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Acanthosaura meridiona sp. nov. (Squamata: Agamidae), a new short-horned lizard from southern Thailand

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A new short – horned lizard species of the genus *Acanthosaura* from southern Thailand, is described herein. The species was previously recognised as *Acanthosaura crucigera* and has been reported to present a wide distribution across mainland south-east Asia. The combination of modern morphological studies of *Acanthosaura meridiona* **sp. nov.** allows its separation from closely related species *A. crucigera*, on the basis of presenting more nuchal scales, more scales between diastema, more scales bordering rostral scales and more midline ventral scales. Mitochondrial DNA analysis also indicated a sister relationship between *A. meridiona* **sp. nov.** and *A. crucigera* with a 100 % probability according to Bayesian and maximum – likelihood analyses. The pairwise distance between *A. meridiona* **sp. nov.** and *A. crucigera* ranges from 9.9 – 11.1 %, while the distance between *A. meridiona* populations ranges from 0 – 0.9 %. This new discovery contributes to the redescription of the distribution of *A. crucigera* under Kra Isthmus and its replacement by *A. meridiona* **sp. nov.**

Keywords: crucigera complex, tropical rainforest, Thai – Malay Peninsula, ND2, taxonomy

INTRODUCTION

Agamid lizards of the genus *Acanthosaura* Gray, 1831 are distributed in south-east Asia with a range extending from Myanmar, eastward through Thailand, Cambodia, Laos, Vietnam, and Yunnan and southward through the Indochinese and Thai – Malay Peninsula, Sumatra, and Anambas and Natunus Archipelagos (Taylor, 1963; Grismer et al., 2008; Manthey, 2008; Das, 2010; Wood et al., 2010; Ananjeva et al., 2011, 2020; Pauwels et al., 2015; Trivalairat et al., 2020; Liu et al., 2020). Previously, *Acanthosaura crucigera* (Boulenger, 1885) was described from the type locality in Tavoy with a distribution, covering the distribution of the entire genus (Boulenger, 1912; Taylor, 1963; Pauwels et al., 2003; Grismer et al., 2006; Manthey, 2008). However, recent morphological and molecular studies of the *A. crucigera* complex have revised the complex identifying several undescribed and cryptic species, and its members have also been separated into distinct species with different geographic distributions. For instance, two montane populations from Peninsular Malaysia are likely *A. bintangensis* (Wood et al., 2009) and *A. titiwangsaensis* (Wood et al., 2009); one population from the eastern Thailand and Cambodia populations consists of *A. cardamomensis* (Wood et al., 2010); and the species from Phuket Island and south – western Thailand are *A. phuketensis* (Pauwels et al., 2015) (Chan – ard et al., 1999; Pauwels et al., 2002; Pauwels & Iskandar 2010; Wood et al., 2009, 2010; Grismer, 2011; Pauwels et al., 2015).

In the 19th century, within the geographic distribution on the Thai – Malay Peninsula, only two species of *Acanthosaura* were considered to be present (*A. crucigera* and *A. armata* (Hardwick & Gray, 1827)) before being separated into five species recently, as mentioned above (Wood et al., 2009; Pauwels et al., 2015). In addition, Boulenger (1885) and Taylor (1963) had described specimens No. 3885 (female) and No. 3887 (male) from Na Pradoo Sub – district, Khok Pho District, Pattani Province and No. 192 (female) from Nabon District, Nakhon Si Thammarat Province from southern Thailand and designated these specimens as *A. crucigera*. However, some of the described characteristics of these specimens and the *A.* cf. *crucigera* population from southern Thailand and Malaysia of Wood et al. (2010) were confused with the true *A. crucigera* population from western Thailand and southern Myanmar. To clarify the taxonomic confusion of these *A.* cf. *crucigera* populations, *Acanthosaura* lizards in these southern regions were collected and compared with other *Acanthosaura* lizards through genetic and morphological analysis. The results showed that this population represents an undescribed species.

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MATERIALS & METHODS

Sampling and specimen preparation

Fieldwork for *A. crucigera* was conducted in four localities of Thailand: seven specimens from the western region of Taksin Maharat National Park, Mueang, Tak Province on 26 April 2016; eight specimens from the southern region of Na Yong District, Trang Province on 27 April 2017; one specimen from the southern region of Ton Lat Waterfall, Nathavee District, Songkhla Province on 15 May 2017; and four specimens from southern region, Wang Hip River, Thung Song District, Nakhon Si Thammarat Province on 3 June 2017. Specimens were collected by hand, photographed, euthanised by freezing at – 10 ˚C for a few days, fixed in 10 % formalin, and later transferred to 70 % ethanol. Fresh liver samples were stored in absolute ethanol prior to formalin fixation. Specimens were deposited at the Natural History Museum, National Science Museum, Technopolis, Pathum Thani Province (THNHM) and Queen Saovabha Memorial Institute, Thai Red Cross Society, Bangkok Province, Thailand (QSMI).

Morphological characters

A total of 34 specimens of six *Acanthosaura* species in Thailand, including one from Vietnam, were examined from THNHM and QSMI (Appendix 1). All data of currently recognised *Acanthosaura* species were obtained from Günther (1861), Boulenger (1885), Ananjeva et al. (2008), Wood et al. (2009), Wood et al. (2010), Ananjeva et al. (2011), Nguyen et al. (2018), Pauwels et al. (2015), Nguyen et al. (2019), Trivalairat et al. (2020), Ananjeva et al. (2020), and Liu et al. (2020). Meristic and measured morphological characters were noted for each specimen of the type series on the left side followed Pauwels et al. (2015), Liu et al. (2020), and Ananjeva et al. (2020). Measurements were performed with callipers to the nearest 0.01 mm.

The following morphometric and meristic data were collected: SVL – snout – vent length, measured from the tip of the snout to the tip of the vent; TaL – tail length, measured from the posterior margin of the vent to the tip of the tail; TBW – tail base width, maximum width at tail base; HL – head length, measured from posterior edge of the rectis of the jaw to the tip of the snout; HW – head width, maximum head width, the width at the level of the tympanum; HD – maximum head height, measured across the parietal region; SL – snout length, measured from the anterior edge of the orbit to the tip of the snout; ORBIT – orbit diameter, measured from the posterior to the anterior edge of the orbit; EYE – eye diameter, measured from the posterior to the anterior edge of the eye; TD – tympanum diameter, measured horizontally from the anterior to the posterior border of the tympanum; TN – scales absent on tympanum (0) or present (1); PS – postorbital spine length, measured from the base to the tip of the spine; NS – number of nuchal scales; NSL – maximum length of the largest spine in the nuchal crest measured from the base to the tip; DS – maximum length of the largest spine in the dorsal crest measured from the base to the tip; WNC – maximum width of the spines in the nuchal crest, measured at the base; DIAS – length of the diastema, measured from the posterior end of the nuchal crest to the anterior end of the dorsal crest; DIASN – number of scales in the vertebral crest scale diastema counted from the posterior end of the nuchal crest to the anterior end of the dorsal crest; FOREL – forelimb length, measured from axilla to the proximal edge of the palmar region; HINDL – hindlimb length, measured from groin to the proximal edge of the plantar region; SUPRAL – number of supralabials; INFRAL – number of infralabials; VENT – number of ventral scales counted at the midline from the anterior edge of the shoulders to the edge of the vent; FI – number of subdigital lamellae on the fourth finger; TO – subdigital lamellae on the fourth toe; OS – length of the occipital spine, measured from the base to the tip; NSSOS – number of scales surrounding the occipital spine; CS – number of canthus rostralis – supraciliary scales, counted from the nasal scale to the posterior end of the ridge at the posterior margin of the orbit; RW – rostral width; RH – rostral height; RS – number of scales bordering the rostral scale; NS – number of scales between the nasals; NCS – number of scales between the fifth canthals; NSCSL – number of scales from the fifth canthal to the fifth supralabial; NR – number of scales between the nasal and the rostral scales; NSSLC – number of scales between the seventh supralabial and the sixth canthal; MW – mental width; MH – mental height; PM – number of scales bordering the mental; YAS – presence (1) or absence (0) of a Y – shaped arrangement of enlarged scales on the snout; ND – presence (1) or absence (0) of a black, diamond shaped, nuchal collar; LKP – presence (1) or absence (0) of light knee patch; BEP – presence (1) or absence (0) of a black eye patch; ESBO – presence (1) or absence (0) of elliptical scales below the orbit; GP – size of gular pouch scored as absent, small, medium or large; OF – presence (1) or absence (0) of oblique fold anterior to the fore limb insertions.

Molecular analysis

Three specimens of *A. crucigera* from each region (western and southern regions, total six specimens) were examined for molecular data comparing with other taxa of *Acanthosaura* species from GenBank (Macey et al., 1997, 2000; Zug et al., 2006; Okajima & Kumazawa, 2010; Wood et al., 2010; Yu et al., 2015; Trivalairat et al., 2020) (Table 1). DNA was extracted from liver samples with a TIANamp Genomic DNA Kit (catalog number DP304 – 02; TIANGEN Biotech (Beijing) Co., Ltd., Beijing). The samples were lysed using proteinase K for three hours at 56 ˚C. DNA was eluted from the spin column with 150 µl of buffer.

Polymerase chain reaction (PCR) was performed using EP0402 TAQ DNA POLYMERASE. The samples were amplified using two primers, METF6 (L4437a; 5' – AAG CTT TCG GGC CCA TAC C – 3') and ACANTHND2.833. R1 (5' – AGG GAG GTT ATT GTT GCT AG – 3'), for a 698 bp fragments of the NADH dehydrogenase subunit 2 (ND2) gene (Wood et al., 2010). PCR protocol for the amplification of genomic DNA began with an initial denaturation for 2 min at 95 ˚C, followed by 95 ˚C for 35 s, annealing at 50 ˚C for 35 s, and extension at 72 ˚C

for 154 s per cycle for 32 cycles (Jackman et al., 2008). Successful PCR products were cleaned and sequenced at Macrogen Co., South Korea.

Phylogenetic analysis

DNA sequences were cleaned and aligned using ClustalW v. 1.83 (Thompson et al., 1994) with default parameters using MEGA6 (Tamura et al., 2013). All DNA sequences were translated into amino acids to confirm the absence

Table 1. GenBank accession numbers for agamid sequence used in phylogenetic analyses of *Acanthosaura*.

Taxon	Voucher	Locality	Coordination	GenBank	References
				ND2	
Ingroup					
Acanthosaura meridiona **sp. nov**	QSMI1594	Na Yong, Trang, Thaiand	7°34'12.0"N, 99°46'48.0"E	MH777404	This study
Acanthosaura meridiona **sp. nov**	THNHM28061	Na Yong, Trang, Thaiand	7°34'12.0"N, 99°46'48.0"E	MH777407	This study
Acanthosaura meridiona **sp. nov**	THNHM28062	Na Yong, Trang, Thaiand	7°34'12.0"N, 99°46'48.0"E	MH777405	This study
Acanthosaura crucigera	QSMI1592	Muang, Tak, Thailand	16°46'48.0"N, 98°55'12.0"E	MH777408	This study
Acanthosaura crucigera	QSMI1593	Muang, Tak, Thailand	16°46'48.0"N, 98°55'12.0"E	MH777403	This study
Acanthosaura crucigera	THNHM28057	Muang, Tak, Thailand	16°46'48.0"N, 98°55'12.0"E	MH777402	This study
Acanthosaura crucigera	CAS229582	Kawthaung, Tanintharyi, Myanmar	-	GU817389	Wood et al. (2010)
Acanthosaura crucigera	CUMZR2008.05.26.1	Petchaburi, Thailand	-	HM143889	Wood et al. (2010)
Acanthosaura armata	NSMT-H4595	Asia	-	AB266452	Okajima and Kumazawa (2010)
Acanthosaura armata	-	Asia	-	NC014175	Okajima and Kumazawa (2010)
Acanthosaura aurantiacrista	THNHM28064	Mae Sariang, Mae Hong Son, Thailand	18°09'02.8"N, 97°58'50.2"E	MH777406	Trivalairat et al. (2020)
Acanthosaura aurantiacrista	QSMI1446	Sop Khong, Omkoi, Chiang Mai, Thailand	17°39'45.4"N, 98°11'53.6"E	MK798128	Trivalairat et al. (2020)
Acanthosaura aurantiacrista	THNHM28521	Sop Khong, Omkoi, Chiang Mai, Thailand	17°39'45.4"N, 98°11'53.6"E	MK798129	Trivalairat et al. (2020)
Acanthosaura aurantiacrista	THNHM28522	Sop Khong, Omkoi, Chiang Mai, Thailand	17°39'45.4"N, 98°11'53.6"E	MK798130	Trivalairat et al. (2020)
Acanthosaura aurantiacrista	QSMI1447	Sop Khong, Omkoi, Chiang Mai, Thailand	17°39'45.4"N, 98°11'53.6"E	MK798131	Trivalairat et al. (2020)
Acanthosaura aurantiacrista	QSMI1448	Sop Khong, Omkoi, Chiang Mai, Thailand	17°39'45.4"N, 98°11'53.6"E	MK798132	Trivalairat et al. (2020)
Acanthosaura aurantiacrista	THNHM28523	Sop Khong, Omkoi, Chiang Mai, Thailand	17°39'45.4"N, 98°11'53.6"E	MK798133	Trivalairat et al. (2020)
Acanthosaura capra	MVZ222130	Vietnam	-	AF128498	Macey et al. (1997)
Acanthosaura cardamomensis	FMNH263225	Kampot, Cambodia	10°37'19"N, 104°02'52"E	GU817397	Wood et al. (2010)
Acanthosaura cardamomensis	FMNH263261	Kampot, Cambodia	10°37'19"N, 104°02'52"E	GU817400	Wood et al. (2010)
Acanthosaura lepidogaster	MVZ224090	Vinh Thu, Vietnam	-	AF128499	Macey et al. (2000)
Acanthosaura lepidogaster	MD001	Hainan, China	-	KR092427	Yu et al. (2015)
Outgroup					
Calotes emma	CAS223062	Rakhine State, Myanmar	-	DQ289460	Zug et al. (2006)

Table 2. Pairwise distances of ND2 within and among six species of *Acanthosaura*, including outgroup *Calotes emma*: *A. meridiona* **sp. nov**- MH777405 (THNHM 28062, Holotype), MH777404 (QSMI 1594, Paratype), MH777407 (THNHM 28061, Paratype); *A. crucigera*- MH777402 (THNHM 28057), MH777403 (QSMI 1593), MH777408 (QSMI 1592).

Taxa	1	2	3	4	5	6
Calotes emma	-	-	-	-	-	-
Acanthosaura armata	0.332	-	-	-	-	-
Acanthosaura cardamomensis	0.344-0.354	0.165-0.172	-	-	-	-
Acanthosaura meridiona **sp. nov.**	0.340-0.346	0.189-0.192	0.147-0.155	0.000-0.009	-	-
Acanthosaura crucigera	0.348-0.367	0.196-0.215	0.140-0.148	0.099-0.111	-	-
Acanthosaura capra	0.344	0.173	0.199-0.210	0.215-0.222	0.224-0.233	-
Acanthosaura lepidogaster	0.363	0.182-0.189	0.182-0.222	0.199-0.231	0.208-0.237	0.163-0.185

of premature stop codons in the sequences. Average pairwise distance between individuals and mitochondrial clades were generated in MEGA6. The Maximum Likelihood analysis (ML) was performed using MEGA6 with 2,000 tree search replicates, 25 initial GAMMA rate categories and final optimisation using four GAMMA shape categories.

Bayesian Inference was performed in MrBayes v.3.1.2 (Ronquist & Huelsenbeck, 2003), based on best – fit models of sequence evolution selected by MrModetest 2.3 (Nylander, 2004) under the Akaike Information Criterion (AIC). To calculate Bayesian posterior probabilities (BPP), 2,000 pseudo – replicates of the rapid bootstrap algorithm were run for 20 million generations with tree sampling every 100 generations implementing a General Time Reversible model (GTR) and GAMMA distribution of nucleotide rates. Bayesian posterior probabilities were then estimated using a Markov Chain Monte Carlo (MCMC) sampling approach after the average standard deviations once reached 0.002. A 50 % majority consensus tree was generated after discarding 20 % of initial samples as burn – in. Bootstrap values 70 % for ML and BPP of ≥ 95% were considered as indicators of strongly – supported nodes (Hillis & Bull, 1993; Felsenstein, 2004).

RESULTS

Molecular analysis

Molecular comparison of 698 nucleotides of ND2 revealed a difference of 0 – 0.9 % among three specimens of *A.* cf. *crucigera* from the southern region (GenBank references MH777404, MH777405 and MH777407) (Table 2). The ND2 analyses among the three specimens of *A.* cf. *crucigera* from revealed differences of 9.9 – 11.1 % compared to five specimens of *A. crucigera* from western region (GenBank GU817389, HM143889, MH777402, MH777403, and MH777408); differences of 14.7 – 15.5 % compared to two specimens of *A. cardamomensis* (GenBank GU817397 and GU817400); differences of 18.9 – 19.2 % compared to two specimens of *A. armata* (GenBank AB266452 and NC014175); differences of 19.9 – 23.1 % compared to two specimens of *A. lepidogaster* (Cuvier, 1829) (GenBank AF128499 and KR092427); and differences of 21.5 – 22.2 % compared to one specimen of *A. capra* Günther, 1861 (GenBank AF128498). The phylogenetic relationships within the genus *Acanthosaura* revealed through Bayesian inference and maximum – likelihood analyses of the ND2 gene showed multiple, strongly supported lineages (Fig. 1). In both analyses *Acanthosaura* cf. *crucigera* from southern Thailand form a clade that is distinct from other populations.

Taxonomy

Acanthosaura meridiona **sp. nov.**

(ZooBank: BAD96710-9B36-4E22-BE76-C126E2D1DF13)

Acanthosaura armata: Blanford 1879: 130. (part)

Acanthosaura crucigera: Taylor 1963: 870–874. (No. 192, 3885, 3887)

Holotype: THNHM28062, ethanol – preserved whole adult male individual, collected by Poramad Trivalairat (formerly TP.RE000013SO) on 28 April 2017 (Fig. 2).

Type locality: Na Yong District, Trang Province, southern Thailand (7°57'57.9"N, 99°78'65.8"E), at 195 m asl.

Paratype: Six ethanol – preserved whole individuals. Two adult males, QSMI1594 and THNHM28059 (formerly TP.RE000004SO and TP.RE000003SO, respectively), with the hemipenis everted and four adult females, QSMI1595, QSMI1596, THNHM28060, and THNHM28061 (formerly TP.RE000005SO, TP.RE000010SO, TP.RE000009SO, and TP.RE000011SO, respectively), from the same location, collection date and collector as the holotype (Fig. 3 – 4).

Diagnosis: A medium – sized species (maximum SVL 115.1 mm for males and 118.1 mm for females) with a single short conical spine above the posterior margin of the eye; small spine on the occiput between the tympanum and the nuchal crest; tympanum scaled, large, roundish; moderately developed gular pouch; small scales intermixed with medium keeled scales on the flanks with a random distribution; nuchal crest with slightly equal rows of 8 – 10 tiny semi – conical spines; large diastema of 10 – 16 scales between the nuchal and vertebral crests; vertebral crest composed of small equally sized saw – like scales beginning in the shoulder region and decreasing in size until the base of the tail; tail 1.07 – 1.61 of SVL; black collar and black eye patch present, extending posteriorly to reach the nuchal crest. Description of the holotype: Adult male. SVL 109 mm; TL 176 mm, tail complete; HL 20.8 mm; head is one – fifth the length of the body (HL/SVL 0.19), narrow (HW/SVL 0.15), moderately tall (HD/HL 0.60), triangular in dorsal and lateral views; snout moderately long (SL/HL 0.45); rostrum moderately wide (RW/RH 2.44), steeply sloping anteriorly; canthus rostralis prominent, forming a large projecting shelf extending above the eye, composed of 14 large scales; shelf terminates with a notch anterior to the postorbital spine; rostrum moderate in size, rectangular, bordered laterally by the first supra labials and posteriorly by six smaller scales; nasal roundish, surrounded by one prenasal anteriorly, three postnasals posteriorly and one subnasal; six scales between the nasal scales; elongate supra nasal scales; moderate scales above the orbit weakly keeled; three rows of slightly keeled scales below the orbit extending from the posterior margin of the nasal to half of the eye; eye very large (EYE/HL 0.30), orbit very large (ORBIT/HL 0.50); prefrontal and frontal slightly keeled and smaller than the scales between the orbit and supralabials occipital scales weakly keeled; large parietal; short conical epidermal spine above the posterior margin of the eye, posteriorly pointed, surround by five small lanceolate scales; suborbital scales small, slightly keeled, extending in a row of five equal large scales from below the posterior margin of the eye to the anterior margin of the tympanum, decreasing in size posteriorly; short conical epidermal spine equal to the postorbital spine, laterally pointing outward, surrounded by a rosette of four small lanceolate scales; tympanum exposed, roundish similar to half of the eye, surrounded by tiny conical scales; 13 rectangular supralabials of similar size; mental pentagonal similar in size to the adjacent infralabials; two postmentals similar in size, four scales contacting the mental; chin shield large, extending

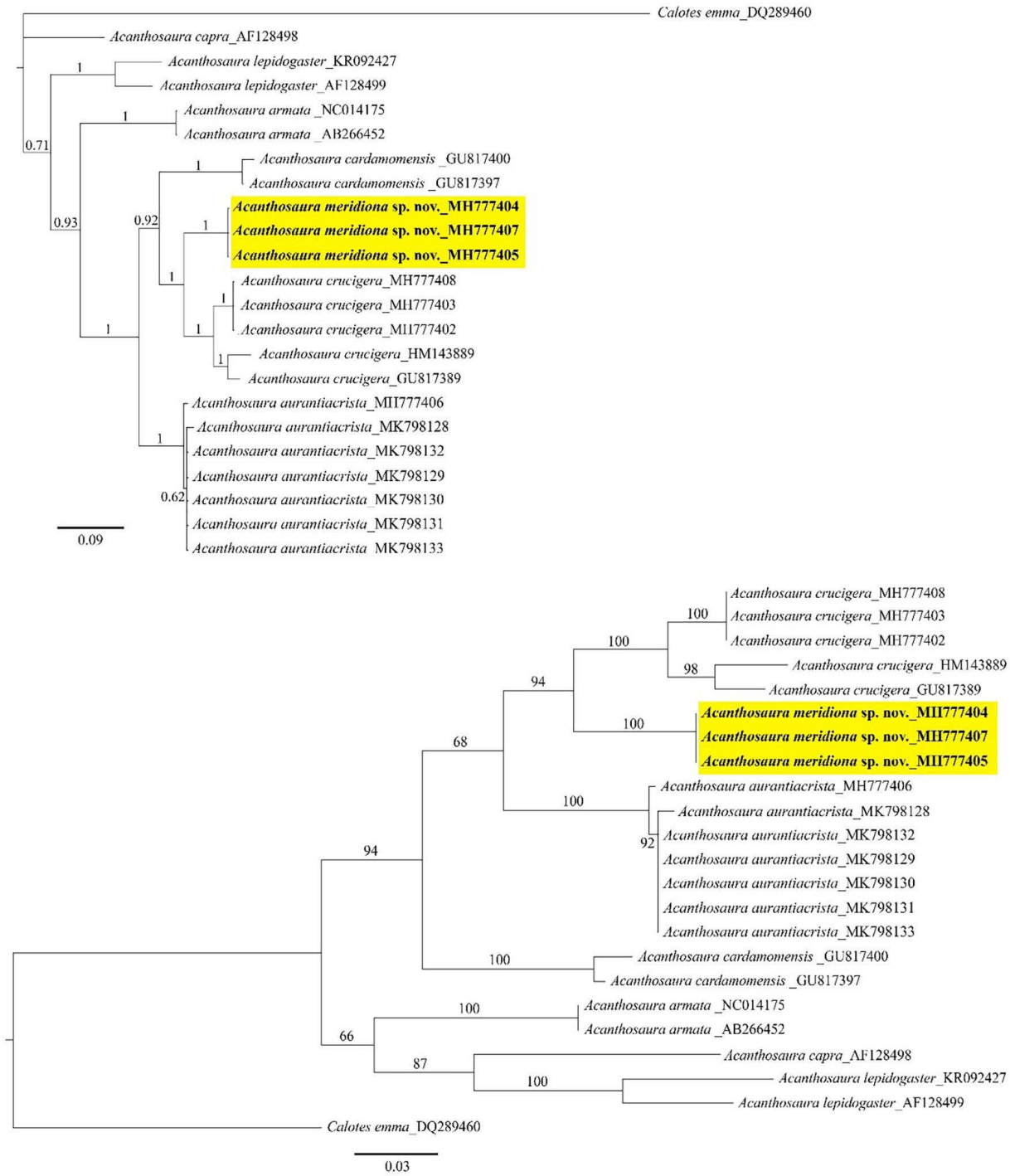

Figure 1. Phylogenetic analyses of mitochondrial NADH dehydrogenase subunit 2 gene (ND2) of *Acanthosaura*. The above phylogeny represents the analysis using Bayesian inference and the lower phylogeny was generated using maximum likelihood. Codes after sequences represent GenBank accession numbers. Highlighted tips represent *Acanthosaura meridiona* **sp. nov.**

posteriorly to the angle of the jaw, separated from the infralabials by one scales row anteriorly and four at the angle of the jaw; 11 rectangular infralabials, scales slightly decreasing in size posteriorly; gular sharply keeled and spinose with a creamy, small midventral row; dewlap and gular pouch very small and melanistic; nuchal crest composed of eight short semi – conical scales similar in size to the postorbital and occipital spine, bordered on each side by two rows of keeled, triangular scales; nuchal crest followed by a diastema of 13 scales at the base of the nape; dorsal body crest is half of the nuchal crest, extending from the posterior margin of the diastema onto the sacrum; vertebral crest composed of small, epidermal, flat, triangular scales, bordered by three rows of smaller paravertebral triangular scales; vertebral crest slightly decreasing to the sacrum, then fading progressively.

Moderate sized body, laterally compressed triangular in cross – section; dorsal body scales small and moderate keeled, randomly arranged, keels projecting posteriorly; scales of the pectoral region and abdomen larger than the dorsal scales, keeled, semi – transverse rows arranged; keeled scales anterior to the vent large; limbs relatively long, dorsal and ventral scales of forelimbs

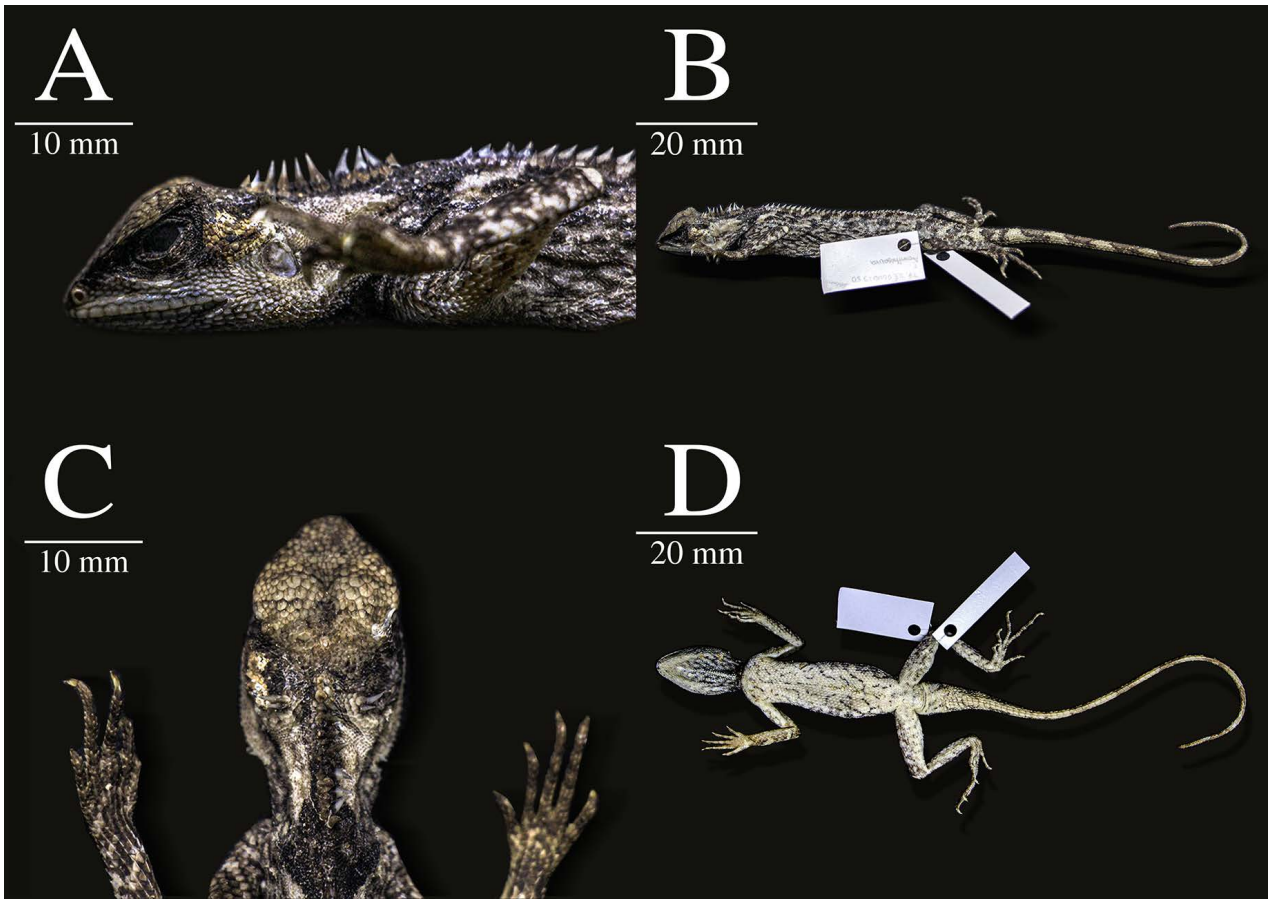

Figure 2. Adult male holotype (THNHM28062) of *Acanthosaura meridiona* **sp. nov.** from Wang Nam Rab Resort Na Yong District, Trang Province, southern Thailand (7°57'57.9"N, 99°78'65.8"E) at 195 m above sea level. **(A)** Lateral view of head. **(B)** Dorsal view. **(C)** Dorsal view of head. **(D)** Ventral view.

sponged rosette shape. In preserved ethanol, the penises exhibited creamy yellow coloration.

Coloration in life: Front of head with transverse bars of black and green, the most prominent bar crossing the orbital region; lips whitish yellow, areas where black lines radiate from the eye; black eye patch, body with a deep black marbled reticulum with some light – brown enclosing yellowish to brownish yellow spots, or greenish spots; whitish or whitish yellow ocellated spot at the knee and elbow, with others indicated on the arm and leg; ventral coloration creamy, with irregular black stripes in some cases; arms with darker and lighter marks above; legs darker above with brown bars below; tail banded with dark brown and dirty light – brown (Fig. 5).

Natural history: This species usually lives near streams, waterfalls or moist areas with rocks and logs and in areas covered with high trees shading evergreen rainforests (Fig. 6). It is active during the day on various substrates such as the ground, logs, rocks, ferns of approximately 0.5 m in height, or trees 1 – 2 m above the ground. It sleeps at night approximately 1 – 2 m above the forest floor, in a log holes or under rocks on the ground. When awakened by approach or provocation, the lizards quickly climb upward, while others may drop to the ground and seek refuge under rocks or hollow logs. Our observations showed that some individuals had eaten earthworms on the ground.

Distribution. *Acanthosaura meridiona* **sp. nov.** occurs in southern Thailand according to personal field observations, including records in Na Yong District, Trang Province; Khao Bantad Wildlife Sanctuary, Trang – Phattalung Province; Krabi Province; Wang Hip River, Thung Song District, Nakhon Si Tammarat Province; Ton Lat Waterfall, Nathavee District, Songkhla Province. In addition, specimens were collected from Natural History Museum, National Science Museum, Technopolis, Pathum Thani Province at the following locations: Khanom Waterfall, Lan Saka District, Nakhon Si Tammarat Province; Tak Ta Khan, Ban Ta Khun District, Surat Thani Province; and Thale Ban National Park, Khuan Don District, Satun Province (Fig. 7).

Etymology: The specific name meridiona comes from the Latin word meridionalis, meaning southern. It is a reference to the distribution of the species in the southern region of Thailand. We suggested the following common names: kingkakhaownaamsunn tai (Thai), southern short- horned lizard (English), süd-kurzhorn nackenstachler (German), and Acanthosaurus à cornes courtes du sud (French).

Comparisons: Table 4 summarises the comparisons of the morphometric measurements and meristic data for all currently recognised species in comparison with *A. meridiona* **sp. nov.** and other recognised *Acanthosaura* species.

Acanthosaura meridiona **sp. nov.** differs from *A. armata* in having smaller ORBIT/HL ratio (0.44 – 0.53 vs

Table 3. Morphological (in mm) and meristic data for the type series of *Acanthosaura meridiona* **sp. nov**. For character abbreviations see Materials & Methods.

	Holotype THNHM28062Adult male	Paratype THNHM28059 Adult male	Paratype QSMI 1594 Adult male	Paratype QSMI 1595 Adult female	Paratype QSMI 1596 Adult female	Paratype THNHM28060 Adult female	Paratype THNHM 28061 Adult female
SVL	109.0	100.6	115.1	109.7	116.3	116.3	118.1
Tal	176.0	>107.6	171.6	140.7	>112.0	156.7	159.9
Tal/SVL	1.61	NA	1.49	1.28	NA	1.35	1.35
TBW	11.0	12.7	13.3	10.8	9.0	14.4	10.8
HL	20.8	21.4	23.2	22.0	23.4	24.1	21.2
HL/SVL	0.19	0.21	0.20	0.20	0.20	0.21	0.18
HW	16.7	19.3	18.8	18.2	18.0	22.0	18.4
HW/SVL	0.15	0.19	0.16	0.17	0.15	0.19	0.16
HD	12.4	14.7	16.5	14.8	18.0	19.6	17.2
HD/SVL	0.11	0.15	0.14	0.13	0.15	0.17	0.15
SL	9.4	9.2	12.2	9.9	10.0	12.7	9.2
SL/HL	0.45	0.43	0.53	0.45	0.43	0.53	0.43
ORBIT	10.4	9.7	12.4	9.7	10.9	12.0	10.5
ORBIT/HL	0.50	0.45	0.53	0.44	0.47	0.50	0.50
EYE	6.2	6.6	7.5	6.7	7.4	7.6	3.0
TD	3.1	3.7	3.4	3.6	3.9	4.3	3.0
TD/HD	0.25	0.17	0.15	0.16	0.22	0.18	0.14
TN	0	0	0	0	0	0	0
PS	4.0	4.6	5.9	5.0	5.0	5.3	3.4
PS/HL	0.19	0.22	0.25	0.23	0.21	0.22	0.16
NSL	5.2	3.8	5.3	3.9	4.9	5.7	3.5
NSL/HL	0.25	0.18	0.23	0.18	0.21	0.24	0.17
NS	10	9	9	10	9	9	8
DS	2.5	2.1	2.1	2.6	3.1	2.2	2.2
DS/HL	0.12	0.10	0.09	0.12	0.13	0.09	0.10
WNC	0.8	1.0	1.3	0.9	1.2	1.6	1.0
DIAS	7.5	6.6	7.6	8.1	8.1	5.5	7.7
DIAS/SVL	0.07	0.07	0.07	0.07	0.07	0.05	0.07
DIASN	13	10	13	14	16	10	14
FOREL	49.5	43.8	54.1	56.1	41.0	49.1	44.2
HINDL	59.4	56.9	65.6	46.7	57.8	59.6	56.8
SUPRAL	13	12	12	13	13	13	13
INFRAL	11	12	11	13	13	12	11
VENT	65	66	67	64	63	60	60
FI	18	18	17	17	17	18	16
TO	23	22	22	23	>14	22	22
OS	4.1	5.3	3.1	3.8	3.8	4.4	3.4
OS/HL	0.20	0.25	0.13	0.17	0.16	0.18	0.16
NSSOS	4	4	5	4	4	4	4
CS	14	12	13	14	15	13	12
RW	2.2	3.0	2.9	2.7	3.5	3.4	3.1
RH	0.9	1.2	1.4	1.1	1.7	1.4	1.5
RS	6	6	5	5	6	5	5
NS	6	7	7	7	9	7	7
NCS	10	13	13	15	15	13	14
NSCSL	9	10	9	9	10	9	9
NR	1	1	1	1	1	1	1
NSSLC	12	12	10	10	9	10	12
MW	1.0	1.4	1.1	1.2	1.0	1.2	1.0
MH	0.5	1.2	0.9	1.0	0.9	0.9	0.7
MW/MH	2.00	1.17	1.22	1.20	1.11	1.33	1.43
PM	4	4	4	4	4	4	4
YAS	1	1	1	1	1	1	1
ND	1	1	1	1	1	1	1
LKP	1	1	1	1	1	1	1
BEP	1	1	1	1	1	1	1
ESBO	0	0	0	0	0	0	0
GP	1	1	2	1	1	1	1
OF	**1**	**1**	**1**	**1**	**1**	**1**	**1**

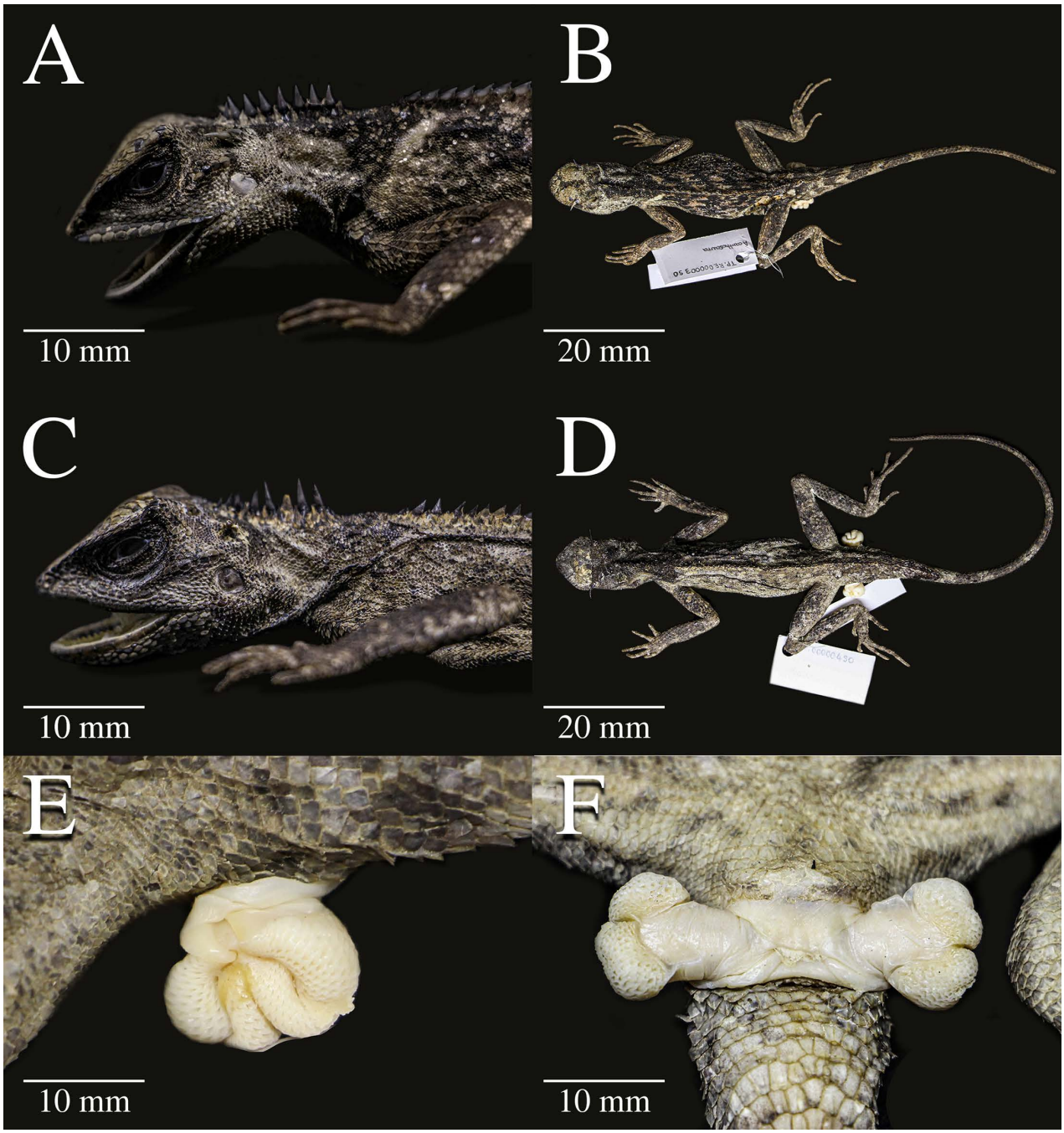

Figure 3. Paratype specimens of male *Acanthosaura meridiona* **sp. nov. (A)** Lateral view of head of THNHM28059. **(B)** Dorsal view of THNHM28059. **(C)** Lateral view of head of QSMI1594. **(D)** Dorsal view of QSMI1594. **(E)** Everted left hemipenis. **(F)** Cloaca opening with everted hemipenis.

slightly keeled, proximal scales smaller than the distal scales; five digits on the manus; subdigital scales keeled, subdigital lamellae under the fourth finger 18. Scales on the hindlimb keeled, femoral scales slightly keeled and smaller than those on the tibia; five digits on the pes; subdigital scales keeled, subdigital lamellae under the fourth finger toe 23; tail length 1.6 times SVL, tail covered with keeled spinose scales, keels on subcaudals directed posteriorly; subcaudals much longer than supracaudals; base of the tail 11 mm wide.

Variation: The paratypes resemble the holotype in all the characters except that THNHM28059 (male), THNHM28061 (female) and QSMI1594 (female) differ from the holotype in lacking stripes in the dorsal head region. All specimens present varied nuchal scales 8 – 10. THNHM28061 (female), QSMI1594 (male), QSMI1595 (female) and QSMI1596 (female) differ from the holotype in lacking a faint dark marbled pattern on the dorsum bearing small randomly distributed yellow markings. QSMI1594 (male) and QSMI1596 (female) differ from the holotype in exhibiting creamy ventral coloration without black stripes. The paratypes except for THNHM25089 (male) differ from the holotype in presenting a darker gular region. Morphometric and meristic data for the type series are shown in Table 3.

The hemipenis of two specimens (THNHM28059 and QSMI1594) were everted and showed lengths of 10 – 13 mm, and each penis side diverged to a symmetrical

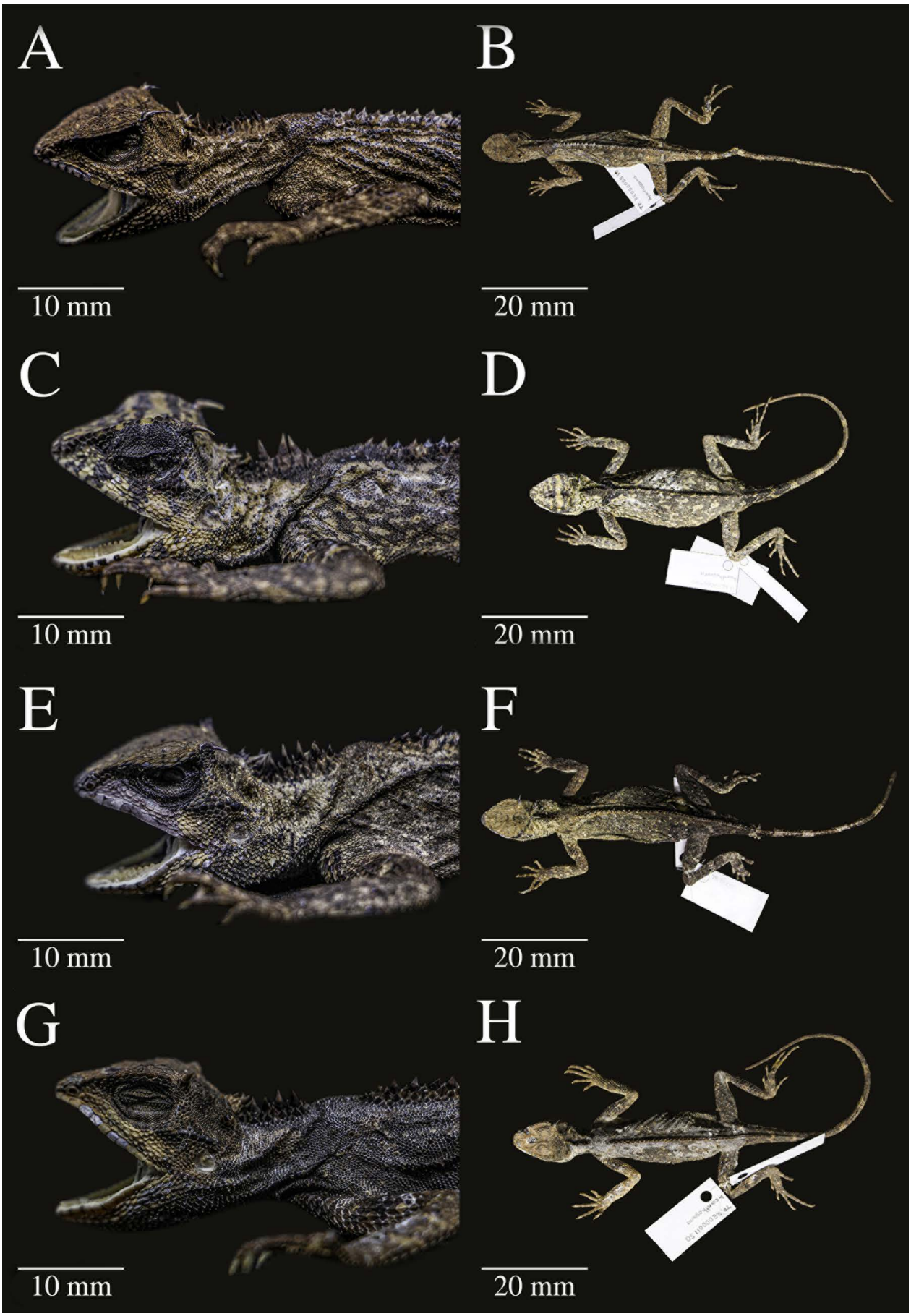

Figure 4. Paratype specimens of female *Acanthosaura meridiona* **sp. nov. (A)** Lateral view of head of QSMI1595. **(B)** Dorsal view of QSMI1595. (**C)** Lateral view of head of QSMI1596. **(D)** Dorsal view of QSMI1596. **(E)** Lateral view of head of THNHM28060. **(F)** Dorsal view of THNHM28060. **(G)** Lateral view of head of THNHM28061. **(H)** Dorsal view of THNHM28061.

Table 4. Comparison of morphometric (in mm) and meristic data for all currently recognised species of *Acanthosaura* and *Acanthosaura meridiona* **sp. nov.**, "?" = data not available.

	***A. meridiona* sp. nov.**	***A. aurantiacrista***	***A. armata***	***A. bintangensis***	***A. brachypoda***	***A. capra***	***A cardamomensis***	***A. coronata***	***A. crucigera***	***A. lepidogaster***	***A. murphyi***	***A. nataliae***	***A. phongdienensis***	***A. phuketensis***	***A. tongbinguanensis***	***A. titiwangsaensis***	***A. prasina***	***A. liui***
SVL	88.7-118.1	80.8-130.1	69.2-138.0	83.9-142.0	117	94.0-137.9	82.0-149.0	66.0-86.1	69.2-127.0	76.5-101.1	103.7-127.3	106.7-158.0	58.5-77.4	69.2-123.5	93.0-115.6	91.8-118.4	79.8-88.4	84.1-95.9
TaL	108.5-176.0	137.0-202.2	96.6-190.0	112.8-206.0	185.4	133.6-182.1	103.0-188.0	86.3-105.0	130.0-174.0	130.6-144.1	159.3-195.8	132.5-190.0	94.6-137.2	107.0-205.6	144.9-205.0	136.0-174.0	137.7-152.6	139.3-155.3
Tal/SVL	1.10-1.60	1.40-1.70	1.2-1.6	1.3-1.4	1.58	1.2-1.5	1.2-1.6	0.6-1.0	1.1-1.8	1.6-1.9	1.48-1.54	1.0-1.5	1.5-1.9	1.4-1.7	1.56-1.85	1.1-1.5	1.64-20.7	1.47-1.77
TBW	8.3-14.4	7.3-19.2	15.1-15.6	?	?	?	5.8-12.8	?	7.4-14.5	5.9-11.8	?	15.0-16.3	?	5.4-14.5	?	?	?	10.6-13.9
HL	17.0-24.1	15.6-24.2	6.6-33.7	16.9-25.4	30.3	16.3-38.9	16.3-42.2	14.4-16.3	18.7-23.6	18.9-29.7	29.1-36.8	15.0-43.6	18.6-23.8	19.7-31.4	27.5-33.2	20.0-24.3	20.7-22.4	26.7-30.0
HL/SVL	0.18-0.21	0.17-0.22	0.18	?	0.26	?	0.19-0.37	?	0.20-0.26	0.19-0.26	?	?	?	0.21-0.22	?	?	0.25-0.28	0.30-0.31
HW	14.7-22.0	14.7-19.9	15.3-23.0	17.5-23.4	20.6	16.8-27.0	16.4-27.7	13.6-17.5	16.0-22.3	13.4-20.8	20.3-24.6	20.2-27.8	13.1-15.9	14.4-22.8	18.6-23.3	17.5-23.4	14.0-16.4	18.3-22.4
HW/SVL	0.15-0.19	0.15-0.18	0.16-0.18	?	0.18	?	0.15-0.28	?	0.16-0.20	0.19-0.24	?	?	?	0.06-0.24	?	?	0.17-0.20	0.21-0.23
HD	12.4-19.6	12.5-21.7	12.2-18.9	15.0-19.2	17.2	14.8-24.3	12.6-21.7	11.9-16.8	15.7-22.5	12.0-12.5	18.5-20.6	16.9-24.9	10.4-13.6	10.9-18.6	13.9-17.4	15.7-20.2	12.3-13.3	15.1-17.3
HD/SVL	0.11-0.17	0.14-0.18	0.14-0.16	?	0.15	?	0.14-0.29	?	0.13-0.18	0.16-0.30	?	?	?	0.15-0.19	?	?	0.15	0.17-0.18
SL	9.2-12.7	6.6-12.4	6.3-16.6	7.9-11.3	12.2	7.6-16.6	8.6-18.7	6.9-8.4	8.7-12.1	9.3-10.2	10.3-15.3	12.0-19.9	?	6.8-11.0	9.2-11.0	9.7-12.5	8.8-9.4	10.3-11.3
SL/HL	0.43-0.53	0.41-0.58	0.42-0.60	?	0.40	?	0.47-0.57	?	0.38-0.50	0.42-0.66	?	?	?	0.41-0.56	?	?	0.10-0.12	0.11-0.13
ORBIT	8.5-12.4	6.8-11.8	5.4-13.3	8.4-12.6	8.3	7.6-11.6	5.8-12.7	6.9-7.5	8.9-10.8	4.7-9.1	9.9-12.3	7.2-10.9	?	6.6-11.2	7.7-11.0	9.8-13.2	6.5-8.7	8.4-8.9
ORBIT/HL	0.44-0.53	0.41-0.52	0.59-0.65	?	0.27	?	0.45-0.54	?	0.41-0.61	0.40-0.57	?	?	?	0.59-0.66	?	?	0.31-0.39	0.09-0.10
EYE	3.0-7.6	4.4-8.5	8.0-9.9	?	?	?	4.0-8.8	?	3.5-7.2	3.2-6.0	?	?	?	3.3-7.5	?	?	?	5.8-6.4
TD	2.9-4.3	2.0-4.9	2.4-5.2	2.5-3.0	3.6	3.4-5.2	2.5-5.8	1.7-2.8	2.5-3.9	2.2-3.0	3.2-5.2	3.9-7.0	1.78-2.81	3.5-4.7	3.2-4.2	2.7-4.0	2.7-5.3	2.9-3.8
TD/HD	0.14-0.27	0.15-0.30	0.19-0.28	0.16	0.21	0.21-0.23	0.20-0.27	0.14-0.17	0.14-0.21	0.18-0.24	0.17-0.28	0.23-0.28	0.17-0.22	0.22-0.33	0.21-0.24	0.17-0.20	0.22-0.43	0.03-0.04
TN	0	0	0	0	0	0	0	0	0	0-1	1	0	0	0	0	0	?	0
PS	3.4-7.0	5.5 -19.1	4.9-12.0	1.9-4.2	3.2	5.2-10.2	3.2-12.7	Absent	1.9-7.8	1.2-2.5	5.6-11.8	7.7-17.8	1.18-2.07	4.6-11.8	3.6-6.3	3.3-4.4	0.8-3.2	2.1-3.2
PS/HL	0.16-0.38	0.24-0.84	0.22-0.58	0.07-0.19	0.11	0.36	0.14-0.45	Absent	0.09-0.33	0.06-0.17	0.16-0.34	0.36-0.52	0.06-0.09	0.23-0.38	0.13-0.19	0.14-0.18	0.04-0.15	0.07-0.11
NSL	2.6-6.9	5.5-21.6	5.5-11.2	1.3-4.7	4.7	4.2-14.7	3.8-17.4	Absent	3.1-8.9	2.9-3.4	7.0-14.9	8.5-23.8	1.24-4.18	4.1-12.2	4.0-6.7	2.7-4.4	2.8-3.2	2.2-7.1
NSL/HL	0.15-0.37	0.35-0.95	0.22-0.51	0.17-0.21	0.16	0.42-0.43	0.17-0.66	Absent	0.14-0.38	0.12-0.15	0.24-0.43	0.58-0.75	0.07-0.18	0.21-0.39	0.15-0.21	0.11-0.18	0.13-0.14	0.17-0.24
NS	8-10	8	12	?	?	?	7-9	Absent	6-7	6-8	?	7	?	7-8	?	?	?	5-7
DS	1.4-3.9	2.4-8.7	4.9-11.3	1.8-2.2	1.9	3.5-6.8	2.0-14.2	Absent	2.0-5.5	0.8-3.0	2.6-10.5	6.0-17.7	0.58-1.65	2.3-8.3	2.4-4.2	1.7-2.1	?	2.7-3.7
DS/HL	0.08-0.21	0.15-0.38	0.20-0.52	0.08-0.09	0.06	0.16-0.17	0.14-0.45	Absent	0.09-0.24	0.06-0.15	0.14-0.51	0.41-0.53	0.03-0.07	0.11-0.26	0.09-0.13	0.07-0.09	?	0.10-0.12
WNC	0.8-1.6	0.6-2.9	1.0-2.2	1.6-2.1	1.6	2.3-4.1	1.8-4.2	Absent	1.3-3.4	0.9-1.5	2.9-4.8	3.0-4.8	?	1.4-2.9	1.0-1.5	1.4-1.6	?	1.1-1.3
DIAS	4.7-8.1	3.3-5.4	1.2-6.8	5.0-7.9	?	2.0-6.7	2.7-8.3	Absent	4.9-8.4	2.2-6.3	2.6-4.8	2.5-5.3	Absent	3.6-7.6	3.9-6.1	5.1-7.6	?	3.5-4.7
DIAS/SVL	0.05-0.07	0.03-0.05	0.01-0.06	0.04-0.07	?	0.05	0.03-0.09	Absent	0.04-0.08	0.02-0.08	0.02-0.04	0.03-0.04	Absent	0.05-0.08	0.03-0.07	0.05-0.07	?	0.04-0.05
DIASN	10-16	8-9	1-11	11-15	7	4-7	6-17	Absent	9-25	10-14	4-8	7-10	Absent	12-17	6-10	10-13	?	?
FOREL	40.8-56.1	36.8-54.2	33.7-56.0	33.9-61.5	?	54.2-83.8	31.7-56.8	30.2-35.3	35.6-49.8	28.2-42.8	49.8-56.6	58.4-85.0	?	22.3-42.9	34.7-43.2	38.0-51.7	?	35.8-37.0
HINDL	46.7-56.1	46.2-72.9	39.0-69.6	43.3-68.6	?	78.5-107.2	42.0-77.1	38.4-47.8	48.8-65.0	48.5-50.4	60.4-68.4	72.1-129.7	?	38.2-60.6	54.1-63.9	48.5-65.6	?	50.7-52.6
SUPRAL	11-13	10-13	10-14	12	12-13	10	11-15	12-13	10-13	10-13	12-14	10-11	9-12	10-12	11-14	12-13	9-11	10-13
INFRAL	11-13	9-11	12-15	11-12	11	12-13	10-14	11-13	10-12	9-13	12-14	11-12	10-11	10-12	10-14	11-12	9-11	10-11
VENT	60-68	63-66	51-68	51-55	63	55-66	50-67	53-58	55-63	52-61	55-65	64-71	?	57-67	52-66	47-57	59-63	52-56
FI	16-18	17-23	13-17	23	18	16-17	15-20	13-14	16-18	17-19	15-18	16-21	14-17	15-17	19-21	20-21	16-18	16-18

	A. meridiona **sp. nov.**	*A. aurantiacrista*	*A. armata*	*A. bintangensis*	*A. brachypoda*	*A. capra*	*A cardamomensis*	*A. coronata*	*A. crucigera*	*A. lepidogaster*	*A. murphyi*	*A. nataliae*	*A. phongdienensis*	*A. phuketensis*	*A. tongbinguanensis*	*A. titiwangsaensis*	*A. prasina*	*A. liui*
TO	22-25	25-29	19-26	26-28	24	22-24	20-26	17-19	21-26	22-23	21-23	20-27	19-23	21-24	25-28	23-27	23-26	22-25
OS	2.4-7.0	3.1-10.0	4.0-9.4	1.2-2.6	1.0	Absent	4.1-13.6	Absent	2.5-4.9	3.2-3.4	Absent	Absent	?	2.6-9.5	4.5-7.0	1.8-2.3	?	3.6-4.8
OS/HL	0.13-0.25	0.19-0.44	0.16-0.43	0.10-0.11	0.03	Absent	0.24-0.56	Absent	0.11-0.50	0.14-0.15	Absent	Absent	?	0.13-0.30	0.16-0.23	0.09-0.10	?	0.12-0.16
NSSOS	3-5	5	4-6	6-7	?	Absent	4-6	4-5	4-6	4-5	Absent	Absent	?	4-5	4-5	4-5	?	4-6
CS	12-15	10-14	11-15	14-15	?	12-14	11-16	12-15	12-15	10-14	12-14	12-13	9-13	10-14	10-14	14-15	5-6	12
RW	1.9-3.5	2.5-3.7	1.7-4.5	3.6-5.3	3.5	4.2-4.6	1.7-4.7	0.8-0.9	2.7-4.0	2.8-3.0	3.3-5.1	4.6-6.1	2.07-2.65	2.3-3.8	3.3-4.5	3.6-5.2	1.6-2.4	3.4-4.2
RH	0.8-1.8	0.9-2.1	0.9-1.8	1.7-2.0	2.3	1.8-2.3	1.1-2.2	0.5-0.8	1.3-2.0	1.4-1.5	1.2-2.0	1.8-2.9	1.00-1.32	1.1-1.7	1.0-2.0	1.4-1.8	1.0-1.5	1.4-1.9
RS	3-6	4-6	5-8	5-9	5-9	5-9	7-9	9	7-8	6-7	8-9	7	?	5-9	6-9	5	?	8-9
NS	5-9	5-6	6-10	8	9	9	7-10	7-9	7-9	7-8	7-8	5-8	?	7-8	8-9	8	?	?
NCS	10-15	11-13	10-17	10-11	?	9	9-17	8-11	9-12	7-11	13-16	10-14	?	12-13	10-13	11-12	?	?
NSCSL	9-11	6-10	6-14	7-8	?	7-8	7-12	5-6	7-11	7-12	7-10	8-11	?	8-10	7-9	9-11	?	?
NR	1	1-2	1-2	1	?	1-2	1-2	3-4	1-2	1-2	3-4	1	?	1-2	2	1-2	?	1-2
NSSLC	9-13	9-13	10-22	9-12	?	9-11	10-19	6-11	10-14	10-18	?	13-16	?	11-14	9-13	11-14	?	?
MW	0.2-1.4	1.1-2.5	0.8-2.0	1.3-1.8	2.9	1.9-2.2	0.2-2.1	0.6-1.5	1.0-1.5	1.2-1.3	1.7-2.2	2.3-2.9	0.87-1.52	0.5-1.4	1.4-1.9	1.4-2.0	1.4-1.9	1.8-2.4
MH	0.5-1.4	0.8-1.6	0.8-2.3	1.4-2.1	2.1	1.7-2.2	0.9-2.0	1.3-1.6	1.1-1.7	1.2-1.3	1.4-2.0	2.0-2.9	1.04-1.60	0.6-1.6	1.2-2.0	1.4-2.4	1.0-1.2	1.7-2.3
MW/MH	1.11-2.00	0.69-2.08	0.50-0.87	?	1.38	?	?	?	1.23-2.69	0.69-1.08	?	0.79-0.96	?	1.00-2.00	?	?	1.40-1.90	1.00-1.33
PM	4	4	3-6	4-5	4	4	4-5	4-5	4	5	?	4-5	?	4	4-5	5	?	5-6
YAS	1	1	0-1	1	1	1	0-1	0-1	1	1	0-1	1	?	0-1	1	1	?	1
ND	1	1	0-1	1	1	1	1	0	1	1	?	0	1	1	1	1	?	1
LKP	1	1	1	0	1	1	1	1	1	1	?	0	1	1	1	0	?	1
BEP	**1**	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**0-1**	**0-1**	**0-1**	**?**	**1**	**1**	**1**	**?**	**1**
ESBO	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**0**	**?**	**0**	**0**	**0**	**?**	**0**
GP	**1-2**	**1-4**	**1**	**3-4**	**0**	**3-4**	**1-4**	**0**	**1-2**	**0-1**	**4**	**3-4**	**?**	**0-2**	**1-2**	**2-4**	**?**	**2-3**
OF	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**?**	**1**	**1**	**1**	**1**	**1**	**?**	**1**

0.59 – 0.65), fewer NS (8 – 10 vs 12), greater MW/MH ratio (1.11 – 2.00 vs 0.50 – 0.87) and the presence of BEP, which is absent in *A. armata*.

Acanthosaura meridiona **sp. nov.** differs from *A. aurantiacrista* Trivalairat et al., 2020 in having smaller PS/HL ratio (0.16 – 0.25 vs 0.24 – 0.84), smaller NSL/HL (0.17 – 0.25 vs 0.35 – 0.95) and more DIASN (10 – 16 vs 8 – 9).

Acanthosaura meridiona **sp. nov.** differs from *A. bintangensis* in having more VENT (60 – 67 vs 51 – 55), fewer FI (16 – 18 vs. 23), fewer TO (22 – 25 vs. 26 – 28), greater OS/HL (0.13 – 0.25 vs. 0.10 – 0.11), fewer NSSOS (4 – 5 vs. 6 – 7), more NSCSL (9 – 11 vs. 7 – 8), LKP, fewer GP (1 – 2 vs 3 – 4), and the absence of ESBO.

Acanthosaura meridiona **sp. nov.** differs from *A. brachypoda* Ananjeva et al., 2011 in having smaller HL/SVL ratio (0.18 – 0.21 vs 0.26), greater ORBIT/HL ratio (0.44 – 0.53 vs 0.27), greater PS/HL ratio (0.16 – 0.25 vs 0.11), greater DS/HL ratio (0.08 – 0.21 vs 0.06), more DIASN (10 – 16 vs 7), fewer TO (22 – 25 vs. 24), greater OS/HL (0.13 – 0.25 vs 0.03) and more GP (1 – 2 vs 0)

Acanthosaura meridiona **sp. nov.** differs from *A. capra* in having smaller NSL/HL (0.15 – 0.37 vs 0.42 – 0.43), and the presence of occipital spines and fewer GP (1 – 2 vs 3 – 4).

Acanthosaura meridiona **sp. nov.** differs from *A. coronata* Günther, 1861 in having postorbital spines, nuchal scales, dorsal scales, diastema, and occipital spines, which is absent in *A. coronata*.

Acanthosaura meridiona **sp. nov.** differs from *A. lepidogaster* in having greater NSL/HL (0.17 – 0.25 vs 0.12 – 0.15), fewer RS (3 – 6 vs 7 – 8) and fewer PM (4 vs 5).

Acanthosaura meridiona **sp. nov.** differs from *A. murphyi* Nguyen et al., 2018 in having greater DIAS/SVL ratio (0.05 – 0.07 vs 0.02 – 0.04), more DIASN (10 – 16 vs 4 – 8), fewer RS (3 – 6 vs 8 – 9), fewer NR (1 vs 3 – 4), occipital spines, fewer GP (1 – 2 vs 4), and the absence of TN, which is present in *A. murphyi*.

Acanthosaura meridiona **sp. nov.** differs from *A. nataliae* Orlov et al., 2006 in having smaller NSL/HL ratio (0.17 – 0.25 vs 0.58 – 0.75), smaller DS/HL ratio (0.08 – 0.21 vs 0.41 – 0.53), greater DIAS/SVL ratio (0.05 – 0.07 vs 0.03 – 0.04), fewer RS (3 – 6 vs 7), greater MW/MH ratio (1.11 – 2.00 vs 0.79 – 0.96) and the presence of occipital spines, ND, LKP, and fewer GP (1 – 2 vs 3 – 4).

Acanthosaura meridiona **sp. nov.** differs from *A.*

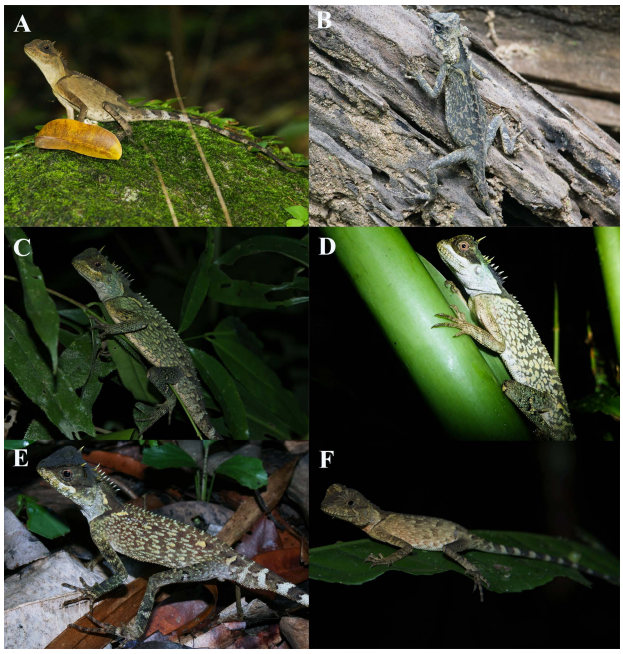

Figure 5. Colour pattern variation within *Acanthosaura meridiona* **sp. nov. (A – B)** Adult female from Wang Nam Rab Resort Na Yong District, Trang Province. **(C – D)** Adult male from Wang Hip Dam, Thung Song District, Nakhon Si Tammarat Province. **(E)** Sub adult male from Wang Hip Dam, Thung Song District, Nakhon Si Tammarat Province. **(F)** Juvenile from Wang Hip Dam, Thung Song District, Nakhon Si Tammarat Province.

Figure 6. Habitat of *Acanthosaura meridiona* **sp. nov.** Photo in Wang Nam Rab Resort Na Yong District, Trang Province, lower – southern Thailand.

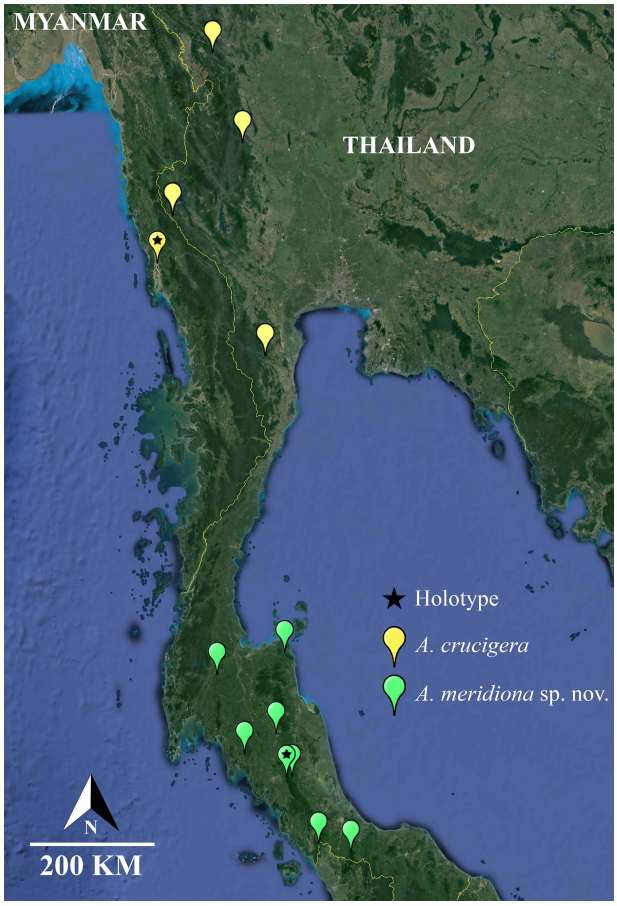

Figure 7. The distribution of *Acanthosaura meridiona* **sp. nov.** and *A. crucigera* in Thailand.

phongdienensis Nguyen et al., 2019 in having greater PS/HL ratio (0.16 – 0.38 vs 0.06 – 0.09), greater DS/HL ratio (0.08 – 0.21 vs 0.03 – 0.07), and the presence of diastema, which is absent in *A. phongdienensis*.

Acanthosaura meridiona **sp. nov.** differs from *A. tongbiguanensis* Liu & Rao, 2019 having fewer FI (16 – 18 vs 19 – 21) and fewer NR (1 vs 2).

Acanthosaura meridiona **sp. nov.** differs from *A. titiwangsaensis* in having more VENT (60 – 67 vs 47 – 57), fewer FI (16 – 18 vs 20 – 21), greater OS/HL ratio (0.13 – 0.25 vs 0.10 – 0.11), fewer PM (4 vs 5), and the presence of LKP, which is absent in *A. titiwangsaensis*.

Acanthosaura meridiona **sp. nov.** differs from *A. prasina* Ananjeva et al., 2020 in having smaller TaL/SVL ratio (1.10 – 1.60 vs 1.64 – 2.07), smaller HL/SVL ratio (0.18 – 0.21 vs 0.25 – 0.28), greater ORBIT/HL ratio (0.44 – 0.53 vs 0.31 – 0.39), greater PS/HL ratio (0.16 – 0.25 vs 0.04 – 0.15), greater NSL/HL ratio (0.17 – 0.25 vs 0.13 – 0.14) and more CS (12 – 15 vs 5 – 6).

Acanthosaura meridiona **sp. nov.** differs from *A. liui* Liu et al., 2020 in having smaller HL/SVL ratio (0.18 – 0.21 vs 0.30 – 0.31), smaller HW/SVL ratio (0.15 – 0.19 vs 0.21 – 0.23), greater ORBIT/HL ratio (0.44 – 0.53 vs 0.09 – 0.10), greater TD/HL ratio (0.14 – 0.27 vs 0.03 – 0.04), greater PS/HL ratio (0.16 – 0.25 vs 0.07 – 0.11), more NS (8 – 10 vs 5 – 7), more VENT (60 – 67 vs 52 – 56), fewer RS (3 – 6 vs 8 – 9) and fewer PM (4 vs 5 – 6).

However, it is noted that the morphological comparative data of species in the *A. crucigera* complex, including *A. cardamomensis*, *A. crucigera*, and *A. phuketensis*, overlapped with *A. meridiona* **sp. nov.** A close examination of the material and comparison data by Wood et al. (2010) and Wood et al. (2015) led to separate *A. meridiona* **sp. nov.** from these similar species based on coloration, morphological characteristics, especially nuchal – dorsal scale patterns, as well as on molecular data (Fig. 8) (Table 5).

Acanthosaura meridiona **sp. nov.** differs from *A. cardamomensis* in having a much smaller maximum length of DS (7.0 vs 12.7 mm) and NSL (6.9 vs 17.4 mm), with a slight decrease in size of posterior nuchal pattern in *A. meridiona* **sp. nov.** contrast to sudden decrease in

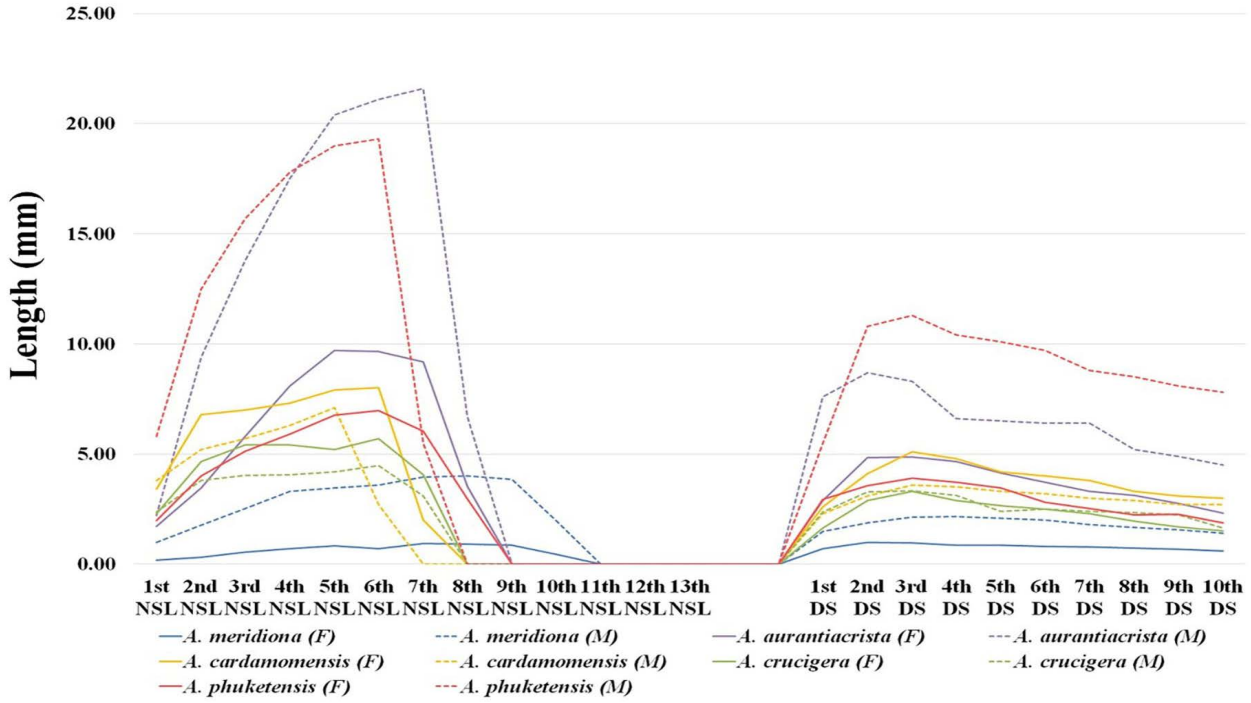

Figure 8. Average length of nuchal (NSL) and dorsal (DS) scales for five *Acanthosaura* species in the *A. crucigera* complex.

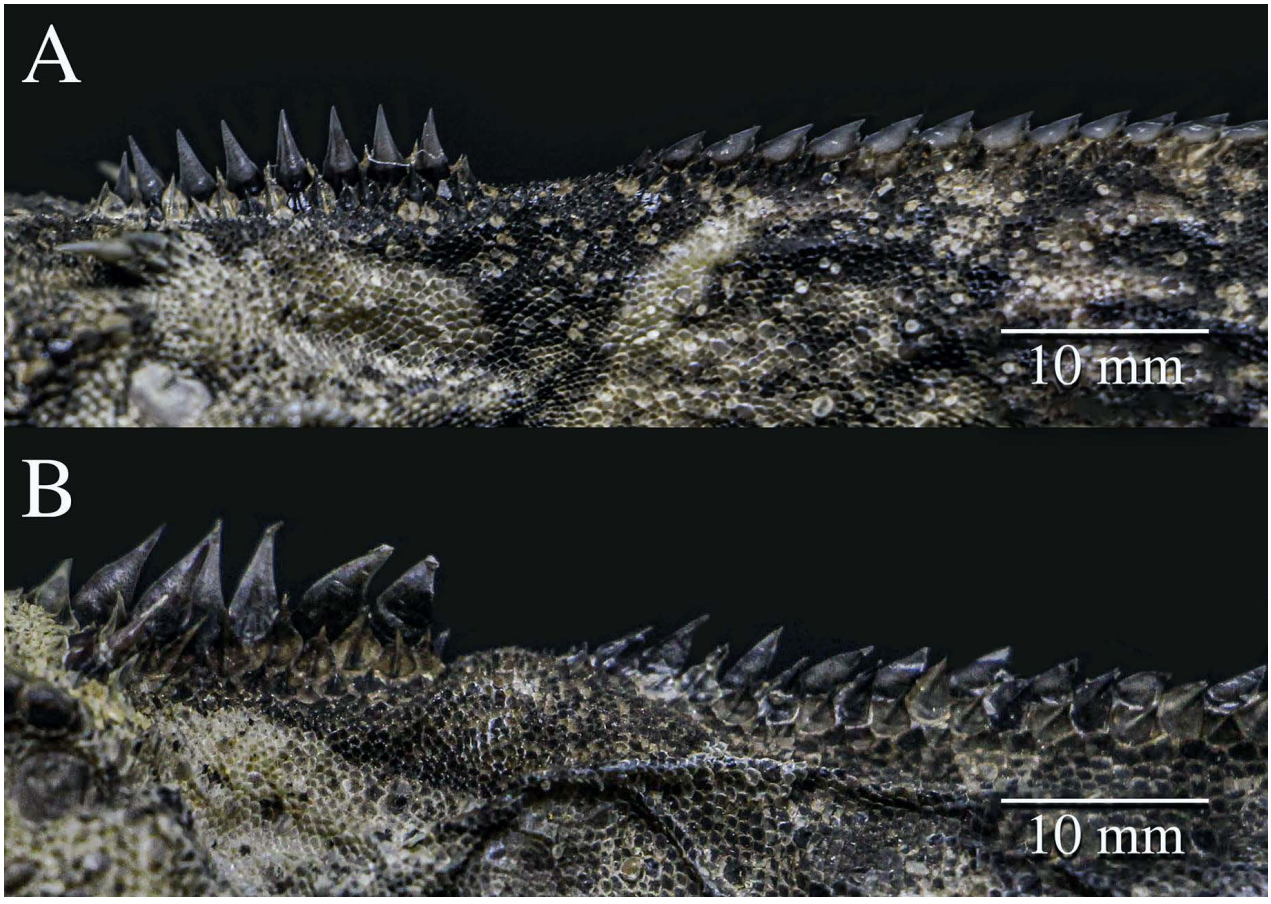

Figure 9. Morphological differentiation of nuchal scales between adult males of **(A)** *Acanthosaura meridiona* **sp. nov.** (THNHM28059) from Wang Nam Rab Resort Na Yong District, Trang Provinc, and **(B)** *Acanthosaura crucigera* (QSMI1590) from Taksin Maharat National Park, Muang District, Tak Province.

Table 5. Average and range of length (in mm) of each nuchal and first ten dorsal scales of *Acanthosaura* species in the *A. crucigera* complex for adult female (F) and male (M). "-" = no scale.

Characters	***A. meridiona* sp. nov.**		***A. aurantiacrista***		***A. cardamomensis***		***A. crucigera***		***A. phuketensis***	
	F (n = 6)	M (n = 7)	F (n = 5)	M (n = 1)	F (n = 1)	M (n = 1)	F (n = 3)	M (n = 3)	F (n = 3)	M (n = 1)
1st NSL	0.19 (0.15-1.00)	1.00 (1.00)	1.72 (0.90-2.90)	2.20	3.40	3.80	2.30 (1.70-2.90)	2.37 (1.60-3.50)	1.97 (1.40-2.40)	5.80
2nd NSL	0.31 (0.20-2.30)	1.77 (0.90-3.10)	3.46 (2.10-5.00)	9.40	6.80	5.20	4.65 (3.60-5.70)	3.80 (2.20-4.60)	4.00 (2.40-5.00)	12.50
3rd NSL	0.54 (0.46-3.80)	2.51 (1.60-3.30)	5.80 (4.30-7.40)	13.80	7.00	5.70	5.40 (4.80-6.00)	4.03 (2.50-5.00)	5.13 (4.00-6.20)	15.70
4th NSL	0.69 (0.52-4.50)	3.31 (2.00-4.90)	8.10 (6.10-10.50)	17.50	7.30	6.30	5.40 (5.00-5.80)	4.07 (2.80-4.80)	5.90 (5.60-6.50)	17.80
5th NSL	0.84 (0.72-4.70)	3.47 (1.90-4.60)	9.70 (7.50-11.70)	20.40	7.90	7.10	5.20 (4.40-6.00)	4.20 (2.90-5.30)	6.77 (6.00-7.60)	19.00
6th NSL	0.70 (0.74-5.20)	3.59 (2.20-5.00)	9.64 (7.10-12.70)	21.10	8.00	2.70	5.70 (5.40-6.10)	4.47 (2.90-5.30)	6.97 (6.30-7.80)	19.30
7th NSL	0.94 (0.86-5.70)	3.95 (2.60-5.20)	9.18 (7.10-11.40)	21.60	2.00	-	4.05 (2.20-5.90)	3.10 (1.90-3.90)	6.03 (4.40-6.90)	5.50
8th NSL	0.92 (0.61-5.30)	4.01 (2.50-5.10)	3.54 (2.90-4.20)	6.70	-	-	-	-	2.97 (1.70-4.20)	-
9th NSL	0.86 (0.61-5.40)	4.01 (2.50-5.10)	-	-	-	-	-	-	-	-
10th NSL	0.45 (0.22-3.30)	1.94 (1.00-3.90)	-	-	-	-	-	-	-	-
1st DS	0.70 (0.41-2.50)	1.47 (0.80-2.70)	2.90 (1.00-5.40)	7.60	2.60	2.30	1.65 (1.40-1.90)	2.37 (1.70-2.90)	2.93 (1.50-3.70)	5.50
2nd DS	0.99 (0.96-3.10)	1.87 (1.00-3.20)	4.84 (3.60-6.50)	8.70	4.10	3.10	2.90 (2.10-3.70)	3.27 (2.60-4.40)	2.93 (1.50-3.70)	10.80
3rd DS	0.96 (0.77-3.10)	2.14 (1.00-3.50)	4.88 (3.70-5.80)	8.30	5.10	3.60	3.30 (2.70-3.90)	3.33 (2.60-4.60)	3.90 (3.30-4.50)	11.30
4th DS	0.86 (0.73-2.70)	2.17 (1.40-3.20)	4.66 (3.80-5.60)	6.60	4.80	3.50	2.90 (2.40-3.40)	3.13 (1.90-4.40)	3.73 (2.90-4.50)	10.40
5th DS	0.85 (0.71-2.40)	2.07 (1.40-2.70)	4.14 (2.60-5.40)	6.50	4.20	3.30	2.65 (2.20-3.10)	2.40 (1.90-2.90)	3.47 (2.60-4.20)	10.10
6th DS	0.81 (0.71-2.20)	2.01 (1.30-2.70)	3.72 (2.80-5.00)	6.40	4.00	3.20	2.50 (2.10-2.90)	2.50 (1.90-3.10)	2.80 (2.10-3.30)	9.70
7th DS	0.77 (0.62-2.20)	1.80 (1.30-2.60)	3.30 (2.50-4.60)	6.40	3.80	3.00	2.30 (2.00-2.60)	2.40 (1.80-3.00))	2.53 (1.90-2.90)	8.80
8th DS	0.74 (0.59-2.20)	1.67 (1.20-2.40)	3.12 (2.20-4.30)	5.20	3.30	2.90	1.95 (1.70-2.20)	2.35 (1.60-3.10)	2.53 (1.90-2.90)	8.50
9th DS	0.68 (0.52-2.10)	1.56 (1.20-2.20)	2.76 (1.80-3.60)	4.90	3.10	2.70	1.70 (1.40-2.00)	2.25 (1.70-2.80)	2.27 (2.10-2.50)	8.10
10th DS	0.59 (0.45-1.90)	1.41 (1.10-2.10)	2.32 (1.40-3.00)	4.50	3.00	2.70	1.50 (1.10-1.90)	1.65 (0.80-2.50)	1.87 (1.60-2.00)	7.80

A. cardamomensis, smaller maximum length of PS (7.0 vs 12.7 mm) and OS (7.0 – 13.6 mm, and OS/HL ratio 0.13 – 0.25 vs 0.24 – 0.56), less – developed GP (1 – 2 vs 1 – 4), and the presence of BEP extend posteriorly to reach the occipital spine, which reach to the nuchal crest in *A. cardamomensis*.

Acanthosaura meridiona **sp. nov.** is most closely related to *A. crucigera*. The most important character separating these two species is the nuchal scales. *A. meridiona* **sp. nov.** has 8 – 10 short semi – conical scales that are different from those of *A. crucigera*, which exhibits 6 – 8 short triangular lanceolate scales (Fig. 9). *A. meridiona* **sp. nov.** can also be identified from *A. crucigera*. in presenting more VENT (60 – 68 vs 55 – 63), fewer RS (3 – 6 vs 7 – 9), more NCS (10 – 15 vs 9 – 12), and smaller MH (0.5 – 1.4 vs 1.1 – 1.7).

Acanthosaura meridiona **sp. nov.** differs from *A. phuketensis* in having a much smaller maximum length of DS (7.0 vs 8.3 mm) and NSL (6.9 vs 12.2 mm), with a sudden decrease in *A. phuketensis*, smaller ORBIT/HL ratio (0.44 – 0.53 vs 0.59 – 0.66), smaller TD/HD (0.14 – 0.22 vs 0.22 – 0.33), smaller maximum length of PS (7.0 vs 11.8 mm) and OS (7.0 vs 9.5), and longer FOREL (40.8 – 56.1 vs 22.3 – 42.9 mm).

DISCUSSION

Historically, *Acanthosaura crucigera* was reported to have a wide distribution and various conserved morphological characteristics. However, after the 20th century, cryptic species in the crucigera complex have been increasingly described and designated as new members in the genus *Acanthosaura*, such as *A. cardamomensis* from eastern Thailand and Cambodia, *A. phuketensis* from south-western Thailand, and *A. bintangensis* and *A. titiwangsaensis* from Peninsular Malaysia. *Acanthosaura meridiona* **sp. nov.** is separated from the true *A. crucigera* population from the western region of Thailand and

Southern Myanmar and *A. cardamomensis* by the Kra Isthmus based on the combination of morphological comparisons, based on nuchal scales, and molecular data (Boulenger, 1885; Orlov et al., 2006; Stuart et al,. 2006; Ananjeva et al., 2008; Wood et al., 2009, 2010; Pauwels et al., 2015). Distinct characteristics have also been reported for other currently recognised species of *Acanthosaura* in the southern region, such as *A. armata* and *A. phuketensis*, which present smaller nuchal and dorsal spines. And also different from *A. bintangensis* and *A. titiwangsaensis* from Peninsular Malaysia by present light knee patch. Therefore, our research team suggested that the previously reported specimens and distribution range of *A.* cf. *crucigera* south of the Kra Isthmus should be redescribed as *A. meridiona* **sp. nov.** as a specific name related to southern Thailand.

Furthermore, *Acanthosaura meridiona* **sp. nov.** usually inhabits forests near streams and waterfalls in areas that are conserved, including Khao Pu-Khao Ya National Park; Yong Waterfall National Park; Hat Khanom – Mu Koh Thale Tai National Park; Khao Sok National Park; and the Khao Bantad Wildlife Sanctuary. However, several headwater areas are currently experiencing the effects of forest degradation for dam creation, such as those of the Wang Hip River and Yong Waterfall National Park, which are important habitats for rare endemic nearly aquatic reptiles from southern Thailand, such as *Bronchocela cristatella* (Kuhl, 1820), *B. rayaensis* Grismer et al, 2015, Varanus dumerilii Schlegel, 1839, and *V. rudicollis* (Gray, 1845), including *A. meridiona* **sp. nov.** (Lauprasert & Thirakhupt, 2001; Grismer et al., 2015, 2016). To protect this *Acanthosaura* species and all others rare endemic species that inhabit nearby streams or waterfalls, we implore the government to inhibit forest degradation and dam creation in evergreen rainforests in the southern region of Thailand.

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Appendix 1. List of comparative material examined.

Acanthosaura armata: THNHM15209, Hala – Bala, Narathiwat Province; THNHM18884, Sungai Kolok District, Narathiwat Province

Acanthosaura aurantiacrista: THNHM28064, Mae Sariang District, Mae Hong Son Province; THNHM28521, 28522, 28523, 28524, QSMI1446, 1447, Omkoi District, Chiang Mai Province.

Acanthosaura cardamomensis: THNHM15597, 20169, Koh Kut, Trat Province, THNHM24711, 24712, 24715, Khao Yai National Park, Nakhon Ratchasrima Province.

Acanthosaura crucigera: QSMI1590, 1591, 1592, 1593, THNHM28507, 28508, Taksin Maharat National Park, Muang District, Tak Province; THNHM22658 Thong Pha Phum District, Kanchanaburi Province; THNHM18594, Huai Kha Khaeng, Lan Sak District, Uthai Thani Province.

Acanthosaura lepidogaster: THNHM08736, 08777, Phu Luang District, Loei Province; THNHM19619, Phu Kieo District, Chaiyaphum Province; THNHM20537, Ban Sun Phae Kae, Chiang Dao District, Chiang Mai Province; THNHM20647, Roi Praputabath, Umphang District, Tak Province; THNHM10080, Huai Na Tee, Pua District, Nan Province; THNHM16569, 16570, 16571, Doi Khun Tan National Park, Lam Phun Province.

Acanthosaura meridiona **sp. nov.**: QSMI 1594, 1595 & 1596 and THNHM 28059, 28060, 28061 & 28062, Wang Nam Rab Resort, Na Yong District, Trang Province; THNHM 12687 & 12688, Kanom Waterfall, Lan Saka, Nakhon Si Thammarat Province; THNHM 13449, Krabi Province; ; THNHM 19793, Tak Ta Khum, Ban Ta Khum, Surat Thani Province; THNHM 23843 & 23844, Khao Bantad Wildlife Sanctuary, Trang & Phattalung Province

Acanthosaura nataliae: THNHM13454, 13455, Xe Sap National Biodiversity Conservation Area, Samoy District, Saravane Province, Laos.

Acanthosaura phuketensis: THNHM08865, Ton Sai Waterfall, Thalang District, Phuket Province; THNHM22663, Khao Sok, Ban Ta Khun, Surat Thani Province.

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