Three New Karst-Dwelling *Cnemaspis* Strauch, 1887 (Squamata; Gekkoniade) from Peninsular Thailand and the Phylogenetic Placement of *C. punctatonuchalis* and *C. vandeventeri* (#12968)

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Three new species of Rock Geckos *Cnemaspis lineogularis* sp. nov., *C. phangngaensis*, sp. nov., and *C. thachanaensis* sp. nov. of the *chantaburiensis* and siamensis groups are described from the Thai portion of the Thai-Malay Peninsula. These new species are distinguished from all other species in their two respective groups based on a unique combination of morphological characteristics, which is further supported by mitochondrial DNA (mtDNA). *Cnemaspis lineogularis* sp. nov. is differentiated from all species in the *chantaburiensis* group by having a smaller maximum SVL 38 mm, 13 paravetebral tubercles, enlarged femoral scales, no caudal bands, and a 19.5–23.0% pairwise sequence divergence. *Cnemaspis phangngaensis* sp. nov. is differentiated from all species in the siamensis group by having the unique combination of 10 infralabial scales, four continuous pore-bearing precloacal scales, paravetebral tubercles linearly arranged, lacking tubercles on the lower flanks, having ventrolateral caudal tubercles anteriorly present, caudal tubercles restricted to a single paraveterbral row on each side, a single median row of keeled subcaudals, and a 8.8–25.2% pairwise sequence divergence. *Cnemaspis thachanaensis* sp. nov. is distinguished by having 10 or 11 supralabial scales 9–11 infralabial scales, paravertebral tubercles linearly arranged, ventrolateral caudal tubercles anteriorly, caudal tubercles restricted to a single paravetebral row on each side, a single median row of keeled subcaudal scales, lacking a single enlarged subcaudal scale row, lacking postcloaclal tubercles in males, the presence of an enlarged submetatarsal scale at the base if the 1st toe, and a 13.4–28.8% pairwise sequence divergence. The phylogenetic analyses place ~~both~~ *C. punctatonuchalis* and *C. vandeventeri* in the siamensis group with

C. punctatonuchalis as the sister species to *C. huaseesom* and *C. vandeventeri* as the sister species to *C. siamensis*, corroborating previous hypotheses based on morphology. The discovery of three new karst-dwelling endemics brings the total number of nominal Thai *Cnemaspis* species to 15 and underscores the need for continued field research in poorly known areas of the Thai-Malay Peninsula, especially those that are threatened and often over looked as biodiversity hot spots.

Three new karst-dwelling *Cnemaspis* Strauch, 1887 (Squamata; Gekkoniade) from Peninsular Thailand and the phylogenetic placement of *C. punctatonuchalis* and *C. vandeventeri*

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ABSTRACT

Three new species of Rock Geckos *Cnemaspis lineogularis* sp. nov., *C. phangngaensis*, sp. nov., and *C. thachanaensis* sp. nov. of the *chantaburiensis* and *siamensis* groups are described from the Thai portion of the Thai-Malay Peninsula. These new species are distinguished from all other species in their two respective groups based on a unique combination of morphological characteristics, which is further supported by mitochondrial DNA (mtDNA). *Cnemaspis lineogularis* sp. nov. is differentiated from all species in the *chantaburiensis* group by having a smaller maximum SVL 38 mm, 13 paravetebral tubercles, enlarged femoral scales, no caudal bands, and a 19.5–23.0% pairwise sequence divergence. *Cnemaspis phangngaensis* sp. nov. is differentiated from all species in the *siamensis* group by having the unique combination of 10 infralabial scales, four continuous pore-bearing precloacal scales, paravetebral tubercles linearly arranged, lacking tubercles on the lower flanks, having ventrolateral caudal tubercles anteriorly present, caudal tubercles restricted to a single paraveterbral row on each side, a single median row of keeled subcaudals, and a 8.8–25.2% pairwise sequence divergence. *Cnemaspis thachanaensis* sp. nov. is distinguished by having 10 or 11 supralabial scales 9–11 infralabial scales, paravertebral tubercles linearly arranged, ventrolateral caudal tubercles anteriorly, caudal tubercles restricted to a single paravetebral row on each side, a single median row of keeled subcaudal scales, lacking a single enlarged subcaudal scale row, lacking postcloaclal tubercles in males, the presence of an enlarged submetatarsal scale at the base if the 1st toe, and a 13.4–28.8% pairwise sequence divergence. The phylogenetic analyses place both *C. punctatonuchalis* and *C. vandeventeri* in the *siamensis* group with *C. punctatonuchalis* as the sister species to *C. huaseesom* and *C. vandeventeri* as the sister species to *C. siamensis*, corroborating previous hypotheses based on morphology. The discovery of three new karst-dwelling endemics brings the total number of nominal Thai *Cnemaspis* species to 15 and underscores the need for continued field research in poorly known areas of the Thai-Malay Peninsula, especially those that are threatened and often over looked as biodiversity hot spots.

Keywords: *chantaburiensis* group, Limestone forests, Malay peninsula, *siamensis* group

INTRODUCTION

The Malay Peninsula (MP) is a long (1,127 km) an narrow (maximum width 322 km) appendix of mainland Asia extending from Indochina in the north to its southern terminus in Singapore. The MP is

comprised of the southern portion of Myanmar, the southwestern section of Thailand, West Malaysia, and Singapore. This region is both geologicaly and climatically complex and has been influenced by a number of factors. The environmental complexity of this region has helped to form two prominent biogeographic barriers, the Isthmus of Kra and the Kangar-pattani line. These biogeographic barriers serve as pivotal crossroads for faunal exchange between the Indochinese and Sundaic biota (*e.g.* Raes et al., 2014; de Bruyn et al., 2013; Parnell, 2013; Patou et al., 2009; Woodruff and Turner, 2009; Gorog et al., 2004; Pauwels et al., 2003; Hughes et al., 2003; Woodruff, 2003; Grismer et al., 2014d; Grismer, 2011). One feature that is often over-looked in terms of biodiversity are the myriad of limestone forests and karst formations dispersed throughout the MP.

Karstic regions have been referred to as "arks" or biodiversity reservoirs that can be used as stock for repopulating degraded environments during ecosystem reassembly (Schilthuizen, 2004). In addition to serving as arks, karst formations have been known to provide natural laboratories for biogeographic, evolutionary, ecological, and taxonomic research (*e.g.* Ng, 1991; Grismer et al., 2014c,b; Schilthuizen et al., 2005, 1999; Kiew, 1991). From chemical and mechanical weathering karst formations have been molded into a unique suite of microhabitats in which a number of species have become adapted (*e.g.* Vermeulen and Whitten, 1999; Komo, 1998a,b; Tija, 1998). To date there has been a fair amount of research conducted on the flora of karst formations and ~~the~~ their surrounding limestone forests, resulting in a high estimate of endemic species (Kiew, 1998; Clements et al., 2006; Chin, 1977, and references therein). In addition to the high level of floral endemism there are also high levels of invertebrate endemism associated with karst formations (*e.g.* Holloway, 1986; Vermeulen and Whitten, 1999). Although these areas harbor a high degree of endemism for invertebrates and plant species they are generally not considered to hold large numbers of endemic terrestrial vertebrates (*i.e.* Jenkins et al., 2005; Alström et al., 2010; Woxvold et al., 2009), because most vertebrates have high dispersal capabilities. There are only a few mammals and birds that are thought to be restricted to karst formations (*e.g.* Latinne et al., 2011; Clements et al., 2006). In contrast recent taxonomic work in Peninsular Malaysia has uncovered an impressive amount of new microendemic karst-dwelling species of reptiles, including 14 new lizards (Grismer et al., 2008a,b, 2009, 2013b, 2012, 2014e,c, 2013a, 2016a; Wood et al., 2013) and two new snakes (Grismer et al., 2014b, Quah *et al.* in prep). However, these surveys only covered a small portion of the limestone forests and karst formations Peninsular Malaysia and the karst formations continue northward up the entire Thai-Malay Peninsula into central Thailand.

Dispersed throughtout Peninsular Thailand are hundreds of unexplored isolated karst formations. From the few surveys that have been conducted (with a central focus on *Cyrtodactylus*) at least 15 new micro-endemic karst-dwelling *Cyrtodactylus* have been discovered within the last two decades (e.g. Ellis and Pauwels, 2012; Pauwels et al., 2013; Grismer et al., 2016a; Sacha, 2015, ~~see~~ references therein). Often when there are microendemic karst-dwelling *Cyrtodactylus* (nocturnal) there is usually an endemic diurnal karst-dwelling *Cnemaspis* occupying the same niche during different activity periods (e.g. Grismer et al., 2016a, 2012, 2014e, 2016b). Recent surveys in Phang nga, Thachana, Thap Sakae, Som Roi Yot, and Tham Sonk hill during the month of September 2015 resulted in the collection of *Cnemaspis punctatonuchalis*, *C. vandeventeri* and three undescribed species of *Cnemaspis* ~~(mentioned above)~~ that co-occur with some of the aforementioned species of karst endemic *Cyrtodactlyus*. These new populations can be placed in the genus *Cnemaspis* based on having broad, flattened heads; large somewhat forward and upwardly directed eyes with round pupils and no eyelids; flattened bodies; long, widely splayed limbs with long, inflected digits; and no femoral pores. Here we present morphological and color pattern data as evidence, for delimitation of these three new species of *Cnemaspis*, bolstered by mtDNA genetic data, and present the phylogenetic placement of *C. punctatonuchalis* and *C. vandeventeri*.

MATERIALS AND METHODS

Taxon sampling

We obtained 203 samples of *Cnemaspis* and outgroups from Grismer et al. (2014d). In combination with this dataset we added 14 new samples including two species of Thai *Cnemaspis* (*C. punctatonuchalis* and *C. vandeventeri*) that have never been sequenced, along with three undescribed species of *Cnemaspis* from peninsular Thailand (Figure 1, ~~Appendix 1~~). The Institutional Animal Care and Use Committee (IACUC) has approved the animal use protocol for this study (protocol # 160401). The electronic version of this article in Portable Document Format (PDF) will represent a published work according to the International Commission on Zoological Nomenclature (ICZN), and hence the

new names contained in the electronic version are effectively published under that Code from the electronic edition alone. This published work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the ICZN. The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed through any standard web browser by appending the LSID to the prefix `http://zoobank.org/`. The LSID for this publication is: `urn:lsid:zoobank.org:pub:987831FC-F4BA-4409-A43C-9929F913E9F9`. The online version of this work is archived and available from the following digital repositorie: PubMed Central.

Molecular and Phylogenetic analyses

Genomic DNA was isolated from liver or muscle tissues stored in 95% ethanol using the animal tissue protocol in the Qiagen DNeasy^{TM} tissue kit (Valencia, CA, USA). The mitochondrial gene NADH dehydrogenase subunit 2 (ND2) and the flanking tRNAs ($\sim$ 1335 bp) was amplified using a double-stranded Polymerase Chain Reaction (PCR) under the following conditions: 1.0 μl ($\sim$10–33 μg) genomic DNA, 1.0 μl (10 μM) forward primer L4437b (5'-AAGCAGTTGGGCCCATACC-3'), 1.0 μl (10 μM) reverse primer L5002 (5'-AACCAAACCCAACTACGAAAAAT-3'), 1.0 μl deoxynucleotide pairs (1.5 μM), 2.0 μl 5x buffer (1.5 μM), 1.0 MgCl 10x buffer (1.5 μM), 0.18 μl Promega Taq polymerase (5u/μl), and 7.5 μl H2O, primers are from Macey et al. (1997). All PCR reactions were executed in an Eppendorf Mastercycler gradient theromocycler under the following conditions: initial denaturation at 95°C for 2 min, followed by a second denaturation at 95°C for 35 s, annealing at 52°C for 35 s, followed by a cycle extension at 72°C for 35s, for 33 cycles. All PCR products were visualized on a 1% agarose gel electrophoresis. Successful targeted PCR products were vacuum purified using MANU 30 PCR plates Millipore plates and purified products were resuspended in DNA grade water. Purified PCR products were sequenced using the PCR primers from above and sequencing primers CyrtintF1 (5'-TAGCCYTCTCYTCYATYGCCC-3') and CyrtintR1 (5'-ATTGTKAGDGTRGCYAGGSTKGG-3') from (Siler et al., 2010) on the ABI Big-Dye Terminator v3.1 Cycle Sequencing Kit in an ABI GeneAmp PCR 9700 thermal cycler. Cycle sequencing reactions were purified with Sephadex G-50 Fine (GE Healthcare) and sequenced on an ABI 3730xl DNA Analyzer at the BYU DNA Sequencing Center (DNASC). All new sequences produced from this study are deposited in GenBank under the following accession numbers XX00000–XX00000 (Table S1). All sequences were edited and aligned in Geneious v6.1.8 (Drummond et al., 2012), alignment was constructed using the Muscle plugin (Edgar, 2004). Mesquite v3.02 (Maddison and Maddison, 2015) was used to check for stop codons and to ensure the correct amino acid read frame.

For estimating the phylogenetic relationships we used both partitioned Maximum Likelihood (ML) and partitioned Bayesian Inference (BI) methods. The ND2 gene was partitioned by codon position and the tRNAs were treated as a single partition for both the ML and BI analyses. All models of molecular evolution were estimated in ModelTest v3.7 (Posada and Crandall, 1998), using the Bayesian Information Criterion (BIC). The best fit models of evolution are in presented in Table 1. The partitioned ML analyses was performed using RAxML HPC v7.5.4 (Stamatakis, 2006), 1000 bootstrap pseudoreplicates via therapid hill-climbing algorithm (Stamatakis et al., 2008) with 200 searches for the best tree. The Bayesian analysis was carried out in MrBayes v3.2 (Huelsenbeck et al., 2001; Ronquist et al., 2012) using the default priors. Two simultaneous runs were performed with eight chains per run, seven hot and one cold following default priors. The analysis was run for 2 x 10^6 generations and sampled every 1000 generations from the Markov Chain Monte Carlo (MCMC). The analysis was halted after the average standard deviation split frequency was below 0.01 and we assumed convergence. We conservatively discarded the first 25% of the trees as burnin and constructed a consensus tree using the sumt command in MrBayes. Nodes having bootstrap support values (BS) greater than 70 and posterior probabilities (PP) above 0.95 were considered significantly supported (Huelsenbeck et al., 2001; Wilcox et al., 2002). We calculated uncorrected percent sequence divergences for ND2 in Mega v6.06 (Tamura et al., 2013).

Morphological analyses

Morphological and color pattern characteristics follow Grismer et al. (2014d): Color pattern characters were taken from digital images of living specimens cataloged in the La Sierra University Digital Photo Collection (LSUDPC) and from living specimens in the field. The following measurements on the type series were taken with a electronic digital caliper to the nearest 0.1 mm, under a Lica WILD M10

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, original or regenerated; 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 90° to the inflection of the flexed wrist; tibia length (TBL), taken on the ventral surface from the posterior surface of the knee while flexed 90° 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 throat; 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; inner 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. Additional character states evaluated were numbers of supralabial and infralabial scales counted from below the middle of the orbit to the rostral and mental scales, respectively; the texture of the scales on the anterior margin of the forearm; the number of paravertebral tubercles between limb insertions counted in a straight line immediately left of the vertebral column (where applicable); the presence or absence of a row of enlarged, widely spaced, tubercles along the ventrolateral edge of the body (flank) between the limb insertions; the general size (i.e., strong, moderate, weak) and arrangement (i.e., random or linear) of the dorsal body tubercles; the number of subdigital lamellae beneath the fourth toe counted from the base of the first phalanx to the claw; the distribution of transverse and granular subdigital lamellae on the fourth toe; the total number of precloacal pores, their orientation and shape; the number of precloacal scales lacking pores separating the left and right series of pore-bearing precloacal scales; the degree and arrangement of body and tail tuberculation; the relative size and morphology of the subcaudal scales, subtibial scales, and submetatarsal scales beneath the first metatarsal; and the number of postcloacal tubercles on each side of the tail base. Longitudinal rows of caudal tubercles on the non-regenerated portion of the tail are quite variable between species and useful in differentiating several taxa. Up to five pairs of the following rows may be present in varying combinations: paravertebral row—the dorsal row adjacent to the middorsal, caudal furrow; dorsolateral row—the row between the paravertebral row and the lateral, caudal furrow on the dorsolateral margin of the tail; lateral row—the row immediately below the lateral, caudal furrow; and ventrolateral row—the row below the lateral row on the ventrolateral margin of the tail below the lateral caudal furrow. When present, this row is usually restricted to the anterior 25% (or less) of the tail. Occasionally there may be a row of tubercles within the lateral, caudal furrow.

RESULTS

The phylogenetic analyses place both *C. punctatonuchalis* and *C. vandeventeri* in the *siamensis* group (Figure 2). *Cnemaspis punctatonuchalis* is strongly recovered for the ML analysis (100 BS) but not the BI (0.87 PP) as the sister species to *C. huaseesom*. *Cnemaspis vandeventeri* is strongly supported (100 BS and 0.99 PP) as the sister lineage to *C. siamensis*. Phylogenetic analyses of the three new populations sampled from Som Roi Yot, Phangnga, and Thachana represent strongly supported independent lineages (100 BS, 1.0 PP; 100 BS, 1.0 PP; 100 BS, 1.0 PP, respectively). The samples from Wat Khao Daeng are strongly supported (~~92~~ BS, 1.0 PP) as the sister lineage to the *chantaburiensis* group (Figure 2A) and bare a 19.5–23.0% mtDNA pairwise sequence divergence from all of the other species in this group (Table 2). Both the Phangnga and the Thachana populations are nested within the *siamensis* group (Figure 2B). The Phangnga population is strongly supported for ML (99 BS) but lacks support from the BI (0.56 PP) as the sister lineage to a clade composed of *C. omari* and *C. roticani* and bares a 8.8–25.2% mtDNA pairwise sequence divergence from all of the other species in the *siamensis* group (Table 3). The population from Thachana forms a well-support lineage (100 BS and 1.0 PP) and is strongly (100 BS and 1.0 PP) placed as the sister lineage to a clade composed of *C. siamensis* and *C. vandeventeri* and bares a 13.4–28.~~0~~% mtDNA pairwise sequence divergence form all of the other species in the *siamensis* group (Table 3). Given the fact that these new populations form well-supported independent lineages (Figs. 2A, B) coupled with

high genetic distances and a unique set of morphological and color pattern characteristics that separate them from all members of their respective groups, we describe these three populations below as new species.

Systematics

Cnemaspis lineogularis sp. nov. urn:lsid:zoobank.org:act:8E3B21A4-93BF-4D08-B8D1-0A3EEF6BE44F

(Figs. 3–5)

Holotype. BYU 62535 adult male, collected near Wat Khao Daeng, Kui Buri, Prachuap Khiri Khan, Thiland (12.134620°N, 99.961078°E; 12 m a.s.l.), 31 July 2016, by PLW, LLG, CA, MC, MSG, MLM.

Paratopotypes. BYU 62536 adult male and ZMKU R 00728 adult female paratypes bear the same collection and data as the holotype.

Diagnosis. *Cnemaspis lineogularis* is distinguished from all other species of *Cnemaspis* in the *chantaburiensis* group by the combination of the following morphological and color pattern characters: maximum SVL 38 mm; nine supralabials; eight infralabials; ventral scales smooth; no precloacal pores; 13 paravetebral tubercles linearly arranged; no tubercles on the lower flanks; lateral caudal furrows present; no caudal tubercles in the lateral furrows; ventrolateral caudal tubercles anteriorly; caudal tubercles not encircling tail; caudal tubercles not restricted to a single paravetebral row; subcaudals smooth bearing a single median row of enlarged scales; one post cloacal tubercle in males; ~~no enlarged femoral or submetatarsal scales;~~ enlarged femoral scales; subtibials smooth; no enlarged submetatarsal scale on first toe; 27–29 subdigital fourth toe lamellae; sexually dimorphic for dorsal color pattern; gular region yellow-orange, thick, black lineate markings in males, absent in females; subcaudal region whitish (Figures 4–6).

Description of the holotype. Adult male; SVL 38 mm; head oblong in dorsal profile, moderate in size (HL/SVL 0.25), somewhat narrow (HW/SVL 0.16), flattened (HD/HL 0.38), head distinct from neck; snout moderate (ES/HL 0.52), snout slightly concave in lateral view; postnasal region concave medially; scales on rostrum smooth becoming keeled posteriorly, raised, larger than conical scales on occiput; weak to absent supra ocular ridges; frontalrostralis sulcus deep; canthus rostralis nearly absent, smoothly rounded; eye large (ED/HL 0.26); extra-brillar, fringe scales largest anteriorly; pupil round; ear opening more round than oval; rostral slightly concave, dorsal 80% divided by longitudinal median groove; rostral bordered posteriorly by supra nasals and one small azygous scale and laterally by first supralabials; 9,9 (R,L) slightly raised supralabials decreasing in size posteriorly; 8,8 (R,L) infralabials decreasing in size posteriorly; nostrils elliptical, oriented dorsoposteriorly; bordered by small postnasal scales; mental large, triangular, concave, bordered posteriorly by three postmentals; gular and throat scales raised, smooth, small and round.

Body slender, elongate (AG/SVL 0.46); small, keeled, dorsal scales equal in size throughout body, intermixed with several large, multicarinate conical tubercles more or less randomly arranged; tubercles extend from the occiput to base of the tail; no tubercles on flanks; pectoral and abdominal scales smooth, not larger posteriorly; abdominal scales slightly larger than dorsals; no pore-bearing, precloacal scales or precloacal depressions; forelimbs moderately long, slender; dorsal scales slightly raised, multicarinate; ventral scales of brachia smooth, raised, juxtaposed; scales beneath forearm smooth, raised, subimbricate; palmar scales smooth, juxtaposed, raised; digits long with an inflected joint; claws recurved; sub digital lamellae unnotched; lamellae beneath first phalanges granular proximally, widened distally; lamellae beneath phalanx immediately following inflection granular, lamellae of distal phalanges wide; interdigital webbing absent; fingers increase in length from first to fourth with fourth and fifth equal in length; hind limbs slightly longer and thicker than forelimbs; dorsal scales raised, multicarinate, juxtaposed; dorsal scales on anterior margin of thighs enlarged, multicariante, becoming smaller posteriorly; ventral scales of thigh smooth; subtibial scales smooth, flat, imbricate, with no enlarged anterior row; plantar scales smooth, juxtaposed, raised; no enlarged submetatarsal scales beneath first metatarsal; digits elongate with an inflected jointed; claws recurved; subdigital lamellae unnotched; lamellae beneath first phalanges granular proximally, widened distally; lamellae beneath phalanx immediately following inflection granular, lamellae of distal phalanges wide; interdigital webbing absent; toes increase in length from first to fourth with fourth and fifth equal in length; 29,28 (R,L) subdigital lamellae on fourth toe;

caudal scales similar to dorsal scale size, enlarge caudal tubercles arranged in segmented whorls, no encircling tail; caudal scales keeled, juxtaposed anteriorly; shallow, middorsal furrow; deeper, single, lateral furrow; enlarged, median, subcaudal scales; subcaudals smooth; median row of enlarged, keeled, subcaudal scales; transverse, tubercle rows do not encircle tail; caudal tubercles absent from lateral furrow; 2,1 (R,L) enlarged, postcloacal tubercles on lateral surface of hemipenal swellings at base of tail; posterior 30% of tail regenerated.

Coloration. In life, dorsal ground color of head light beige-green, that of the body, limbs and tail slightly lighter than head; top of the head bearing, small black and light green markings; thin diffuse broken dark-brown to black postorbital stripe, extending to the nape; two dark lines radiating distally from orbit; dark paravetebral markings extend from nape to anterior fourth of tail where they transform into diffuse incomplete bands, intermixed with sage colored paravetebral blotches; single dark prescapular blotch dorsoanteriorly of forelimb insertion; limbs slightly lighter than dorsal ground color with randomly placed, diffuse dark blotches; all ventral surfaces grayish white, except gular region and anteriormost portion of throat orange with black midgular stripe and adjacent black stripes along the mandibular margin; posterior margin of orange gular coloration edged with black, transverse markings (Figures 4–5).

Variation. Paratypes approximate the holotype (BYU 62535) in general aspects of coloration except that the female paratype (ZMKU R 00728) lacks the black markings in the gular region and the orange gular coloration is less prominent, additionally the dorsal coloration is much lighter. Selected body measurements and variation in squamation are presented in Table 4.

Etymology. The specific epithet *lineogularis* is derived from the Latin adjective *linues* for the word "line" and the nominative form of the Latin word *gulare* meaning "throat" and is in reference to the multiple dark gular lines ~~in~~ this species.

Distribution. Only known from the type locality but we hypothesize it will be found in nearby karst formations (Figures 1 and 6).

Natural history. The type series and several other individuals were active during the day in shaded areas and would rapidly retreat to nearby cracks and crevices at the slightest provocation. We hypothesize this may be due to high predation as we found *Trimeresurus fucatus* in an ambush posture in the same microhabitat. No individuals were seen deep within the caves and from our observations, it appears this species primarily inhabits the more exterior surfaces of the karst tower (Figure 6). The karst formations in this area are extensive and we assume this species has a much wider distribution than that reported here. We hypothesize that diurnality in this species is to avoid competition with and predation from the much larger *Cyrtodactylus lineogularis* with which it is syntopic. This is a commonly observed pattern among syntopic paris of *Cnemaspis* and *Cyrtodactylus* throughout their distributions in Southeast Asia (Grismer et al., 2014d, and references therein).

Comparisons. *Cnemaspis lineogularis* sp. nov. can be differentiated for all other species in the *chantaburiensis* group based on the following morphological and color pattern characteristics (see Tables 5, 6 for additional comparisons). *Cnemaspis lineogularis* sp. nov. differs from *C. chanataburiensis*, *C. neangthyi*, *C. laoensis*, *C. aurantiacopes*, *C. caudanivea*, *C. nuicamensis*, and *C. tucdupensis* by having a smaller maximum SVL (38 mm vs. 42.2 mm, 54.0 mm, 40.9 mm, 58.4 mm, 47.2 mm, 48.2 mm, and 51.0 mm, respectively), by having less paravetebral tubercles (13 vs. 21–25, 20–26, 22, 23–31, 20–24, 16–21, and 16–22 respectively), and by having enlarged femoral scales. *Cnemaspis lineogularis* sp. nov. is further differentiated from *C. neangthyi* by having less supralabial scales (9 vs. 11–13). *Cnemaspis lineogularis* sp. nov. differs from *C. neangthyi* by having less infralabial scales (8 vs. 10–12) and from *C. nuicamensis* by having more infralabial scales (8 vs. 6–7). It is further differentiated from *C. chantaburiensis*, *C. neangthyi*, *C. aurantiacopes*, *C. caudanivea*, and *C. nuicamensis* by lacking precloacal pores. From *C. loaensis*, *C. lineogularis* sp. nov. differs by having linearly arranged tubercles versus randomly arranged tubercles. *Cnemaspis lineogularis* differs from *C. chantaburiensis*, *C. neangthyi*, *C. laoensis*, *C. aurantiacopes*, *C. nuicamensis*, and *C. tucdupensis* by lacking tubercles on the lower flanks. *Cnemaspis lineogularis* sp. nov. differs from *C. chantaburiensis*, *C. neangthyi*, *C. laoensis*, by lacking caudal tubercles in the lateral furrow. *Cnemaspis lineogularis* sp. nov. has ventrolateral caudal tubercles anteriorly which separates it from *C. chantaburiensis* and *C. laoensis* which lack this character. *Cnemaspis lineogularis* differs from *C. loaensis*, *C. caudanivea*, *C. nuicamensis*, and *C. tucdupensis*

by the presence of a lateral caudal tubercle row. From *C. chantaburiensis*, *C. laoensis*, *C. caudanivea*, and *C. tucdupensis*, *C. lineogularis* sp. nov. differs by having an enlarged median subcaudal scale row. *C. lineogularis* sp. nov. differs from *C. laoensis* and *C. nuicamensies* by having one postcloacal tubercle in males versus 2,3 and 2–4 respectively. *C. lineogularis* sp. nov. is further differentiated from *C. caudanivea* by lacking shield-like subtibial scales. *Cnemaspis lineogularis* sp. nov. differs from *C. neangthyi*, *C. laoensis*, and *C. aurantiacopes* by lacking keeled subtibial scales. *Cnemaspis lineogularis* sp. nov. differs from *C. aurantiacopes* and *C. tucdupensis* by lacking an enlarged submetatarsal scale on the 1st toe. *Cnemaspis lineogularis* sp. nov. is further differentiated from from *C. neangthyi* by having more 4th toe lamellae (27–29 vs. 22–25). *Cnemaspis lineogularis* is further differentiated from all other species in the *chantaburiensis* group based on squamation and color pattern characteristics (Tables 5 and 6).

Cnemaspis phangngaensis sp. nov. urn:lsid:zoobank.org:act:6053C709-A409-4F65-B15C-8C647D7EDF1C

(Figs. 7–9)

Holotype. BYU 62538 adult male, collected at Phung Chang Cave, Phangnga, Mueang Phangnga, Thailand (8.442344°N, 98.514869°E; 12 m a.s.l.), 26 July 2016, by PLW, LLG, CA, MC, MSG, MLM.

Paratopotype. BYU 62537 adult female paratype bears all the the same collection and locality information as the holotype.

Diagnosis. *Cnemaspis phangngaensis* sp. nov. is distinguished from all other species of *Cnemaspis* in the *siamensis* group by the combination of the following morphological and color pattern characteristics: maximum SVL 42 mm; 10 supralabials; 10 infralabials; ventral scales keeled; four continuous precloacal scales bearing a single round pore in males; 22 paravetebral tubercles linearly arranged; no tubercles on the lower flanks; lateral caudal furrows present; no caudal tubercles in the lateral furrows; ventrolateral caudal tubercles anteriorly; caudal tubercles not encircling tail; caudal tubercles restricted to a single paravetebral row; subcaudals keeled bearing a single median row of enlarged keeled scales; two post cloacal tubercle in males; no enlarged femoral, tibial, or sub-metatarsal scales; subtibials keeled; no submetatarsal scale on first toe; 29 subdigital fourth toe lamellae; dorsal and ventral color pattern sexually dimorphic; yellow or white bars present on flanks; prescapular marking present; anterior gular region yellow, no dark lineate markings in males or females, and no mid-gular marking; posterior gular region and pectoral region whitish in males; abdomen yellow; subcaudal region yellow (Table 6).

Description of the holotype. Adult male; SVL 42 mm; head oblong in dorsal profile, moderate in size (HL/SVL 0.27), somewhat narrow (HW/SVL 0.16), flattened (HD/HL 0.35), head distinct from neck; snout moderate (ES/HL 0.44), slightly concave in lateral view; postnasal region concave medially; scales on rostrum smooth becoming keeled posteriorly, raised, larger than conical scales on occiput; weak to absent supra ocular ridges; frontalrostralis sulcus shallow; canthus rostralis nearly absent, smoothly rounded; eye large (ED/HL 0.20); extra-brillar, fringe scales largest anteriorly; pupil round; ear opening more oval, taller than wide; rostral slightly concave, dorsal 80% divided by longitudinal median groove; rostral bordered posteriorly by supra nasals and one small azygous scale and laterally by first supralabials; 10, 10 (R,L) slightly raised supralabials decreasing in size posteriorly; 10, 10 (R,L) infralabials decreasing in size posteriorly; nostrils elliptical, oriented dorsoposteriorly; bordered by small postnasal scales; mental large, triangular, concave, bordered posteriorly by three postmentals; gular and throat scales raised, keeled, small and round.

Body slender, elongate (AG/SVL 0.45); small, raised, keeled, dorsal scales equal in size throughout body, intermixed with several large, multicarinate conical tubercles more or less randomly arranged; tubercles extend from the occiput to base of the tail; no tubercles on flanks; pectoral and abdominal scales keeled, not larger posteriorly; abdominal scales slightly larger than dorsals; two pore-bearing, continuous, precloacal pores on each side; forelimbs moderately long, slender; dorsal scales slightly raised, keeled; ventral scales of brachia smooth, raised, juxtaposed; scales beneath forearm smooth, slightly raised, subimbricate; palmar scales smooth, juxtaposed, raised; digits long with an inflected joint; claws recurved; sub digital lamellae unnotched; lamellae beneath first phalanges granular proximally, widened distally; lamellae beneath phalanx immediately following inflection granular, lamellae of distal phalanges wide; interdigital webbing absent; fingers increase in length from first to fourth with fourth

and fifth equal in length; hind limbs slightly longer and thicker than forelimbs; dorsal scales raised, multicarinate, juxtaposed; ventral scales of thigh, slightly raised, conical, keeled; subtibial scales keeled, flat, imbricate, with no enlarged anterior row; plantar scales smooth, juxtaposed, raised; no enlarged submetatarsal scales beneath first metatarsal; digits elongate with an inflected jointed; claws recurved; subdigital lamellae unnotched; lamellae beneath first phalanges granular proximally, widened distally; lamellae beneath phalanx immediately following inflection granular, lamellae of distal phalanges wide; interdigital webbing absent; toes increase in length from first to fourth with fourth and fifth equal in length; 29, 29 (R,L) subdigital lamellae on fourth toe; caudal scales similar to dorsal scale size, enlarge caudal tubercles arranged in segmented whorls, not encircling tail; caudal scales keeled, juxtaposed anteriorly; shallow, middorsal furrow; deeper, single, lateral furrow; enlarged, median, subcaudal scales; subcaudals keeled; median row of enlarged, keeled, subcaudal scales; transverse, tubercle rows do not encircle tail; caudal tubercles absent from lateral furrow; 1, 1 (R,L) enlarged flat, postcloacal tubercle on lateral surface of hemipenal swellings at base of tail; posterior ~30% of tail missing.

Coloration. In life dorsal ground color of head light beige, that of the body, limbs and tail slightly darker than the head with darker irregular blotches; top of the head bearing, small black and sage markings; thin diffuse broken dark brown to black postorbital stripe, extending to the nape, not complete; light sage vertebral blotches extending form the nape to tail where they transform into diffuse near complete irregular bands; intermixed with light sage blotches; single light-yellowish prescapular crescent dorsoanteriorly of forelimb insertion; flanks with irregular incomplete sage to yellowish-orange bars becoming more orange distally; limbs slightly darker than dorsal ground color with randomly placed, diffuse dark and sage colored blotches; all ventral surfaces grayish-white, except gular, abdominal, and subcaudal regions are yellowish-orange, with more pronounced darker yellow stippling (Figs. 7–9).

Variation in the type series. The female paratype (BYU 62537) approximates the holotype in general aspects of coloration except the overall dorsal coloration is lighter and the ~~the~~ ventral coloration is a uniform light yellow and is not as prominent in the gular and abdominal regions. Select body measurements and variation in squamation are presented in Table 7.

Etymology. The specific epithet *phangngaensis* is a noun in apposition to the the type locality where this species is found.

Distribution. Only known from the karst formation in which it is found the Phung Chang Cave, Phangnga, Mueang Phangnga, Thailand. We hypothesize that this species will be found on near-by contiguous karst formations.

Natural history. *Cnemaspis phangngaensis* inhabits a karst formation in a lowland limestone forest (Fig. 10) surrounded by highly disturbed, urbanized habitat. The male holotype was collected at night on the karst approximately 15 m above the ground on the exterior surface of the tower and the female was collected at night sleeping on a leaf approximately 1.2 meters above the limestone forest floor adjacent to the nearby karst formation. Individuals were also observed active during the day, but avoided being caprtured be retreating into the rock crevices. We hypothesize that these are diurnal karst dwellers that use the vegetation at night for refuge. We hypothesize that diurnality in this species is to avoid competition with and predation from the much larger *Cyrtodactylus lekaguli* with which it is syntopic.

Comparisons. The phylogenetic analysis recovers ~~of~~ the *chanardi* group and *C. phangngaensis* sp. nov. as the sister species to a clade containing *C. omari* and *C. roticani* (Figure 2). This relationship is further supported by the following derived morphological characters (*sensu* Grismer et al., 2014d), prescapular crescent present, yellow abdomen, yellow ventral surfaces of the hind limbs and tail being yellow and numerous other morphological and color pattern characteristics (Tables 5 and 9). *C. phangngaensis* sp. nov. differs from *C. chanardi*, *C. omari*, and *C. roticanai* by having; more infralabial scales (10 vs. 6–8, 7,8, and 7,8, respectively); continuous precloacal pores; paravetebral tubercles linearly arranged; lacking tubercles on the lower flank; ventrolateral caudal tubercles anteriorly; caudal tubercles restricted to a single paraveterbral row on each side; a single median row of keeled subcaudals. *Cnemaspis phangngaensis* sp. nov. is further differentiated from *C. chanardi* and *C. omari* by having a larger maximum SVL (42 mm vs. 40.1 mm and 41.3 mm, respectively). *Cnemaspis phangngaensis* sp. nov. differs from *C. omari*, and *roticani* by having more supralabial scales (10 vs. 8,9 and 8,9, respectively). *C.*

phangngaensis sp. nov. differs from *C. chanardi* by having fewer precloacal pores (4 vs. 6–8). *Cnemaspis phangngaensis* sp. nov. differs from *C. roticani* by having fewer paravetebral tubercles (22 vs. 25–27). From *C. roticanai*, *C. phangngaensis* sp. nov. differs by lacking caudal tubercles in the lateral furrow and by having a lateral caudal tubercle row present. *Cnemaspis phangngaensis* sp. nov. differs from *C. omari* by lacking caudal tubercles encircling the tail and by having more lamellae under the 4th toe (29 vs. 25–28). *Cnemaspis phangngaensis* sp. nov. is further differentiated from *C. chanardi* by lacking an enlarged median subcaudal scale row. From *C. chanardi* and *C. omari*, *C. phangngaensis* differs by have two postcloacal tubercles in males versus one. *Cnemaspis phangngaensis* is further differentiated from all other species in the *siamensis* group based on squamation and color pattern characteristics (Table 5 and 9).

Cnemaspis thachanaensis sp. nov. urn:lsid:zoobank.org:act:3581C94E-6170-4F42-9159-E2B564B576F1

(Figs. 11–13)

Cnemaspis kamolnorranathi (Grismer et al., 2010, pg. 29)
Cnemaspis kamolnorranathi (Grismer et al., 2014d, pg. 130)

Holotype. BYU 62544 adult male, collected at Tham Khao Sonk Hill, Thachana District, Changwat Surat Thani, Thailand (9.549878°N, 99.175544°E; 107 m a.s.l.), 30 July 2016, by PLW, LLG, CA, MC, MSG, MLM.

Paratopotypes. All paratypes (BYU 62542–62543, ZMKU R 00729–00731) bear the same collection and locality data as the holotype.

Diagnosis. *Cnemaspis thachanaensis* sp. nov. is distinguished from all other species of *Cnemaspis* in the *siamensis* group by the combination of the following morphological and color pattern characteristics: maximum SVL 39 mm; 10 or 11 supralabials; 9–~~10~~ infralabials; ventral scales keeled; no precloacal pores in males; 15–19 paravetebral tubercles linearly arranged; tubercles present on the lower flanks; lateral caudal furrows present; no caudal tubercles in the lateral furrows; ventrolateral caudal tubercles anteriorly; caudal tubercles not encircling tail; caudal tubercles restricted to a single paravetebral row; subcaudals keeled bearing a single median row of enlarged keeled scales; ~~one or two~~ post cloacal tubercles in males; no enlarged femoral or tibial scales; subtibials keeled; enlarged submetatarsal scale on first toe; ~~24~~ subdigital fourth toe lamellae; sexually dimorphic for ventral and dorsal coloration; yellow or white bars present on flanks; prescapular marking present; gular region orange, dark incomplete lineate markings in males, less prominent in females; abdomen, limbs and subcaudal region whitish (Table 8).

Description of the holotype. Adult male; SVL 33 mm; head oblong in dorsal profile, moderate in size (HL/SVL 0.29), somewhat narrow (HW/SVL 0.16), flattened (HD/HL 0.37), head distinct from neck; snout moderate (ES/HL 0.44), snout slightly concave in lateral view; postnasal region concave medially; scales on rostrum smooth becoming keeled posteriorly, raised, larger than conical scales on occiput; weak to absent supra ocular ridges; frontalrostralis sulcus shallow; canthus rostralis nearly absent, smoothly rounded; eye large (ED/HL 0.22); extra-brillar, fringe scales largest anteriorly; pupil round; ear opening more oval than round, taller than wide; rostral slightly concave, dorsal 80% divided by longitudinal median groove; rostral bordered posteriorly by supra nasals and one small azygous scale and laterally by first supralabials; 11, 11 (R,L) slightly raised supralabials decreasing in size posteriorly; 10, 10 (R,L) infralabials decreasing in size posteriorly; nostrils elliptical, oriented dorsoposteriorly; bordered by small postnasal scales; mental large, triangular, concave, bordered posteriorly by three postmentals; gular scales small, smooth, raised and round; throat scales subimbricate, keeled, small and round.

Body slender, elongate (AG/SVL 0.44); small, raised, keeled, dorsal scales equal in size throughout body, intermixed with several large, multicarinate conical tubercles more or less randomly arranged; tubercles extend from the occiput to base of the tail; enlargerd multicarinate conical tubercles on flanks; pectoral and abdominal scales keeled, not larger posteriorly; abdominal scales slightly larger than dorsals; no pore-bearing, precloacal pores on either side; forelimbs moderately long, slender; dorsal scales slightly raised, keeled; ventral scales of brachia smooth, raised, juxtaposed; scales beneath forearm smooth, slightly raised, subimbricate; palmar scales smooth, juxtaposed, raised; digits long with an inflected joint; claws recurved; sub digital lamellae unnotched; lamellae beneath first phalanges granular proximally, widened distally; lamellae beneath phalanx immediately following inflection granular, lamellae of distal phalanges

wide; interdigital webbing absent; fingers increase in length from first to fourth with fourth and fifth equal in length; hind limbs slightly longer and thicker than forelimbs; dorsal scales raised, multicarinate, juxtaposed; ventral scales of thigh, slightly raised, conical, keeled; subtibial scales keeled, flat, imbricate, with no enlarged anterior row; plantar scales smooth, juxtaposed, raised; enlarged submetatarsal scales beneath first metatarsal; digits elongate with an inflected jointed; claws recurved; subdigital lamellae unnotched; lamellae beneath first phalanges granular proximally, widened distally; lamellae beneath phalanx immediately following inflection granular, lamellae of distal phalanges wide; interdigital webbing absent; toes increase in length from first to fourth with fourth and fifth equal in length; 24,24 (R,L) subdigital lamellae on fourth toe; caudal scales similar to dorsal scale size, enlarge caudal tubercles arranged in segmented whorls, not encircling tail; caudal scales keeled, juxtaposed anteriorly; shallow, middorsal furrow; deeper, single, lateral furrow; enlarged, median, subcaudal scales; subcaudals keeled; median row of enlarged, keeled, subcaudal scales on last 2/3 of tail; transverse, tubercle rows do not encircle tail; caudal tubercles absent from lateral furrow; 1,1 (R,L) enlarged flat, postcloacal tubercle on lateral surface of hemipenal swellings at base of tail.

Coloration. In life dorsal ground color of head light-brown, that of the body, limbs and tail slightly darker than the head with even darker irregular blotches; top of the head bearing, small dark-brown and light-green markings; thin diffuse broken dark brown to black postorbital stripe, extending to the nape, not complete; light-green vertebral blotches extending form the nape to tail where they transform into diffuse near complete irregular bands intermixed with dark brown blotches turning into bands posteriorly; flanks with irregular incomplete small light-green colored blotches to yellow-orange bars becoming smaller posterior; limbs much lighter than dorsal ground color, limbs grayish-white and dark brown incomplete irregular bands; all ventral surfaces grayish-white, except gular and throat regions are yellow-orange not restricted to the gular region and extend onto the throat and the anterior region of the pectoral region in males, incomplete transverse markings in the gular region in male and is less prominent in females (Figures 11–13).

Variation. The paratypes approximate the holotype (BYU 62544) in general aspects of morphology except that the female paratypes lack precloacal pores and yellow-orange gular regions. Paratypes ZMKU R 00731, BYU 62542, and BYU 62541 have more paravetebral tubercles (19, 17, 16 respectively vs. 15), dark irregular gular spots not as prominent in females (Figure 12). Select body measurements and additional variation in squamation are presented in Table 8.

Etymology. The specific epithet *thachanaensis* is a noun in apposition to the the type locality where this species is found.

Distribution. This species is only know from the type locality Thom Sonk Hill, Thachana District, Surat Thani Province, Thailand and we expect that it will be found on nearby adjacent karst formations (Figure 14).

Natural history. *Cnemaspis thachanaensis* inhabits a karst tower embedded within a highly disturbed lowland limestone forest. One male individual was observed during the day situated upside down on a karst overhang displaying its yellow-orange throat by doing push-ups. All other specimens were found active during the day on the karst and we hypothesize that these are diurnal karst dwellers. No specimens were observed at night.Grismer et al. (2010) noted that one specimen (CUMZ-R 2009,624-3) was collected on a vine near the adjacent lime[illegible]e. Karst dwelling species of *Cnemaspis* have been know to sleep on vegetation at night (Grismer et a[illegible]010, 2014d, Wood, pers. obs.). This species may use the vegetation at night for refuge to avoid *Cyrtodactylus thirakaputhi* which is nocturnal and maybe a potential predator.

Remarks. Specimen CUMZ-R [illegible],6,24-3 was collected from Thom Sonk Hill, Thachana District, Surat Thani Province and was des[illegible]ed as *C. kamolnorranathi* in Grismer et al. (2010). Grismer et al. (2010) noted that the relatively wide separation (∼110 km) between the type locality of *C. kamolnorranathi* (Petchphanomwat Waterfall, Tai Rom Yen National Park, Ban Nasan District, Surat Thai Province) and the locality of the paratype CUMZ-R 2009,6,24-3 from Thom Sonk Hill, Thachana District, Surat Thani Province and suggested that there are probably undiscovered, geographically intervening populations in the appropriate habitat separating these two localities (Grismer et al., 2014d). Grismer et al. (2010) and Grismer et al. (2014d) noted that there is exceptional intrapopulational variation in the degree of keeling of the ventral and the subtibial scales in *C. kamolnorranathi* suggesting the possibility that

C. kamolnorranathi may be composed of multiple species. After examining additional specimens from Thom Sonk Hill, Thachana District, Surat Thani Province (BYU 62542, ZMKU R 00729–00731 and the paratype CUMZ-R 2009,6,24-3) we determined that CUMZ-R 2009,6,24-3 is not conspecific with *C. kamolnorranathi* and with additional specimens it can be diagnosed as a new species (see comparisons below for details). Here we remove CUMZ-R 2009,6,24-3 from *C. kamolnorranthi* and place it in *C. thachanaensis* restricting *C. kamolnorranathi* to the Petchphanomwat Waterfall, Tai Rom Yen National Park, Ban Nasan District, Surat Thai Province. There are no genetic samples of *C. kamolnorranthi* available to further test this hypotheses, however we present strong morphological evidence separating these species.

Comparisons. *Cnemaspis thachanaensis* sp. nov. is the sister species to a clade containing *C. siamensis* and *C. vandeventeri* (Figure 2). Although we were not able to obtain genetic material for *C. kamolnorranathi* we compare it here using morphology to demonstrate that the paratype (CUMZ-R 2009,6,24-3, MS101) is conspecific with *C. thachanaensis* sp. nov. *Cnemaspis thachanaensis* differs from *C. siamensis* and *C. vandeventeri* by having a smaller SVL (39 mm, vs. 39.7 mm and 44.7 mm) and by having a larger maximum SVL from *C. kamolnorranathi* (39 mm vs. 37.8 mm). *C. thachanaensis* sp. nov. differs from *C. siamensis*, *C. vandeventeri*, and *C. kamolnorranathi* by; having more supralabial scales (10–11 vs. 8–9, 8–9, 8–9, respectively); having more infralabials (9–11 vs. 6–8, 7–9, and 7–8, respectively); having paravertebral tubercles linearly arranged; having ventrolateral caudal tubercles anteriorly; having caudal tubercles restricted to a single paravetebral row on each side; having a single median row of keeled subcaudal scales; lacking a single enlarged subcaudal scale row; lacking postcloaclal tubercles in males; the presence of an enlarged submetatarsal scale on the 1st toe. *Cnemaspis thachanaensis* is further differentiated from *C. kamolnorranathi* by having keeled ventral scales. *Cnemaspis thachanaensis* sp. nov. differs from *C. vandeventeri* and *C. kamolnorranathi* by lacking precloacal pores. We can further differentiate *C. thachanaensis* sp. nov. from *C. vandeventeri* by having less paravetebral tubercles (15–19 vs. 25–29). *Cnemaspis thachanaensis* sp. nov. differs from *C. kamolnorranathi* by lacking tubercles in the lateral furrow. *Cnemaspis thachanaensis* is further differentiated the more distantly related species *C. huaseesom* and *C. punctatonuchalis* in the *siamensis* group by having a smaller maximum SVL (39 mm vs. 43.5 mm and 49.6 mm, respectively); having more supralabials 10,11 vs. 8; having caudal tubercles restricted to a single paravetebral row; having keeled ventral scales; single median row of keeled subcaudals; lacking enlarged median subcaudal scale row; by lacking postcloacal tubercles in males. *Cnemaspis thachanaensis* differs by having more infralabials 9–11 vs. 7, 8 in *C. punctatonuchalis*. *Cnemaspis thachanaensis* differs from *C. huaseesom* by lacking precloacal pores. From *C. huaseesom*, *C. thachanaensis* differs by having ventrolateral caudal tubercles anteriorly and the presence of a lateral caudal tubercle row. *Cnemaspis thachanaensis* differs from *C. punctatonuchalis* by having keeled subcaudal scales. *Cnemaspis thachanaensis* differs from *C. huaseesom* by having keeled subtibial scales an an enlarged submetatarsal scale on the first toe. From *C. punctatonuchalis*, *C. thachanaensis* differs by having less fourth toe lamellae, 24 vs. 29–31. *Cnemaspis thachanaensis* is differentiated from all other species in the *siamensis* group based on squamation and color pattern characteristics (Table 5 and 9).

DISCUSSION

The discovery of three new species of karst-dwelling *Cnemaspis* from Peninsular Thailand is not surprising, given the nature of the vastly unexplored karst and limestone forests dispersed throughout this area. Peninsular Malaysia received considerable attention with respect to herpetofaunal surveys, yet new karst-dwelling species are being discovered and described every year (see Grismer et al., 2016a, for a summary). The results of these brief surveys have resulted in the discovery of 14 species of geckos (including *Cnemaspis* and *Cyrtodactylus* as well as two snakes [Grismer et al. 2016a]). In comparison, Peninsular Thailand has received little attention with most of the focus on the genus *Cyrtodactylus* resulting in the discovery and description of 15 species in the last 55 years, with 14 of these being described in the last 15 years (see Table 6 in Grismer et al., 2016a). However, there has been little focus on the Thai karst-dwelling *Cnemaspis* from these areas except for in Grismer et al. (2010) and this paper. With the results of the small amount of time spent in Phangnga, Thachana, and Prachuap Khiri Khan, we were able to discover three new species (*C. lineogularis* sp. nov., *C. phangngaensis* sp. nov., *C. thachanaensis* sp.

nov.) and obtain genetic samples of *C. punctatonuchalis* and *C. vandeventeri*.

The inclusion of *C. punctatonuchalis* and *C. vandeventeri* in the phylogenetic analyses helps test previous morphological hypotheses set forth by Grismer et al. (2010, 2014d), and has also contributed towards a more complete phylogeny of the genus *Cnemaspis* (50 of the 55 named species including the three new species described herein). *Cnemaspis punctatonuchalis* was nested within the *siamensis* group confirming the placement solely based on morphological and color pattern characteristics by Grismer et al. (2014d), which was also hypothesized to be more closely related to the other northern species (north of the Isthmus of Kra, *C. huaseesom* and *C. siamensis*). This is further supported here as the sister species to *C. huaseesom* (Figure 2). *Cnemaspis vandeventeri* was hypothesized based on its distribution that it should align with the *siamensis* group, however Grismer et al. (2014d) also suggested that the presence of a light prescapular crescent that diagnoses a monophyletic group composed of *C. chanardi*, *C. phangngaensis*, *C. omari* and *C. roticanai* may suggest that it is more closely related to this group. The phylogenetic placement of *C. vandeventeri* is well nested in the *siamensis* group confirming the placement based on its distribution of Grismer et al. (2010, 2014d), however the hypothesis that it may be more closely related to the group with the prescapular crest is not supported by our phylogenetic hypothesis and could represent an instance of convergent evolution of the prescapular crescent. This in not surprising based on the well documented parallel/convergent evolution present in the genus *Cnemaspis* (Grismer et al., 2014d), and further analyses to address hypotheses pertaining to parallel/convergent evolution are in preparation (Wood et al. in prep).

The phylogenetic position of *C. lineogularis* as the sister taxon to the entire *chantaburiensis* group, indicates a trans-Gulf of Thailand relationship with other species from southern Indochina. This is not a novel biogeographic pattern and the close relationship between Indochinese and Malaysian lineages has been observed in Butterfly lizards in the genus *Leiolepis* (J. Grismer et al., 2014a), and in some species of *Cyrtodactylus* (Grismer et al., 2015). However, the previous documented cases of this pattern are much further south on the peninsula (near the Thai-Malay border). This pattern could easily be explained by previous cyclic sea level fluctuations that exposed the Sunda Shelf providing multiple dispersal corridors between the MP and Indochina (e.g. Voris, 2000; Sathiamurthy and Voris, 2006; Woodruff, 2010). Further investigation into the biogeographic patterns for *Cnemaspis* are in preparation (Wood et al. in prep), and with the continued discovery of new species of *Cnemasapis* in the area, these broader studies will contribute to the understanding of the complex biogeography patterns on the MP. The discovery of three new species of *Cnemaspis* described here underscores the need for additional fieldwork in the karst towers of the MP and the surrounding areas to aid in conservation efforts, document the herpetofauna diversity, and provide data for biogeographic studies.

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REFERENCES

Alström, P., Davidson, P., Duckworth, J., Eames, J. C., Le, T. T., Nguyen, C., Olsson, U., Robson, C., and Timmins, R. (2010). Description of a new species of *Phylloscopus* warbler from Vietnam and Laos. *Ibis*, 152(1):145–168.

Chin, S. C. (1977). Limestone Hill flora of Malaya: Part 1. *Gardens' bulletin, Singapore*.

Clements, R., Sodhi, N. S., Schilthuizen, M., and Ng, P. K. (2006). Limestone karsts of Southeast Asia: imperiled arks of biodiversity. *Bioscience*, 56(9):733–742.

de Bruyn, M., Rüber, Lüber, L., Nylinder, S., Stelbrink, B., Lovejoy, N. R., Lavoué, S., Tan, H. H., Nugroho, E., Wowor, D., Ng, P. K., Siti Azizah, M., Rintelen, T., Hall, R., and GR, C. (2013). Paleo-drainage basin connectivity predicts evolutionary relationships across three Southeast Asian biodiversity hotspots. *Systematic Biology*, 62(3):398–410.

Drummond, A., Ashton, B., Buxton, S., Cheung, M., Cooper, A., Duran, C., Field, M., et al. (2012). Geneious v5.6. created by biomatters. *Website http://www. geneious. com [accessed 10 December 2013]*.

Edgar, R. C. (2004). Muscle: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research*, 32(5):1792–1797.

Ellis, M. and Pauwels, O. S. (2012). The bent-toed geckos (*Cyrtodactylus*) of the caves and karst of Thailand. *Cave and Karst Science*, 39(1):16–22.

Gorog, A., Sinaga, M., and Engstrom, M. (2004). Vicariance or dispersal? Historical biogeography of three Sunda shelf murine rodents (*Maxomys surifer*, *Leopoldamys sabanus* and *Maxomys whiteheadi*). *Biological Journal of the Linnean Society*, 81(1):91–109.

Grismer, J. L., Bauer, A. M., Grismer, L. L., Thirakhupt, K., Aowphol, A., Oaks, J. R., Wood Jr, P. L., Onn, C. K., Thy, N., Cota, M., et al. (2014a). Multiple origins of parthenogenesis, and a revised species phylogeny for the Southeast Asian butterfly lizards, *Leiolepis*. *Biological Journal of the Linnean Society*, 113(4):1080–1093.

Grismer, L., Wood Jr, P. L., Mohamed, M., Chan, K., Heinz, H. M., Sumarli, A. S., Chan, J. A., and Loredo, A. I. (2013a). A new species of karst-adapted *Cnemaspis* strauch, 1887 (Squamata: Gekkonidae) from a threatened karst region in Pahang, Peninsular Malaysia. *Zootaxa*, 3746(3):463–472.

Grismer, L. L. (2011). *Field Guide to the Amphibians and Reptiles of the Seribuat Archipelago (Peninsular Malaysia)*. Ed. Chimaira.

Grismer, L. L., Chan, K., Nurolhuda, N., and Sumontha, M. (2008a). A new species of karst dwelling gecko (genus *Cnemaspis* Strauch 1887) from the border region of Thailand and Peninsular Malaysia. *Zootaxa*, 1875:51–68.

Grismer, L. L., Grismer, J. L., Wood Jr, P. L., and Onn, C. K. (2008b). The distribution, taxonomy, and redescription of the geckos *Cnemaspis affinis* (stoliczka 1887) and *C. flavolineata* (nicholls 1949) with descriptions of a new montane species and two new lowland, karst-dwelling species from Peninsular Malaysia. *Zootaxa*, 1931:1–24.

Grismer, L. L., Norhayati, A., Chan, K., Daicus, B., Muin, M., Wood Jr, P. L., and Grismer, J. L. (2009). Two new diminutive species of *Cnemaspis* Strauch 1887 (squamata: Gekkonidae) from Peninsular Malaysia. *Zootaxa*, 2019:40–56.

Grismer, L. L., Quah, S. H., Anuar, S., Muin, M. A., and Wood Jr, P. L. (2014b). A diminutive new species of a cave-dwelling Wolf Snake (Colubridae: *Lycodon* Boie, 1826) from Peninsular Malaysia. *Zootaxa*, 3815(1):051–067.

Grismer, L. L., Shahrul, A., Muin, M. A., Quah, E. S., and Wood Jr, P. L. (2013b). Phylogenetic relationships and description of a new upland species of Bent-toed Gecko (*Cyrtodactylus* Gray, 1827) of the *C. sworderi* complex from northeastern Peninsular Malaysia. *Zootaxa*, 3616(3):239–252.

Grismer, L. L., Sumontha, M., Cota, M., Grismer, J. L., Wood Jr, P. L., Pauwels, O. S., and Kunya, K. (2010). A revision and redescription of the rock gecko *Cnemaspis siamensis* (Taylor 1925)(Squamata: Gekkonidae) from Peninsular Thailand with descriptions of seven new species. *Zootaxa*, 2576:1–55.

Grismer, L. L., Wood Jr, P., Anuar, S., Davis, H. R., Co[illegible] A. J., and Murdoch, M. L. (2016a). A new species of karst forest Bent-toed Gecko (genus Cyrtodactylus Gray) not yet threatened by foreign cement companies and a summary of Peninsular Malaysia's endemic karst forest herpetofauna and the need for its conservation. *Zootaxa*, 4061(1):1–17.

Grismer, L. L., Wood Jr, P., Quah, E. S., Anuar, S., Muin, M. A., Sumontha, M., Ahmad, N., and Bauer, A. M. (2012). A phylogeny and taxonomy of the Thai-Malay Peninsula Bent-toed Geckos of the *Cyrtodactylus pulchellus* complex (squamata: Gekkonidae): combined morphological and molecular analyses with descriptions of seven new species. *Zootaxa*, 3520:1–55.

Grismer, L. L., Wood Jr, P., Tri, N., and Murdoch, M. L. (2015). The systematics and independent evolution of cave ecomorphology in distantly related clades of Bent-toed Geckos (Genus Cyrtodactylus Gray, 1827) from the Mekong Delta and islands in the Gulf of Thailand. *Zootaxa*, 3980(1):106–126.

Grismer, L. L., Wood Jr, P. L., Onn, C. K., Anuar, S., and Muin, M. A. (2014c). Cyrts in the city: A new Bent-toed Gecko (Genus *Cyrtodactylus*) is the only endemic species of vertebrate from Batu Caves,

Selangor, Peninsular Malaysia. *Zootaxa*, 3774(4):381–394.

Grismer, L. L., Wood Jr, P. L., Shahrul, A., Awal, R., Norhayati, A., Muin, M., Sumontha, M., Grismer, J., Chan, K., Quah, E. S., and Pauwels, O. (2014d). Systematics and natural history of Southeast Asian Rock Geckos (genus *Cnemaspis* Strauch, 1887) with descriptions of eight new species from Malaysia, Thailand, and Indonesia. *Zootaxa*, 3880(1):1–147.

Grismer, L. L., Wood Jr, P. L., Shahrul, A., Grismer, M. S., Quah, E. S. H., Murdoch, M. L., Muin, M. A., Davis, H. R., Aguilar, C., Klabacka, R., Cobos, A. J., and A, A. (2016b). Two new Bent-toed Geckos of the *Cyrtodactylus pulchellus* complex from Peninsular Malaysia and multiple instances of convergent adaptation to limestone forest ecosystems. *Zootaxa*, in press.

Grismer, L. L., Wood Jr, P. L., Shahrul, A., Quah, E. S., Muin, M. A., Mohamed, M., and Onn, C. K. (2014e). The phylogenetic relationships of three new species of the *Cyrtodactylus pulchellus* complex (squamata: Gekkonidae) from poorly explored regions in northeastern peninsular malaysia. *Zootaxa*, 3786(3):359–381.

Holloway, J. (1986). *High Altitude Tropical BIogeography*, chapter Origins of lepidopteran faunas in high mountains of the Indo-Australian tropics, pages 533–566. Oxford University Press.

Huelsenbeck, J. P., Ronquist, F., Nielsen, R., and Bollback, J. P. (2001). Bayesian inference of phylogeny and its impact on evolutionary biology. *Science*, 294(5550):2310–2314.

Hughes, J. B., Round, P. D., and Woodruff, D. S. (2003). The Indochinese–Sundaic faunal transition at the Isthmus of Kra: an analysis of resident forest bird species distributions. *Journal of Biogeography*, 30(4):569–580.

Jenkins, P. D., Kilpatrick, C. W., Robinson, M. F., and Timmins, R. J. (2005). Morphological and molecular investigations of a new family, genus and species of rodent (Mammalia: Rodentia: Hystricognatha) from Lao PDR. *Systematics and Biodiversity*, 2(4):419–454.

Kiew, R. (1991). The limestone flora. *The State of Nature Conservation in Malaysia, Malaysian Nature Society*, pages 42–50.

Kiew, R. (1998). *The Encyclopedia of Malaysia: Plants*, chapter Limestone, Quartzite and Ultramafic Vegetation, pages 26–27. Editions Didier Miller, Singapore.

Komo, I. (1998a). *The Encyclopedia of Malaysia: The Environment*, chapter The Karst Morphology of Langkawi, pages 40–41. Editions Didier Miller, Singapore.

Komo, I. (1998b). *The Encyclopedia of Malaysia: The Environment*, chapter Caves and cave Systems: The Mulu Caves, pages 42—43. Editions Didier Miller, Singapore.

Latinne, A., Waengsothorn, S., Herbreteau, V., and Michaux, J. R. (2011). Evidence of complex phylogeographic structure for the threatened rodent *Leopoldamys neilli*, in Southeast Asia. *Conservation genetics*, 12(6):1495–1511.

Macey, J. R., Larson, A., Ananjeva, N. B., Fang, Z., and Papenfuss, T. J. (1997). Two novel gene orders and the role of light-strand replication in rearrangement of the vertebrate mitochondrial genome. *Molecular Biology and Evolution*, 14(1):91–104.

Maddison, W. and Maddison, D. (2015). Mesquite: a modular system for evolutionary analysis. version 3.04. 2015. *URL http://mesquiteproject. org*.

Ng, P. (1991). *Cancrocaeca xenomorpha*, new genus and species, a blind troglobitic freshwater hymenosomatid (Crustacea: Decapoda: Brachyura) from Sulawesi, Indonesia. *Raffles Bulletin of Zoology*, 39(1):59–73.

Parnell, J. (2013). The biogeography of the Isthmus of Kra region: a review. *Nordic Journal of Botany*, 31(1):001–015.

Patou, M.-L., Chen, J., Cosson, L., Andersen, D., Cruaud, C., Couloux, A., Randi, E., Zhang, S., and Veron, G. (2009). Low genetic diversity in the masked palm civet *Paguma larvata* (Viverridae). *Journal of Zoology*, 278(3):218–230.

Pauwels, O., David, P., Chimsunchart, C., and Thirakhupt, K. (2003). Reptiles of Phetchaburi Province, Western Thailand: a list of species, with natural history notes, and a discussion on the biogeography at the Isthmus of Kra. *The Natural History Journal of Chulalongkorn University*, 3(1):23–53.

Pauwels, O. S., Sumontha, M., Latinne, A., and Grismer, L. L. (2013). *Cyrtodactylus sanook* (Squamata: Gekkonidae), a new cave-dwelling gecko from Chumphon Province, southern Thailand. *Zootaxa*, 3635(3):275–285.

Posada, D. and Crandall, K. A. (1998). Modeltest: testing the model of DNA substitution. *Bioinformatics*, 14(9):817–818.

Raes, N., Cannon, C. H., Hijmans, R. J., Piessens, T., Saw, L. G., van Welzen, P. C., and Slik, J. F. (2014). Historical distribution of Sundaland's Dipterocarp rainforests at Quaternary glacial maxima. *Proceedings of the National Academy of Sciences*, 111(47):16790–16795.

Ronquist, F., Teslenko, M., van der Mark, P., Ayres, D. L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M. A., and Huelsenbeck, J. P. (2012). Mrbayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic biology*, 61(3):539–542.

Sacha, M. (2015). Herpetoreisen in Thailand: Erste Eindrücke aus Krabi. *Sauria*, 37(3):43–55.

Sathiamurthy, E. and Voris, H. K. (2006). Maps of Holocene sea level transgression and submerged lakes on the Sunda Shelf. *The Natural History Journal of Chulalongkorn University, Supplement*, 2:1–43.

Schilthuizen, M. (2004). Land snail conservation in Borneo: Limestone outcrops act as arks. *Journal of Conchology Special Publication*, 3:149–154.

Schilthuizen, M., Liew, T.-S., Elahan, B. B., and Lackman-Ancrenaz, I. (2005). Effects of karst forest degradation on pulmonate and prosobranch land snail communities in Sabah, Malaysian Borneo. *Conservation Biology*, 19(3):949–954.

Schilthuizen, M., Vermeulen, J., Davison, G., and Gittenberger, E. (1999). Population structure in a snail species from isolated Malaysian limestone hills, inferred from ribosomal DNA sequences. *Malacologia*, 41:271–284.

Siler, C. D., Oaks, J. R., Esselstyn, J. A., Diesmos, A. C., and Brown, R. M. (2010). Phylogeny and biogeography of Philippine bent-toed geckos (Gekkonidae: *Cyrtodactylus*) contradict a prevailing model of Pleistocene diversification. *Molecular Phylogenetics and Evolution*, 55(2):699–710.

Stamatakis, A. (2006). Raxml-vi-hpc: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics*, 22(21):2688–2690.

Stamatakis, A., Hoover, P., and Rougemont, J. (2008). A rapid bootstrap algorithm for the raxml web servers. *Systematic Biology*, 57(5):758–771.

Tamura, K., Stecher, G., Peterson, D., Filipski, A., and Kumar, S. (2013). MEGA6: molecular evolutionary genetics analysis version 6.0. *Molecular Biology and Evolution*, 30(12):2725–2729.

Tija, H. D. (1998). *The Encyclopedia of Malaysia: The Environment*, chapter Limestone and Karst Morphology, pages 38–39. Editions Didier Miller, Singapore.

Vermeulen, J. and Whitten, T. (1999). Biodiversity and cultural property in the management of limestone resources. *World Bank, Washington, DC*, 120.

Voris, H. K. (2000). Maps of pleistocene sea levels in southeast asia: shorelines, river systems and time durations. *Journal of Biogeography*, 27(5):1153–1167.

Wilcox, T. P., Zwickl, D. J., Heath, T. A., and Hillis, D. M. (2002). Phylogenetic relationships of the dwarf boas and a comparison of bayesian and bootstrap measures of phylogenetic support. *Molecular Phylogenetics and Evolution*, 25(2):361–371.

Wood, Jr, P. L., Quah, E. S., Anuar, S., and Muin, M. A. (2013). A new species of lowland karst dwelling *Cnemaspis* Strauch 1887 (Squamata: Gekkonidae) from northwestern Peninsular Malaysia. *Zootaxa*, 3691(5):538–558.

Woodruff, D. S. (2003). Neogene marine transgressions, palaeogeography and biogeographic transitions on the Thai–Malay Peninsula. *Journal of Biogeography*, 30(4):551–567.

Woodruff, D. S. (2010). Biogeography and conservation in southeast asia: how 2.7 million years of repeated environmental fluctuations affect today's patterns and the future of the remaining refugial-phase biodiversity. *Biodiversity and Conservation*, 19(4):919–941.

Woodruff, D. S. and Turner, L. M. (2009). The Indochinese–Sundaic zoogeographic transition: a description and analysis of terrestrial mammal species distributions. *Journal of Biogeography*, 36(5):803–821.

Woxvold, I., Duckworth, J., and Timmins, R. (2009). An unusual new bulbul (Passeriformes: Pycnonotidae) from the limestone karst of Lao PDR. *Forktail*, 25:1–12.

760 **Figs. and Tables**

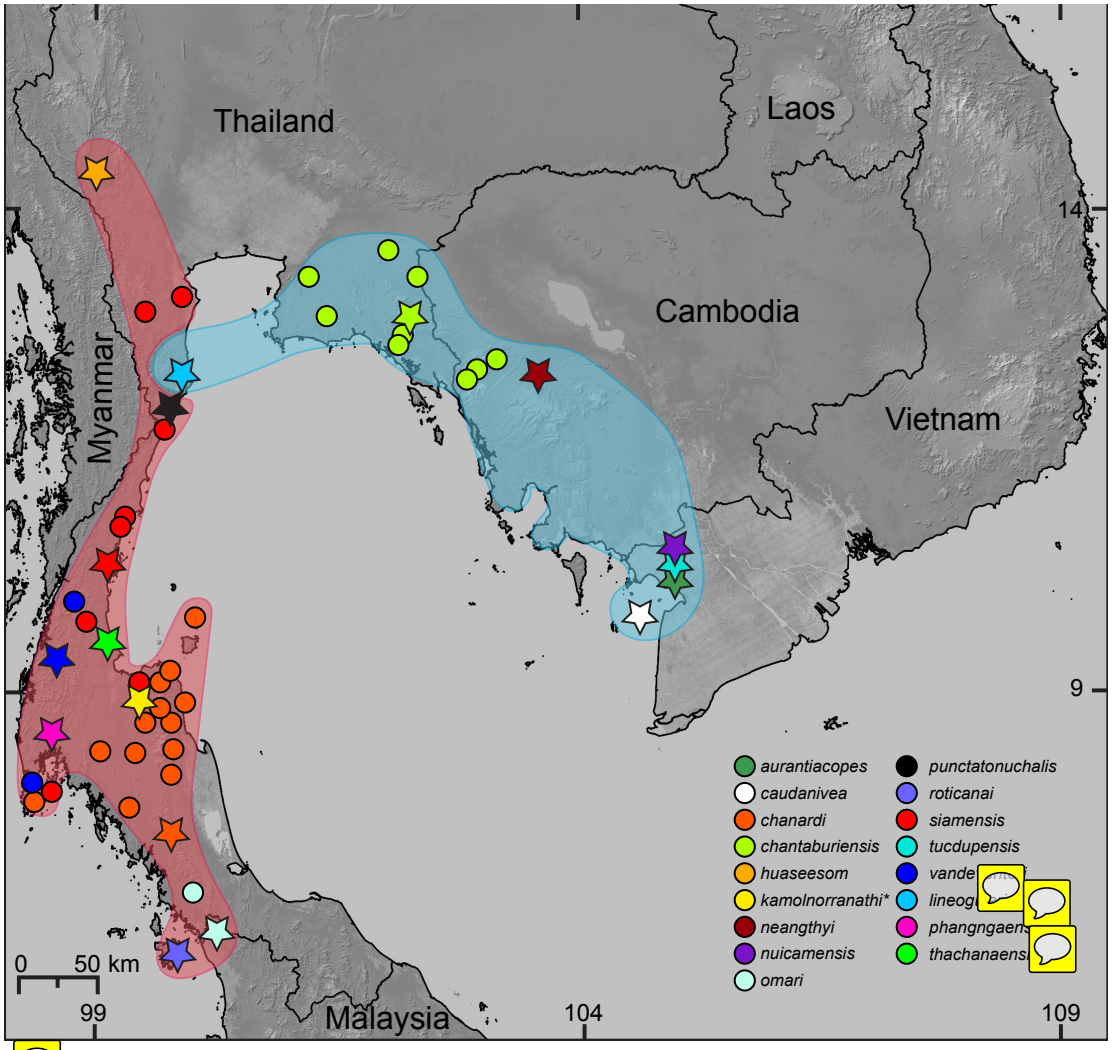

Figure 1. Distribution of the species of *Cnemaspis* in the *chantaburiensis* and *siamensis* groups. Stars indicate type localities, colored dots represent additional localities for the respective species, and the colored outlines correspond to colored clades in Figure 2. The asterisks (*) identify species not included in the molecular analysis.

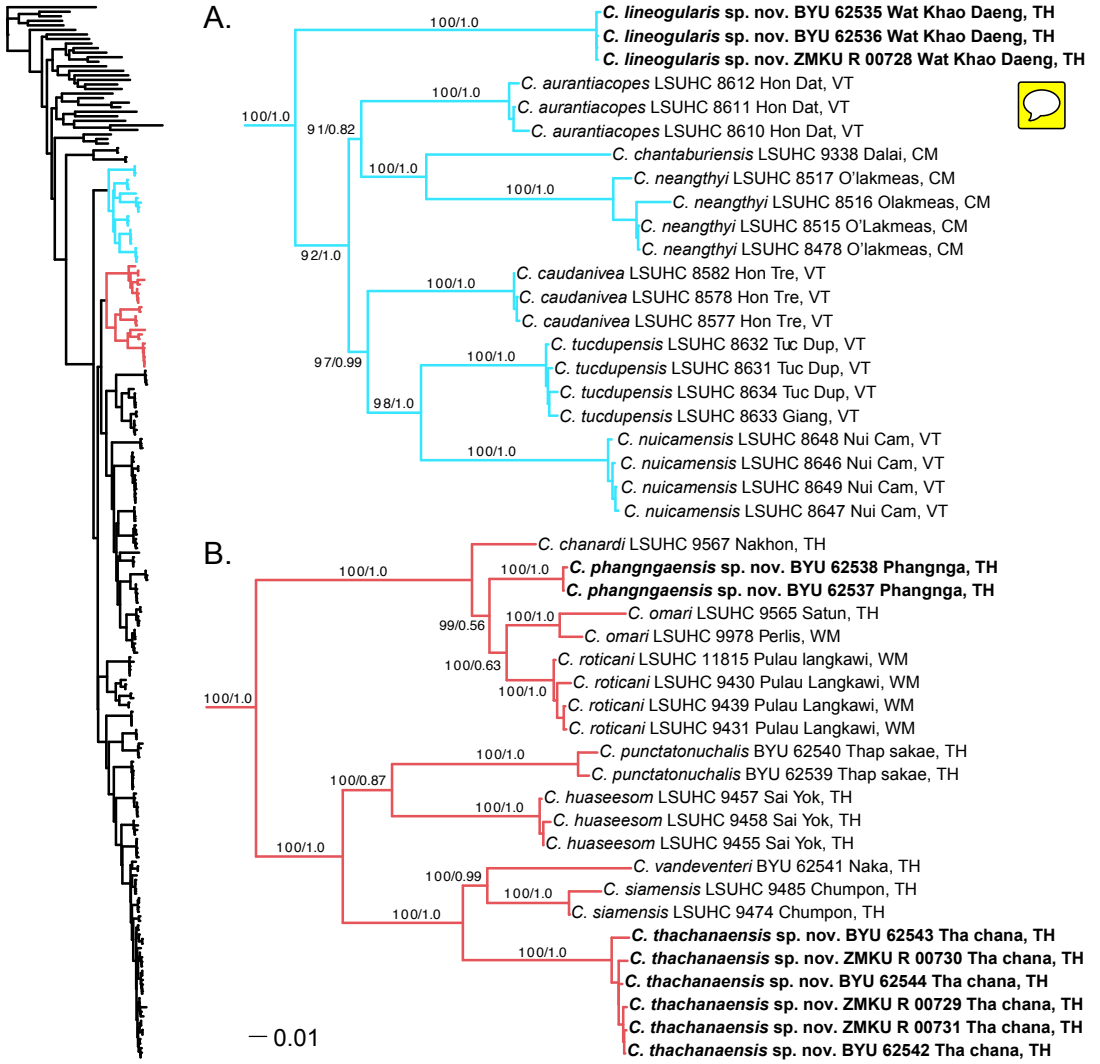

Figure 2. Phylogenetic relationships of the *chantaburiensis* (A) and the *siamensis* (B) groups. Right, Maximum Likelihood tree from RAxML (-ln L 60818.390304) for all species of *Cnemaspis* with bootstrap support values (BS) and Bayesian posterior probabilities (PP), respectively. Country abbreviations for the tip labels are as follows: CM= Cambodia, TH= Thailand, WM=West Malaysia, VT= Vietnam.

Figure 3. Top, male holotype BYU 62535 and bottom female paratype ZMKU R 00728 of *Cnemaspis lineogularis* sp. nov.

Figure 4. Ventral coloration and sexual dichromatism in the type series of *Cnemaspis lineogularis* sp. nov. From left to right, adult male holotype BYU 62535, adult male paratype BYU 62536, adult female paratype ZMKU R 00728.

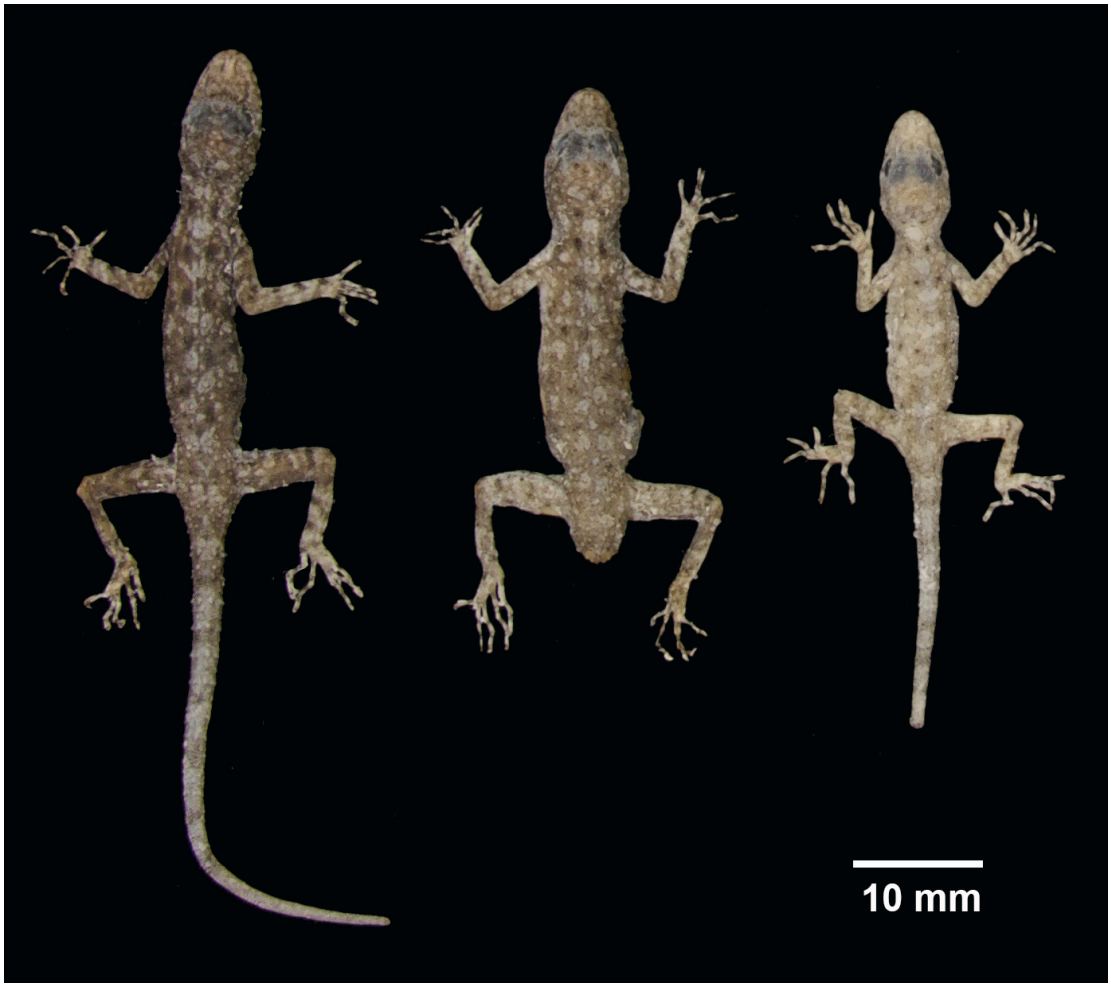

Figure 5. Dorsal view of the type series of *Cnemaspis lineogularis* sp. nov. From left to right, adult male holotype BYU 62535, adult male paratype BYU 62536, adult female paratype ZMKU R 00728.

Figure 6. Left, habitat and right, microhabitat of *Cnemaspis lineogularis* sp. nov.

Figure 7. Top, adult male holotype BYU 62538 and bottom female paratype BYU 62537 of *Cnemaspis phangngaensis* sp. nov.

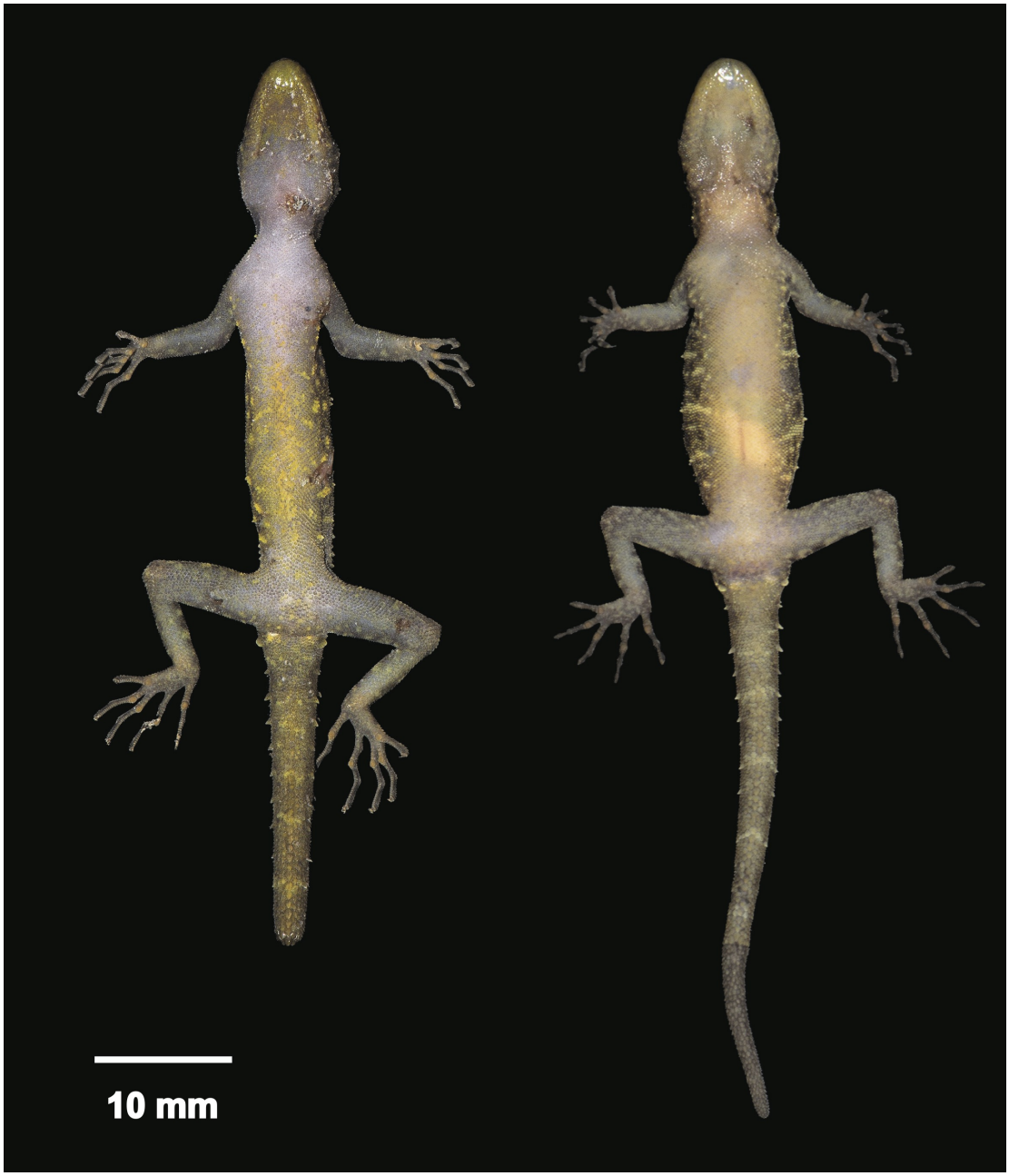

Figure 8. Ventral coloration and sexual dichromatism of *Cnemaspis phangngaensis* sp. nov. Left; male holotype BYU 62538 and right female paratype BYU 62537.

Figure 9. Dorsal coloration of the type series of *Cnemaspis phangngaensis* sp. nov. Left; male holotype BYU 62538 and right female paratype BYU 62537.

Figure 10. Top, general karst and limestone forest near the type locality of *Cnemaspis phangngaensis* sp. nov. Bottom, karst microhabitat where *C. phangngaensis* occurs.

Figure 11. Coloration of *Cnemaspis thachanaensis* sp. nov. Top, male holotype BYU 62544 and bottom, BYU 62542 female paratype.

Figure 12. Ventral coloration and sexual dichromatism of the type series of *Cnemaspis thachanaensis* sp. nov., from left to right, males: BYU 62543, BYU 62544, ZMKU R 00731, females: ZMKU R 00729, ZMKU R 00730, BYU 62542.

Figure 13. Dorsal coloration of the type series of *Cnemaspis thachanaensis* sp. nov., from left to right, males: BYU 62543, BYU 62544, ZMKU R 00731, females: ZMKU R 00729, ZMKU R 00730, BYU 62542.

Figure 14. Left, karst and limestone forest near the type locality of *Cnemaspis thachanaensis* sp. nov. Right, karst microhabitat of *Cnemaspis thachanaensis* sp. nov.

Table 1. Models of molecular evolution used for the ML and BI analyses.

gene	model selected	model applied for ML	model applied for BI
ND2			
1st pos	GTR+I+Γ	GTR+I+Γ	GTR+I+Γ
2nd pos	GTR+I+Γ	GTR+I+Γ	GTR+I+Γ
3rd pos	GTR+I+Γ	GTR+I+Γ	GTR+I+Γ
tRNAs	TrN+I+Γ	GTR+I+Γ	HKY+I+Γ

Table 2. Pairwise uncorrected p-distances based on 1335 bp of ND2 and associated tRNAs calculated in MEGA v6.06 (Tamura et al., 2013) within the *chantaburiensis* group. Within species distances are presented in bold text and between species distances are presented below the diagonal.

	C. lineogularis sp. nov.	*C. aurantiacopes*	*C. caudanivea*	*C. chantaburiensis*	*C. neangthyi*	*C. nuicamensis*	*C. tucdupensis*
C. lineogularis sp. nov.	**0.003**						
C. aurantiacopes	0.200	**0.011**					
C. caudanivea	0.195	0.136	**0.002**				
C. chantaburiensis	0.217	0.161	0.167	**–**			
C. neangthyi	0.230	0.161	0.169	0.156	**0.001**		
C. nuicamensis	0.207	0.158	0.160	0.175	0.179	**0.002**	
C. tucdupensis	0.206	0.149	0.140	0.171	0.166	0.140	**0.006**

Table 3. Pairwise uncorrected p-distances based on 1335 bp of ND2 and associated tRNAs calculated in MEGA v6.06 (Tamura et al., 2013) within the *siamensis* group. Within species distances are presented in bold text and between species distances are presented below the diagonal.

	C. thachanaensis sp. nov.	*C. phangngaensis* sp. nov.	*C. omari*	*C. chanardi*	*C. punctatonuchalis*	*C. vandeventeri*	*C. huaseesom*	*C. roticani*	*C. siamensis*
C. thachanaensis sp. nov.	**0.003**								
C. phangngaensis sp. nov.	0.260	**0.002**							
C. omari	0.282	0.112	**0.042**						
C. chanardi	0.243	0.114	0.118	–					
C. punctatonuchalis	0.211	0.250	0.264	0.255	–				
C. vandeventeri	0.144	0.252	0.266	0.240	0.211	–			
C. huaseesom	0.208	0.237	0.282	0.262	0.170	0.201	**0.004**		
C. roticani	0.275	0.088	0.090	0.117	0.256	0.268	0.274	**0.002**	
C. siamensis	0.134	0.250	0.278	0.255	0.194	0.123	0.194	0.281	–

Table 4. Mensural and meristic character states for the type ~~serious~~ of *Cnemaspis lineogularis* sp. nov. All measurements taken are in millimeters and the abbreviations are defined in the materials and methods. m=male; f=female; /=data unavailable or absent; b=broken.

	BYU 62535 Holotype	BYU 62536 Paratype	ZMKU R 00728 Paratype
Supralabials	9	9	9
Infralabials	8	8	8
Ventral scales keeled (1) or smooth (0)	0	0	0
No. of precloacal pores	/	/	/
Precloacal pores continuous (1) or separated (0)	/	/	/
Precloacal pores elongate (1) or round (0)	/	/	/
No. of paravertebral tubercles	13	13	13
Tubercles linearly arranged (1) or more random (0)	1	1	1
Tubercles present (1) or absent (0) on lower flanks	0	0	0
Lateral caudal furrows present (1) or absent (0)	1	/	1
Caudal tubercles in lateral furrow (1) or not (0)	0	/	0
Ventrolateral caudal tubercles anteriorly (1) or not (0)	1	/	1
Lateral caudal tubercle row present (1) or absent (0)	1	/	1
Caudal tubercles restricted to a single paravertebral row on each side (1) or not (0)	0	/	1
Subcaudals keeled (1) or smooth (0)	0	/	0
Single median row of keeled subcaudals (1) or smooth (0)	0	/	0
Caudal tubercles encircle tail (1) or not (0)	0	/	0
Enlarged median subcaudal scale row (1) or not (0)	1	/	1
No. of postcloacal tubercles in males	1	1	/
Enlarged femoral scales present (1) or absent (0)	1	1	1
Shield-like subtibial scales present (1) or absent (0)	0	0	0
Subtibial scales keeled (1) or smooth (0)	0	0	0
Enlarged submetatarsal scales on 1st toe (1) or not (0)	0	0	0
No. of 4th toe lamellae	29	27	29
SVL	38	35	29
TL	48	b	24
TW	2.9	/	2.66
FL	6.5	6.3	4.34
TBL	7.3	7.1	5.27
AG	17.5	15.7	10.6
HL	9.6	9.6	5.95
HW	6.4	6.3	5
HD	3.7	3.56	3.1
ED	2.5	1.78	1.71
EE	2.68	2.9	2.19
ES	5	4.2	3.54
EN	3.7	3.2	2.88
IO	3.1	2.5	1.99
EL	0.7	0.3	0.4
IN	1.2	1.2	0.89
Sex	m	m	f

Table 5. Diagnostic color pattern characters separating various species of *Cnemaspis* from one another following (Grismer et al., 2014d). / = data unavailable.

	***chanthaburiensis* group**								***siamensis* group**									
	lineogularis sp. nov.	*chanthaburiensis*	*neangthyi*	*laoensis**	*aurantiacopes*	*caudanivea*	*nuicamensis*	*tucdupensis*	*phangngaensis* sp. nov.	*thachanaensis* sp. nov.	*siamensis*	*huaseesom*	*chanardi*	*omari*	*roticanai*	*punctatonuchalis*	*vandeventeri*	*kamolnorranathi**
Dorsal color pattern sexually dimorphic	yes	no	no	/	yes	no	no	no	yes	yes	no	yes	no	no	yes	yes	no	no
Ventral pattern sexually dimorphic	yes	yes	no	/	yes	no	no	no	yes	yes	yes	yes	yes	/	yes	yes	yes	/
Head yellow	no	no	no	no	no	no	no	no	no	no	no	yes	no	no	no	no	no	no
Reddish blotches on head and body	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Dense yellow reticulum on occiput and side of neck	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Ocelli on occiput and nape	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Ocelli on shoulder	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Dual ocelli on shoulder	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Ocelli on brachium and side of neck	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	yes	no	no
Thin, white, nuchal loop	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Large, black round spots on nape and anterior of body	no	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no	no	no
Thin yellow reticulum on side of neck	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Yellowish, prescapular crescent	no	no	no	no	no	no	no	no	yes?	no	no	no	yes	yes	yes	no	yes	var
Forelimbs yellow	no	no	no	no	no	no	no	no	no	no	no	yes	no	no	no	no	no	no
Hind limbs yellow	no	no	no	no	no	no	no	no	no	no	no	yes	no	no	no	no	no	no
Reddish blotches or bands on limbs	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Forearms and forelegs orange	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no	no	no	no
Dorsal ground color magenta	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Dorsal ground color reddish	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Uniform brown ground color	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Light vertebral stripe	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Yellow postscapular band	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Black, squarish, paired, paravertebral dorsal markings	no	no	no	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no
Small, light, round spots on flanks	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Black flanks with distinct yellowish spots	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Yellow or white bars on flanks	no	no	no	no	no	no	no	no	yes	no	no	no	no	no	no	no	no	no
Original tail yellow	no	no	no	no	no	no	no	no	no	no	no	var	no	no	no	no	no	no
Original tail orange	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no	no	no	no
Regenerated tail yellow	no	no	no	/	no	/	no	no	/	no	no	no	no	no	yes	/	no	no
Regenerated tail orange	no	no	no	/	no	/	no	no	/	no	no	no	no	no	no	/	no	no
White, dorsal caudal tubercles	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Caudal bands present	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Wide black and yellow bands on tail	no	no	no	no	no	yes	no	yes	no	no	no	no	no	no	no	no	no	no
Thin, yellow caudal bands anteriorly	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Posterior portion of original tail white	no	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no	no	no
Posterior portion of original tail black	no	no	no	no	no	no	no	yes	/	no	no	no	no	no	no	no	no	no
Disticnt black and white caudal bands at least posteriorly	no	no	no	no	no	no	no	no	/	no	no	no	no	no	no	no	no	no
Gular region orange	yes	yes	no	/	yes	no	no	yes	no	yes	no	no	no	no	no	/	yes	no
Gular region yellow	no	no	no	/	no	no	no	no	yes	no	yes	yes	yes	yes	yes	/	no	no
Lineate gular markings	yes	no	no	/	yes	no	yes	no	no	yes	yes	no	no	no	no	/	no	no
Throat yellow	no	no	no	/	no	no	no	no	no	no	yes	yes	no	no	no	no	no	no
Throat orange	no	yes	no	/	yes	no	no	yes	no	yes	no	no	no	no	no	yes	no	no
Pectoral region yellow	no	no	no	/	no	no	no	no	no	no	yes	yes	no	no	yes	/	no	no
Pectoral region orange	no	no	no	/	yes	no	no	yes	no	no	no	no	no	no	no	/	var	no
Abdomen yellow	no	no	no	/	no	no	no	no	yes	no	no	no	yes	yes	yes	/	no	no
Abdomen orange	no	yes	no	/	yes	no	no	yes	no	no	no	no	no	no	no	/	yes	no
Ventral surfaces of forelimbs orange	no	no	no	/	yes	no	no	yes	no	no	no	no	no	no	no	/	yes	no
Ventral surfaces of forelimbs yellow	no	no	no	/	no	no	no	no	no	no	no	yes	no	no	no	/	no	no
Ventral surfaces of hind limbs orange	no	no	no	/	yes	no	no	yes	no	no	no	no	no	no	no	/	yes	no
Ventral surfaces of hind limbs yellow	no	no	no	/	no	no	no	no	no	no	no	no	yes	yes	yes	/	no	no
Subcaudal region yellow	no	no	no	/	no	no	no	no	yes	no	no	yes	yes	yes	yes	no	no	no
Subcaudal region orange	no	yes	no	/	no	no	yes	no	no	no	no	no	no	no	no	yes	yes	no
At least posterior half of subcaudal region white	no	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no	no	no

Table 6. Diagnostic morphological characters (in bold font) separating *C. lineogularis* from species of *Cnemaspis* in the *chantaburiensis* group. w =weak; ant = anterior; post = posterior; * = species that are not included in the molecular analyses; / = data unavailable or absent. Character abbreviations follow that of (Grismer et al., 2014d).

	lineogularis sp. nov.	*chanthaburiensis*	*neangthyi*	*laoensis**	*aurantiacopes*	*caudanivea*	*nuicamensis*	*tucdupensis*
Maximum SVL	38	42.2	54.0	40.9	58.4	47.2	48.2	51.0
Supralabials	9	8–10	11–13	9	9–11	8,9	7–9	8–10
Infralabials	8	7–10	10–12	7	8–10	7,8	6–7	7–9
Ventral scales keeled (1) or smooth (0)	0	0	0	0	0	0	0	0
No. of precloacal pores	0	6–9	2	/	0	0–2	3–6	0
Precloacal pores continuous (1) or separated (0)	/	1	1	/	/	0	0	/
Precloacal pores elongate (1) or round (0)	/	0,1	0	/	/	0,1	0,1	/
No. of paravertebral tubercles	13	21–25	20–26	22	23–31	20–24	16–21	16–22
Tubercles linearly arranged (1) or more random (0)	1	1	1	0	1	1	1	w,1
Tubercles present (1) or absent (0) on lower flanks	0	1	1	1	1	0	1	1
Lateral caudal furrows present (1) or absent (0)	1	1	1	1	1	1	1	1
Caudal tubercles in lateral furrow (1) or not (0)	0	1	1	1	0	0, ant	0, ant	0
Ventrolateral caudal tubercles anteriorly (1) or not (0)	1	0	1	0	1	1	1	1
Lateral caudal tubercle row present (1) or absent (0)	1	1	1	0	1	0, ant	0, ant	0
Caudal tubercles restricted to a single paravertebral row on each side (1) or not (0)	0	0	0	0	0	0	0	0
Subcaudals keeled (1) or smooth (0)	0	0	0	0	0	0	0	0
Single median row of keeled subcaudals (1) or smooth (0)	0	0	0	0	0	0	0	0
Caudal tubercles encircle tail (1) or not (0)	0	0	0	0	0	0	0	0
Enlarged median subcaudal scale row (1) or not (0)	1	0, post, w	1	w	1	0,w	1	w
No. of postcloacal tubercles in males	1	1–3	1	2,3	1,2	1,2	2–4	0–3
Enlarged femoral scales present (1) or absent (0)	1	0	0	0	0	0	0	0
Shield–like subtibial scales present (1) or absent (0)	0	0	0	0	0	1	0	0
Subtibial scales keeled (1) or smooth (0)	0	0,1	1	1	1	0,w	0	0
Enlarged submetatarsal scales on 1st toe (1) or not (0)	0	0	0	0	1	0,w	0	1
No. of 4th toe lamellae	27–29	22–29	22–25	29	27–31	23–30	27–33	26–32
Sample size (*n*=)	3	8	5	1	17	9	10	11

Table 7. Mensural and meristic character states for the type ~~serious~~ of *Cnemaspis phangngaensis* sp. nov. All measurements are taken in millimeters and the abbreviations are defined in the materials and methods. m=male; f=female; /=data unavailable or absent; b=broken.

	BYU 62538 Holotype	BYU 62537 Paratype
Supralabials	10	10
Infralabials	10	10
Ventral scales keeled (1) or smooth (0)	1	1
No. of precloacal pores	4	0
Precloacal pores continuous (1) or separated (0)	1	/
Precloacal pores elongate (1) or round (0)	0	/
No. of paravertebral tubercles	22	22
Tubercles linearly arranged (1) or more random (0)	1	1
Tubercles present (1) or absent (0) on lower flanks	0	0
Lateral caudal furrows present (1) or absent (0)	1	1
Caudal tubercles in lateral furrow (1) or not (0)	0	0
Ventrolateral caudal tubercles anteriorly (1) or not (0)	1	1
Lateral caudal tubercle row present (1) or absent (0)	1	1
Caudal tubercles restricted to a single paravertebral row on each side (1) or not (0)	1	1
Subcaudals keeled (1) or smooth (0)	1	1
Single median row of keeled subcaudals (1) or smooth (0)	1	1
Caudal tubercles encircle tail (1) or not (0)	0	0
Enlarged median subcaudal scale row (1) or not (0)	0	0
No. of postcloacal tubercles in males	2	/
Enlarged femoral scales present (1) or absent (0)	0	0
Shield-like subtibial scales present (1) or absent (0)	0	0
Subtibial scales keeled (1) or smooth (0)	1	1
Enlarged submetatarsal scales on 1st toe (1) or not (0)	0	0
No. of 4th toe lamellae	29	30
SVL	42	41
TL	23B	44
TW	3.3	3.2
FL	6.37	6.6
TBL	8.26	8.23
AG	19.28	17.6
HL	11.6	11.1
HW	6.79	6.56
HD	4.1	4.1
ED	2.4	2.4
EE	3.1	3.1
ES	5.17	4.86
EN	3.9	4.2
IO	2.6	2.9
EL	1	0.99
IN	2.85	2.75
Sex	m	f

Table 8. Menusural and meristic character state for the type ~~serious~~ of *Cnemaspis thachanaensis* sp. nov. All measurements are taken in millimeters and the abbreviations are defined in the materials and the methods. m=male; f=female; /=data unavailable or absent; b=broken.

	BYU 62544 holotype	ZMKU R 00731 paratype	BYU 62543 paratype	BYU 62542 paratype	ZMKU R 00729 paratype	ZMKU R 00730 paratype
Supralabials	10	11	10	10	10	10
Infralabials	10	11	10	10	9	9
Ventral scales keeled (1) or smooth (0)	1	1	1	1	1	1
No. of precloacal pores	0	0	0	/	/	/
Precloacal pores continuous (1) or separated (0)	/	/	/	/	/	/
Precloacal pores elongate (1) or round (0)	/	/	/	/	/	/
No. of paravertebral tubercles	15	19	15	17	15	16
Tubercles linearly arranged (1) or more random (0)	1	1	1	1	1	1
Tubercles present (1) or absent (0) on lower flanks	1	1	0	1	1	1
Lateral caudal furrows present (1) or absent (0)	1	1	1	1	1	1
Caudal tubercles in lateral furrow (1) or not (0)	0	0	0	0	0	0
Ventrolateral caudal tubercles anteriorly (1) or not (0)	1	1	1	1	1	1
Lateral caudal tubercle row present (1) or absent (0)	1	1	1	1	1	1
Caudal tubercles restricted to a single paravertebral row on each side (1) or not (0)	1	1	1	1	1	1
Subcaudals keeled (1) or smooth (0)	1	1	1	1	1	1
Single median row of keeled subcaudals (1) or smooth (0)	1	1	1	1	1	1
Caudal tubercles encircle tail (1) or not (0)	0	0	0	0	0	0
Enlarged median subcaudal scale row (1) or not (0)	0	0	0	0	0	0
No. of postcloacal tubercles in males	0	0	0	/	/	/
Enlarged femoral scales present (1) or absent (0)	1	2	1	0	0	0
Shield-like subtibial scales present (1) or absent (0)	0	0	0	0	0	0
Subtibial scales keeled (1) or smooth (0)	1	1	1	1	1	1
Enlarged submetatarsal scales on 1st toe (1) or not (0)	1	1	1	1	1	1
No. of 4th toe lamellae	24	23	24	25	23	23
SVL	33	37	34	39	35	35
TL	41	44R	43	46	6B	16B
TW	3.6	3.91	3.32	4	3.4	3.7
FL	5.97	5.68	5.39	5.83	5	5.9
TBL	6.8	7.3	6.19	7.14	6.9	6.5
AG	14.55	16	13.1	17.72	14.49	15.6
HL	9.79	10.3	9.74	11.49	9.37	9.8
HW	5.55	6.27	5.3	6.6	5.45	5.7
HD	3.64	4.1	3.8	4.32	3.9	3.8
ED	2.21	2.4	2	2.36	2.04	1.9
EE	2.85	2.79	2.6	2.79	2.67	3
ES	4.4	4	3.6	4.29	4.29	4.57
EN	2.5	1.18	2.6	3.1	2.79	3.7
IO	2.58	2.97	2.3	3.29	3.1	2.8
EL	0.76	0.82	0.67	1	0.71	0.75
IN	2.1	2.8	2.4	2.2	2.29	2.2
Sex	m	m	m	f	f	f

Table 9. Diagnostic morphological characters (in bold font) separating species of *Cnemaspis* from one another in the *siamensis* group. w =weak; ant = anterior; post = posterior; * = species that are not included in the molecular analyses; / = data unavailable or absent. Character abbreviations follow that of (Grismer et al., 2014d).

	phangngaensis sp. nov.	*thachanaensis* sp. nov.	*siamensis*	*huaseesom*	*chanardi*	*omari*	*roticanai*	*punctatonuchalis*	*vandeventeri*	*kamolnorranathi**
Maximum SVL	42	39	39.7	43.5	40.1	41.3	47.0	49.6	44.7	37.8
Supralabials	10	10,11	8,9	7–10	7–10	8,9	8,9	8	8,9	8,9
Infralabials	10	9–11	6–8	6–9	6–8	7,8	7,8	7,8	7–9	7,8
Ventral scales keeled (1) or smooth (0)	1	1	1	0	1	1	1	0	1	0,w
No. of precloacal pores	4	0	0	5–8	6–8	4	3–6	0	4	7
Precloacal pores continuous (1) or separated (0)	1	/	/	1	0	0	0	/	0	1
Precloacal pores elongate (1) or round (0)	0	/	/	0	0	0	0	/	0	1
No. of paravertebral tubercles	22	15–19	19–25	18–24	20–30	22–29	25–27	24–27	25–29	19–24
Tubercles linearly arranged (1) or more random (0)	1	1	0	w,0	0	w,0	0	w	0	w
Tubercles present (1) or absent (0) on lower flanks	0	1	1	1	1	w,1	1	1	0	1
Lateral caudal furrows present (1) or absent (0)	1	1	1	1	1	1	1	1	1	1
Caudal tubercles in lateral furrow (1) or not (0)	0	0	0	1	0	0	1	0	0	1
Ventrolateral caudal tubercles anteriorly (1) or not (0)	1	1	0	0	0	0	0	1	0	0
Lateral caudal tubercle row present (1) or absent (0)	1	1	1	0	1	1	0	ant	1	1
Caudal tubercles restricted to a single paravertebral row on each side (1) or not (0)	1	1	0	0	0	0	0	0	0	0
Subcaudals keeled (1) or smooth (0)	1	1	1	0	1	1	1	0	1	1
Single median row of keeled subcaudals (1) or smooth (0)	1	1	0	0	0	0	0	0	w	w
Caudal tubercles encircle tail (1) or not (0)	0	0	0	0	0	1	0	0	0	0
Enlarged median subcaudal scale row (1) or not (0)	0	0	1	0	1	0	w	1	1	w
No. of postcloacal tubercles in males	2	0	1,2	1,2	1	1	1,2	1–3	1–3	1,2
Enlarged femoral scales present (1) or absent (0)	0	0	0	0	0	0	0	0	0	0
Shield–like subtibial scales present (1) or absent (0)	0	0	0	0	0	0	0	0	0	0
Subtibial scales keeled (1) or smooth (0)	1	1	1	0	1	1	1	0	1	0,1
Enlarged submetatarsal scales on 1st toe (1) or not (0)	0	1	0	0	0	0	0	0	0	0
No. of 4th toe lamellae	29	24	24–26	21–31	25–30	25–28	26–29	29–31	24–28	24–28
Sample size	2	6	12	5	25	4	8	5	3	3

Table S1. Specimens used for the molecular phylogenetic analyses. Voucher number abbreviations are as follows: ABTC, Australian Biological Tissue Collection; AMS, Australian Museum, Sydney; ANWC, Australian National Wildlife Collection; BYU, Monte L. Bean Life Science Museum at Brigham Young University; CAS, California Academy of Sciences; FMNH, Field Museum of Natural History; HC, Herpetological Collection of the Universiti Kebangsaan Malaysia, Bangi, Selangor; ID, Indraneil Das field series; JB, Jon Boone captive collection; MVZ, Museum of Vertebrate Zoology (Berkeley); LSUHC, La Sierra University Herpetological Collection; LSUMZ, Louisiana State University Museum of Zoology; MZB, Museum Zoologicum Bogoriense, Cibinung, Java, Indonesia; RAH, Rod A. Hitchmough field series; TG, Tony Gamble; USMHC, Universiti Sains Malaysia Herpetological Collection at the Universiti Sains Malaysia, Penang, Malaysia; USNM, United States National Museum (Smithsonian); YPM, Yale Peabody Museum; ZMKU, Zoological Museum Kasetsart University, Thailand; ZRC, Zoological Reference Collection, Raffles Museum.

Voucher	Species	Locality	GenBank number
FMNH 274474	*Agamura persica*	Pakistan: Balochistan, Makran district, Gwadar division	JX440515
n/a	*Anolis carolinensis*	n/a	EU747728
ID 7618	*Crossobamon orientalis*	Rajasthan, India, Krom River	JX041338
LSUHC 8638	*Cyrtodactylus grismeri*	Vietnam: An Giang Province, Tuc Dup Hill	JX440538
JB 127	*Cyrtopodion elongatum*	captive	JX440516
n/a	*Dixonius melanostictus*	Thailand	HM997153
LSUHC 7328	*Dixonius siamensis*	Cambodia: Pursat Provinve, Keo Seima District	EU054299
TG 00723	*Gehyra fehlmanni*	Imported from Malaysia	JN393948
ABTC 13940	*Gehyra insulensis*	Indonesia: Krakatau	GQ257784
LSUHC 7379	*Gehyra mutilata*	Cambodia: Pursat Province, Phnom Aural	JN393914
n/a	*Gekko gecko*	unknown	EU054288
MVZ 245438	*Hemidactylus angulatus*	Ghana: Volta region, Togo Hills	EU268367
CAS 229633	*Hemidactylus frenatus*	Myanmar: Tanintharyi Division, Kaw Thaung District	HM559629
CAS 223286	*Hemidactylus garnotii*	Myanmar: Rakhine State, Taung Gok Township	EU268363
YPM 14798	*Hemidactylus mabouia*	USA: Florida	HM559639
LSUMZ H-1981	*Hemidactylus turcicus*	USA: Louisiana	EU268360
ANWC R6147	*Heteronotia binoei*	Australia: Northern Territory	AY369027
ZRC 24847	*Lepidodactylus lugubris*	Singapore	JN393944
n/a	*Lialis jicari*	Australia	AY369025
n/a	*Mediodactylus russowii*	captive	JX440517
USNM 322160	*Nactus pelagicus*	Tonga: Eua Island	HM997161
AMS 143861	*Oedura marmorata*	Australia, Queensland	GU459951
n/a	*Perochirus ateles*	Federated States of Micronesia	JN393938
MVZ 197233	*Pygopus nigriceps*	Australia: Northern Territory	JX440518
CAS 198428	*Sphaerodactylus roosevelti*	USA: Puerto Rico	JN393943

Table S1 continued…			
JB 34	*Sphaerodactylus torrei*	Cuba	JX440519
CAS 228602	*Tenuidactylus caspius*	Iran: Protected Area, Semnan Province	JX041448
JB 28	*Tropicolotes steudneri*	captive	JX440520
RAH292	*Woodworthia maculata*	New Zealand: Titahi Bay	GU459852
LSUHC 6757	*Cnemaspis affinis*	Malaysia: Penang, Pulau Pinang	KM024684
LSUHC 6774	*Cnemaspis affinis*	Malaysia: Penang, Pulau Pinang	KM024681
LSUHC 6787	*Cnemaspis affinis*	Malaysia: Penang, Pulau Pinang	KM024682
LSUHC 6788	*Cnemaspis affinis*	Malaysia: Penang, Pulau Pinang	KM024683
LSUHC 6758	*Cnemaspis affinis*	Malaysia: Penang, Pulau Pinang	KM024685
LSUHC 6759	*Cnemaspis affinis*	Malaysia: Penang, Pulau Pinang	KM024686
LSUHC 8304	*Cnemaspis argus*	Malaysia: Terengganu, Gunung Lawit	KM024687
LSUHC 10834	*Cnemaspis argus*	Malaysia: Terengganu, Gunung Tebu	KM024688
LSUHC 10835	*Cnemaspis argus*	Malaysia: Terengganu, Gunung Tebu	KM024689
LSUHC 10858	*Cnemaspis argus*	Malaysia: Terengganu, Gunung Tebu	KM024690
LSUHC 10859	*Cnemaspis argus*	Malaysia: Terengganu, Gunung Tebu	KM024691
LSUHC 8610	*Cnemaspis aurantiacopes*	Vietnam: Kien Giang Province, Hon Dat Hill	KM024692
LSUHC 8611	*Cnemaspis aurantiacopes*	Vietnam: Kien Giang Province, Hon Dat Hill	KM024693
LSUHC 8612	*Cnemaspis aurantiacopes*	Vietnam: Kien Giang Province, Hon Dat Hill	KM024694
LSUHC 7301	*Cnemaspis baueri*	Malaysia: Johor, Pulau Aur	KM024695
LSUHC 7302	*Cnemaspis baueri*	Malaysia: Johor, Pulau Aur	KM024696
LSUHC 7303	*Cnemaspis baueri*	Malaysia: Johor, Pulau Aur	KM024697
LSUHC 7273	*Cnemaspis baueri*	Malaysia: Johor, Pulau Aur	KM024698
LSUHC 7274	*Cnemaspis baueri*	Malaysia: Johor, Pulau Aur	KM024699
LSUHC 9070	*Cnemaspis bayuensis*	Malaysia: Kelantan, Kampung Bayu	KM024700
LSUHC 9071	*Cnemaspis bayuensis*	Malaysia: Kelantan, Kampung Bayu	KM024701
LSUHC 9072	*Cnemaspis bayuensis*	Malaysia: Kelantan, Kampung Bayu	KM024702
LSUHC 11444	*Cnemaspis bidongensis*	Malaysia: Terengganu, Pulau Bidong	KM024703
LSUHC 11445	*Cnemaspis bidongensis*	Malaysia: Terengganu, Pulau Bidong	KM024704
LSUHC 11446	*Cnemaspis bidongensis*	Malaysia: Terengganu, Pulau Bidong	KM024705
LSUHC 11447	*Cnemaspis bidongensis*	Malaysia: Terengganu, Pulau Bidong	KM024706
LSUHC 8789	*Cnemaspis biocellata*	Malaysia: Perlis, Gua Kelam	KM024707
LSUHC 8817	*Cnemaspis biocellata*	Malaysia: Perlis, Kuala Perlis	KM024708
LSUHC 8818	*Cnemaspis biocellata*	Malaysia: Perlis, Kuala Perlis	KM024709

Table S1 continued…			
LSUHC 9278	*Cnemaspis boulengerii*	Vietnam: Ca Mau Province, Con Dao Archipelago	KM024710
LSUHC 9279	*Cnemaspis boulengerii*	Vietnam: Ca Mau Province, Con Dao Archipelago	KM024711
LSUHC 8577	*Cnemaspis caudanivea*	Vietnam: Kien Giang Province, Hon Tre Island	KM024712
LSUHC 8578	*Cnemaspis caudanivea*	Vietnam: Kien Giang Province, Hon Tre Island	KM024713
LSUHC 8582	*Cnemaspis caudanivea*	Vietnam: Kien Giang Province, Hon Tre Island	KM024714
LSUHC 9567	*Cnemaspis chanardi*	Thailand: Nakhon Si Thammarat Prov., Thum Thong Panra	KM024715
LSUHC 9338	*Cnemaspis chanthaburiensis*	Cambodia: Pursat Prov., Phnom Dalai	KM024716
LSUHC 6562	*Cnemaspis flavigaster*	Malaysia: Selangor, Kepong	KM024717
LSUHC 8835	*Cnemaspis flavigaster*	Malaysia: Selangor, Kepong	KM024718
LSUHC 8836	*Cnemaspis flavigaster*	Malaysia: Selangor, Kepong	KM024719
LSUHC 10380	*Cnemaspis flavigaster*	Malaysia: Selangor, Ulu Gombak	KM024720
LSUHC 8079	*Cnemaspis flavolineata*	Malaysia: Pahang, Fraser's Hill, The Gap	KM024721
LSUHC 9969	*Cnemaspis grismeri*	Malaysia: Perak, Lenggong	KM024722
LSUHC 9970	*Cnemaspis grismeri*	Malaysia: Perak, Lenggong	KM024723
LSUHC 9730	*Cnemaspis grismeri*	Malaysia: Perak, Lenggong	KM024724
LSUHC 9732	*Cnemaspis grismeri*	Malaysia: Perak, Lenggong	KM024725
LSUHC 9733	*Cnemaspis grismeri*	Malaysia: Perak, Lenggong	KM024726
LSUHC 9358a	*Cnemaspis hangus*	Malaysia: Pahang, Bukit Hangus	KM024727
LSUHC 9358b	*Cnemaspis hangus*	Malaysia: Pahang, Bukit Hangus	KM024728
HC 0225	*Cnemaspis hangus*	Malaysia: Pahang, Bukit Hangus	KM024729
LSUHC 9665	*Cnemaspis harimau*	Malaysia: Kedah, Gunung Jerai	KM024730
LSUHC 9667	*Cnemaspis harimau*	Malaysia: Kedah, Gunung Jerai	KM024731
LSUHC 9668	*Cnemaspis harimau*	Malaysia: Kedah, Gunung Jerai	KM024732
LSUHC 9455	*Cnemaspis huaseesom*	Thailand: Kanchanaburi Province, Sai Yok National Park	KM024733
LSUHC 9457	*Cnemaspis huaseesom*	Thailand: Kanchanaburi Province, Sai Yok National Park	KM024734
LSUHC 9458	*Cnemaspis huaseesom*	Thailand: Kanchanaburi Province, Sai Yok National Park	KM024735
LSUHC 9054	*Cnemaspis karsticola*	Malaysia: Kelantan, Gunung Reng	KM024736
LSUHC 9055	*Cnemaspis karsticola*	Malaysia: Kelantan, Gunung Reng	KM024737
LSUHC 5317	*Cnemaspis kendallii*	Indonesia: Riau Prov., Pulau Serasan	KM024738
LSUHC 9171	*Cnemaspis kendallii*	Malaysia: Sarawak, Gunung Gading	KM024739
LSUHC 9172	*Cnemaspis kendallii*	Malaysia: Sarawak, Gunung Gading	KM024740
LSUHC 9173	*Cnemaspis kendallii*	Malaysia: Sarawak, Gunung Gading	KM024741
LSUHC 9174	*Cnemaspis kendallii*	Malaysia: Sarawak, Gunung Gading	KM024742

Table S1 continued…			
LSUHC 9178	*Cnemaspis kendallii*	Malaysia: Sarawak, Santubong	KM024743
LSUHC 9179	*Cnemaspis kendallii*	Malaysia: Sarawak, Santubong	KM024744
LSUHC 8847	*Cnemaspis kumpoli*	Malaysia: Perlis, Perlis State Park	KM024745
LSUHC 8848	*Cnemaspis kumpoli*	Malaysia: Perlis, Perlis State Park	KM024746
LSUHC 3902	*Cnemaspis limi*	Malaysia: Pahang, Pulau Tioman	KM024747
LSUHC 3904	*Cnemaspis limi*	Malaysia: Pahang, Pulau Tioman	KM024748
LSUHC 3774	*Cnemaspis limi*	Malaysia: Pahang, Pulau Tioman	KM024749
LSUHC 3888	*Cnemaspis limi*	Malaysia: Pahang, Pulau Tioman	KM024750
LSUHC 8853	*Cnemaspis mcguirei*	Malaysia: Perak, Bukit Larut	KM024751
LSUHC 8854	*Cnemaspis mcguirei*	Malaysia: Perak, Bukit Larut	KM024752
LSUHC 8855	*Cnemaspis mcguirei*	Malaysia: Perak, Bukit Larut	KM024753
LSUHC 9114	*Cnemaspis monachorum*	Malaysia: Kedah, Langkawi Archipelago, Pulau Langkawi	KM024754
LSUHC 10807	*Cnemaspis monachorum*	Malaysia: Kedah, Langkawi Archipelago, Pulau Langgun	KM024755
LSUHC 10808	*Cnemaspis monachorum*	Malaysia: Kedah, Langkawi Archipelago, Pulau Langgun	KM024756
LSUHC 10809	*Cnemaspis monachorum*	Malaysia: Kedah, Langkawi Archipelago, Pulau Langgun	KM024757
LSUHC 10810	*Cnemaspis monachorum*	Malaysia: Kedah, Langkawi Archipelago, Pulau Langgun	KM024758
MZB.Lace 10155	*Cnemaspis mumpuniae*	Indonesia: Riau Province, Bedung fragmented forest area	KM024759
MZB.Lace 10166	*Cnemaspis mumpuniae*	Indonesia: Riau Province, Sekunyam Forest Reserve	KM024760
MZB.Lace 10167	*Cnemaspis mumpuniae*	Indonesia: Riau Province, Sekunyam Forest Reserve	KM024761
USMHC 1347	*Cnemaspis narathiwatensis*	Malaysia: Perak, Belum-Temengor, Sungai Enam	KM024762
USMHC 1348	*Cnemaspis narathiwatensis*	Malaysia: Perak, Belum-Temengor, Sungai Enam	KM024763
USMHC 1349	*Cnemaspis narathiwatensis*	Malaysia: Perak, Belum-Temengor, Sungai Enam	KM024764
USMHC 1350	*Cnemaspis narathiwatensis*	Malaysia: Perak, Belum-Temengor, Sungai Enam	KM024765
LSUHC 8478	*Cnemaspis neangthyi*	Cambodia: Pursat Prov., O'Lakmeas	KM024766
LSUHC 8515	*Cnemaspis neangthyi*	Cambodia: Pursat Prov., O'Lakmeas	KM024767
LSUHC 8516	*Cnemaspis neangthyi*	Cambodia: Pursat Prov., O'Lakmeas	KM024768
LSUHC 8517	*Cnemaspis neangthyi*	Cambodia: Pursat Prov., O'Lakmeas	KM024769
LSUHC 9168	*Cnemaspis nigridia*	Malaysia: Sarawak, Gunung Gading	KM024770
LSUHC 9169	*Cnemaspis nigridia*	Malaysia: Sarawak, Gunung Gading	KM024771
LSUHC 9170	*Cnemaspis nigridia*	Malaysia: Sarawak, Gunung Gading	KM024772
LSUHC 9568	*Cnemaspis niyomwanae*	Thailand: Trang Prov., Thum Khao Ting	KM024773
LSUHC 9571	*Cnemaspis niyomwanae*	Thailand: Trang Prov., Thum Khao Ting	KM024774
LSUHC 8646	*Cnemaspis nuicamensis*	Vietnam: An Giang Province, Nui Cam Hill	KM024775

Table S1 continued…			
LSUHC 8647	*Cnemaspis nuicamensis*	Vietnam: An Giang Province, Nui Cam Hill	KM024776
LSUHC 8648	*Cnemaspis nuicamensis*	Vietnam: An Giang Province, Nui Cam Hill	KM024777
LSUHC 8649	*Cnemaspis nuicamensis*	Vietnam: An Giang Province, Nui Cam Hill	KM024778
LSUHC 9978	*Cnemaspis omari*	Malaysia: Perlis, Perlis State Park	KM024779
LSUHC 9565	*Cnemaspis omari*	Thailand: Satun Prov., Phuphaphet Cave	KM024780
LSUHC 9184	*Cnemaspis paripari*	Malaysia: Sarawak, Gua Pari-pari	KM024781
LSUHC 9185	*Cnemaspis paripari*	Malaysia: Sarawak, Gua Angin	KM024782
LSUHC 9186	*Cnemaspis paripari*	Malaysia: Sarawak, Gua Angin	KM024783
LSUHC 9192	*Cnemaspis paripari*	Malaysia: Sarawak, Gua Angin	KM024784
LSUHC 8011	*Cnemaspis pemanggilensis*	Malaysia: Johor, Pulau Pemanggil	KM024785
LSUHC 8012	*Cnemaspis pemanggilensis*	Malaysia: Johor, Pulau Pemanggil	KM024786
LSUHC 8013	*Cnemaspis pemanggilensis*	Malaysia: Johor, Pulau Pemanggil	KM024787
LSUHC 8014	*Cnemaspis pemanggilensis*	Malaysia: Johor, Pulau Pemanggil	KM024788
LSUHC 3773	*Cnemaspis peninsularis*	Malaysia: Pahang, Pulau Tioman	KM024789
LSUHC 3797	*Cnemaspis peninsularis*	Malaysia: Pahang, Pulau Tioman	KM024790
LSUHC 3820	*Cnemaspis peninsularis*	Malaysia: Pahang, Pulau Tioman	KM024791
LSUHC 4707	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Tinggi	KM024792
LSUHC 4756	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Tinggi	KM024793
LSUHC 4958	*Cnemaspis peninsularis*	Malaysia: Pahang, Sungai Lembing	KM024794
LSUHC 5056	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Tulai	KM024795
LSUHC 5184	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Seribuat	KM024796
LSUHC 5185	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Seribuat	KM024797
LSUHC 5307	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Aceh	KM024798
LSUHC 5703	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Aceh	KM024799
LSUHC 6380	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Ibol	KM024800
LSUHC 6381	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Ibol	KM024801
LSUHC 5731	*Cnemaspis peninsularis*	Malaysia: Johor, Pulau Babi Besar	KM024802
LSUHC 8122	*Cnemaspis peninsularis*	Malaysia: Johor, Endau-Rompin, Selai	KM024803
LSUHC 8126	*Cnemaspis peninsularis*	Malaysia: Johor, Endau-Rompin, Selai	KM024804
LSUHC 8910	*Cnemaspis peninsularis*	Malaysia: Johor, Gunung Panti Forest Reseve	KM024806
LSUHC 8965	*Cnemaspis peninsularis*	Malaysia: Johor, Gunung Ledang	KM024807
LSUHC 8966	*Cnemaspis peninsularis*	Malaysia: Johor, Gunung Ledang	KM024808
LSUHC 8967	*Cnemaspis peninsularis*	Malaysia: Johor, Gunung Ledang	KM024809

Table S1 continued…			
LSUHC 9376	*Cnemaspis peninsularis*	Malaysia: Terengganu, Pulau Tenggol	KM024810
LSUHC 9377	*Cnemaspis peninsularis*	Malaysia: Terengganu, Pulau Tenggol	KM024811
LSUHC 9380	*Cnemaspis peninsularis*	Malaysia: Terengganu, Pulau Tenggol	KM024812
LSUHC 9382	*Cnemaspis peninsularis*	Malaysia: Terengganu, Pulau Tenggol	KM024813
LSUHC 10238	*Cnemaspis peninsularis*	Malaysia: Johor, Gunung Berlumut	KM024814
LSUHC 10239	*Cnemaspis peninsularis*	Malaysia: Johor, Gunung Berlumut	KM024815
LSUHC 10454	*Cnemaspis peninsularis*	Singapore, Nee Soon Swamp	KM024816
HC 0226	*Cnemaspis peninsularis*	Malaysia: Pahang, Bukit Hangus	KM024817
HC 0228A	*Cnemaspis peninsularis*	Malaysia: Pahang, Bukit Hangus	KM024818
HC 0228B	*Cnemaspis peninsularis*	Malaysia: Pahang, Bukit Hangus	KM024819
LSUHC 8699	*Cnemaspis perhentianensis*	Malaysia: Terengganu, Pulau Perhentian Besar	KM024820
LSUHC 8700	*Cnemaspis perhentianensis*	Malaysia: Terengganu, Pulau Perhentian Besar	KM024821
LSUHC 9060	*Cnemaspis perhentianensis*	Malaysia: Terengganu, Pulau Perhentian Besar	KM024822
LSUHC 9412	*Cnemaspis perhentianensis*	Malaysia: Terengganu, Pulau Perhentian Besar	KM024823
LSUHC 9145	*Cnemaspis pseudomcguirei*	Malaysia: Perak, Bukit Larut	KM024824
LSUHC 9146	*Cnemaspis pseudomcguirei*	Malaysia: Perak, Bukit Larut	KM024825
LSUHC 9147	*Cnemaspis pseudomcguirei*	Malaysia: Perak, Bukit Larut	KM024826
LSUHC 9243	*Cnemaspis psychedelica*	Vietnam: Can Mau Province, Hon Khoai Island	KM024827
LSUHC 9244	*Cnemaspis psychedelica*	Vietnam: Can Mau Province, Hon Khoai Island	KM024828
LSUHC 9430	*Cnemaspis roticanai*	Malaysia: Kedah, Pulau Langkawi, Gunung Raya	KM024829
LSUHC 9431	*Cnemaspis roticanai*	Malaysia: Kedah, Pulau Langkawi, Gunung Raya	KM024830
LSUHC 9439	*Cnemaspis roticanai*	Malaysia: Kedah, Pulau Langkawi, Gunung Raya	KM024831
LSUHC 11015	*Cnemaspis selamatkanmerapoh*	Malaysia: Pahang, Merapoh, Gua Gunting	KM024832
LSUHC 11016	*Cnemaspis selamatkanmerapoh*	Malaysia: Pahang, Merapoh, Gua Gunting	KM024833
LSUHC 6773	*Cnemaspis shahruli*	Malaysia: Kedah, Pulau Pinang	KM024834
LSUHC 9163	*Cnemaspis shahruli*	Malaysia: Penang, Pulau Jerejak	KM024835
LSUHC 9586	*Cnemaspis shahruli*	Malaysia: Kedah, Sungai Sedim	KM024836
LSUHC 9613	*Cnemaspis shahruli*	Malaysia: Penang, Pulau Jerejak	KM024837
LSUHC 9474	*Cnemaspis siamensis*	Thailand, Chumpon Province, Pathio	KM024838
LSUHC 9485	*Cnemaspis siamensis*	Thailand, Chumpon Province, Pathio	KM024839
LSUHC 11089	*Cnemaspis stongensis*	Malaysia: Kelantan, Gunung Stong, Kem Baha	KM024840
LSUHC 11090	*Cnemaspis stongensis*	Malaysia: Kelantan, Gunung Stong, Kem Baha	KM024841
LSUHC 11091	*Cnemaspis stongensis*	Malaysia: Kelantan, Gunung Stong, Kem Baha	KM024842

Table S1 continued…			
LSUHC 5314	*Cnemaspis sundainsula*	Indonesia: Riau Province, Pulau Natuna Besar	KM024843
MZB.Lace 9436	*Cnemaspis sundainsula*	Indonesia: Riau Province, Pulau Natuna Besar, Gunung Ranai	KM024844
MZB.Lace 10156	*Cnemaspis sundainsula*	Indonesia: Riau Province, Pulau Natuna Besar, Ceruk Forest Conserve	KM024845
MZB.Lace 10157	*Cnemaspis sundainsula*	Indonesia: Riau Province, Pulau Natuna Besar, Ceruk Forest Conserve	KM024846
MZB.Lace 10158	*Cnemaspis sundainsula*	Indonesia: Riau Province, Pulau Natuna Besar, Ceruk Forest Conserve	KM024847
MZB.Lace 10160	*Cnemaspis sundainsula*	Indonesia: Riau Province, Pulau Natuna Besar, Gunung Air Hiu	KM024848
LSUHC 9160	*Cnemaspis temiah*	Malaysia: Pahang, Cameron Highlands, Tanah Rata	KM024849
LSUHC 9739	*Cnemaspis temiah*	Malaysia: Pahang, Cameron Highlands, Tanah Rata	KM024850
LSUHC 9816	*Cnemaspis temiah*	Malaysia: Pahang, Cameron Highlands, Tanah Rata	KM024851
LSUHC 8631	*Cnemaspis tucdupensis*	Vietnam: An Giang Province, Tuc Dup Hill	KM024852
LSUHC 8632	*Cnemaspis tucdupensis*	Vietnam: An Giang Province, Tuc Dup Hill	KM024853
LSUHC 8633	*Cnemaspis tucdupensis*	Vietnam: An Giang Province, Tuc Dup Hill	KM024854
LSUHC 8634	*Cnemaspis tucdupensis*	Vietnam: An Giang Province, Tuc Dup Hill	KM024855
BYU 62535	*Cnemaspis lineogularis* sp. nov.	Thailand, Prachuap Khiri Khan, Kui Buri District, Wat Khao Daeng	XX000000
BYU 62536	*Cnemaspis lineogularis* sp. nov.	Thailand, Prachuap Khiri Khan, Kui Buri District, Wat Khao Daeng	XX000000
ZMKU R 00728	*Cnemaspis lineogularis* sp. nov.	Thailand, Prachuap Khiri Khan, Kui Buri District, Wat Khao Daeng	XX000000
BYU 62537	*Cnemaspis phangngaensis* sp. nov.	Thailand, Phangnga, Mueang Phangnga, Khao Chang, Phung Chang Cave	XX000000
BYU 62538	*Cnemaspis phangngaensis* sp. nov.	Thailand, Phangnga, Mueang Phangnga, Khao Chang, Phung Chang Cave	XX000000
BYU 62539	*Cnemaspis punctatonuchalis*	Thailand, Prachaup Khiri Khan, Thap Sakae	XX000000
BYU 62540	*Cnemaspis punctatonuchalis*	Thailand, Prachaup Khiri Khan, Thap Sakae	XX000000
BYU 62541	*Cnemaspis vandeventeri*	Thailand, Ranong, Suk Samran, Naka	XX000000
BYU 62542	*Cnemaspis thachanaensis* sp. nov.	Thailand, Surat Thani, Thachana, Tham Khao Sonk Hill	XX000000
ZMKU R 00729	*Cnemaspis thachanaensis* sp. nov.	Thailand, Surat Thani, Thachana, Tham Khao Sonk Hill	XX000000
ZMKU R 00730	*Cnemaspis thachanaensis* sp. nov.	Thailand, Surat Thani, Thachana, Tham Khao Sonk Hill	XX000000
ZMKU R 00731	*Cnemaspis thachanaensis* sp. nov.	Thailand, Surat Thani, Thachana, Tham Khao Sonk Hill	XX000000
BYU 62543	*Cnemaspis thachanaensis* sp. nov.	Thailand, Surat Thani, Thachana, Tham Khao Sonk Hill	XX000000
BYU 62544	*Cnemaspis thachanaensis* sp. nov.	Thailand, Surat Thani, Thachana, Tham Khao Sonk Hill	XX000000