Horsfield, 1821	Pedda-thoka Reyi-pitta	Res	Uncommon	LC	II
61	Jerdon's Nightjar	*Caprimulgus atripennis*	Jerdon, 1845	Jedon Reyi-pitta	Res, Br	Common	LC	II
62	Indian Nightjar	*Caprimulgus asiaticus*	Latham, 1790	Bharatha Reyi-pitta	Res, Br	Common	LC	II
63	Savanna Nightjar	*Caprimulgus affinis*	Horsfield, 1821	Savanna Reyi-pitta	Res, Br	Common	LC	II
X. Order Apodiformes								
10. Family Apodidae								
64	White-rumped Spinetail	*Zoonavena sylvatica*	(Tickell, 1846)	Tella-nadumu Soodhi-thoka	Res	Common	LC	II
65	Alpine Swift	*Tachymarptis melba*	(Linnaeus, 1758)	Konda Chataka Pakshi	WM	Common	LC	II
66	Blyth's Swift	*Apus leuconyx*	(Blyth, 1845)	Payala-thokala Kolanki	WM	Common	NE	II
67	Little Swift	*Apus affinis*	(Gray, 1830)	Chataka Pakshi	Res, Br	Common	LC	II

	English name	Species	Authority	Vernacular name	Status	Abundance	IUCN Red List Status	IWPA
68	Asian Palm-Swift	*Cypsiurus balasiensis*	(Gray, 1829)	Taati Chataka Pakshi	Res, Br	Common	LC	II
11. Family Hemiprocnidae								
69	Crested Treeswift	*Hemiprocne coronata*	(Tickell, 1833)	Juttula-wadi Chetla-kolanki	Res, Br	Common	LC	I
XI. Order Gruiformes								
12. Family Rallidae								
70	Slaty-breasted Rail	*Lewinia striata*	(Linnaeus, 1766)	Vadi-kodi	Res	Uncommon	LC	II
71	Common Moorhen	*Gallinula chloropus*	(Linnaeus, 1758)	Jambu Kodi	Res, Br	Common	LC	II
72	Eurasian Coo	*Fulica atra*	Linnaeus, 1758	Nalla-boli Kodi	Res, Br	Common	LC	II
73	Gray-headed Swamphen	*Porphyrio poliocephalus*	(Latham, 1801)	Oodhi-chenchu Kodi	Res, Br	Common	NE	II
74	Watercock	*Gallicrex cinerea*	(Gmelin, 1789)	Neeti-kodi	Res	Rare	LC	II
75	White-breasted Waterhen	*Amaurornis phoenicurus*	(Pennant, 1769)	Tella-borra Neeti-kodi	Res, Br	Common	LC	II
76	Ruddy-breasted Crake	*Zapornia fusca*	(Linnaeus, 1766)	Erra-borra Vadi-kodi	WM	Common	LC	II
77	Brown Crake	*Zapornia akool*	(Sykes, 1832)	Goduma-rangu Vadi-kodi	Res, Br	Common	LC	II
78	Baillon's Crake	*Zapornia pusilla*	(Pallas, 1776)	Baillon Vadi-kodi	WM	Common	LC	II
13. Family Gruidae								
79	Common Crane	*Grus grus*	(Linnaeus, 1758)	Kulangu Konga	WM	Rare	LC	I
80	Demoiselle Crane	*Anthropoides virgo*	(Linnaeus, 1758)	Vadakoraka	WM	Rare	LC	I
XII. Order Charadriiformes								
14. Family Burhinidae								
81	Indian Thick-knee	*Burhinus indicus*	(Salvadori, 1865)	Rathi Kaledu	Res, Br	Common	LC	II
82	Great Thick-knee	*Esacus recurvirostris*	(Cuvier, 1829)	Pedda Rathi Kaledu	V	Rare	NT	II
15. Family Recurvirostridae								
83	Black-winged Stilt	*Himantopus himantopus*	(Linnaeus, 1758)	Nalla-rekala Ullanki-pitta	Res, Br	Common	LC	II
84	Pied Avocet	*Recurvirostra avosetta*	Linnaeus, 1758	Batta-pravala Pedda-ullanki	WM	Uncommon	LC	II
16. Family Charadriidae								
85	Black-bellied Plover	*Pluvialis squatarola*	(Linnaeus, 1758)	Boodida-rangu Ullanki	WM	Uncommon	LC	II
86	Pacific Golden-Plover	*Pluvialis fulva*	(Gmelin, 1789)	Bangaru Ullanki	WM	Uncommon	LC	I
87	River Lapwing	*Vanellus duvaucelii*	(Lesson, 1826)	Nadi Chitava	Res, Br	Common	NT	II
88	Yellow-wattled Lapwing	*Vanellus malabaricus*	(Boddaert, 1783)	Chitava	Res, Br	Common	LC	II
89	Gray-headed Lapwing	*Vanellus cinereus*	(Blyth, 1842)	Boodida-thala Chitava	WM	Rare	LC	II
90	Red-wattled Lapwing	*Vanellus indicus*	(Boddaert, 1783)	Enappa Chitava	Res, Br	Common	LC	II
91	Spur-winged Lapwing	*Vanellus spinosus*	(Linnaeus, 1758)	Mulla Chitava	V	Rare	LC	-
92	Siberian Sand-Plover	*Anarhynchus mongolus*	(Pallas, 1776)	Chinna Isuka-ullanki	WM	Uncommon	EN	II
93	Kentish Plover	*Anarhynchus alexandrinus*	(Linnaeus, 1758)	Chinna Baithu-ullanki	WM	Common	LC	II
94	Common Ringed Plover	*Charadrius hiaticula*	Linnaeus, 1758	Pedda Baithu-ullanki	WM	Common	LC	II
95	Little Ringed Plover	*Charadrius dubius*	Scopoli, 1786	Baithu-ullanki	Res, Br	Common	LC	II
17. Family Rostratulidae								
96	Greater Painted-Snipe	*Rostratula benghalensis*	(Linnaeus, 1758)	Pedda Kuruvi-pitta	Res, Br	Common	LC	II
18. Family Jacanidae								
97	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	(Scopoli, 1786)	Jamudu-thoka Jacana	Res, Br	Common	LC	II
98	Bronze-winged Jacana	*Metopidius indicus*	(Latham, 1790)	Kanchu-rekala Jacana	Res, Br	Common	LC	II
19. Family Scolopacidae								
99	Whimbrel	*Numenius phaeopus*	(Linnaeus, 1758)	Pedda Ullanki	WM	Uncommon	LC	II
100	Eurasian Curlew	*Numenius arquata*	(Linnaeus, 1758)	Podugu-mukku Ullanki	WM	Uncommon	NT	II
101	Bar-tailed Godwit	*Limosa lapponica*	(Linnaeus, 1758)	Charala-thoka Ullanki	WM	Uncommon	NT	II
102	Black-tailed Godwit	*Limosa limosa*	(Linnaeus, 1758)	Thondu Ullanki	WM	Common	NT	II

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103	Ruddy Turnstone	*Arenaria interpres*	(Linnaeus, 1758)	Rathi Pollika	WM	Rare	LC	II
104	Ruff	*Calidris pugnax*	(Linnaeus, 1758)	Ruff	WM	Common	LC	II
105	Curlew Sandpiper	*Calidris ferruginea*	(Pontoppidan, 1763)	Ullanki	WM	Uncommon	NT	II
106	Temminck's Stint	*Calidris temminckii*	(Leisler, 1812)	Temminck Ullanki	WM	Common	LC	II
107	Sanderling	*Calidris alba*	(Pallas, 1764)	Sanderling	WM	Uncommon	LC	II
108	Dunlin	*Calidris alpina*	(Linnaeus, 1758)	Erra-mukku Ullanki	WM	Uncommon	LC	II
109	Little Stint	*Calidris minuta*	(Leisler, 1812)	Chinna Ullanki	WM	Common	LC	II
110	Jack Snipe	*Lymnocryptes minimus*	(Brünnich, 1764)	Chinna Ulamu-kuruvi	WM	Uncommon	LC	II
111	Common Snipe	*Gallinago gallinago*	(Linnaeus, 1758)	Ulamu-kuruvi	WM	Common	LC	II
112	Pin-tailed Snipe	*Gallinago stenura*	(Bonaparte, 1831)	Soodhi-thoka Puredhi	WM	Common	LC	II
113	Terek Sandpiper	*Xenus cinereus*	(Güldenstädt, 1775)	Terek Ullanki	WM	Uncommon	LC	II
114	Red-necked Phalarope	*Phalaropus lobatus*	(Linnaeus, 1758)	Erra-meda Phalarope	WM	Uncommon	LC	II
115	Red Phalarope	*Phalaropus fulicarius*	(Linnaeus, 1758)	Erra Phalarope	WM	Rare	LC	II
116	Common Sandpiper	*Actitis hypoleucos*	(Linnaeus, 1758)	Ullanki	WM	Common	LC	II
117	Green Sandpiper	*Tringa ochropus*	Linnaeus, 1758	Nalla Ullanki	WM	Common	LC	II
118	Spotted Redshank	*Tringa erythropus*	(Pallas, 1764)	Pedda Erra-kalla Ullanki	WM	Common	LC	II
119	Common Greenshank	*Tringa nebularia*	(Gunnerus, 1767)	Paccha-kalla Ullanki	WM	Common	LC	I
120	Marsh Sandpiper	*Tringa stagnatilis*	(Bechstein, 1803)	Chittadhi Ullanki	WM	Common	LC	II
121	Wood Sandpiper	*Tringa glareola*	Linnaeus, 1758	Poddala Ullanki	WM	Common	LC	II
122	Common Redshank	*Tringa totanus*	(Linnaeus, 1758)	Erra-kalla Ullanki	WM	Common	LC	II
20. Family Turnicidae								
123	Small Buttonquail	*Turnix sylvaticus*	(Desfontaines, 1789)	Chinna-dabba Gundala	Res, Br	Rare	LC	II
124	Yellow-legged Buttonquail	*Turnix tanki*	Blyth, 1843	Erra Chinna Gundala	Res, Br	Common	LC	II
125	Barred Buttonquail	*Turnix suscitator*	(Gmelin, JF, 1789)	Charala Chinna Gundala	Res, Br	Common	LC	II
21. Family Glareolidae								
126	Indian Courser	*Cursorius coromandelicus*	(Gmelin, 1789)	Erra Chitava	Res, Br	Common	LC	I
127	Collared Pratincole	*Glareola pratincola*	(Linnaeus, 1766)	Kalar Lola-pakshi	Res	Common	LC	II
128	Oriental Pratincole	*Glareola maldivarum*	Forster, 1795	Pedda Lola-pakshi	WM	Common	LC	II
129	Small Pranticole	*Glareola lactea*	Temminck, 1820	Chinna Lola-pakshi	Res, Br	Common	LC	II
22. Family Laridae								
130	Slender-billed Gull	*Chroicocephalus genei*	(Breme, 1839)	Sana-mooku Gouru-kaki	WM	Rare	LC	II
131	Black-headed Gull	*Chroicocephalus ridibundus*	(Linnaeus, 1766)	Nalla-thala Gouru-kaki	WM	Common	LC	II
132	Brown-headed Gull	*Chroicocephalus brunnicephalus*	(Jerdon, 1840)	Goduma-thala Gouru-kaki	WM	Common	LC	II
133	Pallas's Gull	*Ichthyaetus ichthyaetus*	(Pallas, 1773)	Pallas Gouru-kaki	WM	Uncommon	NT	II
134	Lesser Black-backed Gull	*Larus fuscus*	Linnaeus, 1758	Chinna Nalla-veepu Gouru-kaki	WM	Rare	LC	II
135	Indian Skimmer	*Rynchops albicollis*	Swainson, 1838	Eedchu-pakshi	WM	Rare	EN	
136	Sooty Tern	*Onychoprion fuscatus*	(Linnaeus, 1766)	Nalla Revu-pitta	V	Rare	LC	II
137	Little Tern	*Sternula albifrons*	(Pallas, 1764)	Chitti Revu-pitta	Res, Br	Common	LC	II
138	Gull-billed Tern	*Gelochelidon nilotica*	(Gmelin, 1789)	Gouru-kaki-muku Revu-pitta	WM	Uncommon	LC	I
139	Caspian Tern	*Hydroprogne caspia*	(Pallas, 1770)	Samudrapu Kaki	WM	Uncommon	LC	II
140	White-winged Tern	*Chlidonias leucopterus*	(Temminck, 1815)	Tella-rekala Revu-pitta	WM	Rare	LC	II
141	Whiskered Tern	*Chlidonias hybrida*	(Pallas, 1811)	Meesamula Revu-pitta	WM	Common	LC	II
142	Common Tern	*Sterna hirundo*	Linnaeus, 1758	Revu-pitta	WM	Uncommon	LC	II
143	Black-bellied Tern	*Sterna acuticauda*	Gray, 1831	Nalla-potta Ramadasu	Res, Br	Common	EN	I

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144	River Tern	*Sterna aurantia*	Gray, 1831	Ramadasu	Res, Br	Common	VU	I
XIII. Order Ciconiiformes								
23. Family Ciconiidae								
145	Asian Openbill	*Anastomus oscitans*	(Boddaert, 1783)	Therapi-mukku Konga	Res, Br	Common	LC	II
146	Black Stork	*Ciconia nigra*	(Linnaeus, 1758)	Nalla Konga	WM	Uncommon	LC	II
147	Woolly-necked Stork	*Ciconia episcopus*	(Boddaert, 1783)	Thella-meda Konga	Res, Br	Common	NT	II
148	Lesser Adjutant	*Leptoptilos javanicus*	(Horsfield, 1821)	Chinna Beguru Konga	WM	Uncommon	NT	I
149	Painted Stork	*Mycteria leucocephala*	(Pennant, 1769)	Erra-kalla Konga	Res, Br	Common	LC	II
XIV. Order Suliformes								
24. Family Fregatidae								
150	Lesser Frigatebird	*Fregata ariel*	(Gray, 1845)	Chinna Budaga Pakshi	V	Rare	LC	II
25. Family Anhingidae								
151	Oriental Darter	*Anhinga melanogaster*	Pennant, 1769	Pamu-bathu	Res, Br	Common	NT	II
26. Family Phalacrocoracidae								
152	Little Cormorant	*Microcarbo niger*	(Vieillot, 1817)	Chinna Neeti-Kaki	Res, Br	Common	LC	II
153	Great Cormorant	*Phalacrocorax carbo*	(Linnaeus, 1758)	Pedda Neeti-Kaki	Res, Br	Common	LC	II
154	Indian Cormorant	*Phalacrocorax fuscicollis*	Stephens, 1826	Neeti-Kaki	Res, Br	Common	LC	II
XV. Order Pelecaniformes								
27. Family Pelecanidae								
155	Spot-billed Pelican	*Pelecanus philippensis*	Gmelin, 1789	Chukala-mukku Chinka Bathu	WM	Common	NT	II
28. Family Ardeidae								
156	Yellow Bittern	*Ixobrychus sinensis*	(Gmelin, 1789)	Pasupu Vakhi	Res	Common	LC	II
157	Little Bittern	*Ixobrychus minutus*	(Linnaeus, 1766)	Chinna Vakhi	Res	Common	LC	II
158	Cinnamon Bittern	*Ixobrychus cinnamomeus*	(Gmelin, 1789)	Erra Vakhi	Res	Common	LC	I
159	Black Bittern	*Ixobrychus flavicollis*	(Latham, 1790)	Nalla Vakhi	Res	Common	LC	II
160	Gray Heron	*Ardea cinerea*	Linnaeus, 1758	Narayana Pakshi	Res, Br	Common	LC	II
161	Purple Heron	*Ardea purpurea*	Linnaeus, 1766	Erra Narayana Pakshi	Res, Br	Common	LC	II
162	Great Egret	*Ardea alba*	Linnaeus, 1758	Pedda Tella Konga	Res, Br	Common	LC	II
163	Intermediate Egret	*Ardea intermedia*	Wagler, 1829	Tella Konga	Res, Br	Common	LC	II
164	Little Egret	*Egretta garzetta*	(Linnaeus, 1766)	Chinna Tella Konga	Res, Br	Common	LC	II
165	Western Reef Egret	*Egretta gularis*	(Bosc, 1792)	Teerapu Konga	WM	Rare	LC	II
166	Cattle Egret	*Bubulcus ibis*	(Linnaeus, 1758)	Santi Konga	Res, Br	Common	LC	II
167	Indian Pond-Heron	*Ardeola grayii*	(Sykes, 1832)	Gudi Konga	Res, Br	Common	LC	II
168	Striated Heron	*Butorides striata*	(Linnaeus, 1758)	Dosi Konga	Res, Br	Common	LC	II
169	Black-crowned Night-Heron	*Nycticorax nycticorax*	(Linnaeus, 1758)	Chinta Vakhi	Res, Br	Common	LC	II
29. Family Threskiornithidae								
170	Glossy Ibis	*Plegadis falcinellus*	(Linnaeus, 1766)	Taati Kankanam	WM	Common	LC	II
171	Black-headed Ibis	*Threskiornis melanocephalus*	(Latham, 1790)	Nalla-thala Kankanam	Res, Br	Common	NT	II
172	Red-naped Ibis	*Pseudibis papillosa*	(Temminck, 1824)	Nalla Kankanam	Res, Br	Common	LC	II
173	Eurasian Spoonbill	*Platalea leucorodia*	Linnaeus, 1758	Theddu-moothi Konga	Res	Common	LC	I
XVI. Order Accipitriformes								
30. Family Pandionidae								
174	Osprey	*Pandion haliaetus*	(Linnaeus, 1758)	Korramenu-gaddha	WM	Common	LC	I
31. Family Accipitridae								
175	Black-winged Kite	*Elanus caeruleus*	(Desfontaines, 1789)	Adavi Ramadasu	Res, Br	Common	LC	II
176	Egyptian Vulture	*Neophron percnopterus*	(Linnaeus, 1758)	Tella Borava	Res, Br	Uncommon	EN	I

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177	European Honey-buzzard	*Pernis apivorus*	(Linnaeus, 1758)	Eurasia Thene-dega	V	Rare	LC	II
178	Oriental Honey-buzzard	*Pernis ptilorhynchus*	(Temminck, 1821)	Oriental Thene-dega	Res, Br	Common	LC	II
179	Black Baza	*Aviceda leuphotes*	(Dumont, 1820)	Nalla Gaddha	V	Rare	LC	I
180	Jerdon's Baza	*Aviceda jerdoni*	(Blyth, 1842)	Jerdon Gaddha	V	Rare	LC	I
181	Indian Vulture	*Gyps indicus*	(Scopoli, 1786)	Podugu-mukku Borava	Res, Br	Rare	CR	I
182	Crested Serpent-Eagle	*Spilornis cheela*	(Latham, 1790)	Nalla Pamula Gaddha	Res, Br	Common	LC	I
183	Short-toed Snake-Eagle	*Circaetus gallicus*	(Gmelin, 1788)	Pamula Gaddha	Res, Br	Common	LC	I
184	Changeable Hawk-Eagle	*Nisaetus cirrhatus*	(Gmelin, 1788)	Juttu Byari	Res, Br	Common	LC	I
185	Black Eagle	*Ictinaetus malaiensis*	(Temminck, 1822)	Adavi Nalla Gaddha	WM	Common	LC	I
186	Indian Spotted Eagle	*Clanga hastata*	(Lesson, 1831)	Chinna Nalla Gaddha	WM	Uncommon	VU	I
187	Greater Spotted Eagle	*Clanga clanga*	(Pallas, 1811)	Pedda Nalla Gaddha	WM	Common	VU	I
188	Booted Eagle	*Hieraaetus pennatus*	(Gmelin, 1788)	Udathala Gaddha	WM	Common	LC	I
189	Tawny Eagle	*Aquila rapax*	(Temminck, 1828)	Alava	Res, Br	Common	VU	I
190	Steppe Eagle	*Aquila nipalensis*	Hodgson, 1833	Pedda Salava	WM	Common	EN	I
191	Imperial Eagle	*Aquila heliaca*	Savigny, 1809	Bangaru Salava	WM	Rare	VU	I
192	Bonelli's Eagle	*Aquila fasciata*	Vieillot, 1822	Kundeli Salava	Res	Common	LC	I
193	Rufous-bellied Eagle	*Lophotriorchis kienerii*	(de Sparre, 1835)	Matti-rangu-potta Salava	WM	Uncommon	NT	I
194	White-eyed Buzzard	*Butastur teesa*	(Franklin, 1831)	Buda Mali Gaddha	Res, Br	Common	LC	I
195	Western Marsh Harrier	*Circus aeruginosus*	(Linnaeus, 1758)	Eurasia Tella Thala Pilli-gaddha	WM	Common	LC	I
196	Eastern Marsh Harrier	*Circus spilonotus*	Kaup, 1847	Thurpu Tella Thala Pilli-gaddha	WM	Uncommon	LC	I
197	Hen Harrier	*Circus cyaneus*	(Linnaeus, 1766)	Chinna Pilli-gaddha	WM	Uncommon	LC	I
198	Pallid Harrier	*Circus macrourus*	(Gmelin S.G., 1770)	Udathala Pilli-gaddha	WM	Common	NT	I
199	Pied Harrier	*Circus melanoleucos*	(Pennant, 1769)	Batta Pilli-gaddha	WM	Uncommon	LC	I
200	Montagu's Harrier	*Circus pygargus*	(Linnaeus, 1758)	Montagu Pilli-gaddha	WM	Common	LC	I
201	Crested Goshawk	*Accipiter trivirgatus*	(Temminck, 1824)	Kokila-dega	WM	Common	LC	I
202	Shikra	*Accipiter badius*	(Gmelin, 1788)	Jale-dega	Res, Br	Common	LC	I
203	Besra	*Accipiter virgatus*	(Temminck, 1822)	Vaishtapa-dega	WM	Uncommon	LC	I
204	Eurasian Sparrowhawk	*Accipiter nisus*	(Linnaeus, 1758)	Varnapa-dega	WM	Common	LC	I
205	Black Kite	*Milvus migrans*	(Boddaert, 1783)	Mala Gaddha	Res, Br	Common	LC	II
206	Brahminy Kite	*Haliastur indus*	(Boddaert, 1783)	Bapana Gaddha	Res, Br	Common	LC	I
207	Gray-headed Fish-Eagle	*Haliaeetus ichthyaetus*	(Horsfield, 1821)	Boodida-rangu-thala Chepala Gaddha	Res, Br	Common	NT	I
208	Common Buzzard	*Buteo buteo*	(Linnaeus, 1758)	Eluka Gaddha	WM	Uncommon	LC	I
209	Long-legged Buzzard	*Buteo rufinus*	(Cretzschmar, 1829)	Korre Gaddha	WM	Uncommon	LC	I
XVII. Order Strigiformes								
32. Family Tytonidae								
210	Barn Owl	*Tyto alba*	(Scopoli, 1769)	Chavu-pitta	Res, Br	Common	LC	I
33. Family Strigidae								
211	Indian Scops-Owl	*Otus bakkamoena*	Pennant, 1769	Pedda-chitta Gubba	Res, Br	Common	LC	II
212	Oriental Scops-Owl	*Otus sunia*	(Hodgson, 1836)	Chinna Gudla-gubba	Res	Common	LC	II
213	Indian Eagle-Owl	*Bubo bengalensis*	(Franklin, 1831)	Erra Gudla-gubba	Res, Br	Common	LC	I
214	Spot-bellied Eagle-Owl	*Ketupa nipalensis*	(Hodgson, 1836)	Chukala-potta Gudla-gubba	SM	Uncommon	LC	I
215	Dusky Eagle-Owl	*Ketupa coromanda*	(Latham, 1790)	Boodida-rangu Gudla-gubba	Res, Br	Uncommon	LC	II
216	Brown Fish-Owl	*Ketupa zeylonensis*	(Gmelin, 1788)	Chepala Gudla-gubba	Res, Br	Common	LC	I
217	Jungle Owlet	*Glaucidium radiatum*	(Tickell, 1833)	Adavi Pagadi-gante	Res, Br	Common	LC	II
218	Spotted Owlet	*Athene brama*	(Temminck, 1821)	Pagadi-gante	Res, Br	Common	LC	II

	English name	Species	Authority	Vernacular name	Status	Abundance	IUCN Red List Status	IWPA
219	Mottled Wood-Owl	*Strix ocellata*	(Lesson, 1839)	Machala Adavi Gudla-gubba	Res, Br	Common	LC	I
220	Brown Wood-Owl	*Strix leptogrammica*	Temminck, 1832	Goduma-rangu Adavi Gudla-gubba	Res, Br	Uncommon	LC	I
221	Short-eared Owl	*Asio flammeus*	(Pontoppidan, 1763)	Potti-chevula Gudla-gubba	WM	Common	LC	I
222	Brown Hawk-Owl	*Ninox scutulata*	(Raffles, 1822)	Goduma-rangu Dega Gudla-gubba	Res, Br	Common	LC	II
XVIII. Order Trogoniformes								
34. Family Trogonidae								
223	Malabar Trogon	*Harpactes fasciatus*	(Pennant, 1769)	Malabar Trogon	Res, Br	Uncommon	LC	II
XIX. Order Bucerotiformes								
35. Family Upupidae								
224	Eurasian Hoopoe	*Upupa epops*	Linnaeus, 1758	Kukudu Pitta	Res, Br	Common	LC	II
36. Family Bucerotidae								
225	Indian Gray Hornbill	*Ocyceros birostris*	(Scopoli, 1786)	Komuka-siri	Res, Br	Common	LC	II
226	Malabar Pied-Hornbill	*Anthracoceros coronatus*	(Boddaert, 1783)	Batta-chupanathi	Res	Uncommon	NT	I
XX. Order Coraciiformes								
37. Family Alcedinidae								
227	Common Kingfisher	*Alcedo atthis*	(Linnaeus, 1758)	Chinna Nela-buchigadu	Res, Br	Common	LC	II
228	Stork-billed Kingfisher	*Pelargopsis capensis*	(Linnaeus, 1766)	Pedda-mukku Buchigadu	Res, Br	Uncommon	LC	II
229	White-throated Kingfisher	*Halcyon smyrnensis*	(Linnaeus, 1758)	Tella-gonthu Buchigadu	Res, Br	Common	LC	II
230	Black-capped Kingfisher	*Halcyon pileata*	(Boddaert, 1783)	Nalla-thala Buchigadu	SM	Uncommon	VU	II
231	Pied Kingfisher	*Ceryle rudis*	(Linnaeus, 1758)	Neela Buchigadu	Res, Br	Common	LC	II
38. Family Meropidae								
232	Blue-bearded Bee-eater	*Nyctyornis athertoni*	(Jardine & Selby, 1828)	Neeli-gaddam Passiriki	SM	Uncommon	LC	II
233	Green Bee-eater	*Merops orientalis*	Latham, 1801	Chinna Passiriki	Res, Br	Common	LC	II
234	Blue-tailed Bee-eater	*Merops philippinus*	Linnaeus, 1767	Komu Passiriki	WM	Common	LC	II
235	Chestnut-headed Bee-eater	*Merops leschenaulti*	Vieillot, 1817	Penku-rangu-thala Passiriki	Res	Common	LC	II
39. Family Coraciidae								
236	European Roller	*Coracias garrulus*	Linnaeus, 1758	Europa Palapitta	WM	Common	LC	II
237	Indian Roller	*Coracias benghalensis*	(Linnaeus, 1758)	Palapitta	Res, Br	Common	LC	II
XXI. Order Piciformes								
40. Family Megalaimidae								
238	Coppersmith Barbet	*Psilopogon haemacephalus*	(Müller, 1776)	Kamsali Pitta	Res, Br	Common	LC	II
239	Brown-headed Barbet	*Psilopogon zeylanicus*	(Gmelin, 1788)	Goduma-thala Kamsali Pitta	Res, Br	Common	LC	II
41. Family Picidae								
240	Eurasian Wryneck	*Jynx torquilla*	Linnaeus, 1758	Medanulingadu	WM	Common	LC	II
241	Speckled Piculet	*Picumnus innominatus*	Burton, 1836	Chukala Vadrangi-pitta	Res	Uncommon	LC	II
242	Heart-spotted Woodpecker	*Hemicircus canente*	(Lesson, 1832)	Ravi-aaku Machala Vadrangi-pitta	Res	Uncommon	LC	I
243	Brown-capped Pygmy Woodpecker	*Yungipicus nanus*	(Vigors, 1832)	Chitta Suruti Pakshi	Res, Br	Common	LC	II
244	Yellow-crowned Woodpecker	*Leiopicus mahrattensis*	(Latham, 1801)	Vadrangi-pitta	Res, Br	Common	LC	I
245	Greater Flameback	*Chrysocolaptes guttacristatus*	(Tickell, 1833)	Pedda Bangaru-veepu Vadrangi-pitta	Res	Uncommon	LC	II
246	White-naped Woodpecker	*Chrysocolaptes festivus*	(Boddaert, 1783)	Tella Vadrangi-pitta	Res, Br	Common	LC	II
247	Rufous Woodpecker	*Micropternus brachyurus*	(Vieillot, 1818)	Errapu-goduma Vadrangi-pitta	Res, Br	Uncommon	LC	II

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248	Common Flameback	*Dinopium javanense*	(Ljungh, 1797)	Bangaru-veepu Vadrangi-pitta	Res	Uncommon	LC	II
249	Black-rumped Flameback	*Dinopium benghalense*	(Linnaeus, 1758)	Nalla-nadumu Bangaru-veepu Vadrangi-pitta	Res, Br	Common	LC	II
250	Lesser Yellownape	*Picus chlorolophus*	Vieillot, 1818	Chinna Paspu-meda Vadrangi-pitta	Res, Br	Uncommon	LC	II
251	Streak-throated Woodpecker	*Picus xanthopygaeus*	(Gray J.E. & Gray G.R., 1846)	Charala-gonthu Vadrangi-pitta	Res, Br	Common	LC	II
252	Greater Yellownape	*Chrysophlegma flavinucha*	(Gould, 1834)	Pedda Paspu-meda Vadrangi-pitta	Res	Uncommon	LC	II
253	White-bellied Woodpecker	*Dryocopus javensis*	(Horsfield, 1821)	Tella-potta Vadrangi-pitta	Res	Common	LC	II
XXII. Order Falconiformes								
42. Family Falconidae								
254	Lesser Kestrel	*Falco naumanni*	Fleischer, 1818	Chinna Thondala Muchi Dega	WM	Uncommon	LC	II
255	Common Kestrel	*Falco tinnunculus*	Linnaeus, 1758	Thondala Muchi Dega	WM	Common	LC	II
256	Red-necked Falcon	*Falco chicquera*	Daudin, 1800	Erra-topi Jale Dega	SM	Common	NT	I
257	Amur Falcon	*Falco amurensis*	Radde, 1863	Erra-kalla Jale Dega	WM	Uncommon	LC	I
258	Eurasian Hobby	*Falco subbuteo*	Linnaeus, 1758	Pedda Nalla Dega Byari Dega	WM	Uncommon	LC	II
259	Laggar Falcon	*Falco jugger*	Gray, J.E., 1834	Laggadu	SM	Uncommon	NT	I
260	Peregrine Falcon	*Falco peregrinus*	Tunstall, 1771	Byari Dega	SM	Common	LC	I
XXIII. Order Psittaciformes								
43. Family Psittaculidae								
261	Alexandrine Parakeet	*Psittacula eupatria*	(Linnaeus, 1766)	Pedda Chiluka	Res, Br	Common	NT	II
262	Rose-ringed Parakeet	*Psittacula krameri*	(Scopoli, 1769)	Chiluka	Res, Br	Common	LC	II
263	Plum-headed Parakeet	*Psittacula cyanocephala*	(Linnaeus, 1766)	Rama-chiluka	Res, Br	Common	LC	II
264	Vernal Hanging-Parrot	*Loriculus vernalis*	(Sparrman, 1787)	Paccha-vrelade Chiluka	Res	Uncommon	LC	II
XXIV. Order Passeriformes								
44. Family Pittidae								
265	Indian Pitta	*Pitta brachyura*	(Linnaeus, 1766)	Ponangi Pitta	WM	Common	LC	II
45. Family Campephagidae								
266	White-bellied Minivet	*Pericrocotus erythropygius*	(Jerdon, 1840)	Thella-potta Kumkumpu-jitta	Res	Uncommon	LC	II
267	Small Minivet	*Pericrocotus cinnamomeus*	(Linnaeus, 1766)	Chinna Kumkumpu-jitta	Res, Br	Common	LC	I
268	Scarlet Minivet	*Pericrocotus speciosus*	(Latham, 1790)	Kumkumpu-jitta	Res, Br	Uncommon	LC	II
269	Ashy Minivet	*Pericrocotus divaricatus*	(Raffles, 1822)	Gachakaya Kumkumpu-jitta	SM	Uncommon	LC	II
270	Brown-rumped Minivet	*Pericrocotus cantonensis*	Swinhoe, 1861	Goduma-veepu Kumkumpu-jitta	WM	Uncommon	LC	II
271	Rosy Minivet	*Pericrocotus roseus*	(Vieillot, 1818)	Gulabi Kumkumpu-jitta	Res	Uncommon	LC	II
272	Large Cuckooshrike	*Coracina macei*	(Lesson, 1831)	Pedda Aaku-rayi	Res, Br	Common	LC	II
273	Black-winged Cuckooshrike	*Lalage melaschistos*	(Hodgson, 1836)	Nalla-rekala Aaku-rayi	SM	Uncommon	LC	II
274	Black-headed Cuckooshrike	*Lalage melanoptera*	(Rüppell, 1839)	Nalla-thala Aaku-rayi	Res, Br	Common	LC	II
46. Family Oriolidae								
275	Indian Golden Oriole	*Oriolus kundoo*	Sykes, 1832	Vangapandu	Res, Br	Common	LC	II
276	Black-naped Oriole	*Oriolus chinensis*	Linnaeus, 1766	Nalla-moopu Vangapandu	Res	Common	LC	II
277	Black-hooded Oriole	*Oriolus xanthornus*	(Linnaeus, 1758)	Nalla-thala Vangapandu	Res, Br	Common	LC	II
47. Family Artamidae								
278	Ashy Woodswallow	*Artamus fuscus*	Vieillot, 1817	Thadi-pitta	Res, Br	Common	LC	II
48. Family Vangidae								
279	Large Woodshrike	*Tephrodornis virgatus*	(Temminck, 1824)	Pedda Ula-pitta	SM	Uncommon	LC	II

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280	Common Woodshrike	*Tephrodornis pondicerianus*	(Gmelin, 1789)	Chinna Ula-pitta	Res, Br	Common	LC	II
281	Bar-winged Flycatcher-shrike	*Hemipus picatus*	(Sykes, 1832)	Charala-rekala Billinchi-Dasari Pitta	SM	Uncommon	LC	II
49. Family Aegithinidae								
282	White-tailed Iora	*Aegithina nigrolutea*	(Marshall, 1876)	Thela-thoka Pasupu-jitta	Res	Uncommon	LC	II
283	Common Iora	*Aegithina tiphia*	(Linnaeus, 1758)	Pasupu Jitta	Res, Br	Common	LC	II
50. Family Rhipiduridae								
284	White-throated Fantail	*Rhipidura albicollis*	(Vieillot, 1818)	Thella-meda Dasari Pitta	Res, Br	Common	LC	II
285	Spot-breasted Fantail	*Rhipidura albogularis*	(Lesson, 1832)	Chukala Dasari Pitta	Res, Br	Common	LC	II
286	White-browed Fantail	*Rhipidura aureola*	Lesson, 1831	Thela-kanubomala Dasari Pitta	Res, Br	Common	LC	II
51. Family Dicruridae								
287	Black Drongo	*Dicrurus macrocercus*	Vieillot, 1817	Nalla Etrintha	Res, Br	Common	LC	II
288	Ashy Drongo	*Dicrurus leucophaeus*	Vieillot, 1817	Boodida-rangu Etrintha	WM	Common	LC	II
289	White-bellied Drongo	*Dicrurus caerulescens*	(Linnaeus, 1758)	Thela-potta Etrintha	Res, Br	Common	LC	II
290	Bronzed Drongo	*Dicrurus aeneus*	Vieillot, 1817	Kanche Etrintha	SM	Common	LC	II
291	Hair-crested Drongo	*Dicrurus hottentottus*	(Linnaeus, 1766)	Etnrukala Etrintha	Res, Br	Common	LC	II
292	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	(Linnaeus, 1766)	Goppa Chetta-thoka Etrintha	Res, Br	Common	LC	II
52. Family Monarchidae								
293	Black-naped Monarch	*Hypothymis azurea*	(Boddaert, 1783)	Nalla-musa Dasari Pitta	Res	Common	LC	II
294	Blyth's Paradise-Flycatcher	*Terpsiphone affinis*	(Blyth, 1846)	Blyth Pigili-pitta	WM	Uncommon	LC	II
295	Amur Paradise-Flycatcher	*Terpsiphone incei*	(Gould, 1852)	Amur Pigili-pitta	WM	Rare	LC	II
296	Indian Paradise-Flycatcher	*Terpsiphone paradisi*	(Linnaeus, 1758)	Thoka Pigili-pitta	Res, Br	Common	LC	II
53. Family Laniidae								
297	Isabelline Shrike	*Lanius isabellinus*	Hemprich & Ehrenberg, 1833	Erra-thoka Bilinchi	WM	Common	LC	II
298	Brown Shrike	*Lanius cristatus*	Linnaeus, 1758	Erra Bilinchi	WM	Common	LC	II
299	Bay-backed Shrike	*Lanius vittatus*	Valenciennes, 1826	Chinna Bilinchi	Res, Br	Common	LC	II
300	Long-tailed Shrike	*Lanius schach*	Linnaeus, 1758	Podugu-thoka Bilinchi	Res, Br	Common	LC	II
301	Great Gray Shrike	*Lanius excubitor*	Linnaeus, 1758	Pedda Bilinchi	WM	Common	LC	II
54. Family Corvidae								
302	Rufous Treepie	*Dendrocitta vagabunda*	(Latham, 1790)	Erra Gokkurayi	Res, Br	Common	LC	II
303	House Crow	*Corvus splendens*	Vieillot, 1817	Kaki	Res, Br	Common	LC	
304	Large-billed Crow	*Corvus macrorhynchos*	Wagler, 1827	Nalla Kaki	Res, Br	Common	LC	II
55. Family Stenostiridae								
305	Gray-headed Canary-Flycatcher	*Culicicapa ceylonensis*	(Swainson, 1820)	Boodida-rangu Thala Eega-pattu Pitta	WM	Common	LC	II
56. Family Paridae								
306	Cinereous Tit	*Parus cinereus*	Vieillot, 1818	Chinna Jitta	Res, Br	Common	NE	II
307	Indian Black-lored Tit	*Machlolophus aplonotus*	(Blyth, 1847)	Nalla-chevi Chinna Jitta	Res, Br	Common	LC	II
57. Family Alaudidae								
308	Rufous-tailed Lark	*Ammomanes phoenicura*	(Franklin, 1831)	Ambali Jorigadu	Res, Br	Common	NE	II
309	Ashy-crowned Sparrow-Lark	*Eremopterix griseus*	(Scopoli, 1786)	Potti Pichuka	Res, Br	Common	LC	II
310	Singing Bushlark	*Mirafra javanica*	Horsfield, 1821	Burruta Pitta	Res, Br	Common	LC	II
311	Jerdon's Bushlark	*Mirafra affinis*	Blyth, 1845	Jerdon Eela Jitta	Res, Br	Common	LC	II
312	Indian Bushlark	*Mirafra erythroptera*	Blyth, 1845	Chinna Eela Jitta	Res, Br	Common	LC	II
313	Greater Short-toed Lark	*Calandrella brachydactyla*	(Leisler, 1814)	Goppa Chinna Chandul	WM	Common	LC	II

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314	Mongolian Short-toed Lark	*Calandrella dukhunensis*	(Sykes, 1832)	Shikhi Chinna Chandul	Res, Br	Common	LC	II
315	Oriental Skylark	*Alauda gulgula*	Franklin, 1831	Bharadwaja Pakshi	Res, Br	Common	LC	II
316	Tawny Lark	*Galerida deva*	(Sykes, 1832)	Sykes Chinna Chandul	Res, Br	Common	LC	II
58. Family Cisticolidae								
317	Common Tailorbird	*Orthotomus sutorius*	(Pennant, 1769)	Likku Jitta	Res, Br	Common	LC	II
318	Rufous-fronted Prinia	*Prinia buchanani*	Blyth, 1844	Erra-romu Veduru-kampa Jitta	Res	Common	LC	I
319	Grey-breasted Prinia	*Prinia hodgsonii*	Blyth, 1844	Veduru-kampa Jitta	Res, Br	Common	LC	II
320	Jungle Prinia	*Prinia sylvatica*	Jerdon, 1840	Kondalotakunna Jitta	Res, Br	Common	LC	II
321	Ashy Prinia	*Prinia socialis*	Sykes, 1832	Boodida-rangu Veduru-kampa Jitta	Res, Br	Common	LC	II
322	Plain Prinia	*Prinia inornata*	Sykes, 1832	Sada Chitkuruvi	Res, Br	Common	LC	II
323	Zitting Cisticola	*Cisticola juncidis*	(Rafinesque, 1810)	Charala Veduru-kampa Jitta	Res, Br	Common	LC	II
59. Family Acrocephalidae								
324	Thick-billed Warbler	*Arundinax aedon*	(Pallas, 1776)	Doddu-mukku Jitta	WM	Uncommon	LC	II
325	Booted Warbler	*Iduna caligata*	(Lichtenstein, 1823)	Kalujodu Patala Pitta	WM	Common	LC	II
326	Sykes's Warbler	*Iduna rama*	(Sykes, 1832)	Sykes Patala Pitta	WM	Common	LC	II
327	Paddyfield Warbler	*Acrocephalus agricola*	(Jerdon, 1845)	Erra Kampa Jitta	WM	Common	LC	II
328	Blyth's Reed Warbler	*Acrocephalus dumetorum*	Blyth, 1849	Kampa Jitta	WM	Common	LC	II
329	Clamorous Reed Warbler	*Acrocephalus stentoreus*	(Hemprich & Ehrenberg, 1833)	Borra Jitta	WM	Common	LC	II
60. Family Locustellidae								
330	Grasshopper Warbler	*Locustella naevia*	(Boddaert, 1783)	Gaddi-pathala Pitta	WM	Uncommon	LC	II
331	Bristled Grassbird	*Schoenicola striatus*	(Jerdon, 1841)	Grenta Pitta	SM	Uncommon	VU	I
61. Family Hirundinidae								
332	Gray-throated Martin	*Riparia chinensis*	(Gray, 1830)	Boodida-rangu-meda Vana Koila	SM	Common	LC	II
333	Sand Martin	*Riparia riparia*	(Linnaeus, 1758)	Isuka Vana Koila	WM	Common	LC	II
334	Eurasian Crag-Martin	*Ptyonoprogne rupestris*	(Scopoli, 1769)	Eurasia Konda Vana Koila	WM	Common	LC	II
335	Dusky Crag-Martin	*Ptyonoprogne concolor*	(Sykes, 1832)	Dumu-rangu Konda Vana Koila	Res, Br	Common	LC	II
336	Barn Swallow	*Hirundo rustica*	Linnaeus, 1758	Vana Koila	WM	Common	LC	II
337	Wire-tailed Swallow	*Hirundo smithii*	Leach, 1818	Theega-thoka Vana Koila	Res, Br	Common	LC	II
338	Red-rumped Swallow	*Cecropis daurica*	(Laxmann, 1769)	Erra-nadumu Vana Koila	Res, Br	Common	LC	II
339	Streak-throated Swallow	*Petrochelidon fluvicola*	(Blyth, 1855)	Charala-meda Vana Koila	Res, Br	Common	LC	II
340	Northern House-Martin	*Delichon urbicum*	(Linnaeus, 1758)	Ura Chatakamu	WM	Uncommon	LC	II
341	Asian House-Martin	*Delichon dasypus*	(Bonaparte, 1850)	Asia Chatakamu	WM	Uncommon	LC	II
62. Family Pycnonotidae								
342	Black-crested Bulbul	*Rubigula flaviventris*	(Tickell, 1833)	Nalla-siki Pigili-pitta	Res	Rare	LC	II
343	Red-vented Bulbul	*Pycnonotus cafer*	(Linnaeus, 1766)	Pigili-pitta	Res, Br	Common	LC	II
344	Red-whiskered Bulbul	*Pycnonotus jocosus*	(Linnaeus, 1758)	Thuraka Pigili-pitta	Res, Br	Common	LC	II
345	Yellow-throated Bulbul	*Pycnonotus xantholaemus*	(Jerdon, 1845)	Konda-poda Pigili-pitta	Res, Br	Common	VU	II
346	White-browed Bulbul	*Pycnonotus luteolus*	(Lesson, 1841)	Poda Pigili-pitta	Res, Br	Common	LC	II
63. Family Phylloscopidae								
347	Yellow-browed Warbler	*Phylloscopus inornatus*	(Blyth, 1842)	Pasupu-kanubomala Patala Pitta	Res	Uncommon	LC	II
348	Hume's Warbler	*Phylloscopus humei*	(Brooks, 1878)	Hume Patala Pitta	WM	Common	LC	II
349	Tytler's Leaf Warbler	*Phylloscopus tytleri*	Brooks, 1871	Tytler Akula Patala Pitta	WM	Common	LC	II

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350	Sulphur-bellied Warbler	*Phylloscopus griseolus*	Blyth, 1847	Pasupu-paccha Patala Pitta	WM	Common	LC	II
351	Tickell's Leaf Warbler	*Phylloscopus affinis*	(Tickell, 1833)	Tickel Akula Patala Pitta	WM	Common	LC	II
352	Common Chiffchaff	*Phylloscopus collybita*	(Vieillot, 1817)	Donna Patala Pitta	WM	Common	LC	II
353	Green-crowned Warbler	*Phylloscopus burkii*	(Burton, E., 1836)	Paccha-topi Patala Pitta	WM	Uncommon	LC	II
354	Green Warbler	*Phylloscopus nitidus*	Blyth, 1843	Paccha Patala Pitta	WM	Common	LC	II
355	Greenish Warbler	*Phylloscopus trochiloides*	(Sundevall, 1837)	Paccha-rangu Akula Patala Pitta	WM	Common	LC	II
356	Large-billed Leaf Warbler	*Phylloscopus magnirostris*	Blyth, 1843	Pedda-mukkula Patala Pitta	WM	Common	LC	II
357	Western Crowned Warbler	*Phylloscopus occipitalis*	(Blyth, 1845)	Akula Patala Pitta	WM	Common	LC	II
358	Blyth's Leaf Warbler	*Phylloscopus reguloides*	(Blyth, 1842)	Blyth Akula Patala Pitta	WM	Common	LC	II
64. Family Sylviidae								
359	Lesser Whitethroat	*Curruca curruca*	(Linnaeus, 1758)	Chinna Kampa Jitta	WM	Common	LC	II
360	Eastern Orphean Warbler	*Curruca crassirostris*	(Cretzschmar, 1830)	Pedda Kampa Jitta	WM	Common	LC	II
361	Yellow-eyed Babbler	*Chrysomma sinense*	(Gmelin, 1789)	Pasupu-kalla Saida	Res, Br	Common	LC	II
65. Family Zosteropidae								
362	Indian White-eye	*Zosterops palpebrosus*	(Temminck, 1824)	Vella-kanti	Res, Br	Common	LC	II
66. Family Timaliidae								
363	Pin-striped Tit-Babbler	*Mixornis gularis*	(Horsfield, 1822)	Charala Chitta Saida	Res	Uncommon	LC	II
364	Tawny-bellied Babbler	*Dumetia hyperythra*	(Franklin, 1831)	Thela-meda Saida	Res, Br	Common	LC	II
365	Indian Scimitar-Babbler	*Pomatorhinus horsfieldii*	Sykes, 1832	Dasari Pitta	Res, Br	Common	LC	II
67. Family Pellorneidae								
366	Puff-throated Babbler	*Pellorneum ruficeps*	Swainson, 1832	Adavi Jittu-kankulu Saida	Res, Br	Common	LC	II
68. Family Leiothrichidae								
367	Brown-cheeked Fulvetta	*Alcippe poioicephala*	(Jerdon, 1841)	Fulvetta Chitkuruvi	Res	Uncommon	LC	II
368	Common Babbler	*Argya caudata*	(Dumont, 1823)	Chinna Saida	Res, Br	Common	LC	II
369	Large Gray Babbler	*Argya malcolmi*	(Sykes, 1832)	Verri-chinda	Res, Br	Common	LC	II
370	Jungle Babbler	*Argya striata*	(Dumont, 1823)	Adavi Saida-pitta	Res, Br	Common	LC	II
371	Yellow-billed Babbler	*Argya affinis*	(Jerdon, 1845)	Pasupu-mukku Chitkuruvi	Res, Br	Common	LC	II
69. Family Sittidae								
372	Indian Nuthatch	*Sitta castanea*	Lesson, 1830	Siri Pitta	Res, Br	Common	LC	II
373	Velvet-fronted Nuthatch	*Sitta frontalis*	Swainson, 1820	Makmal-romu Siri Pitta	Res	Common	LC	II
70. Family Certhidae								
374	Indian Spotted Creeper	*Salpornis spilonota*	(Franklin, 1831)	Chukkala Theega Jitta	Res	Uncommon	LC	II
71. Family Sturnidae								
375	Common Hill Myna	*Gracula religiosa*	Linnaeus, 1758	Konda Gorinka	Res	Common	LC	I
376	Common Starling	*Sturnus vulgaris*	Linnaeus, 1758	Pariki Pitta	WM	Uncommon	LC	II
377	Rosy Starling	*Pastor roseus*	(Linnaeus, 1758)	Gulabi Pariki Pitta	WM	Common	LC	II
378	Asian Pied Starling	*Gracupica contra*	(Linnaeus, 1758)	Vendi Pariki Pitta	Res, Br	Common	LC	II
379	Brahminy Starling	*Sturnia pagodarum*	(Gmelin, 1789)	Nalla-topi Pariki Pitta	Res, Br	Common	LC	II
380	Chestnut-tailed Starling	*Sturnia malabarica*	(Gmelin, 1789)	Boodida-rangu Thala Pariki Pitta	WM	Common	LC	II
381	Common Myna	*Acridotheres tristis*	(Linnaeus, 1766)	Gorinka	Res, Br	Common	LC	II
382	Bank Myna	*Acridotheres ginginianus*	(Latham, 1790)	Vaddu Gorinka	Res	Common	LC	II
383	Jungle Myna	*Acridotheres fuscus*	(Wagler, 1827)	Adavi Gorinka	Res, Br	Common	LC	II
72. Family Turdidae								
384	Orange-headed Thrush	*Geokichla citrina*	(Latham, 1790)	Narinja-rangu Gante-pitta	Res, Br	Common	LC	II
385	Pied Thrush	*Geokichla wardii*	(Blyth, 1843)	Chukala Gante-pitta	WM	Rare	LC	II

	English name	Species	Authority	Vernacular name	Status	Abundance	IUCN Red List Status	IWPA
386	Indian Blackbird	*Turdus simillimus*	Jerdon, 1839	Poda Palisa	Res	Common	LC	II
387	Tickell's Thrush	*Turdus unicolor*	Tickell, 1833	Tickell Gante-pitta	WM	Common	LC	II
388	Scaly Thrush	*Zoothera dauma*	(Latham, 1790)	Chukala Gante-pitta	WM	Common	LC	II
73. Family Muscicapidae								
389	Asian Brown Flycatcher	*Muscicapa dauurica*	Pallas, 1811	Palina Eega-pattu Pitta	WM	Common	LC	II
390	Brown-breasted Flycatcher	*Muscicapa muttui*	(Layard, 1854)	Goduma-romu Eega-pattu Pitta	WM	Common	LC	II
391	Indian Robin	*Copsychus fulicatus*	(Linnaeus, 1766)	Nallanchi	Res, Br	Common	LC	II
392	Oriental Magpie-Robin	*Copsychus saularis*	(Linnaeus, 1758)	Pedda Nallanchi	Res, Br	Common	LC	II
393	White-rumped Shama	*Copsychus malabaricus*	(Scopoli, 1786)	Thoka Nallanchi	Res, Br	Common	LC	II
394	Blue-throated Flycatcher	*Cyornis rubeculoides*	(Vigors, 1831)	Neeli-meda Eega-pattu Pitta	WM	Common	LC	II
395	Tickell's Blue Flycatcher	*Cyornis tickelliae*	Blyth, 1843	Tickel Neeli Eega-pattu Pitta	Res, Br	Common	LC	II
396	Verditer Flycatcher	*Eumyias thalassinus*	(Swainson, 1838)	Neeli Eega-pattu Pitta	WM	Common	LC	II
397	Indian Blue Robin	*Larvivora brunnea*	Hodgson, 1837	Neeli Nallanchi	WM	Common	LC	II
398	Bluethroat	*Luscinia svecica*	(Linnaeus, 1758)	Podala Neeli Kandam	WM	Common	LC	II
399	Malabar Whistling-Thrush	*Myophonus horsfieldii*	Vigors, 1831	Eela-vese Gante-pitta	SM	Common	LC	II
400	Siberian Rubythroat	*Calliope calliope*	(Pallas, 1776)	Siberia Kempu Kandam	WM	Uncommon	LC	II
401	Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	(Temminck, 1829)	Neeli-Thella Eega-pattu Pitta	WM	Uncommon	LC	II
402	Little Pied Flycatcher	*Ficedula westermanni*	(Sharpe, 1888)	Pied Eega-pattu Pitta	V	Rare	LC	II
403	Ultramarine Flycatcher	*Ficedula superciliaris*	(Jerdon, 1840)	Neeli-tellani Eega-pattu Pitta	WM	Common	LC	II
404	Rusty-tailed Flycatcher	*Ficedula ruficauda*	(Swainson, 1838)	Thupu-thoka Eega-pattu Pitta	WM	Common	LC	II
405	Taiga Flycatcher	*Ficedula albicilla*	(Pallas, 1811)	Taiga Eega-pattu Pitta	WM	Common	LC	II
406	Red-breasted Flycatcher	*Ficedula parva*	(Bechstein, 1792)	Erra-meda Eega-pattu Pitta	WM	Common	LC	II
407	Black Redstart	*Phoenicurus ochruros*	(Gmelin, S.G., 1774)	Nune Buddigadu	WM	Common	LC	II
408	Blue-capped Rock-Thrush	*Monticola cinclorhyncha*	(Vigors, 1831)	Neeli-topi Gante-pitta	WM	Common	LC	II
409	Blue Rock-Thrush	*Monticola solitarius*	(Linnaeus, 1758)	Neeli Gante-pitta	WM	Common	LC	II
410	Siberian Stonechat	*Saxicola maurus*	(Pallas, 1773)	Banda Nallanchi	WM	Common	NE	II
411	Pied Bushchat	*Saxicola caprata*	(Linnaeus, 1766)	Kampa Nallanchi	Res, Br	Common	LC	II
412	Isabelline Wheatear	*Oenanthe isabellina*	(Temminck, 1829)	Isabell Goduma Kanki	WM	Uncommon	LC	II
413	Desert Wheatear	*Oenanthe deserti*	(Temminck, 1825)	Nalla-meda Goduma Kanki	WM	Uncommon	LC	II
414	Brown Rock Chat	*Oenanthe fusca*	(Blyth, 1851)	Goduma Banda Nallanchi	WM	Common	LC	II
74. Family Dicaeidae								
415	Thick-billed Flowerpecker	*Dicaeum agile*	(Tickell, 1833)	Dalasarimukku Poopoduchu Jitta	Res, Br	Common	LC	II
416	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*	(Latham, 1790)	Palina-mukku Poopoduchu Jitta	Res, Br	Common	LC	II
75. Family Nectariniidae								
417	Purple-rumped Sunbird	*Leptocoma zeylonica*	(Linnaeus, 1766)	Mudaga Jitta	Res, Br	Common	LC	II
418	Purple Sunbird	*Cinnyris asiaticus*	(Latham, 1790)	Oodha-thene Pitta	Res, Br	Common	LC	II
419	Loten's Sunbird	*Cinnyris lotenius*	(Linnaeus, 1766)	Loten Sitlu Jitta	Res, Br	Rare	LC	II
420	Crimson Sunbird	*Aethopyga siparaja*	(Raffles, 1822)	Erra Sitlu Jitta	Res	Rare	LC	II
421	Little Spiderhunter	*Arachnothera longirostra*	(Latham, 1790)	Chinna Saledu-vetagadu	Res	Rare	LC	II
76. Family Chloropseidae								
422	Jerdon's Leafbird	*Chloropsis jerdoni*	(Blyth, 1844)	Jerdon Aaku-pitta	Res, Br	Common	LC	II

	English name	Species	Authority	Vernacular name	Status	Abundance	IUCN Red List Status	IWPA
423	Golden-fronted Leafbird	*Chloropsis aurifrons*	(Temminck, 1829)	Bangaru-romu Aaku-pitta	Res, Br	Common	LC	II
77. Family Ploceidae								
424	Streaked Weaver	*Ploceus manyar*	(Horsfield, 1821)	Charala Pichuka	Res, Br	Common	LC	II
425	Baya Weaver	*Ploceus philippinus*	(Linnaeus, 1766)	Pasupu Pitta	Res, Br	Common	LC	II
426	Black-breasted Weaver	*Ploceus benghalensis*	(Linnaeus, 1758)	Nalla-gonthu Pichuka	Res, Br	Common	LC	II
78. Family Estrildidae								
427	Red Munia	*Amandava amandava*	(Linnaeus, 1758)	Erra Jinuvayi	Res, Br	Common	LC	II
428	Indian Silverbill	*Euodice malabarica*	(Linnaeus, 1758)	Jinuvayi	Res, Br	Common	LC	II
429	White-rumped Munia	*Lonchura striata*	(Linnaeus, 1766)	Thella-veepu Jinuvayi	Res, Br	Common	LC	II
430	Scaly-breasted Munia	*Lonchura punctulata*	(Linnaeus, 1758)	Chukala Jinuvayi	Res, Br	Common	LC	II
431	Tricolored Munia	*Lonchura malacca*	(Linnaeus, 1766)	Nalla Jinuvayi	Res, Br	Common	LC	II
79. Family Passeridae								
432	House Sparrow	*Passer domesticus*	(Linnaeus, 1758)	Voora Pichuka	Res, Br	Common	LC	II
433	Yellow-throated Sparrow	*Gymnoris xanthocollis*	(Burton, 1838)	Adavi Pichuka	Res, Br	Common	LC	II
80. Family Motacillidae								
434	Forest Wagtail	*Dendronanthus indicus*	(Gmelin, 1789)	Adavi Jittangi	WM	Common	LC	I
435	Gray Wagtail	*Motacilla cinerea*	Tunstall, 1771	Boodida-rangu Jittangi	WM	Common	LC	II
436	Western Yellow Wagtail	*Motacilla flava*	Linnaeus, 1758	Padamara Pacha Kampa Jittangi	WM	Common	LC	II
437	Eastern Yellow Wagtail	*Motacilla tschutschensis*	Gmelin, 1789	Thurpu Pacha Kampa Jittangi	WM	Uncommon	LC	II
438	Citrine Wagtail	*Motacilla citreola*	Pallas, 1776	Pasupu-thala Jittangi	WM	Common	LC	II
439	White-browed Wagtail	*Motacilla maderaspatensis*	Gmelin, 1789	Tella Kampa Jittangi	Res, Br	Common	LC	II
440	White Wagtail	*Motacilla alba*	Linnaeus, 1758	Tella Jittangi	WM	Common	LC	II
441	Richard's Pipit	*Anthus richardi*	Vieillot, 1818	Richard Likku	WM	Common	LC	II
442	Paddyfield Pipit	*Anthus rufulus*	Vieillot, 1818	Bharatha Jittangi	Res, Br	Common	LC	II
443	Blyth's Pipit	*Anthus godlewskii*	(Taczanowski, 1876)	Blyth Likku Jitta	WM	Common	LC	II
444	Tawny Pipit	*Anthus campestris*	(Linnaeus, 1758)	Palina-merupu Likku Jitta	WM	Common	LC	II
445	Tree Pipit	*Anthus trivialis*	(Linnaeus, 1758)	Chettu Likku Jitta	WM	Common	LC	II
446	Olive-backed Pipit	*Anthus hodgsoni*	Richmond, 1907	Paccha-veepu Likku Jitta	WM	Common	LC	II
447	Long-billed Pipit	*Anthus similis*	(Jerdon, 1840)	Podugu-mukku Likku Jitta	WM	Rare	LC	II
81. Family Fringillidae								
448	Common Rosefinch	*Carpodacus erythrinus*	(Pallas 1770)	Eduru Jinuvayi	WM	Common	LC	II
82. Family Emberizidae								
449	Crested Bunting	*Emberiza lathami*	Gray, J.E., 1831	Sikhi Jinuvayi	SM	Uncommon	LC	II
450	Black-headed Bunting	*Emberiza melanocephala*	Scopoli, 1769	Nalla-thala Jinuvayi	WM	Common	LC	II
451	Red-headed Bunting	*Emberiza bruniceps*	von Brandt, 1841	Erra-thala Jinuvayi	WM	Common	LC	II
452	Grey-necked Bunting	*Emberiza buchanani*	Blyth, 1845	Boodida-rangu-meda Jinuvayi	WM	Common	LC	II

Table 2. Species removed from the final list of birds known from Telangana, India.

Order Family	Species	Reason
Galliformes Phasianidae	*Synoicus chinensis* Blue-breasted Quail	Historical record by Dr. Salim Ali at Ramappa temple, Mulugu in 1937; no subsequent records in Telangana.
	Coturnix coturnix Common Quail	No photographic or audio evidence of the bird in the state, despite numerous reports, including one by Salim Ali in 1931.
	Perdicula erythrorhyncha Painted Bush-Quail	Unconfirmed eBird sighting in Nagarkurnool.
	Gallus gallus Red Junglefowl	No confirmed reports of this bird in Telangana in recent times; its current distribution is limited to areas north of the Godavari River.
Phoenicopteriformes Phoenicopteridae	*Phoeniconaias minor* Lesser Flamingo	There are historical sightings of the species from various parts of Telangana (Taher 1985). But no confirmed recent reports of this species from the state.
Columbiformes Columbidae	*Columba punicea* Pale-capped Pigeon	No reports of this bird from Telangana; all records are from Andhra Pradesh due to mapping issues on eBird.
Otidiformes Otididae	*Ardeotis nigriceps* Great Indian Bustard	Locally extinct; historic reports.
	Cacomantis merulinus Plaintive Cuckoo	Historical record by Dr. Salim Ali at Mannanur in October 1931.
Caprimulgiformes Caprimulgidae	*Caprimulgus jotaka* Gray Nightjar	Gray Nightjar *Caprimulgus indicus* is now split into Gray Nightjar (*C. jotaka*; northern & eastern India) and Jungle Nightjar (*C. indicus*; southern India) (*vide* Rasmussen & Anderton 2005).
Apodiformes Apodidae	*Apus apus* Common Swift	Though it was reported multiple times (individual checklists on eBird), there is no evidence to confirm their sighting.
Gruiformes Rallidae	*Rallina eurizonoides* Slaty-legged Crake	One misreport in eBird.
Charadriiformes Charadriidae	*Vanellus gregarious* Sociable Lapwing	An unconfirmed single report from ICRISAT in 1991.
	Vanellus leucurus White-tailed Lapwing	An unconfirmed single report from ICRISAT in 1991.
Charadriiformes Glareolidae	*Rhinoptilus bitorquatus* Jerdon's Courser	Historic report, locally extinct.
Ciconiiformes Ciconiidae	*Ciconia ciconia* White Stork	A historical report by Dr. Salim Ali at Narsampet in November 1931. Also see Majumdar (1991).
	Ephippiorhynchus asiaticus Black-necked Stork	A historical report by Dr. Salim Ali at Borgampad in November 1931.
Accipitriformes Accipitridae	*Sarcogyps calvus* Red-headed Vulture	Historic reports. No recent sightings.
	Gyps bengalensis White-rumped Vulture	Historic reports. No recent sightings.
	Gyps fulvus Eurasian Griffon	Historic reports. No recent sightings.
Strigiformes Tytonidae	*Tyto longimembris* Australasian Grass-Owl	One historic report from ICRISAT; but no notes to confirm the sighting.
Piciformes Picidae	*Dendrocopos macei* Fulvous-breasted Woodpecker	No confirmed reports from Telangana. The historical reports from Narsapur forest have inadequate documentation.
Falconiformes Falconidae	*Falco columbarius* Merlin	Historical sightings at ICRISAT and Manjeera; no documentation available.
Passeriformes Laniidae	*Lanius tephronotus* Gray-backed Shrike	No valid reports from Telangana. One unconfirmed report in eBird. The species is distributed in the Himalayan and northeastern regions.
Passeriformes Corvidae	*Dendrocitta formosae* Grey Treepie	No valid reports from Telangana. The species distribution starts from northern Andhra region and extends to the Himalayan and northeastern regions.
Passeriformes Paridae	*Machlolophus xanthogenys* Himalayan Black-lored Tit	The species distribution is restricted to Himalayan range. There are few unconfirmed reports from Umamaheshwaram.
Passeriformes Alaudidae	*Galerida cristata* Crested Lark	The species distribution is restricted to northwestern regions of India.
Passeriformes Cisticolidae	*Prinia rufescens* Rufescent Prinia	The species distribution is restricted to regions of northeastern India.
Passeriformes Locustellidae	*Locustella major* Long-billed Bush Warbler	The species distribution is restricted to Kashmir and Ladakh regions.
Passeriformes Phylloscopidae	*Phylloscopus neglectus* Plain Leaf Warbler	No confirmed reports. Its distribution is restricted to northwestern regions of India.
Passeriformes Timaliidae	*Cyanoderma ambiguum* Buff-chested Babbler	No confirmed reports. Its distribution is restricted to northeastern regions of India.
Passeriformes Muscicapidae	*Cyornis banyumas* Hill Blue Flycatcher	No confirmed reports. Its distribution is restricted to northeastern regions of India.
	Ficedula subrubra Kashmir Flycatcher	Historical reports; no confirmed documentation.

Order Family	Species	Reason
	Saxicola ferreus Gray Bushchat	No confirmed reports from the state. Some unconfirmed reports in eBird.
Passeriformes Estrildidae	*Amandava formosa* Green Avadavat	Reported by Dr. Salim Ali from Utnoor region based on the information given by Gond Raja of Utnoor.
	Lonchura kelaarti Black-throated Munia	No confirmed reports of the species from the region. There are many unconfirmed sightings in eBird.
Passeriformes Motacillidae	*Anthus cervinus* Red-throated Pipit	One historical sighting from Shamirpet in February 1983; but the sighting is doubtful.

Aythya ferina (present study), River Tern *Sterna aurantia* (Prasad et al. 2014), Indian Spotted Eagle *Clanga hastata* (present study), Greater Spotted Eagle *Clanga clanga* (Prasad et al. 2014), Tawny Eagle *Aquila rapax* (Srinivasulu 2004), Imperial Eagle *Aquila heliaca* (present study), Black-capped Kingfisher *Halcyon pileata* (present study), Bristled Grassbird *Schoenicola striatus* (Srinivasulu 2004), and Yellow-throated Bulbul *Pycnonotus xantholaemus* (Sreekar & Srinivasulu 2010).

The majority of the species are protected under the Indian Wildlife (Protection) Act, with 69 species (15.36%) being listed in Schedule I and 375 species (83.51%) listed under Schedule II.

The Great Indian Bustard *Ardeotis nigriceps* and Jerdon's Courser *Rhinoptilus bitorquatus* have been historically documented in the southern region and northeastern regions of Telangana. Despite their past presence in the region, there have been no confirmed sightings of former species in Telangana for the past three to four decades and the past century for the latter species. This prolonged absence of documented sightings, despite ongoing bird surveys, and increased birding activities in the region, strongly suggests that these species are now locally extinct within Telangana's boundaries. The local extinction of these critically endangered birds reflects broader patterns of habitat loss and degradation across their historical ranges.

During the compilation of this list, we have identified species that were previously included in other checklists (whether published or online databases) and have since been removed due to lack of evidence and/or distribution mismatches (Table 2).

Moving forward, we recommend that future bird documentation efforts in Telangana incorporate both photographic evidence and audio recordings of bird calls to strengthen species identification. Sound recordings are particularly valuable for cryptic species, nocturnal birds, and those more frequently detected by their vocalizations than by visual observations. To maintain the relevance and accuracy of this checklist, we propose establishing a systematic protocol for documenting new species records for Telangana. New sightings should be supported by clear photographic evidence and/or sound recordings, along with detailed field notes including location, date, habitat, and behavioural observations. These records should be submitted to established biodiversity databases (such as eBird, India Biodiversity Portal, or iNaturalist) and published in peer-reviewed journals. We commit to maintaining an updated digital repository of Telangana's avifauna, which will be periodically revised to include newly documented species that meet these verification criteria. This approach will ensure that the checklist remains a dynamic and reliable reference for future ornithological research, and conservation efforts in the region.

REFERENCES

Ali, S. & H. Whistler (1933a). The Hyderabad State Ornithological Survey. Part 1. *Journal of the Bombay Natural History Society* 36(2): 356–390.

Ali, S. & H. Whistler (1933b). The Hyderabad State Ornithological Survey. Part 2. *Journal of the Bombay Natural History Society* 36(3): 707–725.

Ali, S. & H. Whistler (1933c). The Hyderabad State Ornithological Survey. Part 3. *Journal of the Bombay Natural History Society* 36(4): 898–919.

Ali, S. & H. Whistler (1934a). The Hyderabad State Ornithological Survey. Part 4. *Journal of the Bombay Natural History Society* 37(1): 124–142.

Ali, S. & H. Whistler (1934b). The Hyderabad State Ornithological Survey. Part 5. *Journal of the Bombay Natural History Society* 37(2): 425–454.

Ali, S. (1939). An additional list of birds from Hyderabad State. *Journal of the Bombay Natural History Society* 40(3–4): 497–499.

Chakravarty, R. (2021). A strange encounter with an unlikely visitor: a Eurasian Woodcock *Scolopax rusticola* in Hyderabad, Telangana. *Indian BIRDS* 17(2): 54–55.

Clements, J.F., P.C. Rasmussen, T.S. Schulenberg, M.J. Iliff, T.A. Fredericks, J.A. Gerbracht, D. Lepage, A. Spencer, S.M. Billerman, B.L. Sullivan, M. Smith & C.L. Wood (2024). The eBird/Clements checklist of Birds of the World: v2024. https://www.birds.cornell.edu/clementschecklist/download/. Accessed on date

Hanumanthu, M. (2020). Dusky Eagle Owl. *Cheetal* 57(1): 65–67.

Hash, C.T., A. Varadachary & S.E. Moss (1996). Mallards and other mysteries — an update on the birds of ICRISAT Asia Center. *Mayura* 11: 12–15.

Jha, A. & K. Vasudevan (2020). Demographic history of the fragmented Yellow-throated Bulbul *Pycnonotus xantholaemus* population in the

Deccan Peninsula, India. *Endangered Species Research* 43: 199–207.

Jha, A. (2016). Snapshot sightings: Spot-bellied Eagle Owl from Umamaheswaram, Telangana. *Indian BIRDS* 12(2&3): 88A.

Jha, A. (2021). Records and observations on Yellow-throated Bulbul *Pycnonotus xantholaemus* in the Deccan Peninsula, India. *Journal of the Bombay Natural History Society* 118: 1–4.

Kanniah, P. & T. Ganesh (1990). Occurrence of the Black Stork *Ciconia nigra* near Hyderabad. *Mayura* 7&8(1–4): 46–48.

Kumar, V.V. & B.C. Choudhury (1999). Studies on the waterfowl of Manjira Wildlife Sanctuary, Medak district, Andhra Pradesh. *Mayura* 12: 20–35.

Kumar, V.V. (1990). On sightings of Demoiselle Cranes *Anthropoides virgo* in Medak district, Andhra Pradesh. *Mayura* 7&8(1–4): 50–52.

Majumdar, N. (1984). On a collection of birds from Adilabad district, Andhra Pradesh. Records of the Zoological Survey of India, Miscellaneous Publications, occasional paper no. 65. 63 pp.

Majumdar, N. (1991). Past and present wintering distribution of the White Stork *Ciconia ciconia* in India and suggestions for its conservation. *Zusammenfassung* 1991: 373–378.

Manoj, V. & S. Dey (2021). The Blue-and-white Flycatcher *Cyanoptila cyanomelana*: new record for Telangana, India. *Indian BIRDS* 17(4): 125–127.

Nagulu, V., V.V. Rao, C. Srinivasulu & V.M. Reddy (1998). Birds Karimnagar (East) Forest division — a potential corridor connecting Eturnagaram Wildlife Sanctuary, Andhra Pradesh and Indravathi National Park, Madhya Pradesh. *Pavo* 35(1&2): 39–52.

Narayanan, S.P. & S. Manchi (2008). Sighting of Malabar Whistling Thrush from the Deccan. *Malabar Trogon* 5(3): 13–14.

Peters, J. & M.V.N. Vinay (2020). Collared Pratincole *Glareola pratincola* in Telangana and Andhra Pradesh region. *Indian Birds* 16(6): 190–191.

Pittie, A. & M.S. Ulla (2006). Occurrence of Desert Wheatear *Oenanthe deserti* and Isabelline Wheatear *Oenanthe isabellina* in Mahbubnagar district, Andhra Pradesh. *Journal of the Bombay Natural History Society* 102(2): 234–235.

Pittie, A. & R. Mathew (1994). Occurrence of the Hobby and observations on Little Grebe in Hyderabad, Andhra Pradesh. *Newsletter for Birdwatchers* 34(5): 117.

Pittie, A. & R. Mathew (2001). Sighting of Rufoustailed Flycatcher *Muscicapa ruficauda* in and around Hyderabad, Andhra Pradesh. *Newsletter for Birdwatchers* 41(6): 83.

Pittie, A. (1987). Occurrence of the Little Pied Flycatcher *Muscicapa westermanni* in Narsapur, Medak district, Andhra Pradesh. *Journal of the Bombay Natural History Society* 83(3): 665–666.

Pittie, A., M.S. Kulkarni & R. Mathew (1998a). Range extension of White Wagtail *Motacilla alba leucopsis* at Pocharam Lake, Medak district, Andhra Pradesh. *Journal of the Bombay Natural History Society* 95(2): 347–348.

Pittie, A., C.T. Hash, S.A. Taher, M.S. Kulkarni & V. Totawar (1998b). Sightings of Lesser Florican *Sypheotides indica* (J.F. Miller) from Medak, Andhra Pradesh. *Journal of the Bombay Natural History Society* 95(3): 503–504.

Pittie, A., S. Quader & P. Pittie (2005). Distribution of White-winged Tern *Chlidonias leucopterus* in India and a new record from Andhra Pradesh. *Indian Birds* 1(4): 81–83.

Prasad, K.K., B. Ramakrishna, C. Srinivasulu & B. Srinivasulu (2014). Avifaunal diversity of Manjeera Wildlife Sanctuary, Andhra Pradesh, India. *Journal of Threatened Taxa* 6(2): 5464–5477. https://doi.org/10.11609/JoTT.o3505.5464-77

Rao, V.V., V. Nagulu, M. Anjaneyulu, B. Srinivasulu, C. Srinivasulu & J.V.R. Rao (1997). Status of avifauna of Rajiv Gandhi National Park, Andhra Pradesh, India. *Pavo* 35(1 & 2): 85–100.

Rao, V.V., C.M. Reddy, C. Srinivasulu & V. Nagulu (1998a). Habitat preference patterns of ducks at selected waterbodies of Nalgonda district, Andhra Pradesh. *Pavo* 35(1&2): 25–38.

Rao, V.V., C. Srinivasulu, V. Nagulu & C.M. Reddy (1998b). Population fluctuation, species variation and habitat utilization of egrets and herons at selected waterbodies of Nalgonda District, Andhra Pradesh. *Pavo* 35(1&2): 101–110.

Reddy, S. & G. Ramachandran (2023). Breeding of the Dusky Eagle Owl *Ketupa coromanda* in Telangana, and its status in southern India. *Indian BIRDS* 19(2): 44–47.

Sailu, G. & J. Swamy (2020). Avifaunal diversity of Pocharam Wildlife Sanctuary, Medak. *Pitta* 17(12): 4–15.

Sailu, G., G. Maheshwaran, B. Bharath, S.S. Jadhav & M. Karuthapandi (2021). Aves. pp. 341–366. In: Chandra, K., J. Deepa, C. Raghunathan, S.S. Jadhav & M. Karuthapandi (Eds.). *Current status of faunal diversity in Telangana*. Zoological Survey of India, Kolkata, 394 pp.

Shah, N. (2016). Sighting of Curlew Sandpipers near Hyderabad, Telangana, India. *Indian BIRDS* 11(3): 83–84.

Singh, D.K. (2015). Snapshot sightings: Amur Falcon at Narsapur Forest, Telangana. *Indian BIRDS* 10(2): 56A.

Sivakumar, S., S.R. Kumar, P. Sathiyaselvam & P. Ganesh (2021). Bird ringing programme in Manjeera Wildlife Sanctuary, Telangana, India: Findings and Conservation Issues. *Journal of the Bombay Natural History Society* 118: 195–201.

Sreekar, R. & R. Ram (2010). Sighting of Grey-headed Lapwing *Vanellus cinereus* (Blyth) in Hyderabad, Andhra Pradesh, India. *Journal of the Bombay Natural History Society* 106(2): 207.

Sreekar, R. & C. Srinivasulu (2010). New site record of Yellow-throated Bulbul *Pycnonotus xantholaemus* from Andhra Pradesh. *Indian Birds* 5(5): 157.

Sreekar, R., A. Naidu & C. Srinivasulu (2010a). Occurrence of Desert Wheatear *Oenanthe deserti* in ICRISAT campus, Medak district, Andhra Pradesh, India. *Zoo's Print* 25(4): 21.

Sreekar, R., A. Naidu, M. Seetharamaraju & C. Srinivasulu (2010b). Lesser Adjutant Stork and Stork-billed Kingfisher, additions to the birds of Kawal Wildlife Sanctuary, Andhra Pradesh. *Indian BIRDS* 6(6): 163–164.

Srikanth, B., H. Taher, S. Moorti, A.G. Krishna, L. Mathappan & R. Reddy (2020). Notes on sighting of Rufous-bellied Eagle in Telangana and its status in Eastern Ghats. *Pitta* 17(10): 16–17.

Srinivasan, S., B. Ramakrishna, C. Srinivasulu & G. Ramakrishna (2012). Records of Jerdon's Baza *Aviceda jerdoni* (Blyth 1842) (Aves: Falconfirmes: Accipitridae) in Andhra Pradesh, India. *Journal of Threatened Taxa* 4(9): 2920–2923. https://doi.org/10.11609/JoTT.o2922.2920-3

Srinivasulu, B. & C. Srinivasulu (1999a). Foraging behaviour, dispersion and movement of Openbill Stork *Anastomus oscitans* (Boddaert). *Zoos' Print Journal* 14(10): 117–119. https://doi.org/10.11609/JoTT.ZPJ.14.10.117-9

Srinivasulu, B. & C. Srinivasulu (1999b). Status of vultures in Andhra Pradesh, India. *Vulture News* 40: 26–34.

Srinivasulu, B., C. Srinivasulu, V. Nagulu, V.V. Rao & C. Koteshwarulu (1997). Avifauna of selected waterbodies in northern suburb of Secunderabad, Andhra Pradesh. *Pavo* 34(1&2): 87–94.

Srinivasulu, B., C. Srinivasulu, V.V. Rao, C. Koteshwarulu & V. Nagulu (1998). Avian use of paddy agro-ecosystem. *Pavo* 35(1&2): 75–84.

Srinivasulu, C. & B. Srinivasulu (2000). Sex ratio of wintering waterfowl at selected waterbodies in northern suburb of Secunderabad, Andhra Pradesh. *Zoos' Print Journal* 15(2): 199–201. https://doi.org/10.11609/JoTT.ZPJ.15.2.199-201

Srinivasulu, C. & B. Srinivasulu (2001). Avifaunal diversity of Medchal Mandal, Rangareddi district, Andhra Pradesh. *Mayura* 14: 23–36.

Srinivasulu, C. & B. Srinivasulu (2010). Aves. pp. 113–168. In: Director ZSI (ed.). *Limnological and faunistic studies of Pocharam Lake, Nizamabad-Medak District, Andhra Pradesh*. Wetland Ecosystem Series No. 13, Zoological Survey of India, Kolkata, India. 181 pp.

Srinivasulu, C. & G.C. Kumar (2022). A checklist of herpetofauna of Telangana State, India. *Journal of Threatened Taxa* 14(6): 21266–21281. https://doi.org/10.11609/jott.7360.14.6.21266-21281

Srinivasulu, C. & R. Sreekar (2012). Birds of Greater Hyderabad, Andhra Pradesh, India. In: Srinivasulu, C. & B. Srinivasulu (Compilers and Editors). *Glimpses of Biodiversity of Greater Hyderabad*. Greater Hyderabad Municipal Corporation, Hyderabad, Osmania University, Hyderabad and Zoo Outreach Organization, Coimbatore, 86 pp.

Srinivasulu, C. & V. Nagulu (2002). Mammalian and avian diversity of Nallamala Hills, Andhra Pradesh, India. *Zoos' Print Journal* 17(1):

675–684

Srinivasulu, C. (2004a). Birds of Kawal Wildlife Sanctuary, Andhra Pradesh, India. *Journal of the Bombay Natural History Society* 101(1): 3–25.

Srinivasulu, C. (2004b). Albinism in White-breasted Kingfisher *Halcyon smyrnensis* (Linne) from India. *Journal of the Bombay Natural History Society* 101(1): 157.

Srinivasulu, C. (2006). Additions to the mammalian and avian diversity of Nallamala Hills, with two mammal records. *Zoos' Print Journal*, (3): 2185–2186.

Srinivasulu, C. (2013). Aves. pp. 125–158. In: Director ZSI (ed.), *Faunistic Studies and Limmnological Studies on Wyra Lake*. Wetland Ecosystem Series, Zoological Survey of India, 16. Zoological Survey of India, Kolkata, 158 pp.

Srinivasulu, C. & V.V. Rao (2000). Occurrence of the Yellow-browed Bulbul *Hypsipetes indicus* (Jerdon) in the Nalamalla Hills, Andhra Pradesh. *Journal of the Bombay Natural History Society* 97(1): 144–145.

Srinivasulu, C., B. Srinivasulu, V. Nagulu & V.V. Rao (1997). Additional Coot (*Fulica atra* Linn.) breeding site records from Andhra Pradesh, India. *Journal of the Bombay Natural History Society* 94(3): 566–568.

Srinivasulu, C., V. Vasudeva Rao, G. Ravinder & V. Nagulu (2001). New site record of Indian Great Black Woodpecker *Dryocopus javensis* (Horsfield) from Andhra Pradesh. *Journal of the Bombay Natural History Society* 98(2): 280–281.

Swamy, K., G. Surender & V.V. Rao (2016). Checklist of birds in and around Baswapur village, Nizamabad district of Telangana State, India. *Newsletter for Birdwatchers* 55(5): 51–54.

Stotrabhashyam, S., B. Reddy, V. Satla, & I. Siddiqui (2015). A breeding site record of Long-billed Vulture *Gyps indicus* (Aves: Accipitriformes: Accipitridae) from Bejjur Reserve Forest, Telangana, India. *Journal of Threatened Taxa* 7(1): 6800–6804. https://doi.org/10.11609/jott.o4014.6800-4

Taher, H. & K.C. Ramakrishnan (2001). Possible range extension of the Peninsular Brooks's Flycatcher (*Muscicapa poliogenys vernayi*) in Andhra Pradesh. *Journal of the Bombay Natural History Society* 98(2): 282.

Taher, H. (2015). Some interesting sightings from the 2014 Asian Water Bird Census in Andhra Pradesh, and Telangana, India. *Indian BIRDS* 11(2): 42–44.

Taher, H., B. Srikanth, L. Mathappan & H. Kumar (2017). Sighting of the Ferruginous Duck *Aythya nyroca* in Adilabad district, Telangana State, India. *Journal of the Bombay Natural History Society* 113(1): 25–26.

Taher, H., U. Mani, K.B. Rao & N. Raha (2011). Sighting of the Sooty Tern *Sterna fuscata* near Hyderabad, Andhra Pradesh, India. *Indian BIRDS* 7(3): 87–88.

Taher, S. & A. Pittie (1989). *A Checklist of Birds of Andhra Pradesh*. Published by the Authors, Hyderabad, ix+39 pp.

Taher, S. & A. Pittie (1996). Additions to "A checklist of birds of Andhra Pradesh". *Mayura* 11: 1–5.

Taher, S.A. & A. Pittie (1983). The Black-throated Weaver Bird *Ploceus benghalensis* on the Musi River, Hyderabad city. *Mayura* 4(2): 15.

Taher, S.A. (1985). Lesser Florican *Sypheotides indica* found in Medak district, Andhra Pradesh. *Mayura* 5(4): 77–79.

Umapathy, G., S. Hussain & S. Shivaji (2009). Status and distribution on vultures in Andhra Pradesh, India. *Forktail* 25(2009): 163.


Image 1. *Anser indicus*


Image 2. *Sarkidiornis melanotos*


Image 3. *Tadorna ferruginea*


Image 4. *Tadorna tadorna*


Image 5. *Nettapus coromandelianus*


Image 6. *Mareca penelope*


Image 7. *Anas poecilorhyncha*


Image 8 *Anas acuta*


Image 9. *Anas crecca*


Image 10. *Pavo cristatus*


Image 11. *Galloperdix spadicea*


Image 12. *Coturnix coromandelica*


Image 13. *Francolinus pictus*


Image 14. *Ortygornis pondicerianus*


Image 15. *Gallus sonneratii*


Image 16. *Phoenicopterus roseus*


Image 17. *Tachybaptus ruficollis*


Image 18. *Streptopelia decaocto*


Image 19. *Spilopelia chinensis*


Image 20. *Spilopelia senegalensis*


Image 21. *Chalcophaps indica*


Image 22. *Treron bicinctus*


Image 23. *Treron phoenicopterus*


Image 24. *Ducula aenea*


Image 25. *Pterocles exustus*


Image 26. *Centropus sinensis*


Image 27. *Taccocua leschenaultii*


Image 28. *Phaenicophaeus tristis*


Image 29. *Clamator jacobinus*


Image 30. *Eudynamys scolopaceus*


Image 31. *Cuculus canorus*


Image 32. *Caprimulgus indicus*


Image 33. *Caprimulgus affinis*


Image 34. *Gallinula chloropus*


Image 35. *Fulica atra*


Image 36. *Amaurornis phoenicurus*


Image 37. *Zapornia fusca*


Image 38. *Zapornia akool*


Image 39. *Zapornia pusilla*


Image 40. *Burhinus indicus*


Image 41. *Esacus recurvirostris*


Image 42. *Himantopus himantopus*


Image 43. *Recurvirostra avosetta*


Image 44. *Pluvialis squatarola*


Image 45. *Vanellus duvaucelii*


Image 46. *Vanellus malabaricus*


Image 47. *Vanellus indicus*


Image 48. *Vanellus spinosus*


Image 49. *Charadrius alexandrinus*


Image 50. *Charadrius dubius*


Image 51. *Hydrophasianus chirurgus*


Image 52. *Metopidius indicus*


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Image 54. *Limosa limosa*


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Image 56. *Tringa nebularia*


Image 57. *Tringa glareola*


Image 58. *Turnix tanki*


Image 59. *Turnix suscitator*


Image 60. *Cursorius coromandelicus*


Image 61. *Glareola lactea*


Image 62. *Sterna acuticauda*


Image 63. *Sterna aurantia*


Image 64. *Anastomus oscitans*


Image 65. *Ciconia nigra*


Image 66. *Ciconia episcopus*


Image 67. *Mycteria leucocephala*


Image 68. *Anhinga melanogaster*


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Image 70. *Phalacrocorax fuscicollis*


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Image 98. *Circus macrourus*


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Image 101. *Accipiter badius*


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SHORT COMMUNICATION

Small Wild Cats Special Series

First photographic evidence of Marbled Cat *Pardofelis marmorata* (Martin, 1836) (Mammalia: Carnivora: Felidae) in Kakoi Reserve Forest, Assam, India

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Abstract: We report the first photographic records of the Marbled Cat *Pardofelis marmorata* in Kakoi Reserve Forest in Assam, India, obtained during a camera trap survey in July 2024. These records document its presence within its known range in northeastern India and highlight the importance of protecting little-disturbed forests. We recommend further research in the surrounding area to assess the population size and habitat requirements of the Marbled Cat in this part of its range, and the threats it faces in this region.

Keywords: Camera trap, canopy cover, conservation, habitat, Lakhimpur Forest Range, population size, semi-evergreen forest, semi-structured interviews, small wild cat, survey.

Assamese: ভাৰতৰ অসম ৰাজ্যৰ কাকৈ সংৰক্ষিত বনাঞ্চলত ২০২৪ চনৰ জুলাই মাহত এক কেমেৰা ট্ৰেপৰ জৰীপত আমি পোন-প্ৰথমবাৰৰ বাবে সেই অঞ্চলত মাৰ্বলড কেটৰ *Pardofelis marmorata* ফটো সংগ্ৰহ কৰিবলৈ সক্ষম হওঁ। এই ফটো সম্বলিত তথ্যৰ জৰিয়তে উত্তৰ-পূব ভাৰতত প্ৰাণীবিধৰ জ্ঞাত পৰিসৰৰ ভিতৰত অঞ্চলটোত ইয়াৰ অৱস্থিতি নিৰ্ধাৰণ হয় আৰু কাকৈৰ দৰে সৰু-সৰু বনাঞ্চলসমূহৰ সংৰক্ষণৰ প্ৰয়োজনীয়তাৰ গুৰুত্বৰ বিষয়ে সূচায়। এই অধ্যয়নৰ জৰিয়তে আমি কাকৈ বনাঞ্চল আৰু ইয়াৰ দাঁতিকাষৰীয়া অঞ্চলসমূহত মাৰ্বলড কেটৰ সংখ্যা, প্ৰাণীবিধৰ বাবে প্ৰয়োজনীয় বাসস্থানৰ বৈশিষ্ট্য তথা ই সন্মুখীন হোৱা ভাবুকি সংক্ৰান্ত অধিক গৱেষণাৰ মত পোষণ কৰোঁ।

The Marbled Cat *Pardofelis marmorata* (Martin, 1836) is distributed in the Indo-Malayan region from the Himalayan foothills in eastern Nepal (Lama et al. 2019) to southwestern China, continental southeastern Asia, and the islands of Sumatra and Borneo (Ross et al. 2016). It is classified as 'Near Threatened' on the IUCN Red List and is listed in CITES Appendix I (Ross et al. 2016). It is predominantly associated with large moist and mixed deciduous, and evergreen forest tracts that exhibit a high canopy connectivity, and a forest cover of at least 48.6% (Hendry et al. 2023). In Borneo, it has also been recorded in selectively logged forests (Mohamed et al. 2009; Wearn et al. 2013; Hearn et al. 2016).

In India, the Marbled Cat is afforded the highest protection level under Schedule I of the Wildlife Protection Act (1972) (Ministry of Law and Justice 2022). It has been recorded in evergreen, semi-evergreen, and bamboo mixed forests in the eastern Himalayan foothills

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of northern West Bengal, and of the states of Assam, Arunachal Pradesh, Nagaland, Meghalaya, and Mizoram (Choudhury 1996; Lyngdoh et al. 2011; Sethy et al. 2017; Chatterjee et al. 2019; Joshi et al. 2019; Mukherjee et al. 2019; Bal et al. 2022). A camera trap record at 2,690 m in Eaglenest Wildlife Sanctuary represents the upper elevation limit of the Marbled Cat known in India to date (Mukherjee et al. 2016). Camera trap records of the Marbled Cat in Assam are limited to lower elevations in Manas and Nameri Tiger Reserves (Jhala et al. 2020).

Here, we present camera trap records of the Marbled Cat in Kakoi Reserve Forest, Assam. These records provide further evidence for its occurrence in Assam, highlighting the value of systematic camera trapping in small and under-surveyed reserve forests.

Study Area

Lakhimpur District in northeastern Assam shares a common boundary with the Brahmaputra River and Majuli District in the south, Dhemaji District in the east, and Sonitpur District in the west. It covers approximately 2,277 km^2, and has nearly 196.5 km^2 forested area (Chetia et al. 2025).

Kakoi Reserve Forest spreads over 49.8 km^2 to the north-west of Lakhimpur District, bordering Arunachal Pradesh to the north (Figure 1) (Saikia & Saikia 2020). In the south-west, it is bounded by Boginadi River and in the north-east by Ranganadi River (Chetia et al. 2024). It was declared in 1919 (Saikia & Saikia 2020) and is under the jurisdiction of the Lakhimpur Forest Range today (Chetia et al. 2024). In 2017, it had a forest cover of 45.5 km^2, equivalent to 91.4% of the reserve's total size (Saikia & Saikia 2020).

The region's habitat consists of semi-evergreen and moist deciduous forests with some wetlands. Key tree species include *Mesua ferrea*, *Bombax ceiba*, *Shorea robusta*, *Dillenia indica*, *Kayea assamica* endemic to Lakhimpur, and various bamboo species (Chetia et al. 2025).

Kakoi Reserve Forest experiences a tropical climate characterized by substantial rainfall and a short dry period (Chetia et al. 2025). The average annual rainfall is approximately 3,200 mm (Fick & Hijmans 2017). Rainfall is generally lower during January–March than during April–July (Chetia et al. 2025). Rainfall occurs on about 125 days annually, with July being the wettest

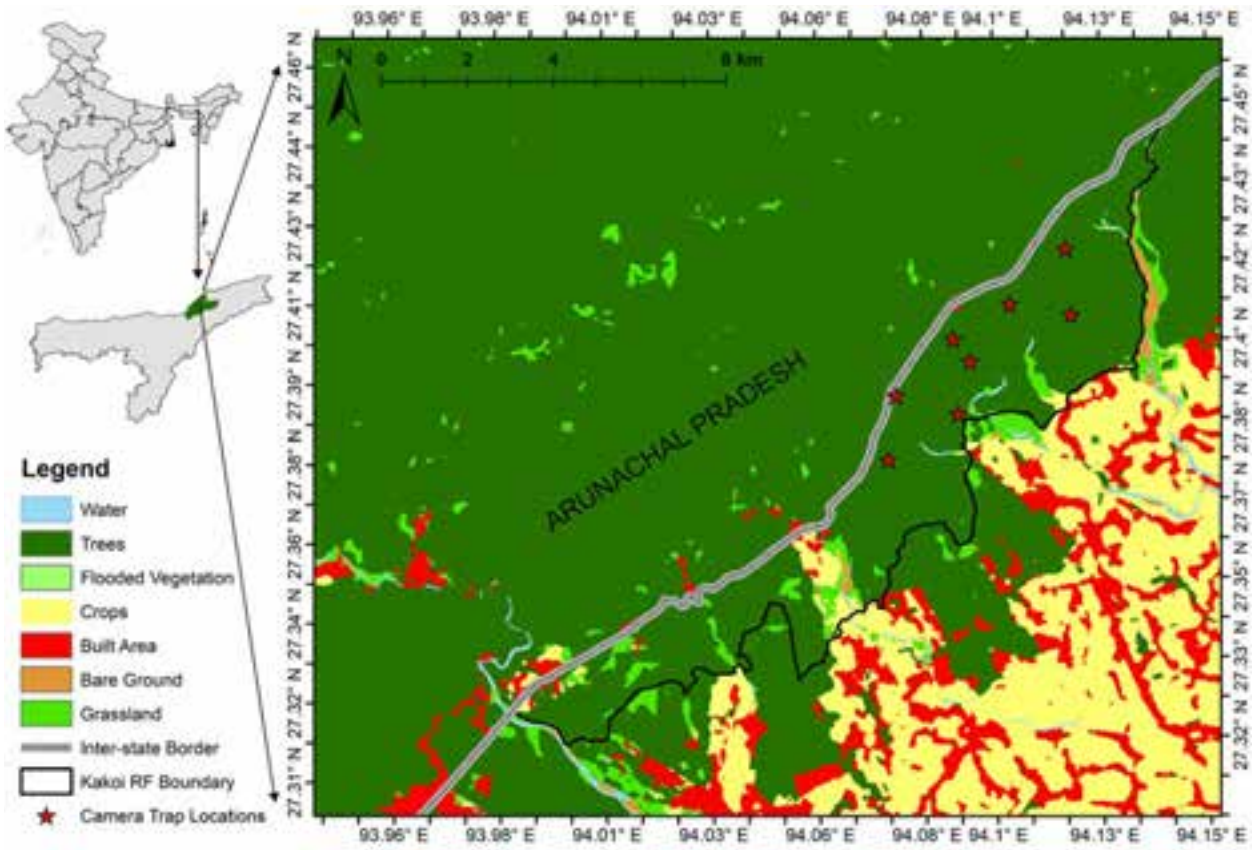

Figure 1. Location and land cover of Kakoi Reserve Forest, Assam, India.

month (Directorate of Economics and Statistics Assam 2014). The average annual temperature is 23.8°C, with seasonal variation from 10°C in winter to 35°C in summer (Buragohain et al. 2023). Relative humidity ranges 74–89 %, with an average of 81% (Buragohain et al. 2023).

Material and Methods

As part of an ongoing biodiversity monitoring project in Kakoi Reserve Forest, eight passive infrared Browning Strike Force Pro DCL camera traps were deployed to document small mammalian fauna over a 28-day period from 10 July to 6 August 2024. The camera traps were placed opportunistically along animal trails and natural paths approximately 30–50 cm above ground level, depending on the slope, without bait.

Locations were selected based on indirect signs of animal presence, such as tracks, and scat. The camera traps were configured for high sensitivity, with a delay of one second between photographs. They were spaced 1.5–2 km apart and remained active for 24 hours a day throughout the survey period, totalling 224 camera trap days. Each camera location was geo-referenced using a handheld Garmin GPS etrex10 GPS device set to WGS 84 geodetic datum.

Semi-structured interviews were conducted with 18 local people residing near Kakoi Reserve Forest. The respondents are primarily farmers and herders who frequently use the forest for grazing their livestock, firewood collection, and other subsistence activities. They were shown a field guide image of the Marbled Cat displayed in Menon (2014) and asked whether, when, and where they had sighted a similar animal. This method aimed to assess local awareness of the species' presence in the area.

Results

Two photographs of the Marbled Cat were recorded in two camera trap locations (Images 1 and 2) on different days within the reserve forest. The first photograph was taken at 18:34 h on 13 July 2024 at an elevation of 160 m at the coordinates 27.384° N, 94.091° E. The second image was recorded at 17:47 h on 16 July 2024 at an elevation of 201 m at 27.395° N, 94.094° E. The two locations were approximately 1.5 km apart, within 200–300 m of a perennial stream, and about 50–600 m away from the forest edge. The surrounding habitat at these locations had 60–70 % canopy cover and the dominant tree species were *Canarium bengalense*, *Mesua ferrea*, and *Dillenia indica*.

Our camera traps also recorded the Leopard Cat *Prionailurus bengalensis,* Malayan Porcupine *Hystrix brachyura,* and Wild Boar *Sus scrofa.*

All our interview respondents were aware of the Marbled Cat's presence in Kakoi Reserve Forest.

Image 1. Marbled Cat recorded on 13 July 2024 in Kakoi Reserve Forest, Assam, India. © Hiranmoy Chetia.

Image 2. Marbled Cat recorded on 16 July 2024 in Kakoi Reserve Forest, Assam, India. © Hiranmoy Chetia.

They identified it as "Godhafutuki" and "Godhafutuki mekuri." Thirteen respondents said they had never harmed or killed a Marbled Cat. Five others mentioned that when Marbled Cats came near their poultry coops, they sometimes used catapults to scare them away, but made it clear they never intended to kill them. They also emphasized that they neither eat wild cat meat nor sell any parts of wild animals.

Discussion

Our records of the Marbled Cat represent the first evidence for its presence in Kakoi Reserve Forest. It is not possible to determine whether the two photographs show one or different individuals, as the cat in Image 2 is slightly motion-blurred. The nearest sites where the Marbled Cat was reported earlier are Talle Valley Wildlife Sanctuary in Arunachal Pradesh (Selvan et al. 2013) and Subansiri Reserve Forest of Dhemaji District (Choudhury 1996). These sites are about 20–30 km away from our study area.

The forest cover in Kakoi Reserve Forest is well above the minimum forest cover observed in the southeastern Asian range and preferred habitat of the Marbled Cat (Hendry et al. 2023). Our records corroborate findings in Eaglenest Wildlife Sanctuary indicating that the Marbled Cat is associated with dense forest and a high canopy cover of around 70% (Mukherjee et al. 2016). Reserve Forests adjacent to our study area also exhibit high proportions of densely forested areas (Saikia & Saikia 2020). We therefore think it likely that the Marbled Cat is present along a broader section of the lower Himalayan foothills in the Lakhimpur Forest Range and the borderlands with Arunachal Pradesh.

The local name "Godhafutuki" for the Marbled Cat is also a common name for the Clouded Leopard *Neofelis nebulosus* in Assamese (Choudhury 2013), which indicates that local people use one name for similar looking species. Some informants correctly identified the Clouded Leopard and provided insights into the size difference between the two species.

Our respondents indicated that poaching, ritualistic hunting, and retaliatory killing do not currently pose a significant threat to the Marbled Cat in Kakoi Reserve Forest and surroundings. Tribal hunters in Assam reportedly have hunted Marbled Cats near Subansiri and Dhansiri Reserve Forests (Choudhury 1996). In Arunachal Pradesh, Marbled Cat skins have been recorded with local hunters in West Kameng District, Dihang-Dibang Biosphere Reserve, Pakke Tiger Reserve, and Ziro Valley (Mishra et al. 2006; Choudhury 2010; Lyngdoh et al. 2011; Selvan et al. 2013).

In view of the scarce knowledge about the Marbled Cat in Assam, we highly recommend further surveys to better understand its distribution, habitat use, and the

threats it faces in this region. Convincing local people to protect rather than hunt the Marbled Cat is essential for its conservation.

References

Bal, A.K., D. Panda & N.S. Chauhan (2022). First photographic evidence of Marbled Cat from Murlen National Park, Mizoram, India. *Cat News* 75: 14–15.

Buragohain, M.K., A.A. Dar, K.N. Babu & N. Parthasarathy (2023). Tree community structure, carbon stocks and regeneration status of disturbed lowland tropical rain forests of Assam, India. *Trees, Forests and People* 11: 100371. https://doi.org/10.1016/j.tfp.2023.100371

Chatterjee, P., K. Mondal, B. Tripathy & K. Chandra (2019). Evidence of presence of Marbled Cat *Pardofelis marmorata* (Martin, 1837) in Neora Valley National Park, Central Himalaya, India. *Records of the Zoological Survey of India* 119(2): 193–196. https://doi.org/10.26515/rzsi/v119/i2/2019/129097

Chetia, H., S.D. Rout & M. Neog (2024). An assessment of herpetofauna in Kakoi Reserve Forest of Lakhimpur District, Assam, India. *Proceedings of the Zoological Society* 77: 183–189. https://doi.org/10.1007/s12595-024-00520-w

Chetia, H., R. Hazarika, C. Gogoi & S.D. Rout (2025). Edible flora: An assessment from Kakoi Reserve Forest of Lakhimpur District. *Journal of Bioresearch* 4(1): 12–22. https://doi.org/10.5281/zenodo.12776679

Choudhury, A. (1996). The Marbled Cat *Felis marmorata* Martin in Assam – some recent records. *Journal of the Bombay Natural History Society* 93(1): 583–584.

Choudhury, A. (2010). Records of cats in Dihang-Dibang Biosphere Reserve in northeastern India. *Cat News* 53: 22–24.

Choudhury, A. (2013). *The Mammals of Northeast India*. Gibbons Books, Guwahati, India, 432 pp.

Directorate of Economics and Statistics Assam (2014). *Statistical Handbook of Assam*. Government of Assam, Guwahati, 417 pp.

Fick, S.E. & R.J. Hijmans (2017). WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. *International Journal of Climatology* 37(12): 4302–4315.

Hearn, A.J., J. Ross, H. Bernard, S.A. Bakar, L.T. Hunter & D.W. Macdonald (2016). The first estimates of Marbled Cat *Pardofelis marmorata* population density from Bornean primary and selectively logged forest. *PLoS One* 11(3): e0151046. https://doi.org/10.1371/journal.pone.0151046

Hendry, A., Z. Amir, H. Decoeur, C.P. Mendes, J.H. Moore, A. Sovie & M.S. Luskin (2023). Marbled Cats in Southeast Asia: Are diurnal and semi-arboreal felids at greater risk from human disturbances? *Ecosphere* 14(1): e4338. https://doi.org/10.1002/ecs2.4338

Jhala, Y.V., Q. Qureshi & A.K. Nayak (2020). *Status of Tigers, co predators and prey in India, 2018.* National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun, 656 pp.

Joshi, B., B.L.N. Syiem, R. Kuotsu, A. Menon, J. Gogoi, V.R. Goswami & D. Vasudev (2019). Records of the Marbled Cat *Pardofelis marmorata* and the Asiatic Golden Cat *Catopuma temminckii* (Mammalia: Carnivora: Felidae) from the community forests surrounding the Dzükou Valley in Nagaland, India. *Journal of Threatened Taxa* 11(10): 14363–14367. https://doi.org/10.11609/jott.4921.11.10.14363-14367

Lama, S.T., J.G. Ross, D. Bista, A.P. Sherpa, G.R. Regmi, M.K. Suwal, P. Sherpa, J. Weerman, S.S. Lama, M. Thapa, L.P. Poudyal & A.M. Paterson (2019). First photographic record of Marbled Cat *Pardofelis marmorata* Martin, 1837 (Mammalia, Carnivora, Felidae) in Nepal. *Nature Conservation* 32: 19–34. https://doi.org/10.3897/natureconservation.32.29740

Lyngdoh, S., K.M. Selvan, G.V. Gopi & B. Habib (2011). First photographic evidences of two rare cats from Pakke Tiger Reserve, western Arunachal Pradesh. *Current Science* 101(10): 1284.

Menon, V. (2014). Indian Mammals: a Field Guide. Hachette Book Publishing, Gurgaon, India, 528 pp.

Ministry of Law and Justice (2022). The Wild Life (Protection) Amendment Act, 2022. The Gazette of India Extraordinary, Part II, Section 1, New Delhi.

Mishra, C., M.D. Madhusudan & A. Datta (2006). Mammals of the high altitudes of western Arunachal Pradesh, eastern Himalaya: an assessment of threats and conservation needs. *Oryx* 40(1): 29–35. https://doi.org/10.1017/S0030605306000032

Mohamed, A., H. Samejima & A. Wilting (2009). Records of five Bornean cat species from Deramakot Forest Reserve in Sabah, Malaysia. *Cat News* 51: 14–17.

Mukherjee, S., R. Athreya, P.V. Karunakaran & P. Choudhary (2016). Ecological species sorting in relation to habitat structure in the small cat guild of Eaglenest Wildlife Sanctuary, Arunachal Pradesh. Technical Report PR-182, 1–52. Sálim Ali Centre for Ornithology and Natural History, Coimbatore, 61 pp.

Mukherjee, S., P. Singh, C. Ri, K. Kakati, B. Borah, T. Tapi, S. Kadur, P. Choudhary, S. Srikant, S. Nadig, R. Navya, M. Björklund & U. Ramakrishnan (2019). Activity patterns of the small and medium felid (Mammalia: Carnivora: Felidae) guild in northeastern India. *Journal of Threatened Taxa* 11(4): 13432–13447. https://doi.org/10.11609/jott.4662.11.4.13432-13447

Ross, J., J. Brodie, S. Cheyne, A. Datta, A. Hearn, B. Loken, A.J. Lynam, J. McCarthy, C. Phan, A. Rasphone, P. Singh & A. Wilting (2016). *Pardofelis marmorata*. The IUCN Red List of Threatened Species 2016: e.T16218A97164299. Accessed on 15.i.2025. https://doi.org/10.2305/IUCN.UK.2016-1.RLTS.T16218A97164299.en

Saikia, J. & S. Saikia (2020). Forest cover change detection in Ranga, Kakoi, and Dulung Reserve Forests in the Lakhimpur District of Assam, India. *Journal of the Social Sciences* 48(4): 1664–1674.

Selvan, K.M., G.V. Gopi, B. Habib & S. Lyngdoh (2013). Hunting record of endangered Marbled Cat *Pardofelis marmorata* in the Ziro valley of Lower Subansiri, Arunachal Pradesh, India. *Journal of Threatened Taxa* 5(1): 3583–3584. https://doi.org/10.11609/JoTT.o3208.100

Sethy, J., S. Gouda & N.S. Chauhan (2017). Photographic evidence of Marbled Cat from Dampa Tiger Reserve, Mizoram, India. *Cat News* 65: 26–27.

Wearn, O.R., J.M. Rowcliffe, C. Carbone, H. Bernard & R.M. Ewers (2013). Assessing the status of wild felids in a highly-disturbed commercial forest reserve in Borneo and the implications for camera trap survey design. *PLoS One* 8(11): e77598. https://doi.org/10.1371/journal.pone.0077598

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SHORT COMMUNICATION

A new species of millipede of the genus *Xiphidiogonus* Carl, 1932 (Paradoxosomatidae: Polydrepanini) from Satara District, Maharashtra State, India

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Abstract: The new species *Xiphidiogonus sinispinus* sp. nov. is described and illustrated from Satara District, Maharashtra. The new species belongs to the tribe Polydrepanini (Paradoxosomatidae). The genus was established by Carl in 1932 with three new species, all from Tamil Nadu. This is the first record of the genus *Xiphidiogonus* from Maharashtra. The species *X. sinispinus* sp. nov. differs from its congeners by the lack of a gonofemoral process whereas all three previously known species bear an either internal or external gonofemoral process.

Keywords: Arid zone, biodiversity, Diplopoda, millipedes, Polydesmida, taxonomy, *Xiphidiogonus sinispinus* sp. nov.

The family Paradoxosomatidae is one of the most diverse of class Diplopoda, having more than 200 genera worldwide (Jeekel 1968; Nguyen & Sierwald 2013; Golovatch et al. 2021). Golovatch & Wesener (2016) published the millipede (Diplopoda) checklist of India reporting more than 270 species falling under 16 orders and 125 families. A total of 22 genera and 56 species were reported in family Paradoxosomatidae.

There are three subfamilies within family Paradoxosomatidae. Of these, two subfamilies—Alogolykinae Hoffman, 1963 and Paradoxosomatinae Daday, 1889 (Jeekel 1968; Golovatch et al. 2021)—are reported from India. Golovatch et al. (2021) revised the tribe Polydrepanini with a new species *Delarthrum anomalans* (Golovatch et al. 2021) from Kerala. The tribe Polydrepanini is distinguished on the basis of long, slender & untwisted gonofemorite (fe), and thin & subflagelliform solenomere (sl). The tribe currently comprises seven genera, which are illustrated by Golovatch et al. (2021). The genus *Xiphidiogonus* is a member of the tribe Polydrepanini (Jeekel 1968). The genus *Xiphidiogonus* was proposed by Carl (1932) to accommodate three new species from southern Indian states with distinctive characters, such as the presence of a leaf shaped acropodite and a small & twisted solenophore with a flagelliform solenomere.

The current paper puts forth a record of new species *Xiphidiogonus sinispinus* sp. nov. from Satara District, Maharashtra, India.

Materials and Methods

The material underlying this study was collected by hand from a dry mixed deciduous forest region

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and agricultural field of Diwadi (17.696^0 N, 74.445^0 E), Dahiwadi Tehsil, Satara District, Maharashtra, India. The samples were collected between May 2024 (Summer) and July 2024 (Monsoon) and preserved in ethanol (98%). The holotype and paratypes are deposited in BNHS (Bombay Natural History Society) Depository.

The in-field photographs were taken with a Realme 3 Pro smartphone with a 64 MP rear camera. The laboratory work was done with a compound microscope with zoom capacity of 20–60 x. The laboratory photographs were taken by Realme 3 Pro smartphone and stacked by an online photo stacking website https://focusstackingonline.com/. The map used in this study was prepared using QGIS 3.34.11-Prizren software. Approximate coordinates were obtained from Google Earth Pro software and satellite data were accessed via quick map services. Scanning electron microscopy (SEM) was done after dehydrating samples in ethanol (90%, 2 x 100%) followed by drying for 24 hours, and mounted on aluminum stubs. The sample was then coated with gold for half a minute in a sputter coater and SEM images were taken by using a JEOL JSM IT 200 scanning electron microscope. The SEM samples were returned to ethanol after the study.

Taxonomic Account

Order Polydesmida Latreille, 1802/03
Family Paradoxosomatidae Daday, 1889
Subfamily Alogolykinae Hoffman, 1963
Tribe Polydrepanini Jeekel, 1968
Genus *Xiphidiogonus* Carl, 1932

Type species: *Xiphidiogonus spinipleurus* Carl, 1932

Diagnosis: Carl (1942) described the genus *Xiphidiogonus* from peninsular India with three new species. The genus is defined by the following characters: metazonites with fine longitudinal and mostly smooth transverse furrows, weakly developed keels (paraterga) without corners. Sternal cones are present on coxae of 4th leg pairs of males. Legs robust, first & second pair of legs short, somewhat thick, more or less hooked, and femur with adenostyle. Gonofemorite straight, long, cylindrical, untwisted, and armed with processes on either or both sides. Acropodite leaf-shaped with short lobes; solenophore (sph) unusually small and strongly twisted with a free flagelliform solenomere (sl) (Golovatch et al. 2021).

***Xiphidiogonus sinispinus* sp. nov.**
(Figure 1, Image 1–16, 23, 24)

urn:lsid:zoobank.org:act:1779DD8D-65CE-4539-ACA2-F6E876FF6EC2

Material examined

Holotype: Male, BNHS Mi 1, 27.v.2024, Diwadi, Dahiwadi Tehsil, Satara District, Maharashtra, India. (17.696^0 N, 74.445^0 E), coll. P. Badade & S. Mane.

Paratypes: 2 males, BNHS Mi 2, BNHS Mi 3, same as holotype. 2 females, BNHS Mi 4, BNHS Mi 5, same as holotype.

Other material examined: Aasrai Devi Temple (17.841^0 N, 74.340^0 E), Phaltan Tehsil, Satara District, Maharashtra. Near Kartik Swami Temple (17.604^{0}N, 74.276^0 E), Rahimatpur, Koregaon Tehsil, Satara District, Maharashtra.

Etymology: The specific epithet *'sinispinus'* refers to the absence of gonofemoral spine/ wing-like projections.

Diagnosis: *Xiphidiogonus sinispinus* sp. nov. is defined by the presence of long, slender and untwisted gonofemorite lacking a gonofemoral process, unlike *Xiphidiogonus hendersoni* Carl, 1932 with internal wing-like femoral edge, *Xiphidiogonus dravidus* Carl, 1932 with one internal and two external femoral edges, or *Xiphidiogonus spinipleurus* Carl, 1932 with two internal and one external femoral edges.

Description

Colour of live animals black with brown shade on metazonites (Image 1); head, paraterga and prozonites black; clypeolabral and mandible region yellow; antennae, sterna, and legs black or black-brown; trochanter and prefemur joints are paler; tips of legs with yellow tint. After preservation in alcohol for two months the specimen appeared darker.

Body moniliform with 20 segments. Length of holotype, 28 mm, of paratypes, 27–29 mm (male) or 28–31 mm (female). Antennae longer in males (reaching up to segment 4) than in females (reaching up to segment 3). Body width, head < collum < segment 2 < segment 5 – 16 (both male & female), thereafter tapering towards epiproct. Segment 3 and 4 comparatively smaller than others. Head setose with longitudinal groove starting from vertex to clypeus. Clypeolabrum setose. Collum with minor arc shape and two rows of setae, anteriorly 4+4, and posteriorly 3+3 setae. Post collum terga with a single row of 2+2 setae at anterior side and 3+3 setae at posterior side of metazonites. Collum shows a sagittal sulcus from anterior to posterior side. Some segments show traces of sagittal sulcus. Metazonites with clearly visible transverse sulcus up to 18th segment. Paraterga

Image 1–3. *Xiphidiogonus sinispinus* sp. nov.: 1—in-situ photograph of male paratype (BNHS Mi 3) | 2,3—Habitat. © Shubham Mane.

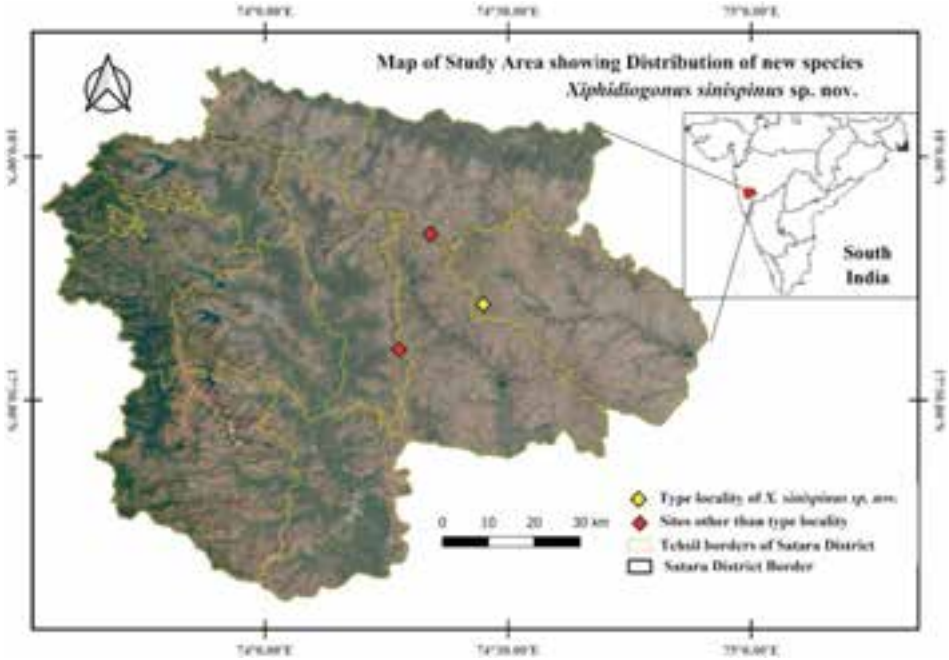

Figure 1. Known localities of *Xiphidiogonus sinispinus* sp. nov. from Satara District surveyed between May 2024 and July 2024. © Shubham Mane.

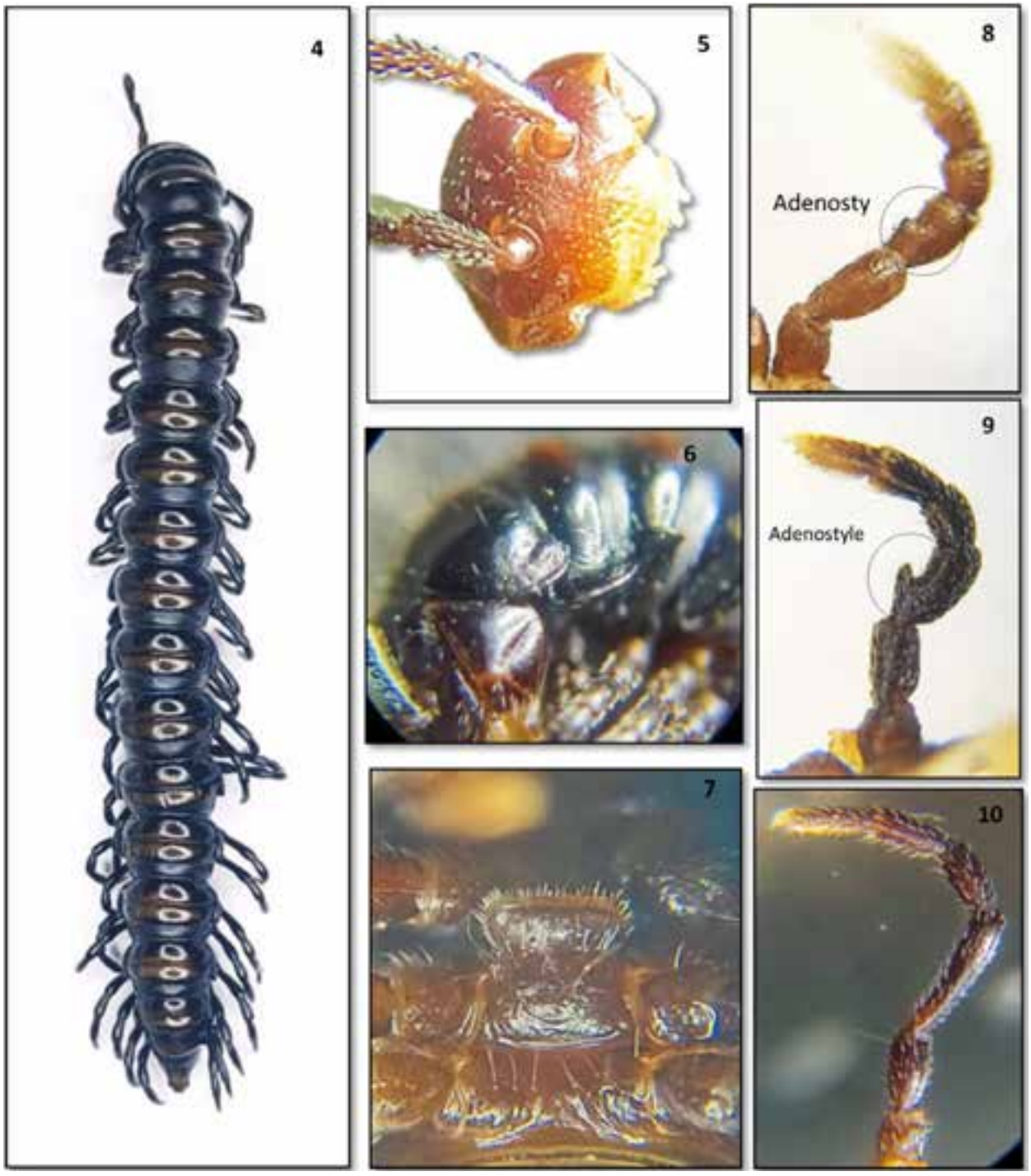

Image 4–10. *Xiphidiogonus sinispinus* sp. nov.: 4—Whole animal dorsal view | 5—Head from anterior view | 6—Lateral view of head with next three segments | 7—Sternal cones of 4th coxa | 8—First leg | 9—Second leg | 10—Leg of midbody segment. © Shubham Mane.

smooth and well developed from segment 3–18 and relatively smaller on segments 3, and 4; paraterga of second segment with rounded corners and extended forward, and backward. All paraterga anteriorly convex; caudal corner of paraterga rounded laterally. Ozopores evident, lateral at ovoid groves of paraterga of segment—5, 7, 9, 10, 12, 13, 15–19. Epiproct conical, not pointed posteriorly, dorsoventrally flat. Sterna granular, setose, dark brown coloured. Fourth coxa of males with sternal cones (Image 7) directed towards anterior side. Sternal cones are trapezoid, bearing setae. Sterna of segments 2–4 with small triangular outgrowth ventrally.

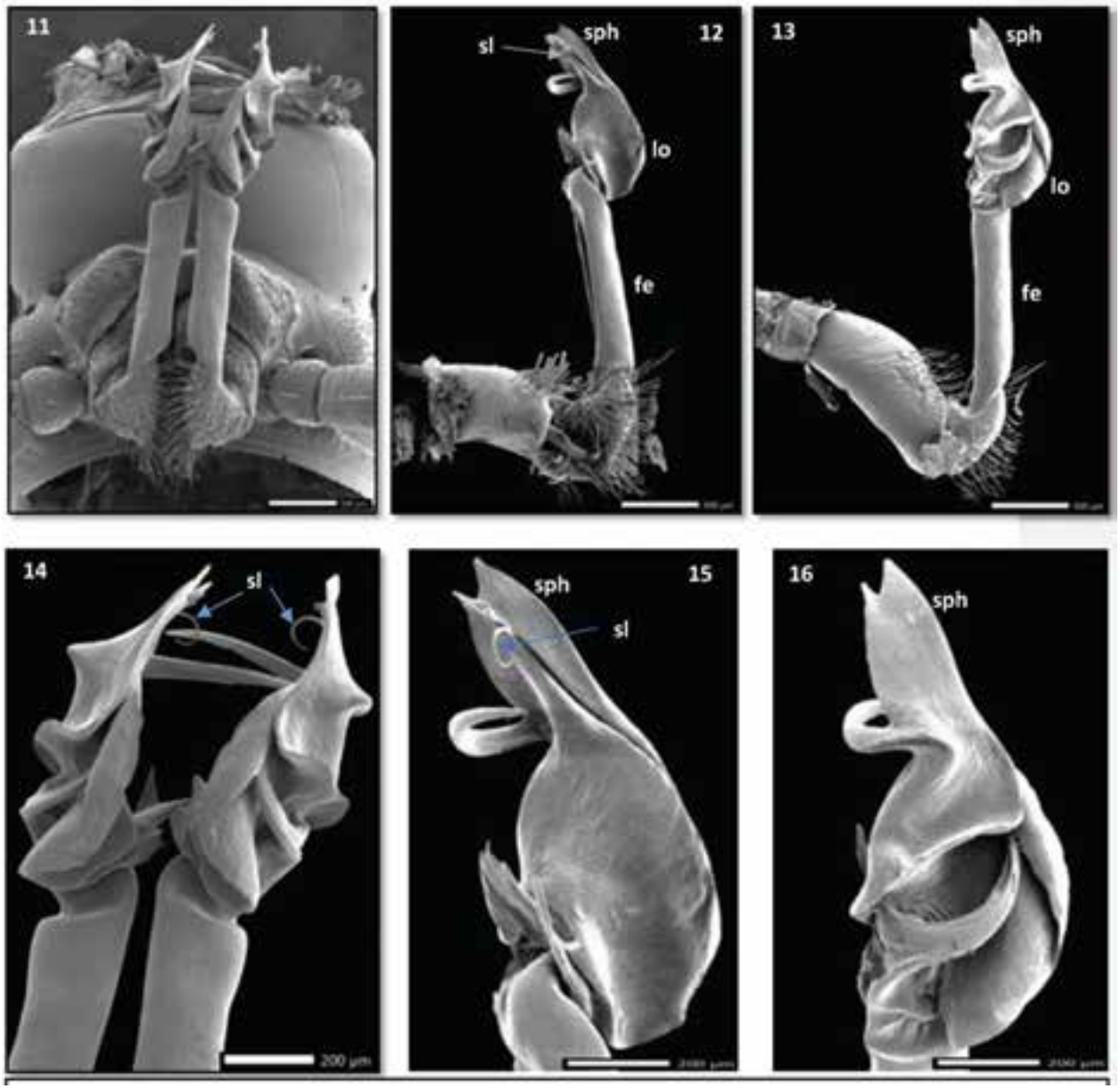

Image 11–16. SEM photographs of gonopods of *Xiphidiogonus sinispinus* sp. nov.: 11—7th segment with gonopods | 12—Entire gonopod mesal view | 13—Entire gonopod lateral view | 14—Acropodite ventral view | 15—Acropodite mesal view | 16—Acropodite lateral view. Abbreviations: fe—gonofemorite | lo—lateral lobe | sph—solenophore | sl—solenomere. © Shubham Mane.

Legs long, first two pairs are modified, thickened, with femoral adenostyle (Image 8, 9). Adenostyle of 1st leg pair is small while 2nd leg pair bears a more protruding adenostyle. Tarsi with small and dense bristles.

Gonopods with strong, cylindrical, untwisted gonofemorite (fe) lacking a femoral process while *X. hendersoni* with internal wing-like femoral edge, *X. dravidus* with one internal and two external femoral edges, *X. spinipleurus* with two internal and one external femoral edges. Coxite sparsely setose near prefemur. Prefemur short, dark, and densely setose, with cannula.

Acropodite from mesal view with semilunar extension, i.e., lateral lobe (lo) at exterior side (Image 12, 13) with seminal canal which runs internally towards the solenophore (sph) located at caudal part of acropodite (Image 12, 13). Solenophore (lateral view) is a leaf-like structure with two pointed edges at the tip, between which solenomere (sl) extends out (Image 14, 15). Solenomere (sl) is a short, unprotected, hair-like extension from solenophore.

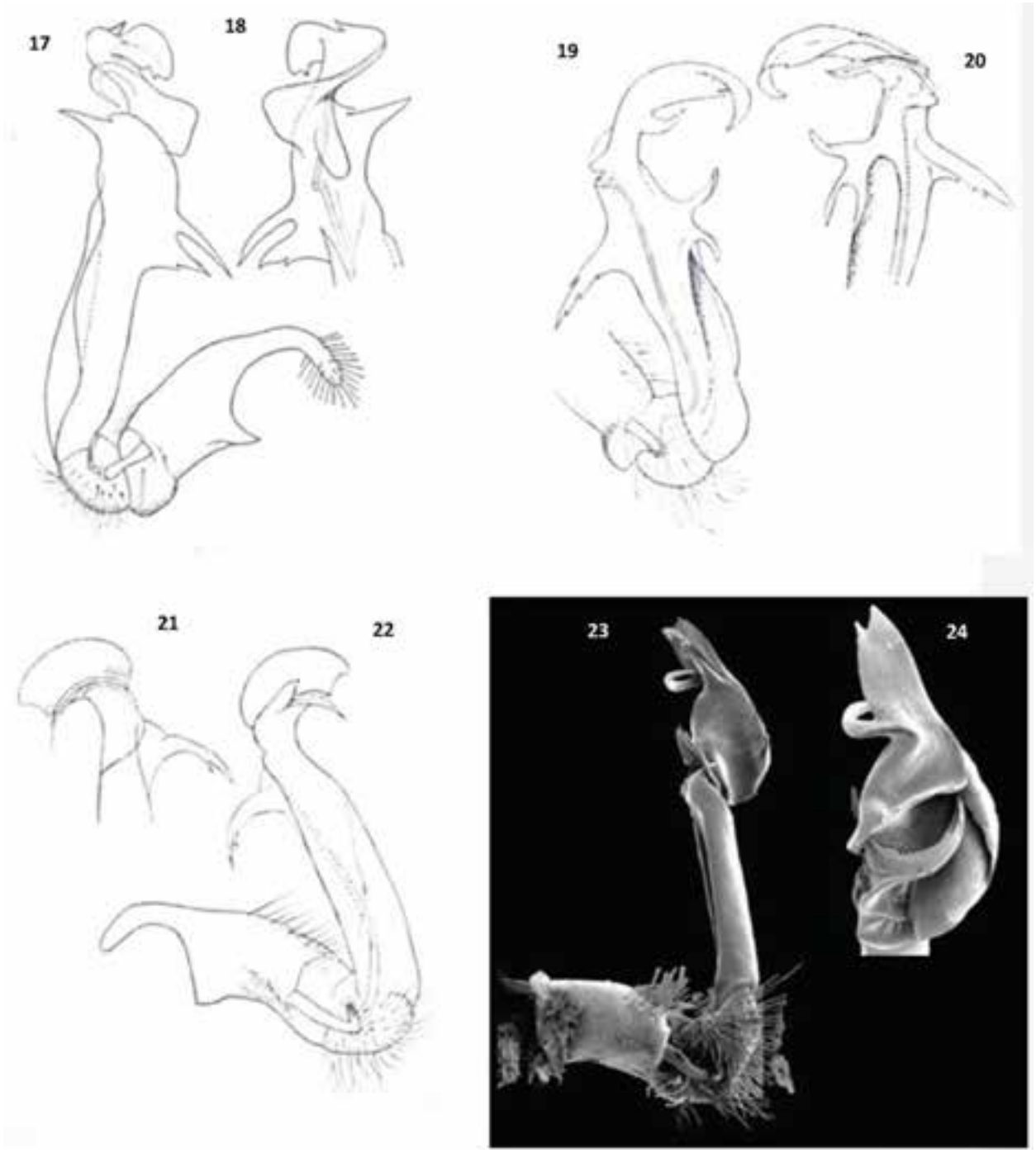

Image 17–24. Gonopods of all species of genus *Xiphidiogonus* (Carl): 17–18—*X. spinipleurus* (Carl) gonopods: 17—Entire gonopod mesal view | 18—Acropodite lateral view | 19–20—*X. dravidus* (Carl) gonopods: 19—Entire gonopod mesal view | 20—Acropodite lateral view | 21–22—*X. hendersoni* (Carl) gonopods: 21—Acropodite lateral view | 22—Entire gonopod mesal view | 23–24—*X. sinispinus* sp. nov. gonopods: 23—Entire gonopod mesal view | 24—Acropodite lateral view. © 17–22—taken from Carl (1932) | 23–24—Shubham Mane.

Habitat

Xiphidiogonus sinispinus sp. nov. is reported from three tehsils of Satara District named Dahiwadi, Koregaon, and Phaltan (Figure 1). All three regions are relatively arid as compared to the western region of Satara District. The species is commonly found under small logs, along with other burrowing animals in dry regions. The species is moderately abundant in dry areas.

Key to the accepted genera of Polydrepanini, based on gonopodal characters (Golovatch et al. 2021)

1. Gonofemorite clearly twisted 2
   Gonofemorite untwisted 3
2. Solenophore particularly simple, two upright lobes on either side of a higher, and suberect solenomere, the latter devoid of a basal curve/loop ..... ***Dasypharkis***
   Solenophore much more complex, strongly coiled; solenomere with a basal loop/curve .... ***Polydrepanum***
3. Solenomere with neither a distinct basal loop nor a protecting lobe at its base 4
   Solenomere with both a distinct basal loop and a protecting lobe at its base 5
4. Solenophore relatively small but clearly twisted ..... ***Xiphidiogonus***
   Solenophore usually large, varied ..... ***Delarthrum***
5. Solenophore cup-shaped, enlarged ..... ***Pocockina***
   Solenophore otherwise 6
6. Both solenophore and solenomere either suberect or subcircular ..... ***Grammorhabdus***
   Both solenophore and solenomere strongly coiled, the former with two distomesal processes (a and b), b being unusually large and shield-like ..... ***Telodrepanum***

The above key is the modified version of key suggested by Golovatch et al. (2021)

We suggest the new key to all species of genus *Xiphidiogonus* as below:

Key to all species of the genus *Xiphidiogonus*

1. Gonofemorite without additional wing-like edges or outgrowths ..... *X. sinispinus* sp. nov.
   Gonofemorite with additional wing-like edges 2
2. Gonofemorite with internal wing-like edges only ..... *X. hendersoni*
   Gonofemorite with both internal and external wing-like edges 3
3. Gonofemorite with one internal and two external edges ..... *X. dravidus*
   Gonofemorite with two internal and one external edges ..... *X. spinipleurus*

Discussion

The genus *Xiphidiogonus* was established on the basis of long, untwisted gonofemorite with small solenomere (Carl 1932; Golovatch et al. 2021). The genus was established with three new species named *X. hendersoni* having internal wing like gonofemoral edges, *X. dravidus* with one internal and two external gonofemoral edges, *X. spinipleurus* with two internal and one external gonofemoral edges (Carl 1932). Herein we describe a fourth species in the genus *Xiphidiogonus* and provide the first report of the genus from Maharashtra. The novel species lacks any type of gonofemoral edges with a long, straight, cylindrical gonofemorite.

References

Bhakat, S. (2021). A new paradoxosomatid millipede, *Manikidesmus suriensis* (Polydesmida: Paradoxosomatidae) from West Bengal, India. *bioRxiv* 2021: 1–15. (preprint) https://doi.org/10.1101/2021.04.25.441377

Carl, J. (1932). Diplopoden aus Süd-Indien und Ceylon. I. Teil. Polydesmoidea. *Revue suisse de Zoologie* 39(17): 411–529.

Golovatch S.I., M.D. Aswathy, U. Bhagirathan & A.V. Sudhikumar (2021). Review of the millipede tribe Polydrepanini, with the description of a new species from Kerala state, southern India (Diplopoda, Polydesmida, Paradoxosomatidae, Alogolykinae). *Zootaxa* 5068(4): 485–516. https://doi.org/10.11646/zootaxa.5068.4.2

Golovatch, S.I. & T. Wesener (2016). A species checklist of the millipedes (Myriapoda, Diplopoda) of India. *Zootaxa* 4129(1): 001–075. https://doi.org/10.11646/zootaxa.4129.1.1

Jeekel, C.A.W. (1968). *On the Classification and Geographical Distribution of the family Paradoxosomatidae (Diplopoda, Polydesmida).* Academisch Proefschrift, Rotterdam, 162 pp.

Nguyen, A.D. & P. Sierwald (2013). A worldwide catalog of the family Paradoxosomatidae Daday, 1889 (Diplopoda: Polydesmida). *Check List* 9(6): 1132–1353. https://doi.org/10.15560/9.6.1132

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SHORT COMMUNICATION

Mucuna interrupta Gagnep. (Magnoliopsida: Fabaceae): a new plant record for Nagaland, India

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Abstract: *Mucuna interrupta* Gagnep. (Fabaceae), a riparian climber of the genus, is reported for the first time in the flora of Nagaland. A comprehensive taxonomic account of the species is presented in this paper, including a morphological description, colour photographs, ecological notes, ethnobotanical uses, phenology, and the need for conservation.

Keywords: Climber, ecological notes, ethnobotanical uses, new record, phenology, riparian vegetation, Nagaland flora, taxonomic description.

The genus *Mucuna* Adans (Fabaceae) is comprised of 112 species, which are native to tropical and subtropical regions of the world (POWO 2025). With the wild occurrence of 68 taxa, the taxonomic diversity of the genus is highest in Asia (Moura et al. 2016). As of now, the genus *Mucuna* is represented by 11 species and three varieties in India (Wilmot-Dear 1987; Sanjappa 1992; Aitawade & Yadav 2012; Ingalhalikar et al. 2017; Gaikwad et al. 2018). While species like *M. pruriens*, *M. monosperma*, and *M. gigantea* are widespread in India, *M. imbricata*, *M. bracteata*, *M. macrocarpa*, *M. sempervirens*, and *M. nigricans* have so far been reported from the eastern Himalayas only. *Mucuna atropurpurea* is endemic to peninsular India. An intraspecific taxon, *M. pruriens* var. *thekkadiensis* described by Thothatri & Ravikumar (1997), has later been reduced to a synonym of *M. pruriens* var. *hirsuta* (Krishanraj & Mohanan 2012). Subsequently, three new species of *Mucuna*, viz., *M. sanjappae* from Western Ghats (Aitawade & Yadav 2012), *M. laticifera* from Sikkim (Ingalhalikar et al. 2017), and *M. yadaviana* from Andaman & Nicobar Islands (Gaikwad et al. 2018), have been added to the Indian flora.

During a field survey in the semievergreen forests near Akuluto Village of Zuneheboto District of Nagaland, we encountered a climbing plant growing in association with *Combretum quadrangulare* at an elevation of 822.23 m. Based on morphological analysis and literature study, the species was determined to be *M. interrupta* Gagnep. For the identification of the species, the Herbarium Catalogue of the Royal Botanical Garden, Kew (accession number K000894901) and Plants of the World Online (POWO 2024) were consulted. In India, the species is reported to occur in the states of Andhra Pradesh, Odisha, Bihar, West Bengal, Haryana, Uttar Pradesh, Himachal Pradesh, Assam, Arunachal Pradesh, Sikkim, and Andaman & Nicobar Islands (Sanjappa 1992; Aitawade & Yadav 2012; Patil et al. 2016). Therefore, the present report on the occurrence of *M. interrupta* from Zunheboto District, Nagaland is a new distribution record for the state. The field study was carried out between April 2023–October 2024 in the Reserve Forest of Akuluto Village, Zuneheboto District,

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Nagaland, located between 26.214^0 N, 94.487^0 E (Figure 1). The region receives 2,500 mm of rainfall annually, and its elevation ranges 800–1,800 m. The herbarium specimens were prepared following standard field and herbarium methods (Rao & Jain 1977). The specimens were stored in the Herbarium of Nagaland University, Lumami, Zunheboto, Nagaland. A comprehensive botanical description notes on ecology, distribution, and morphological characteristics by which the species can be distinguished from its closely-related species like *M. revoluta* and *M. hainanensis* have been provided (Image 1).

Results and Discussion

Taxonomic treatment

Mucuna interrupta Gagnep. in Notul. Syst. (Paris) 3: 26. 1914. *Mucuna nigricans* (Lour.) Steud. in Nomencl. Bot., ed. 2, 2: 163. 1841; Sanjappa, Legumes of India 217. 1992. *Citta nigricans* Lour. in Fl. Cochinch.: 456. 1790, nom. utique rej. *Stizolobium nigricans* (Lour.) Pers. Syn. Pl. 2: 299. 1807.

Type: Thailand, Mao Mak Kok, Muah Lek. Sasabusi, NI Nai (K000894901 image!).

Climbers or twining vine stems glabrous or with fine hairs, light brown to reddish. Leaves alternate, petiole 6–9 cm, hairy on petiolules and petioles, lateral veins 5–7 pairs, terminal leaflets larger, up to 12 x 6.5 cm and thinly papery; lateral base slightly less asymmetrical , rounded, semi-cordate or ± cordate. Inflorescence axillary, 4–8 cm, unbranched and bearing 1–6 knob-like flowers on side branches towards apex, bracts large, and persistent; axis with thick adpressed pale pubescence, finer than stem, pedicels 8–10 mm long, bracteoles long, linear-oblanceolate, and pointed, 22–30 x 5 cm, calyx with stinging bristles, hairy like the axis, cup-shaped, tube 10 x 10 mm long, and broad. Corolla white or violet, medium to large, 3–3.5 × 1.8–2 cm, wings 5.5–6 cm; keel equaling wings. Fruit elongate, twisted, apex and bottom considerably large, 13–14 × 6–7 cm, 1.5–2 cm thick, markedly laterally flattened ± 2.5 cm in thickness and 7 cm wide, reddish hairs and irritant bristles, 10–20 obliquely transverse, upright, crowded, interrupted parallel lamellae cover the fruit on both sides, two wings along its edge but not midline,

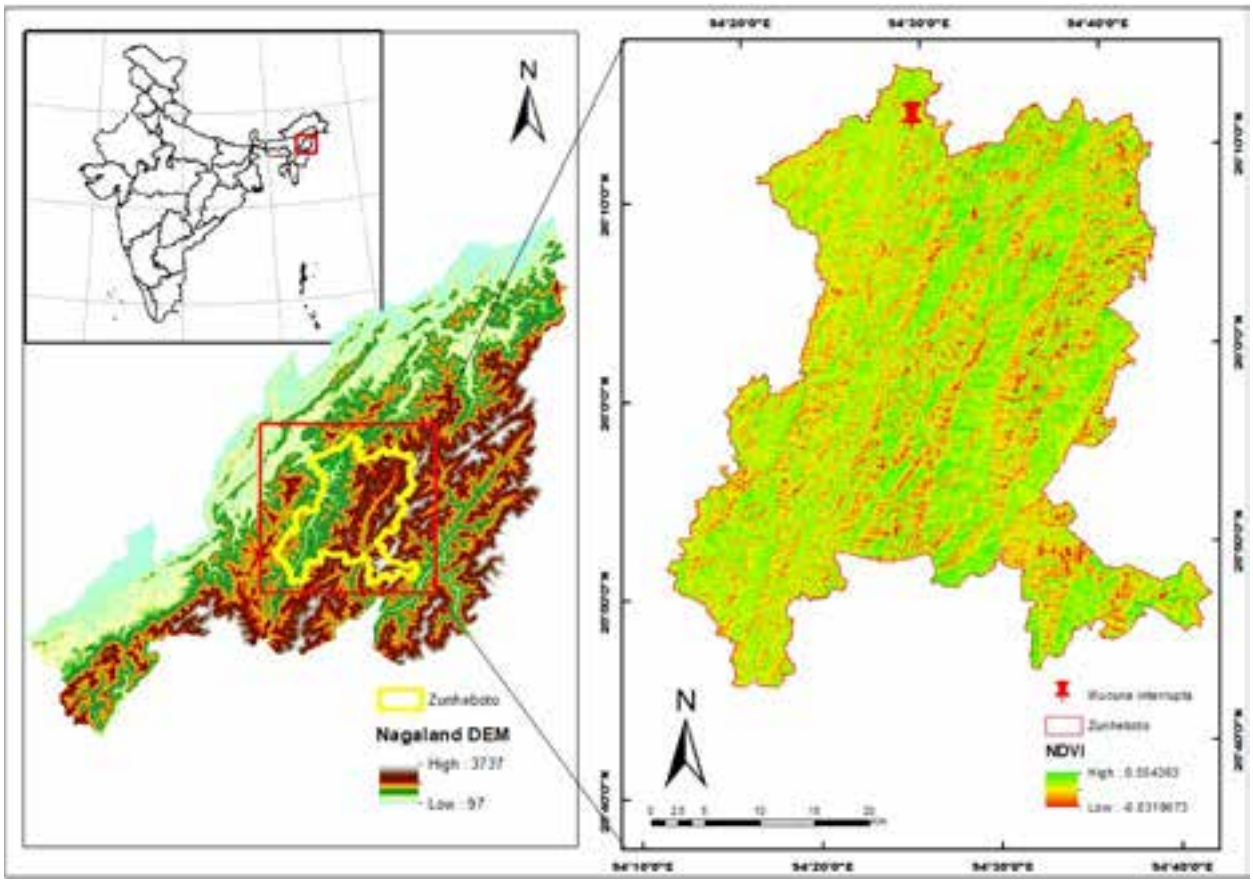

Figure 1. Map of study area.

Image 1. *Mucuna interrupta*: A–B—habitat | C–D—stem bearing fruit | E–G—cross-section of the fruits with embedded seeds | H–I—pericarp| J–K—sizes of seeds and cross-section of seeds | L—matured seed. © Vieneite-o Koza & Joynath Pegu.

legume extended to marginal wings or fruits, seeds 2 or 3, orange- brown to hilum black, reniform or fairly globular, length 2–2.5 cm, ± 1 cm in thickness.

Flowering & fruiting: August–October.

Habitat: Growing in wetland and riverine settings with high humus content, where it can adhere to trees and other vegetation for support.

Distribution: India (Andhra Pradesh, Odisha, Bihar, West Bengal, Haryana, Uttar Pradesh, Himachal Pradesh, Assam, Arunachal Pradesh, Sikkim, Andaman & Nicobar Islands, and Nagaland), Nepal, Bangladesh, Cambodia, Laos, China, Myanmar, Thailand, Vietnam.

Image 2. Herbarium specimen of *Mucuna interrupta* prepared and deposited at Nagaland University, Lumami (NU/FRS-238). © Vieneite-o Koza & Joynath Pegu.

Specimens studied: Akuluto Village, Zuneheboto District, Nagaland (26.214^0 N, 94.487^0 E), 11.x.2024, NU/FRS-238 (Image 2).

Conclusion

The present study documented *M. interrupta* as a new record for the flora of Nagaland, India. The fruit extract of the species is traditionally utilized for application on lacerations to promote rapid healing. The oil derived from the leaves and fruit is used to treat iron corrosion. The seeds are utilized as adornments by the tribes of Tripura. *Mucuna interrupta* is rare in its natural habitat, and it is currently protected in the Lumami Village, Zuneheboto District, Nagaland, India.

References

Aitawade, M.M. & S.R. Yadav (2012). *Mucuna sanjappae*, a new species from the northwestern Ghats, India. *Kew Bulletin* 67(3): 539–543. https://doi.org/10.1007/s12225-012-9369-1

Gaikwad, S., P. Lawand & R. Gurav (2018). *Mucuna yadaviana* sp.

Table 1. Distinguishing characteristics of *Mucuna interrupta* and its closely related species.

Characters	*M. interrupta* Gagnep.	*M. revoluta* Wilmot-Dear	*M. hainanensis* Hayata
Natural habitat	Isolated wetland area	Moist, lowland area	Humid forest, forest edge, and disturbed areas
Leaf-shape and size	Ovate, entire, acute	Elliptic or ovate	Elliptic ovate or elliptic obovate
Stem	Glabrous or fine hairs, light brown, reddish	Glabrous, sparsely haired	Young stems either glabrous or sparsely adpressed hairy.
Inflorescence	Inflorescence axillary, 8–24 cm long, bracts persistent, pedicles 8–10 mm, spreading fine pale hairs.	Short, velvety pubescent pedicels, 8–16 cm long, unbranched or branching at the base bearing 5-13 reduced, Knob-like flower.	Inflorescence axillary, 5–18 nodes, 6–40 cm. base nodes devoid of flowers; few long acuminate bracts 2–3 cm; large flowering nodes
Flower colour and size	Purple; keel-white, 4.50 ± 0.04	Pink or brownish-purple; 4.8 ± 1	Purple to dark purple; 4.2 ± 0.6
Fruit shape, size, and color	Fruit elongate, twisted apex and bottom, 13–14 × 6–7 cm, 1.5–2 cm thick, reddish hairs and irritant bristles	Small to medium-sized, leathery, flattened, 6–9 cm long, with obliquely transverse lamellae that bifurcate at the tip.	Asymmetrical or oblong-ovate, 9–18 × 4.5–5.5 cm
No. of seed	2–3 seeds	1–2 seeds	2–4 seeds
Size of seed	4.2 ± 0.13 cm	4.5 ± 2.5 cm	4.2 ± 2 cm
Shape of seed	Elliptic, discoid	Ellipsoid, convex face	Oblong or reniform
Color of seed	Creamy, reddish-brown	Red to brown with black mottling	Reddish-brown or black
Wings	Narrow marginal wings	Marginal wings	Marginal wings
Distribution	Yunnan, Cambodia, Laos, Myanmar, Thailand, Vietnam, Tripura	Yunnan, Cambodia, Laos, Myanmar, Thailand, Vietnam	Guangdong, Guangxi, Hainan, Yunnan, Vietnam

nov. (Leguminosae: Papilionoideae) from the Andaman Islands, India. *Phytotaxa* 348(2): 153–158. https://doi.org/10.11646/phytotaxa.348.2.11

Ingalhalikar S., N. Page, S. Gaikwad & R. Gurav (2017). *Mucuna laticifera*, a new species from north-eastern India. *Phytotaxa* 319(1): 118–122. https://doi.org/10.11646/phytotaxa.319.1.8

Jain, S.K. & R.R. Rao (1976). *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers and Publishers, New Delhi, 158 pp.

Krishnaraj, M.V. & N.N. Mohanan (2012). Notes on identity and status of two legumes (Fabaceae: Papilionoideae) from India. *Phytotaxa* 66: 13–20. https://doi.org/10.11646/phytotaxa.66.1.3

Moura, T.M.D., M. Wilmot-Dear, M. Vatanparast, A.P. Fortuna-Perez, A.M. Tozzi & G.P. Lewis (2016). A new infrageneric classification of *Mucuna* (Leguminosae-Papilionoideae): supported by morphology, molecular phylogeny and biogeography. *Systematic Botany* 41(3): 606–616. https://doi.org/10.1086/684131

Patil, R.R., K.D. Pawar, M.R. Rane, S.R. Yadav, V.A. Bapat & J.P. Jadhav (2016). Assessment of genetic diversity in *Mucuna* species of India using randomly amplified polymorphic DNA and inter simple sequence repeat markers. *Physiology and Molecular Biology of Plants* 22: 207–217. https://doi.org/10.1007/s12298-016-0361-3

POWO (2025). *Plants of the World Online*. Facilitated by the Royal Botanic Gardens, Kew. http://www.plantsoftheworldonline.org/. Accessed on 05.v.2025.

Sanjappa, M. (1992). *Legumes of India*. Bishen Singh Mahendra Pal Singh, Dehradun, 338 pp.

Thothathri, K. & S. Ravikumar (1998). A new variety of the tribal pulse, *Mucuna pruriens* (L.) DC. from the Thekkady forest, Kerala. *Journal of Economic and Taxonomic Botany* 21: 703–704.

Wilmot-Dear, C.M. (1983). A revision of *Mucuna* (Leguminosae-Phaseoleae) in the Indian Subcontinent and Burma. *Kew Bulletin* 39: 23–46. https://doi.org/10.2307/4109895

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NOTE

Sighting of Royle's Pika *Ochotona roylei* Ogilby, 1839 (Mammalia: Lagomorpha: Ochotonidae) in Kishtwar District, Jammu & Kashmir, India

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Pikas *Ochotona* Link, 1795 are small-sized mammals weighing around 100–175 g (Beever 2002). They have rounded ears, short legs, and lack a tail. Pikas are native to Himalaya, the steppes of central Asia, and the mountains of northwestern America (Prater 2005). Unique among the alpine mammals as they gather up vegetation throughout summer including grasses, flowers, leaves, evergreen pine needles, and even pine cones, and create a hay pile to sustain throughout the winter, and maintain fecundity in early spring, rather than hibernating or moving to lower elevations (Huntly et al. 1986; Dearing 1997; Morrison & Hik 2007; Holtcamp 2010). At present there are 30 species of *Ochotona* found globally, with seven species occurring in the Indian Himalayan region (Hoffmann & Smith 2005). Royle's Pika *Ochotona roylei* Ogilby, 1839, is a common species in the Himalayan region (Hoffmann & Smith 2005). Their body length varies 15–20 cm with a head diameter around 7 cm (Alfred et al. 2006). They can be found at 2,500–5,000 m in western Himalaya (Bhattacharya et al. 2009), preferring open rocky grounds, and rhododendron forests (Tak & Lamba 1985). Their distribution directly depends on the availability of forage plant species (Kawamichi 1968). According to IUCN Red List of Threatened Species, the Royle's Pika is classified as 'Least Concern' (Smith & Bhattacharyya 2016) and as per the IUCN Green Status of Species assessment information it is classified as slightly depleted in 2021 (Bhattacharyya & Dahal 2021). Additionally it is listed under Schedule I of Wildlife (Protection) Amendment Act, 2022 in India indicating highest protection.

During our biodiversity survey assessment on 03 January 2024 in a reserve forest of Upper Dool area (Image 1) (33.341^0 N, 75.810^0 E), at an altitude of 2,411 m in Kishtwar, a Royle's Pika was sighted on a rock feeding on stems of herbaceous plants and running around in between the rocks (Image 2). We observed it for approximately 20 minutes. The species was identified based on external characters using a standard field guide (Menon 2014). The site was located within a coniferous forest habitat with huge rocks and boulders (Image 3). The ground cover consisted mostly of dried grasses due to the winter season. Large fallen tree logs were present over the rocks. The dominant tree species in the area were *Cedrus deodara* and *Pinus wallichiana*.

The sighting of Royle's Pika in the study area confirms the presence of this elusive alpine mammal and highlights the ecological significance of relatively understudied regions such as Kishtwar. This observation emphasizes the need for comprehensive biodiversity assessments in these areas, which may harbour species that are otherwise overlooked. To better understand

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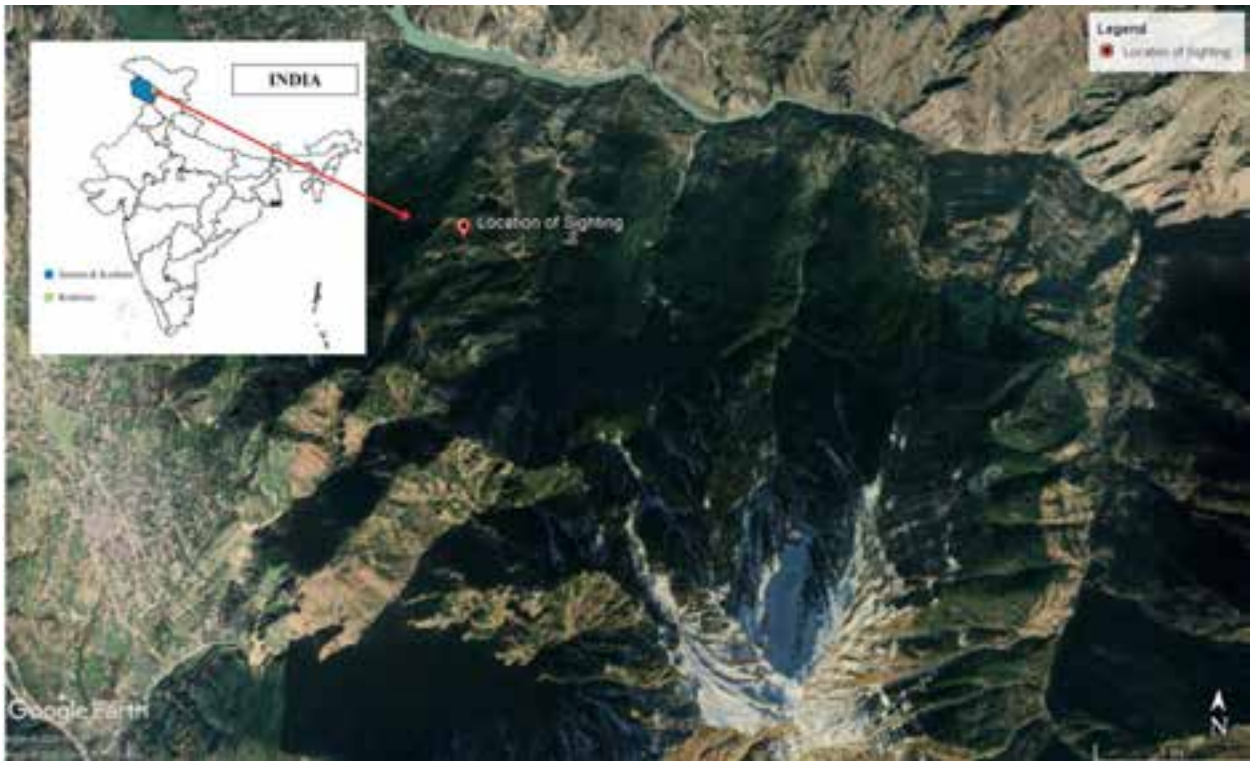

Image 1. Location map of the Royle's Pika *Ochotona roylei* sighting. (Source: Google Earth).

Image 2. Royle's Pika *Ochotona roylei* in Kishtwar, Jammu & Kashmir. © Umar Mushtaq.

the conservation status of Royle's Pika, further research is needed, particularly studies focusing on population trends, habitat preferences, anthropogenic pressures, and the effects of climate change. Given that the Himalaya is among the most climate-sensitive ecosystems globally, characterized by warmer winters, increased summer precipitation, and accelerated glacial retreat (Shrestha et al. 1999; Kulkarni & Karyakarte 2014), it is possible that such environmental changes are already impacting small mammals like Royle's Pika. These effects may remain undocumented due to limited scientific investigation in the region.

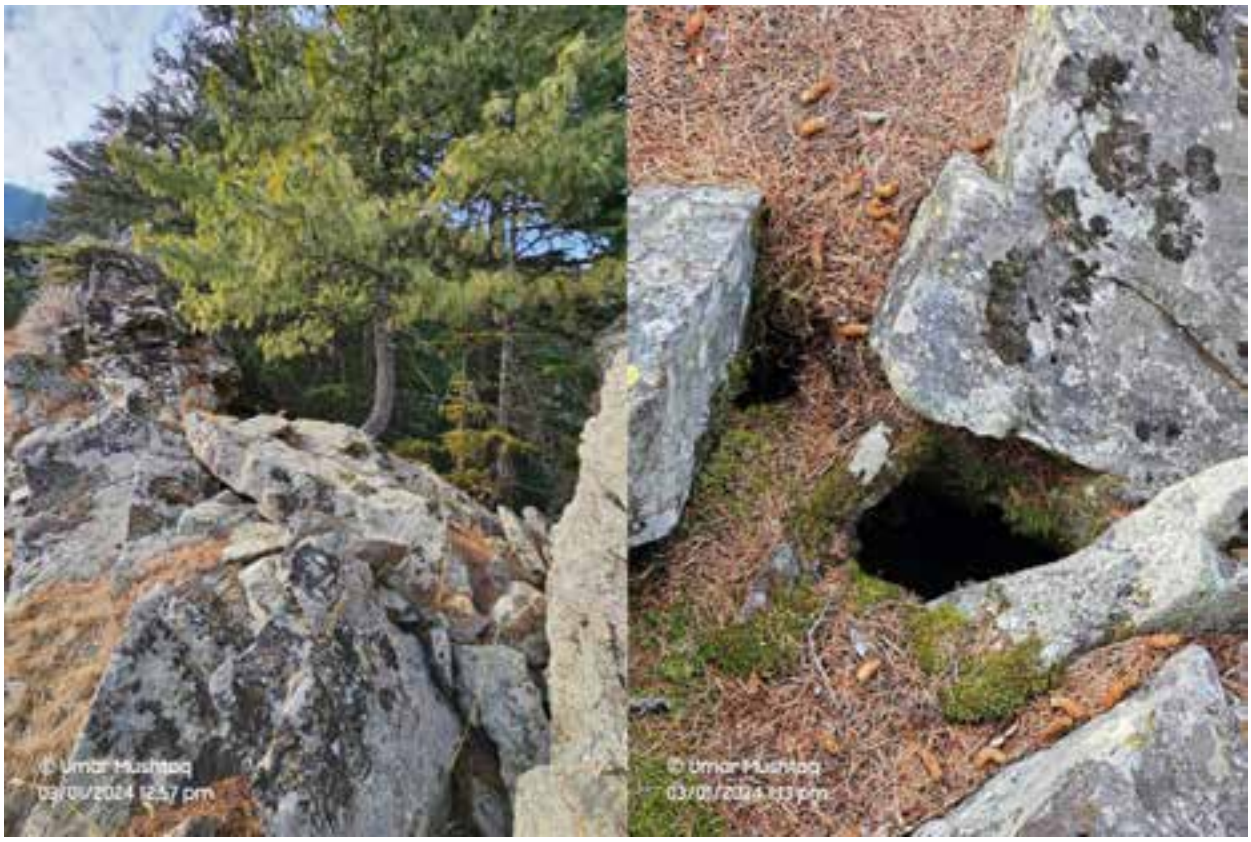

Image 3. Royle's Pika *Ochotona roylei* habitat in the study site.

References

Alfred, J.R.B., A.K. Das & A.K. Sanyal (2006). *Animals of India: Mammals*. Zoological Survey of India, 236 pp.

Beever, E.A. (2002). Persistence of Pikas in two low-elevation national monuments in the western United States. U.S. National Park Service, 7 pp.

Bhattacharya, S., B.S. Adhikari & G.S. Rawat (2009). Abundance of Royle's Pika (*Ochotona roylei*) along an altitudinal gradient in Uttarakhand Western Himalaya. *Hystrix Italian Journal of Mammalogy* 20(2): 111–119. https://doi.org/10.4404/hystrix-20.2-4441

Bhattacharyya, T. & S. Dahal (2021). *Ochotona roylei* (Green status assessment). The IUCN Red List of Threatened Species 2021: e.T41268A4126820251. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T41268A45184591.en. Accessed on 24.v.2025.

Dearing, M.D. (1997). The function of haypiles of Pikas (*Ochotona princeps*). *Journal of Mammalogy* 78(4): 1156–1163. https://doi.org/10.2307/1383058

Hoffmann, R.S. & A.T. Smith (2005). Order Lagomorpha, pp. 185–211. In: Wilson, D.E. & D.M. Reeder (eds.). *Mammal Species of The World: A Taxonomic and Geographic Reference.* Johns Hopkins University Press, 2142 pp.

Holtcamp, W. (2010). Silence of the Pikas. *Bio Science* 60(1): 8–12. https://doi.org/10.1525/bio.2010.60.1.3

Huntly, N., A.T. Smith & B.L. Ivins (1986). Foraging behavior of the Pika (*Ochotona princeps*), with comparisons of grazing versus haying. *Journal of Mammalogy* 67(1): 139–148. https://doi.org/10.2307/1381010

Kawamichi, T. (1968). Winter Behaviour of the Himalayan Pika (*Ochotona roylei*). *Journal of the Faculty of Science Hokkaido University Series VI. Zoology* 16: 582–554. http://hdl.handle.net/2115/27467

Kulkarni, A.V. & Y. Karyakarte (2014). Observed changes in Himalayan glaciers. *Current Science* 106(2): 237–244.

Menon, V. (2014). *Indian Mammals*: *A Field Guide*. Hachette India, 528 pp.

Morrison, S.F. & D.S. Hik (2007). Demographic analysis of a declining Pika population: Linking survival to broad-scale climate patterns via spring snowmelt patterns. *Journal of Animal Ecology* 76(5): 899–907. https://doi.org/10.1111/j.1365-2656.2007.01276.x

Prater, S.H. (2005). *The Book of Indian Animals (3rd Ed.)*. Bombay Natural History Society & Oxford University Press, 348 pp.

Shrestha, A.B., C.P. Wake, P.A. Mayewski & J.E. Dibb (1999). Maximum temperature trends in the Himalaya and its vicinity: an analysis based on temperature records from Nepal for the period 1971–94. *Journal of Climate* 12(9): 2775–2786. https://doi.org/10.1175/1520-0442(1999)012%3C2775:MTTITH%3E2.0.CO;2

Smith, A.T. & S. Bhattacharyya (2016). *Ochotona roylei*. *The IUCN Red List of Threatened Species* 2016: e.T41268A45184591. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T41268A45184591.en. Accessed on 24.v.2025.

Tak, P.C. & B.S. Lamba (1985). Nanda Devi National Park: a contribution to its mammalogy. *Indian Journal of Forestry* 8: 219–230.

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NOTE

First record of an Amber Snail *Succinea daucina* Pfeiffer, 1855 (Gastropoda: Succineidae) from Bihar, India

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Succineidae Beck, 1837 is an Amber Snail's family, mostly amphibious, pseudo-amphibious, (semi-aquatic behavior that can survive in moist environments but is not fully aquatic) or strictly terrestrial creatures widely distributed across the globe (Rao 1924; Pilsbry 1948; Barker 2001). The highest diversity has been recorded in India, the Pacific Islands, and the Americas (Pilsbry 1948; Patterson 1971; Barker 2001; Rundell et al. 2004). The succineids are currently placed in two families and 20 genera , of which three are fossils (MolluscaBase 2021). Indian succineids cover 27 species under five genera, of which 20 are endemic (Ramakrishna et al. 2010). The genus *Succinea* Draparnaud, 1801, is one of the most species-rich genera, with 225 species (19 species are fossils) and is widely distributed across the world (MolluscaBase 2021). In India, this genus represents 17 species, of which 15 are endemic (Ramakrishna et al. 2010). While working on the benthic diversity of urban ponds in Patna by the first author, 10 shells of *Succinea daucina* were collected from Sandalpur pond (25.606^0 N, 85.185^0 E) (Image 1), and Phulwari Sharif pond (25.581^0 N, 85.077^0 E) (Image 2) in Patna. Photographs of specimens were taken from apertural, lateral, dorsal, apical, and umbilical sides with a scale bar (Image 3). The specimens were identified based on the published literature (Pfeiffer 1885; Mitra et al. 2004) and distinguished by their morphological characteristics. Additionally, collected specimens were compared with specimens housed in the National Zoological Collection of the Zoological Survey of India, Kolkata. The current taxonomic status of *Succinea daucina* is as follows:

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
Order: Stylommatophora
Superfamily: Succineoidea
Family: Succineidae
Genus: *Succinea*
Species: *Succinea daucina* L. Pfeiffer 1855

Succinea daucina, described by Pfeiffer from Calcutta [=Kolkata] in 1855 from Cuming's collection, is an air-breathing land snail, commonly called Amber Snails. The shell of *S. daucina* is characterized by a thin and medium sized shell, a fragile, ovately conical body, an inflated body whorl, and a short, twisted spire. The color of the shell is pale white to amber, rounded at the base, with three increasing whorls, with the last being the largest whorl. The species was previously distributed in Tripura and part of the West Bengal States of India (Pfeiffer

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1885; Raut et al. 1997; Mookherjee et al. 2000; Mitra et al. 2004; Ramakrishna et al. 2010; Tripathy & Sajan 2022). Limited literature is available on the dimensions. A size-dependent study on growth and reproduction was carried out by Nandy et al. (2023), where the authors showed the size class (2–12 mm) shell length, among which shell length , which achieved sexual maturity, was 6–7 mm. In the present study, different measurements, i.e. height (H) , width (D), height of last whorl (LW), height of aperture (HA), and width of aperture (WA), were taken

Table 1. Minimal values (min), maximal values (max), mean (M) and standard deviation (SD).

	Min–max (mm)	M±SD (n=10)
Height (H)	5.5–8.8	6.91±0.97
Diameter (D)	3.9–5.9	4.34±0.60
Height of aperture (HA)	3.7–6.7	5.4±0.73
Height of last whorl (LW)	4.5–7.5	6.2±0.80
Width of aperture (WA)	3.2–5.5	3.71±0.67
Spire ratio (SR)	0.02–0.18	0.09±0.04

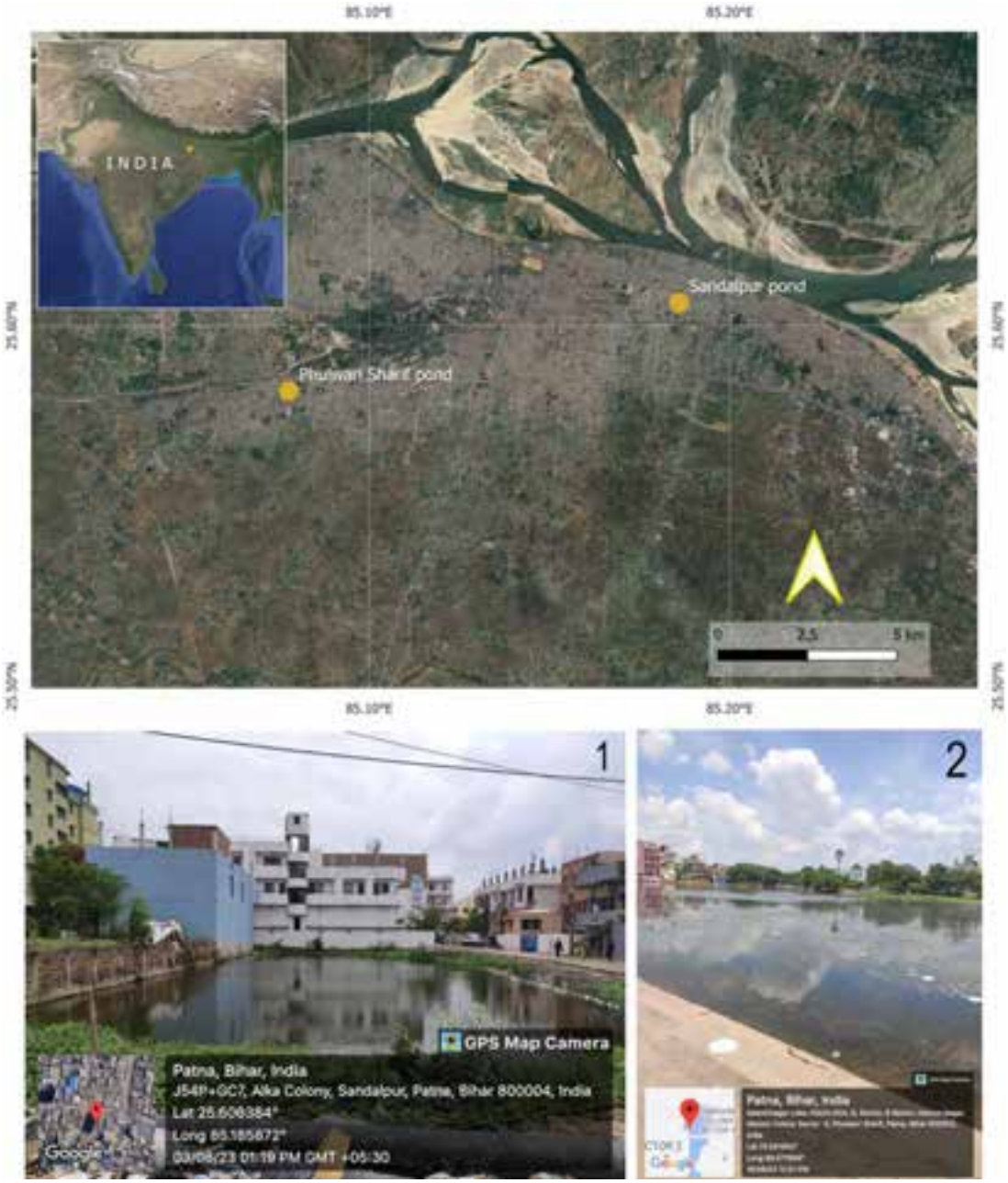

Image 1 & 2. Study area - satellite image of the ponds from where the specimens were collected (source: Google Earth). 1—Sandalpur pond | 2— Phulwari Sharif Pond.

Image 3. Shells of *Succinea daucina* Pfeiffer, 1855 from pond sediments, Patna, Bihar: upper row (left to right)—apertural, lateral, and dorsal views | lower row (left to right)—apical and umbilical views). © Dipty Kumari.

Table 2. Comparison between related *Succinea* species.

Characteristics	*Succinea daucina* Pfeiffer, 1855	*Succinea putris* Linnæus, 1758 (Prokhorova et al. 2020; Barman et al. 2021; www.animalbase)	*Succinea baconi* Pfeiffer, 1854 (Barman et al. 2021)
Shell shape	Broader, ovate to elliptical shell; more pointed.	Conispiral.	More elongated and tapered shell.
Number of whorls	3	3–4	NA
Body whorl	The body whorl is disproportionately large.	Most of the shell is made up by the last whorl, which opens with a large oval aperture strongly tapering near the columella.	More balanced whorl structure.
Surface texture	Smooth, glossy shell with minimal micro sculpture.		Fine growth lines and subtle striations.
Columellar structure	Slightly twisted columella without a visible fold (pronounced).	Relatively simple and unpronounced.	Moderately twisted, with a subtle fold, more pronounced than in *Succinea putris*.
Shell colour	Pale yellow to white, with a glossy finish without streaks	Amber yellow with a reddish hue	Amber color with streaks generally yellow or greyish.

for the specimens (n=10). Specimens' shell height (H) varied from 5.5–8.8 (Table 1). Spire ratio varied between 0.02–0.18 mm (mean±SD = 0.09±0.04) (Table 1). Three whorls are present, increasing in size at the base. The observed specimens of *Succinea daucina* were found to have a smooth and slightly convex profile. The body whorl of *S. daucina* is disproportionately large, which is a typical characteristic of snails in the Succineidae family. The body whorl is inflated and occupies most of the shell's volume, making the aperture relatively large compared to the overall shell size. The edge of the shell was thin, while its surface texture was smooth, glossy, and translucent. The specimen exhibited an oval to conical body. These specimens of *S. daucina* had a slightly twisted columella without a visible fold. Fine and subtle growth lines were also seen on the specimens. There was a lack of prominent microsculpture on the obtained shells. The color of the observed specimens was pale honey color to pale white in dry form. A labelled diagram of the diagnostic feature of the collected specimen is presented in Image 4. Some comparisons are also made between related species of *Succinea*, which helps in the

Table 3. The distribution pattern of Amber Snails *Succinea daucina* Pfeiffer, 1855.

	Species	Locality	References
1	*Succinea daucina* Pfeiffer, 1855	Calcutta [=Kolkata]	Pfeiffer (1855 ["1854"])
2	*Succinea daucina* Pfeiffer, 1855	Calcutta and Port Canning, West Bengal, India	Rao (1924)
3	*Succinea daucina* f. *hraswasikhara* Rao, 1924	Madras, India	Rao (1924)
4	*Succinea daucina* f. *burmanica* Rao, 1928	Hsenwi and Old Lashio, Burma [= Myanmar]	Rao (1928)
5	*Succinea daucina* Pfeiffer, 1855	Gopal chak, Contai, West Bengal, India.	Raut et al. (1997)
6	*Succinea daucina* Pfeiffer, 1855	Ampinagar, Tripura, India	Mookherjee et al. (2000)
7	*Succinea daucina* Pfeiffer, 1855	West Bengal, Myanmar	Mitra et al. (2004)
8	*Succinea daucina* Pfeiffer, 1855	Kolkata, West Bengal, India	Nandy et al. (2022)

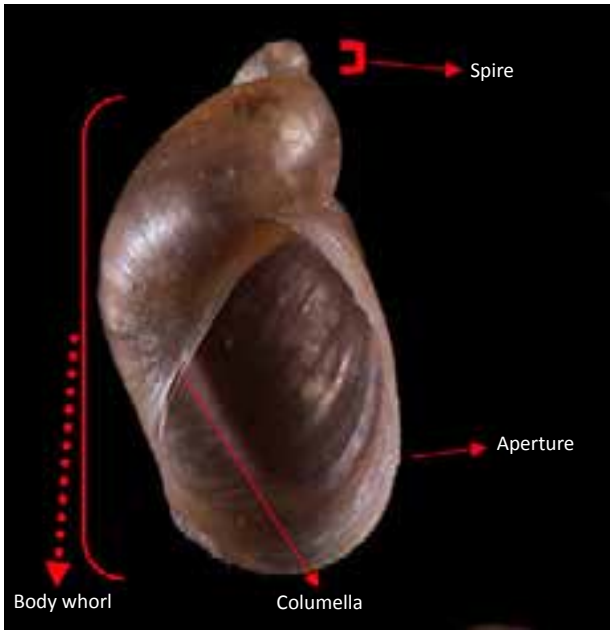

Image 4. Diagnostic features of the collected specimen of *Succinea daucina*. © Dipty Kumari.

identification of this particular species (Table 2). Two infraspecifics, *Succinea daucina f. burmanica* Rao 1928 from "Hsenwi and Old Lashio," Burma [=Myanmar]; and *Succinea daucina f. hraswasikhara* Rao 1924 from "Madras" have been described, which are now considered synonyms of *S. daucina* (Table 3).

Moreover, the presence of *S. daucina* in Patna, Bihar, is not surprising and may have resulted from active dispersal through forest connectivity. All the locations are present in the same eastern zone of Indian boundaries, and with the present record, it is apparent that *S. daucina* is leading its way across boundaries, indicating its existence in urban cities. The existence of *S. daucina* cannot be denied from the border area across Bihar. Thus, extensive surveys are required to get a current update on the population of *S. daucina* which would further aid in understanding the distribution pattern of the species.

References

Barker, G.M. (2001). Gastropods on land: phylogeny, diversity and adaptive morphology, pp. 1–146. In: Barker, G.M. (ed). *The Biology of Terrestrial Molluscs*. CABI, Wallingford, UK, 525 pp.

Barman, H., S. Pramanik, G. Nandy, S. Banerjee & G. Aditya (2021). Spatial distribution and morphometry of the succineid snail *Succinea baconi* (Pfeiffer, 1854) in India. *Zoology and Ecology* 31(2): 99–109. https://doi.org/10.35513/21658005.2021.2.4

Beck, H. (1837–1838). *Index molluscorum praesentis aevi musei principis augustissimi Christiani Frederici*. Hafniae, Copenhagen, 124 pp.

Draparnaud, J.P.R. (1801). *Tableau des mollusques terrestres et fluviatiles de la France. Montpellier / Paris (Renaud / Bossange, Masson & Besson).* Montpellier, Renaud, 116 pp. [in French]

Mitra, S.C., A. Dey & Ramakrishna (2004). *Pictorial Handbook-Indian Land Snails (Selected Species)*. Zoological Survey of India, Kolkata, 344 pp.

MolluscaBase (eds.) (2021). MolluscaBase. Succineidae Beck, 1837. https://www.molluscabase.org/aphia.php?p=taxdetails&id=181585. Accessed on 26.xii.2023.

Mookherjee, H.P., D.K. Thakur, S.C. Mitra & S. Barua (2000). Mollusca, pp. 323–355. In: Director (ed.). *State Fauna Series 7, Fauna of Tripura, Part 4*. Zoological Survey of India, Calcutta, 355 pp.

Nandy, G., H. Barman, S. Pramanik, K. Paul, D. Kundu, A. Ash & G. Aditya (2022). Infestation of sporocysts of parasite Leucochloridium in the snails *Succinea daucina* and *Indosuccinea semiserica*. *Journal of Environmental Biology* 43: 722–726.

Nandy, G., S. Pramanik, S. Banerjee, H. Barman & G. Aditya (2023). Size-dependent growth and fecundity variations of three land snails: implications for population management. *Invertebrate Reproduction & Development* 67: 3–4. https://doi.org/10.1080/07924259.2023.2241848

Patterson, C.M. (1971). Taxonomic studies of the land snail family Succineidae. *Malacological Review* 4: 131–202.

Pfeiffer, L. (1855 ["1854"]). Descriptions of fifty-seven new species of Helicea from Mr. Cuming's collection. *Proceedings of the Zoological Society of London* 22(277): 286–288.

Pilsbry, H.A. (1948). Land mollusca of North America. Vol II, Part 2. *Monographs of the Academy of Natural Sciences of Philadelphia* 3: 771–847.

Prokhorova, E.E., R.R. Usmanova & G.L. Ataev. (2020). An analysis of morphological and molecular genetic characters for species identification of Amber Snails *Succinea putris* (Succineidae). *Invertebrate Zoology* 17(1): 1–17.

Ramakrishna, S.C. Mitra & A. Dey (2010). Annotated Checklist of Indian Land Molluscs. Records of the Zoological Survey of India, Occasional Paper No. 306. Zoological Survey of India, Kolkata, 359 pp.

Rao, H.S. (1924). Asiatic Succineidae in the Indian Museum. *Records of the Indian Museum* 26(5): 367–408.

Rao, H.S. (1928). The aquatic and amphibious mollusca of the northern Shan States, Burma. *Records of the Indian Museum* 30: 399–468.

Raut, S.K., T.K. Mishra & S. Das (1997). Life-history of a Succineid snail *Succinea daucina* (Pfeiffer). *Journal of Bombay Natural History Society* 94: 589–591. https://www.biodiversitylibrary.org/partpdf/156368

Rundell, R.J., B.S. Holland & R.H. Cowie (2004). Molecular phylogeny and biogeography of the endemic Hawaiian Succineidae (Gastropoda: Pulmonata). *Molecular Phylogenetics and Evolution* 31(1): 246–255.

Tripathy, B. & S. Sajan (2022). Mollusca, pp. 337–350. In: Chandra, K., D. Banerjee, C. Raghunathan, D. Gupta, P. Rai & G. Sharma (eds.). *Faunal Diversity of Biogeographic Zones of India: Gangetic Plains*. Zoological Survey of India, Kolkata, 387 pp.

Welter-Schultes, F. (2009). Species summary for Renea veneta. www.animalbase.uni-goettingen.de (version 21-01-2009).

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First record of the ladybird beetle *Novius pumilus* (Weise, 1892) (Coleoptera: Coccinellidae: Noviini) from West Bengal, India, with notes on its ecology

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Ladybird beetles (Coleoptera: Coccinellidae), also known as ladybugs, and ladybeetles, constitute a popular, and significant group of insects with an outstanding economic perspective. At present, over 6,000 species of ladybirds under 360 genera are described worldwide (Ślipiński 2007). More than 400 species of ladybirds, representing 79 genera, and 22 tribes, are currently present in the Indian subcontinent (Poorani 2002). The coccinellid fauna of India is widespread and diversified. The state of West Bengal is rich in biodiversity and plays a crucial role in enriching ladybird diversity. The varied habitats from the Sundarban mangrove forests to the foothills of the Himalaya offer a special home for an array of ladybird beetles. The tribe Noviini is among the most economically important groups in Coccinellidae, with only a single genus, *Novius* Mulsant, 1846 (Pang et al. 2020). Members of this tribe are mainly predators of giant scales belonging to the family Monophlebidae and occasionally, mealybugs (Pseudococcidae). A perusal of the history of biological control revealed that the successful utilization of ladybird beetles was made when an epidemic plague of cottony cushion scale, *Icerya purchasi* Maskell, threatened the orange production in California. As a remedy to the threat imposed by the scale insects, a ladybeetle, *Novius cardinalis* (Mulsant, 1850) (= *Rodolia cardinalis* Mulshant, 1850), was imported to California from Australia in 1888, and was successfully augmented, and utilized for the management of the scale insect (Doutt 1958). At present, 17 species of the genus *Novius* have been documented from the Indian subcontinent (Poorani 2023). According to Poorani (2023), four species of this genus (*amabilis*, *breviusculus*, *fumidus*, and *ruficolis*) are predominant in West Bengal. *Novius pumilus* (Weise, 1892), which was previously reported from Punjab and Uttarakhand, is documented for the first time from West Bengal, India. Morphology of this ladybird *N. pumilus*, has been described significantly by earlier researchers (Ren et al. 2009; Pang et al. 2020; Poorani 2023). Therefore, the morphological attributes of the mentioned ladybird are not reiterated here. Detailed photographs of the habitus, male genitalia, and certain body parts that govern the taxonomic identity of *N. pumilus,* along with brief notes, are provided.

On 24 December 2021, adults and pupae of the ladybird *N. pumilus* were procured from rose plantations at AB Block Farm (Kalyani Municipality) of Bidhan Chandra Krishi Viswavidyalaya (22.990^0 N, 88.425^0 E) where adults were observed preying upon *Icerya aegyptiaca* (Douglass 1890) (Figures 1, 2 & 3). During fortnightly visits (January–December 2023) to the

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jackfruit orchard of ICAR-AICRP on fruits at the Mondouri Farm (Haringhata Municipality) of Bidhan Chandra Krishi Viswavidyalaya (22.936^0 N, 88.508^0 E), larvae, pupae, and adults of this ladybird beetle were also recorded, and both larvae, and adults were observed preying upon *Icerya seychellarum* (Westwood, 1855) (Figures 1, 4 & 5).

Both Kalyani Municipality and Haringhata Municipality, located in the Nadia District of West Bengal, serve as important habitats for the newly recorded *N. pumilus* in the region. Despite their differences in urbanization, Kalyani being a more planned urban township and Haringhata having a predominantly rural agricultural character, both municipalities share ecological conditions favourable for the establishment of *N. pumilus*. Specifically, both areas provide environments that support the prey species of *N. pumilus*, various scale insects such as *Icerya* species, which are common pests in agricultural, and semi-urban landscapes. The presence of these pests creates an opportunity for *N. pumilus* to thrive as a natural biological control agent in these areas.

Additionally, the detection of *N. pumilus* in these two distinct yet geographically close municipalities underscores the beetle's adaptability to varied ecological settings within the Nadia District, indicating its potential utility in integrated pest management across both urban, and rural agricultural systems in West Bengal.

Species identification was accomplished using a stereomicroscope Zeiss Stemi 508. Images were captured using the smartphone Samsung S22 Ultra attached to the eyepiece of the stereomicroscope. Later, the image stacking was conducted in Adobe Photoshop 2024 and arranged in CorelDRAW 2018. Genitalia dissection was carried out following the methodology described by Majerus (1994). The terminology used for genitalia and other aspects of adult morphology mostly adheres to Ślipiński (2007).

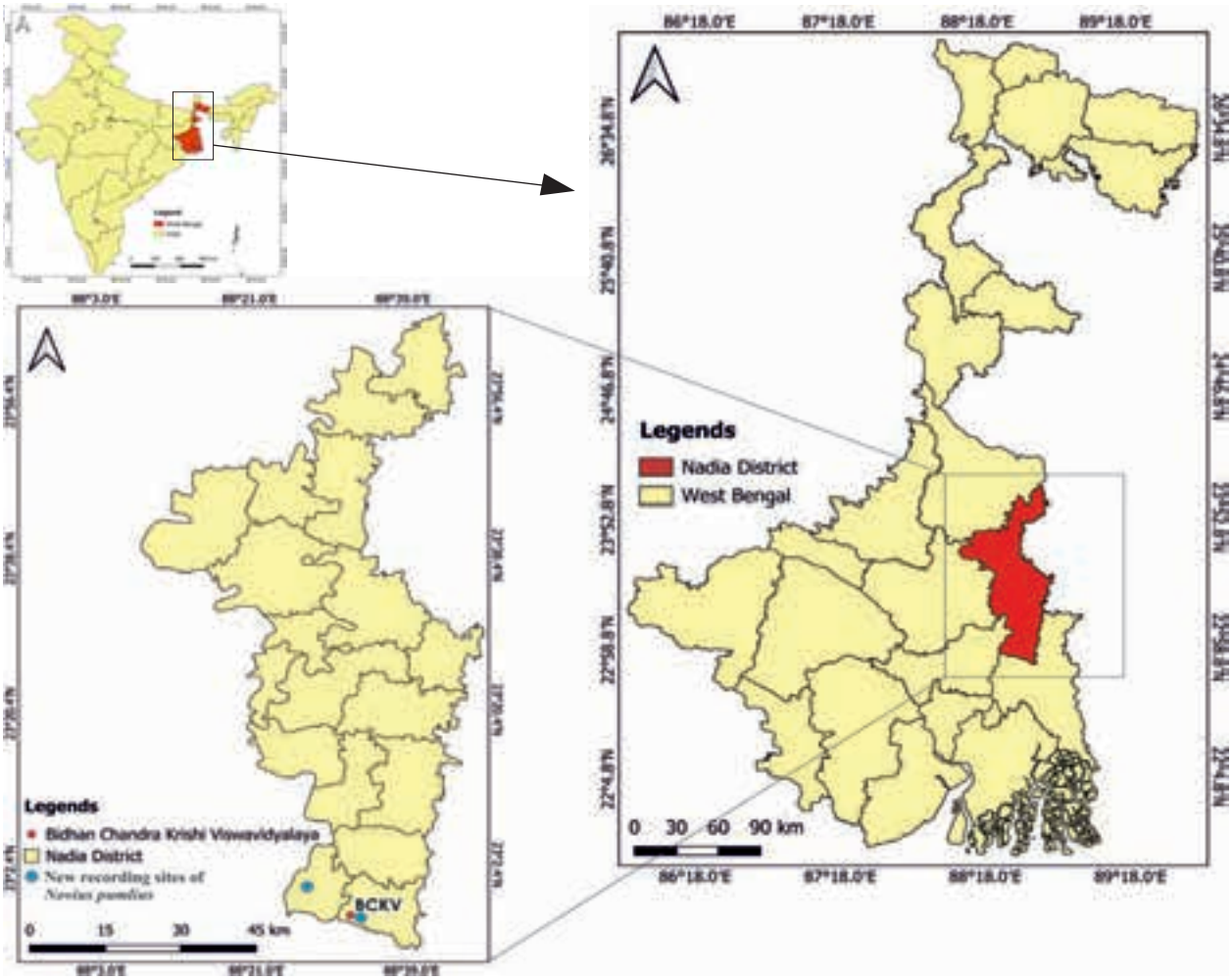

Image 1. Recorded locations of *Novius pumilus* (Weise, 1892) in West Bengal.

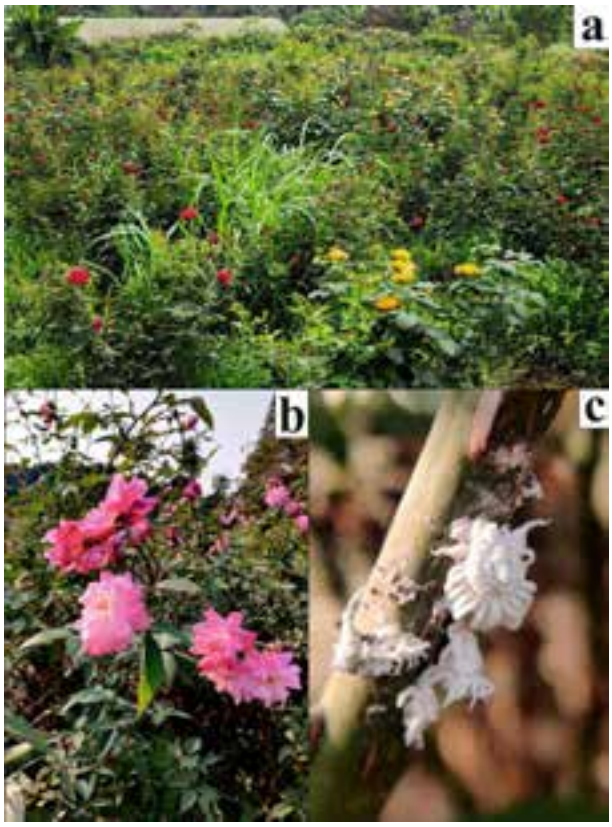

Image 2. a,b—Rose plantations | c—*Icerya aegyptiaca* (Douglass, 1890) infestations on rose. © T. Majumder.

Image 3. a,b—*Novius pumilus* (Weise, 1892) feeding on *Icerya aegyptiaca* (Douglass, 1890) | c—Pupae on rose leaf | d–Eclosing adult on rose leaf. © T. Majumder.

***Novius pumilus* (Weise, 1892)**

Distribution: India: Punjab (PAU, Ludhiana); Uttarakhand; West Bengal (AB Block Farm in Kalyani, Mondouri Farm in Haringhata).

Diagnosis: Dorsal side of the body is orange in colour while ventral side is reddish-brown, broad, oval-shaped, convex, dorsum with dense greyish pubescence (Image 6). Head light brown in colour except rear end of the frons which is dark pitchy brown (Image 7). Pronotum with dense pubescence (Image 6). Eyes oval, densely facetted, interocular distance about 1.25x of the width of an eye (Image 6; 7). Elytral epipleuron broad without foveae (Image 7). Prosternal intercoxal process trapezoidal [Image 6). Abdominal postcoxal line is complete and semicircular shaped (Image 7). Male genitalia (Image 7) as illustrated, tegmen (Image 7) stout; penis guide in dorsal view and ventral view as long as parameres, paramere gently curved on basal portion in lateral view and strongly curved on basal portion in dorsal view with dense setae on the inner side and distal end; penis guide in dorsal view (Image 7) mostly wider at base, gradually narrowing towards acuminate apex; penis guide in lateral view (Image 7), widest at the basal portion, then gradually tapering towards the apex, and slightly curved at the end. Penis stout, long, greatly curved, and coil shaped with a well-defined penis capsule; penis capsule with short outer arm, and long inner arm; penis apex unmodified gradually narrowing towards tip and forming a thread-like structure at the end (Image 7).

References

Doutt, R.L. (1958). Vice, virtue, and the Vedalia. *Bulletin of the Entomological Society of America* 4(4): 119–123. https://doi.org/10.1093/besa/4.4.119

Majerus, M.E.N. (1994). *Ladybirds*. Harper Collins, London, 367 pp.

Pang, H., X.F. Tang, R.G. Booth, N. Vandenberg, J. Forrester, J. McHugh & A. Slipinski (2020). Revision of the Australian Coccinellidae (Coleoptera). Genus Novius Mulsant of tribe Noviini. *Annales Zoologici* 70(1): 1–24. https://doi.org/10.3161/00034541ANZ2020.70.1.001

Poorani, J. (2002). An annotated checklist of the Coccinellidae (excluding Epilachninae) of the Indian subregion. *Oriental Insects* 36: 307–383. https://doi.org/10.1080/00305316.2002.10417335

Poorani, J. (2023). A review of the tribe Noviini (Coleoptera: Coccinellidae) of the Indian subcontinent. *Zootaxa* 5311(1): 1–47. https://doi.org/10.11646/zootaxa.5311.1.1

Ren, S.X., X.M. Wang, H. Pang, Z.Q. Peng & T. Zeng (2009). *Colored Pictorial Handbook of Ladybird Beetles in China*. Science Press,

Image 4. a,b—*Icerya seychellarum* (Westwood, 1855) on jackfruit | c—Larva on jackfruit | d—Pupa on jackfruit leaf. © T. Majumder.

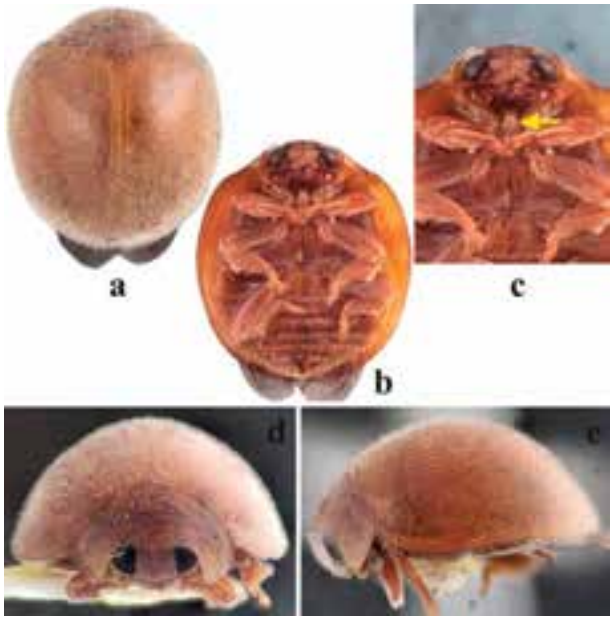

Image 6. *Novius pumilus* (Weise, 1892): a—Adult (dorsal view) | b—Adult (ventral view) | c—Prosternum & mesoventrite| d—Adult (frontal view) | e—Adult (lateral view). © T. Majumder.

Image 5. *Novius pumilus* (Weise, 1892): a—Larva | b—Larva undergoing pupal stage | c—Pupa. © T. Majumder.

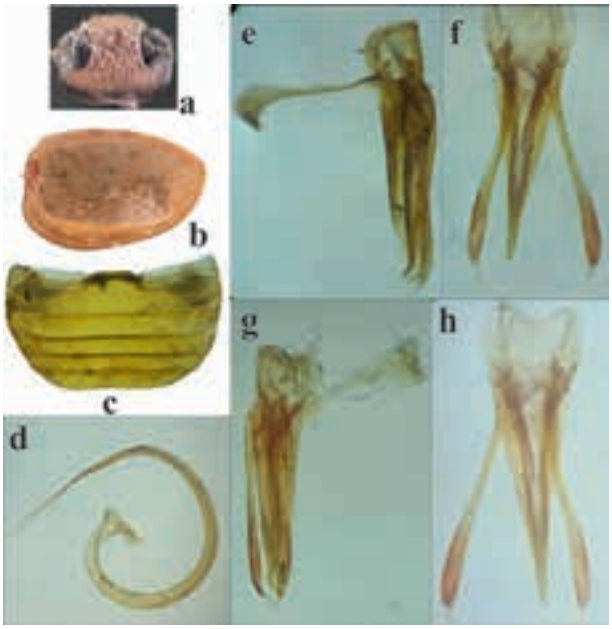

Image 7. Diagnostic characters of *Novius pumilus* (Weise, 1892): a—Head (dorsal view) | b—Elytral epipleuron | c—Abdomen | d—Penis | e,g—Tegmen (lateral view) | f—Tegmen (dorsal view) | h—Tegmen (ventral view). © T. Majumder.

Beijing, 336 pp.

Ślipiński, A. (2007). *Australia ladybird beetles (Coleoptera: Coccinellidae): Their Biology and Classification*. Australian Biological Resources Study, Canberra, xviii+286 pp.

Weise, J. (1892). Les Coccinellides du Chota-Nagapore. *Annales de la Societe Entomologique de Belgique* 36: 19–27.

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Boesenbergia tiliifolia (Baker) Kuntze (Zingiberaceae) - a new record for Maharashtra, India

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The genus *Boesenbergia* Kuntze (Zingiberaceae) was named by Otto Kuntze in honour of his brother-in-law, the artist Walter Boesenberg. It comprises 98 species (Saensouk & Larsen 2002; Aishwarya et al. 2015; Debnath et al. 2024; POWO 2024) and is distributed in India, Indo-China, Malay Peninsula, Myanmar, Sumatra, Borneo, Philippines, and southern China (Sirirugsa 1987, 1992). In India, it is represented by 13 species (Das & Sikdar 1982; Singh & Srivastava 2020; Debnath et al. 2024; Saravanan & Kaliamoorthy 2024). Only *B. rotunda* (L.) Mansf. has been reported to occur in Maharashtra so far (Lakshminarasimhan et al. 1996).

As part of the ongoing taxonomic studies of the flowering plants in the Concan region of Maharashtra, the first author has conducted extensive field studies from 2015 to 2024. During a botanical survey in the Concan region of the northern Western Ghats in Maharashtra in September 2023 and 2024, the first author collected a single specimen of a *Boesenbergia* species from Tillari (Forebay) Dam near Dodamarg in Sindhudurg District, Maharashtra. After a thorough examination of the live and herbarium specimens, study of relevant literature (Mangaly & Swarupanandan 1981; Uthayakumari et al. 2006; Aishwarya & Sabu 2015), the specimen was identified as *Boesenbergia tiliifolia* (Baker) Kuntze. A review of the literature (Cooke 1907; Lakshminarasimhan et al. 1996; Aishwarya & Sabu 2015) indicated that this species has not been previously reported from Maharashtra. Therefore, the present collection constitutes a new distributional record for the flora of Maharashtra.

Materials and Methods

The Concan region of Maharashtra has been previously explored botanically by several botanists, including Dr. Lush, Dr. Stock, Law, Dr. Ritchie, Dalzell, Woodrow, and Nairne, and the specimens were deposited at the Kew Herbarium. Most of these historical collections lack specific collection locations, as only general locality names such as 'Konkan' were used. Additionally, many areas in the region are botanically underexplored, and their floristic wealth remains less known (Kulkarni 1988). The current explorations aim to fill this gap. During a survey (2023–24) in the Tillari Dam area of Dodamarg Tehsil in Sindhudurg District, the first author (VAP) collected an interesting specimen of *Boesenbergia* (Image 1), which was subsequently identified using pertinent literature as *B.*

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tiliifolia. A herbarium specimen was prepared following international standards and deposited in the Herbarium of the Department of Botany at Anandibai Raorane Arts, Commerce and Science College in Vaibhavwadi, Sindhudurg District, Maharashtra. The identity of the specimen was confirmed by Dr. M. Sabu, an expert in Zingiberaceae (Name spelled out pers. comm. 22.ix.2024). A live specimen of *B. tiliifolia* is maintained in the Botanical Garden at ARACS College, Maharashtra. Photographs of the dissected floral parts were taken using a Labomed CSM2 Stereo Microscope coupled with a Nikon Z50 camera.

Taxonomic treatment

Boesenbergia tiliifolia (Baker) Kuntze in Rev. Gen. Pl. 2: 685. 1891; Schum. in Engler, Pflanzenr. 4(46): 94. 1904 (as '*tiliifolium*'); Schltr. in Feddes Repert. 12: 317. 1913; Mangaly & Swarupanandan in Bull. Bot. Surv. India 23(3&4): 236. 1981 (as '*tiliaefolia*'); Das & Sikdar in Bull. Bot. Soc. Bengal 36: 45. 1982 (as '*tiliaefolia*'); Uthayakumari et al. in J. Econ. Taxon. Bot. 30(1): 190. 2006 (as '*tiliaefolia*'); Sabu in Zingiberaceae and Costaceae of South India 124. 2006 (as '*tiliaefolia*'). Aishwarya & Sabu in Rheedea 25(1): 63. 2015.

Herbs perennial, rhizomatous. Rhizome cylindrical, 5–10 × 0.3–0.4 cm, odourless. Leaves 3–6, 10–15 cm long; petiole 1–3.5 cm long; lamina ovate-elliptic, 9–12 × 4–10 cm, fleshy, glabrous, acute at apex, unequal at base. Inflorescence terminal, 4–5 cm long, 8–10-flowered. Bracts 8–10, distichous, oblong, 1.5–2 × 0.4–0.7 cm, minutely white hairy, acuminate at apex and wavy along the margins. Bracteoles oblong-lanceolate, 1.2–1.4 × 0.3–0.4 cm, bi-lipped. Flowers 2.5–3.5 cm long. Calyx tubular, 0.5–1.0 × 0.2–0.4 cm, truncate at base, translucent white, tridentate at apex. Corolla tube 1.4– 1.9 × 0.14 cm, white with a pink tinge; corolla lobes three, oblong, 1.0–1.3 × 0.3–0.5 cm, deeply pouched at apex, translucent white, glabrous, margins entire. Lateral staminodes two. Labellum obovate-cuneate, 1.4–1.5 × 0.8–0.9 cm, white with laterally radiating pink bands in the depression and pink towards the tip, margins wavy towards the upper half. Stamens 0.6–1.1 cm long, white; filaments 0.2–0.5 × 0.15–0.3 cm; anthers 0.4–0.6 × 0.2 cm; connectives not crested or spurred. Pollen grains spheroidal, 90–130 µm in diameter, with small spiny protuberances. Ovary oblong to elliptic, 0.2–0.5 cm long, glabrous, tricarpellary, trilocular with ovules on axile placentum; style filiform, 1.7–3.4 cm long, glabrous, white; stigma cup-shaped, non-ciliate, white. Capsule glabrous, 1–1.1 × 0.5–0.6 cm, slightly constricted, obtuse to blunt at apex. Seeds 2–4, measuring 4–5 × 1–1.5 mm, glabrous, with lacerate arils; aril strands 7–8, whitish, unequal, tubular, sharply or bluntly acute at apex.

Flowering and Fruiting: September–December.

Distribution: India: Andaman Islands, Assam, Karnataka, Kerala, Maharashtra (present study), Meghalaya, Tamil Nadu (Figure 1).

Specimen examined: India, Maharashtra, Sindhudurg District, Tillari Dam, Dodamarg, 15.780^0 N, 74.088^0 E, ±73 m elevation, 21.ix.2024, coll. V.A. Paithane 3028 (Herbarium of ARACS College, Maharashtra).

Taxonomic note: Saravanan & Kaliamoorthy (2024) stated that *Boesenbergia kalakadensis* Saravanan & Kaliamoorthy shares morphological similarities with *B. rotunda* Mansf. and *B. tiliifolia* (Baker) Kuntze. *B. tiliifolia* (Baker) Kuntze can be distinguished by its smaller flowers, measuring 2.5–3.5 cm in length, compared to 8.2 cm in *B. kalakadensis* and 10.1 cm in *B. rotunda*.

References

Aishwarya, K. & M. Sabu (2015). *Boesenbergia pulcherrima* and *B. tiliifolia* (Zingiberaceae) in India: Notes on the identity, variability and typification. *Rheedea* 25(1): 59–68. https://doi.org/10.22244/rheedea.2015.25.01.11

Figure 1. Distribution map of *Boesenbergia tiliifolia* (Baker) Kuntze in the Western Ghats of India.

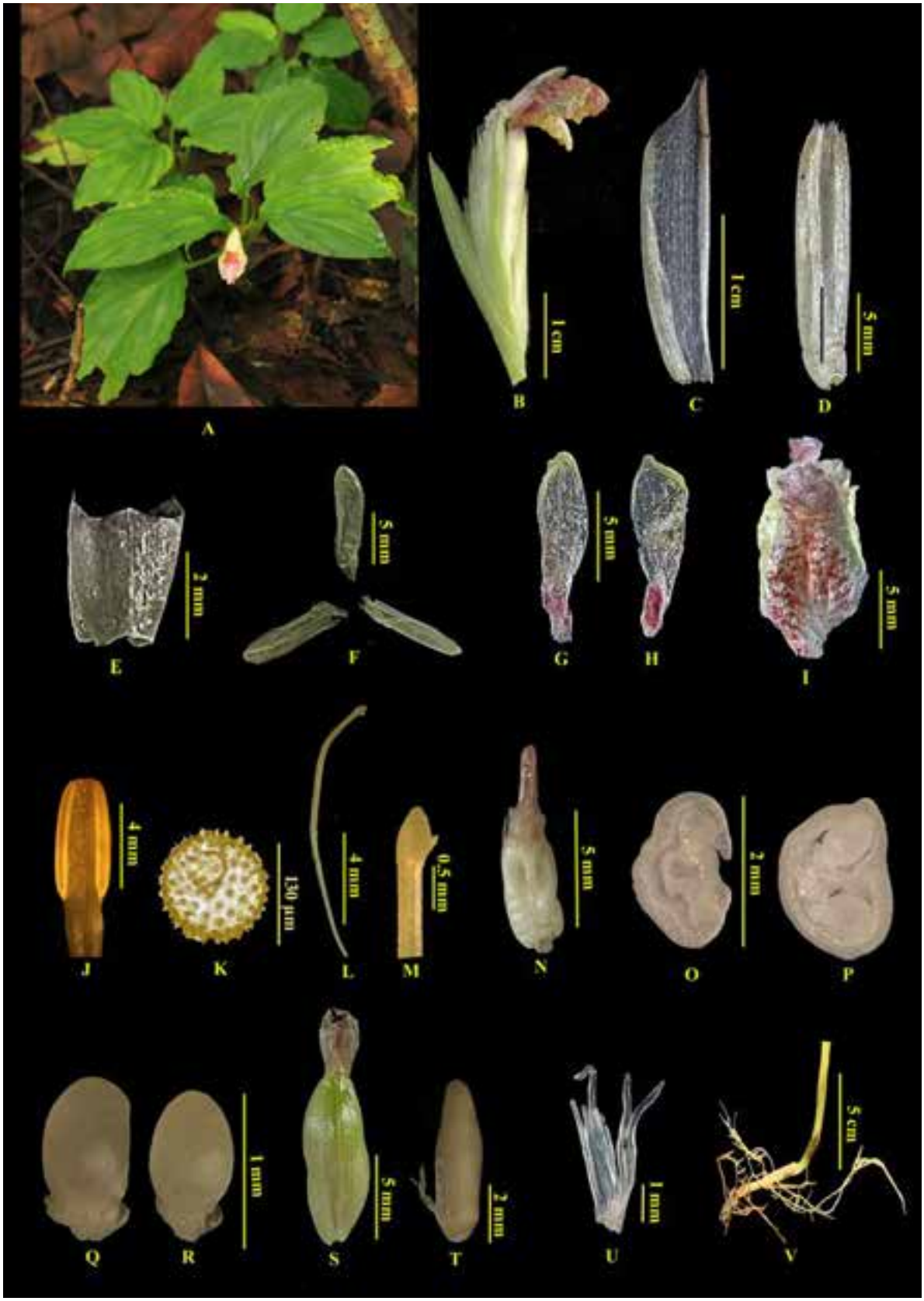

Image 1. ***Boesenbergia tiliifolia*** **(Baker) Kuntze: a—Habit | b—Flower | c—Bract | d—Bracteole | e—Calyx | f—Corolla lobes | g & h—Lateral staminodes | i—Labellum | j—Stamen | k—Pollen | l & m—Style & stigma | n—Ovary with epigynous glands | o & p—Cross-section of ovary | q & r—Ovules | s—Capsule | t—Seed | u—Lacerate arils | v—Rhizome.**

Aishwarya, K., M.R. Vinitha, G. Thomas & M. Sabu (2015). A new species of *Boesenbergia* and rediscovery of *B. rotunda* (Zingiberaceae) from India. *Phytotaxa* 197(3): 186–196. https://doi.org/10.11646/phytotaxa.197.3.2

Cooke, T. (1907). *Flora of the Presidency of Bombay*, *Vol. 3*. Botanical Survey of India, Calcutta, 650 pp.

Das, C.R. & J.K. Sikdar (1982). Review on the genus *Boesenbergia* (Scitamineae) from India. *Bulletin of the Botanical Society of Bengal* 36: 39–46.

Debnath, S., S. Patil & D. Vijayan (2024). *Boesenbergia ashihoi* (Zingiberaceae), a new species from northeast India. *Nordic Journal of Botany* 2024(5): e04319. https://doi.org/10.1111/njb.04319

Kulkarni B.G. (1988). *Flora of Sindhudurg*. Botanical Survey of India, Calcutta, 441–446 pp.

Kuntze, O. (1891). *Revisio Genera Plantarum 2*. Dulau & Co, London, 685 pp.

Lakshminarasimhan, P., B.D. Sharma, S. Karthikeyan & N.P. Singh (1996). *Flora of Maharashtra State Monocotyledones.* Botanical survey of India, Calcutta, 791 pp.

Mangaly, J.K. & K. Swarupanandan (1981). *Boesenbergia* O. Kuntze (Zingiberaceae): new records from Kerala. *Bulletin of Botanical Survey of India* 23: 235–236.

POWO (2025). Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Accessed on 22 September 2024. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:37214-1.

Saensouk, S. & K. Larsen (2002). *Boesenbergia baimaii*, a new species of Zingiberaceae from Thailand. *Nordic Journal of Botany* 21: 595–597. https://doi.org/10.1111/j.1756-1051.2001.tb00818.x

Saravanan, T.S. & S. Kaliamoorthy (2024). *Boesenbergia kalakadensis* sp. nov. (Zingiberaceae) from southern Western Ghats, India. *Nordic Journal of Botany* 2024: e04445. https://doi.org/10.1111/njb.04445

Singh, S.K. & S.C. Srivastava (2020). Zingiberaceae, pp. 116–134. In: Mao, A.A. & S.S. Dash (eds.). *Flowering Plants of India, An Annotated Checklist (Monocotyledons)*. Botanical Survey of India, Kolkata, 545 pp.

Sirirugsa, P. (1987). Three new species and one new combination in *Boesenbergia* (Zingiberaceae) from Thailand. *Nordic Journal of Botany* 7: 421. https://doi.org/10.1111/j.1756-1051.1987.tb00963.x

Sirirugsa, P. (1992). A revision of the genus *Boesenbergia* Kuntze (Zingiberaceae) in Thailand. *Natural History Bulletin of the Siam Society* 40: 67–90. https://www.thaiscience.info/journals/Article/NHB/10439259.pdf

Uthayakumari, F., V.S. Manickam & J. Dulcy (2006). *Boesenbergia tiliaefolia* (Baker) O. Kuntze (Zingiberaceae) - a new record for Tamil Nadu. *Journal of Economic and Taxonomic Botany* 30: 190–192.

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NOTE

Acrospelion alpestre (Aveneae: Poaceae) in India: a new generic record from northwestern Himalaya

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Botanical explorations focused on collecting grass species have enhanced the understanding of Indian grasses (Saha et al. 2024). The scarcity of recent floristic studies and limited documentation on India's grass flora hinders the understanding, resulting in a large number of species remaining unrecorded to date, and their morphological features insufficiently described (Jacobs et al. 1999).

Floristic documentation was carried out from 2022 to 2024 across a range of habitats, from the lesser Himalaya to alpine meadows, in the northwestern Himalaya, covering regions such as Uttarakhand, Himachal Pradesh, Ladakh, and Jammu & Kashmir. These surveys facilitated the documentation of the genus *Acrospelion* (Besser) [Lectotype = *Acrospelion distichophyllum* (Vill.) (Barberá)]. Specimen collection, preservation, and preparation followed the standard herbarium method (Jain & Rao 1977). The herbarium specimen has been deposited at the Forest Research Institute, Dehradun (DD).

The genus *Trisetum* Pers. was first described by Christiaan Hendrik Persoon in 1805 with 11 species (Barberá et al. 2018), comprising both perennial and annual grasses, and no type specimen was designated at that time (Hara & Yü 1983). In 1827, Wilibald Swibert Joseph Gottlieb von Besser proposed new classification based on habit, retaining the annual species within *Trisetum* and transferring the perennials to a newly proposed genus, *Acrospelion* Besser (Baum 1968). This genus initially encompassed seven taxa (*Aira subspicata* L., *Avena flavescens* L., *Avena rigida* M. Bieb., *Avena argentea* Willd., *Avena distichophylla* Vill., *Avena brevifolia* Host., and *Avena alpestris* Host., and was characterized by compound, spreading panicle; compressed, two–three-flowered spikelets; keeled, unequal glumes that are shorter than the florets; lower glume with one nerve and upper glume with three nerves; a bifid lemma with awn emerging from the split, folded, and flexible; seeds (caryopsis) that are covered and grooved. No formal taxonomic combinations were

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made, and no type specimen was designated at that time (Hara & Yü 1983). Later, Chrtek (1965) also divided the genus *Trisetum* in five sections: *T*. sect. *Carpatica*, *T*. sect. *Hispanica*, *T*. sect. *Rigida*, *T*. sect. *Trisetaera*, and *T*. sect. *Trisetum* (Barberá et al. 2017b). Subsequently, Pfeiffer (1871–1873) reclassified *Acrospelion* as a section, replacing *T*. sect. *Rigida*. Due to its earlier publication, the epithet *Acrospelion* takes precedence over *Rigida* at the sectional rank. *Trisetum* sect. *Acrospelion* is characterized by distichous young shoots, rigid or loosely tufted habit, panicles ranging from lax to slightly dense, unequal to subequal glumes, and the presence of long hairs on the rachilla segments between florets, and on the callus (Barberá et al. 2017a). Recently, *Acrospelion* has been expanded to encompass 13 species (WCVP 2025) following the inclusion of taxa previously classified in *Trisetum* sect. *Trisetum* and *Trisetum* sect. *Acrospelion*, and *Acrospelion distichophyllum* designated as the type specimen (Pfeiffer 1871). The recent phylogenetic study by Barberá et al. (2024) has revived and reinforced the recognition of the genus by analysing plastid DNA sequences from the rpl32-trnL, rps16-trnK, rps16 intron, and ITS regions. The genus belongs to the subtribe Aveninae (Clayton & Renvoize 1986), under the tribe Aveneae (Bor 1960), within the subfamily Pooideae of family Poaceae.

The taxonomic identification of the collected grass specimens were confirmed as *Acrospelion alpestre* (Host) Barberá & Quintanar, a European grass, through examination of specimens from Natural History Museum herbarium (BM), Meise Botanic Garden herbarium (BR), Forest Research Institute herbarium (DD), Royal Botanic Gardens herbarium (K), Naturalis Biodiversity Center herbarium (L), Oberösterreichische Landeskultur GmbH herbarium (LI), Muséum National d'Histoire Naturelle herbarium (P), and Naturhistorisches Museum Wien herbarium (W) (acronyms as per Thiers 2024), as well as a review of type specimens (W18850002400 & W0024994), protologues (Host 1805), and pertinent taxonomic literature (Bor 1960; Finot et al. 2006; Barberá et al. 2017a,b, 2018). This species is characterized by spikelets with two–three florets, subequal or shorter upper glumes, keeled lemmas where geniculate or slightly curved awns inserted on the upper one-third; lemma apex bidentate with intermediate nerves prolonged into setae; callus obtuse, scarious to hyaline paleas, and glabrous or sparsely trichome-covered ovaries near the apex (Finot et al. 2006; Barberá et al. 2020; Barberá et al. 2024). Notably, *Acrospelion* represents a new generic record for the flora of India (Prasanna et al. 2020; Kellogg et al. 2020). Overall, *A. alpestre* marks its first occurrence in southern Asia, as previous studies have not documented its presence in literature (Bor 1960; Barberá et al. 2018, 2024; POWO 2024).

Image 1. *Acrospelion alpestre* (Host) Barberá & Quintanar: a—growing in its natural habitat | b—close-up of Inflorescence. © Kuntal Saha.

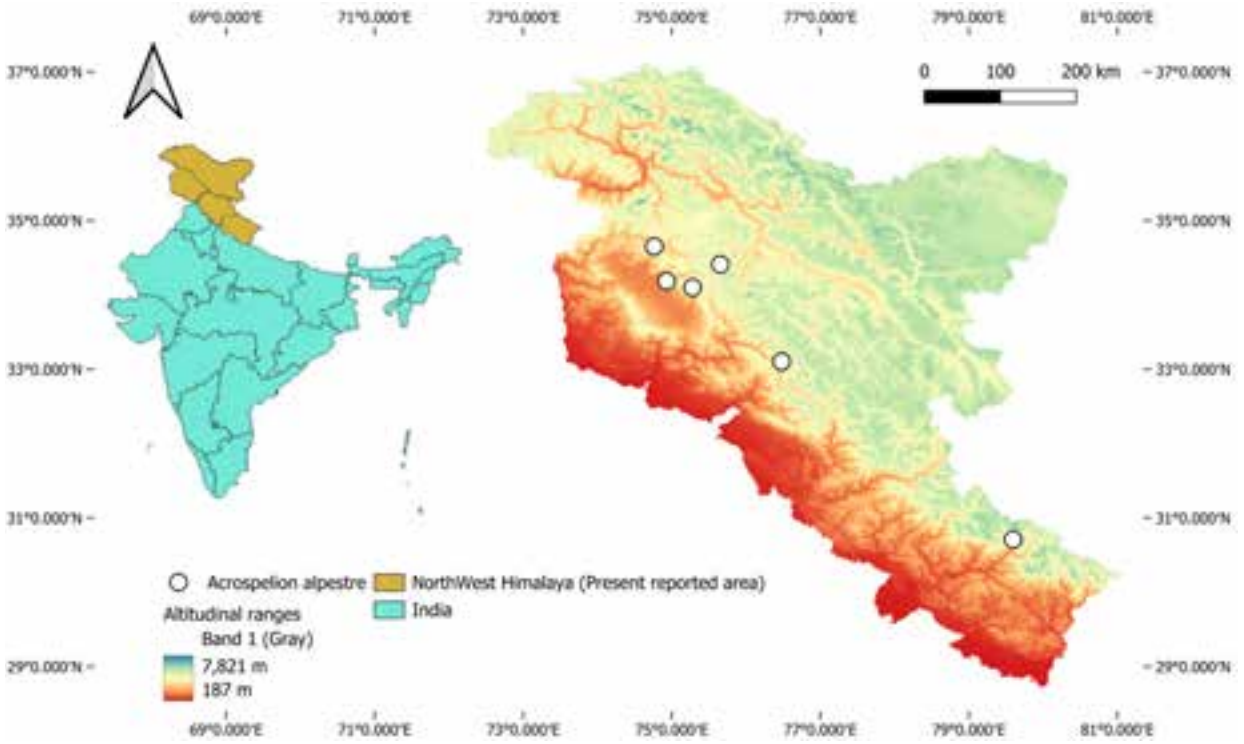

Figure 1. Distribution of *Acrospelion alpestre* (Host) Barberá & Quintanar in northern India.

A detailed description of the species has been provided, accompanied by colour photographs depicting specimens in their natural habitat (Image 1), photo plate (Image 2), and map of collection sites (Figure 1), which was created using QGIS version 3.36.2.

Taxonomic treatment

Acrospelion alpestre (Host) Barberá & Quintanar, J. Syst. Evol. x: [19 of 27] (2024). *Trisetum alpestre* (Host) P. Beauv. in Ess. Agrostogr.: 88 (1812).

Avena alpestris Host, Icon. Descr. Gram. Austriac. 3: 27, t. 39 (1805).

Lectotype: Austria. N.T. Host s.n. (W18850002400!; isolectotype: W0024994!). Lectotype designated by Barberá et al. in taxonomic revision of Trisetum 358. 2018.

Perennial, caespitose. Culms 18.6–31 cm × 0.2–0.8 cm, glabrous, erect, smooth, glabrous; 2–4 nodes, glabrous. Leaf sheaths 4–11 cm × 0.3–0.5 cm, smooth, sparsely pilose. Ligule 1.9–2.3 mm, dentate, with scattered ciliate. Leaf blades 6–21 cm × 0.3–0.4 cm, flat, inrolled in dried, greenish, sparsely pubescent abaxially, pubescent adaxially, apex acuminate. Panicles 5.5–12 × 1–2.5 cm, lax, narrowly oblong, very effuse, greenish-yellow, shining; basal node glabrous; rachis up to 2 cm, sparsely scabrid; branches semi-whorled at lower node, 0.7–1.5 cm. Spikelets 0.5–1.7 × 0.1–0.3 cm (including awns), 2–4-floret, laterally compressed, oblanceolate; disarticulating at maturity; pedicel 0.4–0.7 cm, scabrid. Lower glume 3.1–4 mm, elliptic to oblong or lanceolate, glabrous, one-nerved, hyaline margins, apex acute. Rachilla 0.9–1.5 mm, densely ciliate. Upper glumes 4.6–5.8 mm, oval-lanceolate, membranous, three-nerved, glabrous, apex acuminate. Lemmas 4.5–5.5 mm, glabrous, shining, narrowly to broadly lanceolate, bifid, teeth conspicuous, awned, scabrous toward apex; awn 4.5–8 mm, arising from upper 1/3 of lemmas, bent or straight, very slightly twisted at base, scabrid; callus ciliate, trichomes up to 0.5 mm. Paleas 3.5–4.8 mm, narrowly elliptical hyaline, elliptic, glabrous, scabrid margins. Lodicules 0.5–0.7 mm, glabrous, apex bilobed. Anthers 2–2.5 mm, yellowish. Ovary 0.6–0.8 mm, densely pubescent, scattered hairs at apex.

Flowering and fruiting: July–October.

Habitat: Along roadsides and in open, dry habitats with sandy, and neutral soils, as well as sunny meadows, at elevations ranging from 2100–3700 m.

Distribution: India [Himachal Pradesh, Jammu & Kashmir, Ladakh, Uttarakhand (present report)], Austria, Czechoslovakia, France, Germany, Italy, Poland, Romania, Spain, Ukraine, Yugoslavia (POWO 2024).

Specimens examined: 100218(DD), India, Jammu & Kashmir, Srinagar District, Dara, Harwan, Darah rest point, Dara-Haayan WLS, near Scholars' School,

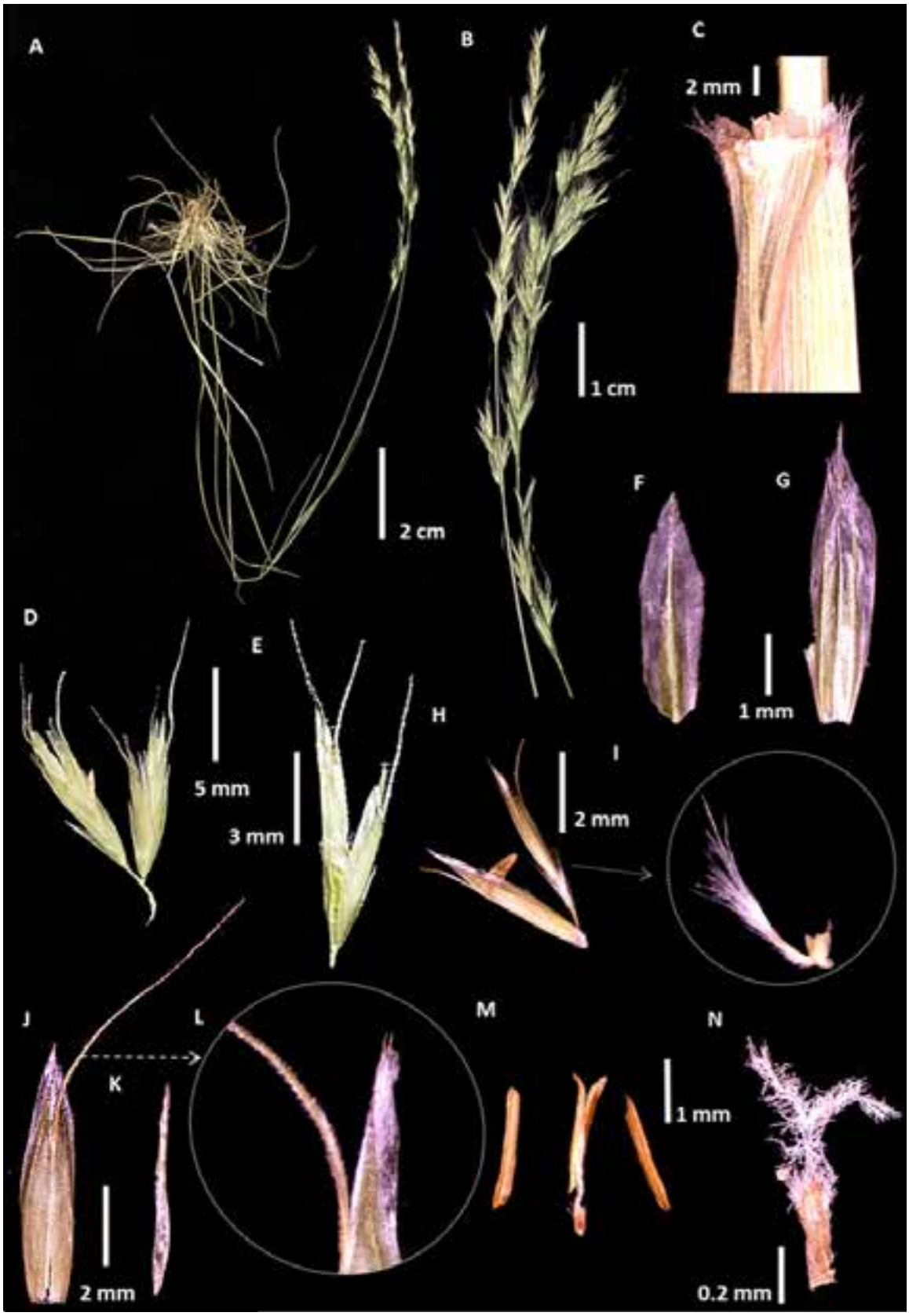

Image 2. ***Acrospelion alpestre*** **(Host) Barberá & Quintanar: a—Habit | b—inflorescence | c—ligule | d—group of spikelets | e—single spikelet | f—lower glume | g—upper glume | h—florets | i—callus of floret | j—lemma with awn | k—pelae | l—bifid apex of lemma & very slightly twisted at base of awn | m—anther | n—ovary. © Kuntal Saha.**

34.184^0 N 74.932^0 E, 2,113 m, 20.ix.2024, coll. Kuntal Saha; 100221(DD), 22.ix.2024, Ganderbal District, Sonamarg, near hotel Snowland Sonamarg, 34.304^{0}N 75.289^0 E, 2,681 m, coll. Kuntal Saha; 100231(DD), 28.ix.2024, Bandipora District, Badwan Wanpora, along the way to Gurez Valley, 34.650^0 N 74.764^0 E, 2,457 m, Kuntal Saha; 100229(DD), 22.ix.2024, Ladakh, Kargil District, Zoji La, along the roadsides near the Zoji La war memorial, 34.300^0 N 75.506^{0}E, 3,479 m, coll. Kuntal Saha; 100207(DD), 28.vii.2024, Uttarakhand, Chamoli District, Valley of Flowers, 30.708^0 N 79.596^0 E, 3,267 m, coll. Kuntal Saha; 100216(DD), 04.viii.2024, Himachal Pradesh, Chamba District, Pangi Valley, on the Hudan Bhatori, 33.103^0 N 76.479^0 E, 3,630 m, coll. Kuntal Saha.

Ethno-botanical notes: Interactions with local villagers in Kashmir Valley, particularly in the Dara region revealed insights into the species' utilization in daily life. They mentioned that *Acrospelion alpestre* is not ideal as fodder, as cows and goats seem to have difficulty digesting it. Instead, locals use it to tie bundles of other fodder, as it is resistant to rats, insects, and pests. Additionally, they use it for roofing material for sheds.

References

Barberá, P., C. Romero-Zarco & C. Aedo (2017a). Taxonomic revision of *Trisetum* section *Acrospelion* (Poaceae: Pooideae: Aveninae) from Eurasia. *Systematic Botany* 42(4): 754–781. https://doi.org/10.1600/036364417x696375

Barberá, P., C. Romero-Zarco & C. Aedo (2017b). Taxonomic revision of *Trisetum* section *Sibirica* (Poaceae: Pooideae: Aveninae). *Systematic Botany* 42(4): 782–806. https://doi.org/10.1600/036364417x696564

Barberá, P., C. Romero-Zarco & C. Aedo (2018). Taxonomic Revision of *Trisetum* Sect. *Trisetum* (Poaceae: Pooideae: Aveninae) from Eurasia and North Africa. *Annals of the Missouri Botanical Garden* 103(3): 350–392. https://doi.org/10.3417/2018067

Barberá, P., R.J. Soreng, P.M. Peterson, K. Romaschenko, A. Quintanar & C. Aedo (2020). Molecular phylogenetic analysis resolves *Trisetum* (Poaceae: Pooideae: Koeleriinae) polyphyletic: Evidence for a new genus, Sibirotrisetum and resurrection of *Acrospelion*. *Journal of Systematics and Evolution* 58(4): 517–526. https://doi.org/10.1111/jse.12523

Barberá, P., R.J. Soreng, P.M. Peterson, J. Garcia-Porta, K. Romaschenko, C. Aedo & A. Quintanar (2024). Phylogenetics and reticulation among koelerioid clades, part I: Contraction of *Trisetum,* expansion of *Acrospelion*, *Graphephorum*, and *Tzveleviochloa*; *Graciliotrisetum* gen. nov. and resurrection of *Aegialina* (Poaceae, Pooideae, Poeae, Aveninae). *Journal of Systematics and Evolution* 63(3): 1–27. https://doi.org/10.1111/jse.13133

Baum, B.R. (1968). Delimitation of the genus *Avena* (Gramineae). *Canadian Journal of Botany* 46(2): 121–132. https://doi.org/10.1139/b68-022

Bor, N.L. (1960). *The Grasses of Burma, Ceylon, India and Pakistan (Excluding Bambuseae)*. Pergamon Press, London, 767 pp.

Clayton, W.D. & S.A. Renvoize (1986). *Genera graminum, Grasses of the World*. Her Majesty's Stationery Office, London, 389 pp.

Finot, V.L., C.M. Baeza & O. Matthei (2006). Micromorfología de la epidermis de la lemma de *Trisetum* y géneros afines (Poaceae, Pooideae). *Darwiniana, nueva serie* 44(1): 32–57. https://doi.org/10.4067/s0717-66432006000200002

Hara, H. & T.T. Yü (1983). (709) Proposal to Conserve 25 Pseudolarix Gordon (Pinaceae) with a type specimen. *Taxon* 32(3): 485–487.

Host, N.T. (1805). *Icones et Descriptiones Graminum Austriacorum*. A. Schmidt, Vindobonae, pp. 27–28. https://doi.org/10.2307/1221524

Jacobs, B.F., J.D. Kingston & L.L. Jacobs (1999). The origin of grass-dominated ecosystems. *Annals of the Missouri Botanical Garden* 86(2): 590–643. https://doi.org/10.2307/2666186

Jain, S.K. & R.R. Rao (1977). *A Handbook of Field and Herbarium Methods*. Today and Tomorrow's printers and publishers, New Delhi, 157 pp.

Kellogg, E.A., J.R. Abbott, K.S. Bawa, K.N. Gandhi, B.R. Kailash, K.N. Ganeshaiah, U.B. Shrestha & P. Raven 2020). Checklist of the grasses of India. *PhytoKeys* 163: 1–560. https://doi.org/10.3897/phytokeys.163.38393

POWO (2024). Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. https://powo.science.kew.org/. Accessed 15.xi.2024.

Prasanna, P.V., S.D. Chowdary & S. Arumugam (2020). Poaceae (Graminae), pp. 313–442. In: Mao, A.A. & Dash S.S. (eds.). *Flowering Plants of India: An Annotated Checklist (Monocotyledons)*. Botanical Survey of India, Kolkata, 545 pp.

Pfeiffer, L.G.K. (1871–1873). *Nomenclator botanicus* Kassel: Cassellis: Sumptibus Theodori Fischeri, Volume 1. https://doi.org/10.5962/bhl.title.10853

Saha, K., M. Chandran, R. Negi & S. Guleri (2024). Challenges and Opportunities in Conserving Grassland Ecosystems of Western Himalayan region. *PhytoTalks* 1(2): 131–142. https://doi.org/10.21276/pt.2024.1.2.7

Thiers, B. (2024). Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/science/ih/. Accessed 05.x.2024.

WCVP (2025). World checklist of vascular plants, version 2.0. –https://checklistbuilder.science.kew.org/reportbuilder.do. Accessed 14.iii.2025.

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RESPONSE

Lesser Noddy *Anous tenuirostris* breeding in the Adam's Bridge Islands, India – a rectification

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Adam's Bridge Islands, also known as Rama's Bridge or Ram Setu, are a group of sandy shoals forming a chain of isles from the tip of Mannar Island, Sri Lanka to Rameshwaram Island, India. These have been noted as an important marine habitat and over the Sri Lankan side, the Adam's Bridge islands have been granted protection by declaring them as Sri Lanka's first Marine National Park (DWC 2025). Several *Laridae* are among the regular breeding species of Adam's Bridge Islands on the Sri Lankan side. These include Great Crested Tern *Thalasseus bergii*, Roseate Tern *Sterna dougallii*, Little Tern *Sternula albifrons*, Saunders's Tern *S. saundersi*, Sooty Tern *Onychoprion fuscatus*, Bridled Tern *O. anaethetus*, and Brown Noddy *Anous stolidus* (Rasmussen & Anderton 2012; Warakagoda et al. 2012; Seneviratne et al. 2015). In addition, there are claims of Caspian Tern *Hydroprogne caspia*, Gull-billed Tern *Gelochelidon nilotica*, Common Tern *Sterna Hirundo*, and Lesser Noddy *Anous tenuirostris* also breeding in these islands (Weerakoon & Dayananda 2021), but these claims are not confirmed through proper documentation or reporting.

A recent article by Byju et al. (2025) notes a nesting record of Brown Noddy on the sand island VII from the Indian section. Interestingly, the photographs of the birds provided in Byju et al. (2025) are that of Lesser Noddy rather than Brown Noddy. Byju et al. (2025) mention "darker chocolate-brown plumage and contrasting pale forehead & crown, black lores that contrast with its pale grey forehead, and a relatively shorter bill" as identification criteria used to identify the birds observed. But, Image 2 of Byju et al. (2025) shows 13 noddies, of which nine birds show pale grey lores and long slender bills, unlike Brown Noddy, which should have dark lores and relatively shorter, broader bills. The pale lores and thin longer bills indicate that these are actually Lesser Noddy (Rasmussen & Anderton 2012; Harrison et al. 2021). Size comparison among the birds of the group suggests that the noddies which do not clearly show these features, should also be Lesser Noddy, as Brown Noddy will stand noticeably larger, being longer, and heavier (Rasmussen & Anderton 2012; Harrison et al. 2021). Similarly, in Image 2. of Byju et al. (2025), three out of the four Noddies show pale grey lores and long slender bills, suggesting them also to be Lesser Noddy rather than Brown. The remaining bird should also belong to the same species, considering the size. The identification of the two species is not always straightforward especially at a distance, but at close range such as the birds in Byju et al. (2025), the pale grey lores together with the relatively long slender bill is quite adequate to eliminate the two similar looking species, i.e., Brown Noddy and Black Noddy (Rasmussen & Anderton 2012; Harrison et al. 2021).

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Lesser Noddy is currently known to breed in tropical islands in the Indian Ocean, particularly in coral atolls, and mangrove islets (Gochfeld et al. 2020; Harrison et al. 2021), and the closest currently known breeding location to India is Chagos Archipelago (Carr 2015). Although there are unconfirmed historical claims of it breeding in the Maldives (Gadow & Gardiner 1903), no breeding has been observed recently (Anderson & Shimal 2020). In addition, no confirmed records of it breeding exist from India or anywhere else in the subcontinent (Rasmussen & Anderton 2012; Praveen 2025). Therefore, this is the first confirmed record of Lesser Noddy breeding in the Indian sub-continent and the nesting data provided in Byju et al. (2025) provides important insights on the breeding behavior of Lesser Noddy, as a lesser known species in the region. The presence of this species along the coasts of southern India and Sri Lanka, especially along the Adam's Bridge Islands throughout the year (eBird 2025) was a good indication that it is a potential breeding species. In addition, Lesser Noddy breeding in the Adam's Bridge Islands further conveys the importance of this delicate ecosystem and stress the need for a more thorough conservation program for the habitats and species, ideally as a joint effort from both Indian and Sri Lankan authorities.

References

Anderson, R.C. & M. Shimal (2020). A checklist of birds of the Maldives. *Indian BIRDS* Monographs 3: 1–52A.

Byju, H., H. Maitreyi, N. Raveendran & D.A. Marshal (2025). First confirmed breeding of Brown Noddy *Anous stolidus* in southeastern India: a new record from Adam's Bridge. *Journal of Threatened Taxa* 17(3): 26747–26749. https://doi.org/10.11609/jott.9578.17.3.26747-26749

Carr, P. (2015). Birds of the British Indian Ocean Territory, Chagos Archipelago, central Indian Ocean. *Indian BIRDS* 10(3&4): 57–70.

Department of Wildlife Conservation (2025). Protected Areas https://www.dwc.gov.lk/protected-areas/. Accessed on 02.iv.2025.

eBird (2025). eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. http://www.ebird.org. Accessed 02.iv.2025.

Gadow, H. & J.S. Gardiner (1903). Aves. In: Gardiner, J.S. (ed.). *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*. Cambridge University Press, Cambridge. 1: 368–373. https://doi.org/10.5962/bhl.title.10215

Gochfeld, M., J. Burger & E. Garcia (2020). Lesser Noddy (*Anous tenuirostris*), version 1.0. In: del Hoyo, J., A. Elliott, J. Sargatal, D.A. Christie & E. de Juana (eds). *Birds of the World*. Cornell Lab of Ornithology, Ithaca, NY. https://doi.org/10.2173/bow.lesnod1.01

Harrison, P., M.R. Perrow & H. Larsson (2021). *Seabirds. The New Identification Guide*. Lynx Edicions, Barcelona, 600 pp.

Praveen, J. (2025). Birds of India - A Synopsis Version 2.0. www.birdtaxonomy.in. Accessed on 06.iv.2025.

Rasmussen, P.C. & J.C. Anderton (2012). *Birds of South Asia: The Ripley Guide*. *2nd ed*. Smithsonian Institution, Michigan State University & Lynx Edicions, Washington DC, Michigan & Barcelona, 683 pp.

Seneviratne, S.S., V. Weeratunga, T. Jayaratne & D. Weerakoon (2015). Brown Noddy *Anous stolidus*: first breeding record in Sri Lanka. *Birding Asia* 23: 55–63.

Warakagoda, D., C. Inskipp, T. Inskipp & R. Grimmett (2012). *Birds of Sri Lanka*. Christopher Helm, London, 224 pp.

Weerakoon, D. & S.K. Dayananda (2021). Outcomes of the Current National Assessment, pp. 48–72. In: *The National Red List 2021 - Conservation Status of the Birds of Sri Lanka*. Biodiversity Secretariat, Ministry of Environment, Sri Lanka, 451 pp.

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