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A new species of Day Gecko of the genus *Cnemaspis* Strauch, 1887 (Squamata : Gekkonidae) from the Nilgiri Hills, Tamil Nadu, India

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Abstract

Based on the field explorations in the Western Ghats, a day gecko of the genus *Cnemaspis* 1887 is described from the Nilgiri hill ranges of Tamil Nadu. A medium sized gecko is distinguished from all the other congeners by a set of distinct morphological characters. Current taxonomic issues persisting among the members of genus *Cnemaspis* reported from the Western Ghats and India are discussed. The new species is found to have restrictive range of distribution in the higher elevations of Nilgiri hills. The discovery of a new high altitude endemic species indicates a need of further explorations in Nilgiri hill ranges.

Keywords: *Cnemaspis*, Gekkonidae, New Species, Nilgiri Hills, Taxonomy, Western Ghats

Introduction

The genus *Cnemaspis* Strauch, 1887, is one of the most species-rich assemblages of day geckos under the family Gekkonidae and distributed from Africa to Southeast Asia. The richest areas of diversity for Asian *Cnemaspis* are in the hill ranges of peninsular India (The Western Ghats and the Eastern Ghats) and the Central hills of Sri Lanka (Smith, 1935; Das & Bauer, 2000). In the last decade, the number of species recognized in the genus *Cnemaspis* has grown rapidly, reaching over 140 species (Uetz & Hallermann, 2018), of which 34 species are known from political boundaries of India, of which 25 species are endemic to the Western Ghats. There is a high upsurge of 94 new species discovery since 2001 (as on April 2019) as a result of many researchers are actively involved in field exploration to study this genus in particular. Day geckos are diminutive and slender bodied; they possess prominent forward and upwardly-directed eyes with round pupils, and elongate slender digits that are bent at an angle with entire sub-digital lamellae (Vidanapathirana *et al.*, 2014; Wood *et al.*, 2013). Day geckoes are mainly diurnal or crepuscular in activity; occur in tropical as well as subtropical regions. Despite their superficial morphological similarities, molecular phylogeny has shown that the genus *Cnemaspis* is not a monophyletic group (Gamble *et al.*, 2012; Pyron *et al.*, 2013; Zheng & Wiens, 2016).

The recent extensive taxonomic revisions and explorations particularly in Southeast Asia, India and Sri Lanka, resulted in the discovery of several new species (Das & Bauer, 2000; Das & Sengupta, 2000; Bauer, 2002; Manamendra-Arachchi *et al.*, 2007; Wickramasinghe & Munindradasa, 2007; Giri *et al.*, 2009; Grismer *et al.*, 2010, 2014; Cyriac & Umesh, 2013, 2014; Mirza *et al.*, 2014; Srinivasulu *et al.*, 2015; Sayyed *et al.*, 2016; Agarwal *et al.*, 2017; Iskandar *et al.*, 2017; Cyriac *et al.*, 2018; Sayyed *et al.*, 2018; Akshay Khandekar, 2019). The Western Ghats harbor a high number of endemic species

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(Myers *et al.,* 2000) in diverse ecosystem, some of the areas remains unexplored and still holding more. This has lead to our interest in documenting and describing the reptilian fauna of the region. Recent field surveys to high altitude regions of the Western Ghats parts of Tamil Nadu have revealed the existence of many undescribed species of Reptiles. Here we describe a new species of genus *Cnemaspis* from Nilgiri hill ranges of the Western Ghats parts of Tamil Nadu based on the distinct morphological characters from other Indian congeners.

Material and Methods

Specimens were collected carefully by hands at Horasolai on the way to Kothagiri on 24th July 2017, photographed in its habitat using Canon 5D Mark III and Canon 100 mm f2.8 macro lens. Coordinates were taken using Garmin Etrex 30x handheld GPS with an accuracy of less than 5 meter. The animals were immobilized carefully by using chloroform to take close-up images of the live specimens under Leica M205 Microscope. The specimens were then euthanized (George, 1973), positioned properly and fixed in 10% formalin for 48 hours, washed in running water and preserved in 70% ethyl alcohol for further studies. The details of the species locality and other aspects were properly labeled and tied around the groin region of each animal using a cotton thread. The type specimens were deposited in National Zoological Collection (NZC) repositories of Zoological Survey of India (ZSI), Western Ghats Regional Centre (WGRC), Kozhikode, Kerala, India.

Morphological Study

The following measurements (Table 1) were taken with Mitutoyo digital caliper (to the nearest 0.1 mm): **SVL**-Snout vent length (from tip of snout to vent), **AG**-Axilla to groin (distance from axilla to groin measured from posterior edge of forelimb insertion to anterior edge of hind limb insertion), **TW**-Trunk width (maximum width of body), **TL**- Tail length (from vent to tip of tail), **TaW**-Tail width (measured at widest point of tail), **HL**-Head length (distance between retroarticular process of jaw and snout-tip), **HW**-Head width (maximum width of head), **HH**-Head height (maximum depth of head, from occiput to underside of jaws), **FaL**-Forearm length (from base of palm to elbow), **TbL**-Tibia length (knee to tarsal), **AeN**-Anterior eye to nostril (distance between anterior most point of eye and nostril), **PeN**- Posterior eye to nostril (distance between posterior most point of eye and nostril), **AeS**-Anterior eye to snout (distance between anterior most point of eye and tip of snout), **PeS**-Posterior eye to snout (distance between posterior most point of eye and tip of snout), **AePe**-Anterior ear to posterior eye (distance from anterior edge of ear opening to posterior end of eye), **EL**-Ear length (maximum end to end distance of the ear), **InD**-Inter nares distance (right side of the nare to left side of the nare), **OD**-Orbital diameter (greatest diameter of orbit).

Meristic Data

Following meristic data were recorded for all specimens (Table 1): the number of Supra-Labial (**SL**) scales, Infra-Labial (**IL**) scales, Femoral Pores (**FP**), and lamellae under digits of Manus (**MLam**) and Pes (**PLam**) for both Left (L) and Right (R) sides (lamellae counts taken from the scale just behind claw to first inter phalangeal joint excluding large scansors), as well as scales across the belly between the lowest rows of dorsal scales (**VS**), spine like tubercles, and lamellae under 4th digit of pes (**LamIVth**). Scale counts and external observations of morphology were made using the microscope Leica DFC 500.

Systematics

Generic Allocation

Day gecko samples collected from the Nilgiri hills were fitting into the set of morphological characters provided for the genus by Gray (1842) and Strauch (1887). Since morphological characters were not matching with any of the extant species of *Cnemaspis*, the new species is described here with the unique set of morphological characters with a comparison with the congeners distributed across India.

Cnemaspis anandani sp. nov.

Holotype: ZSI/WGRC/2958 (adult male) collected during evening hours (16.09 hrs.) at Horasholai (N 11.416; E 76.82 elevation 1,990 mtrs.) from the culvert passage below the road, which is close to a tea estate. The locality is about 6.2 kms from Kothagiri village, Nilgiri district, Tamil Nadu of the Western Ghats region, specimen collected by Nitesh. A, B. H. Channakeshava Murthy and R. Venkitesan on 24th July 2017 (Figure 1A-E; Figure 2 A & B; Figure 7).

Table 1. Mensural and meristic features of the holotype and paratype of *Cnemaspis anandani* sp. nov.

Characters	*	#					#				
	ZSI 2958	ZSI 2960	ZSI 2963	ZSI 2965	ZSI 2966	Average ± SD (Range)	ZSI 2959	ZSI 2961	ZSI 2962	ZSI 2964	Average ± SD (Range)
	Male	Male	Male	Male	Male		Female	Female	Female	Female	
SVL	37.26	39.19	38.09	39.8	40.97	39.06±1.44(37.26-40.97)	38.18	41.21	37.43	38.11	38.73±1.66(37.43-41.21)
AG	13.55	14.38	13.23	15.74	16.66	14.71±1.45(13.23-16.66)	14.79	16.17	16.08	12.66	14.92±1.63(12.66-16.17)
TW	6.63	7.24	6.71	6.98	6.66	6.84±1.45(6.63-7.24)	7.75	8.18	7.45	7.45	7.70±0.34(7.45-8.18)
TL	42.16	35.3(?)	48.36	33.42	40.26	41.05±6.15(33.42-48.36)	42.07	36.19	6.81(**?**)	27	35.08±7.59(6.81-42.07)
TaW	3.8	4.3	4.23	4.6	4.3	4.24±0.28(3.3-4.6)	3.57	4.05	4.15	4.32	4.02±0.32(3.57-4.32)
HL	8.21	9.22	9.46	9.79	9.12	9.16±0.59(8.21-9.79)	8.8	9.7	9.81	9.24	9.38±0.46(8.8-9.81)
HW	6.3	7.12	6.87	6.68	6.9	6.77±0.30(6.63-7.21)	6.35	7.12	6.01	6.57	6.51±0.46(6.01-7.12)
HH	4.43	4.11	4.13	3.92	3.98	4.11±0.19(3.92-4.43)	3.96	4.09	3.44	4.36	3.96±0.38(3.44-4.36)
FaL	4	5.52	5.36	5.56	5.01	5.09±0.64(4-5.56)	4.93	5.11	5.11	5.32	5.11±0.15(4.93-5.32)
TbL	5.38	6	5.92	6.45	5.43	5.83±0.44(5.38-6.45)	5.53	5.53	5.84	5.59	5.526±0.14(5.53-5.84)
AeN	2.7	3.38	3.11	3.43	3.18	3.16±0.28(2.7-3.43)	3.08	3.44	3.56	3.17	3.31±0.22(3.08-3.56)
PeN	4.36	5.23	5.11	5.62	5.18	5.1±0.45(4.36-5.63)	5.45	4.31	5.47	5.39	5.40±0.07(5.31-5.47)
AeS	3.3	4.01	3.89	4.32	3.95	3.89±0.37(3.3-4.32)	3.85	4.2	4.35	3.84	4.06±0.25(3.84-4.35)
PeS	4.9	5.94	5.94	6.49	5.95	5.84±0.57(4.9-6.49)	6.11	6.15	6.21	6.02	6.12±0.07(6.02-6.21)
AePe	2.69	2.9	2.99	2.82	2.76	2.83±0.11(2.69-2.99)	2.57	2.84	3.02	2.91	2.83±0.19(2.57-3.02)
EL	0.55	0.58	0.55	0.48	0.66	0.56±0.06(0.48-0.66)	0.5	0.57	0.65	0.64	0.59±0.06(0.5-0.65)
InD	1.17	1.23	1.06	1.08	1.07	1.12±0.07(1.06-1.23)	1.07	1.22	1.22	1.02	1.13±0.10(1.02-1.22)
OD	2.51	2.54	2.44	2.84	2.72	2.6±0.16(1.06-1.23)	2.81	2.52	2.51	2.62	2.61±0.13(1.51-2.81)
HL/SVL	2.22	0.23	0.24	0.24	0.22	0.23±0.01(0.22-0.24)	0.23	0.23	0.26	0.24	0.24±0.01(0.23-0.26)
HW/SVL	0.16	0.18	0.18	0.16	0.16	0.16±0.01(0.16-0.18)	0.16	0.17	0.16	0.17	0.16±0.005(0.16-0.17)
HW/HL	0.76	0.77	0.72	0.68	0.75	0.73±0.03(0.68-0.77)	0.72	0.73	0.61	0.71	0.69±0.5(0.61-0.73)
AeS/HL	0.40	0.43	0.41	0.44	0.39	0.41±0.02(0.39-0.44)	0.43	0.43	0.44	0.41	0.42±0.01(0.41-0.44)
HH/HL	0.53	0.44	0.44	0.4	0.43	0.44±0.04(0.4-0.53)	0.45	0.42	0.35	0.47	0.42±0.05(0.35-0.47)
AeS/HW	0.52	0.56	0.56	0.64	0.57	0.57±0.04(0.52-0.64)	0.6	0.58	0.72	0.58	0.62±0.06(0.58-0.72)
OD/AeS	0.76	0.63	0.62	0.65	0.68	0.66±0.05(0.62-0.76)	0.73	0.6	0.57	0.68	0.64±0.07(0.57-0.73)
OD/HL	0.30	0.27	0.25	0.28	0.29	0.27±0.01(0.35-0.3)	0.31	0.25	0.25	0.28	0.27±0.02(0.25-0.31)
EL/HL	0.06	0.06	0.05	0.04	0.07	0.05±0.01(0.04-0.07)	0.05	0.05	0.06	0.06	0.05±0.005(0.05-0.06)
AePe/OD	1.07	1.14	1.22	0.91	1.01	1.08±0.09(0.99-1.22)	0.91	1.12	1.2	1.11	1.08±0.123(0.91-1.2)
AG/SVL	0.36	0.36	0.34	0.39	0.4	1.08±0.02(0.99-1.22)	0.38	0.39	0.42	0.33	0.38±0.03(0.33-0.42)
FaL/SVL	0.10	0.14	0.14	0.13	0.12	0.12±0.01(0.99-1.22)	0.12	0.12	0.13	0.13	0.12±0.005(0.12-0.13)
TbL/SVL	0.14	0.15	0.15	0.16	0.13	0.15±0.01(0.13-0.16)	0.14	0.13	0.15	0.14	0.14±0.008(0.13-0.15)
TL/SVL	1.13	0.9	1.26	0.83	0.98	1.02±0.17(0.83-1.26)	1.1	0.87	0.16	0.7	0.70±0.40(0.16-1.1)
VS	17	16	16	18	16	17.4±0.54(17-18)	17	17	17	18	17.5±0.57(17-18)
SL	7	8	7	7	7	7.2±04(7-8)	7	8	7	8	7.25±0.95(6-8)
IL	7	8	7	7	7	7.2±0.44(7-8)	7	7	7	7	6.75±0.5(6-7)
FP	5+5	5+5	5+5	5+5	6+6		—	—	—	—	
MLam (R)	8-11-13-13-12	9-13-14-15-12	9-12-13-12-12	9-14-14-14-13	9-12-15-14-12		8-12-14-15-13	9-12-14-15-13	9-11-11-13-13	9-12-16-14-13	

PLam (R)	9-13-14-17-15	9-13-14-16-15	8-12-14-16-14	8-14-16-17-15	9-14-16-16-15		9-13-15-16-15	9-13-15-17-16	8-12-15-16-14	9-13-16-17-15	
MLam(L)	9-11-14-14-12	8-13-14-14-12	9-12-14-14-12	12-12-14-15-13	9-10-15-15-12		10-13-15-14-13-	9-12-16-14-13	9-12-13-14-12	11-14-16-15-14	
PLam(L)	8-13-15-17-15	8-13-15-16-15	8-12-15-16-15	9-14-15-16-15	9-14-15-16-16		9-14-15-16-15	9-13-16-17-15	8-12-15-16-15	9-14-15-17-17	

Holotype **(*)** Paratype **(#)** Tail Damaged **(?)**

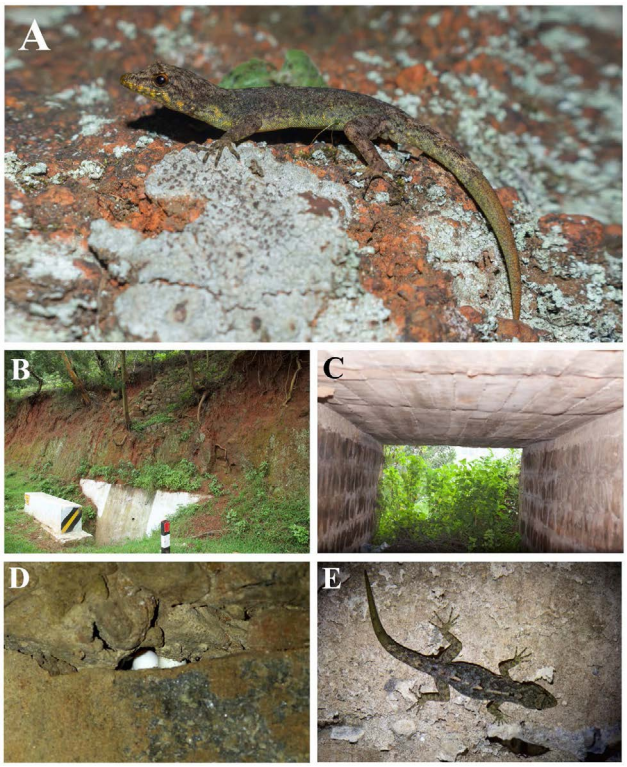

Figure 1. **(A)** *Cnemaspis anandani* sp. nov. (male) live in its habitat. **(B)** Type locality of *Cnemaspis anandani* sp. nov. **(C)** Habitat preference of *Cnemaspis anandani* sp. nov. **(D)** Egg laid by *Cnemaspis anandani* sp. nov. inside the crevices in its habitat. **(E)** *Cnemaspis anandani* sp. nov. (female) dwelling inside the micro habitat in type locality.

Paratypes: ZSI/WGRC/2959 (female), 2960 (male), 2961 (female), 2962 (female), 2963 (male), 2964 (female), 2965 (male) & 2966 (male), a total of 8 numbers, collection data same as holotype (Figure 3), specimens collected by Nitesh. A, B.H. Channakeshava Murthy and R. Venkitesan on 24th July 2017.

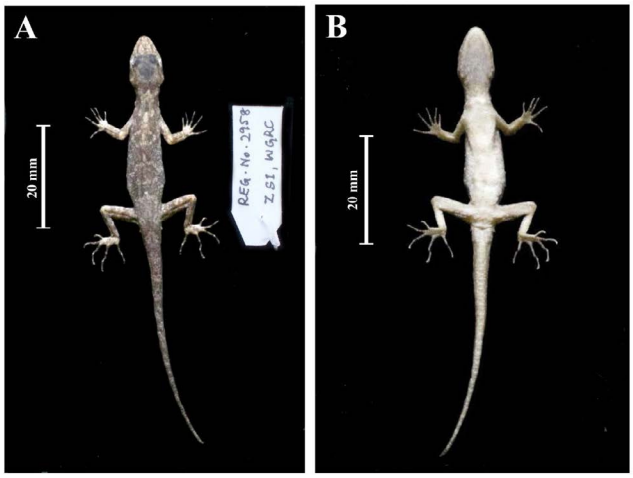

Figure 2. **(A)** Dorsal side of the holotype **(B)** Ventral side of the holotype.

Species Diagnosis: A medium sized *Cnemaspis* with a maximum snout-vent length 41.2 mm; dorsal scales heterogeneous, entire dorsals keeled, scales are variable in size, interspersed with few large scales, irregularly arranged tubercles; two rows of enlarged 7-8 conical tubercles present on flanks; 3-4 small tubercles on the lateral side of the neck region; ventrals smooth with 16-18 mid body scales, imbricate; supra-labials to angle of jaw 7-8; infra-labials 7-8; sub-digital lamellae under manus IV 14-15; under pes IV 16-17; tail base slightly swollen, sub cylindrical, bulbous with a single post-cloacal spurs on each side; dorsal scales of tail is rough, keeled with two small, two enlarged tubercles on each side, weak whorls; sub-caudals smooth, enlarged, hexagonal, regularly arranged scales; male with 5-6 femoral pores, separated by 19–20 unpored femoro-precloacal scales; preanal pores absent.

Figure 3. Type series (Holotype & Paratypes) of *Cnemaspis anandani* sp. nov.

Description of Holotype: An adult male with entire tail (Figure 2 A & B); SVL 37.26 mm; head moderately short (HL/SVL = 0.22), slightly wide (HW/HL =0.76), slightly depressed (HH/HL = 0.53), distinct from elongate neck; canthus rostralis not prominent; rostral scale partially divided by a medial groove, in contact with first supra-labial; nares rounded, separated by two enlarged supra-nasals and a single elongated internasal scale; loreal region slightly inflated; snout slightly longer (AeS/HL = 0.40), longer than orbit diameter (OD/HL = 0.30); scales on snout and canthus rostralis large, variable in shape; granular scales on snout larger than those on occipital region, carinate, intermixed with keeled scales, slightly larger than those on forehead and inter orbital; eye small (OD/HL = 0.30), pupil round, superciliaries slightly elongated; ear opening small, deep, oval shaped (0.55); eye to ear distance much greater than diameter of eye (AePe/OD =1.07); rostral wider (1.633) than deep (0.818), slightly swollen, weakly divided; postnasal in contact with supra labial I; rostral in contact with supralabial I; single row of scales separates orbit from supralabials; mental triangular, wider (2.09) than deep (1.67), posterior not pointed; two pairs of postmentals, primary larger than secondary postmentals, primary touching first postmentals, secondary postmentals touching first and second infra-labials; single enlarged gular scale prevents posterior contact of left and right postmentals; down the mentals, scales smooth, subimbricate in middle, elongated, keeled on either side; gular smooth, imbricate; infra labials bordered by row of elongated scales; supra-labials 7 on both sides; infra-labials- 7 on both sides; body not slender, not elongate (AG/SVL = 0.36), without ventrolateral folds; dorsal scales on trunk heterogeneous, granular keeled, intermixed with flat, feebly keeled triheadral blunt scales; conical or spine-like tubercles present on flank; ventral scales smooth, larger than dorsal, 16-18 scales across the belly; pre-anal scales slightly larger than ventrals; five femoral pores on each side, femoral pores on each side separated by 19 unpored femoro-precloacal scales; fore and hind limbs relatively proportional to the body, slender; forearm and tibia relatively short (FaL/SVL = 0.10; TbL/SVL = 0.14); fore limbs dorsals (upper) scales keeled, ventral (inner) scales smooth; hind limbs dorsals (upper) scales keeled, ventral (inner) scales smooth; Lamellae 8–11–13–13–12 (right manus), 9–13–14–17–15 (right pes), relative length of digits (measurements in mm): IV (3.4) > III (3.2) < V (3.4) > II (3.0) > I (2.4) (right manus), IV (4.9) > III (4.4) > V (4.1) > II (3.5) > I (2.2) (right pes), 9–11–14–14–12 (left manus), 8–13–15–17–15 (left pes), relative length of digits (measurements in mm): IV (3.6) > III (3.4) > V (3.0) < II (3.1) > I (2.5) (left manus), IV (4.7) > III (4.5) > V (4.1) > II (3.6) > I (2.2) (left pes);tail sub-cylindrical, longer than snout-vent length (TL/SVL = 1.13), tail base

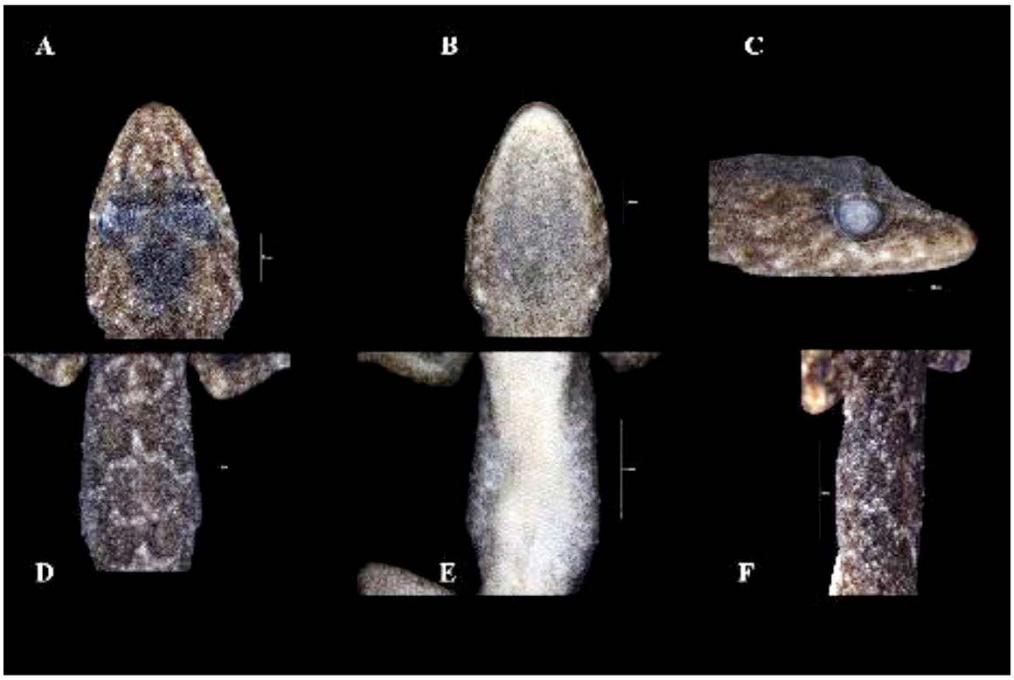

Figure 4. Holotype male *Cnemaspis anandani* sp. nov. (ZSI/WGRC 2958): **(A)** Head dorsal **(B)** Head ventral **(C)** Head lateral **(D)** Dorsal side of trunk **(E)** Ventral side of the trunk **(F)** Lateral side of trunk.

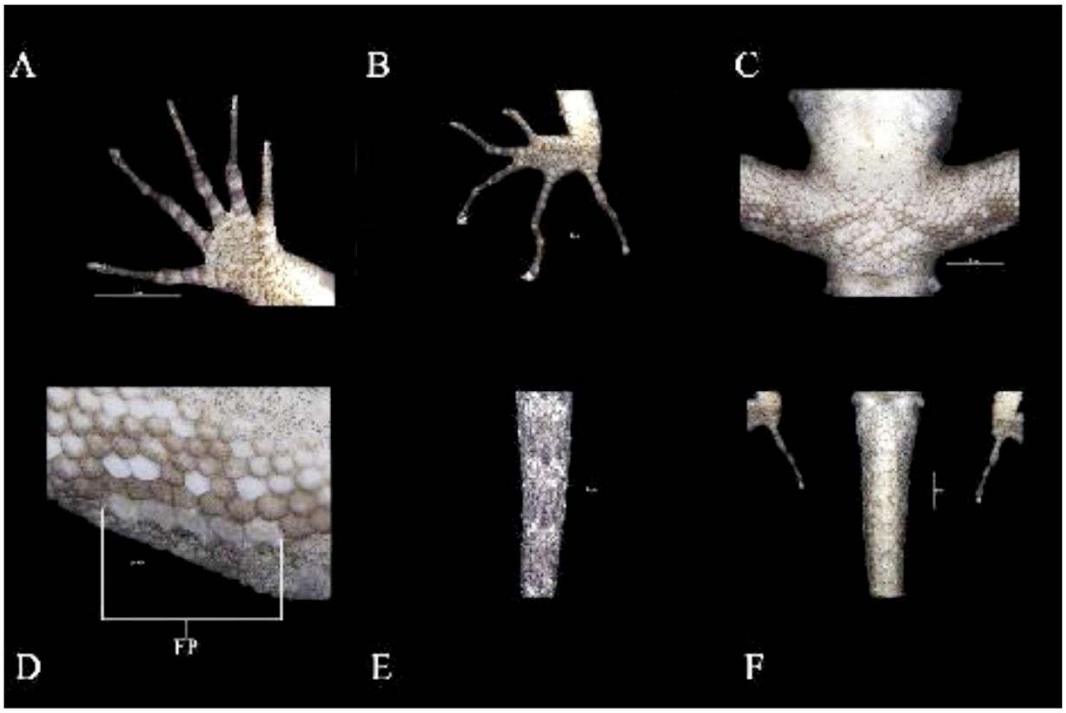

Figure 5. **(A)** Fore limb-Manus **(B)** Hind limb-Pes **(C)** Ventral side of the cloacal region showing femoral pores (FP) on both sides **(D)** Close view of femoral pores **(E)** Dorsal side of the tail **(F)** Ventral side of the tail.

slightly swollen with a single large conical post-cloacal spur on each side of the tail, entire dorsals more or less keeled with weak whorls, small blunt, trihedral tubercles serially arranged backwards, on either side of the tail running down till the tip of the tail, few tubercles vary in size forming weak whorls with enlarged, flattened, obtuse tubercles directed backwards till the tip of the tail; subcaudals anterior region is imbricate, then gradually forming an enlarged, hexagonal scales continuous till the tip of the tail (Figure 4 A-F; Figure 5 A-F).

Coloration in Preservative (Figure 2 A & B; 4 A-F; 5 A-F): Holotype has lost the natural colors, faded after fixation and preservation. Dorsal head is light brown in color with dark brown patches, bluish tinge over the eye and forehead; few tubercles behind eye and neck are crystal white. Vertebral region has irregular shaped, dull whitish blotches starts from nape, continued till the tip of the tail, becoming increasingly larger in the middle, separated with dark brown patches in between; crystal white tubercles present all over the dorsal region; flanks bearing small, crystal white tubercles; limbs covered with distinct, light and dark brownish markings, appearing weakly banded; dark bands on digits; original tail characterized with light brown patches with bands of crystal white tubercles and scales, each scale dotted with dark spots, tip of the tail is brownish.

Mentle dull creamy white; chin scales minutely covered by dark spotted grains; either sides of the infra-labials has dark brown patches; tubercles on gular, either side of the neck white, light black grains diffused on either sides, chest dull creamy white, continuous over the abdominal region; minute dark spots irregularly seen on the side of the abdomen, femoral region is mixed with minute black dotted dusky color in the anterior portion; grayish dull white and brown color spread over mid lower region including femoral pores; femoral pores are light creamy in colour ventral region of tibia creamy white interspersed with black dotted scales, sub-caudal region is creamish white in color interspersed with black dotted scales except the tip; tip is dull brown. Lower region of the hind limb is characterized with black dotted scales; lamellae with light brown bands.

Coloration in life (Figure 1A & Figure 6): Species lacks consistency in expression of coloration, day geckoes are capable of considerable change in coloration from a light

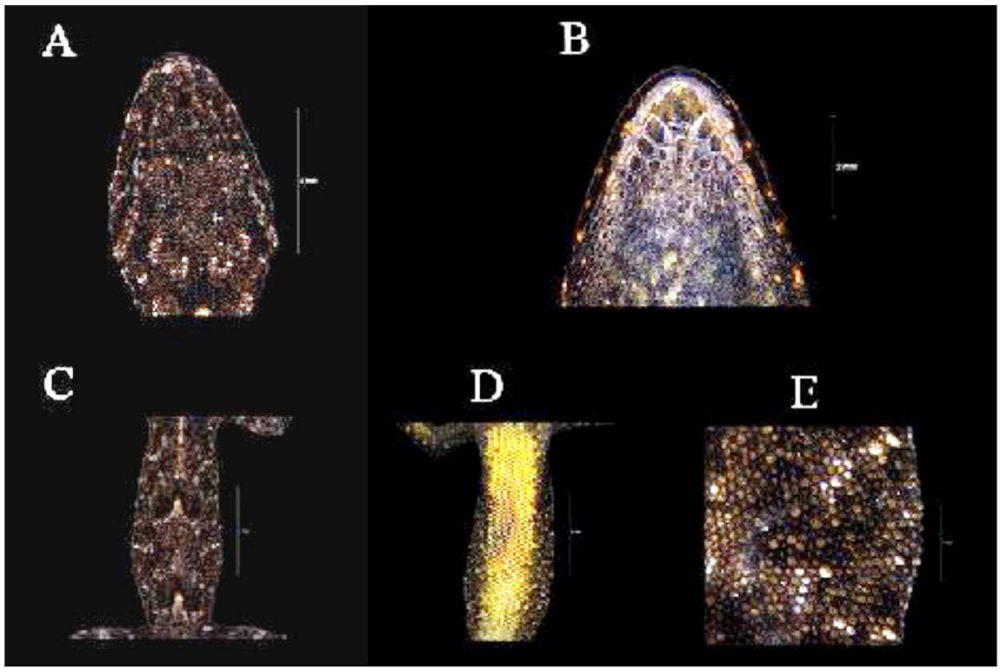

Figure 6. *Cnemaspis anandani* sp. nov. live images of Sub adult **(A)** Dorsal side of head **(B)** Mantle region of the head **(C)** Dorsal side of trunk **(D)** Ventral side of the trunk **(E)** Dorsal pholidosis.

to darker phase to camouflage to its surroundings to escape from the predator. Dorsal head, body, limbs and tail is unevenly yellowish green; velvety in appearance, there are mixture of various colored scale pattern, snout and supra-labials are bright yellowish, infra-labials light yellowish; this may even change to light orangish yellow, light brownish or light purplish postorbital stripes extend from eyes, yellowish orange scales in clusters behind supra-labials, nuchal region with a single, irregular, inverted U-shaped dark brown color pattern, followed by a five to six yellow/orangish yellow bands alternating with smaller dark brown patches; para-vetebral blotches partially fused mid-dorsally confluent to form an indistinct mid dorsal vertebral stripe, the blotches on the tail consists of dark brown, muddy, dull white scales that continues till the tip of the original tail; tip of tail is reddish orange, tubercles on dorsum, flank are bright yellow, it may even change to orangish yellow, dorsal region of the limbs is brown in color with yellow bands on digits; ventral region of the limbs with yellow except manus and pes; brown in color with dull white lamellae, ventral region is completely yellowish with tinge of green color; except the tail tip, which is light reddish orange.

Variation in Paratypes: Paratypes are same as holotype in morphological characters, except for variations in tubercles shape and size. The number of femoral pores (6+6) varies in ZSI/WGRC/2966, number of supralabials (8) varies in ZSI/WGRC/2960, 2961 & 2964, number of infralabials (8) varies in ZSI/WGRC/2960, number of ventral scales (16) varies in ZSI/WGRC/2960, 2963, 2966 and number of ventral scales (18) varies in ZSI/WGRC/2965 & 2964.

Etymology: The specific epithet is a patronym, named after Anandan Sethuraman an reputed Wildlife Conservationist, by honoring his contribution towards protection of Wildlife in the Niligiri district, Tamil Nadu, India.

Suggested common name: Anandan's Day Gecko

Distribution: *Cnemaspis anandani* sp. nov. is currently known to occur in Horasholai, Kotagiri and in Coonoor-

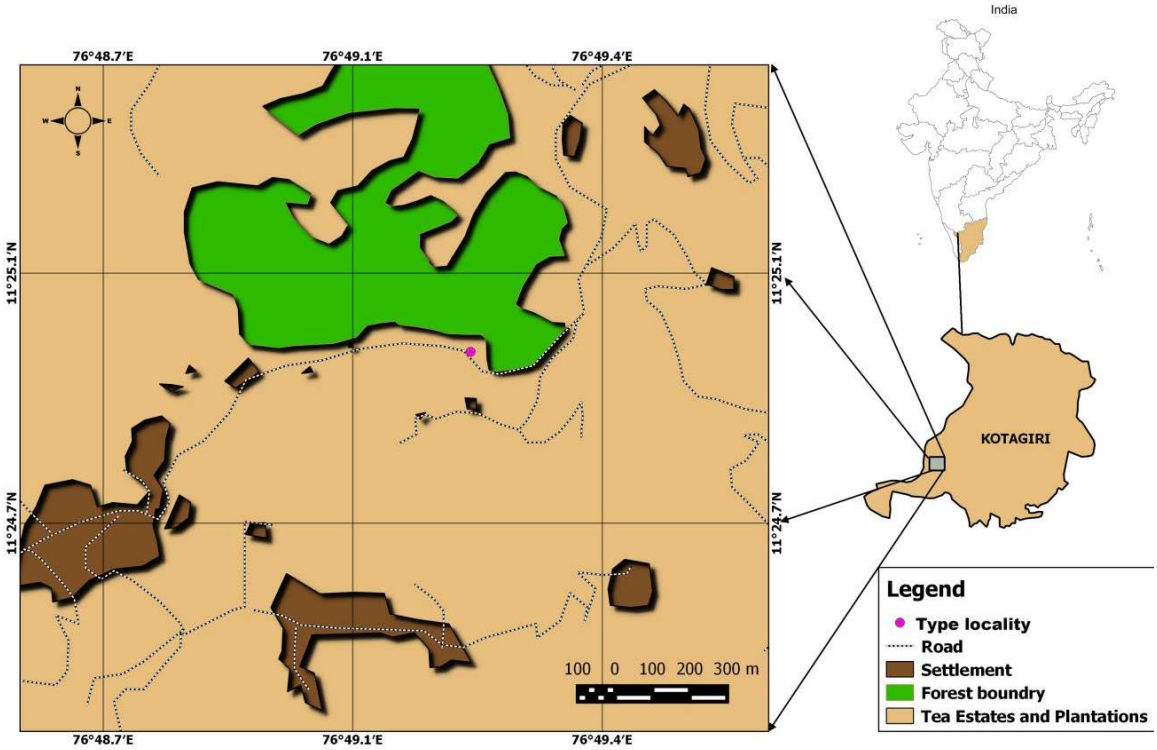

Figure 7. Type locality map of *Cnemaspis anandani* sp. nov.

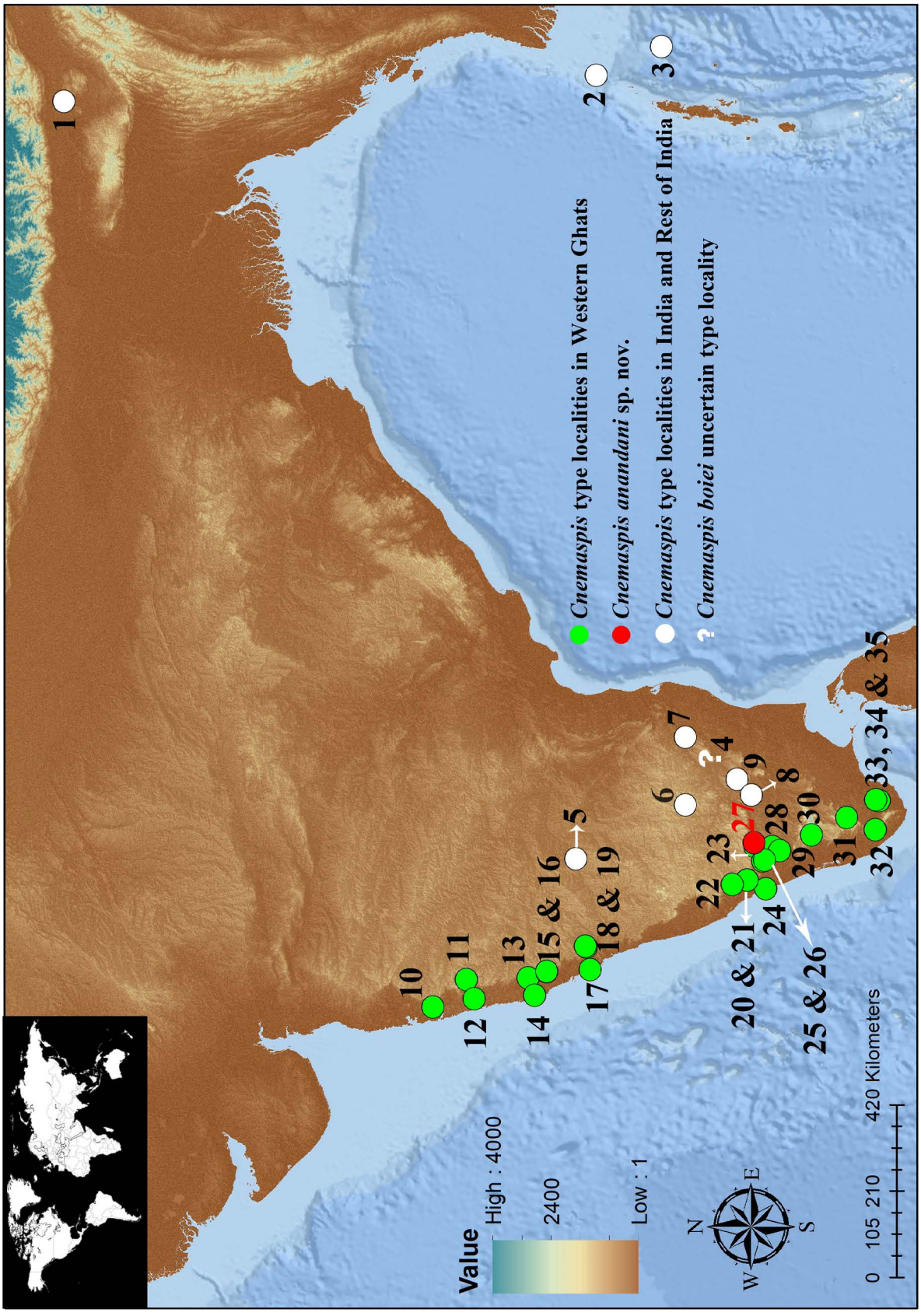

Figure 8. Map showing the type locality/distribution of genus *Cnemaspis* occurring in India (Refer table 2).

Table 2. Showing the overall distribution of the genus *Cnemaspis*

Sl. No	Species Name	Femoral Pores	Preanal Pores	Pholidoses (Dorsal)	Spinal Tubercles on the flank	Type locality	Type locality / predominant distribution in
1	*Cnemaspis assamensis* Das & Sengupta, 2000	Absent	Absent	Heterogeneous	Present	Mayeng Reserve Forest	Rest of India and peninsular India
2	*Cnemaspis wicksii* (Stoliczka, 1873)	4-5+4-5	4-5	Heterogeneous	Present	Preparis Island	
3	*Cnemaspis andersonii* (Annandale, 1904)	4+4	3	Heterogeneous	Present	Narcondum	
4	*Cnemaspis boei* (Gray 1842)	Absent	Absent	Homogenous	Absent	Presumed to be in Peninsular India	
5	*Cnemaspis adii* Srinivasalu, Kumar & Srinivasalu, 2015	2+2	2	Heterogeneous	Absent	Hampi	
6	*Cnemaspis mysoriensis* (Jerdon,1853)	2+2	2	Heterogeneous	Present	Agara Village, Bangalore	
7	*Cnemaspis otai* Das & Bauer, 2000	3+3	4	Heterogeneous	Present	Vellore	
8	*Cnemaspis agarwalii* Akshay kandekar, 2019	4-6+4-6	4	Heterogeneous	Absent	Selam	
9	*Cnemaspis yercaudensis* Das & Bauer, 2000	3+3	2	Heterogeneous	Absent	Yercaud	
10	*Cnemaspis mahabali* Sayyed, Pyron & Dileepkumar, 2018	3+3	Absent	Heterogeneous	Absent	Bhira	Western Ghats
11	*Cnemaspis girii* Mirza, Pal, Bhosale & Sanap, 2014	4+4	Absent	Heterogeneous	Absent	Satara	
12	*Cnemaspis ajijae* Sayyed, Pyron & Dileepkumar, 2018	3-4+3-4	Absent	Heterogeneous	Absent	Mahabaleshwar	
13	*Cnemaspis kolhapurensis* Giri, Bauer & Gaikwad, 2009	Present*	Present*	Homogenous	Absent	Kolhapur	
14	*Cnemaspis limayei* Sayyed, Pyron & Dileepkumar, 2018	4-5+4-5	Absent	Heterogeneous	Absent	Marutiwadi	
15	*Cnemaspis amboliensis* Sayyed, Pyron & Dileepkumar, 2018	3-4+3-4	3-4	Heterogeneous	Present	Amboli	
16	*Cnemaspis flaviventralis* Sayyed,Pyron & Dahanukar, 2016	3+3	Absent	Heterogeneous	Present	Amboli	
17	*Cnemaspis goaensis* Sharma, 1976	2-4+2-4	2-3	Heterogeneous	Present	Canacona	
18	*Cnemaspis indraneildasii* Bauer, 2002	female	female	Heterogeneous	Present	Gund	

19	*Cnemaspis heteropholis* Bauer, 2002	6+6	Absent	Heterogeneous	Present	Gund	Western Ghats
20	*Cnemaspis wynadensis* (Beddome, 1870)	4-6+4-6	Absent	Homogenous	Absent	Wayanad	
21	*Cnemaspis monticola* Manamendra-Arachchi, Batuwita & Pethyiyagoda, 2007	female	female	Heterogeneous	Present	Wayanad	
22	*Cnemaspis kottiyoorensis* Cyrica & Umesh, 2014	4-5+4-5	Absent	Heterogeneous	Absent	Perumalmudi	
23	*Cnemaspis indica* (Gray, 1846)	5+5	Absent	Homogenous	Absent	Madras Presidency	
24	*Cnemaspis littoralis* (Jerdon, 1853)	15-18+15-18	Absent	Homogeneous	Present	Chaliyam coast, Kozhikode	
25	*Cnemaspis sisparensis* (Theobald, 1876)	7-8+7-8	Absent	Homogenous	Absent	Sispara Ghat	
26	*Cnemaspis nilagirica* Manamendra-Arachchi, Batuwita & Pethyiyagoda, 2007	4-6+4-6	Absent	Heterogeneous	Present	Nilgiri hills	
27	*Cnemaspis anandani* sp. nov.	5+5	Absent	Heterogeneous	Present	Horasholai	
28	*Cnemaspis jerdonii* (Theobald, 1868)	8+8	Absent	Homogenous	Present	Siruvani hills	
29	*Cnemaspis gracilis* (Beddome, 1870)	3+5	2	Heterogeneous	Present	Palghat hills	
30	*Cnemaspis anamudiensis* Cyriac, Johny, Umesh & Palot, 2018	Absent	2	Heterogeneous	Absent	Anamudi	
31	*Cnemaspis maculicollis* Cyriac, Johny, Umesh, & Palot, 2018	Absent	10	Heterogeneous	Absent	Pandimotta	
32	*Cnemaspis nairi* Inger, Marks & Koshy, 1984	Absent	7-8	Heterogeneous	Absent	Ponmudi	
33	*Cnemaspis ornata* (Beddome, 1870)	Absent	6-8	Heterogeneous	Absent	Tirunelvely	
34	*Cnemaspis beddomei* (Theobald, 1876)	Absent	7	Heterogeneous	Absent	Tirunelvely	
35	*Cnemaspis australis* Manamendra-Arachchi, Batuwita & Pethyiyagoda, 2007	4-5+4-5	3	Heterogeneous	Absent	Tirunelvely	

* Continuous series of 24-28 precloacal femoral pores in *Cnemaspis kolhapurensis*.

Gandhipuram (N 11.33 ; E 76.79), which is 6.16 miles aerial distance and Dolphin nose (N 11.35 ; E 76.82), which is 4.21 miles aerial distance from the type locality. The maximum altitude recorded for the species is 1,990 m ASL comparing to other high-altitude species described so far such as *C. anamudiensis* (1900 m ASL), *C. maculicollis* (1250 m ASL) and *C. sisparensis* (1500 m ASL).

Natural history: The holotype and paratypes commonly found near the road side culverts, which is very close to the tea plantation and inside the hollow spaces of old wooden logs staked inside the tea plantation. The new species is found to be using the crevices for egg laying. We found large number of live animals in the evening hours around the walls of petrol pump in Kotagiri. Our field observations suggest this species is well adapted to live around human habitation.

Comparison

Cnemaspis anandani sp. nov. differs from all other Indian congeners by the following set of characters: Presence of heterogeneous pholidosis (versus homogeneous pholidosis bearing species *C. boiei*, *C. indica*, *C. jerdoni*, *C. littoralis*, *C. wynadensis*, *C. nilgirica*, *C. sisparensis*, *C. kolhapurensis* and *C. adii*). Presence of enlarged conical or spine-like tubercles on flanks (versus spine-like tubercles absent in *C. beddomei*, *C. nairi*, *C. adii*, *C. otai*, *C. sisparensis*, *C. wynadensis*, *C. anaikattiensis*, *C. indica, C. yercaudensis*, *C. girii, C. australis, C. limayei*, *C. ajijae,* C. *mahabali* and *C. agarwalii*). Presence of 5 femoral pores and absence of precloacal pores (versus absence of femoral pores in *C. assamensis*, *C. boiei, C. indraneildasii, C. monticola, C. anamudiensis, C. maculicollis, C. nairi, C. ornata, C. beddomei* and presence of only preanal pores in *C. anamudiensis, C. maculicollis, C. nairi, C. ornata, C. beddomei,* and presence of both femoral pores and preanal pores in *C. wicksii, C. andersonii, C. adii, C. mysoriensis, C. otai, C. agarwalii, C. yercaudensis, C. amboliensis, C. goaensis, C. gracilis*) Presence of 8-9, enlarged conical tubercles on the flank (versus presence of 5 spinal tubercles on the flank in *C. monticola*). Presence of smooth ventrals (versus presence of completely keeled ventral scales in *C. nilagirica*). Presence of 5 to 6 femoral pores on each side (versus absence of both femoral pores and precloacal pores in *C. boiei* and *C. assamensis*). Presence of 5 to 6 femoral pores on each side (versus presence of continuous series of 24-28 precloacal-femoral pores in *C. kolhapurensis*). Presence of 8-9, enlarged conical tubercles on the flank (versus presence of 5 spinal tubercles on the flank in *C. monticola*). Presence of 17-18 ventral scales and first supra labial in contact nasal scale (versus 22-24 ventral scales and first supra labial is not in contact nasal scale in *C. heteropholis*). Presence of 16-18 ventral scales, 16-17 lamellae on 4th pes and 5 femoral pores on each side (versus presence of 28-29 ventral scales, 10-12 lamellae under 4th pes and 3 femoral pores on each side in *C. flaviventralis*). Presence of 16-18 ventral scales, 16-17 lamellae under 4th pes (versus presence of 20 ventral scales, 12 lamellae under 4th pes in *C. indraneildasii*).

Discussion

Cnemaspis anandani sp. nov. is endemic to the Western Ghats and it is the 35th species reported from India. Our morphological comparisons, strongly confirm the presence of a distinct new species of *Cnemaspis* from Horasholai, Nilgiri hills, Tamil Nadu. Our comparison to other congeners from India, often struck up with many issues relating to lack of precise species type locality name, errors in description, description with single specimen or with only female or with only males and loss of type specimen or damaged type specimens in museum repositories. European researchers have unknowingly committed mistakes in providing precise type locality name or sometimes mentioned it wrongly.

Smith (1933) resurrected the generic name *Cnemaspis* Strauch 1887 in part based on the presence of cloacal bones in all old-world geckos then assigned it to *Gonatodes*, present in American region. Males are brilliantly colored than the females, without femoral or preanal pores. As shown by Noble (1921) and Smith (1933) the American *Gonatodes* are generally distinct from those inhabit the Old World where Strauch's *Cnemaspis* are found. Smith examined and noted that these elements are present in the males of all the Indian and Indo Chinese geckoes, and he included ten species of *Cnemaspis* in his work. Most of them are restricted to the hilly regions of Southern India and Ceylon.

The systematic study of the present genus *Cnemaspis* historically started with the description of *C. boiei* (described as *Goniodactylus boiei*) by Gray (1842) from India without precise name of the type locality, but it is presumed to be from Peninsular India. Systematic

sampling is warranted in the peninsular India to fix the precise type locality with re-description to stabilize the taxonomy of the nomen.

C. indica was described by Gray (1846) as *Goniodactylus indicus* and *Gymnodactylus indicus*, later he considered as *Goniodactylus indicus* as a junior synonym as *Goniodactylus indicus* and the type locality mentioned as Madras Presidency, (now falling under the political boundaries of four states Tamil Nadu, Kerala, Andhra Pradesh and parts of Karnataka). Jerdon (1853) in his Catalogue of Reptiles inhabiting the Peninsula of India, clearly mentioned that he himself procured the specimens from Nilgiris, where the animals were concealing under the stone in day time. He further added the precise locality of a new species collected from the top of Dodabetta, highest mountain in the range and also found it in the Coorg. Manamendra-Arachchi *et al*., (2007) designated lectotype from the specimens available in British Museum of Natural History, London (BMNH 46.11.22.22b, male) and mentioned the type locality as Madras. There is a need to fix the precise type locality to Doddabetta and to collect the fresh specimens to carry out the molecular work.

C. mysoriensis was described as *Gymnodactylus mysoriensis* in 1853 by Jerdon with the type locality mentioned as Bangalore, and later type specimen was found to be lost, then it was clearly established that Jerdon's type material of this species is not present in the collections of Natural History Museum, London or in Zoological Society of India. To stabilize the taxonomy Giri *et al*., (2009) designated a neotype from Agara Village, Bengaluru with a re-description of the *C. mysoriensis*. But there seems to be a discrepancy in the description of the morphological characters. While neotype designation, authors have mentioned dorsal scales pattern to be homogenous whereas the image of the specimen of the same work shows the dorsal scales pattern to be heterogeneous. This needs verification at the time of genus revision.

C. littoralis was described by Jerdon as *Gymnodactylus littoralis* in 1853 from a single male specimen with the mention of type locality as sea coast of Malabar. Later the type specimens were found to be lost after thorough search of reptile collection in ZSI and BMNH. Cyriac and Umesh (2013) designated the neotype of *C. littoralis* from Chaliyam coast, 13 kms from Kozhikode city, Kerala. The species *Gymnodactylus planipes* described by Beddome in 1871 from Nellicootah below the Nilgiris (western side) was treated as junior synonym of *C. littoralis* by Gunther in 1875 (refer Cyriac and Umesh, 2013).

C. jerdoni was described as *Gymnodactylus jerdoni* in 1868 by Theobald without any type locality details having the mention of Syntypes (ZSI 6179, 6180), both the specimens were badly damaged and fragmented. Interestingly the sub species *Cnemaspis jerdonii scalpensis* described by Ferguson in 1877 was assigned to species status with a mention of this species being endemic to Sri Lanka by Wickramsinge and Munindradasa (2007). In our study we have considered *C. jerdoni* distribution in the Siruvani hills (details will be discussed elsewhere).

C. gracilis was described as *Gymnodactylus gracilis* by Beddome in 1870 and the type locality was mentioned as Palghat Hills, Madras Presidency, this species warrants further exploration to fix precise type locality.

C. ornata was described as *Gymnodactylus ornatus* by Beddome (1870) with the type locality mentioned as "Tinnevelly South India". Manamendra-Arachchi *et al.,* (2007) fixed this locality as Tirunelveli, Tamil Nadu, India. The species have to be fixed to a precise location in current Tirunelveli, Tamil Nadu.

C. wynadensis was described by Beddome as *Gymnodactylus wynadensis* in 1870 and the type locality mentioned as Waynaad. Waynaad being a large geographical area having many undulating high mountain ranges that provide a barrier to species movement, precise type locality would provide more taxonomic clarity.

C. wiksii was described as *Gymnodactylus wicksii* by Stoliczka (1873) from Preparis Island, Andman Archipelago. Manamendra - Arachchi *et al.,* (2007) designated the lectotype and paralectotypes from ZSI collection and he included in the description even though its range is outside of our interest (Peninsular India and Sri Lanka) because it was previously listed in the synonymy of *C. kandaiana* by Smith (1935). Further Manamendra-Arachchi *et al.,* found out the character differences between the species and consider the *C. wicksii* to be a valid species and clearly distinguishable from all its Sri Lankan and Penisular Indian congeners. There is a need to revisit the type locality to collect fresh specimens to carry out the molecular work.

C. beddomei is a replacement name for the species *Gymnodactylus marmoratus as* described by Beddome in 1870 and the type locality mentioned as Travoncore, this is again a very largest geographical region. There is a need

to carry out intensive surveys to explore this region to fix the species to a precise locality.

C. sisparensis was described as *Gymnodactylus maculatus* by Beddome (1870) and *Gymnodactylus sisparensis* by Theobald (1876). The species *Gonatodes bireticulatus* described by Annadale in 1935 was treated as junior synonym of *C. sisparensis*. The type locality of *Gymnodactylus sisparensis* [=*C.sisparensis*] is Sholakal, foot hills of the Sispara Ghat, Nilgiri hills (Theobald, 1876). Mukherjee *et al*., (2005) described *C. anaikattiensis* from Anaikatti Hills, part of Nilgiri Biosphere Reserve in Tamil Nadu by comparing it with the holotype of *Gonatodes bireticulatus* [=*C. sisparensis* (Theobald)] of Annandale, the specimen were collected by F.H. Gravely from 'Kavalai, Cochin State' (ZSI 17970), Zoological Survey of India. Manamendra-Arachchi *et al.,* (2007) examined the description and diagnosis of *C. anaikattiensis* provided by Mukherjee *et al*., (2005) and they opined that it is exactly matching with the holotype of *C. sisparensis* and considered it as a junior synonym of *C. sisparensis*. Recently, we collected similar looking specimens from different parts of Wayanad which are cryptic in nature. Therefore, the present *C. sisparensis* seems to be a species complex, needs further sampling of specimens from above mentioned type localities and to carry out a systematic molecular study to solve the cryptic nature of the present *C. sisparensis*.

C. andersonii was described as *Gonatodes andersonii* in 1905 by Annandale and the subsequent synonymy under *C. kandiana by Smith* (1935) and it was again resurrected by Manamendra-Arachchi *et al*., (2007) as a valid species based on the single syntype (ZSI, 15012). As there are two species reported from the Andaman Islands, further field explorations are warranted to resolve the taxonomy issues between the *C. wicksii* and *C. andersonii*.

Bauer (2002) described two new species, *C. heteropholis* and *C. indraneildasii* from Gund, Uttara Kannada, Karnataka. Description of both the species based on single female specimens (*C. heteropholis* based on a single adult female holotype ZMH R06158 and *C. indraneildasii* based on a single sub adult female holotype ZMH R06124) from the collections of G.A. Von Maydell made during 20 January 1956. Absence of male specimens for the consistency of the morphological characters in recognizing the congeneric species are challenging in this group. The first description of the male *C. heteropholis* was provided by Ganesh, *et al*., (2011) from Agumbe. Description of male specimen for *C. indraneildasii* is needed.

Based on historical museum specimens, of morphological studies, Manamendra-Arachchi *et al*., (2007) described three new species of *Cnemaspis* from Southern India, which were among the syntypes of *Gonatodes kandianus var. tropidogaster* (Boulenger, 1885). They described *C. monticola* from Wayanad (based on three female specimens), *C. nilagirica* from Nilgiris (based on single female specimen) and *C. australis* from Tirunelveli (based on single male specimens). Three species are known only from their type specimens which were purchased from Colonel Beddome over 130 years back (Manamendra-Arachchi *et al.,* 2007). The diagnostic characters mentioned as ventral scales smooth, whereas the images of type specimens procured recently from British Museum clearly show ventral scales are completely keeled. There is a need of extensive field surveys in Wayanad region to find out the living populations of *C. monticola* to stabilize the morphological characters across the male specimens to be able to distinguish with its congeners.

The recent paper by Vivek Philip Cyriac, *et al*., (2019) on rediscovery of a living population of *C. nilagirica* from Silent Valley National Park, Palakkad District, Kerala have provided a data on male characters, intraspecific variation and resolved the taxonomic issues. In case of *C. australis*, there is a need to revisit the type locality (Tirunelveli dist.) to find out the living population of both sexes to study intraspecific variations and to carry out the molecular work.

Giri *et al*., 2009 described *C. kolhapurensis* from Dajipur, Kolhapur, Maharashtra and there is a need to study its range distribution. Cyriac and Umesh (2014) described *C. kottiyoorensis* from Perumalmudi, Kannur, Kerala and Mirza *et al.,* (2014) described *C. girii* from Kass plateau, Maharashtra. Srinivasalu Kumar and Srinivasalu described *C. adii* from Hampi, Karnataka in the year 2015. Sayyed, Pyron and Dahanukar described *C. flaviventralis* from Amboli, Maharashtra in the year 2016. In 2018, Cyriac *et al*., (2019) described two species *C. maculicollis* from Pandimotta, Kerala and *C. anamudiensis* from Anamudi Reserve Forest, Kerala. Sayyed *et al*., (2018) described four species *C. limayei* from Marutiwadi, Maharashtra, *C. ajijae* from Mahabaleshwar, Maharashtra, *C. amboliensis* from Amboli, Maharashtra and *C. mahabali* Tamhini, Maharashtra. Akshay Kandekar

(2019) described *C. agarwalii* from Sankari near Salem district of Tamil Nadu outside the Western Ghat.

There is an increase in the new species descriptions in the *Cnemaspis* group in recent past, thus the above discussed taxonomic issues needs an immediate attention followed by demarcating the distribution range of all the species of *Cnemaspis* group. Addressing these inconsistencies is paramount in preventing any further taxonomic ambiguity. The new species described here further enrich the genus, indicating the need for a major revision of the whole group. Along with the morphological study, there is a tremendous need for a whole genus wide phylogenetic study covering the entire range of the group.

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