Zootaxa 5120 (1): 001–029
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5120.1.1
http://zoobank.org/urn:lsid:zoobank.org:pub:53246B55-8BC9-4BB2-99EB-6B34CF48F6D0

Three New Species of *Cnemaspis* (Sauria: Gekkonidae) from Sarawak, East Malaysia, Borneo

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Abstract

Three new species of *Cnemaspis* are described from karst regions of Sarawak, Malaysia, on the island of Borneo. These are *Cnemaspis matahari* **sp. nov.** and *C. sirehensis* **sp. nov.** from limestone hills located in the Serian Division of western Sarawak, and *C. lagang* **sp. nov.** from Gunung Mulu, Miri Division, in northern Sarawak. All can be distinguished from congeners using mitochondrial DNA as well as an enlarged metatarsal scales on the first toe. Individually, each species can be diagnosed by differences in subcaudal scale morphology: *Cnemaspis lagang* **sp. nov.** lacks enlarged subcaudals; *Cnemaspis matahari* **sp. nov.** has keeled subcaudals bearing an enlarged median row of smooth scales; and *Cnemaspis sirehensis* **sp. nov.** has an enlarged median row of weakly keeled scales. The discovery of these species suggests that additional unrecognized species may exist within the genus on Borneo, especially in association with karst formations. High endemism and species diversity notwithstanding, these karst formations are under severe pressure from limestone extraction and deforestation.

Key words: *Cnemaspis*, taxonomy, new species, ecology, conservation, endemic, karst, Sarawak

Introduction

The tropical island of Borneo is a known biodiversity hotspot, with many endemic vertebrates (Van Paddenburg *et al.* 2012). One group which has attracted the attention of taxonomists in the recent past is the Old World gekkonid genus *Cnemaspis* Strauch 1887. The genus currently comprises ~198 species that are distributed across tropical Africa and Asia, although molecular data indicates its polyphyletic nature (Gamble *et al.* 2012; Grismer *et al.* 2014), with three distinct and distantly related clades corresponding to African, south Asian, and south-east Asian groups. Morphology is known to be highly conserved across *Cnemaspis*, with most species being small to medium-sized, cryptically-coloured geckos, with broad, flattened heads, large, forward and upwardly directed eyes, a flattened body, long widely splayed limbs and long, inflected digits. Members of the genus occupy habitats ranging from lowland dipterocarp forests to primary and old-growth forests, often within karst, granite or sandstone landscapes (Das & Bauer, 1998; Das & Sengupta, 2000; Das, 2004; Amarasinghe *et al.* 2016; Iskandar *et al.* 2017) The south-east Asian *Cnemaspis* group has been reported from areas of Vietnam, Cambodia, Laos, Thailand, Peninsular Malaysia and its offshore islands, Singapore, Sumatra and Borneo, with the highest diversity on the Thai-Malay Peninsula (Grismer *et al.* 2014). Despite the south-east Asian clade being the most species rich, only five species have been described from the island of Borneo (Koch & Schulz, 2014; Kurita *et al.* 2017).

The distribution of known Bornean species of *Cnemaspis* is restricted to the state of Sarawak, East Malaysia and West Kalimantan, Indonesia (Maulidi *et al*. 2019), with no records from the state of Sabah, East Malaysia or the

Accepted by M. Heinicke: 18 Jan. 2022; published: 24 Mar. 2022

independent nation of Brunei Darussalam. The greatest species richness occurs in western Sarawak. Phylogenetic analyses of south-east Asian *Cnemaspis* (Grismer *et al.* 2014) reveals two divergent lineages: the southern Vietnamese insular endemics referred to as the Ca Mau clade and a clade containing three major subclades: the Pattani clade, restricted to the southernmost portion of peninsular Thailand and the Northern Sunda and Southern Sunda sister clades; and the Northern Sunda clade extending from Vietnam to central Peninsular Malaysia; and the Southern Sunda clade extending from southern Peninsular Malaysia and Singapore, eastward through the Seribuat, Anambas, and Natuna Archipelagos to northern Borneo. The Bornean elements of the Southern Sunda clade comprise two genetically distinct groups (the *kendallii* group and the *nigridia* group) the former with one representative *Cnemaspis kendallii* (Gray, 1845) and the latter with four, *Cnemaspis nigridia* (Smith, 1925), *Cnemaspis dringi* Das & Bauer, 1998, *Cnemaspis paripari* Grismer & Chan, 2009 and *Cnemaspis leucura* Kurita, Nishikawa, Matsui & Hikida, 2017.

During recent fieldwork conducted in karst regions of Sarawak, we identified three undescribed species of *Cnemaspis*. Using a combination of morphological and molecular data for two of the lineages and only morphological data for a third, we provide evidence to recognize three new species of *Cnemaspis* in Borneo. These new discoveries and an expanded genetic dataset enhance our understanding of the evolutionary history of the genus, especially considering the relatively low diversity of *Cnemaspis* in Borneo.

Materials and Methods

Sampling. Specimens were collected by hand during visual encounter surveys. Coordinates and elevational data were recorded using a Garmin GPSMap 76CS receiver, with the datum set to WGS84. Materials examined are deposited in the Institute of Biodiversity and Environmental Conservation (IBEC) Systematics Lab in Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia (UNIMAS). Specimens examined were from the following collections: The Natural History Museum, London, UK (BMNH); Field Museum, Chicago, USA (FMNH); Herpetological Collection of the Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia (HC); La Sierra University Herpetological Collection, Riverside, USA (LSUHC); Museum of Comparative Zoology, Cambridge, USA (MCZ); Sarawak Biodiversity Center, Kuching, Sarawak, Malaysia (SBC); Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia (UNIMAS); United States National Museum, Washington, DC, USA (USNM); Lee Kong Chian Natural History Museum, Singapore (ZRC). All specimens labeled as IN field series are deposited in the UNIMAS museum collection.

Photographs of live individuals were taken using a Nikon D600 DSLR camera and 105 mm Micro-Nikkor f/2.8 D lens, illuminated by a Speedlight flash unit (SB800), using a Lastolyte softbox. Specimens were euthanized by intracoelomic injection of 6 mg/mL of sodium pentobarbital solution. Sexes were determined by hemipeneal eversion. A small incision was made on the abdominal region of the specimens and liver samples were taken and preserved in 95% ethanol for DNA analysis. Morphometric measurements were taken using digital caliper. Colour identification was determined using the colour swatches in 'Naturalist's Color Guide' (Smithe, 1975, 1981). Radiographic examination of vertebrae and phalanges were conducted with a VistaScan Mini Plus x-ray unit (Dürr Dental SE™). Specimens were fixed in 10% formalin solution for 4–5 days. Once the specimen became rigid, the formalin was washed off in tap water and the specimens were transferred to 70% ethanol solution for long term storage. A total of 92 specimens were examined (Appendix I) representing all known species from the State of Sarawak.

DNA Extraction and Analysis. Genomic DNA was extracted following the technique of Aljanabi and Martinez (1997). The mitochondrial NADH dehydrogenase subunit 2 (ND2) locus was amplified using a double-stranded Polymerase Chain Reaction (PCR) under the following conditions: 2.5 µl 5X buffer, 2.5 µl 10X buffer, 2.5 µl dinucleotide pairs, 2.5 µl forward and reverse primer, 0.18 µl Taq polymerase, 9.82 µl ultra-pure H2O, and 2.5 µl of DNA for a total of 25.0 µl. PCR reactions were executed on an Eppendorf Mastercycler gradient thermocycler under the following conditions: initial denaturation at 95 ºC for 35 s, annealing at 50 ºC for 35 s, and a cycle extension at 72 ºC for 35 s, for a total of 34 cycles. All PCR products were viewed on a 1.0% agarose gel electrophoresis. Successful PCR products were purified using a home-made magnetic bead solution (Rohland & Reich, 2012), and sequenced using the ABI Big-Dye Terminator v3.1 Cycle Sequencing Kit on an Eppendorf Mastercycler gradient thermocycler. Cycle sequencing reactions were purified using an in-house protocol (see Davis *et al.* 2019) and sequenced on an ABI 3730xl DNA Analyzer. Primers used for amplification and sequencing are presented in Appendix II.

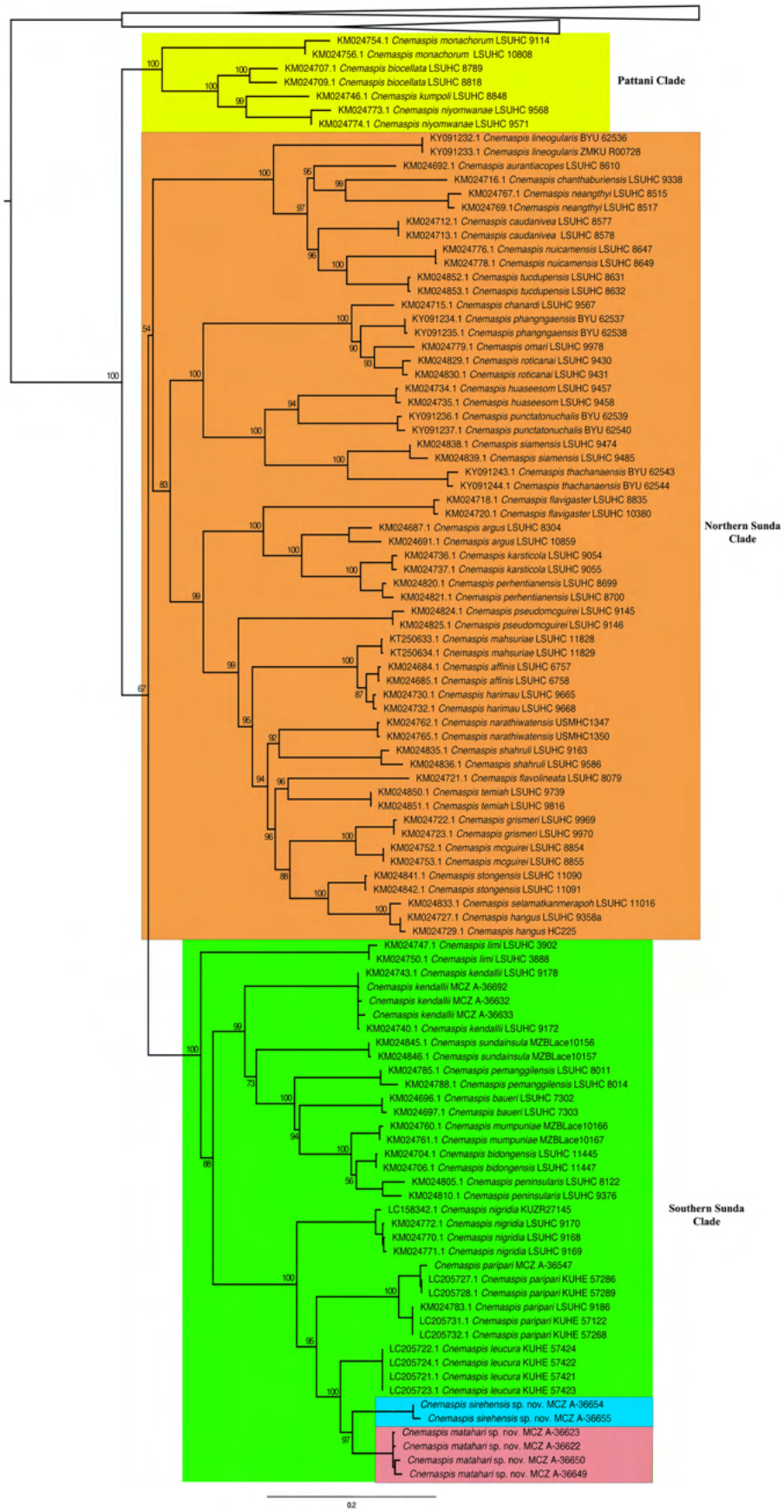

FIGURE 1: ML tree of south-east Asian *Cnemaspis* with placement of the two new species *C. matahari* **sp. nov.** and *C. sirehensis* **sp. nov.** within the *nigridia* group of the Southern Sunda clade.

Sequences were uploaded to Geneious © v11.1.2 (Kearse *et al.* 2012) for alignment and to check the quality of the sequences by searching for miscalled bases. Forward and reverse sequence that formed contigs were then aligned and edited when necessary. In total, 10 new sequences were generated for this study, which were combined with ND2 sequences available on GenBank. Sequences were aligned using the MAFFT algorithm (Katoh & Standley 2013). The final ND2 alignment consisted of 1339 bp and 109 individuals comprising all four major south-east Asia clades with multiple representatives from each group. Outgroup selection for the phylogenetic inference was based on prior, more comprehensive phylogenetic trees incorporating *Cnemaspis* (Grismer *et al.* 2014, 2015; Wood *et al.* 2017).

To determine the phylogenetic placement for the new species, a gene tree was inferred using a Maximum Likelihood (ML) approach. The ML tree was generated using IQ-TREE (Nguyen *et al.* 2015). ModelFinder was used to determine the best-fit evolutionary model, and 1000 ultrafast bootstrap pseudoreplicates were utilized (Hoang *et al.* 2017; Kalyaanamoorthy *et al.* 2017). Nodes having UFBoot2 (UF) values of 95 and above were considered significantly supported (Minh *et al.* 2013). The 10 newly generated sequences are available on GenBank. All sequences and locality data are shown in Appendix III.

Morphological Analyses. Morphological differences were examined by measuring 16 variables along with 33 meristic characters. Measurements of individuals were taken using a Mitutoyo™ digital caliper (to nearest 0.1 mm), under an Olympus™ SZX10 dissecting microscope on the left side of the body (where appropriate): snout-vent length (SVL), taken from the tip of snout to the vent; tail length (TL), taken from the vent to the tip of the tail; tail width (TW), taken at the base of the tail immediately posterior to the postcloacal swelling; forearm length (FL), taken on the dorsal surface from the posterior margin of the elbow while flexed 90º to the inflection of the extended wrist; tibia length (TBL), taken on the ventral surface from the posterior surface of the knee while flexed 90º to the base of the heel; axilla to groin length (AG), taken from the posterior margin of the forelimb at its insertion point on the body to the anterior margin of the hind limb at its insertion point on the body; head length (HL), the distance from the posterior margin of the retroarticular process of the lower jaw to the tip of the snout; head width (HW), measured at the angle of the jaws; head depth (HD), the maximum height of head from the occiput to the underside of the jaw; eye diameter (ED), the greatest horizontal diameter of the eyeball; eye to ear distance (EE), measured from the anterior edge of the ear opening to the posterior edge of the eyeball; eye to snout distance (ES), measured from anteriormost margin of the eyeball to the tip of snout; eye to nostril distance (EN), measured from the anteriormost margin of the eyeball to the posterior margin of the external nares; inter-orbital distance (IO), the width of the frontal bone at the level of the anterior edges of the orbit; ear length (EL), the greatest vertical distance of the ear opening; and internarial distance (IN), measured between the medial margins of the nares across the rostrum.

The following morphological characters were noted: number of supralabial and infralabial scales counted from below the middle of the orbit to the rostral and mental scales; number of internasal and postmental scales; the texture of the dorsal and ventral, anterior margin of the forearm and subtibial scales; number, shape and arrangement of precloacal pores in males; the number of postcloacal tubercles on each side of the tail base (left/right); the degree and arrangement of tail tuberculation; the relative size and morphology of the subcaudal scales, and submetatarsal scales beneath the first metatarsal; the number of subdigital lamellae for both left and right digits counted from the base of the first phalanx to the base of the claw. On the original portion of the tail, longitudinal rows of caudal tubercles and subcaudal scales vary between species and are useful in differentiating several taxa. When present, the rows of caudal tubercles and subcaudal scales are usually restricted to the proximal portion of the tail, and occasionally there may be a row of tubercles within the lateral caudal furrow. Bilateral scale counts were given as left and right (L/R).

Results

The Southern Sunda clade is a well-supported group comprising of *C. limi* from Tioman and Tulai islands in the Seribuat Archipelago as the sister lineage (UFBoot2 = 100), differing morphologically from other members of the clade in having no precloacal pores; randomly arranged body tubercles; paravertebral and lateral row of caudal tubercles present; no ventrolateral caudal tubercles; subcaudals smooth bearing a median, weakly enlarged, scale row; large, black, round spots on nape and anterior portion of body; dorsal caudal tubercles white; at least posterior one-half of subcaudal region white. The *kendallii* group, containing species from east Malaysia and Indonesia with

C. kendallii as the sole representative from Borneo (UFBoot2 = 99), forms a morphologically supported clade. This group comprises the only *Cnemaspis* species in the Southern Sunda clade that lack precloacal pores which is considered derived in that precloacal pores are widespread throughout the Gekkonidae (Kluge 1987); and excluding *C. sundainsula*, they are the only species of *Cnemaspis* in the Southern Sunda clade that have caudal tubercles encircling the tail.

The related species *C. nigridia*, *C. paripari* and *C. leucura* are referred to as the *nigridia* group (UFBoot2 = 100), and phylogenetic analyses placed the two new species for which molecular data are available, *C. matahari* **sp. nov.** and *C. sirehensis* **sp. nov.**, as sister taxa within the *nigridia* group with strong support (UFBoot2 = 97), and as the sister clade to *C. leucura* (Figure 1). The *nigridia* group contains species from north-western Sarawak and the monophyly of this group is further supported in that these are the only species in the Southern Sunda clade to have enlarged scales beneath the first metatarsals. This character state occurs in the two species of the Ca Mau clade, four species of the Northern Sunda clade and does not occur in the Pattani clade, therefore, it is considered to be derived in the *nigridia* group. The *nigridia* group is diagnosed as having weakly to strongly keeled ventral scales; 2–16 contiguous, pore-bearing precloacal scales with round pores; randomly to weakly aligned dorsal tubercles on the body; no tubercles on flanks or in the lateral caudal furrows; caudal tubercles do not encircle tail; lateral row of caudal tubercles present; subcaudals keeled and bearing a median row of enlarged, keeled or smooth scales; 1–4 postcloacal tubercles on either side of the base of the tail; no enlarged femoral or subtibial scales; subtibials keeled; and submetatarsal scales of first toe enlarged. Genetic material for one of the three new species is currently unavailable. Given that these new populations form well-supported independent lineages coupled with high genetic distances and a unique set of morphological and colour pattern characteristics that separate them from all members of their respective groups, we describe these three populations as new species.

SYSTEMATICS

***Cnemaspis lagang* sp. nov.**
North Sarawak Day Gecko; Cicak Gua Mulu
Fig. 2, Fig. 3, Table 1

Holotype. Adult male, UNIMAS 9562, collected by Izneil Nashriq on 10 February 2020 at 22:45 hrs, from the base of Gunung Api (4.13608°N, 114.891304°E; 90 m), Gunung Mulu National Park, Miri District, Sarawak, East Malaysia (Borneo).

Paratype. Adult male, UNIMAS 9591, collected by Hayden Davis and Izneil Nashriq, on 22 July 2017 at 22:00 hrs, from Lagang Cave (4.050144°N, 114.824199°E; 100 m), Gunung Mulu National Park, Miri District, Sarawak, East Malaysia (Borneo).

Diagnosis. SVL up to 46 mm; 13–14 supralabials; 10–11 infralabials; 3 internasals; 9–10 postmentals; adult males with 7–8 discontinuous pore-bearing, precloacal scales with round pores, arranged in a chevron, separated at midline by 2–4 poreless scales; paravertebral and lateral row of caudal tubercles present; ventrolateral caudal tubercles absent; caudal tubercles not encircling tail; subcaudals keeled, not bearing row of enlarged median subcaudal scales; 1–2/1–2 (L/R) postcloacal tubercles on each side of tail base; no enlarged femoral or subtibial scales; submetatarsal scales of first toe enlarged; 29 subdigital fourth toe lamellae; faint Dusky Brown and Trogon Yellow caudal bands anteriorly; tail immaculate posteriorly; and regenerated tail also immaculate.

Description of holotype. Male with original tail, immaculate posteriorly; supralabials 13/14 (L/R); infralabials 11/11 (L/R); snout-vent length 46 mm; head short (HL/SVL 0.29), narrow (HW/SVL 0.28), depressed (HD/HL 0.33), distinct from neck; snout long (ES/HW 0.63), much longer than eye diameter (ED/ES 0.55); scales on snout and forehead tuberculate, with posterior portion of each scale raised; scales on snout larger than those on occipital region; eye small (ED/HL 0.23); orbits of eyes with extra-brillar fringes; pupil round; enlarged supraciliaries on top half of orbit; tympanum deep, oval shaped, greatest diameter vertically, narrow (EL/HL 0.10); eye to ear distance greater than diameter of eyes (EE/ED 1.28); rostral half as deep as wide, contacted posteriorly by 2 nasals and 3 internasals, and rostrals in contact with supralabial I. Nostrils oval, situated within nasals, and oriented dorsally; nostrils not in contact with supralabial I. 7 postnasals bound nasal; mental ovate, much deeper than wide, 9 postmentals border mental; chin scales meet infralabials.

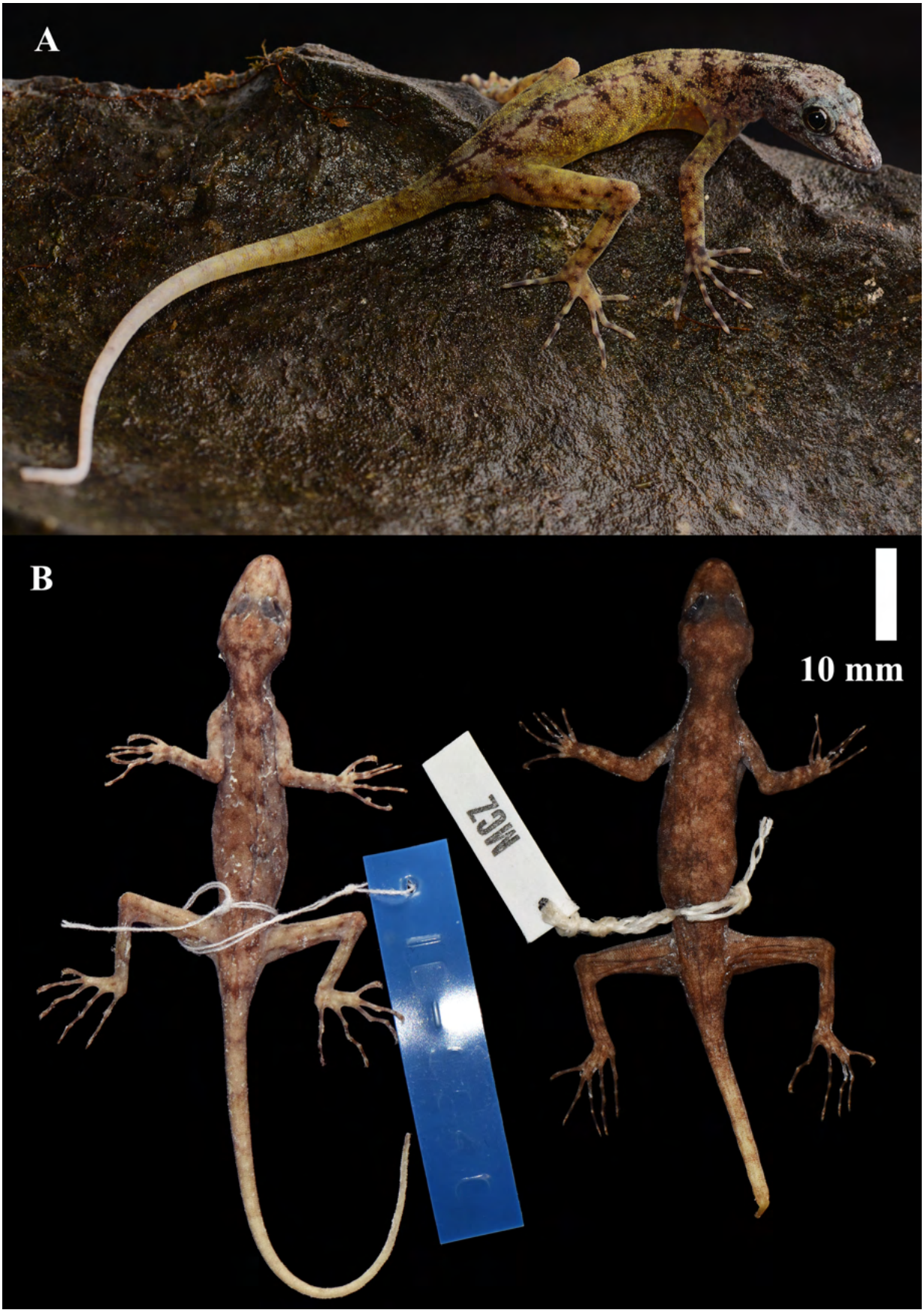

FIGURE 2: (A) *Cnemaspis lagang* **sp. nov.**, holotype, UNIMAS 9562, SVL 46 mm, adult male from Gunung Api, within Gunung Mulu National Park, Miri Division, Sarawak; (B) type series displaying dorsal side of the body (from left to right: UNIMAS 9562 and UNIMAS 9591).

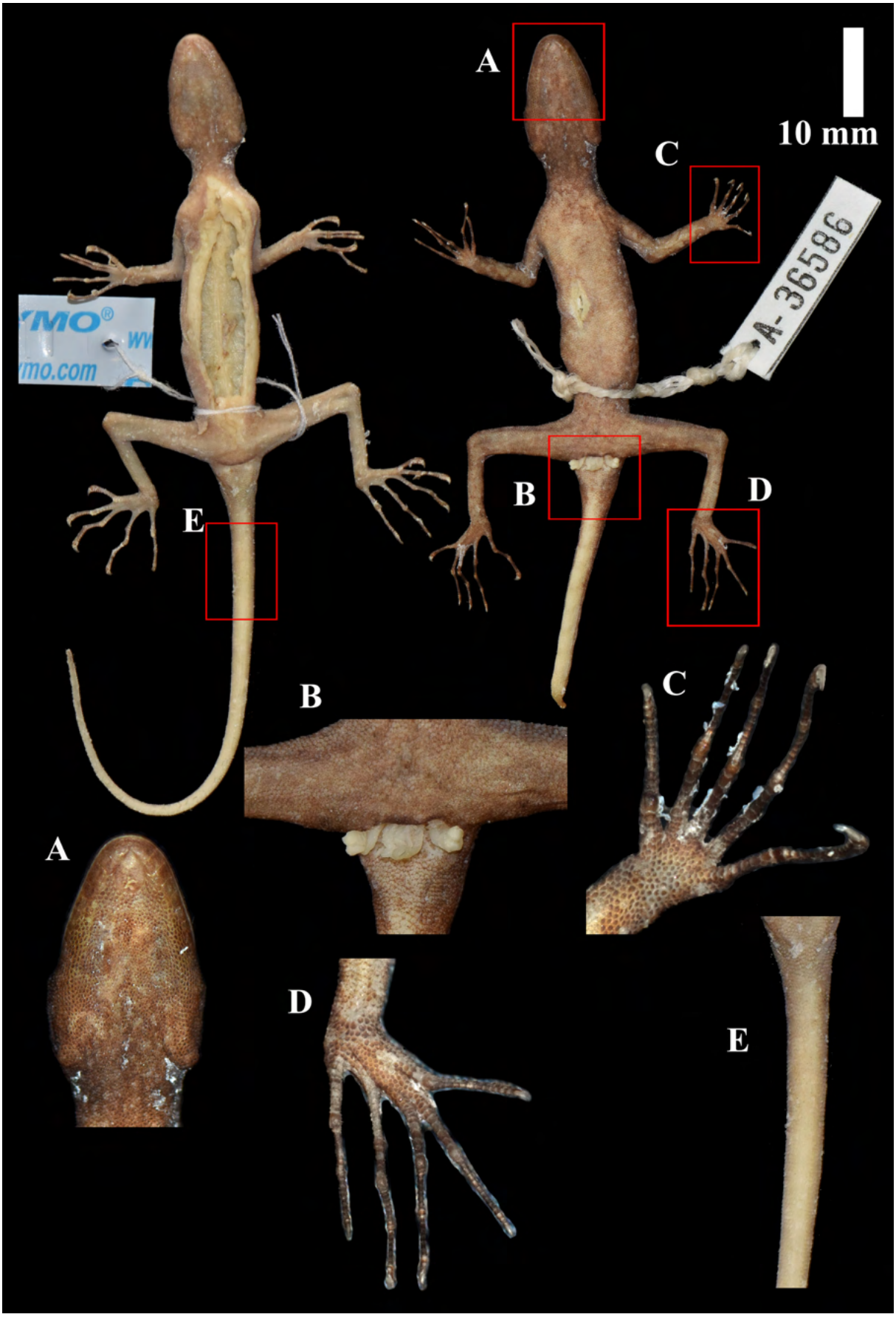

FIGURE 3: Ventral view of *Cnemaspis lagang* **sp. nov.** type series (from left to right: UNIMAS 9562 and UNIMAS 9591); Close up of body parts (A) Postmental, (B) Cloaca, (C) Subcaudal, (D) Manus and (E) Pes.

TABLE 1: Morphometric measurements of *Cnemaspis lagang* **sp. nov.** examined (nearest 0.1 mm).

Type	Museum Number	Field Number	Sex	SVL	HL	HW	HD	ED	EE	ES	EN	IO	EL	IN	TL	TW	FL	TBL	AG
Holotype	9562	ID 9540	M	46.0	13.4	13.0	4.4	3.1	4.0	5.7	4.2	2.2	1.4	2.0	61.1	3.0	8.5	10.3	19.8
Paratype	9591	MCZ A-36586	M	46.0	13.2	8.4	5.1	2.8	4.0	6.0	4.8	1.6	1.1	1.5	24.5	4.5	9.1	10.8	19.4

TABLE 2: Morphometric measurements of *Cnemaspis matahari* **sp. nov.** examined (nearest 0.1 mm).

Type	Museum Number	Field Number	Sex	SVL	HL	HW	HD	ED	EE	ES	EN	IO	EL	IN	TL	TW	FL	TBL	AG
Paratype	9573	IN 077	M	55.7	16.1	10.6	6.3	3.2	4.2	6.8	5.0	2.0	1.4	1.8	69.3	4.7	11.6	13.6	25.4
Paratype	9574	IN 078	F	54.2	16.5	9.9	5.8	3.5	3.5	7.1	5.3	2.7	1.3	1.6	58.1	3.9	10.1	12.2	23.5
Holotype	9602	MCZ A-36622	M	55.4	14.7	9.8	6.3	3.2	3.8	6.4	4.5	1.6	1.6	1.4	71.0	3.6	10.9	12.6	22.5
Paratype	9603	MCZ A-36623	M	52.7	14.5	9.1	5.6	3.6	3.3	6.4	5.3	2.0	1.1	1.7	60.7	3.3	11.6	13.0	23.3
Paratype	9606	MCZ A-36648	M	54.0	15.2	10.3	5.9	3.5	4.4	6.6	5.2	2.1	1.1	1.7	63.0	4.0	10.7	13.3	23.8
Paratype	9607	MCZ A-36649	M	55.5	15.8	10.0	6.2	3.6	4.4	6.7	5.1	2.2	1.7	2.0	54.8	3.9	10.9	14.3	24.5
Paratype	9608	MCZ A-36650	M	54.9	15.8	10.1	5.9	3.3	4.3	7.4	5.6	2.5	1.5	2.1	64.5	4.0	10.7	12.3	25.2
Paratype	9611	MCZ A-36659	M	48.3	13.9	8.2	5.1	3.0	3.8	6.1	5.0	1.8	0.9	1.4	51.3	3.9	9.2	10.9	20.4
Paratype	9615	MCZ A-36671	M	47.1	13.9	8.7	4.9	2.8	3.6	5.8	4.1	1.8	1.0	1.8	44.1	3.6	9.7	11.8	19.6

TABLE 3: Morphometric measurements of *Cnemaspis sirehensis* **sp. nov.** examined (nearest 0.1 mm).

Type	Museum Number	Field Number	Sex	SVL	HL	HW	HD	ED	EE	ES	EN	IO	EL	IN	TL	TW	FL	TBL	AG
Holotype	9609	MCZ A-36654	F	47.2	14.1	8.3	5.1	3.1	3.7	5.7	4.3	1.6	1.2	1.5	57.6	3.6	9.4	11.1	20.3
Paratype	9610	MCZ A-36655	F	48.8	13.7	8.7	5.1	3.1	3.7	5.9	4.7	2.1	1.2	1.6	61.8	3.7	9.7	11.2	20.7
Paratype	9715	-	F	45.1	13.0	7.8	4.8	3.0	3.5	5.8	4.9	2.0	1.0	1.0	57.0	3.3	8.3	11.6	23.2

Body slender, short (AG/SVL 0.43); ventral scales keeled, increase in size from chin region to gular, pectoral and abdominal regions. Dorsal scales increase in size from head to nape and body. Scales on dorsum at midbody approximately equal to those of venter at same level; vertebral scales not reduced; no paravertebral rows of tubercles on dorsum; pectoral and abdominal scales distinctly elongated, imbricate and unicarinate; discontinuous rows of 4/4 (L/R), pore-bearing, precloacal scales with round pores, arranged in a chevron, separated at midline by 4 poreless scales, in adult males; no femoral pores; no preanal groove.

Forelimbs relatively long, slender, shorter than hindlimbs (FL/SVL 0.19, TBL/SVL 0.22). Dorsal scales on forelimbs, raised, unicarinate, juxtaposed, reduced in size posteriorly; ventral scales of forelimbs slightly raised, slightly unicarinate, juxtaposed, reduced in size posteriorly. Dorsal scales of hindlimbs raised, unicarinate, juxtaposed, reduced in size posteriorly; ventral scales of hindlimbs slightly raised, slightly unicarinate, juxtaposed, reduced in size posteriorly. Palmar and plantar scales smooth, granular, raised. Digits elongate, all bearing claws that are slightly recurved; subdigital scansors entire, except for 1–2 fragmented at base of digits, unnotched; an enlarge scansor towards base of digits, which is over twice width of other scansors; interdigital webbing absent. Subdigital lamellae (manus) I (13); II (21); III (23); IV (27); V (21); (pes) I (11); II (19); III (23); IV (29); V (24).

Original tail longer than snout-vent length (TL/SVL 1.33); tail base distinctly swollen; tail arranged in segmented whorls; caudal tubercles keeled, arranged in paravertebral and lateral rows; caudal tubercles do not encircle tail at each whorl; 1/1 (L/R) postcloacal tubercles; tail with distinct pair of furrows laterally; subcaudal scales unicarinate and no enlarged median subcaudals.

Variation in paratype. Male with a regenerated tail; SVL 46 mm; supralabials 14/14 (L/R); infralabials 10/10 (L/R); head short (HL/SVL 0.29), narrow (HW/SVL 0.18), depressed (HD/HL 0.38), distinct from neck; snout long (ES/HW 0.72), longer than eye diameter (ED/ES 0.46); eye small (ED/HL 0.21); tympanum deep, oval shaped, greatest diameter vertically, narrow (EL/HL 0.08); eye to ear distance greater than diameter of eyes (EE/ED 1.45); mental bell-shaped, much deeper than wide, 10 postmentals border mental. Body slender, short (AG/SVL 0.42); discontinuous rows of 3/4 (L/R), pore-bearing, precloacal scales with round pores, arranged in a chevron, separated at midline by 4 poreless scales; no femoral pores; no precloacal groove. Forelimbs moderately long, slender shorter than hindlimbs (FL/SVL 0.20, TBL/SVL 0.24). Subdigital lamellae (manus) I (14); II (19); III (24); IV (25); V (22); (pes) I (13); II (19); III (23); IV (29); V (24). Regenerated tail shorter than snout-vent length (TL/SVL 0.53). 1/2 (L/R) postcloacal tubercles; Tail with distinct pair of furrows laterally. Subcaudal scales unicarinate.

Skeletal notes. Both specimens (UNIMAS 9591 and UNIMAS 9562) have 25 presacral and 2 sacral vertebrae. The low presacral count is uncommon in geckos in general (26 is typical; Hoffstetter and Gasc, 1969). The phalangeal formulae are plesiomorphic for geckos: 2–3–4–5–3 manus and 2–3–4–5–4 pes. Both specimens are skeletally mature, showing fusion of the long bone epiphyses.

Colouration in life. Holotype; Raw Umber head, Venetian Blue shade interorbitally and around postorbital; ventral surface of head Raw Umber with Pratt's Payne's Gray spots; body and limbs Trogon Yellow; ground colour of nape and shoulder region Olive-Brown bearing Dusky Brown lines from orbit; a pair of medium, amorphous, Dusky Brown spots in shoulder region; Sulfur Yellow flecks on flank, forelimbs and hind limbs; small, scattered, Dusky Brown spots between limb insertion; rows of Dusky brown lines along vertebral column; proximal half of tail Trogon Yellow bearing faint, Dusky Brown bands; ventral surfaces Cinnamon with Verona Brown except for tail which is Trogon Yellow and posterior tail immaculate.

Paratype; Dorsal ground colour of head, body and limbs dark Brownish Olive; head bearing small, occipital flecks; ground colour of nape and shoulder region Olive-Brown bearing paravertebral patches of irregularly shaped, dark blotches; transverse, Sulfur Yellow flecks between forelimb and hind limb insertions; anterior one-half of tail Brownish Olive bearing faint, dark bands; all ventral surfaces Dark Grey except for tail which is Buff Yellow; regenerated tail Buff Yellow with whitish tip.

Etymology. The epithet *lagang* is a noun in apposition derived from the paratype locality of Lagang Cave, within Gunung Mulu National Park.

Natural history. The species is nocturnal and was collected between 2000 and 2300 hrs, below 100 m asl of Melinau Limestone formation to which the species is apparently restricted (Figure 4). Ambient temperature was 26°C, and relative humidity 89.9% RH under clear night skies at the time of collection. The holotype was encountered perching head-down on a stalactite at the base of Gunung Api, while the paratype was on the entrance wall of Lagang Cave. They occur sympatrically with *Cyrtodactylus consobrinus*, *C. miriensis* and *C. muluensis* but only syntopically with the last of these.

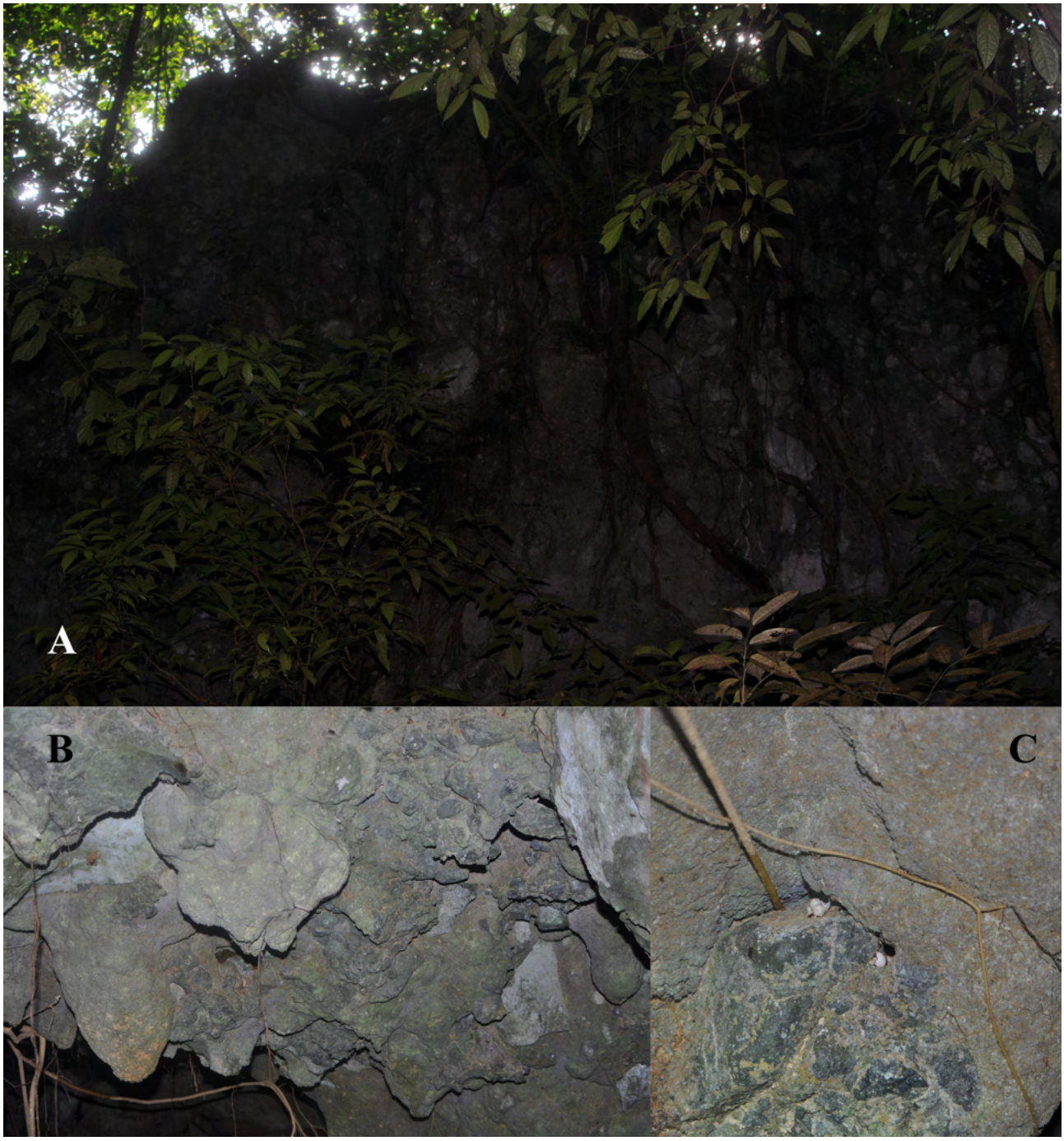

FIGURE 4: Habitat (A) and microhabitat (B) of *Cnemaspis lagang* **sp. nov.** in Gunung Mulu National Park, Miri, Sarawak; (C) egg shells found in the habitat.

Comparisons. *Cnemaspis lagang* **sp. nov.** differs from other Bornean *Cnemaspis* by having Raw Umber head with Venetian Blue shade on interorbital region; 13–14 supralabials (*versus* 11–13 in *C. leucura* and 12–13 in *C. sirehensis* **sp. nov.**); 9–10 postmentals (*versus* 3 in *C. kendallii*, 5–7 in *C. nigridia*, 6–9 in *C. paripari*, 4–6 in *C. leucura*, 5–9 in *C. matahari* **sp. nov.**, and 6–7 in *C. sirehensis* **sp. nov.**); discontinuous rows of 7–8, pore-bearing, precloacal scales (*versus* none in *C. kendallii*, 5–6 in *C. dringi*, and 14–15 in *C. nigridia*,); 1–2/1–2 (L/R) postcloacal tubercles (*versus* 2–3/2–3 in *C. kendallii*, 2–3/2–3 in *C. paripari*, 3–8/3–8 in *C. leucura* and 2–7/2–7 in *C. matahari* **sp. nov.**); ventrolateral caudal tubercles absent (*versus* present in *C. kendallii*, *C. nigridia*, *C. paripari*, *C. leucura* and *C. matahari* **sp. nov.**); keeled subcaudals *versus* smooth in *C. nigridia*; no enlarged median subcaudal scales; tail with Faint Dusky Brown and Trogon Yellow caudal bands anteriorly and immaculate posteriorly (*versus* Dusky Brown and Buff-Yellow caudal bands in *C. kendallii*, Dusky Brown and Orange Yellow caudal bands in *C. nigridia*,

Pratt's Payne's Gray anteriorly and immaculate posteriorly in *C. paripari*, faint Dusky Brown and Lavender caudal bands anteriorly, immaculate posteriorly in *C. matahari* **sp. nov.**, and Brownish Olive and Sulfur Yellow caudal bands in *C. sirehensis* **sp. nov.**); 25–27 subdigital fourth finger lamellae (*versus* 29 in *C. dringi* and 26–31 in *C. matahari* **sp. nov.**).

***Cnemaspis matahari* sp. nov.**
White Rock Gecko; Cicak Batu Putih
Fig. 5, Fig. 6, Table 2

Holotype. Adult male, UNIMAS 9602, collected by Hayden Davis and Izneil Nashriq on 5 August 2017, from the Serian-Tebedu limestone hills (1.131015°N, 110.443988°E; 50 m), Serian, Sarawak, East Malaysia (Borneo).

Paratypes. Serian-Tebedu limestone hills (1.131015°N, 110.443988°E; 50 m), Sarawak, East Malaysia (Borneo) UNIMAS 9603 collected by Hayden Davis and Izneil Nashriq on 5 August 2017; UNIMAS 9606, UNIMAS 9607, UNIMAS 9608, collected by Hayden Davis and Izneil Nashriq on 28 May 2018; UNIMAS 9573, UNIMAS 9574, collected by Izneil Nashriq and Indraneil Das on 22 June 2019; Kampung Mambong, Siburan (1.355571°N, 110.350767°E; 50 m) UNIMAS 9611, collected by Hayden Davis and Izneil Nashriq on 4 June 2018; Jambusan-Semadang limestone hills (1.318342°N, 110.254339°E; 50 m), Sarawak, East Malaysia (Borneo) UNIMAS 9615, collected by Hayden Davis and Izneil Nashriq on 6 June 2018.

Diagnosis. SVL up to 56 mm; 11–14 supralabials; 9–13 infralabials; 2–3 internasals; 5–9 postmentals; ventral scales keeled; adult males with a discontinuous row of 6–12 pore-bearing, precloacal scales with round pores arranged in a chevron, separated at midline by 2–4 poreless scales; paravertebral and lateral row of caudal tubercles present; ventrolateral caudal tubercles absent; caudal tubercles not encircling tail; subcaudals keeled, bearing an enlarged median row of keeled subcaudal scales; 2–7/2–7 (L/R) postcloacal tubercles on each side of tail base; no enlarged femoral or subtibial scales; submetatarsal scales of first toe enlarged; 24–31 fourth toe subdigital lamellae; faint Dusky Brown and Lavender caudal bands anteriorly, immaculate posteriorly; and regenerated tail Spectrum Yellow.

Description of holotype. Male with an original tail; snout-vent length 55 mm; supralabials 14/13 (L/R); infralabials 12/12 (L/R); head short (HL/SVL 0.26), narrow (HW/SVL 0.18), depressed (HD/HL 0.43), distinct from neck; snout long (ES/HW 0.65), much longer than eye diameter (ED/ES 0.50); scales on snout and forehead weakly keeled, with posterior portion of each scale raised; scales on snout larger than those on occipital region; eye small (ED/HL 0.22); orbits of eyes with extra-brillar fringes; pupil round; enlarged supraciliaries on top half of orbit; tympanum deep, oval shaped, greatest diameter vertically, narrow (EL/HL 0.11); eye to ear distance greater than diameter of eyes (EE/ED 1.19); rostral half as deep as wide, contacted posteriorly by 2 nasals and 2 internasals, rostrals is in contact with supralabial I. Nostrils oval, situated within nasals, and oriented dorsally; nostrils are in narrow contact with supralabial I; 6 postnasals bound nasal; mental large, subtriangular, much deeper than wide, five postmentals border mental; chin scales meet infralabials.

Body slender, short (AG/SVL 0.41); ventral scales equal in size from chin region to gular; increase in size from gular to pectoral and abdominal regions, weakly keeled. Dorsal scales increase in size from head to nape and subequal throughout trunk. Scales on dorsum at midbody approximately equal to those of venter at same level; vertebral scales not reduced; paravertebral rows of tubercles on dorsum present; dorsal tubercles extend from occiput to base of tail; tubercles dense dorsally and absent on lower flanks; pectoral and abdominal scales distinctly elongated, imbricate and unicarinate; precloacal scales oval, unicarinate; discontinuous row of 6/6 (L/R), pore bearing, precloacal scales with round pores arranged in a chevron, separated by 3 keeled, poreless scales; no femoral pores; no preanal groove.

Forelimbs moderately long, slender, shorter than hindlimbs (FL/SVL 0.20, TBL/SVL 0.23). Dorsal scales on forelimbs, raised, unicarinate, juxtaposed, reduced in size posteriorly. ventral scales of forelimbs slightly raised, slightly unicarinate, juxtaposed, reduced in size posteriorly. Dorsal scales of hindlimbs raised, unicarinate, juxtaposed, reduced in size posteriorly; ventral scales of hindlimbs slightly raised, slightly unicarinate, juxtaposed, reduced in size posteriorly. Palmar and plantar scales smooth, granular, raised. Digits elongate, all bearing claws that are slightly recurved; subdigital scansors entire, except for 1–2 fragmented at base of digits, unnotched; an enlarge scansor towards the base of digits, which is more than twice width of other scansors; interdigital webbing absent. Subdigital lamellae (manus) I (15); II (20); III (26); IV (29); V (20); (pes) I (12); II (20); III (24); IV (29); V (23).

FIGURE 5: (A) *Cnemaspis matahari* **sp. nov.**, paratype UNIMAS 9573, SVL 56 mm, adult male from Serian–Tebedu limestone hills, Serian District, First Division, Sarawak. (B) type series displaying dorsal side of the body (from left to right: above, UNIMAS 9608, UNIMAS 9607, UNIMAS 9606, UNIMAS 9603, UNIMAS 9602; below, UNIMAS 9574, UNIMAS 9573, UNIMAS 9615 and UNIMAS 9611).

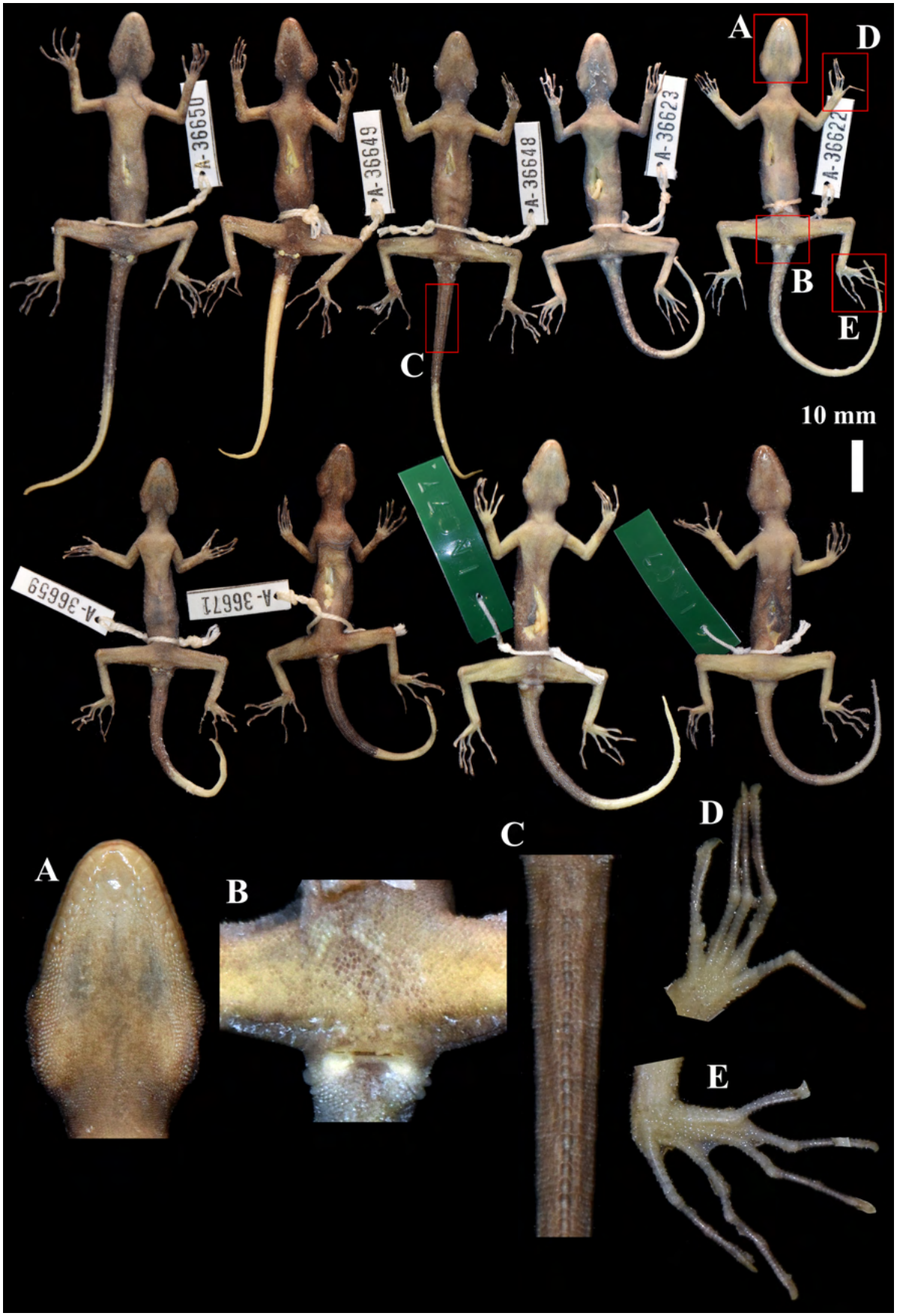

FIGURE 6: Ventral view of *Cnemaspis matahari* **sp. nov.** type series (from left to right: above, UNIMAS 9608, UNIMAS 9607, UNIMAS 9606, UNIMAS 9603, UNIMAS 9602; below, UNIMAS 9574, UNIMAS 9573, UNIMAS 9615 and UNIMAS 9611); Close up of body parts (A) Postmental, (B) Cloaca, (C) Subcaudal, (D) Manus and (E) Pes.

FIGURE 7: Habitat and microhabitat of *Cnemaspis matahari* **sp. nov.** in Serian limestone region, Serian District, Sarawak, East Malaysia (Borneo)

Original tail, longer than snout-vent length (TL/SVL 1.28); tail base distinctly swollen; tail arranged in segmented whorls; caudal tubercles keeled, arranged on paravertebral and lateral rows; caudal tubercles do not encircle tail at each whorl; 2/2 (L/R) postcloacal tubercles; tail with distinct pairs of furrows laterally; subcaudal scales unicarinate; a single median row of enlarged, keeled, imbricate, subcaudal scales with 3–4 scales per segment.

Variation in paratype. The seven males (UNIMAS 9573, 9603, 9606-9608, 9611, 9615) and one female paratype (UNIMAS 9574) closely resemble the holotype in colour and pattern, but differ in the shade of colouration. Spectrum Yellow on upper flanks extends to paravertebral region or further to axillary region. 10–14 supralabials; 9–13 infralabials; 2–3 internasals; 5–9 postmentals; discontinuous row of 6–12 precloacal scales with round pores separated at midline by 2–4 poreless scales; 2–7/2–7 (L/R) postcloacal tubercles on side of tail base; tail arranged in segmented whorls; caudal tubercles do not encircle tail at each whorl; subcaudals with a single median row of imbricated, enlarged, keeled, raised, subtriangular scales, with 3–4 scales per segment. All show regenerated tails with differing proportions of original tail present. Tails regenerated from base or middle are yellow. Scales from dorsal to ventrolateral surfaces of regenerated tail are small, keeled, slightly imbricate, and subequal in size.

Skeletal notes. Holotype UNIMAS 9602 and paratype UNIMAS 9603 have 26 presacral and 2 sacral vertebrae. The phalangeal formulae are 2–3–4–5–3 manus and 2–3–4–5–4 pes. Both specimens are skeletally mature, showing fusion of epiphyses.

Colouration in life. Dorsal ground colour of body and limbs Trogon Yellow; head Spectrum Yellow; ground colour of nape and shoulder region Pratt's Payne's Gray bearing a pair of medium, round, Dusky Brown spots in shoulder axillary; white flecks on nape to shoulder region; faint Sulfur Yellow banding on body; digits Pratt's Payne's Gray with faint dark banding; anterior one-half of tail Lavender bearing faint, Dusky Brown bands; posterior one-half of original tail immaculate; all ventral surfaces Pratt's Payne's Gray except for posterior half of tail, which is white; and regenerated tail Spectrum Yellow.

Etymology. The epithet *matahari* is Malay for sun, in reference to the yellowish tint on the species. It is used as a noun in apposition.

Natural history. Found on limestone escarpments and outcrops and is exclusive to the Siburan and Serian Districts. Individuals were collected between 2000–2200 hrs. Surveys suggest the geckos are mostly active (emerging from rock crevices) when moisture and humidity are high. During dry conditions, when the temperature is relatively high, geckos are not observed in the open. Water droplets can be seen dripping from the limestone formations at the sites where this gecko occurs. Small streams are present with their sources within the karst. Limestone hills are surrounded by vegetation (dipterocarp forest and herbaceous plants, Figure 7). *Cnemaspis matahari* **sp. nov.** occurs sympatrically with the *Cyrtodactylus* geckos *C. limajalur*, *C. consobrinus* and *C. pubisulcus*, with *Cnemaspis* found on the lower part of the limestone hill close to the ground, whereas *Cyrtodactylus* spp. occur from ground level up to > 10 m.

Comparisons. *Cnemaspis matahari* **sp. nov.** differs from other Bornean *Cnemaspis* by having a bright yellow head, body and limbs; 10–14 supralabials; 9–13 infralabials (*versus* 10–11 in *C. lagang* **sp. nov.**); 5–9 postmentals (*versus* 3 in *C. kendallii*, 10 in *C. dringi*, 10–11 in *C. lagang* **sp. nov.**); discontinuous rows of 6–12, pore bearing, precloacal scales (*versus* none in *C. kendallii*, 5–6 in *C. dringi*, 14–15 in *nigridia*); 2–7/2–7 (L/R) postcloacal tubercles (*versus* 1–2/1–2 in *C. lagang* **sp. nov.** and 1–2/1–2 in *C. sirehensis* **sp. nov.**); 26–31 subdigital fourth toe lamellae (*versus* 29 in *C. dringi*); having weekly keeled enlarged median subcaudal scales (*versus* smooth enlarged median subcaudal in *C. nigridia*, *C. leucura*, and *C. paripari*); faint Dusky Brown and Lavender caudal bands anteriorly, immaculate posteriorly and regenerated tail Spectrum Yellow (*versus* Dusky Brown and Buff-Yellow caudal bands in *C. kendallii*, Dusky Brown and Orange Yellow caudal bands in *C. nigridia*, Pratt's Payne's Gray anteriorly and immaculate posteriorly in *C. paripari*, Faint Dusky Brown and Trogon Yellow caudal bands anteriorly and immaculate posteriorly in *C. lagang* **sp. nov.**, and Brownish Olive and Sulfur Yellow caudal bands in *C. sirehensis* **sp. nov.**).

Cnemaspis sirehensis sp. nov.

Blue Day Gecko; Cicak Gua Sireh
Fig. 8, Fig. 9, Table 3

Holotype. Adult female, UNIMAS 9609, collected by Hayden Davis and Izneil Nashriq, on 2 June 2018, from Gua Sireh (1.180407°N, 110.463391°E; 50 m), Gunung Nambi, Kampung Bantang, Serian District, Sarawak, East Malaysia (Borneo).

Paratype. Adult female, UNIMAS 9610, collected by Hayden Davis and Izneil Nashriq, on 2 June 2018, and UNIMAS 9715, collected by Izneil Nashriq, Wong Jye Wen and Indraneil Das, from Gua Sireh (1.180407°N, 110.463391°E, 50 m), Gunung Nambi, Kampung Bantang, Serian District, Sarawak, East Malaysia (Borneo).

Diagnosis. SVL up to 49 mm; 12–13 supralabials; 10–12 infralabials; 3 internasals; 6–7 postmentals; subtibial scales keeled; ventrolateral caudal tubercles absent; paravertebral and lateral row of caudal tubercles present; caudal tubercles not encircling tail; subcaudals keeled, bearing an enlarged median row of weakly keeled scales; 1–2/1–2 (L/R) postcloacal tubercles on each side of tail base; no enlarged femoral or subtibial scales; submetatarsal scales of first toe enlarged; 26–30 fourth toe subdigital lamellae.

Description of holotype. Adult female with original tail, dark banded. Snout-vent length 47 mm; supralabials 12/12 (L/R); infralabials 10/10 (L/R); head oblong, short (HL/SVL 0.30), narrow (HW/SVL 0.18), depressed (HD/HL 0.36), distinct from neck; snout moderately long (ES/HW 0.69), longer than eye diameter (ED/ES 0.54); scales on snout and forehead weakly keeled, with posterior portion of each scale raise; scales on snout larger than those on occipital region; eye small (ED/HL 0.22); orbits of eyes with extra-brillar fringes; pupil round; enlarged supraciliaries on top half of orbit; tympanum deep, oval shaped, greatest diameter vertically, narrow (EL/HL 0.09); eye to ear distance greater than diameter of eyes (EE/ED 1.19); rostral half as deep as wide, contacted posteriorly by 2 nasals and 3 internasals, rostrals is in contact with supralabial I. Nostrils oval, situated within nasals, and oriented dorsally; nostrils are in narrow contact with supralabial I. 5 postnasals bound nasal; mental large, subtriangular, much deeper than wide, 7 postmentals border mental; chin scales meet infralabials.

Body slender, short (AG/SVL 0.43); ventral scales equal in size from chin region to gular; increase in size from gular to pectoral and abdominal regions, weakly keeled. Dorsal scales increase in size from head to nape and subequal throughout trunk. Scales on dorsum at midbody approximately equal to those of venter at same

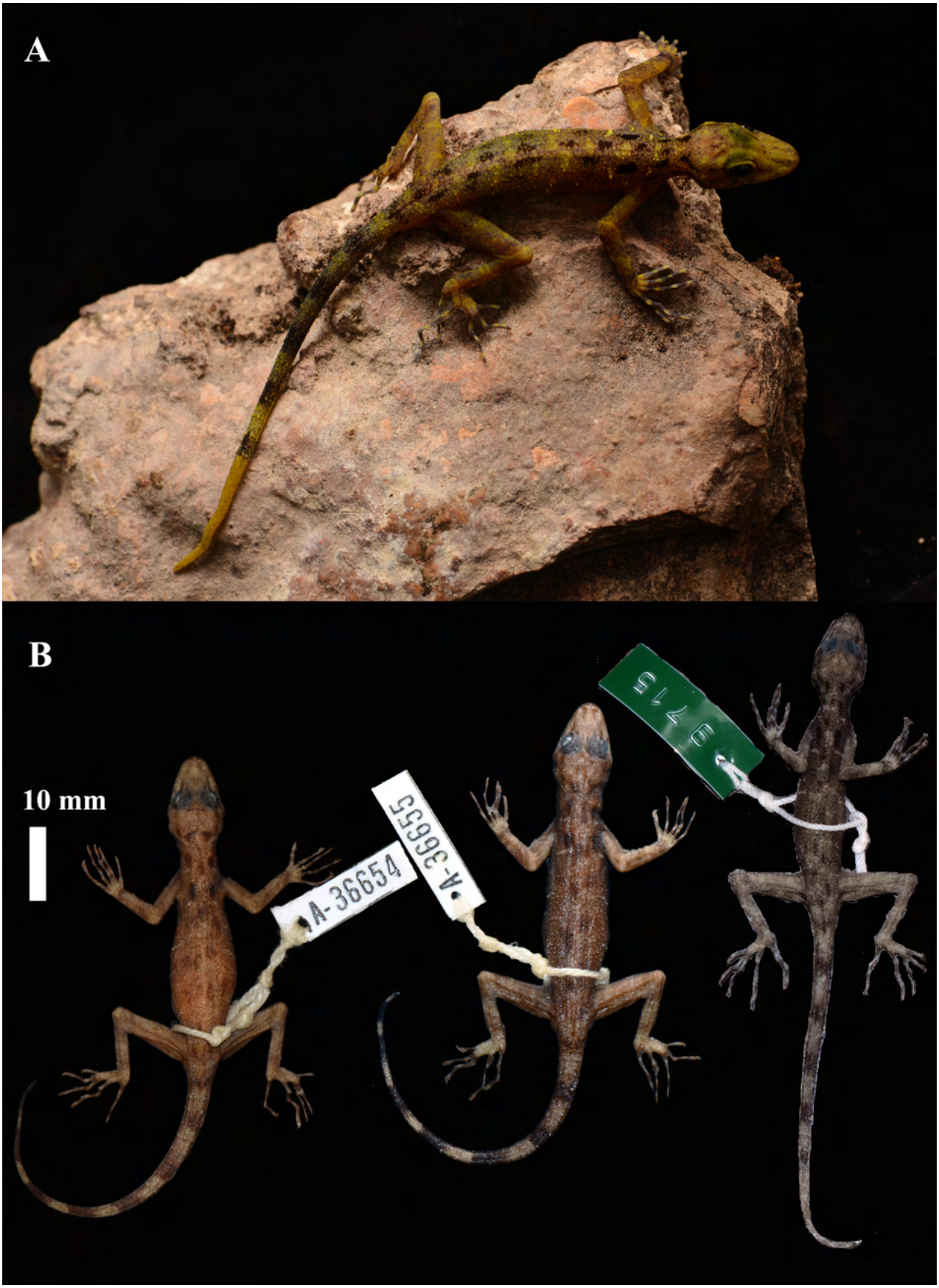

FIGURE 8: *Cnemaspis sirehensis* **sp. nov.**, paratype, UNIMAS 9715, SVL 45 mm, adult female from Gua Sireh, Gunung Nambi, Serian District, First Division, Sarawak. (B) type series displaying dorsal side of the body (from left to right: UNIMAS 9715, UNIMAS 9609 and UNIMAS 9610).

level; vertebral scales not reduced; paravertebral rows of tubercles on dorsum present; dorsal tubercles extend from occiput to base of tail; tubercles dense dorsally and absent on lower flanks; pectoral and abdominal scales distinctly elongated, imbricate and unicarinate; no femoral pores and preanal groove.

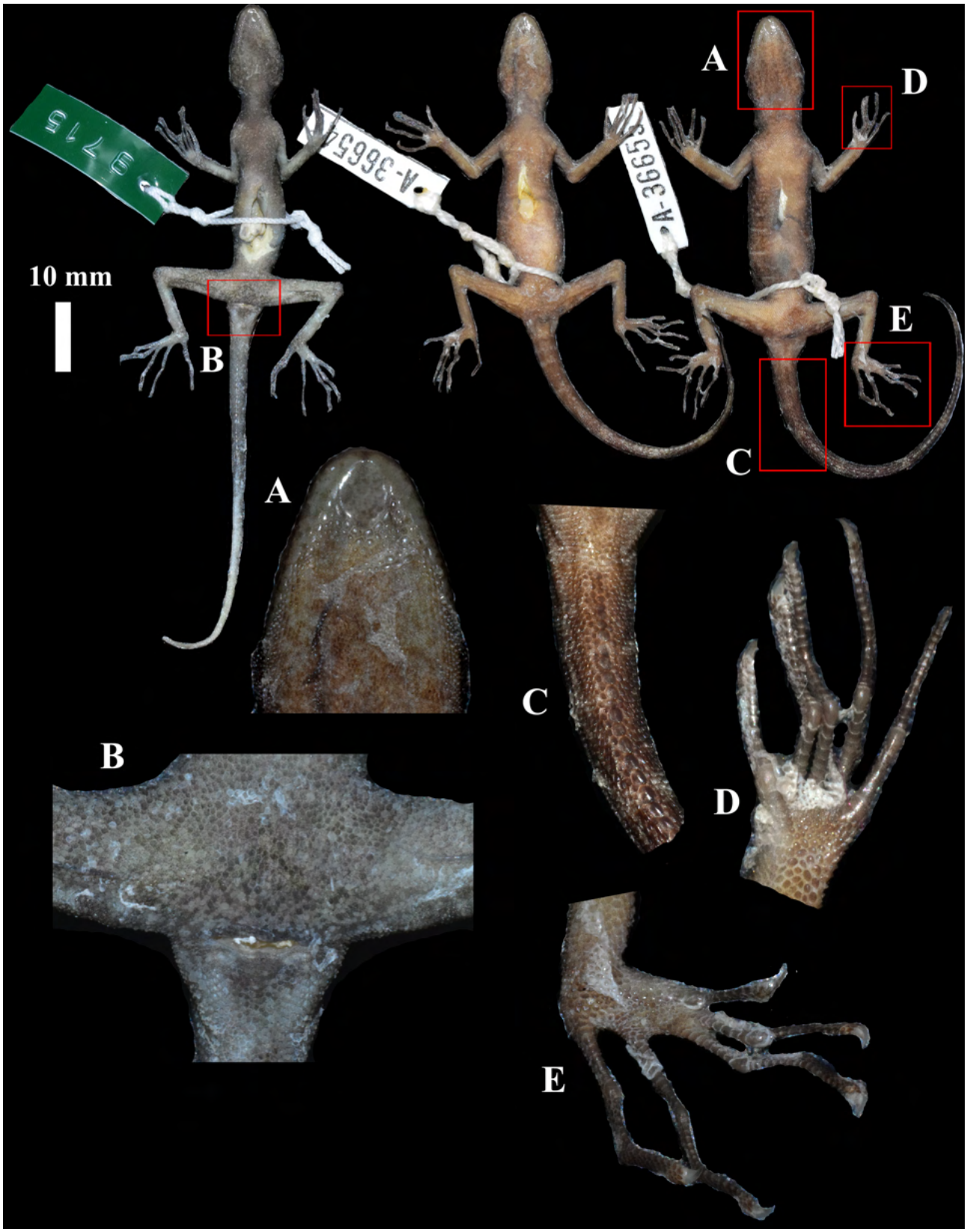

FIGURE 9: Ventral view of *Cnemaspis sirehensis* **sp. nov.** type series (from left to right: UNIMAS 9715, UNIMAS 9609 and UNIMAS 9610); close up of body parts (A) Postmental, (B) Cloaca, (C) Subcaudal, (D) Manus and (E) Pes.

Forelimbs moderately long, slender, shorter than hindlimbs (FL/SVL 0.20, TBL/SVL 0.23). Dorsal scales on forelimbs, raised, unicarinate, juxtaposed, reduced in size posteriorly; ventral scales of forelimbs slightly raised, slightly unicarinate, juxtaposed, reduced in size posteriorly. Dorsal scales of hindlimbs raised, unicarinate, juxtaposed, reduced in size posteriorly; ventral scales of hindlimbs slightly raised, slightly unicarinate, juxtaposed, reduced in size posteriorly. Palmar and plantar scales smooth, granular, raised. Digits elongate, all bearing claws that are slightly recurved; subdigital scansors entire, except for 1–2 fragmented at base of digits, unnotched; an enlarge scansor towards base of digits, which is over twice width of other scansors; interdigital webbing absent. Subdigital lamellae (manus) I (13); II (19); III (21); IV (24); V (18); (pes) I (10); II (17); III (23); IV (26); V (23).

Original tail, longer than snout-vent length (TL/SVL 1.22); tail base distinctly swollen; tail arranged in segmented whorls; caudal tubercles subspinous, raised, weakly keeled, arranged on paravertebral and lateral row; tubercles do not encircle tail; 2/1 (L/R) postcloacal tubercles; tail with a distinct pair of furrows laterally; a single median row of enlarged, weakly keeled, imbricate, subcaudal scales with 3 or 4 scales per segment.

Variation in paratypes. A total of two adult females (UNIMAS 9610 and 9715) indistinguishable from holotype apart from aspects of scale morphology and colouration; 12–13 supralabials; 11–12 infralabials; 6–7 postmentals. They have yellow regenerated tail. Scales from dorsal to ventral surface of regenerated tail are small, keeled, slightly imbricate, and equal in size.

Colouration in life. Dorsal ground colour of head, body and limbs Raw Umber; head Trogon Yellow, bearing small, occipital flecks; nape and shoulder region bearing Dusky Brown patches of irregularly shaped, dark blotches; Pratt's Payne's Gray patches on paravertebral; small, scattered, Spectrum Yellow flecks between limb insertion; irregular Citrine bands on forelimbs and hind limbs; Tail with Brownish Olive and Sulfur Yellow banding from tail base to tip; and Trogon Yellow regenerated tail.

Natural History. The species is nocturnal, with individuals being collected between 2000–2200 hrs from limestone escarpments surfaces, within narrow rock crevices, outside the entrance of Gua Sireh, in Serian. No individuals were found inside the cave. Small streams originating from the limestone formation are present. The limestone hills are edged by dipterocarp forests as well as secondary forests, as well as plantations at the foot of the hills (Figure 10). *Cnemaspis sirehensis* **sp. nov.** occurs sympatrically with *Cyrtodactylus* geckos (*C. consobrinus* and *C. pubisulcus*) and *Hemidactylus* sp.

TABLE 4: Min–Max measurement of Bornean *Cnemaspis* examined (nearest 0.1 mm).

	C. kendallii	***C. nigridia***	***C. dringi***	***C. paripari***	***C. leucura***	***C. matahari* sp. nov.**	***C. lagang* sp. nov.**	***C. sirehensis* sp. nov.**
	N = 52	**N = 5**	**N = 2**	**N = 13**	**N = 6**	**N = 9**	**N = 2**	**N = 3**
SVL	33.1–60.4	57.0–68.9	43.3–45.5	40.3–54.4	49.7–63.3	47.1–55.7	46.0	45.1–48.8
HL	13.1–16.7	16.1–20.5	8.4–8.6	11.4–16.5	14.6–17.6	13.9–16.5	13.2 –13.4	13.0–14.1
HW	6.8–10.3	10.4–12.6	6.9–7.0	7.4–10.3	9.1–11.4	8.2–10.6	8.4–13.0	7.8–8.7
HD	4.0–6.7	6.3–7.7	4.5–5.0	4.0–6.3	5.9–7.1	4.9–6.3	4.4–5.1	4.8–5.1
ED	2.0–4.2	3.3–4.3	2.6–3.0	2.4–3.7	4.2–3.0	2.8–3.6	2.8–3.1	3.0–3.1
EE	2.1–4.8	4.0–5.3	3.0–3.2	2.6–4.3	3.1–4.4	3.5–4.4	4.0	3.5–3.7
ES	5.7–7.7	7.1–9.0	5.5–5.7	4.8–7.4	6.0–7.9	5.8–7.4	5.7–6.0	5.7–5.9
EN	3.5–6.2	5.4–6.7	4.3–4.4	3.7–6.0	4.4–6.3	4.1–5.6	4.2–4.8	4.3–4.9
IO	1.4–3.5	1.7–2.8	2.9	1.5–2.5	1.5–2.8	1.6–2.7	1.6–2.2	1.6–2.1
EL	0.9–2.3	1.3–2.1	0.9–1.2	0.9–1.7	1.4–2.1	0.9–1.7	1.1–1.4	1.0–1.2
IN	1.0–2.4	1.6–2.1	1.6–1.7	1.1–1.7	1.5–2.2	1.4–2.1	1.5–2.0	1.0–1.6
TL	0–78.2	22.7–72.3	31.4–62.7	2.4–70.0	35.6–76.3	44.1–71.0	24.5–61.1	57.0–61.8
TW	2.1–6.1	4.5–6.5	4.7–4.9	2.4–5.7	3.6–5.6	3.3–4.7	3.0–4.5	3.3–3.7
FL	7.4–12.2	10.1–13.2	7.6–8.5	8.1–11.0	9.8–12.0	9.2–11.6	8.5–9.1	8.3–9.7
TBL	7.8–14.5	12.7–15.8	10.0–10.9	9.5–13.1	12.5–14.5	10.9–14.3	10.3–10.8	11.1–11.6
AG	18.3–32.1	19.5–28.5	19.4–20.9	19.5–24.5	23.4–30.8	19.6–25.4	19.4–19.8	20.3–23.2

TABLE 5: Summary of variation in morphology of Bornean species of *Cnemaspis*. Left/Right counts are given as (L/R). ? indicates missing data.

	kendallii	***nigridia***	***dringi***	***paripari***	***leucura***	***matahari* sp. nov.**	***lagang* sp. nov.**	***sirehensis* sp. nov.**
Supralabials	9–13/10–14	12–15/12–14	11/11	10–13	12–13/11–13	11–14/10–14	13–14/14	12–13/12–13
Infralabials	9–12/9–12	10–11/10–12	9–13	9–12	10–13/10–12	9–13/10–12	10–11/10–11	10–12/10–12
Internasals	2–3	2	?	2–3	2–3	2–3	3	3
Postmentals	3	5–7	10	6–9	4–6	5–9	9–10	6–7
Ventral scales	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled
Forearm scales	Keeled	Keeled	Smooth	Keeled	Keeled	Keeled	Keeled	Keeled
Subtibial scales	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled
Number of precloacal pores in males	Absent	14–15	5–6	4–8	8–9	6–12	7–8	?
Precloacal pores continuous or separated	Absent	Separated	Separated	Separated	Separated	Separated	Separated	?
Precloacal pores elongate or round	Absent	Round	Round	Round	Round	Round	Round	?
Number of postcloacal tubercles	2–3/2–3	1–3/1–3	Absent	2–3/2–3	3–8/3–8	2–7/2–7	1–2/1–2	1–2/1–2
Lateral caudal furrows	Present	Present	Present	Present	Present	Present	Present	Present
Caudal tubercles in lateral furrows	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Caudal tubercles restricted to a single paravertebral row on each side	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Paravertebral caudal tubercles	Present	Present	Present	Present	Present	Present	Present	Present
Lateral caudal tubercles	Present	Present	?	Present	Present	Present	Present	Present
Ventrolateral caudal tubercles	Present	Present	?	Present	Present	Present	Absent	Absent
Caudal tubercles encircle tail	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Anterior ventrolateral caudal tubercles	Present	Present	?	Present	Present	Present	Absent	Absent
Dorsal caudal scales	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled
Subcaudal scales	Keeled	Smooth	Keeled	Keeled	Keeled	Keeled	Keeled	Keeled
Median row of subcaudals	Keeled	Smooth	Keeled	Smooth	Smooth	Keeled	Keeled	Keeled
Enlarged median subcaudal scale row	Present	Present	Present	Present	Present	Present	Absent	Present
Enlarged femoral scales	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

.....Continued on the next page

TABLE 5. (Continued)

	kendallii	***nigridia***	***dringi***	***paripari***	***leucura***	***matahari* sp. nov.**	***lagang* sp. nov.**	***sirehensis* sp. nov.**
Shield–like subtibial scales	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Enlarged submetatarsal scales on 1st toe	Absent	Present	Present	Present	Present	Present	Present	Present
Finger lamellae on 1st digit	12–15	14–15	14/16	12–15	14–15	12–15	13–14	12–13
… on 2nd digit	17–23	19–21	24/22	18–24	19–23	19–25	19–21	19–23
…on 3rd digit	23–30	23–24	27/27	21–28	23–29	25–29	23–24	21–28
… on 4th digit	26–33	25–29	29/29	24–31	23–30	27–31	25–27	24–31
… on 5th digit	16–25	18–21	19/21	18–21	18–22	19–24	21–22	18–21
Toe lamellae on 1st digit	11–15	12–13	12/12	10–15	13–15	12–14	11–13	10–13
… on 2nd digit	18–25	20–20	20/21	17–24	17–22	18–22	19	17–24
… on 3rd digit	24–29	23–24	26/25	20–27	24–29	24–28	23	23–27
…on 4th digit	27–32	27–28	30/29	26–31	29–31	26–31	29	26–30
…on 5th digit	20–26	22–24	26/26	22–25	24–26	22–25	24	21–25

FIGURE 10: Habitat (above) and microhabitat (below) of *Cnemaspis sirehenesis* **sp. nov.** in Gua Sireh, Gunung Nambi, Kampung Bantang, Serian District, Sarawak, East Malaysia (Borneo).

Etymology. The epithet *sirehensis* comes from the type locality, Gua Sireh (Sireh Cave), Kampung Bantang, Serian and translates to betel in Malay. Betel is a type of plant of the family Piperaceae, consumed as betel quid or in 'paan'. Gua Sireh is also known as an important archaeological site in south-western Sarawak.

Comparison. *Cnemapsis sirehensis* **sp. nov.** differs from other Bornean *Cnemaspis* by having a reddish-brown head, body and limbs; 12–13 supralabials (*versus* 13–14 in *C. lagang* **sp. nov.**); 10–12 infralabials; 6–7 postmentals (*versus* 3 in *C. kendallii*, 10 in *C. dringi*, and 10–11 in *C. lagang* **sp. nov.**); a pair of medium, subtriangular, dusky brown patches in shoulder region; 1–2/1–2 (L/R) postcloacal tubercles on each side of tail base (*versus* 2–3/2–3 in *C. kendallii*, 2–3/2–3 in *C. paripari*, 3–8/3–8 in *C. leucura* and 2–7/2–7 in *C. matahari* **sp. nov.**); ventrolateral row of caudal tubercles absent (except *C. lagang* **sp. nov.**, *C. matahari* **sp. nov.**); keeled median subcaudals (*versus* smooth in C. *leucura*, *C. nigridia*, *C. paripari*); tail with Brownish-Olive and Bright Yellow banding from tail base to tail tip (*versus* Dusky Brown and Buff-Yellow caudal bands in *C. kendallii*, Dusky Brown and Orange Yellow caudal bands in *C. nigridia*, Pratt's Payne's Gray anteriorly and immaculate posteriorly in *C. paripari*, Faint Dusky Brown and Trogon Yellow caudal bands anteriorly and immaculate posteriorly in *C. lagang* **sp. nov.**); and regenerated tail Trogon Yellow (*versus* Spectrum Yellow in *C. matahari* **sp. nov.** and Buff Yellow in *C. lagang* **sp. nov.**).

A summary of Bornean *Cnemaspis* morphology is presented in Tables 4 and 5. Compared to nominal south-east Asian *Cnemaspis* the Bornean *Cnemaspis* differ in multiple morphological aspects. The Cau Mau clade (*C. boulengerii* and *C. psychedelica*) have fewer supralabials (7–10 *versus* 9–15 in Bornean species) and infralabials (5–8 *versus* 9–13 in Bornean species); caudal tubercles restricted to single paravertebral rows; no lateral caudal furrows; and plate-like femoral and subtibial scales. The Pattani clade (*C. monachorum*, *C. biocellata*, *C. niyomwanae*, and *C. kumpoli*) have smooth ventral scales; and in *C. niyomwanae* and *C. kumpoli*, no lateral and ventrolateral row of caudal tubercles. The Northern Sunda clade, comprising the *chantaburiensis* group, are the only species of *Cnemaspis* that have a dark, mid-gular line, thought to be synapomorphic; the *siamensis* group exhibit the states of light-coloured prescapular crescent, a yellow belly and ventral surface of hindlimbs and caudal tubercles not restricted to a single paravertebral row and encircling tail; the *argus* group have no lateral or ventrolateral caudal tubercles; and the *affinis* group have a lateral row of caudal tubercles, no median row of enlarged subcaudal scales and submetatarsal scales on first toe.

Discussion

The discovery of the three new *Cnemaspis* species (*C. lagang* **sp. nov.**, *C. matahari* **sp. nov.** and *C. sirehensis* **sp. nov.**) suggest the possibility of additional cryptic species on Borneo. The current distributions of Bornean *Cnemaspis* species are limited to particular geological formations and intact forests within such formations, with six species (*C. kendallii*, *C. nigridia*, *C. paripari*, *C. leucura*, *C. matahari* **sp. nov.** and *C. sirehensis* **sp. nov.**) recorded in west Sarawak and two recorded species (*C. dringi* and *C. lagang* **sp. nov.**) in the north of Sarawak. The newly described species occupy isolated formations of west Sarawak, the Serian and Padawan limestone formations (*C. matahari* **sp. nov.** and *C. sirehensis* **sp. nov.**) and in north Sarawak, the Mulu limestone formation (*C. lagang* **sp. nov.**). The distribution of the three newly described species is reflected in Figure 11.

Sarawak consists of three distinct geological provinces, coinciding with geographic demarcations -West Sarawak and Central-North Sarawak- with the Lupar Line bounding the Sibu Zone and Kuching Zone, and the Bukit-Mersing Line bounding the Miri Zone and Sibu Zone (James 1984; Hutchison 1989). The 15 km wide east-southeast trending suture zone has been associated with faunal distributional disjunctions, supported in a variety of taxonomy groups, for instance, lineages of the dipterocarps (Ashton 1972), distributional pattern mirrored by several lineages (described in detail by Bornbusch & Lundberg 1989; Davis *et al.* 2021). The distributional limits to the south on the island of Borneo appear to be coincident with the hill ranges of Penrissen, and the west-flowing Kapuas, which periodically connected to the east coast of Sumatra (another large island inhabited by *Cnemaspis*, of the *kendallii* group; Amarasinghe *et al.* 2015), most recently during the Pleistocene. Weber (1921) summarised geological and biological evidence for such a connection, that is currently referred to as the Riau Pocket (sensu Corner 1958; 1960; see also Kiew and Saw 2019).

The northern-most representative, *C. lagang* **sp. nov.**, is found in the Baram Basin, at the headwaters of the Sungei Baram. The southern-most species, *C. leucura*, has been recorded from Gunung Penrissen as has *C. kendallii*, with which it is occasionally sympatric (but non-syntopic, occupying vegetation such as tree trunks, rather than rock

surfaces). The known distribution of *Cnemaspis* in Sarawak is fragmented by human intervention (mining activities, development and land conversion to agriculture). Shifting agriculture and mining activities are intense in Sarawak and if not mitigated or done sustainably, will not only affect the assemblages of this genus, but in a wider context will result in loss of diversity in other taxa (Nashriq & Das 2021). This study was focused on western Sarawak. The formations in western Sarawak were easily accessible compared to those of central and northern Sarawak. Future efforts should be directed in finding species of *Cnemaspis* in central and northern Sarawak, especially along the karst limestone regions of the State.

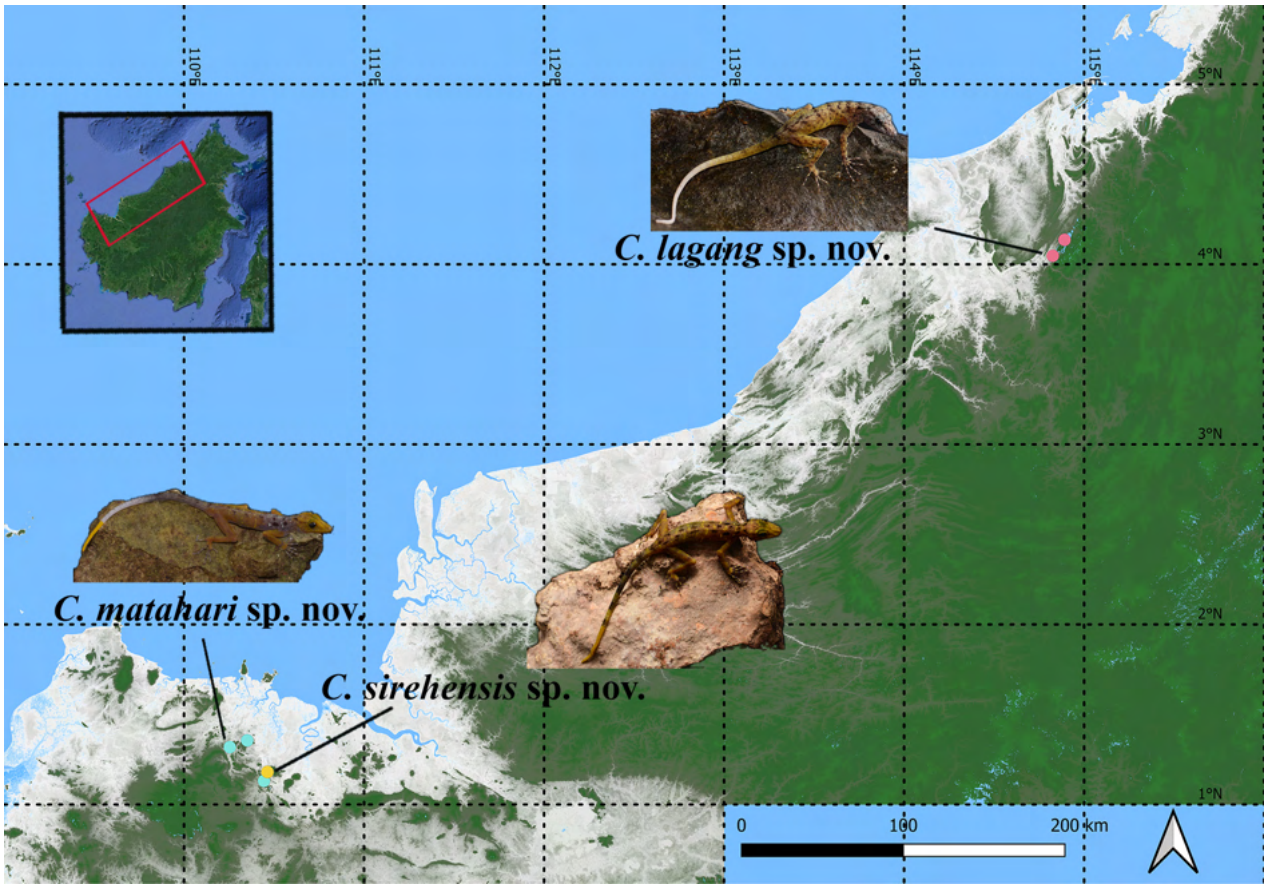

FIGURE 11: Distribution of the three newly described *Cnemaspis* species in Sarawak, East Malaysia, Borneo.

Acknowledgements

We are grateful to the staff of the Institute of Biodiversity and Environmental Conservation, Gabriel Tonga Noweg, Andrew Alek Tuan, Mohd-Azlan Jayasilan, Felicia Anthony Reyap, Pasey Lisus, Rahah Mohamad Yakup, Hasri Al-Hafiz Haba, Mohsin Zainalabidin, Ketty Daun and Sauyah Su'aut for support and supplies. We are grateful to the following curators, collection managers and institutions for access to material under their care: BMNH, London (E.N. Arnold and C.J. McCarthy); FMNH, Chicago (H.K. Voris, R.F. Inger and A. Resetar); MCZ, Cambridge, MA (J.E. Cadle, J. Hanken and J. Rosado); SBC, Semenggoh (C. Yeo and M. Naming); SM, Kuching (P. Kedit and C. Leh); USNM, Washington, D.C. (W.R. Heyer, R.I. Crombie and G.R. Zug); and ZRC, Singapore (P.K.L. Ng and K.K.P. Lim). We thank the Sarawak Forest Department for research permits (147) JHS/NCCD/600-7/2/107/Jld.2 and Park Permit N0.74/2019. We thank Abang Abdul Rahman Zohari Abang Openg, the Honourable Chief Minister of Sarawak for approval of the new names of the species on 2 December 2021, and to the staff of the Sarawak Forestry Corporation, Haji Zolkipli Mohamad Aton and Oswald Braken Tisen for their assistance. The Sarawak Forestry Corporation, allowed us entrance to the National Parks and other protected areas. At Gunung Mulu National Park, we thank the authorities, in particular Ellen McArthur for facilitating our research. Funding came from a grant from the Niche Research Grant Scheme of the Ministry of Higher Education, Government of Malaysia: NRGS/1087/2013(01) to Indraneil Das. We also thank the Herpetofaunal Biology team, Pui Yong Min,

Anthony K. Pine, Siti Nor Baizurah, Wong Jye Wen, Veronica Martin, Veronica Leah anak Buma, Awang Khairul Ikhwan and Chien C. Lee for field assistance and company.

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APPENDIX I. List of Comparative Material Examined

***Cnemaspis dringi* Das & Bauer, 1998.** "Labang Camp (03º20'N; 113º29'E), Bintulu District, Fourth Division, Sarawak, East Malaysia, Borneo" (FMNH 148588, ex-FMNH FS 19914; holotype); "Sungai Segaham (02º44'N; 113º53'E), Belaga District, Seventh Division, Sarawak, East Malaysia" (FMNH 221478, ex-FMNH FS 34321; paratype).

***Cnemaspis kendallii* (Gray, 1845).** "Borneo" (BMNH XXII.92a, lectotype); Bako National Park, Kuching Division (FMNH 223201; MCZ 157158–59; SM uncatalogued, ZRC 2.4662 [three specimens]; UNIMAS 9556, 9588); Bau, Kuching Division (BMNH 1911.1.30.7–9); Bidi, Kuching Division (BMNH 1902.12.12.12); Bukit Kawa, Bau, Kuching Division (SBC R.103); Bukit Meraja, Bau, Kuching Division (SBC R.60); Bukit Poing,

Bau, Kuching Division (SBC R.104); Bukit Tongga, Bau, Kuching Division (SBC R.27); Gua Pari Pari, Bau, Kuching Division (UNIMAS 9545, 9548–51, 9587); Gua Silabur, Serian, Samarahan Division (UNIMAS 9504–05); Gumbang (UNIMAS 9577–82); Gunung Matang, Kuching Division (BMNH RR1962.182; BMNH 99.12.8.1); Gunung Gading, Lundu, Kuching Division (USNM 76633; UNIMAS 9569, 9593, 9595–96); Gunung Penrissen, Kuching Division (SM c.c.1.2.2.B; in addition to a second uncatalogued SM specimen; UNIMAS 9623–25); Gunung Santubong, Kuching Division (SM c.c.1.2.1; ZRC uncatalogued; UNIMAS 9557–58, 9566, 9597–9601); Gunung Serambu (UNIMAS 9626–28); Gunung Singai (UNIMAS 9542–43); Kampung Haji Baki (UNIMAS 9552); Kampung Mambong (UNIMAS 9612–14); Kampung Temurang (UNIMAS 9618); Kubah National Park, Kuching Division (UNIMAS 9554–55, 9617); Kuching, Kuching Division (SM c.c.2.1.D: three specimens); Matang Wildlife Center, Kuching Division (UNIMAS 9559–60); Ranchan Pool Forest, Serian, Samarahan Division (UNIMAS 9553; ZRC 2.4938–39); Samunsam Wildlife Sanctuary (UNIMAS 9575–76); Semenggoh Wildlife Sanctuary, Kuching Division (ZRC 2.4958); Tanjung Datu National Park (UNIMAS 9630–31).

Cnemaspis leucura **Kurita, Nishikawa, Matsui & Hikida, 2017**. Borneo Highlands Resort, Gunung Penrissen (UNIMAS 9563–65, 9585).

Cnemaspis nigridia **(Smith, 1925)** "Mt. Gadin" (BMNH 1946.8.22.90, ex-BMNH 1925.9.1.8; holotype); BMNH 1974.3790; UNIMAS 9561; 9567–9568; 9592; 9594; SM c.c.1.2.3; individually numbered SM 7659; 7667; 8055; 8060–65; in addition to eight uncatalogued SM specimens; UNIMAS 7980; ZRC 2.1114–115; 2.5324–25; also, PNM 7948; Lundu, Kuching Division (MCZ 15250); Gunung Pueh, Kuching Division (BMNH 1925.9.1.9–10); Gunung Beremput, Kuching Division (UNIMAS 7559–7562).

Cnemaspis paripari **Grismer & Chan, 2009** "Gua Pari-pari, Bau District, Sarawak, Malaysia (01º22.867 N, 110º07.164 E)" (ZRC 2.6812, holotype; UNIMAS 9544–47; 9584–86); "Gua Angin, Bau District, Sarawak, Malaysia (01º24.882 N, 110º08.255 E)" (ZRC 2.6813–14, paratypes; UNIMAS 9570–72; 9589–90).

APPENDIX II. Primers used for amplification and sequencing in the current study.

Primer Name	Primer Reference	Primer Sequence
ND2-METF1	Macey *et al.* (1997)	5' AAGCTTTCGGGCCCATACC 3'
ND2-COIRI	Macey *et al.* (1997)	5' AGRGTGCCAATGTCTTTGTGRTT 3'

APPENDIX III. GenBank accession numbers and locality for the taxa included in the phylogenetic analyses. The accession numbers represent all ND2 sequences of gekkonid lizards of the genus *Cnemaspis* and outgroups used to generate phylogenetic relationships.

Species	Accession No.	Museum No.	Locality
Ailuronyx seychellensis	KY038014.1	PL17	NA
Cnemaspis affinis	KM024684.1	LSUHC:6757	Pulau Pinang, Penang, Malaysia
Cnemaspis affinis	KM024685.1	LSUHC:6758	Pulau Pinang, Penang, Malaysia
Cnemaspis argus	KM024687.1	LSUHC:8304	Gunung Lawit, Terengganu, Malaysia
Cnemaspis argus	KM024691.1	LSUHC:10859	Gunung Tebu, Terengganu, Malaysia
Cnemaspis aurantiacopes	KM024692.1	LSUHC:8610	Hon Dat Hill, Vietnam
Cnemaspis baueri	KM024696.1	LSUHC:7302	Pulau Aur, Johor, Malaysia
Cnemaspis baueri	KM024697.1	LSUHC:7303	Pulau Aur, Johor, Malaysia
Cnemaspis bidongensis	KM024704.1	LSUHC:11445	Pulau Bidong, Terengganu
Cnemaspis bidongensis	KM024706.1	LSUHC:11447	Pulau Bidong, Terengganu
Cnemaspis biocellata	KM024707.1	LSUHC:8789	Gua Kelam, Perlis, Malaysia
Cnemaspis biocellata	KM024709.1	LSUHC:8818	Kuala Perlis, Perlis, Malaysia
Cnemaspis boulengerii	KM024710.1	LSUHC:9278	Con Dao Archipelago, Vietnam
Cnemaspis caudanivea	KM024712.1	LSUHC:8577	Hon Tre Island, Vietnam
Cnemaspis caudanivea	KM024713.1	LSUHC:8578	Hon Tre Island, Vietnam

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APPENDIX III (Continued)

Species	Accession No.	Museum No.	Locality
Cnemaspis chanardi	KM024715.1	LSUHC:9567	Thum Thong Panra, Thailand
Cnemaspis chanthaburiensis	KM024716.1	LSUHC:9338	Phnom Dalai, Cambodia
Cnemaspis flavigaster	KM024718.1	LSUHC:8835	Kepong, Selangor, Malaysia
Cnemaspis flavigaster	KM024720.1	LSUHC:10380	Ulu Gombak, Selangor, Malaysia
Cnemaspis flavolineata	KM024721.1	LSUHC:8079	Fraser's Hill, Pahang, Malaysia
Cnemaspis grismeri	KM024722.1	LSUHC:9969	Lenggong, Perak, Malaysia
Cnemaspis grismeri	KM024723.1	LSUHC:9970	Lenggong, Perak, Malaysia
Cnemaspis hangus	KM024727.1	LSUHC:9358a	Bukit Hangus, Pahang, Malaysia
Cnemaspis hangus	KM024729.1	HC225	Bukit Hangus, Pahang, Malaysia
Cnemaspis harimau	KM024730.1	LSUHC:9665	Gunung Jerai, Kedah, Malaysia
Cnemaspis harimau	KM024732.1	LSUHC:9668	Gunung Jerai, Kedah, Malaysia
Cnemaspis huaseesom	KM024734.1	LSUHC:9457	Sai Yok National Park, Thailand
Cnemaspis huaseesom	KM024735.1	LSUHC:9458	Sai Yok National Park, Thailand
Cnemaspis karsticola	KM024736.1	LSUHC:9054	Gunung Reng, Kelantan, Malaysia
Cnemaspis karsticola	KM024737.1	LSUHC:9055	Gunung Reng, Kelantan, Malaysia
Cnemaspis kendallii	KM024740.1	LSUHC:9172	Gunung Gading, Lundu, Sarawak, Malaysia
Cnemaspis kendallii	KM024743.1	LSUHC:9178	Gunung Santubong, Sarawak, Malaysia
Cnemaspis kendallii	OL770080	UNIMAS 9604	Lobang Batu, Serian, Sarawak, Malaysia
Cnemaspis kendallii	OL770081	UNIMAS 9605	Lobang Batu, Serian, Sarawak, Malaysia
Cnemaspis kendallii	OL770082	UNIMAS 9618	Padawan, Sarawak, Malaysia
Cnemaspis kumpoli	KM024746.1	LSUHC:8848	Perlis State Park, Perlis, Malaysia
Cnemaspis leucura	LC205721.1	KUHE:57421	Kampung Sadir, Padawan, Sarawak, Malaysia
Cnemaspis leucura	LC205722.1	KUHE:57424	Kampung Sadir, Padawan, Sarawak, Malaysia
Cnemaspis leucura	LC205723.1	KUHE:57423	Kampung Sadir, Padawan, Sarawak, Malaysia
Cnemaspis leucura	LC205724.1	KUHE:57422	Kampung Sadir, Padawan, Sarawak, Malaysia
Cnemaspis limi	KM024747.1	LSUHC:3902	Pulau Tioman, Pahang, Malaysia
Cnemaspis limi	KM024750.1	LSUHC:3888	Pulau Tioman, Pahang, Malaysia
Cnemaspis lineogularis	KY091232.1	BYU:62536	Wat Khao Daen, Thailand
Cnemaspis lineogularis	KY091233.1	ZMKU: R00728	Wat Khao Daen, Thailand
Cnemaspis mahsuriae	KT250633.1	LSUHC:11828	Gunung Raya, Kedah, Malaysia
Cnemaspis mahsuriae	KT250634.1	LSUHC:11829	Gunung Raya, Kedah, Malaysia
Cnemaspis matahari **sp. nov.**	OL770084	UNIMAS 9602	Serian-Tebedu, Sarawak, Malaysia
Cnemaspis matahari **sp. nov.**	OL770085	UNIMAS 9603	Serian-Tebedu, Sarawak, Malaysia
Cnemaspis matahari **sp. nov.**	OL770086	UNIMAS 9607	Serian-Tebedu, Sarawak, Malaysia
Cnemaspis matahari **sp. nov.**	OL770087	UNIMAS 9608	Serian-Tebedu, Sarawak, Malaysia
Cnemaspis mcguirei	KM024752.1	LSUHC:8854	Bukit Larut, Perak, Malaysia
Cnemaspis mcguirei	KM024753.1	LSUHC:8855	Bukit Larut, Perak, Malaysia
Cnemaspis monachorum	KM024754.1	LSUHC:9114	Pulau Langgun, Kedah, Malaysia
Cnemaspis monachorum	KM024756.1	LSUHC:10808	Pulau Langgun, Kedah, Malaysia
Cnemaspis mumpuniae	KM024760.1	MZBLace10166	Sekunyam Forest Reserve, Riau

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APPENDIX III (Continued)

Species	Accession No.	Museum No.	Locality
Cnemaspis mumpuniae	KM024761.1	MZBLace10167	Sekunyam Forest Reserve, Riau
Cnemaspis narathiwatensis	KM024762.1	USMHC1347	Sungai Enam, Perak, Malaysia
Cnemaspis narathiwatensis	KM024765.1	USMHC1350	Sungai Enam, Perak, Malaysia
Cnemaspis neangthyi	KM024767.1	LSUHC:8515	O'Lakmeas, Cambodia
Cnemaspis neangthyi	KM024769.1	LSUHC:8517	O'Lakmeas, Cambodia
Cnemaspis nigridia	KM024770.1	LSUHC:9168	Gunung Gading, Lundu, Sarawak, Malaysia
Cnemaspis nigridia	KM024771.1	LSUHC:9169	Gunung Gading, Lundu, Sarawak, Malaysia
Cnemaspis nigridia	KM024772.1	LSUHC:9170	Gunung Gading, Lundu, Sarawak, Malaysia
Cnemaspis nigridia	LC158342.1	KUZR27145	Gunung Gading, Lundu, Sarawak, Malaysia
Cnemaspis niyomwanae	KM024773.1	LSUHC:9568	Thum Khao Ting, Thailand
Cnemaspis niyomwanae	KM024774.1	LSUHC:9571	Thum Khao Ting, Thailand
Cnemaspis nuicamensis	KM024776.1	LSUHC:8647	Nui Cam Hill, Vietnam
Cnemaspis nuicamensis	KM024778.1	LSUHC:8649	Nui Cam Hill, Vietnam
Cnemaspis omari	KM024779.1	LSUHC:9978	Perlis State Park, Perlis, Malaysia
Cnemaspis paripari	OL770083	UNIMAS 9585	Gua Pari Pari, Bau, Sarawak, Malaysia
Cnemaspis paripari	LC205727.1	KUHE:57286	Gua Pari Pari, Bau, Sarawak, Malaysia
Cnemaspis paripari	LC205728.1	KUHE:57289	Gua Pari Pari, Bau, Sarawak, Malaysia
Cnemaspis paripari	LC205731.1	KUHE:57122	Gua Angin, Bau, Sarawak, Malaysia
Cnemaspis paripari	LC205732.1	KUHE:57268	Gua Angin, Bau, Sarawak, Malaysia
Cnemaspis paripari	KM024783.1	LSUHC:9186	Gua Angin, Bau, Sarawak, Malaysia
Cnemaspis pemanggilensis	KM024785.1	LSUHC:8011	Pulau Pemanggil, Johor, Malaysia
Cnemaspis pemanggilensis	KM024788.1	LSUHC:8014	Pulau Pemanggil, Johor, Malaysia
Cnemaspis peninsularis	KM024805.1	LSUHC:8122	Selai, Johor, Malaysia
Cnemaspis peninsularis	KM024810.1	LSUHC:9376	Pulau Tenggol, Terengganu, Malaysia
Cnemaspis perhentianensis	KM024820.1	LSUHC:8699	Pulau Perhentian Besar, Terengganu, Malaysia
Cnemaspis perhentianensis	KM024821.1	LSUHC:8700	Pulau Perhentian Besar, Terengganu, Malaysia
Cnemaspis phangngaensis	KY091234.1	BYU:62537	Phang Nga, Thailand
Cnemaspis phangngaensis	KY091235.1	BYU:62538	Phang Nga, Thailand
Cnemaspis pseudomcguirei	KM024824.1	LSUHC:9145	Bukit Larut, Perak, Malaysia
Cnemaspis pseudomcguirei	KM024825.1	LSUHC:9146	Bukit Larut, Perak, Malaysia
Cnemaspis psychedelica	KM024827.1	LSUHC:9243	Hon Khoai Island, Vietnam
Cnemaspis psychedelica	KM024828.1	LSUHC:9244	Hon Khoai Island, Vietnam
Cnemaspis punctatonuchalis	KY091236.1	BYU:62539	Thap Sakae, Thailand
Cnemaspis punctatonuchalis	KY091237.1	BYU:62540	Thap Sakae, Thailand
Cnemaspis roticanai	KM024829.1	LSUHC:9430	Gunung Raya, Pulau Langkawi, Malaysia
Cnemaspis roticanai	KM024830.1	LSUHC:9431	Gunung Raya, Pulau Langkawi, Malaysia
Cnemaspis selamatkanmerapoh	KM024833.1	LSUHC:11016	Gua Gunting, Pahang, Malaysia

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APPENDIX III (Continued)

Species	Accession No.	Museum No.	Locality
Cnemaspis shahruli	KM024835.1	LSUHC:9163	Pulau Jerejak, Penang, Malaysia
Cnemaspis shahruli	KM024836.1	LSUHC:9586	Sungai Sadim, Kedah, Malaysia
Cnemaspis siamensis	KM024838.1	LSUHC:9474	Pathio, Thailand
Cnemaspis siamensis	KM024839.1	LSUHC:9485	Pathio, Thailand
Cnemaspis sirehensis **sp. nov.**	OL770088	UNIMAS 9609	Gua Sireh, Serian, Sarawak, Malaysia
Cnemaspis sirehensis **sp. nov.**	OL770089	UNIMAS 9610	Gua Sireh, Serian, Sarawak, Malaysia
Cnemaspis stongensis	KM024841.1	LSUHC:11090	Gunung Stong, Kelantan, Malaysia
Cnemaspis stongensis	KM024842.1	LSUHC:11091	Gunung Stong, Kelantan, Malaysia
Cnemaspis sundainsula	KM024845.1	MZBLace10156	Pulau Natuna Besar
Cnemaspis sundainsula	KM024846.1	MZBLace10157	Pulau Natuna Besar
Cnemaspis temiah	KM024850.1	LSUHC:9739	Cameron Highland, Pahang, Malaysia
Cnemaspis temiah	KM024851.1	LSUHC:9816	Cameron Highland, Pahang, Malaysia
Cnemaspis thachanaensis	KY091243.1	BYU:62543	Tha Chana, Thailand
Cnemaspis thachanaensis	KY091244.1	BYU:62544	Tha Chana, Thailand
Cnemaspis tucdupensis	KM024852.1	LSUHC:8631	Tuc Dup Hill, Vietnam
Cnemaspis tucdupensis	KM024853.1	LSUHC:8632	Tuc Dup Hill, Vietrnam
Urocotyledon inexpectata	KY038015.1	2MA29	NA