



# Three new cryptic species of South Asian *Cnemaspis* Strauch, 1887 (Squamata, Gekkonidae) from Karnataka, India

Akshay Khandekar<sup>1,2</sup>, Tejas Thackeray<sup>1</sup>, Ishan Agarwal<sup>1,2</sup>

<sup>1</sup> Thackeray Wildlife Foundation, Mumbai, 400051, India

<sup>2</sup> National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bengaluru, 560065, India

<http://zoobank.org/62E690DF-174B-45FD-B2A6-1595F7782E43>

Corresponding author: Ishan Agarwal ([ishan.agarwal@gmail.com](mailto:ishan.agarwal@gmail.com))

Academic editor Uwe Fritz

Received 08 October 2021

Accepted 16 February 2022

Published 7 March 2022

**Citation:** Khandekar A, Thackeray T, Agarwal I (2022) Three new cryptic species of South Asian *Cnemaspis* Strauch, 1887 (Squamata, Gekkonidae) from Karnataka, India. *Vertebrate Zoology* 72 115–142. <https://doi.org/10.3897/vz.72.e76308>

## Abstract

We describe three new small-bodied, cryptic species of south Asian *Cnemaspis* belonging to the *mysoriensis* and *goaensis* clades from the Mysore Plateau and the Western Ghats biodiversity hotspot in Karnataka, peninsular India; and provide a key to members of each clade, besides providing the first ND2 sequence data for *C. ranganaensis*. *Cnemaspis tigris* **sp. nov.** from Kaiwara in Karnataka is a member of the *mysoriensis* clade and can be morphologically distinguished from all six described members of the clade in a number of meristic characters and subtle differences in colouration, beside  $\geq 12.1$ –23.4 % uncorrected pairwise ND2 sequence divergence. *Cnemaspis sakleshpurensis* **sp. nov.** from Sakleshpur and *C. vijayae* **sp. nov.** from Coorg, both in the Western Ghats of Karnataka, are members of the *goaensis* clade and are easily diagnosed from all three described members of the clade in meristic characters beside 5.2–14.8 % divergence from described members of the clade and 14.6 % from each other in uncorrected pairwise ND2 sequence divergence. The discovery of these new species from two different clades and biogeographic regions is not surprising, given the steep rise in the number of species of *Cnemaspis* known from peninsular India. Comprehensive geographic sampling in conjunction with molecular and morphological data is essential to understand the true diversity and distributional ranges of species within this ancient clade of gekkonid lizards.

## Keywords

*Cnemaspis stellapulvis*, dwarf geckos, granite boulders, Mysore plateau, systematics, taxonomy, Western Ghats

## Introduction

South Asian *Cnemaspis* (SAC) is an exceptionally diverse radiation of geckos that originated in the Western Ghats with species distributed in India, Sri Lanka, Myanmar, Thailand, Sumatra and associated islands off its west coast (Iskandar et al. 2017; Lee et al. 2019; Agarwal et al. 2020a, 2020c, 2021a; Amarasinghe et al. 2021; Karunarathna et al. 2021; Khandekar et al. 2021a). Con-

sidered part of the paraphyletic gekkonid genus *Cnemaspis* Strauch, 1887 (Grismer et al. 2014), this is the oldest extant Indian squamate clade with its most recent common ancestor dating back to ~62 million years ago (Agarwal et al. 2020c; Pal et al. 2021) and is represented by more than 100 species with over 50 % of its diversity restricted to India (68 species) followed by Sri Lanka (40 species) (Am-

arasinghe et al. 2021; Khandekar et al. 2021b; Pal et al. 2021; Uetz et al. 2021). The taxonomic revision of Indian and Sri Lankan *Cnemaspis* by Manamendra-Arachchi et al. (2007) and published phylogenies have led to a steady surge in new species descriptions from India—more than doubling the known diversity of the genus in less than the past four years (Sayyed et al. 2018, 2019, 2020, 2021; Cyriac et al. 2018, 2020; Khandekar, 2019; Khandekar et al. 2019a, 2019b, 2020a, 2020b; 2021a, 2021b, Murthy et al. 2019; Agarwal et al. 2020a, 2020b, 2020c, 2021b; Chandramouli, 2020; Sayyed and Sulakhe 2020; Pal et al. 2021). Currently, SAC is the country's most diverse reptilian clade and recently surpassed the rhacophorid frog genus *Raorchestes* Biju, Shouche, Dubois, Dutta and Bossuyt, 2010 that includes 65 species (Frost 2022) to become the most diverse Indian vertebrate genus (Vijayakumar et al. 2014; Garg et al. 2021; Khandekar et al. 2021b; Sayyed et al. 2021).

During surveys of an ongoing project on the systematics and taxonomy of peninsular Indian geckos, we collected small-bodied *Cnemaspis* specimens from multiple localities in Karnataka state. Molecular and preliminary morphological analysis revealed that material collected from Kaiwara in Chickballapur district of Karnataka represents an undescribed species that falls within the *mysoriensis* clade. Similarly, specimens collected from near Sakleshpur in Hassan District and Coorg in Kodagu district of Karnataka, respectively, belong to the *goaensis* clade and represent two more undescribed species. These three undescribed species are morphologically diagnosable from previously known members of their respective clades and in this paper, we describe them as three new species based on detailed morphology and ND2 mitochondrial sequence data. We also provide a key to the *goaensis* and *mysoriensis* clades.

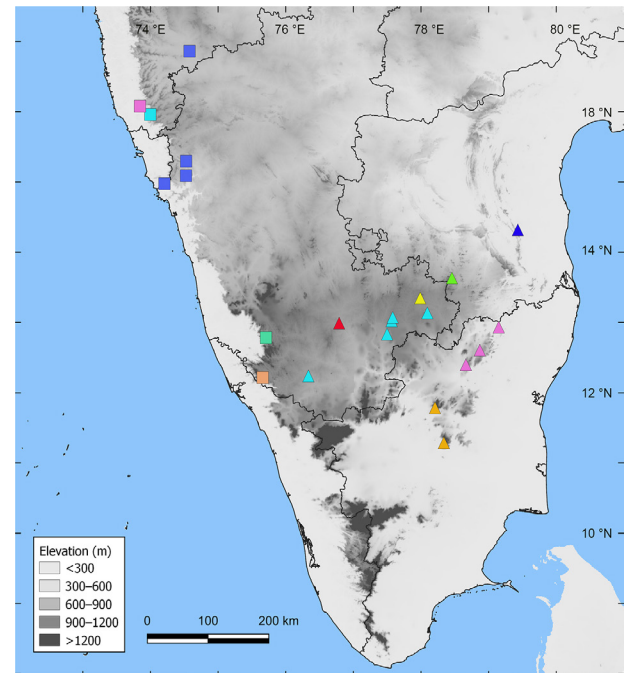
## Materials and methods

### Taxon sampling

Specimen sampling, processing and tissue collections of the new species were done following Khandekar et al. (2020a; Fig. 1). Specimens are deposited in the Museum and Research Collection Facility at National Centre for Biological Sciences, Bengaluru (NRC-AA) and Bombay Natural History Society, Mumbai (BNHS).

### Morphological and meristic data

Morphological data were collected from a total of 13 specimens of the new species. Comparative morphological data of all other members of the *mysoriensis* clade were obtained from Khandekar et al. (2020a) and for the *goaensis* clade from Khandekar et al. (2019b, 2021b), and Sayyed and Sulakhe (2020). Counts and measurements



**Figure 1.** Map showing our sampling for members of the *goaensis* (squares) and *mysoriensis* (triangles) clades. Squares, *goaensis* clade: light blue (*C. amboliensis*), dark blue (*C. goaensis*), pink (*C. ranganaensis*), peach (*C. sakleshpurensis* sp. nov.), green (*C. vijayae* sp. nov.). Triangles, *mysoriensis* clade, light blue (*C. mysoriensis*), dark blue (*C. avasabinae*), pink (*C. otai*), brown (*C. yercaudensis*), green (*C. rishivalleyensis*), red (*C. stellapulvis*), yellow (*C. tigris* sp. nov.).

were taken under a ZEISS Stemi 305 stereo dissecting microscope and on the right side of the body where possible. Colour pattern was recorded from photographs taken in life. All measurements were taken with a Mitutoyo digital vernier calliper (to the nearest 0.1 mm). We follow Agarwal et al. (2020c) for body size categories for South Asian *Cnemaspis*; mensural, meristic and additional morphological character states evaluation in accordance with Khandekar et al. (2019a, 2019b): snout vent length (SVL), axilla to groin length (AGL), body height (BH), body width (BW), forearm length (FL), crus length (CL), tail length (TL), tail width (TW), head length (HL), head width (HW), head depth (HD), eye diameter (ED), eye to nares distance (EN), eye to snout distance (ES), eye to ear distance (EE), ear length (EL), internarial distance (IN), interorbital distance (IO); meristic data recorded for all specimens were number of supralabials (SL), infralabials (IL), supralabials at midorbital position (SL M), infralabials at midorbital position (IL M), dorsal tubercle rows including longitudinal rows of spine-like scales on lower flank (DTR), paravertebral tubercles (PVT), ventral scales (VS), mid-body scale rows across the belly (MVSR), precloacal pores (PP), femoral pores (FP), poreless scales between precloacal and femoral pores (SB PP&FP), poreless scales between precloacal pores (SB PP), postcloacal tubercles (PCT), transverse subdigital lamellae on finger 1 (LamF1), finger 4 (LamF4), toe 1 (LamT1), toe 4 (LamT4), and toe 5 (LamT5).

**Table 1.** List of *Cnemaspis* sequences used in this study. Museum abbreviations are as follows: AA, Rohan Pethiyagoda field series; AMB, Aaron M. Bauer field series; AK, Akshay Khandekar field series; BNHS, Bombay Natural History Society; CES, Centre for Ecological Sciences, Bangalore; NRC-AA, National Centre for Biological Sciences; SB, Sayantan Biswas field series; USNM, United States National Museum; VG, Varad Giri field series.

Species	Voucher	Locality	GeneBank Accession number
<i>C. adii</i>	BNHS 2494	India, Karnataka, Ballari District, Hampi	MT188142
<i>C. agarwali</i>	AK 107	India, Tamil Nadu, Salem District, Sankari	MK792466
<i>C. amboliensis</i>	VG 393	India, Maharashtra, Sindhudurg District, Amboli	MK792480
<i>C. amboliensis</i>	VG 394	India, Maharashtra, Sindhudurg District, Amboli	MK792481
<i>C. cf. assamensis</i>	BNHS 2808	India, Meghalaya, Ri Bhoi District, Saiden	MW3674
<i>C. avasabinae</i>	CES G416	India, Andhra Pradesh, Nellore District, Penchalakona	MT773207
<i>C. bangara</i>	BNHS 2584 (AK 292)	India, Karnataka, Kolar District, Paparajanahalli	MT188143
<i>C. flaviventralis</i>	VG 354	India, Maharashtra, Sindhudurg District, Amboli	MK792495
<i>C. gemunu</i>	AMB 7495	Sri Lanka, Nuwara Eliya District, Hakgala	KY037998
<i>C. goaensis</i>	VG 385	India, Karnataka, Uttara Kannada District, Gund	MK792475
<i>C. goaensis</i>	VG 388	India, Karnataka, Uttara Kannada District, Ganeshgudi	MK792476
<i>C. goaensis</i>	VG 399	India, Maharashtra, Sangli District, KWC Campus	MK792478
<i>C. goaensis</i>	AK 360	India, Goa, South Goa District, Canacona	MK792479
<i>C. gracilis</i>	CES G385	India, Kerala, Palakkad District, near Chittur River	MK792465
<i>C. graniticola</i>	BNHS 2589 (CES L839)	India, Andhra Pradesh, Chittoor District, Horsley hills	MT188145
<i>C. kallima</i>	AA 82	Sri Lanka, Matale District, Rattota, Gammaduwa	KY037970
<i>C. kolhapurensis</i>	unvouchered	India, Maharashtra, Kolhapur District, Dajipur	MK792501
<i>C. koyanaensis</i>	CES G349	India, Maharashtra, Satara District, Humbarli	MK792490
<i>C. magnifica</i>	unvouchered	India, Karnataka, Hassan District, Sakleshpur	MK792503
<i>C. monticola</i>	NRC-AA-1112 (AK 942)	India, Kerala, Wayanad District, MS Swaminathan Research Foundation	MW580955
<i>C. monticola</i>	NRC-AA-1115 (AK 943)	India, Kerala, Wayanad District, MS Swaminathan Research Foundation	MW580956
<i>C. monticola</i>	NRC-AA-1113 (AK 944)	India, Kerala, Wayanad District, MS Swaminathan Research Foundation	MW580957
<i>C. monticola</i>	BNHS 2793 (AK 945)	India, Kerala, Wayanad District, MS Swaminathan Research Foundation	MW580958
<i>C. mysoriensis</i>	unvouchered	India, Karnataka, Bangalore Urban District, IISc Campus	MK792474
<i>C. mysoriensis</i>	AK 570	India, Karnataka, Bangalore Urban District, NCBS Campus	MT773208
<i>C. mysoriensis</i>	AK 676	India, Karnataka, Mysore District, Hunsur	MT773209
<i>C. mysoriensis</i>	AK 851	India, Karnataka, Kolar District, Kolar	MT773210
<i>C. mysoriensis</i>	AK 852	India, Karnataka, Kolar District, Kolar	MT773211
<i>C. mysoriensis</i>	AK 979	India, Karnataka, Bangalore Rural District, near Thathaguni	MT773212
<i>C. otai</i>	AK668	India, Tamil Nadu, Vellore district, Vellore Fort	MT188146
<i>C. otai</i>	AK823	India, Tamil Nadu, Vellore district, Jawadhu Hills	MT773213
<i>C. otai</i>	AK935	India, Tamil Nadu, Vellore district, Jawadhu Hills	MT773214
<i>C. punctata</i>	AA 80	Sri Lanka, Matale District, Rattota, Gammaduwa	KY038007
<i>C. ranganaensis</i>	AK R 788	India, Maharashtra, Kolhapur, Rangana Fort	OM160946
<i>C. rishivalleyensis</i>	AK 659	India, Andhra Pradesh, Chittoor district, Rishi Valley School	MT773218
<i>C. rishivalleyensis</i>	AK 660	India, Andhra Pradesh, Chittoor district, Rishi Valley School	MT773219
<i>C. sakleshpurensis</i> <b>sp. nov.</b>	AK 862 (BNHS 2814)	India, Karnataka, Hassan District, Sakleshpur	OK424588
<i>C. sakleshpurensis</i> <b>sp. nov.</b>	AK 864 (NRC-AA-1165)	India, Karnataka, Hassan District, Sakleshpur	OK424589
<i>C. schalleri</i>	BNHS 2795 (AK 871)	India, Karnataka, Hassan District, Mookanana resort	MW580959
<i>C. schalleri</i>	NRC-AA-1116 (AK 872)	India, Karnataka, Hassan District, Mookanana resort	MW580960
<i>C. cf. schalleri</i>	SB 048	India, Karnataka, Kodagu District, Kumarahalli	KY037995
<i>C. cf. schalleri</i>	AK R 829	India, Karnataka, Kodagu District, Honey Valley Estate	OM160937
<i>C. cf. schalleri</i>	AK R 830	India, Karnataka, Kodagu District, Honey Valley Estate	OM160938
<i>C. cf. schalleri</i>	AK R 831	India, Karnataka, Kodagu District, Honey Valley Estate	OM160939
<i>C. cf. schalleri</i>	AK R 832	India, Karnataka, Kodagu District, Honey Valley Estate	OM160940
<i>C. cf. schalleri</i>	AK R 833	India, Karnataka, Kodagu District, Honey Valley Estate	OM160941
<i>C. cf. schalleri</i>	AK R 834	India, Karnataka, Kodagu District, Honey Valley Estate	OM160942
<i>C. cf. schalleri</i>	AK R 835	India, Karnataka, Kodagu District, Honey Valley Estate	OM160943
<i>C. stellapulvis</i>	AK 846	India, Karnataka, Mandya District, Yadiyur	MT773215

Species	Voucher	Locality	GeneBank Accession number
<i>C. stellapulvis</i>	AK 847	India, Karnataka, Mandya District, Yadiyur	MT773216
<i>C. thayawthadangyi</i>	USNM 595052	Myanmar, Tanintharyi Region, Myeik Archipelago, southeast side of Linn Lune Kyun	MN104950
<i>C. tigris</i> <b>sp. nov.</b>	AK 884 (NRC-AA-1160)	India, Karnataka, Chickballapur, Kaiwara	OK424590
<i>C. tigris</i> <b>sp. nov.</b>	AK 885 (NRC-AA-1159)	India, Karnataka, Chickballapur, Kaiwara	OK424591
<i>C. vijayae</i> <b>sp. nov.</b>	AK 599 (BNHS 2815)	India, Karnataka, Kodagu District, Honey Valley Estate	OK424592
<i>C. vijayae</i> <b>sp. nov.</b>	AK R 836 (NRC-AA-1185)	India, Karnataka, Kodagu District, Honey Valley Estate	OM160944
<i>C. vijayae</i> <b>sp. nov.</b>	AK R 839 (NRC-AA-1188)	India, Karnataka, Kodagu District, Honey Valley Estate	OM160945
<i>C. yercaudensis</i>	CES G133	India, Tamil Nadu, Namakkal District, Kollimalai massif	MK792473
<i>C. yercaudensis</i>	AK 767	India, Tamil Nadu, Salem District, Yercaud massif	MT773217
<i>C. sp.</i>	SB 151	India, Kerala, Thrissur District, Athirappilly Falls	KY038013

**Table 2.** Pairwise uncorrected ND2 sequence divergence within the *mysoriensis* clade and the *goaensis* clade, numbers in bold along diagonal represent intraspecific genetic diversity (– indicates only a single sequence available).

		1	2	3	4	5	6	7	8	9	10	11	12
1	<i>avasabinae</i>	–											
2	<i>mysoriensis</i>	19.9	<b>0.6</b>										
3	<i>otai</i>	8.3	19.7	<b>0.8</b>									
4	<i>rishivalleyensis</i>	5.6	21.3	8.3	<b>0.0</b>								
5	<i>stellapulvis</i>	15.9	21.3	15.2	15.8	<b>0.0</b>							
6	<i>tigris</i> <b>sp. nov.</b>	15.6	23.4	16.5	17.2	12.1	<b>0.1</b>						
7	<i>yercaudensis</i>	17.9	22.7	18.3	18.4	13.4	14.5	<b>2.4</b>					
8	<i>amboliensis</i>	21.1	23.0	20.1	21.4	20.4	23.2	21.6	0.6				
9	<i>goaensis</i>	21.0	23.6	21.4	21.6	21.8	22.9	22.6	12.5	<b>0.9</b>			
10	<i>ranganaensis</i>	23.4	24.0	21.8	23.9	25.7	25.0	25.3	13.2	8.8	–		
11	<i>sakleshpurensis</i> <b>sp. nov.</b>	22.1	24.1	21.6	23.0	22.8	24.0	23.2	13.7	5.2	9.3	<b>0.6</b>	
12	<i>vijayae</i> <b>sp. nov.</b>	21.0	24.8	20.9	23.1	22.8	23.4	23.1	13.8	13.6	14.8	14.6	<b>1.1</b>

## Molecular data

Total genomic DNA was extracted from tail or liver samples stored in 100 % ethanol using the Qiagen DNeasy Blood & Tissue kit. PCR and sequencing were outsourced to Medauxin (Bangalore, India) and used the Macey et al. (1997) primers L4437 (AAGCTTTCGGGCCCATACC) and H5934 (AGRGTGCCAATGTCTTTGTGRTT) to PCR amplify the entire ND2 gene + flanking tRNAs with L4437 used to sequence partial fragment of the ND2 gene (up to 1035 nucleotides). Besides the new species described herein, we additionally generated ND2 sequence data for *Cnemaspis ranganaensis* Sayyed and Sulakhe, 2020 as well as some sympatric congeners (Table 1). These sequences were added to an alignment containing published sequences for the *goaensis* and *mysoriensis* clades and representatives of other major SAC clades (after Agarwal et al. 2020c, 2021a) with *C. kolhapurensis* Giri, Bauer and Gaikwad, 2009 and *C. magnifica* Khandekar, Thackeray, Pal and Agarwal, 2020 used as outgroups (Table 1). Sequence alignment used default settings in ClustalW (Thompson et al. 1994) and % pairwise uncorrected sequence divergence was calculated using the pairwise deletion option in MEGA 5.2 (Tamura et al. 2011). Partitionfinder2 (Lanfear et al. 2012) was used to select the best partitioning scheme and corresponding models of se-

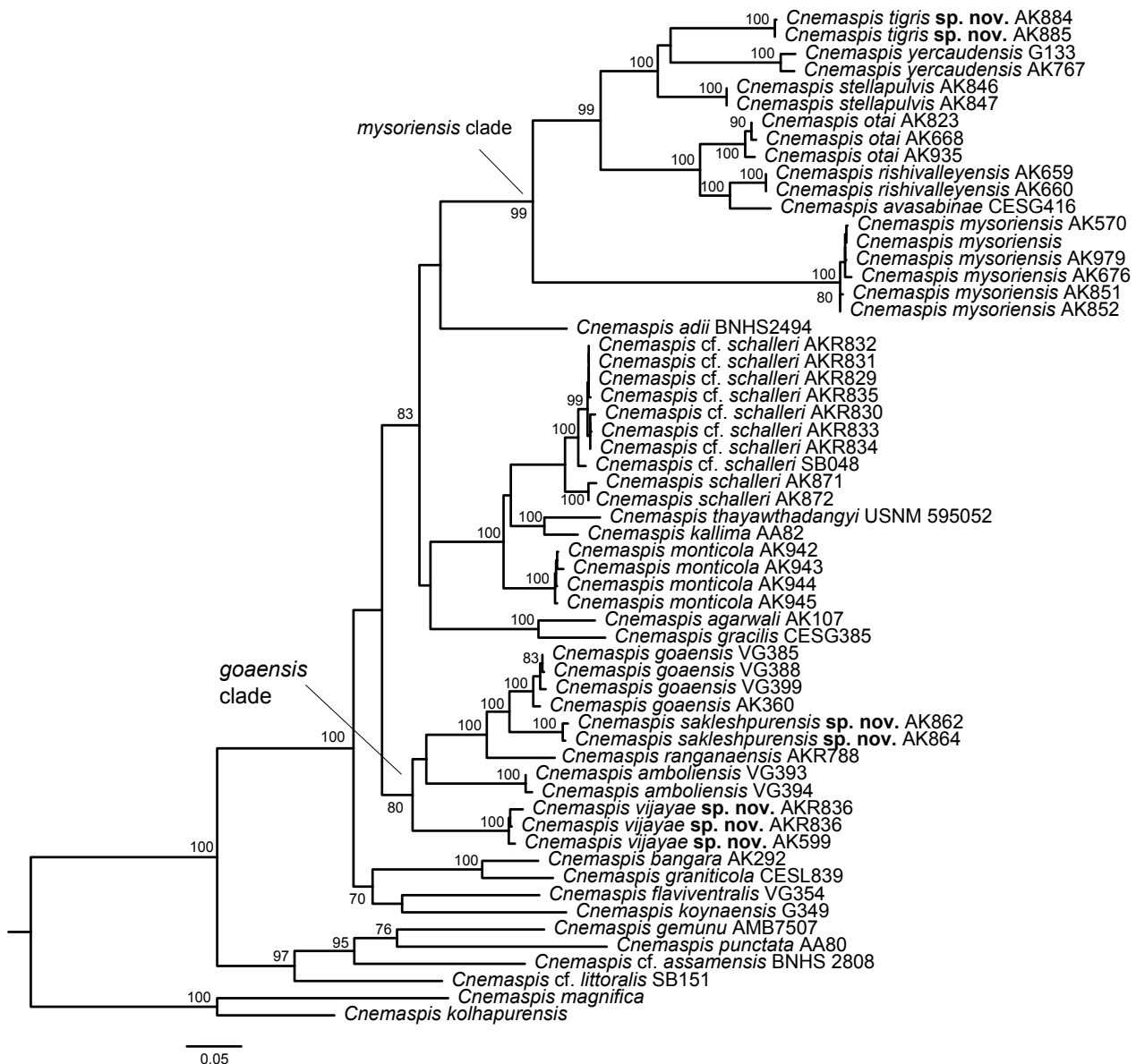
quence evolution with the greedy algorithm and Bayesian Information Criteria. A Maximum Likelihood (ML) phylogeny was reconstructed using RAXML 8.2.12 (Stamatakis 2006) with 10 independent runs on distinct starting trees, 1000 thorough bootstraps, and the GTR + G model applied on the data partitioned by codon position as implemented on the CIPRES web server (RAXML-HPC2 Workflow on XSEDE; Miller et al. 2010).

## Results

### Phylogenetic relationships

ND2 sequences of the new species varied from 472–1047 aligned nucleotides, with a nine base pair insertion in *C. tigris* **sp. nov.** at position 455. We recovered the same broad clades for SAC as Agarwal et al. (2020c, 2021a). Within the *mysoriensis* clade, a basal split separates *C. mysoriensis* (Jerdon, 1853) and a sub-clade grouping the remaining species of the clade (Fig. 2). Within this sub-clade are two well-supported sub-clades, the first grouping *C. tigris* **sp. nov.**, *C. stellapulvis* Khandekar, Thackeray and Agarwal, 2020 and *C. yercaudensis* Das and Bauer,





**Figure 2.** Maximum likelihood phylogeny of South Asian *Cnemaspis* based on the mitochondrial ND2 gene. Bootstrap support >70 shown at nodes and the *goaensis* and *mysoriensis* clades are marked.

2000 (pairwise divergence between the three species 12.1–14.5 %) (Table 1); and the second *C. avasabinae* Agarwal, Bauer and Khandekar, 2020 *C. otai* Das and Bauer, 2000 and *C. rishivalleyensis* Agarwal, Thackeray and Khandekar, 2020. Uncorrected pairwise sequence divergence between the new species and other members of the *mysoriensis* clade varies from 12.1–23.4 %. Within the *goaensis* clade, *C. vijayae* sp. nov. is the sister taxon to the rest of the species (pairwise divergence between the new species and the rest of the clade 13.6–14.8 %) while *C. sakleshpurensis* sp. nov. is sister to *C. goaensis* Sharma, 1976 (5.2 % pairwise sequence divergence) and *C. ranganaensis* is the sister taxon to the former two species collectively. We describe the three new species using morphology below.

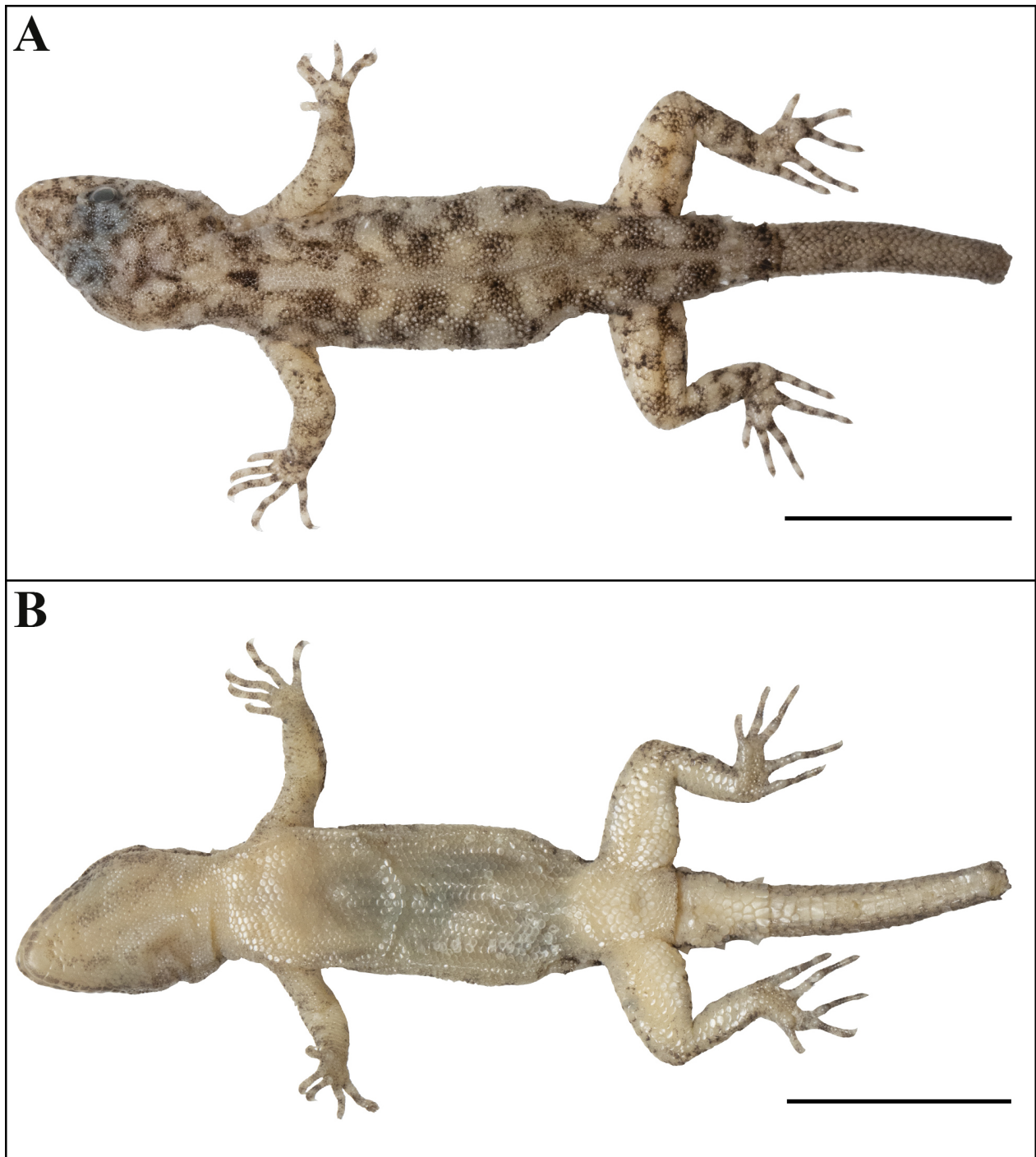
## Systematics

### *Cnemaspis tigris* sp. nov.

<http://zoobank.org/F9CDF6C9-BC5F-40AD-A43F-0DB9EFF-FC881>

Figs 3–7A, 16A; Tables 3–5

**Holotype.** NRC-AA-1159 (AK 885), adult male, from near Kaiwara (13.3469°N, 77.9881°E; elevation ca. 910 m), Chickballapur district, Karnataka state, India, collected by Akshay Khandekar, Swapnil Pawar and Vaibhav Patil, on 7<sup>th</sup> June 2019.



**Figure 3.** *Cnemaspis tigris* sp. nov. (holotype, NRC-AA-1159): **A** dorsal view of body and **B** ventral view of body. Scale bars 10 mm; photos by Akshay Khandekar and Satpal Gangalmale.

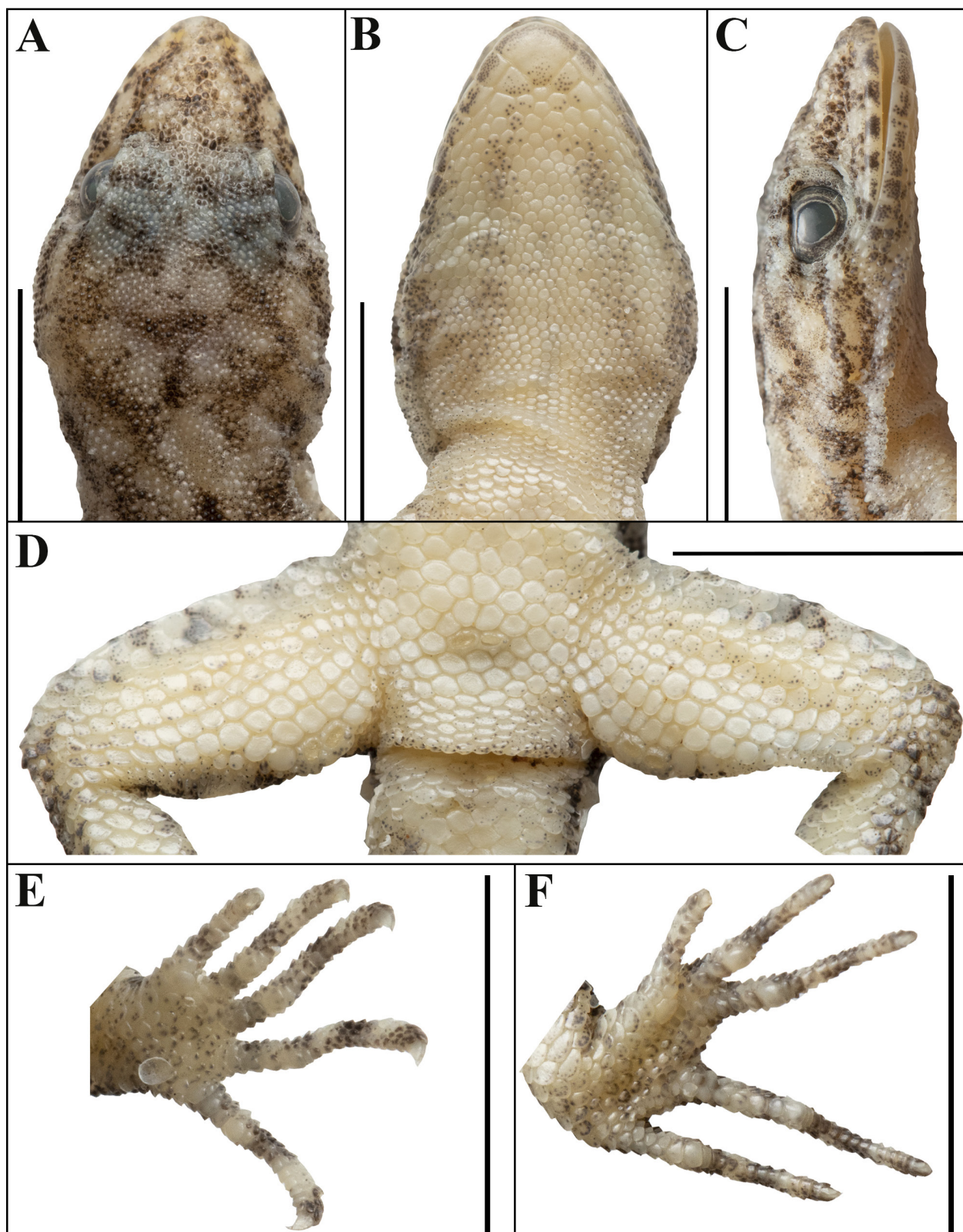
**Paratypes.** NRC-AA-1160 (AK 884), BNHS 2809 (AK 886), and BNHS 2810 (AK 887), adult males, BNHS 2811 (AK 888), adult female, same collection data as holotype.

**Etymology.** The specific epithet is the Latin *tigris* (tiger), treated here as a noun in apposition, referencing the tiger-like colour pattern in males of the new species with a strongly banded dorsum suffused with yellow.

**Suggested Common Name.** Tiger dwarf gecko or Kaiwara dwarf gecko.

**Diagnosis.** A small-sized *Cnemaspis*, snout to vent length less than 32 mm ( $n=5$ ). Dorsal pholidosis heterogeneous; weakly keeled, granular scales in the vertebral and paravertebral region with a few scattered enlarged keeled tubercles, intermixed with about three irregularly arranged rows of large, weakly keeled tubercles on each side of flank, tubercles in lowest row largest, spine-like; six rows of dorsal tubercles; ventral scales smooth, imbricate, 23–25 scales across belly, 91–107 longitudinal scales from mental to cloaca; subdigital scensors smooth, entire, unnotched; nine or 10 lamellae under digit I of manus and 9–11 lamellae under digit I of pes, 15–17 lamellae under





**Figure 4.** *Cnemaspis tigris* sp. nov. (holotype, NRC-AA-1159): **A** dorsal view of head, **B** ventral view of head, **C** right side lateral view of head, **D** view of cloacal region showing femoral and precloacal pores, **E** ventral view of left manus, and **F** ventral view of left pes. Scale bars 5 mm; photos by Akshay Khandekar and Satpal Gangalmale.

digit IV of manus and 17–21 lamellae under digit IV of pes; males ( $n=4/5$ ) with two femoral pores on each thigh separated on either side by 6–9 poreless scales from a continuous series of two (rarely three,  $n=1/4$ ) precloacal pores; tail with enlarged, strongly keeled, distinctly

pointed, conical tubercles forming whorls; a median row of sub-caudals smooth, slightly enlarged. Dorsal colouration grey-brown; continuous light brown mid-dorsal streak runs from occiput to tail base, a single medial dark ocellus on mid-dorsal streak just anterior to forelimb in-

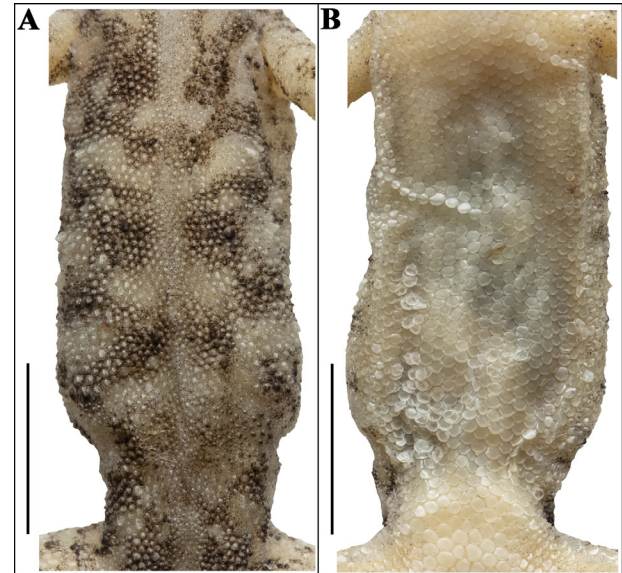
**Table 3.** Mensural (mm) data for the type series of the new species. Abbreviations are listed in Materials and Methods; \* = tail incomplete.

Clade	<i>mysoriensis</i>					<i>goaensis</i>		
Species	<i>C. tigris</i> sp. nov.					<i>C. sakleshpurensis</i> sp. nov.		
Type	Holotype	Paratypes				Holotype	Paratypes	
Specimen number	NRC-AA-1159	NRC-AA-1160	BNHS 2809	BNHS 2810	BNHS 2811	BNHS 2814	NRC-AA-1164	NRC-AA-1165
Sex	Male	Male	Male	Male	Female	Male	Female	Female
SVL	30.9	31.2	28.5	27	24.7	31.8	23.7	32.0
TL	14.1*	14.0 *	2.6*	30.7	28.7	42.2	7.9*	3.4*
TW	2.5	3.1	2.5	2.7	2.0	3.2	1.9	2.4
LAL	4.0	4.4	4.2	3.8	3.5	4.9	2.9	5.1
CL	5.2	5.6	5.5	4.5	4.2	5.7	3.6	5.9
AGL	12.6	13.8	11.9	10	10.5	12.5	9.7	14.1
BH	3.3	3.4	2.5	2.9	2.5	2.1	1.9	2.1
BW	5.8	6.6	4.4	4.5	5.5	5.3	4.3	5.2
HL	7.5	8.0	7.3	7.1	6.3	7.6	5.8	7.7
HW	5.5	5.5	5.4	4.9	4.4	4.9	3.8	4.8
HD	2.9	2.8	2.6	2.6	2.5	3.0	2.1	3.0
ED	1.6	1.7	1.5	1.5	1.4	1.5	1.1	1.4
EE	2.7	2.8	2.5	2.3	2.2	2.2	1.8	2.5
ES	3.8	3.9	3.5	3.3	2.3	3.8	2.8	4.2
EN	3.0	3.0	2.7	2.5	2.2	3.4	2.3	3.3
IN	0.8	0.7	0.8	0.8	0.6	0.9	0.6	1.0
IO	1.3	1.4	1.3	1.2	0.9	1.3	0.9	1.3
EL	0.4	0.4	0.4	0.3	0.4	0.7	0.4	0.4

sections; five or six yellow-orange elongate blotches on dorsum, original tail with indistinct bands.

#### Comparison with members of *C. mysoriensis* clade.

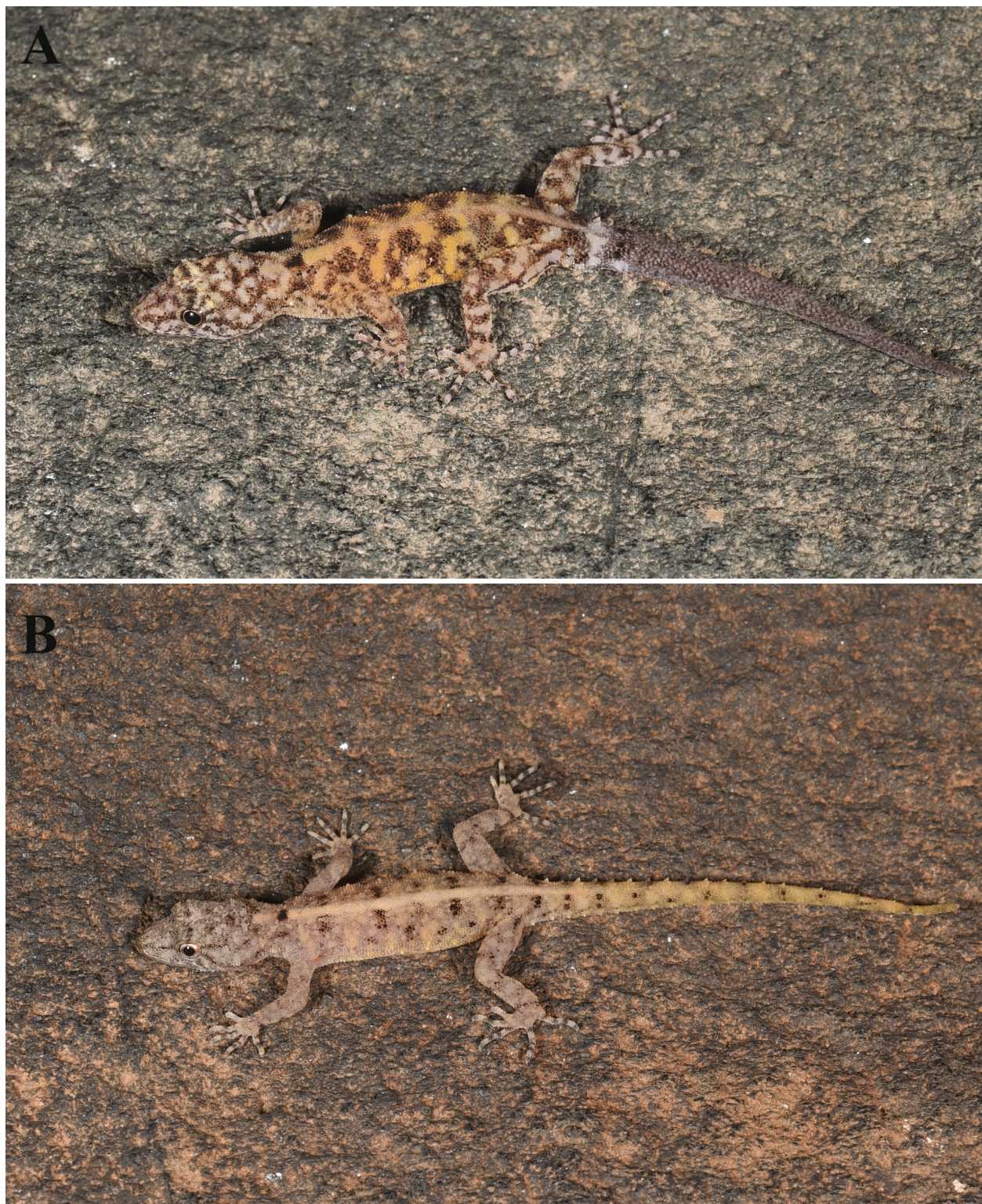
*Cnemaspis tigris* sp. nov. can be distinguished from all other six members of the *mysoriensis* clade on the basis of the following differing or non-overlapping characters: males with two femoral pores on each thigh, separated on either side by 6–9 poreless scales from two (rarely three) continuous precloacal pores (*versus* femoral pores absent, continuous series of 2–5 precloacal pores in *C. avasabinae*; three femoral pores on each thigh, separated by nine or ten poreless scales from continuous series of four precloacal pores in *C. otai*; a single femoral pore on each thigh, separated by ten poreless scales from continuous series of three precloacal pores in *C. rishivalleyensis*; three femoral pores on each thigh, separated by five or six poreless scales from two continuous precloacal pores in *C. yercaudensis*); six rows of dorsal tubercles at mid-body (*versus* dorsal tubercles irregularly arranged at mid-body in *C. avasabinae*; 7–10 rows of dorsal tubercles at mid-body in *C. stellapulvis*); 23–25 ventral scales across belly at mid-body (*versus* 17–20 ventral scales across belly at mid-body in *C. avasabinae*; 18 ventral scales across belly at mid-body in *C. otai*; 20 or 21 ventral scales across belly at mid-body in *C. mysoriensis*; 20–22 ventral scales across belly at mid-body in *C. stellapulvis*; 18–20 ventral scales across belly at mid-body in *C. yercaudensis*); spine-like tubercles present on flank (*versus* spine-like tubercles absent on flank in *C. avasabinae*); a single distinct black dorsal ocellus on mid-dorsal streak just



**Figure 5.** *Cnemaspis tigris* sp. nov. (holotype, NRC-AA-1159): **A** dorsal view of mid-body and **B** ventral view of mid-body. Scale bars 5 mm; photos by Akshay Khandekar and Satpal Gangalmale.

anterior to forelimb insertions (*versus* distinct black dorsal ocellus absent just anterior to forelimb insertions in *C. mysoriensis* and *C. yercaudensis*); a continuous light mid-dorsal streak runs from occiput onto tail base (*versus* a light mid-dorsal streak formed by seven fused, elongate chain-links that runs from occiput to tail base in *C. otai* and *C. rishivalleyensis*).





**Figure 6.** *Cnemaspis tigris* sp. nov., in life: **A** adult male (holotype, NRC-AA-1159), and **B** adult female (paratype, BNHS 2811). Photos by Tejas Thackeray.

**Description of the holotype.** Adult male in good state of preservation except head slightly bent towards right, a small portion of the regenerated tail taken for DNA extraction, and digit IV and V of manus of the right side are incomplete (Fig. 3A, B). SVL 30.9 mm, head short (HL/SVL 0.24), wide (HW/HL 0.73), not strongly depressed (HD/HL 0.38), distinct from neck. Loreal region slightly inflated, canthus rostralis not prominent.

Snout half the head length (ES/HL 0.50), 2.5 times eye diameter (ED/ES 0.42); scales on snout and canthus rostralis large, weakly keeled, weakly conical; much larger than those on forehead and interorbital region; occipital and temporal region with much smaller, weakly keeled granules intermixed with slightly larger, weakly keeled, conical tubercles (Fig. 4A). Eye small (ED/HL 0.21); with round pupil; left orbit without extra-brillar fringe



**Table 4.** Meristic data for the type series of the new species. Abbreviations are listed in Materials and Methods except for: L&R = Left & Right; irr.arr. = irregularly arranged; \* = lamellae missing or incomplete; abs. = absent.

Clade	<i>mysoriensis</i>					<i>goaensis</i>		
Species	<i>C. tigris</i> sp. nov.					<i>C. sakleshpurensis</i> sp. nov.		
Type	Holotype	Paratypes				Holotype	Paratypes	
Specimen number	NRC-AA-1159	NRC-AA-1160	BNHS 2809	BNHS 2810	BNHS 2811	BNHS 2814	NRC-AA-1164	NRC-AA-1165
Sex	Male	Male	Male	Male	Female	Male	Female	Female
SL L&R	8&8	10&10	9&9	9&9	9&9	8&8	9&9	7&8
IL L&R	8&8	8&8	8&7	8&8	8&8	7&7	8&8	8&8
SL M L&R	6&6	8&7	6&7	6&6	8&7	6&7	7&7	6&6
IL M L&R	5&6	6&6	5&6	5&5	7&5	5&6	5&5	6&6
PVT	irr.arr.	irr.arr.	irr.arr.	irr.arr.	irr.arr.	irr.arr.	irr.arr.	irr.arr.
DTR	6	6	6	6	6	9	9	8
MVSR	24	25	23	25	24	24	26	23
VS	101	107	92	91	96	118	124	127
LamF1 L&R	10&9	9&10	9&9	9&9	9&9	11&11	11&11	10&9
LamF4 L&R	16&10*	15&16	17&17	15&15	15&15	16&16	16&16	16&14
LamT1 L&R	9&10	9&10	9&11	9&9	9&9	11&11	11&11	11&11
LamT4 L&R	19&19	21&20	19&19	17&18	19&18	20&20	19&16	20&17
LamT5 L&R	17&17	18&17	16&16	15&16	17&16	17&18	17&18	16&17
PP L&R	2	2	2	2	abs.	2	abs.	abs.
SBPP	abs.	abs.	abs.	abs.	abs.	abs.	abs.	abs.
FP L&R	2&2	3&2	2&2	2&2	abs.	3&4	abs.	abs.
SB PP and FP L&R	8&7	7&8	9&8	6&6	abs.	11&10	abs.	abs.
PCT L&R	1&1	1&1	1&1	1&1	1&1	1&1	1&1	1&1

scales (missing/damaged), right orbit with nine or 10 extra-brillar fringe scales, largest scales on anterior side; supraciliaries not elongate; interorbital scale rows across narrowest point of frontal seven or eight; 27 or 28 scale rows between left and right supraciliaries at mid-orbit (Fig. 4A). Ear-opening deep, oval, small (EL/HL 0.05); eye to ear distance greater than diameter of eye (EE/ED 1.68) (Fig. 4C). Rostral twice wider (1.2 mm) than long (0.6 mm), deformed on the right side; a single enlarged supranasal on each side, roughly same the size as postnasals, separated from each other by a single enlarged internasal and a smaller scale on the snout; rostral in contact with nostril, supralabial I, supranasal and internasal; nostrils oval, each surrounded by postnasals, supranasal, rostral and supralabial I; two rows of scales separate the orbit from the supralabials (Fig. 4C). Mental enlarged, subtriangular, marginally wider (1.5 mm) than long (1.3 mm); two pairs of postmentals, inner pair marginally larger than outer pair, roughly rectangular, separated from each other below mental by a single enlarged chin shield; inner pair bordered by mental, infralabial I, outer postmental and two enlarged chin shields on right side, and by mental, infralabial I and II, outer postmental and two enlarged chin shields on the left side; outer postmentals roughly rectangular, bordered by inner postmentals, infralabial I and II, and four enlarged chin shields on left and by inner postmentals, infralabial II, and five enlarged chin shields on right; three enlarged gular scales prevent contact of left and right outer postmentals; chin shields bordering postmentals flat, smooth, smaller than outer-

most postmentals, rest flattened, small, smooth (Fig. 4B). Infralabials bordered below by a row or two of slightly enlarged scales, decreasing in size posteriorly. Eight supralabials up to angle of jaw and six at midorbital position on each side; supralabial I largest, decreasing in size posteriorly; eight infralabials up to angle of jaw, five at midorbital position on left and six on right side; infralabial I largest, infralabials decreasing in size posteriorly (Fig. 4C).

Body relatively slender (BW/AGL 0.46), trunk less than half of SVL (AGL/SVL 0.40) without ventrolateral folds; spine-like scales present on flank on each side. Dorsal pholidosis heterogeneous; keeled, granular scales on the vertebral and paravertebral region with a few scattered enlarged keeled tubercles, intermixed with about three irregularly arranged rows of large, weakly keeled, tubercles on each side of flank (Fig. 5A). Scales on occiput and nape slightly smaller and weakly keeled than those on paravertebral rows; scales on flank slightly larger than those on dorsum, weakly keeled, conical or spine-like. Ventral scales much larger than granular scales on dorsum, those on belly smooth, subimbricate, equal from chest to vent except for those on preclacal region which slightly larger; mid-body scale rows across belly 24; 101 scales from mental to anterior border of cloaca (Fig. 5B). Scales on throat slightly smaller than those on belly and imbricate; gular region with much smaller, flattened scales with those on chin bordering postmentals, enlarged, juxtaposed and flattened (Fig. 4B). Two femoral pores on each thigh, separated by eight poreless scales

**Table 5.** Additional morphological character states evaluation for the type series of the new species *Cnemaspis tigris* sp. nov.. abs. = absent; / = data unavailable.

Clade	<i>mysoriensis</i>					<i>goaensis</i>		
Species	<i>C. tigris</i> sp. nov.					<i>C. sakleshpurensis</i> sp. nov.		
Type	Holotype	Paratypes				Holotype	Paratypes	
Specimen number	NRC-AA-1159	NRC-AA-1160	BNHS 2809	BNHS 2810	BNHS 2811	BNHS 2814	NRC-AA-1164	NRC-AA-1165
Sex	Male	Male	Male	Male	Female	Male	Female	Female
Occipital ocellus/ ocellus just behind occiput present (1) or not (0)	0	0	0	0	0	1	1	1
Dorsal ocellus between forelimb insertions present (1) or not (0)	1	1	1	1	1	1	1	1
Anterior extra-brilliar fringe scales enlarged (1) or not (0)	1	1	1	1	1	1	1	1
Ventral scales keeled (1) or smooth (0)	0	0	0	0	0	0	1	0
Gular scales keeled (1) or smooth (0)	0	0	0	0	0	0	0	0
Pectoral scales keeled (1) or smooth (0)	0	0	0	0	0	0	0	0
Precloacal pores continuous (1) or separated (0)	1	1	1	1	abs.	1	abs.	abs.
Precloacal pores elongate (1) or round (0)	1	1	1	1	abs.	0	abs.	abs.
femoral pores elongate (1) or round (0)	1	1	1	1	abs.	0	abs.	abs.
Dorsal pholidosis homogeneous (1) or heterogeneous (0)	0	0	0	0	0	0	0	0
Dorsal tubercles keeled (1) or not keeled (0)	1	1	1	1	1	1	1	1
Tubercles linearly arranged (1) or more random (0)	0	0	0	0	0	0	0	0
Spine-like tubercles on flank present (1) or absent (0)	1	1	1	1	1	1	1	1
Lateral caudal furrows present (1) or absent (0)	/	1	/	1	1	1	/	/
Sub-caudals keeled (1) or smooth (0)	/	0	/	0	0	abs.	abs.	abs.
Single median row of sub-caudals keeled (1) or smooth (0)	/	0	/	0	0	1	/	/
Caudal tubercles encircle tail (1) or not (0)	/	1	/	1	1	1	/	1
Slightly enlarged median sub-caudal scale row (1) or not (0)	/	1	/	1	1	1	/	1
Enlarged femoral scales present (1) or absent (0)	1	0	1	1	0	0	1	0
Subtibial scales keeled (1) or smooth (0)	0	0	0	0	0	0	0	0

on left and seven on right side from continuous series of two precloacal pores (Fig. 4D).

Scales on dorsal aspect of manus heterogenous, upper arm with scales much larger than dorsal granules, weakly keeled, imbricate; those near forelimb insertion much smaller than scales on upper arm; dorsal aspect of lower arm and elbow with scales much smaller than those on upper arm, weakly keeled, flat, roughly rounded; dorsal aspect of hand predominantly bearing large, flattened, weakly keeled, imbricate scales. Ventral aspect of upper arm with smooth, roughly rounded, subimbricate scales; scales on lower arm and wrist large, smooth, imbricate; scales on palm and sole smooth, flat and roughly circular. Scales on dorsal aspect of thigh much larger than those on dorsal granules, weakly keeled, imbricate except those near hindlimb insertion which are granular, much smaller than dorsal granules, conical. Scales on dorsal aspect of knee and shank fairly smaller than those on dorsum of

thigh, subimbricate, weakly keeled; dorsal aspect of foot predominantly bearing small, flattened, strongly keeled, imbricate scales; scales on ventral aspect of thigh and shank larger than those on mid-body ventrals, smooth, subimbricate on thigh and imbricate on shank (Fig. 3B).

Fore-limbs and hind-limbs slightly long, slender (LAL/SVL 0.12); (CL/SVL 0.16); digits long, with a strong, recurved claw, distinctly inflected, distal portions laterally compressed conspicuously. Series of unpaired lamellae on basal portion of digits, separated from unpaired, narrower distal lamellae by a single large scale at the inflection; proximal lamellae series: 1-3-4-4-4 (right manus), 2-4-5-7-5 (right pes), 1-3-4-4-4 (left manus; Fig. 4E), 1-4-6-7-5 (left pes; Fig. 4F); distal lamellae series: 8-10-12-6\*-8\* (right manus; \* = incomplete), 8-10-12-12-12 (right pes), 8-10-12-12-10 (left manus; Fig. 4E), 8-10-12-12-12 (left pes; Fig. 4F). Relative length of digits (measurements in mm in parentheses): IV (2.6) > III (2.4)

> V (2.2) > II (2.1) > I (1.4) (left manus); IV (3.4) > V (3.0) > III (2.9) > II (2.7) > I (1.4) (left pes).

Tail regenerated, sub-cylindrical, relatively slender, flattened beneath, not entire, less than half of the snout-vent length (TL = 14.9) (Fig. 3A, B). Dorsal scales at tail base granular, similar in size and shape to those on mid-body dorsum, intermixed with much enlarged, strongly keeled, distinctly pointed, conical tubercles forming whorls, six tubercles on first whorl; rest of the tail regenerated, covered above with weakly keeled, imbricate scales without enlarged tubercles. Ventral scales at tail base similar (or marginally larger) in size to mid-body ventrals, smooth, imbricate; a single enlarged postcloacal spur on each side (Fig. 3B). Scales on ventral aspect of regenerated tail much larger than those on dorsal, smooth and imbricate; medial series with smooth, enlarged roughly rectangular scales (Fig. 3B).

**Colouration in life (Fig. 6A).** Dorsal ground colouration of head, body and limbs brown-grey; head heavily mottled with small grey and brown blotches. A dark preorbital streak runs from nostril to orbit, two fine dark postorbital streaks extend till temporal region; supraciliaries and labials with alternating light and dark bars radiating out of the orbital region, snout reticulated. A straw-coloured mid-dorsal streak runs from occiput to regenerated part of the tail; dark medial ocellus outlined by a few orange scales anterior to forelimb insertions, flanked on either side by brown blotch with fine black speckles; followed by five or six yellow-orange elongate blotches alternating with patches of brown scales interspersed with fewer dark scales. Flank with smaller dark and larger yellow blotches, enlarged spine-like tubercles yellow. Tail colouration of regenerated tail grey without bands. Dorsum of forelimbs with few light and dark blotches, hindlimbs with alternating dark and light bands and two strong dark horizontal streaks on the posterior of each femur, digits with distinct alternating dark and light bands. Ventral surfaces dull-white, underside of head and neck, throat yellow, fine black spots under forelimbs, minor markings on the throat and no dark markings on belly; underside of regenerated tail dull-white without any dark markings. Pupil black, iris bronze outlined by silver.

**Variation and additional information from type series.** Mensural, meristic and additional character states evaluation data for the type series is given in Tables 3–5 respectively. There are three male and a single female specimen ranging in size from 24.7–31.2 mm. All paratypes resemble the holotype except as follows: inner postmentals bordered by mental, infralabial I outer postmental and two enlarged chin scales on each side in all four paratypes; outer postmentals bordered by inner postmental, infralabial I & II and four enlarged chin scales on each side in NRC-AA-1160, BNHS 2809 and BNHS 2811; outer postmentals bordered by inner postmental, infralabial I & II and three enlarged chin scales on each side in BNHS 2810. Two paratypes—BNHS 2810 and BNHS 2811 with original and complete tail, slightly longer than body (TL/SVL 1.13 and 1.16 respectively) All paratypes agree with the holotype in overall colouration except for female paratype (BNHS 2811) which is overall duller, lacking yellowish colouration on the body (Fig. 6B). Original tail (in BNHS 2810 and BNHS 2811) with enlarged, strongly keeled, distinctly pointed, conical tubercles forming whorls; median row of sub-caudals smooth, slightly enlarged. Regenerated portion of tail (in NRC-AA-1160) is light brown, and without enlarged tubercles (Fig. 7A).

**Distribution and Natural history.** Like most of the other South Asian *Cnemaspis*, *C. tigris* **sp. nov.** is currently known from its type locality (near Kaiwara village in Chickballapur district, Karnataka), at an elevation of ca. 910 m asl (Fig. 1). The species was encountered during a single day of fieldwork at the base of a rocky granite hillock with large boulders, predominantly covered by thorny scrub forest (Fig. 16A). Numerous individuals ( $n = > 30$ ) of the new species were observed to be active in day-time on granite boulders < 2 m of height from the ground. All the individuals were only seen in the shaded and relatively cooler areas among the rocks. Sympatric lizards recorded by us at the type locality include *Hemidactylus frenatus* Duméril and Bibron, 1836; *Hemidactylus rishivalleyensis* Agarwal, Thackeray and Khandekar, 2020; *Eutropis carinata* (Schneider, 1801) and *Psammodromus dorsalis* (Gray, 1831).

## Key to the *Cnemaspis mysoriensis* clade

- 1 Paravertebral tubercles absent.....2
- Paravertebral tubercles present .....3
- 2 Femoral pores present in males..... *Cnemaspis rishivalleyensis*
- Femoral pores absent in males ..... *Cnemaspis avasabinae*
- 3 Continuous mid-dorsal streak .....4
- Mid-dorsal streak made up of fused blotches ..... *Cnemaspis otai*
- 4 Medial dark ocellus anterior to forelimb insertions present.....5
- Medial dark ocellus anterior to forelimb insertions absent.....6
- 5 Six rows of dorsal tubercles, 23–25 mid ventral scale rows..... *Cnemaspis tigris* **sp. nov.**
- 7–10 rows of dorsal tubercles, 20–22 mid ventral scale rows ..... *Cnemaspis stellapulvis*
- 6 Two femoral pores, seven or eight scales between femoral and precloacal pores..... *Cnemaspis mysoriensis*
- Three femoral pores, five or six scales between femoral and precloacal pores ..... *Cnemaspis yercaudensis*





**Figure 7.** Paratype series of the new species: **A** *Cnemaspis tigris* **sp. nov.**, from left to right, NRC-AA-1160, BNHS 2809, BNHS 2810, and BNHS 2811; **B** *C. sakleshpurensis* **sp. nov.**, NRC-AA-1164 (AK 863), and NRC-AA-1165 (AK 864). Scale bar 10 mm; photos by Akshay Khandekar and Satpal Gangalmale.

### *Cnemaspis sakleshpurensis* **sp. nov.**

<http://zoobank.org/390EDF17-4D01-43AE-88C6-19-2BCA012671>

Figs 7B–11A, 16B; Tables 3–5

**Holotype.** BNHS 2814 (AK 862), adult male, from the vicinity of Mookanana Resort, Hongadahalla village, Sakleshpur (12.7811°N, 75.7079°E; elevation *ca.* 850 m), Hassan District, Karnataka, India, collected by Akshay Khandekar, Swapnil Pawar and Tejas Thackeray on 5<sup>th</sup> June 2019.

**Paratypes.** NRC-AA-1165 (AK 864), adult female, NRC-AA-1164 (AK 863), sub-adult female, same collection data as holotype.

**Etymology.** The specific epithet is a toponym for Sakleshpur in Hassan district of Karnataka, the place where the species is currently known from.

**Suggested Common Name.** Sakleshpur dwarf gecko.

**Diagnosis.** A small-sized *Cnemaspis*, snout to vent length less than 32 mm ( $n=3$ ). Dorsal pholidosis heterogeneous; weakly keeled, granular scales on the vertebral and paravertebral region with a few scattered enlarged keeled tubercles, intermixed with irregularly arranged rows of large, keeled, tubercles on flank; upper most row strongly keeled and weakly conical, rest much enlarged, weakly keeled and spine-like; eight or nine rows of dorsal tubercles at mid-body; ventral scales smooth, imbricate, 23–26 scales across belly, 118–127 longitudinal scales from mental to cloaca; subdigital scensors smooth, entire, unnotched; 9–11 lamellae under digit I of manus and 11 lamellae under digit I of pes, 14–16 lamellae under digit IV of manus and 16–20 lamellae under digit IV of pes; male ( $n=1/3$ ) with three or four femoral pores, sepa-

rated by 10 or 11 poreless scales from continuous series of two precloacal pores; each pore bearing scale flanked posteriorly with enlarged spine-like scale; tail with enlarged, strongly keeled, distinctly pointed, conical tubercles forming whorls; a median row of sub-caudal scales slightly enlarged, smooth only at anterior half of the tail, rest strongly keeled. Dorsal colouration grey-brown with a discontinuous, poorly defined light brown mid-dorsal streak extending from occiput to tail base, with yellow diffuse blotches and a few small black spots forming eight indistinct bars on dorsum; dark medial ocellus on occiput and another slightly smaller just anterior to forelimb insertions; original tail banded.

**Comparison with members of *C. goaensis* clade.** *Cnemaspis sakleshpurensis* **sp. nov.** can be morphologically distinguished from all other described members of the *goaensis* clade on the basis of the following differing or non-overlapping characters: male with three or four femoral pores on each thigh, separated by 10 or 11 poreless scales from continuous series of two precloacal pores (*versus* three or four femoral pores on each thigh, separated by seven or eight poreless scales from continuous series of three or four precloacal pores in *C. amboliensis* Sayyed, Pyron and Dileepkumar, 2018; two or three femoral pores, separated by eight or nine poreless scales from continuous series of three precloacal pores in *C. ranganaensis*); 23–26 scales across belly at mid-body (*versus* 19–22 ventral scales across belly at mid-body in *C. amboliensis*; 27–32 ventral scales across belly at mid-body in *C. goaensis*; 30 or 31 ventral scales across belly at mid-body in *C. ranganaensis*); 118–127 longitudinal ventral scales from mental to cloaca (*versus* 93–101 longitudinal ventral scales from mental to cloaca in *C. ranganaensis*); scales on upper arm and thigh uncarinate (*versus* scales on upper arm and thigh tricarinate in *C. amboliensis*); internasal scales absent, supranasals in strong contact with each other on snout (*versus* one or two internasal scales present, supranasals separated from

each other by one or two internasal scales on snout in *C. goaensis*).

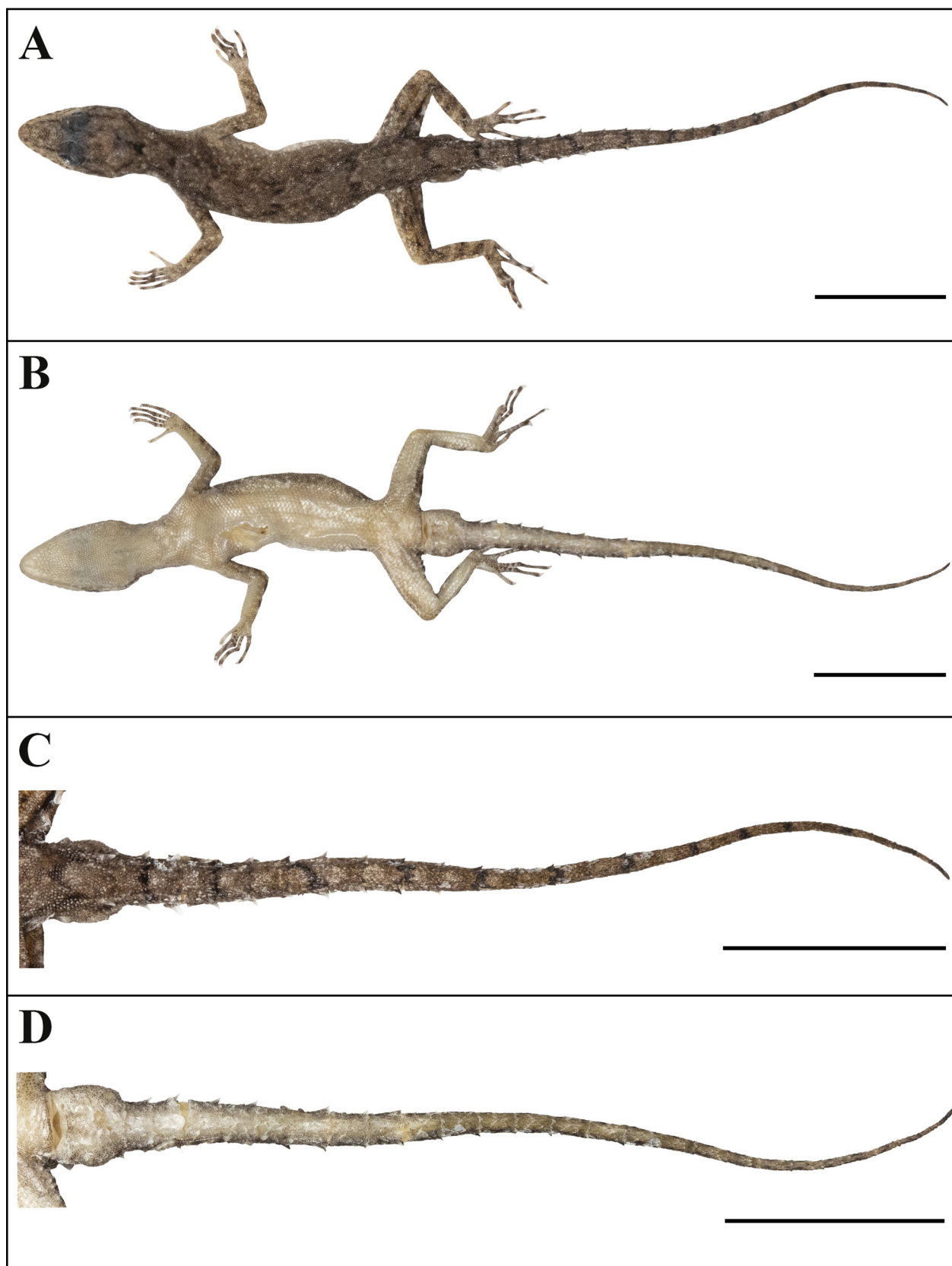
*Cnemaspis sakleshpurensis* **sp. nov.** is morphologically similar to its sympatric species *C. schalleri* Khandekar, Thackeray and Agarwal, 2021 of *monticola* clade in body size, having spine-like scales on flanks and presence of both femoral and precloacal pores in males. However, the new species can be easily distinguished from *C. schalleri* by having eight or nine irregularly arranged rows of dorsal tubercles at mid-body (*versus* 14–16 regularly arranged rows of dorsal tubercles at mid-body), and having only a few scattered tubercles in paravertebral region on body between forelimb and hindlimb insertion (*versus* a regular series of 17–20 tubercles in paravertebral rows on the body between forelimb and hindlimb insertions). Comparison against *C. vijayae* **sp. nov.** is provided after its description.

**Description of the holotype.** Adult male in good state of preservation except body slightly bent towards left and tail tip towards left, and a 3.7 mm long incision in the sternal region for liver tissue collection (Fig. 8A, B). SVL 31.8 mm, head short (HL/SVL 0.23), wide (HW/HL 0.64), not strongly depressed (HD/HL 0.39), and distinct from neck. Loreal region marginally inflated, canthus rostralis indistinct. Snout half of the head length (ES/HL 0.50), more than twice of the eye diameter (ES/ED 2.53); scales on snout and canthus rostralis large, weakly keeled, and weakly conical; twice the size than those on forehead and interorbital region; occipital and temporal region with much smaller, weakly keeled granules sparsely intermixed with slightly larger, weakly keeled, conical tubercles (Fig. 9A). Eye small (ED/HL 0.19); with round pupil; orbit with nine or 10 extra-brilliar fringe scales, largest scales on anterior side; supraciliaries not elongate; six interorbital scale rows across narrowest point of frontal; 27 scale rows between left and right supraciliaries at mid-orbit (Fig. 9A). Ear-opening deep, oval, small (EL/HL 0.09); eye to ear distance greater than diameter of eye (EE/ED 1.46) (Fig. 9C). Rostral two times wider (1.3 mm) than long (0.6 mm), incompletely divided dorsally by a strongly developed rostral groove for more than half of its height; a single enlarged supranasal on each side, slightly larger than upper postnasal and almost twice the size than lower postnasal, supranasals in contact with each other on snout; rostral in contact with nostril, supranasal, supralabial I and marginally with upper postnasals on each side; nostrils oval, each surrounded by rostral, supranasal, upper and lower postnasals, and supralabial I on each side; one or two rows of scales separate the orbit from the supralabials (Fig. 9C). Mental enlarged, subtriangular, slightly wider (1.6 mm) than long (1.1 mm); two pairs of postmentals, inner pair larger than outer pair, rectangular, an enlarged chin scale prevent the contact between them below mental; inner pair bordered by mental, infralabial I, outer postmental and two enlarged chin shields on each side; outer postmentals roughly square, bordered by inner postmentals, infralabial I, and three enlarged chin shields on left and by inner postmentals, infralabial I, and four enlarged chin shields on right side;

three enlarged gular scales prevent contact between left and right outer postmentals; chin shields bordering postmentals and one or two rows bordering infralabials flat, smooth, slightly smaller than outermost postmentals, decreasing in size posteriorly (Fig. 9B). Eight supralabials up to angle of jaw on each side, six supralabials on left and seven on right side at midorbital position; supralabial I largest, decreasing in size posteriorly; seven infralabials up to angle of jaw on each side; six infralabials on left and five on right side at midorbital position; infralabial I largest, decreasing in size posteriorly (Fig. 9B).

Body slender (BW/AGL 0.42), trunk less than half of SVL (AGL/SVL 0.39) without ventrolateral folds; spine-like scales present on flank on each side. Dorsal pholidosis heterogeneous; weakly keeled, granular scales on the vertebral and paravertebral region with a few scattered enlarged keeled tubercles, intermixed with irregularly arranged rows of large, keeled, tubercles on each flank; upper most row strongly keeled and weakly conical, rest much enlarged, weakly keeled and spine-like; nine dorsal tubercles rows at mid-body including spine-like scales (Fig. 10A). Ventral scales more than thrice the size than granular scales on dorsum, those on belly smooth, imbricate, subequal from chest to vent; mid-body scale rows across belly between lowest rows of enlarged tubercles on flank 24; 118 scales from mental to anterior border of cloaca (Fig. 10B). Scales on throat slightly smaller than those on belly; gular region with much smaller, flattened scales with those on chin bordering postmentals, enlarged, juxtaposed and flattened (Fig. 9B). Three femoral pores on left thigh and four on right, separated by 11 poreless scales on left and 10 on right side from continuous series of two precloacal pores; each pore bearing scale flanked posteriorly with enlarged spine-like scale (Fig. 9D).

Scales on dorsal aspect of manus heterogeneous, upper arm with scales much larger than dorsal granules, strongly keeled, imbricate; those near forelimb insertion small and granular; dorsal aspect of lower arm and elbow with scales slightly smaller than those on upper arm, strongly keeled, flat, subimbricate; dorsal aspect of hand predominantly bearing large, flattened, weakly keeled, imbricate scales. Ventral aspect of upper arm with smooth, roughly subcircular, subimbricate scales; scales on lower arm and wrist large, smooth, subimbricate; scales on palm and sole smooth, flat and subcircular, subimbricate. Scales on dorsal and antero-lateral aspect of thigh much larger than those on dorsal granules, strongly keeled, subimbricate except those near hindlimb insertion which are granular, much smaller than dorsal granules and somewhat conical; scales on posterior-lateral aspect of thigh with scales similar in shape to granular scales on mid-body dorsum, marginally larger, becoming smaller, circular and smooth posteriorly. Scales on dorsal aspect of knee slightly smaller than those on dorsal aspect of thigh, weakly keeled; scales on shank still smaller, strongly keeled, subimbricate; dorsal aspect of foot predominantly bearing large flattened, weakly keeled, imbricate scales. Scales on ventral aspect of thigh and shank more or less similar in size to those on mid-body ventrals, smooth, imbricate (Fig. 8A, B).

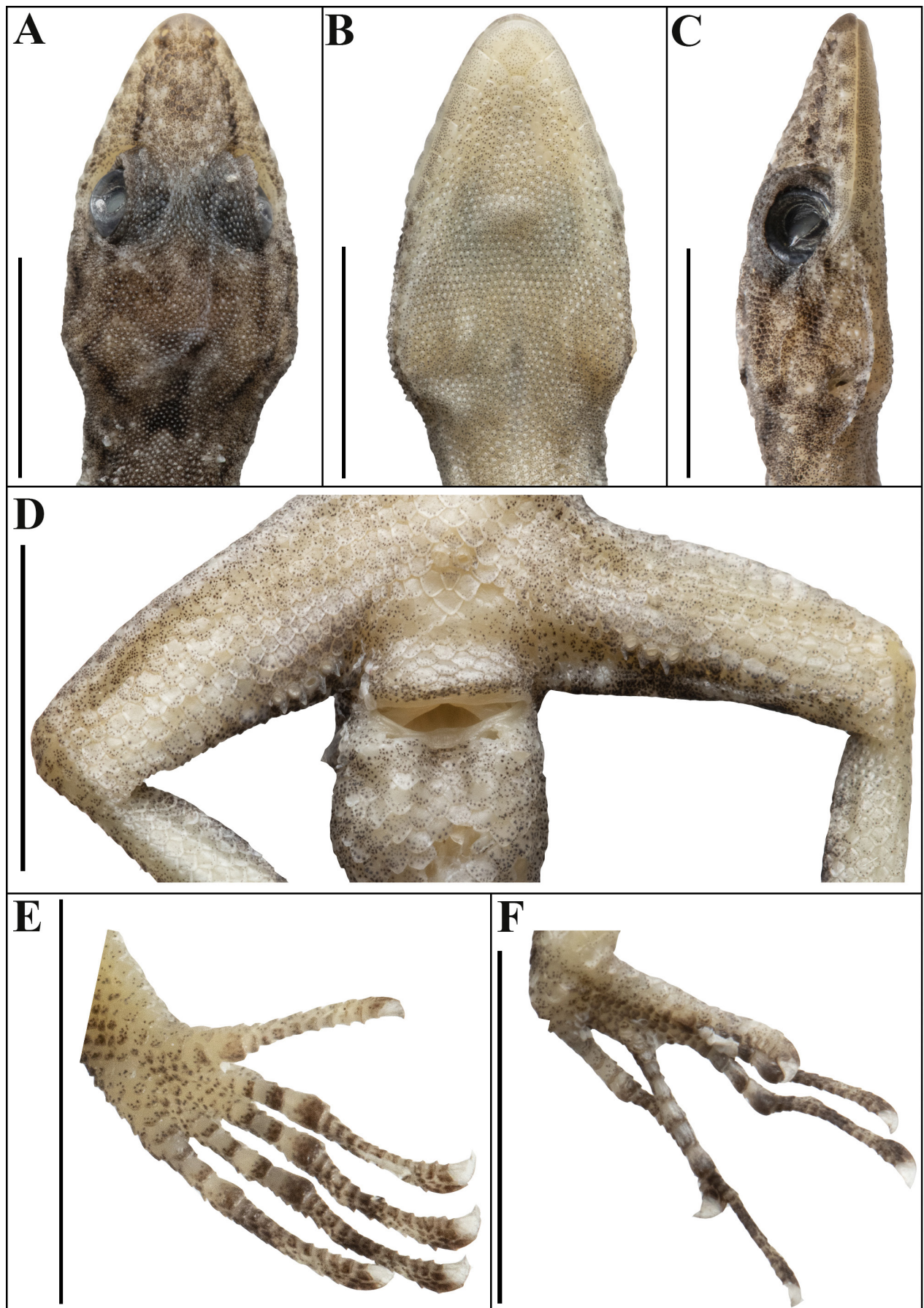


**Figure 8.** *Cnemaspis sakleshpurensis* sp. nov. (holotype, BNHS 2814): **A** dorsal view of body, **B** ventral view of body, **C** dorsal view of tail, and **D** ventral view of tail. Scale bars 10 mm; photos by Akshay Khandekar and Satpal Gangalmale.

Fore-limbs and hind-limbs slightly long, slender (LAL/SVL 0.15); (CL/SVL 0.17); digits long, with a strong, recurved claw, distinctly inflected, distal portions laterally compressed conspicuously. Series of unpaired

lamellae on basal portion of digits, separated from unpaired, narrower distal lamellae by a single large scale at the inflection; proximal lamellae series: 2-4-5-4-4 (right manus), 2-4-5-7-5 (right pes), 2-4-5-4-4 (left manus; Fig.





**Figure 9.** *Cnemaspis sakleshpurensis* sp. nov. (holotype, BNHS 2814): **A** dorsal view of head, **B** ventral view of head, **C** right side lateral view of head, **D** view of cloacal region showing femoral and precloacal pores, **E** ventral view of left manus, **F** ventral view of left pes. Scale bars 5 mm; photos by Akshay Khandekar and Satpal Gangalmale.

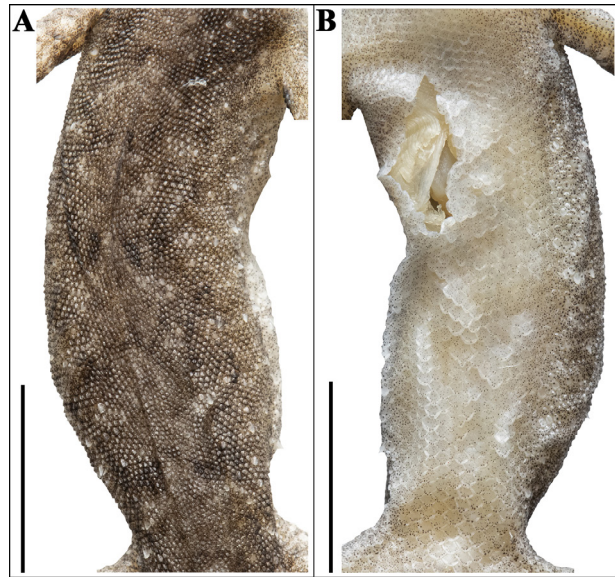


9E), 2-4-5-7-4 (left pes; Fig. 9F); distal lamellae series: 9-10-13-12-10 (right manus), 9-10-14-13-13 (right pes), 9-10-12-12-10 (left manus; Fig. 9E), 9-10-13-13-13 (left pes; Fig. 9F). Relative length of digits (measurements in mm in parentheses): IV (3.0) > III (2.7) > V (2.6) = II (2.6) > I (1.9) (left manus); IV (4.2) > III (3.6) > V (3.3) > II (3.0) > I (2.0) (left pes).

Tail original, entire, subcylindrical, slender, longer than snout-vent length (TL/SVL 1.32; Fig. 8C, D). Dorsal scales on tail base weakly keeled, granular, similar in size and shape to granular scales on mid-body dorsum, gradually becoming larger, flattened, imbricate posteriorly, intermixed with enlarged, strongly keeled, distinctly pointed, conical tubercles; enlarged tubercles on the tail forming whorls; six tubercles each on first 10 whorls, four in 11–15<sup>th</sup> whorls, rest of the tail with only paravertebral tubercles (Fig. 8C). Scales on ventral aspect of tail much larger than those on dorsal aspect, subimbricate, smooth only at anterior half of the tail, rest strongly keeled; median series slightly larger than rest, roughly pentagonal; scales on tail base slightly smaller than those on mid-body ventrals, smooth, imbricate; a single enlarged, conical, and smooth postcloacal spur on each side (Fig. 8D).

**Colouration in life (Fig. 11A).** Dorsal ground colouration of head, body, limbs and tail grey-brown; head mottled with smaller dark speckles. An indistinct fine darker vertical streak runs between the orbits; indistinct slightly darker preorbital streak runs from orbit to supranasal, two darker postorbital streaks extending onto neck; labials light yellow with indistinct darker bars; supraciliaries dirty yellow. A dark medial ocellus on occiput and another slightly smaller just anterior to forelimb insertions. A discontinuous, poorly defined light brown mid-dorsal streak extends from occiput to tail base, with yellow diffuse blotches and a few small black spots forming eight indistinct bars on dorsum. Lower flank much lighter with straw coloured enlarged spine-like tubercles on each side; tail colouration light brown with 13 alternating darker bands, post cloacal tubercles and pointed tubercles on lateral rows in alternating whorls dull-white. Dorsum of limbs with few indistinct light and dark bands, digits with distinct alternating dark and light bands, a strong dark streak on the posterior of femur. Ventral surfaces dull-white, underside of head and neck throat dirty white with light yellow on lateral sides, fine black spots under forelimbs, belly, hindlimbs and tail white with fine black speckles. Pupil black, outlined by bronze iris.

**Variation and additional information from type series.** Mensural and meristic data and additional character states evaluation data for both female paratypes are given in Tables 3–5. The two female paratypes (NRC-AA-1164, sub-adult and NRC-AA-1165, adult) having 23.7 and 32 mm SVL respectively. Both paratypes resemble holotype in overall morphology and colouration except as follows: outer postmental bordered by inner pair, infralabial I and II and three enlarged gular scales on either side in both the paratypes. Both the paratypes with incomplete tails



**Figure 10.** *Cnemaspis sakleshpurensis* sp. nov. (holotype, BNHS 2814): **A** dorsal view of mid-body and **B** ventral view of mid-body. Scale bars 5 mm; photos by Akshay Khandekar and Satpal Gangalmale.

and both with head and neck slightly bent towards right as an artefact of the preservation (Fig. 7B).

**Distribution and Natural history.** *Cnemaspis sakleshpurensis* sp. nov. is currently known only from its type locality (in and around Mookanana Resort, Hongadahalla village, Sakleshpur, Hassan District, Karnataka), at an elevation of ca. 850 m. (Fig. 1). The type locality is part of Central Western Ghats and dominated by semi-evergreen forest. Approximately 10 individuals of the new species were encountered during two days of fieldwork. Individuals were seen active during the day time (0800–1700 hrs) on rocky faces in shaded areas alongside streams, on tree trunks and occasionally on building walls at a height of 2–5 m above ground (Fig. 16B). The holotype (BNHS 2814) was collected from a rock crevice in a forested patch just after moderate rain showers, a sub-adult female (NRC-AA-1164) was found active on a mossy tree trunk in the afternoon hours, and an adult female (NRC-AA-1165) was collected early morning (0700 hrs) from a building wall. Sympatric lizards sighted by us at the type locality include *Cnemaspis magnifica*, *C. schalleri*, *Hemidactylus frenatus* and *Monilesaurus rouxii* (Duméril and Bibron, 1837).

### *Cnemaspis vijayae* sp. nov.

<http://zoobank.org/FCE13D91-13C5-4FA0-AB40-F4740-C60F865>

Figs 11B–15, 16C; Tables 6–8

**Holotype.** NRC-AA-1188 (AK-R 839), adult male, from Honey Valley Estate (12.2146°N, 75.6586°E; elevation ca. 1250 m) near Bylликere peak, Kodagu district, Kar-





**Figure 11.** Colouration in life of male holotypes: **A** *Cnemaspis sakleshpurensis* **sp. nov.**, (BNHS 2814), and **B** *Cnemaspis vijayae* **sp. nov.** (NRC-AA-1188). Photos by Tejas Thackeray (**A**), and Akshay Khandekar (**B**).

nataka state, India, collected by Ishan Agarwal on 2<sup>nd</sup> December 2018.

**Paratypes.** NRC-AA-1186 (AK-R 837), BNHS 2815 (AK 599), adult males, NRC-AA-1185 (AK-R 836), NRC-AA-1187 (AK-R 838), adult females, same locality data as holotype except collected by Akshay Khandekar, Ishan Agarwal and Swapnil Pawar on 2<sup>nd</sup> December 2021.

**Etymology.** The specific epithet is a Latinized eponym in honour of India's first women herpetologist, Late Jagan-

nathan Vijaya (1959–1987) for her inspiring contribution towards ecology of rare Indian turtles.

**Suggested Common Name.** Vijaya's Coorg dwarf gecko.

**Diagnosis.** A small-sized *Cnemaspis*, snout to vent length less than 36 mm ( $n=5$ ). Dorsal pholidosis heterogeneous; weakly keeled, granular scales, intermixed with irregularly arranged rows of large, keeled, tubercles on the body; two or three rows of enlarged tubercles on each flank weakly keeled and spine-like; 9–11 rows of dorsal tubercles at



**Table 6.** Mensural (mm) data for the type series of *Cnemaspis vijayae* **sp. nov.** of the *goaensis* clade. Abbreviations are listed in Materials and Methods; \* = tail incomplete.

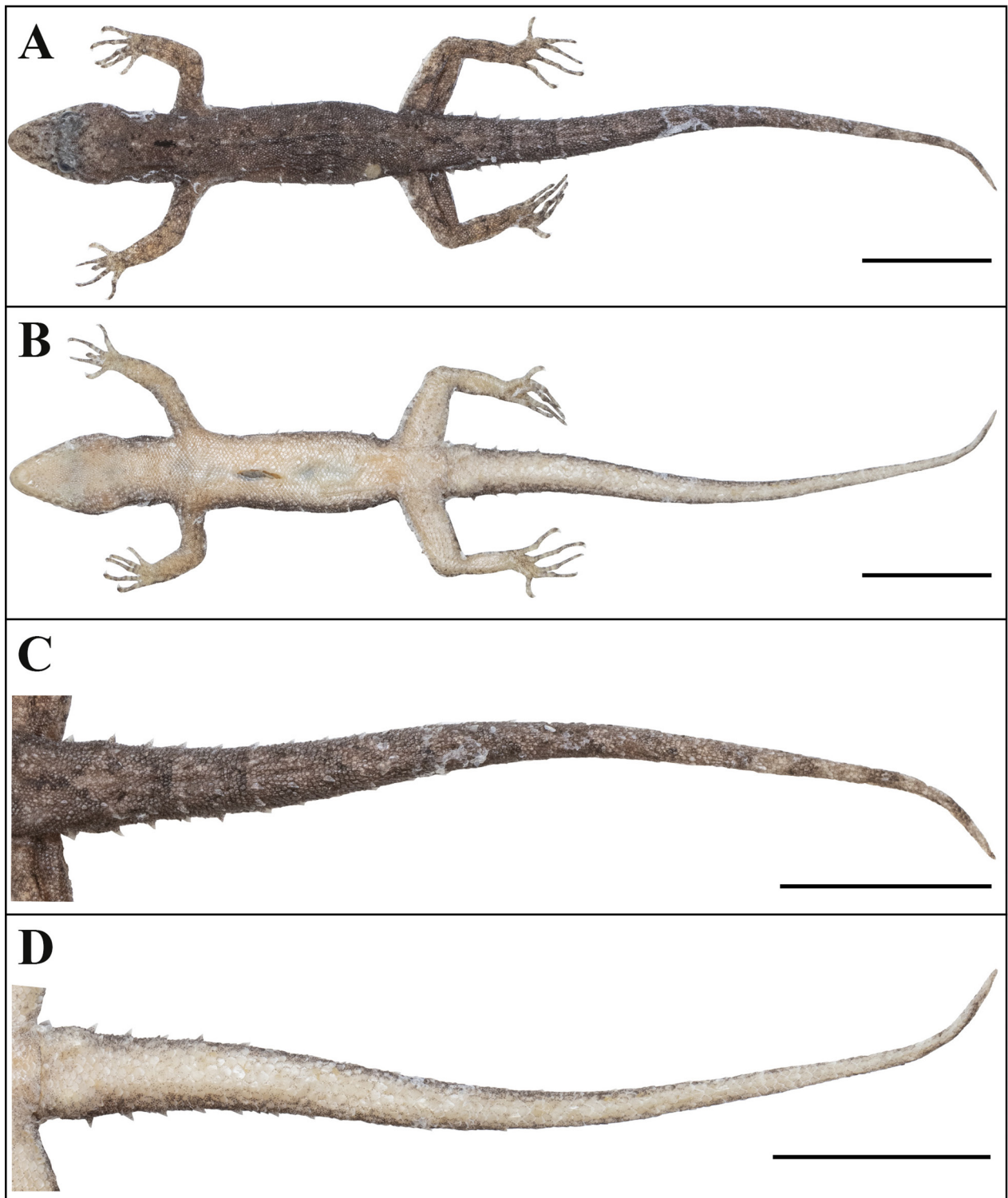
Type	Holotype	Paratypes			
Specimen number	NRC-AA-1188	NRC-AA-1185	NRC-AA-1186	NRC-AA-1187	BNHS 2815
Sex	Male	Female	Male	Female	Male
SVL	35.6	32.1	32.4	34.1	33.0
TL	46.8	21.0*	42.2	39	2.6*
TW	4.2	3.1	3.6	3.4	3.3
LAL	5.1	4.1	4.56	4.4	4.6
CL	6.1	5.1	5.5	5.4	5.5
AGL	14.7	13.2	14	14.8	13.4
BH	3.8	3.3	3.2	4.6	2.8
BW	6.6	5.8	6.6	7.5	6.5
HL	8.6	7.7	8.3	8.2	8.2
HW	6.4	5.5	5.7	5.8	5.2
HD	3.8	3.6	3.6	3.5	3.3
ED	1.6	1.3	1.7	1.6	1.5
EE	2.6	2.7	2.8	2.9	2.7
ES	4.2	3.7	3.8	4.1	4.3
EN	3.4	2.7	3.0	3.4	3.6
IN	1.0	0.9	1.0	1.0	1.1
IO	2.6	2.3	2.4	2.5	1.4
EL	0.5	0.4	0.5	0.5	0.6

mid-body, irregularly arranged rows of paravertebral tubercles between forelimb and hindlimb insertions; ventral scales smooth (rarely keeled  $n=1$ ), subimbricate, 26–30 scales across belly at mid-body, 118–127 longitudinal scales from mental to cloaca; subdigital scancers smooth, entire, unnotched; 10 or 11 lamellae under digit I of manus and pes, 15 or 16 lamellae under digit IV of manus and 17–19 lamellae under digit IV of pes; males ( $n=3/5$ ) with three or four femoral pores on thigh, separated by seven or eight poreless scales on either side from three discontinuous precloacal pores, a single precloacal pore on left and two on right side, separated by one or two poreless scale ( $n=2/3$ ); precloacal pores sometime continuous ( $n=1/3$ ); each femoral pore bearing scale flanked posteriorly with enlarged spine-like scale; tail with enlarged, strongly keeled, distinctly pointed, conical tubercles forming whorls; median row of sub-caudal scales slightly enlarged, smooth only at anterior half of the tail, rest weakly keeled. Dorsal ground colour dirty brown with a bright straw-coloured mid-dorsal stripe that extends from occiput to tail in some specimens; dark blotch on nape forming indistinct collar and smaller ocellus just anterior to forelimb insertions; dark markings and light grey blotches on dorsum; original tail with thick mid-dorsal stripe.

**Comparison with members of *C. goaensis* clade.** *Cnemaspis vijayae* **sp. nov.** can be morphologically distinguished from all other described members of the *goaensis* clade on the basis of the following differing or non-overlapping characters: 9–11 dorsal tubercle rows at mid-body (*versus* 6–8 dorsal tubercle rows at mid-body in *C. amboliensis* and *C. goaensis*; eight or nine dorsal tubercles rows at mid-body in *C. sakleshpurensis* **sp. nov.**); paravertebral tubercles on the body between forelimb and

hindlimb irregularly arranged (*versus* 7–12 paravertebral tubercles on the body between forelimb and hindlimb insertions in *C. amboliensis*); 26–30 scales across belly at mid-body (*versus* 19–22 ventral scales across belly at mid-body in *C. amboliensis* and 23–26 scales across belly at mid-body in *C. sakleshpurensis* **sp. nov.**); scales on upper arm and those towards knee on thigh tricarinate (*versus* scales on upper arm and thigh unicarinate in *C. goaensis*; *C. ranganaensis* and *C. sakleshpurensis* **sp. nov.**); males with three or four femoral pores on thigh, separated by seven or eight poreless scales on either side from three discontinuous precloacal pores, a single precloacal pore on left and two on right side, separated by one or two poreless scale ( $n=2/3$ ), precloacal pores sometime continuous ( $n=1/3$ ) (*versus* three or four femoral pores on each thigh, separated by seven or eight poreless scales from continuous series of three or four precloacal pores in *C. amboliensis*; two or three femoral pores on each thigh, separated by 8–12 poreless scales from continuous series of two or three precloacal pores in *C. goaensis*; two or three femoral pores on each thigh, separated by eight or nine poreless scales from continuous series of three precloacal pores in *C. ranganaensis*; three or four femoral pores on each thigh, separated by 10 or 11 poreless scales from continuous series of two precloacal pores in *C. sakleshpurensis* **sp. nov.**).

*Cnemaspis vijayae* **sp. nov.** is morphologically similar to its sympatric species *C. cf. schalleri* of *monticola* clade in body size, having spine-like scales on flanks and presence of both femoral and precloacal pores in males. However, the new species can be easily distinguished from *C. schalleri* by having 9–11 irregularly arranged rows of dorsal tubercles at mid-body (*versus* 14–16 regularly arranged rows of dorsal tubercles at mid-body); having irregularly



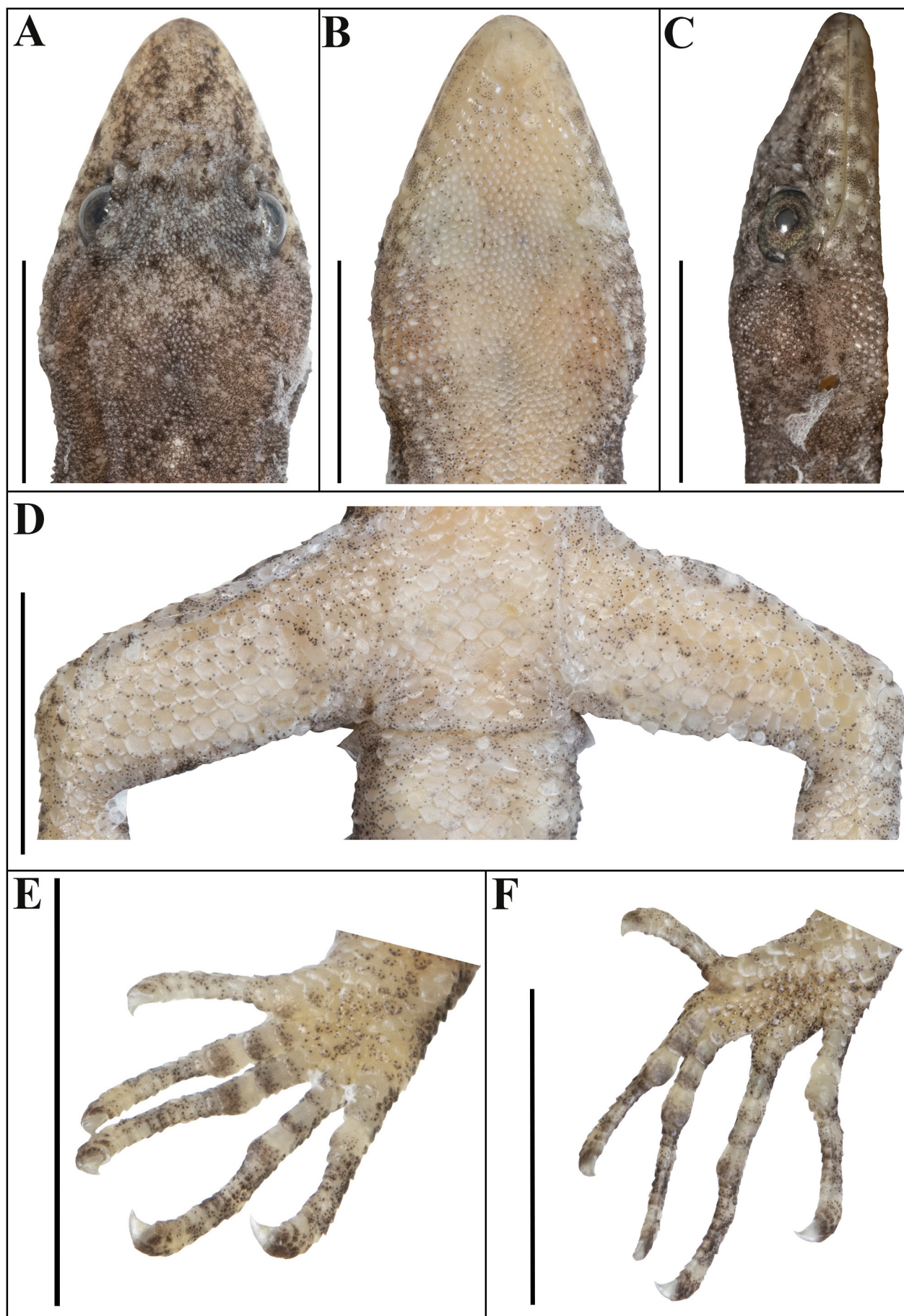
**Figure 12.** *Cnemaspis vijayae* sp. nov. (holotype, NRC-AA-1188): **A** dorsal view of body, **B** ventral view of body, **C** dorsal view of tail, and **D** ventral view of tail. Scale bars 10 mm; photos by Akshay Khandekar and Satpal Gangalmale.

arranged rows of paravertebral tubercles on body between forelimb and hindlimb insertion (*versus* a regular series of 17–20 tubercles in paravertebral rows on the body between forelimb and hindlimb); and by presence of small dorsal ocellus just anterior to forelimb insertions (*versus* dorsal ocellus just anterior to forelimb insertions absent).

**Description of the holotype.** Adult male in a fairly good state of preservation except a 3.2 mm long incision in the

sternal region for liver tissue collection, tail tip slightly bent towards left, and digit III of left manus incomplete (Fig. 12A–D). SVL 35.6 mm, head short (HL/SVL 0.24), wide (HW/HL 0.74), not strongly depressed (HD/HL 0.44), and distinct from neck. Loreal region marginally inflated, canthus rostralis indistinct. Snout almost half of the head length (ES/HL 0.48), slightly more than 2.5 times of the eye diameter (ES/ED 2.62); scales on snout and canthus rostralis large, weakly keeled, and weakly





**Figure 13.** *Cnemaspis vijayae* sp. nov. (holotype, NRC-AA-1188): **A** dorsal view of head, **B** ventral view of head, **C** right side lateral view of head, **D** view of cloacal region showing femoral and precloacal pores, **E** ventral view of right manus, and **F** ventral view of right pes. Scale bars 5 mm; photos by Akshay Khandekar and Satpal Gangalmale.

**Table 7.** Meristic data for the type series of *Cnemaspis vijayae* sp. nov. of the *goaensis* clade. Abbreviations are listed in Materials and Methods except for: L&R = Left & Right; irr.arr. = irregularly arranged; \* = lamellae missing or incomplete; abs. = absent.

Type	Holotype	Paratypes			
Specimen number	NRC-AA-1188	NRC-AA-1185	NRC-AA-1186	NRC-AA-1187	BNHS 2815
Sex	Male	Female	Male	Female	Male
SL L&R	8&8	8&8	8&8	9&8	9&10
IL L&R	7&7	8&7	8&8	7&7	7&7
SL M L&R	5&6	6&6	5&6	7&6	7&7
IL M L&R	4&5	5&5	5&5	5&5	5&6
PVT	irr.arr.	irr.arr.	irr.arr.	irr.arr.	irr.arr.
DTR	11	9	9	11	11
MVSR	26	26	27	27	30
VS	127	119	118	122	124
LamF1 L&R	11&11	10&10	8*&10	10&11	10&10
LamF4 L&R	16&16	15&15	13*&16	15&16	15&16
LamT1 L&R	11&11	10&10	10&10	11&11	10&11
LamT4 L&R	17&17	12*&17	17&17	18&18	18&19
LamT5 L&R	17&17	16&16	16&15	16&17	17&17
PP L&R	1&2	abs.	3	abs.	1&2
SBPP	2	abs.	abs.	abs.	1
FP L&R	4&4	abs.	3&3	abs.	4&3
SB PP and FP L&R	7&7	abs.	7&8	abs.	8&8
PCT L&R	1&1	1&1	1&1	1&1	1&1

**Table 8.** Additional morphological character states evaluation for the type series of *Cnemaspis vijayae* sp. nov. of the *goaensis* clade. abs. = absent; / = data unavailable.

Type	Holotype	Paratypes			
Specimen number	NRC-AA-1188	NRC-AA-1185	NRC-AA-1186	NRC-AA-1187	BNHS 2815
Sex	Male	Female	Male	Female	Male
Occipital ocellus/ ocellus just behind occiput present (1) or not (0)	0	0	0	0	0
Dorsal ocellus between forelimb insertions present (1) or not (0)	1	1	1	1	1
Anterior extra-brilliar fringe scales enlarged (1) or not (0)	1	1	1	1	1
Ventral scales keeled (1) or smooth (0)	0	1	0	0	0
Gular scales keeled (1) or smooth (0)	1	1	1	1	1
Pectoral scales keeled (1) or smooth (0)	0	1	0	0	0
Precloacal pores continuous (1) or separated (0)	0	abs.	1	abs.	0
Precloacal pores elongate (1) or round (0)	0	abs.	0	abs.	0
femoral pores elongate (1) or round (0)	1	abs.	1	abs.	0
Dorsal pholidosis homogeneous (1) or heterogeneous (0)	0	0	0	0	0
Dorsal tubercles keeled (1) or not keeled (0)	1	1	1	1	1
Tubercles linearly arranged (1) or more random (0)	0	0	0	0	0
Spine-like tubercles on flank present (1) or absent (0)	1	1	1	1	1
Lateral caudal furrows present (1) or absent (0)	1	1	/	1	1
Sub-caudals keeled only on posterior tail (1) or smooth entirely (0)	1	1	/	1	1
Single median row of sub-caudals keeled (1) or smooth (0)	1	1	/	1	1
Caudal tubercles encircle tail (1) or not (0)	1	1	/	1	1
Slightly enlarged median sub-caudal scale row (1) or not (0)	1	1	/	1	1
Enlarged femoral scales present (1) or absent (0)	1	0	1	0	1
Subtibial scales keeled (1) or smooth (0)	0	1	1	1	0

conical; twice the size than those on forehead and inter-orbital region; occipital and temporal region with much smaller, weakly keeled granules sparsely intermixed with slightly larger, weakly keeled, weakly conical tubercles (Fig. 13A). Eye small (ED/HL 0.18); with round pupil;

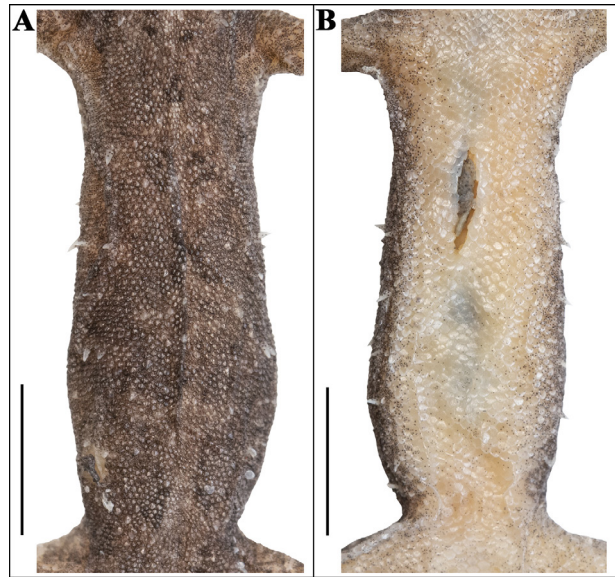
orbit with nine or 10 extra-brilliar fringe scales, largest scales on anterior side; supraciliaries not elongate; eight interorbital scale rows across narrowest point of frontal; 35 or 36 scale rows between left and right supraciliaries at mid-orbit (Fig. 13A). Ear-opening deep, oval, small



(EL/HL 0.05); eye to ear distance slightly more than 1.5 times of eye diameter (EE/ED 1.62) (Fig. 13C). Rostral two times wider (1.6 mm) than long (0.7 mm), incompletely divided dorsally by a strongly developed rostral groove for more than half of its height; a single enlarged supranasal on each side, slightly larger than postnasals, separated from each other by a single elongated internasal; rostral in contact with nostril, internasal, supranasal, lower postnasal and supralabial I on either side; nostrils circular, each surrounded by rostral, supranasal, and upper and lower postnasals on each side; two rows of scales separate the orbit from the supralabials (Fig. 13C). Mental enlarged, subtriangular, slightly wider (1.9 mm) than long (1.5 mm); two pairs of postmentals, inner pair larger than outer pair, rectangular, an enlarged chin scales prevent the contact between them below mental; inner pair bordered by mental, infralabial I, outer postmental and three enlarged chin shields on right and three on left side; outer postmentals roughly rectangular, bordered by inner postmentals, infralabial I and II, and four enlarged chin shields on either side; four enlarged gular scales prevent contact between left and right outer postmentals; chin shields bordering postmentals and one or two rows bordering infralabials somewhat flattened, smooth, slightly smaller than outermost postmentals, rest still smaller, weakly conical, weakly keeled and subimbricate (Fig. 13B). Eight supralabials up to angle of jaw on either side, five supralabials at midorbital position on left and six on right side; supralabial I largest, decreasing in size posteriorly; seven infralabials up to angle of jaw on each side; four infralabials on left and five on right side at midorbital position; infralabial I largest, decreasing in size posteriorly (Fig. 13C).

Body slender (BW/AGL 0.44), trunk less than half of SVL (AGL/SVL 0.41) without ventrolateral folds; three of spine-like scales present on flank on each side. Dorsal pholidosis heterogeneous; weakly keeled, granular scales, intermixed with irregularly arranged rows of large, keeled, tubercles on each flank; three rows of enlarged tubercles on flank on either side much enlarged, weakly keeled and spine-like; 11 dorsal tubercles rows at mid-body including spine-like scales; paravertebral tubercles on the body between forelimb and hindlimb insertions irregular (Fig. 14A). Ventral scales more than thrice the size than granular scales on dorsum, those on belly smooth, subimbricate, subequal from chest to vent; mid-body scale rows across belly between lowest rows of enlarged scales on flank 26; 127 scales from mental to anterior border of cloaca (Fig. 14B). Scales on throat slightly smaller than those on belly; gular region with much smaller, weakly conical, weakly keeled subimbricate scales with those on chin bordering postmentals, enlarged, smooth, juxtaposed and flattened (Fig. 13B). Four femoral pores on each thigh, separated by seven poreless scales on each side from three discontinuous precloacal pores, a single precloacal pore on left and two on right side, separated by two poreless scale; femoral pore bearing scales flanked posteriorly with enlarged slightly spine-like scale (Fig. 13D).

Scales on dorsal aspect of manus much larger than dorsal granular scales, tricarinate, and imbricate; those near forelimb insertion small and granular; dorsal as-



**Figure 14.** *Cnemaspis vijayae* sp. nov. (holotype, NRC-AA-1188): **A** dorsal view of mid-body, and **B** ventral view of mid-body. Scale bars 5 mm; photos by Akshay Khandekar and Satpal Gangalmale.

pect of hand predominantly bearing large, flattened, 1–3 carinate, and imbricate scales. Ventral aspect of manus with smooth, roughly subcircular, subimbricate scales; scales on palm and sole smooth, flat and subcircular, subimbricate. Scales on dorsal and anterio-lateral aspect of thigh much larger than those on dorsal granules, strongly keeled, imbricate except those near hindlimb insertion which are granular, much smaller than dorsal granules, weakly keeled and somewhat conical; scales on posterior-lateral aspect of thigh similar in shape to granular scales on mid-body dorsum, marginally larger, becoming smaller, and smooth posteriorly. Scales on dorsal aspect of knee slightly smaller than those on thigh dorsal, weakly keeled, those around knee large, tricarinate, imbricate; scales on shank still smaller, strongly keeled, subimbricate; dorsal aspect of foot predominantly bearing large flattened, tricarinate, imbricate scales. Scales on ventral aspect of thigh slightly larger than mid-body ventrals, smooth and imbricate; scales on shank more or less similar in size to those on mid-body ventrals, smooth, imbricate (Fig. 12A, B).

Fore-limbs and hind-limbs slightly long, slender (LAL/SVL 0.14); (CL/SVL 0.17); digits long, with a strong, recurved claw, distinctly inflected, distal portions laterally compressed conspicuously. Series of unpaired lamellae on basal portion of digits, separated from unpaired, narrower distal lamellae by a single large scale at the inflection; proximal lamellae series: 2-3-3-4-4 (right manus; Fig. 13E), 2-3-4-6-5 (right pes; Fig. 13F), 2-3-3-4-3 (left manus), 2-3-4-6-5 (left pes); distal lamellae series: 9-10-11-12-10 (right manus; Fig. 13E), 9-9-11-11-12 (right pes; Fig. 13F), 9-9-11-11-10 (left manus), 9-10-12-11-12 (left pes). Relative length of digits (measurements in mm in parentheses): IV (3.2) > III (3.00) > II (2.8) > V (2.6) = I (2.06) (right manus); IV (4.2) > III (3.8) > V (3.5) > II (3.2) > I (2.0) (right pes).





**Figure 15.** Paratype series of *Cnemaspis vijayae* sp. nov., from left to right, NRC-AA-1185 (AK-R 836), NRC-AA-1186 (AK-R 837), NRC-AA-1187 (AK-R 838), BNHS 2815 (AK 599). Scale bar 10 mm; photos by Akshay Khandekar and Satpal Gangalmale.

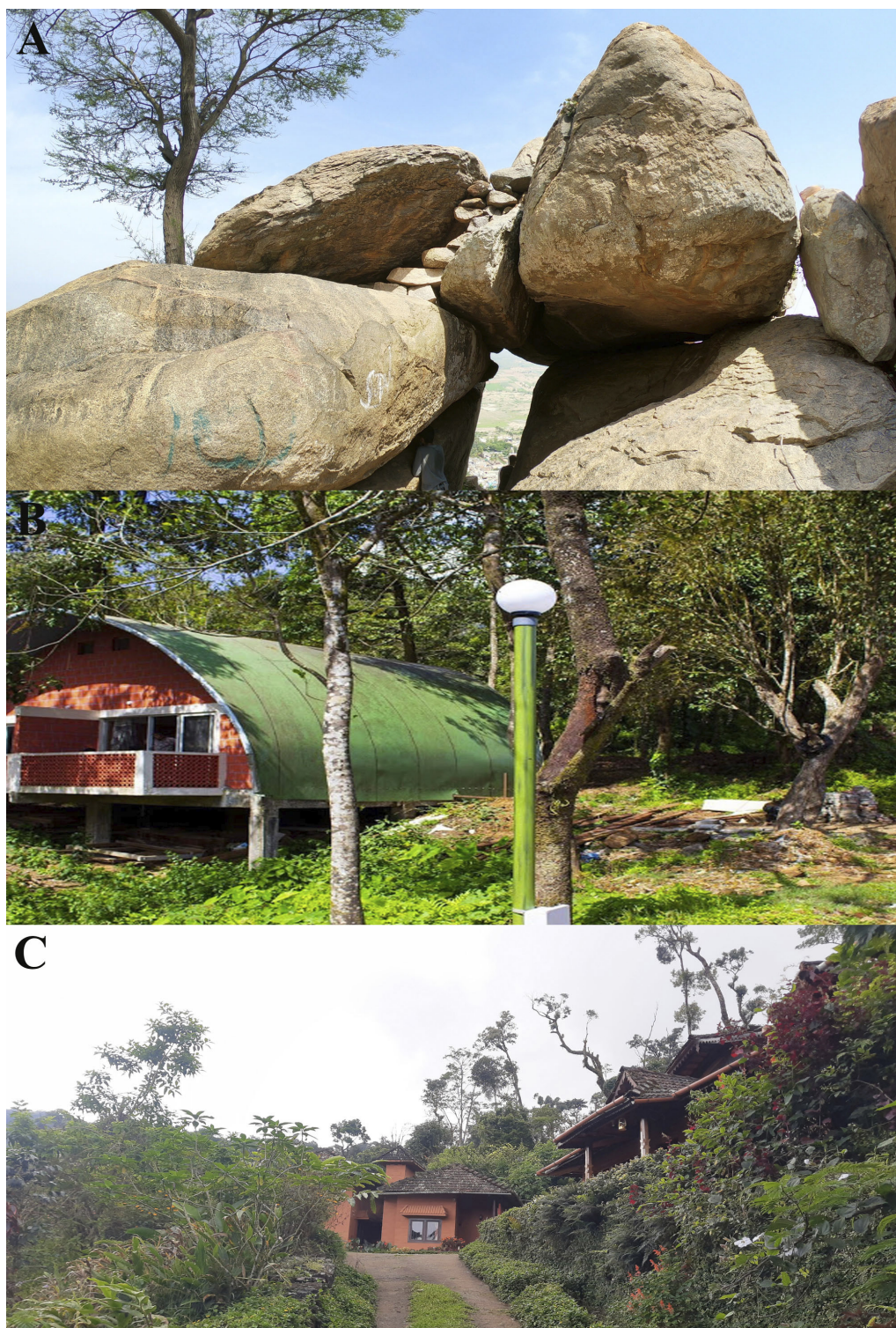
Tail entire, original, subcylindrical and slender (Fig. 12C, D). Dorsal scales on tail base weakly keeled, granular, similar in size and shape to granular scales on mid-body dorsum, gradually becoming larger, flattened, imbricate posteriorly, intermixed with enlarged, strongly keeled, distinctly pointed, conical tubercles; enlarged tubercles on the tail forming whorls six tubercles each on first 10 whorls, four in 11–14<sup>th</sup> whorls, rest of the tail with only paravertebral tubercles (Fig. 12C). Scales on ventral aspect of tail much larger than those on dorsal aspect, subimbricate, smooth only at anterior half of the tail, rest weakly keeled; median series slightly larger than rest, roughly subtriangular (Fig. 12D). Scales on tail base slightly smaller than those on mid-body ventrals, smooth, imbricate; a single enlarged, conical, and weakly keeled postcloacal spur on each side (Fig. 13D).

**Colouration in life (Fig. 11B).** Dorsal ground colour of head, body, limbs and tail brown; head speckled with black, fine dark vertical streak between left and right orbit; fine dark pre-orbital streak from nostril to orbit, two fine dark postorbital streaks just extending onto neck; labials yellow with lighter and darker bars. A discontinuous straw-coloured mid-dorsal stripe runs from occiput to tail; a small, dark ocellus is present just anterior to forelimb insertions; enlarged, spine-like tubercles on flank yellow. Tail lighter than body; dorsum of forelimbs mottled, hindlimbs with light and dark markings, digits with alternating indistinct dark and light bands. Ventral surfaces dull-white, underside of head and neck throat dirty yellow with fine back spots fading out between hindlimb insertions,

fine black spots under forelimbs and sides of the belly; underside of the tail off white, without any dark markings. Pupil black, iris bronze, outlined by fine silver ring.

**Variation and additional information from type series.** Mensural, meristic and additional character states evaluation data for the type series is given in Tables 6–8 respectively. There are two male and two female specimens ranging in size from 32.1–34.1 mm. All paratypes resemble the holotype except as follows: inner postmentals bordered by mental, infralabial I outer postmental and two enlarged chin scales either side in NRC-AA-1185, NRC-AA-1187, and in BNHS 2815. Outer postmentals bordered by inner postmental, infralabial I & II, five enlarged chin scales on left and three on right side in NRC-AA-1186; outer postmentals bordered by inner postmental, infralabial I & II, four enlarged chin scales on left and five on right side in and NRC-AA-1187; outer postmentals bordered by inner postmental, infralabial I & II and five enlarged chin scales on left and three on right side in NRC-AA-1186, outer postmentals bordered by inner postmental, infralabial I & II and three enlarged chin scales on left and four on right side in BNHS 2815; outer postmental separated from each other by three enlarged gular scales in NRC-AA-1185 and NRC-AA-1187. NRC-AA-1187 with original and complete tail, slightly longer than body (TL/SVL 1.31); NRC-AA-1186 with entire but partially regenerated tail, slightly longer than body (TL/SVL 1.30); NRC-AA-1185 with original but incomplete tail (TL = 21 mm); and BNHS 2815 with tail entirely missing. All paratypes agree with the holotype in overall





**Figure 16.** Habitats of the new species at their type localities: **A** *Cnemaspis tigris* **sp. nov.**; **B** *C. sakleshpurensis* **sp. nov.**; **C** *C. vijayae* **sp. nov.**. Photos by Akshay Khandekar.

colouration except for BNHS 2815 which has more or less continuous middorsal stripe running from occiput to tail tip (Fig. 15).

**Distribution and Natural history.** The new species is currently known only from its montane type locality (1250 m elevation) in the Central Western Ghats, within a large property surrounded by coffee plantations with large trees and evergreen forest (Fig. 16C). The area is contiguous

with Brahmagiri Wildlife Sanctuary, where the new species may occur. A few individuals were observed during sunny weather between ~0800–1400 hrs at a height of 2–4 m on the walls of a few buildings. The new species is sympatric with two congeners, *C. cf. schalleri* and *C. cf. wynadensis*. During the second trip to the type locality in late November, we observed new species in good numbers, predominantly on the building walls above 2–4 m height and sympatric with *C. cf. schalleri*.



## Key to the *Cnemaspis goaensis* clade

- 1 Scales on upper arm and thigh tricarinate .....2
- Scales on upper arm and thigh unicarinate .....3
- 2 6–8 DTR, <22 MVSR, 7–12 PVT ..... *Cnemaspis amboliensis*
- 9–11 DTR, 26–30 MVSR, PVT irregularly arranged ..... *Cnemaspis vijayae* sp. nov.
- 3 93–101 ventral scales ..... *Cnemaspis ranganaensis*
- >110 ventral scales .....4
- 4 Internasal scales absent, supranasals in strong contact with each other on snout; 23–26 MVSR ..... *Cnemaspis sakleshpurensis* sp. nov.
- One or two internasal scales separating supranasals on snout; 27–32 MVSR ..... *Cnemaspis goaensis*

## Discussion

South Asian *Cnemaspis* continue to be discovered and named at an unprecedented rate in India and Sri Lanka – over 75% of the ~100 known species within the group have been described in the last two decades (Uetz et al. 2021). A combination of renewed survey effort, how little was previously known, and the use of molecular data has facilitated this taxonomic explosion. This includes the discovery of novel, deeply divergent lineages, as in the case of *Cnemaspis tigris* sp. nov. and *C. vijayae* sp. nov. (>12 % sequence divergence from any known species), as well as new species allied to known species as in the case of *C. sakleshpurensis* sp. nov. (5.2 % divergent from its sister species *C. goaensis*).

SAC are perhaps the oldest extant Indian squamate taxon with initial divergence in the Paleocene-Eocene in the Western Ghats, and are ancestrally cool adapted (Agarwal et al. 2020c; Pal et al. 2021). The three new species described in this paper are all from montane habitats (>800 m elevation), and while *Cnemaspis tigris* sp. nov. is from arid, rocky habitats on the Mysore Plateau, the other two species of the *goaensis* clade are from rain-forest habitats in the Central Western Ghats. The mechanisms governing diversification within the *mysoriensis* and *goaensis* clades are likely to be very different given the inherently patchy nature of cool habitats outside the Western Ghats.

The discovery of *Cnemaspis tigris* sp. nov., the seventh species of the *mysoriensis* clade, and the 16<sup>th</sup> species from peninsular India outside the Western Ghats, is not surprising given the inherently patchy nature of the granite habitats they inhabit. Agarwal et al. (2020c) showed that granite boulder habitats on and just off the Mysore Plateau act as a climate refugia for at least these relatively small, ancestrally cool adapted geckos. The patchily distributed granite boulders and high elevation hills on and just off the plateau are isolated from each other by lower and warmer scrub habitats. Interestingly, almost each of the isolated montane (>800 m elevation) habitats we have surveyed have at least one or two deeply divergent, point endemic *Cnemaspis* (either a member each of the *bangara* and *mysoriensis* clades or two divergent members of the *mysoriensis* clade). Considering the vast suitable unexplored area on the plateau, it is likely that many spe-

cies still remain to be discovered (Agarwal et al. 2020b, 2020c; Khandekar et al. 2020a).

The discoveries of *Cnemaspis sakleshpurensis* sp. nov. and *C. vijayae* sp. nov. from the central Western Ghats takes the number of species known from the *goaensis* clade to five and the number of *Cnemaspis* described from the Western Ghats to 49 (Pal et al. 2021). Sakleshpur now has a third *Cnemaspis* species described from its vicinity in addition to *C. magnifica* and *C. schalleri* (Khandekar et al. 2020b, 2021a). *Cnemaspis* species tend to have narrow distributions and most recently described species are known only from their type-localities. Many localities in the central and southern Western Ghats are known to host at least three species from divergent clades at a single locality (Khandekar et al. 2021a; Pal et al. 2021; Khandekar and Agarwal unpubl. data./ pers. obs.), each with specific microhabitat preference and/or different activity pattern. The two new species from the Western Ghats are each sympatric with a species from the *C. schalleri* clade and the *C. wynadensis* clade. While the latter clade includes mainly nocturnal and large bodied (SVL >50 mm) species, the former includes diurnal species which are similar in size to the new species (27–32 mm), and though they sometimes use the same microhabitats, members of the *C. schalleri* clade were observed by us at lower perch heights than *Cnemaspis sakleshpurensis* sp. nov. and *C. vijayae* sp. nov. Much more work is needed to understand microhabitat partitioning between different *Cnemaspis* species. Dedicated thorough sampling efforts throughout the Western Ghats in conjugation with molecular data and a consistent comparative morphological dataset are likely to more than double the current species diversity of the genus in the Western Ghats (e.g. Pal et al. 2021).

## Acknowledgements

All specimens are non-scheduled under the Indian Wildlife Protection Act, 1972 and were collected from private property. Swapnil Pawar, Vaibhav Patil, Varad Giri, Vijay Sandge, Robin Bansode and Rajendra Gujar helped with the fieldwork. We are grateful to the Chengappa family, especially Suresh Chengappa at Honey Valley Homestay for their hospitality. Satpal Gangalmale assisted in morphological data collection

and specimen photography. We are thankful to Uma Ramakrishnan for lab support at NCBS. Vivek Ramachandran and Rahul Khot provided the voucher numbers for the specimens at NCBS and BNHS museum respectively. We thank S. R. Ganesh and two anonymous reviewers for their important comments.

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