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Description of two new species of *Cnemaspis* Strauch, 1887 (Squamata: Gekkonidae) from the Western Ghats of Kerala, India

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Abstract

Two new species of geckos of the genus *Cnemaspis* Strauch, 1887 are described from the southern Western Ghats of Kerala. Both species are medium to large sized *Cnemaspis* and can be differentiated from all other Indian congeners by a suite of distinct morphological characters. Both species are found in the high elevation forests of the two major massifs—Anaimalai Hills and Agasthyamalai Hills and are presently known to have very restricted distributional ranges. The discovery of these novel species highlights the understudied diversity of reptiles in the high mountain ranges of the Western Ghats.

Key words: *Cnemaspis*, Gekkonidae, new species, southern Western Ghats

Introduction

The genus *Cnemaspis* Strauch, 1887 is among the most speciose Old World gekkotan genera, with at least 130 known species (Uetz et al., 2017). Although the genus is presently thought to be distributed in South Asia, Southeast Asia and Tropical Africa, recent large scale molecular phylogenetic analyses have currently construed the genus to be polyphyletic (Gamble *et al.* 2012; Pyron *et al.* 2013; Zheng & Wiens 2016). Having undergone extensive taxonomic revisions, there has been a recent upsurge in documenting the Asian species of *Cnemaspis* particularly in Southeast Asia and Sri Lanka, resulting in the discovery of several new species, (Bauer & Das 1998; Manamendra-Arachchi *et al.* 2007; Wickramasinghe & Munindradasa 2007; Grismer *et al.* 2010, 2014; Agarwal *et al.* 2017; Iskandar *et al.* 2017). However, the Indian members of this genus have received relatively little attention and several species remain undescribed (Giri *et al.* 2009b; Srinivasulu *et al.* 2015; Sayyed *et al.* 2016).

In mainland India, the genus *Cnemaspis* is represented by 26 nominal species (Srinivasulu *et al.* 2015; Sayyed *et al.* 2016), which are recognized by their round pupils and their predominantly diurnal habits (Smith 1935). In the Western Ghats, the genus is represented by 17 species (Srinivasulu *et al.* 2015) of which 11 species are known from Kerala, all of which are endemic to the region (Palot 2015). Most species of *Cnemaspis* are restricted to very narrow ranges within the region, like many other endemic taxa of the Western Ghats (Joshi & Edgecombe 2013; Vijayakumar *et al.* 2014; Robin *et al.* 2017). The recent taxonomic interest in the genus has led to the taxonomic stabilization of several species (Manamendra-Arachchi *et al.* 2007; Giri *et al.* 2009a; Cyriac & Umesh 2013) and the description of several new species from southern India (Manamendra-Arachchi *et al.* 2007; Giri *et al.* 2009b; Cyriac & Umesh 2014; Mirza *et al.* 2014; Srinivasulu *et al.* 2015; Sayyed *et al.* 2016). All these studies, however, indicate that the diversity of *Cnemaspis* presently remains largely underestimated.

The Western Ghats harbor a high number of endemic species (Myers *et al.* 2000). This has spurred great interest in documenting and describing the plants and animals of this region (e.g. Giri *et al.* 2009b; Smith *et al.* 2012; Joshi & Edgecombe 2013; Abraham *et al.* 2015; Hareesh *et al.* 2015; Robin *et al.* 2017). Recent interest in

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amphibians has led to the discovery of more than 120 new species in the last decade (Biju & Bossuyt 2009; Biju *et al.* 2014; Gururaja *et al.* 2014; Vijayakumar *et al.* 2014; Abraham *et al.* 2015; Dinesh *et al.* 2017), indicating the unprecedented amphibian diversity in the hills of the Western Ghats. Reptile diversity of the Western Ghats remains largely unexplored, despite the high degree of endemism and high species richness among reptiles within this region (Giri 2008; Giri & Bauer 2008). Recent field sampling and collection in the high mountain ranges of the southern Western Ghats of Kerala state have revealed the existence of several undescribed species of reptiles. Here we describe two new species of *Cnemaspis* from the higher reaches of the Anaimalai and Agasthyamalai Hill ranges of the Western Ghats of Kerala.

Materials and methods

Opportunistic field sampling was carried out in different parts of Kerala state. Specimens were collected, photographed in life, euthanized, fixed in 10% formalin and later transferred to 70% ethanol. Tissue samples (tail clips) from representative samples were collected and stored in absolute ethanol. The following measurements were taken using a Mitutoyo™ digital vernier caliper (to the nearest 0.1mm): SVL, snout to vent length (distance from tip of snout to anterior margin of vent); AG, distance from axilla to groin; TW, trunk width (maximum width of the body); ED, eye diameter (horizontal diameter of the orbit); EN, distance between anterior point of the orbit to the posterior part of the nostril; ES, snout length (distance from anterior margin of the orbit to the tip of the snout); ET, distance from posterior margin of the orbit to the anterior margin of the ear opening; IN, internarial distance (least distance between the inner margins of the nostrils); TD, tympanum diameter (horizontal distance from the anterior to posterior margin of the ear opening); HL, head length (distance from tip of snout to posterior edge of mandible); HW, head width (maximum width of the head); HD, head depth (maximum depth of the head); IO, interorbital distance (shortest distance between the superciliary scale rows); UAL, upper arm length (distance from axilla to elbow); LAL, lower arm length (distance from elbow to wrist); PAL, palm length (distance from wrist to the tip of the longest finger); FL, finger length (distance from the tip of the finger to the nearest junction with another digit); FEL, femur length (distance from groin to the knee); TBL, tibia length (distance from knee to heel); TOL, toe length (distance from tip of toe to the nearest junction with another digit); TL, tail length (distance between posterior margin of vent to the tip of the tail); TBW, tail base width.

The pholidosis recorded included number of supralabials and infralabials up to the angle of the jaw on the left (L) and right (R) side; subdigital lamellae on the manus and pes, the number of precloacal pores and the number of femoral pores on the left and right femur. The specimens were compared with data collected for Indian congeners obtained from original descriptions (Inger *et al.* 1984; Bauer 2002; Das & Bauer 2000; Giri *et al.* 2009; Cyriac & Umesh 2014; Mirza *et al.* 2014; Srinivasulu *et al.* 2015; Sayyed *et al.* 2016) and from a taxonomic review of the Indian and Sri Lankan *Cnemaspis* by Manamendra-Arachchi *et al.* (2007). Specimens were deposited at the museum of the Zoological Survey of India, Western Ghats Regional Center (ZSI-WGRC), Kozhikode, Kerala. Opportunistic observations were made on the natural history of these lizards.

Systematics

Cnemaspis maculicollis sp. nov.

Figs. 1–3

Holotype: ZSI/WGRC/IR.V/2704, an adult male of SVL 42.5 mm; collected from a rock crevice of a boulder at Pandimotta (08.82749°N, 077.21703°E) at an elevation of 1238m, Shendurney Wildlife Sanctuary, Kollam District, Kerala; collected on 02 January 2016 by Muhamed Jafer Palot and Vivek Philip Cyriac.

Paratype: ZSI/WGRC/IR.V/2705, an adult female of SVL 52.7 mm; collected from rock crevice at the same locality as holotype on 02 January 2016 by Muhamed Jafer Palot and Vivek Philip Cyriac.

Diagnosis: A large sized slender *Cnemaspis* with a maximum snout-vent length 52.7 mm (n = 2); mid-dorsal scales heterogeneous with small granular scales intermixed with large, irregularly arranged, smooth rounded tubercles more pronounced towards the posterior end; spine-like tubercles absent on flanks; ventral scales of neck

and abdomen smooth, subimbricate; supralabials to angle of jaw, 7; infralabials, 7–8; subdigital lamellae under manus IV 20–24, under pes IV 23–24 ; tail base slightly swollen with a single postcloacal spurs on each side; dorsal scales of tail smooth, without whorls of enlarged tubercles; subcaudals on original tail enlarged, smooth irregularly arranged scales; male with 10 precloacal pores, femoral pores absent; pale white spots in the posterior-lateral and posterior-dorsal end of the head; 5–6 pale white spots on the nape.

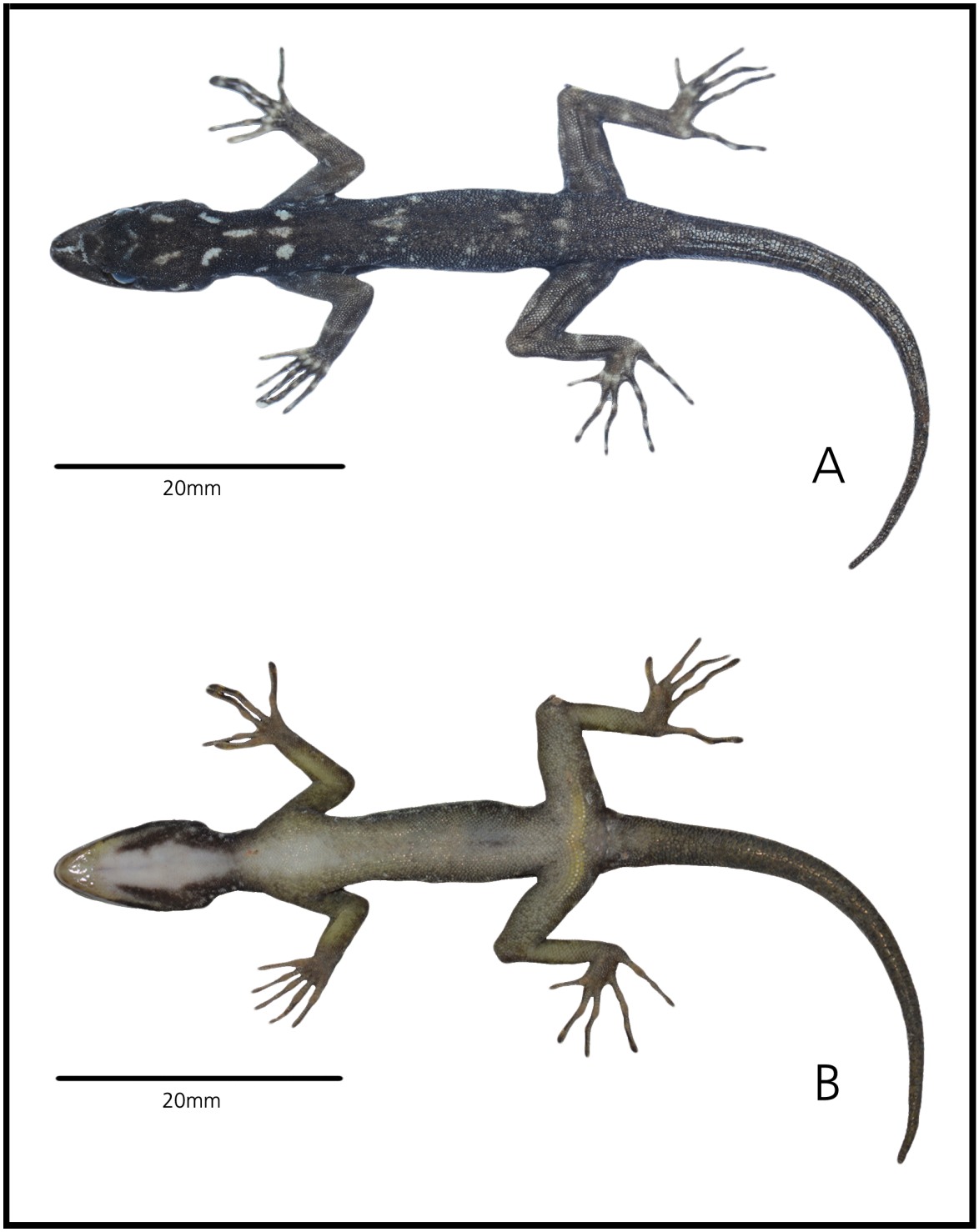

FIGURE 1. Holotype of *Cnemaspis maculicollis* **sp. nov. A.** dorsal view; **B.** ventral view.

Cnemaspis maculicollis **sp. nov.** differs from all other Indian congeners by the following characters: absence of spine-like tubercles on flanks (*versus* spine-like tubercles present on flanks in *C. assamensis* Das & Sengupta, *C. gracilis* (Beddome), *C. goaensis* Sharma, *C. littoralis* (Jerdon), *C. mysoriensis* (Jerdon), *C. indraneildasii* Bauer, *C.*

jerdonii (Theobald), *C. otai* Das & Bauer, *C. wicksii* (Stoliczka), *C. andersonii* (Annandale), *C. monticola* Manamendra-Arachchi, Batuwita & Pethiyagoda, *C. nilagirica* Manamendra-Arachchi, Batuwita & Pethiyagoda, and *C. flaviventralis* Sayyed, Pyron & Dahanukar); presence of 10 precloacal pores and absence of femoral pores (*versus* presence of only femoral pores in *C. wynadensis* (Beddome), *C. sisparensis* (Theobald), *C. anaikattiensis* Mukherjee, Bhupathy & Nixon, *C. heteropholis* Bauer, *C. littoralis*, *C. indica* (Gray), *C. jerdonii, C. girii* Mirza, Pal, Bhosale & Sanap, *C. kotiyoorensis* Cyriac & Umesh and *C. flaviventralis*; presence of both femoral and precloacal pores in *C. gracilis*, *C. goaensis*, *C. mysoriensis*, *C. indraneildasii*, *C. otai*, *C. yercaudensis* Das & Bauer, *C. wicksii*, *C. andersonii*, *C. australis* Manamendra-Arachchi, Batuwita & Pethiyagoda and *C. adii* Srinivasulu, Kumar & Srinivasulu; presence of only 2 precloacal pores in *C. anamudiensis* **sp. nov.**; presence of a continuous series of 24–28 precloacal and femoral pores in *C. kolhapurensis* Giri, Bauer & Gaikwad; absence of both femoral and precloacal pores in *C. boiei* (Gray) and *C. assamensis*); tail without whorls of enlarged pointed or flattened caudal tubercles and two postcloacal spurs at the base of the tail (*versus* tail with whorls of enlarged or flattened caudal tubercles in *C. gracilis*, *C. goaensis*, *C. littoralis*, *C. mysoriensis*, *C. indraneildasii*, *C. jerdonii*, *C. otai*, *C. yercaudensis*, *C. monticola, C. australis* and *C. nilagirica;* without postcloacal spur in *C. wynadensis*, *C. kottiyoorensis*, *C. sisparensis* and *C. heteropholis*); dorsal scales heterogeneous with small granular scales intermixed with irregularly arranged, enlarged, smooth, rounded tubercles (*versus* dorsal scales homogenous in *C.boiei*, *C. indica*, *C. jerdonii*, *C. littoralis*, *C. nilagirica*, *C. wynadensis*, *C. sisparensis*, *C. kolhapurensis* and *C. adii*).

Cnemaspis maculicollis **sp. nov.** closely resembles *C. ornata* (Beddome), *C. nairi* Inger, Marx & Koshy and *C. beddomei* (Theobald). It is differentiated from *C. beddomei* by its comparatively long slender head and body (HL 27.9 % SVL, HW 59.4 % of HL, TW 34.2 % AG), the distinctive white spots on the nape, 23–24 lamellae on pes IV and presence of 10 precloacal pores (*versus* robust head and body [HL 28.1 % SVL, HW 72.5 % HL; see Manamendra-Arachchi *et al.* 2007], lack of white spots on the nape, 16 lamellae on pes IV and 6–8 precloacal pores in *C. beddomei*). *Cnemaspis maculicollis* **sp. nov.** can be differentiated from *C. nairi* by its long slender head (HL 27.9 % SVL, HW 59.4 % of HL), the distinctive white spots on the nape, and presence of 10 precloacal pores (*versus* robust head [HL 29.8 % SVL, HW 64.8 % HL; see Inger *et al.* 1984], lack of white spots on the nape and 7–8 precloacal pores). *Cnemaspis maculicollis* **sp. nov.** can be differentiated from *C. ornata* by its lack of enlarged flattened tubercles on the tail, the presence of 10 precloacal pores and the dorsum with irregularly arranged enlarged rounded tubercles (*versus* enlarged flattened tubercles on the tail, 6–8 precloacal pores and dorsum with irregularly arranged enlarged conical tubercles in *C. ornata*).

Description of Holotype (Figs. 1 and 2): An adult male of SVL 42.5mm; head moderately long (HL 27.9 % SVL), narrow (HW 59.4 % HL) and not strongly depressed (HD 40.7 % HL). Snout moderately long (ES 42.2 % HL); scales on snout granular, smooth, larger than those on the forehead and interorbital region. Eye relatively small (ED 22.0 % HL); pupils round; extra-brillar fringe scales large anteriorly, gradually becoming smaller posteriorly. Tympanum relatively small (TD 8.4 % HL), oval and broader than long. The rostrum is broader than long, partially divided by a median groove. Nasals separated from each other by two supranasals, bordered posteriorly by two postnasals and not in contact with the first supralabial. Mental scale sub-triangular, bordered posteriorly by two widely separated postmentals and a single, large intermediate chin shield; postmentals surrounded posteriorly by 5 scales —first infralabial and four chin shields. Supralabials to the angle of jaw seven; Infralabials to the angle of the jaw, seven. Ventral scales of head and neck granular, smooth.

Body slender (TW 34.2 % AG) and moderately elongate (AG 42.2 % SVL). Mid-dorsal scales heterogeneous with small granular scales intermixed with irregularly arranged, enlarged, smooth, rounded tubercles, more pronounced towards the posterior regions. Ventral scales larger than dorsal scales, smooth and sub-imbricate.

Forelimbs are moderately long; upper arm shorter than lower arm (UAL 10.7 % SVL; LAL 16.3 % SVL). Hindlimbs longer than forelimbs; femur subequal to tibia (FEL 19.2 % SVL; TBL 19.6 % SVL). Dorsal and ventral scales of forelimbs and hindlimbs granular, smooth and without enlarged tubercles; scales on manus and pes smooth. Subdigital lamellae entire, a few fragmented; lamellae on the basal phalanges larger. Interdigital webbing absent. Subdigital lamellae on finger I: 15, finger II: 18, finger III: 20, finger IV: 20, finger V: 18; toe I: 15, toe II: 17, toe III: 24, toe IV: 23 and toe V: 22. Relative length of digits, fingers: IV (5.4 mm) > III (5.3 mm) > V (5.1 mm) > II (4.1 mm) > I (3.9 mm); toes: IV (6.9 mm) > V (6.3 mm) > III (6.1 mm) > II (5.4 mm) > I (2.8 mm). Precloacal scales larger than abdominal scales. Femoral pores absent; 10 precloacal pores.

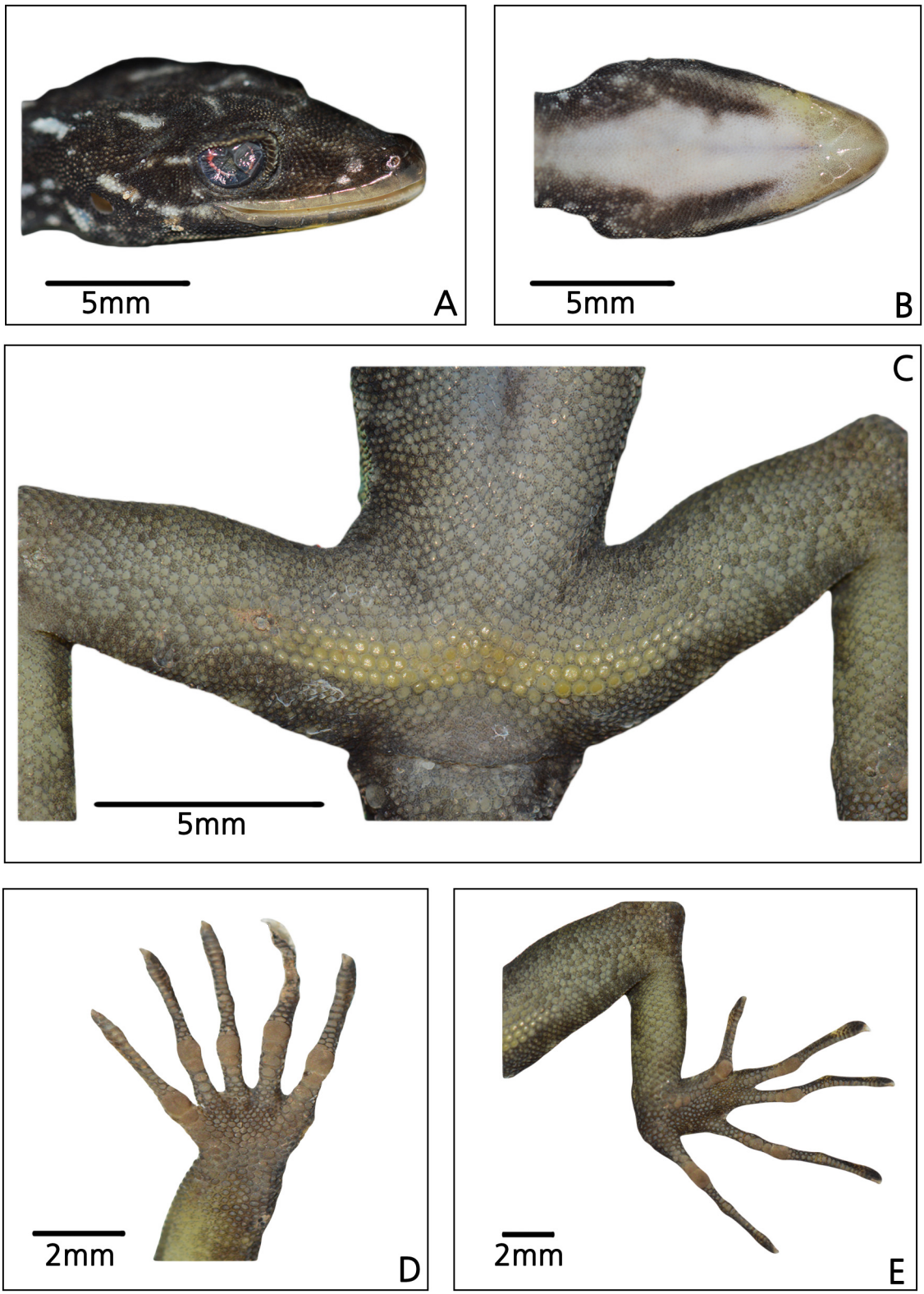

FIGURE 2. Pholidosis of *Cnemaspis maculicollis* **sp. nov. A.** lateral view of head; **B.** ventral side of head; **C.** precloacal and femoral region; **D.**lamellae under hand; **E.**lamellae under foot.

FIGURE 3. Colour in life of *Cnemaspis maculicollis* **sp. nov.** and habitat **A.** dorsal view of male; **B.** dorsal view of female; **C.** habitat of *C. maculicollis* **sp. nov.**

Tail subcylindrical in cross-section, longer than SVL (TL 43.9 mm). Tail base slightly swollen with a single large conical postcloacal spur on each side. Dorsal scales of the tail, smooth and juxtaposed. Ventral scales larger than dorsal scales of tail; subcaudals slightly larger than adjacent scales, rounded and smooth. Subcaudals irregularly arranged.

Colouration in preservative (Fig. 1): Head grayish brown in overall colouration, mottled with darker markings and two prominent pairs of elongated pale white spots behind the orbits and the distal end of the head and three to four pale white spots extending from the angle of the jaw and ending above the tympanum. Nape grayish brown with six prominent pale white spots that extends to the lateral sides. The throat and ventral side of the neck pale white, lateral side of neck black in colour which extends towards the chin as two black streaks. The body dorsum is grayish brown with a vertebral series of three dull buff spots. Dorsum of the forelimbs, hindlimbs and tail grayish brown mottled with darker markings. Dorsum of pes and manus grayish brown with pale white transverse bars. Ventral side of abdomen and limbs are pale white in colour. Precloacal region yellowish.

Colouration in life (Fig. 3A, B): Head grayish brown with light and dark markings with two prominent pairs of buff coloured elongated spots—one pair just behind the eye and the other on the distal end of the head. The lateral side of the head with a series of three to four buff spots extending from the angle of the jaw and ending just above the tympanum. The nape is grayish brown with six prominent bluish white spots extending to the lateral sides. The gular and ventral side of the neck pale white. The lateral sides of the neck are black and extend as a pair of black streaks towards the chin. Dorsum overall grayish brown with a vertebral series of three buff coloured spots and irregularly scattered yellowish spots on the paravertebral region. Forelimbs and hind limbs brown; digits cross barred with black and mustard yellow bands. The tail is grayish brown in colour with darker markings.

TABLE 1. Measurements (to the nearest 0.1 mm) and pholidosis of the type series of *C. maculicollis* **sp. nov.** and *C. anamudiensis* **sp. nov.**

Specimen	*C. maculicollis*		*C. anamudiensis*			
Type	Holotype	Paratype	Holotype	Paratype	Paratype	Paratype
Sex	male	female	male	sub-adult	female	juvenile
Voucherno	ZSI/WGRC/ IR.V/2704	ZSI/WGRC/ IR.V/2705	ZSI/WGRC/ IR.V/2706	ZSI/WGRC/ IR.V/2707	ZSI/WGRC/ IR.V/2708	ZSI/WGRC/ IR.V/2709
SVL	42.5	52.7	58.2	42.1	49.1	29.9
AG	17.9	21.9	26.1	18.2	22.6	12.2
TW	6.1	9.7	16.0	7.5	9.4	6.4
ED	2.6	3.1	3.0	2.4	2.2	1.9
EN	3.5	5.1	4.2	3.4	4.7	2.7
ES	5	6.0	6.3	5.1	5.5	3.7
ET	3.3	3.6	5.6	4.2	4.3	2.9
IN	1.2	1.1	1.7	0.7	1.2	0.8
TD	1.0	1.4	1.1	0.7	0.6	0.5
HL	11.8	13.7	15.7	12.2	12.9	8.7
HW	7.0	8.4	14.9	8.5	9.7	6.2
HD	4.8	5.2	6.7	5.5	5.8	3.8
IO	2.9	4.5	3.8	2.3	2.9	2.3
UAL	4.6	6.8	7.0	4.5	5.0	2.8
LAL	6.9	7.9	6.6	5.9	6.4	3.8
PAL	6.8	7.1	7.8	7.6	8.0	4.9
FL1	3.9	4.1	4.4	3.7	4.2	2.5
FL2	4.1	4.9	5.3	4.9	5.1	3.2
FL3	5.3	5.5	6.4	5.5	6.2	3.8
FL4	5.4	6.2	6.6	5.7	6.5	3.7
FL5	5.1	5.8	6.0	4.9	5.2	2.8
FEL	8.2	5.7	9.7	8.7	9.2	5.3
TBL	8.3	4.8	8.9	7.6	8.6	4.8
TOL1	2.8	3.0	3.5	3.4	3.1	1.6
TOL2	5.4	5.6	5.8	5.7	5.5	3.3
TOL3	6.1	6.0	6.8	6.6	7.1	4.4
TOL4	6.9	6.8	7.8	7.2	7.8	5.0
TOL5	6.3	6.5	6.5	6.1	6.8	4.3
TL	43.9	55.6	40.4	29.7	10.6	—
TBW	4.2	5.3	6.3	4.0	5	2.6
Supralabials(R/L)	7/7	7/7	7/7	7/7	8/8	8/8
Infralabiala(R/L)	8/8	8/7	7/7	7/7	8/7	7/7
Lam IV manus	20	24	19	19	21	19
Lam IV pes	23	24	21	21	22	20
Femoral pores	0	—	0	0	0	0
Precloacal pores	10	—	2	—	—	—

Variation: A detailed account of the variation in this species is deficient due to the lack of sufficient specimens. Variation in the pholidosis of *Cnemaspis maculicollis* **sp. nov.** is summarized in Table 1. The female

paratype of *C. maculicollis* had eight supralabials on the right and seven on the left and juxtaposed pectoral scales and lamellae varies from 15–16 on manus I, 18 on manus II, 20–22 on manus III, 20–24 on manus IV and 18–19 on manus V; lamellae 15 on pes I, 16–17 on pes II, 24–26 on pes III, 23–24 on pes IV and 20–22 on pes V.

Etymology: The specific epithet is derived from the Latin word *macula* meaning spot and *collus* meaning neck referring to the distinctive necklace like white spots on the nape of this species.

Distribution: At present, *Cnemaspis maculicollis* **sp. nov.** is known to occur in Pandimotta (08.82749°N, 077.21703°E), Shendurney Wildlife Sanctuary in Kollam District of Kerala in the Agasthyamalai Hill complex; at an elevation range of 1200–1250 m (Fig. 7).

Natural History: The type specimens were found in crevices of a boulder amidst the shola-grassland ecosystem in the higher reaches of Pandimotta in Shendurney WLS. Several other individuals were observed between such rock boulders. The rock boulders are covered with mosses and lichens (Fig. 3C). The vegetation is dominated by shola forests interspersed with lush growth of reed brakes. The area is contiguous with Alwarkurichi hills of Kalakkadu Mundanthurai of Tamil Nadu. The locality is also known for many recently described species of frogs (Zachariah *et al*. 2009).

***Cnemaspis anamudiensis* sp. nov.**
Figs. 4–6

Holotype: ZSI/WGRC/IR.V/2706, an adult male of SVL 58.2 mm; collected from a rock crevice of a boulder in thick evergreen forest at Anamudi Reserve Forest (10.16675°N, 076. 99791°E), near Pettimudi in Munnar, Idukki District, Kerala, at an elevation of 1873m; collected on 04 September 2013 by Vivek Philip Cyriac.

Paratypes: ZSI/WGRC/IR.V/2707, a sub-adult individual of SVL 42.1mm; collected from rock crevice near a stream at the same locality as holotype on 04 September 2013 by Vivek Philip Cyriac. ZSI/WGRC/IR.V/2708, an adult female of SVL 49.1 mm; collected from rock crevice of a boulder at the same locality as holotype on 04 September 2013 by Vivek Philip Cyriac. ZSI/WGRC/IR.V/2709, a juvenile of SVL 29.9 mm; collected from rock crevice near a stream at the same locality as holotype on 04 September 2013 by Vivek Philip Cyriac.

Diagnosis: A large sized, robust *Cnemaspis* with a maximum snout-vent length 58.2 mm (n = 4); mid-dorsal scales heterogeneous with small granular scales intermixed with few large, irregularly arranged tubercles; spine-like tubercles absent on flanks; ventral scales of neck and abdominal smooth, sub-imbricate; supralabials to angle of jaw 7–8; infralabials 7; subdigital lamellae under manus IV 19–21, under pes IV 20–22; tail base slightly swollen with a single postcloacal spurs on each side; dorsal scales of tail smooth, without whorls of enlarge tubercles; subcaudals enlarged, smooth with regularly arranged scales; male with 2 precloacal pores, femoral pores absent. Dorsum dark brown with an interrupted orange/ochre vertebral line; forelimbs and hind limbs speckled with brick red spots; throat and abdomen black in colour.

Cnemaspis anamudiensis **sp. nov.** differs from all other Indian congeners by the following characters: absence of spine-like tubercles on flanks (*versus* spine-like tubercles present on flanks in *C. assamensis, C. gracilis*, *C. goaensis*, *C. littoralis*, *C. mysoriensis*, *C. indraneildasii*, *C. jerdonii*, *C. otai*, *C. wicksii*, *C. andersonii*, *C. monticola, C. nilagirica* and *C. flaviventrali*); presence of only two precloacal pores and absence of femoral pores (*versus* presence of only femoral pores in *C. wynadensis*, *C. sisparensis*, *C. anaikattiensis*, *C. heteropholis*, *C. littoralis*, *C. indica*, *C. jerdonii, C. girii*, *C. kotiyoorensis* and *C. flaviventralis*; presence of both femoral and precloacal pores in *C. gracilis*, *C. goaensis*, *C. mysoriensis*, *C. indraneildasii*, *C. otai*, *C. yercaudensis*, *C. wicksii*, *C. andersonii*, *C. australis* and *C. adii*; presence of a continuous series of 24–28 precloacal-femoral pores in *C. kolhapurensis*; absence of both femoral and precloacal pores in *C. assamensis* and *C. boiei*; presence of 6–10 precloacal pores in *C. beddomei*, *C. ornata*, *C. nairi* and *C. maculicollis* **sp. nov.**); tail without whorls of enlarged caudal tubercles and a postcloacal spur on either side of the base of the tail (*versus* tail with whorls of enlarged or flattened caudal tubercles in *C. gracilis*, *C. goaensis*, *C. littoralis*, *C. mysoriensis*, *C. indraneildasii*, *C. jerdonii*, *C. otai*, *C. yercaudensis*, *C. monticola, C. australis* and *C. nilagirica;* without postcloacal spur in *C. wynadensis*, *C. kottiyoorensis*, *C. sisparensis* and *C. heteropholis*); dorsal scales heterogeneous with small granular scales intermixed with irregularly arranged enlarged, keeled, conical tubercles (*versus* dorsal scales homogenous in *C. boiei*, *C. indica*, *C. jerdonii*, *C. littoralis*, *C. nilagirica*, *C. wynadensis*, *C. sisparensis*, *C. kolhapurensis* and *C. adii*).

Description of Holotype (Figs. 4 and 5): An adult male of SVL 58.2 mm. Head moderately long (HL 26.9 % SVL), broad (HW 94.9 % HL) and not strongly depressed (HD 42.6 % of HL). Snout short (ES 40.3 % HL); scales on snout granular, keeled, larger than those on forehead and interorbital region. Eye relatively small (ED 19.3 % HL); pupils round; extra-brillar fringe scales large anteriorly, gradually becoming smaller posteriorly. The tympanum is relatively small (TD 6.9 % HL), oval and broader than long. The rostrum is broader than long, with a partially dividing median groove. Nasals separated from each other by two supranasals, which are in contact with each other; nasals bordered posteriorly by two postnasals and are not in contact with the first supralabial. Mental scale sub-pentagonal bordered posteriorly with two widely separated postmentals and a single, large intermediate chin shield. Supralabials to the angle of jaw, seven; Infralabials to the angle of the jaw, seven. Ventral scales of head and neck granular, smooth.

Body rather robust (TW 61.0 % AG) and moderately elongate (AG 44.9 % SVL). Mid-dorsal scales heterogeneous with small granular scales intermixed with irregularly arranged marginally enlarged, keeled tubercles. Ventral scales smooth, larger than dorsal scales. Pectoral scales sub-imbricate, abdominal and pelvic scales juxtaposed.

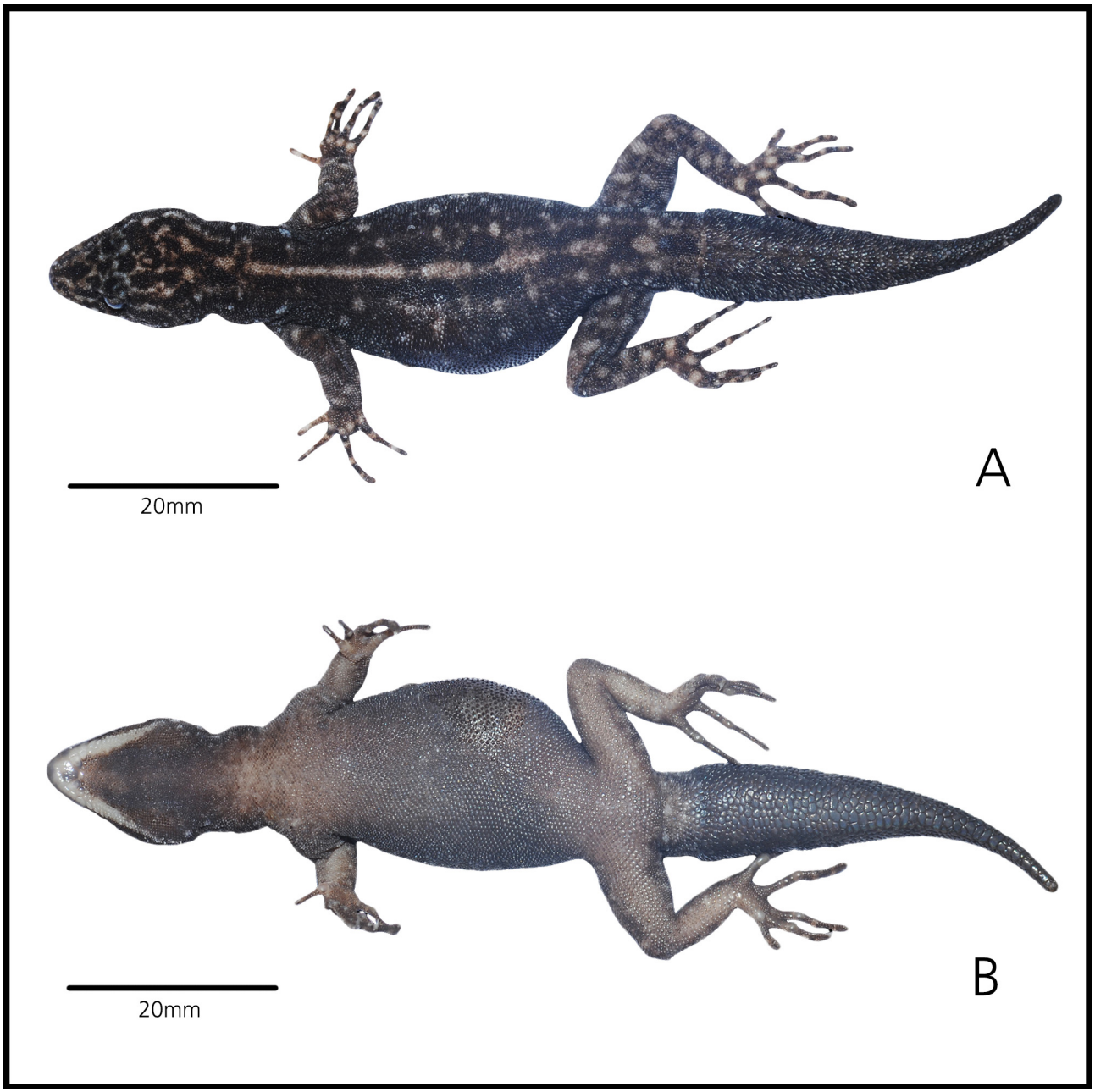

FIGURE 4. Holotype of *Cnemaspis anamudiensis* **sp. nov. A.** dorsal view; **B.** ventral view.

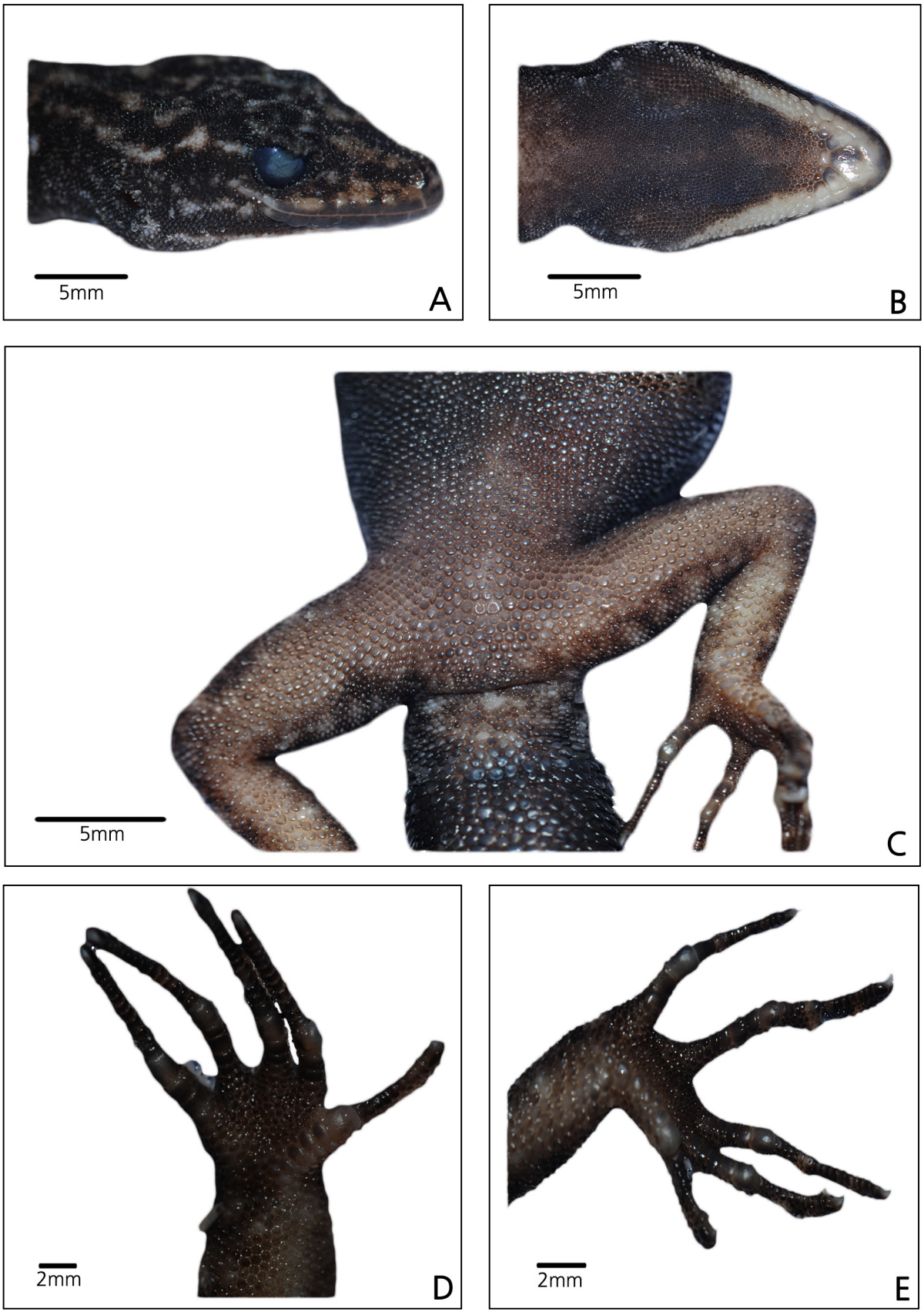

FIGURE 5. Pholidosis of *Cnemaspis anamudiensis* **sp. nov. A.** lateral view of head; **B.** ventral side of head; **C.** precloacal and femoral region; **D.** lamellae under hand; **E.** lamellae under foot.

FIGURE 6. Colour in life of *Cnemaspis anamudiensis* **sp.nov. A.** dorsal view of male; **B.** close-up of head showing the bright red iris; **C.** dorsal view of female.

The forelimbs are moderately long; upper arm longer than lower arm (UAL 12.4 % SVL; LAL 11.4 % SVL). The hindlimbs are longer than forelimbs; femur longer than tibia (FEL 16.6 % SVL; TBL 15.4 % SVL). Dorsal scales of forelimbs and hind limbs granular, keeled and without enlarged tubercles; ventral scales smooth; scales on manus and pes, smooth. Subdigital lamellae entire, a few fragmented; lamellae on the basal phalanges larger. Interdigital webbing absent. Subdigital lamellae on finger I: 14, finger II: 15, finger III: 19, finger IV: 19, finger V: 16; toe I: 12, toe II: 17, toe III: 20, toe IV: 21 and toe V: 17. Relative length of digits, fingers: IV (6.6 mm) > III (6.4 mm) > V (5.9 mm) > II (5.3 mm) > I (4.4 mm); toes: IV (7.8 mm) > III (6.8 mm) > V (6.5 mm) > II (5.8 mm) > I (3.5 mm). Precloacal and femoral scales are larger than abdominal scales. Femoral pores absent; 2 precloacal pores present.

Tail sub cylindrical in cross-section, regenerated, its length shorter than SVL (TL 40.4 mm). The tail base is slightly swollen with a single large, conical postcloacal spurs on each side. Dorsal scales of tail granular. Ventral scales larger than dorsal scales of tail; subcaudals slightly larger than adjacent scales, rounded and smooth. Subcaudals irregularly arranged.

Colouration in preservative (Fig. 4): Head dark brown to black mottled with light brown markings. The ventral side of the head and neck are dark brown except for the first two infralabials and few adjacent scales which are white in colour. The dorsal side of the body is dark brown mottled with lighter brown markings and a vertebral light brown line which is interrupted posteriorly from the mid body to the base of the tail. Dorsal sides of the forelimbs and hindlimbs are dark brown with several lighter brown spots. Dorsal side of the pes and manus are dark brown with lighter brown bands. Ventral side of the abdomen and limbs are dark grayish brown in colour. Dorsal side of tail dark brown mottled with lighter markings, ventral side uniform grayish brown.

Colouration in life (Fig. 6): Dorsum overall dark grayish brown with a long orange/ochre vertebral line on the back interrupted by small paired black spots. Paravertebral region mottled with light and dark brown markings with a series of four to five buff yellow spots running transversely on either side of the vertebral line. The head is grayish brown with light and dark reticulations. The iris is bright red in colour. Forelimbs and hind limbs brown with brick red spots; digits cross-barred with black and brick red bands. The tail is grayish brown with irregular light and dark markings. Ventral sides of throat, neck and abdomen, are dark grey.

Variation: Morphometric data for the type series is provided in Table 1. Supralabials range from seven, as in the holotype and ZSI/WGRC/IR.V/2707, to eight, as in ZSI/WGRC/IR.V/2708 and ZSI/WGRC/IR.V/2709; Infralabials eight on the right side and seven on the left side in ZSI/WGRC/IR.V/2708; supranasals separated by a small internasal in ZSI/WGRC/IR.V/2708; tail complete with subcaudals being enlarged, smooth and regularly arranged in ZSI/WGRC/IR.V/2707. Lamellae varies from13–15 on manus I , 15–17 on manus II , 19–21 on manus III , 19–21 on manus IV and16–17 on manus V ; lamellae ranges from 12–13 on pes I , 17–18 on pes II, 19–21 on pes III , 20–22 on pes IV and17–19 on pes V.

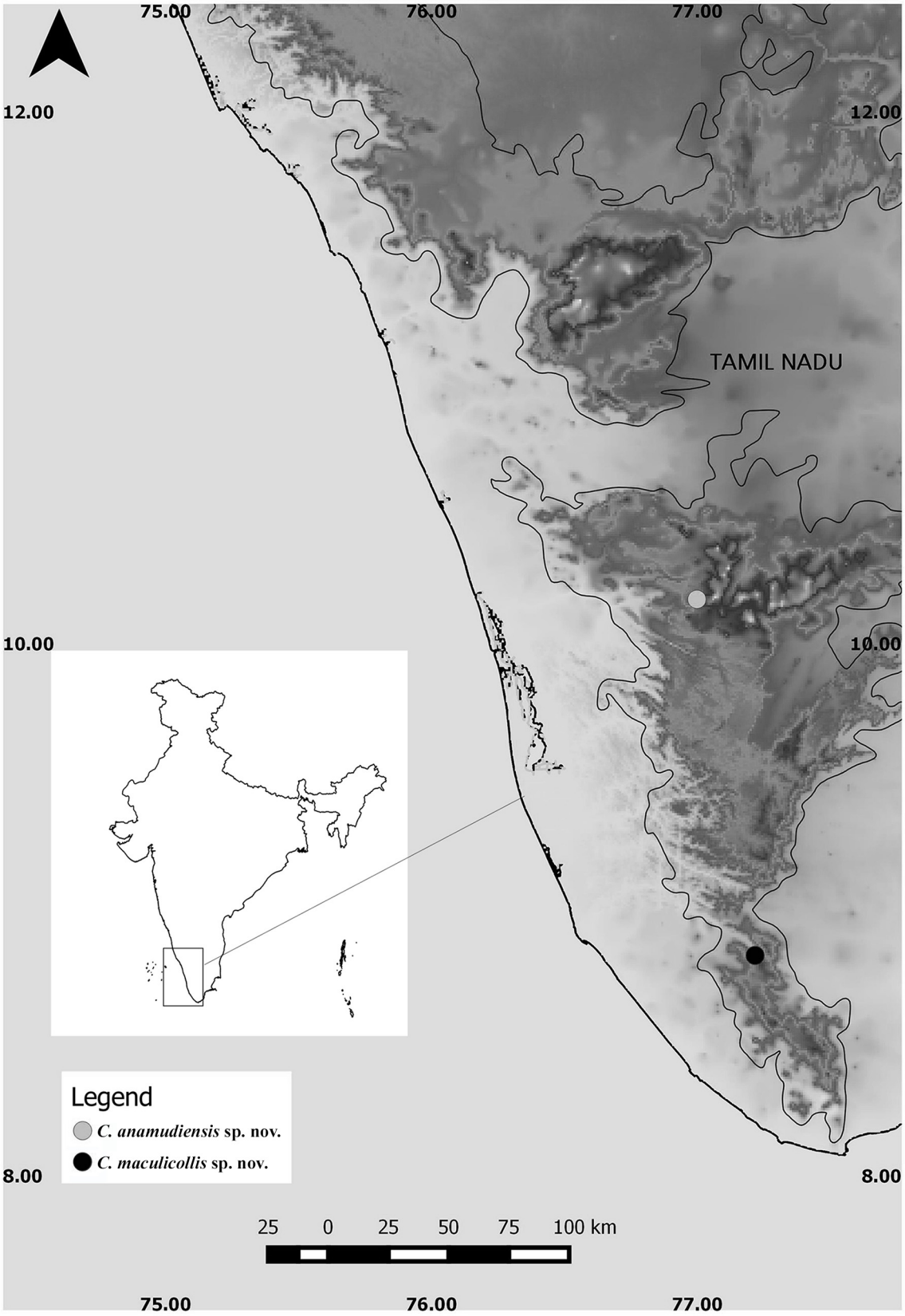

FIGURE 7. Map of southern Western Ghats showing the distribution of *C. maculicollis* **sp. nov.** and *C. anamudiensis* **sp. nov.** Inset shows the map of India with the rectangular box depicting the study region.

Etymology: The specific epithet is named after the Anamudi reserve forest in Munnar of Idukki District of Kerala, the type and only known locality for this species.

Distribution: At present, *Cnemaspis anamudiensis* **sp. nov.** is known to occur in Pettimudi, Anamudi Reserve Forest (10.16675°N, 076.99791°E) in the Munnar Forest Division of Idukki District at an elevation range of 1860 – 1900 m (Fig. 7). The area is contiguous with Eravikulam National Park and is near Anaimudi peak (2695m ASL), the highest peak in the Western Ghats.

Natural History: The adult male holotype was found in the crevice of a huge rock boulder in an evergreen forest in Anamudi Reserve Forest. The paratype ZSI/WGRC/IR.V/2708 was also found between rock crevices in evergreen forest. ZSI/WGRC/IR.V/2707 and ZSI/WGRC/IR.V/2709 were found in the crevices of wet boulders in a stream.

Discussion

Both species described herein are from high elevation forests (above 1200m) of two major massifs in the southern Western Ghats—the Anaimalai Hills, south of the Palghat Gap; and the Agasthyamalai Hills, south of the Shenkottah Gap. The two species are presently known from single localities within these massifs. Both these mountain ranges, being in the southern part of the Western Ghats, are recognized to harbor greater species richness and endemism compared to the northern and central Western Ghats (Davidar *et al.* 2007; Gunawardene *et al.* 2007). Although the reptilian diversity of the Western Ghats remains largely underexplored, recent taxonomic investigations have been centered in the northern and central Western Ghats, with the southern Western Ghats being relatively under-represented (Giri 2008; Giri *et al.* 2009b; Smith *et al.* 2012; Srinivasulu *et al.* 2014; Vogel & van Rooijen 2011).

Mountain ranges are known to harbor high diversity by promoting divergence through allopatric and parapatric speciation (Robin *et al.* 2010; Fjeldså*et al.* 2012; Parra-Olea *et al.* 2012; Vijayakumar *et al.* 2016). Recent explorations in the high mountains of the Western Ghats have led to the discovery of several distinct lineages of birds and amphibians providing insights into the role of the Western Ghats in species diversification (Robin *et al.* 2010, 2017; Vijayakumar *et al.* 2016). Lack of systematic studies leaves many questions unanswered on the ecology, diversification and distribution of cryptic species groups (Bickford *et al.* 2007). The reptilian community of the Western Ghats is exceptionally species rich (Mukherjee *et al.* 2005; Srinivasulu *et al.* 2014), yet studies pertaining to the diversity of reptiles in the high mountains of the Western Ghats remain limited. This is especially so with respect to the genus *Cnemaspis* and is partly due to the high degree of morphological conservatism between species of these geckos, which has long been noted (Das & Bauer 1998; Grismer *et al.* 2014). However, intensive surveys throughout the Western Ghats and detailed examinations of specimens along with molecular analysis could reveal several undescribed cryptic species allowing further studies that enhance our understanding of the role of mountains in generating biodiversity.

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