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A new Bent-toed gecko (Squamata: Gekkonidae) from the Mekongga Mountains, South East Sulawesi, Indonesia

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Abstract

We describe *Cyrtodactylus hitchi* **sp. nov.,** a new species of Bent-toed Gecko from montane forests in the Mekongga Mountains, South East Sulawesi, Indonesia. Although we cannot speculate about relationships, morphologically it shares several traits with *C. batik*, a large species known only from Mount Tompotika near the tip of Sulawesi's Eastern Peninsula. The following unique combination of characters distinguishes it from all other congeners: absence of precloacal groove, absence of precloacal and femoral pores, absence of enlarged femoral scales, no abrupt contact between large and small postfemoral scales, 18–20 lamellae under the fourth toes, and transversely enlarged, median subcaudal scales arranged in a single row.

Key words: new species, *Cyrtodactylus*, Gekkonidae, Mekongga, Sulawesi, Indonesia

Introduction

Sulawesi, formerly Celebes, is one of the island provinces of the Republic of Indonesia with a territory of 189,036 km^2 straddling the Equator. The island is composed of four peninsulas and apart from the narrow coastal plains is mountainous (Fig. 1), covered with tropical rain forest (or, what remains of it after intensive human exploitation during several hundred years) on mainly lateritic soils, and influenced by the monsoon (Bosch, 1985). Geologically, Sulawesi was formed by the collision of different terranes and subsequent fragmentation beginning approximately 15 Mya (Lohman *et al*., 2011). As a consequence, this island provides extensive microhabitat variation which in turn affects the diversity of fauna, not least for Bent-Toed Geckos.

At present only five species of *Cyrtodactylus* are known from Sulawesi: *Cyrtodactylus fumosus* (Müller), *C. jellesmae* (Boulenger), *C. spinosus* Linkem, McGuire, Hayden, Setiadi, Bickford & Brown, *C. wallacei* Hayden, Brown, Gillespie, Setiadi, Linkem, Iskandar, Umilaela, Bickford, Riyanto, Mumpuni & McGuire, and *C. batik* Iskandar, Rachmansah & Umilaela (Fig. 1).

In 2009, the Indonesian Institute of Sciences (LIPI) collaborated with the University of California, Davis (UC Davis) to form the Indonesian International Cooperative Biodiversity Groups (ICBG) Project Mekongga. This international team conducted biodiversity inventories in the Mekongga Mountains from 2009 through 2011. The purpose of the inventory was to estimate species richness and determine the distribution of vertebrates along an elevation gradient, starting from 300 m to the summit of the mountain at 2600 m. The area is characterized by tropical lowland evergreen forest and tropical montane forest (Mortelliti *et al*., 2012). *Cyrtodactylus* was relatively common in lowland and hill forests and the team collected several specimens representing two forms.

Herein we describe a series of *Cyrtodactylus* specimens from Mekongga as a new species. It is readily distinguished from all congeners, both from Wallacea and elsewhere in the range of the genus by a unique combination of characters.

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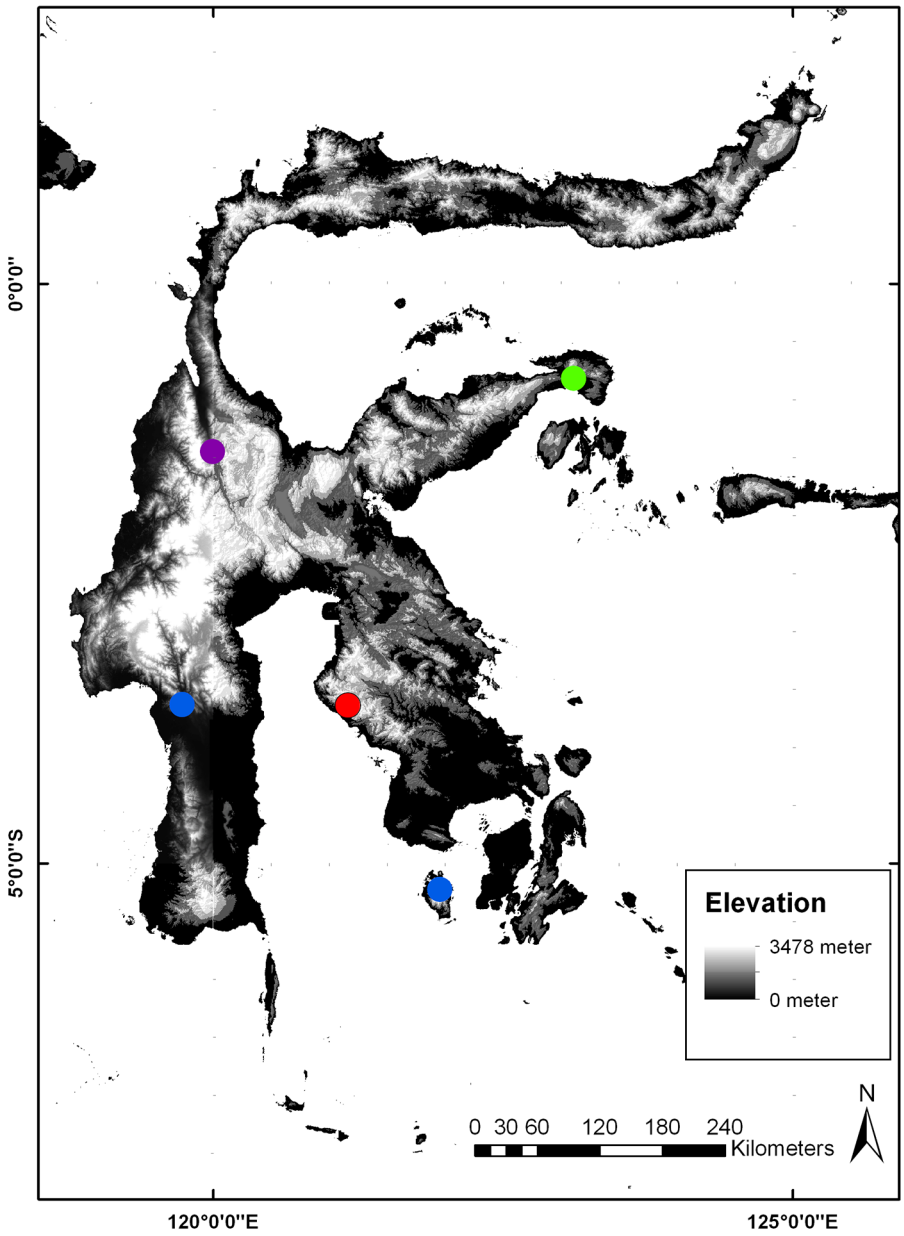

FIGURE 1. Distribution pattern of known Sulawesian *Cyrtodactylus* based on type localities with restricted range. Red circle = *C. hitchi* **sp. nov.**, Green circle = *C.batik*, Purple circle = *C. spinosus*, Blue circle = *C. wallacei*, and Yellow circle = *C. fumosus*. Distribution of the widespread *C. jellesmae* complex is not shown.

Material and methods

The ICBG research team conducted comprehensive vertebrate and botanical surveys in the Masembo Watershed, west facing flank of the Mekongga Mountains in July 2009, July and November 2010, and July and November 2011. The area was accessed on foot from the town of Tinukari (3.67668ºS and 121.033229ºE). The Masembo Watershed is dissected by several rivers and streams and is very steep, rising 2600 m in less than 24 km from the coast. Sampling methods for lizards included hand collection, trapping (sticky traps), and pitfalls.

Measurements were taken with Mitutoyo dial calipers to the nearest 0.1 mm under an AmScope microscope, following Grismer *et al.* (2014). These included: 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 for both original or regenerated; tailwidth (TW), taken at the base of the tail immediately posterior to the postcloacal swelling; forearm length (FL), taken on the dorsal surface from the posterior margin of the elbow while flexed 90º to the inflection of the flexed wrist; tibia length

(TBL), taken on the ventral side from the posterior surface of the knee flexed at 90° to the base of the heel; head length (HL), the distance from the posterior edge 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; eyeball 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 anterior most edge of the eyeball to the tip of the snout; eye-to-nostril distance (EN), measured between the anterior margin of the eyeball to the posterior margin of the external nares; interorbital distance (IO), measured across the head between the anterior edges of the orbit; ear length (EarL), the greatest horizontal distance of the ear opening; and internarial distance (IN), measured between the medial edges of the nares across the rostrum, and Hikida (1990): axial to groin (AGL), measure between the postaxial margin of the arm and preaxial margin of the leg.

The following meristic characters were evaluated following Grismer (2005): precloacal pores (PP), enlarged precloacal scales (EPS), femoral pores (FP), enlarged femoral scales (EFS), longitudinal rows of tubercles at midbody between ventrolateral folds (DT), paravertebral tubercles between midpoint of forelimb insertion and midpoint of hind limb insertion (PVT), and ventral scales across venter between ventrolateral folds (VS). Following Oliver *et al.* (2011), supralabial and infralabial scales were counted to both the midpoint of the eye and to the rictus (SuL) and infralabials (InL, including all enlarged scales from mental to rictus). Number of subdigital lamellae on fingers (F1–F5) and toes (T1–T5), counted from the most proximal lamella at least twice as large as adjacent palmar scales and not including the elongate ungual scale at the base of the claw. Measurements and scale counts were made on the right side of each specimen unless otherwise noted. Following Grismer *et.al.* (2016), we evaluated an abrupt versus smooth transition between rows of large and small postfemoral and ventral femoral scales. To visualize some structures, such as subdigital keels, we applied the reversible stain methylene blue in 70% alcohol (Harvey *et. al.* 2015). Sex was determined by the presence or absence of hemipenes, which were everted at the time of preparation. SVL, TL, and regenerated TL were measured both prior to and after fixation. Color notes were taken from digital images of living specimens prior to preservation. In the comparison of the subcaudal scales, we follow Kathriner *et al.* (2014) who described the subcaudal area as the region of tail from the point where the hind limbs articulate to the distal-most point of the hind toes when the leg is bent backwards along the tail.

Latitude, longitude, and elevation of localities of the specimens collected were recorded using a Garmin GPSmap 60CSx using WGS 84 map datum. Some of the information on character states and their distribution in other species were obtained from Boulenger (1896), Dunn (1927), Hikida (1990), Grismer (2005), Grismer & Leong (2005), Youmans & Grismer (2006), Rösler *et al*. (2007), Grismer *et al*. (2008, 2012), Hayden *et al.* (2008), Linkem *et al.* (2008), Oliver *et al.* (2009), Iskandar *et al.* (2011), Riyanto (2011), Riyanto *et al.* (2014, 2015a,b) and Hartmann *et al.* (2016). We also compared our samples to museum specimens (Appendix)

The holotype was deposited in Museum Zoologicum Bogoriense (MZB) Indonesia, whereas the paratypes were deposited in the MZB and the U.C. Davis Museum of Wildlife and Fish Biology (MWFB), USA. Tissue samples (liver) are archived at MZB with redundant samples at MWFB.

***Cyrtodactylus hitchi* sp. nov. Riyanto, Kurniati & Engilis**

English common name: Hitch's Bent-toed Gecko

Indonesia common name: Cicak Jari Lengkung Hitch

(Figs 2–6)

Holotype. MZB.Lace.8642, an adult male from Camp 3, desa Tinukari, kecamatan Wawo, kabupaten Kolaka Utara, Mekongga Mountains (03.6399ºS; 121.14974ºE, 936 m asl), South East Sulawesi Province, Indonesia; collected by Hellen Kurniati and Wahyu Trilaksono on 3 December 2010.

Paratypes. MZB.Lace.8635–36, 8640–41, 8643–48, MWFB 1054, 1116, from between 03.635943 – 03.63994ºS; 121. 148971 – 121.16268ºE; alt.; 934–1103 m asl collected 25 November – 7 December 2010.

Diagnosis. A small-sized *Cyrtodactylus* with SVL up to 70.3 mm in males, 79.0 mm in females; 18–20 irregularly aligned rows of keeled tubercles; 27–30 paravertebral tubercles; 40–45 ventral scales between

ventrolateral folds; ventrolateral folds with tubercles; no precloacal groove; no precloacal pores; no enlarged femoral and precloacal scales; no femoral pores; 18–20 lamellae beneath fourth toe; smooth transition between rows of large and small postfemoral and ventral femoral scales; and greatly enlarged transverse median subcaudal scales arranged in a single row.

FIGURE 2. Dorsal (above) and ventral (Below) views of the preserved holotype of *Cyrtodactylus hitchi* **sp. nov.** (MZB.Lace.8642). Photo by A. Ryanto.

Description of Holotype. An adult male, SVL 70.39 mm; head moderately long (HL/SVL=0.30), relatively narrow (HW/HL=0.65), depressed (HH/HL=0.39), distinct from neck; lores and interorbital regions concave; canthus rostralis prominent and rounded; frontonasal region concave; snout elongate (ES/HL=0.44), relatively pointed, longer than ED (ED/ES=0.63). Scales on snout and forehead small, rounded, granular, homogeneous; eye large (ED/HL=0.28) with vertical pupil; supraciliaries short; ear opening oval, large (EarL/HL=0.15); EE>ED (EE/ED=0.93); rostral incompletely divided dorsally by a shallow Y-shaped groove; two enlarged supranasals separated from one another by a three intersupranasals, the supranasals and intersupranasal completely surrounded by the smaller scales; naris oval, bordered by rostral anteriorly, first supralabial ventrally, one supranasal dorsally, and three small postnasals posteriorly; orbit separated from supralabials by a row of small scales; mental triangular, wider (2.9 mm) than deep (1.9 mm), bordered anterolaterally by first infralabials and posteriorly by paired elongate primary postmentals that contact medially for 40% of their posterior sections (Fig. 4A); primary postmentals bordered by two enlarged secondary postmentals and three slightly large gular scales (Fig. 4A); both right and left sides consist of 12 supralabials counted to the rictus, 9 counted to the midpoint of the eye; 10 infralabial scales counted to the rictus.

Body elongate (AGL/SVL=0.45); ventrolateral folds small, with scattered rounded tubercles; ventral region with relatively homogeneous, smooth scales; dorsal scales small, granular, with scattered irregular, relatively enlarged keeled tubercles; 20 irregular longitudinal rows of tubercles at midbody; smallest tubercles on flanks and in the frontal region; 19 irregular transverse rows of tubercles between limbs. Ventral scales much larger than

dorsal scales, smooth, round, subimbricate, largest posteriorly; 42 ventral scale rows at midbody between ventrolateral folds; no precloacal groove; no precloacal pores; no enlarged femoral scales; no femoral pores; smooth transition between rows of large and small postfemoral and ventral femoral scales (Fig. 5A); scales on palmar surfaces granular, juxtaposed; scales on plantar surfaces and hind limbs granular, juxtaposed.

FIGURE 3. Head of paratype *Cyrtodactylus hitchi* **sp. nov.** (MZB.Lace.8643) in life, showing the iris greenish metallic during day light. Photo by H. Kurniati.

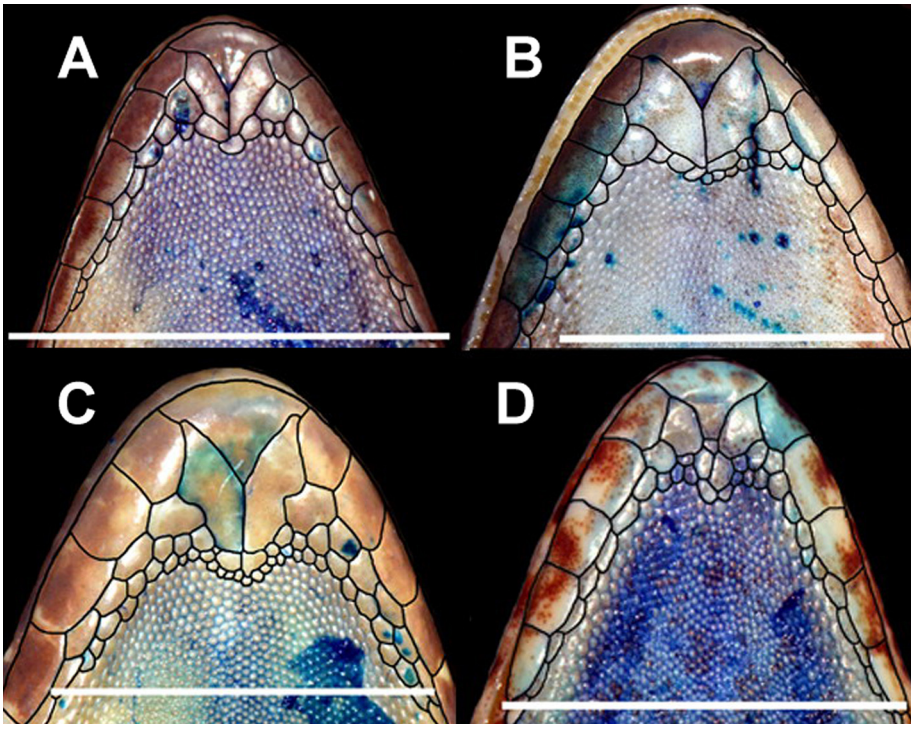

FIGURE 4. Comparison on chin shields between the new species and other Sulawesi members. (A). *Cyrtodactylus hitchi* **sp.nov.** (holotype: MZB.Lace.8642). (B) *C. batik* (holotype: MZB.Lace.8511). (C) *C. wallacei* (paratype: MZB.Lace.4264). (D) *C. spinosus* (holotype: MZB.Lace.7024). Bar = 10 mm.

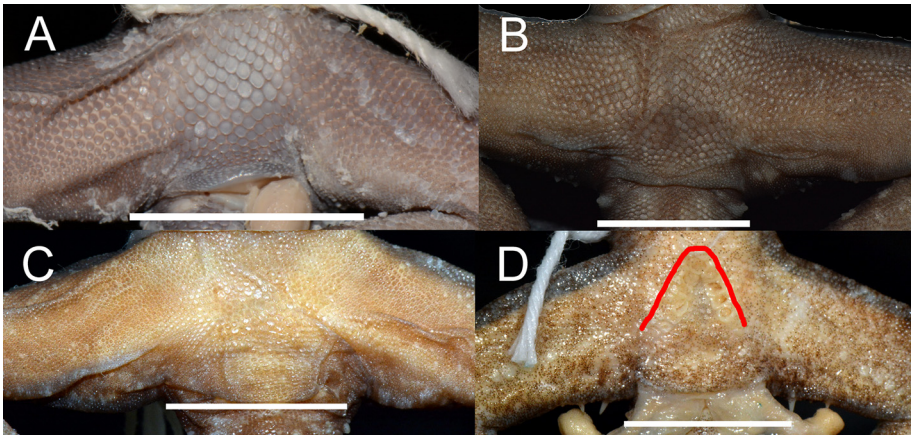

FIGURE 5. Comparison of precloacal and femoral region between the new species and other Sulawesi members. (A). *Cyrtodactylus hitchi* **sp.nov.** (holotype: MZB.Lace.8642). (B) *C. batik* (holotype: MZB.Lace.8511). (C) *C. wallacei* (paratype: MZB.Lace.4264). (D) *C. spinosus* (holotype: MZB.Lace.7024). Red curve shown the precloacal pores. Bar = 10 mm.

Forelimbs and hind limbs relatively robust (FL/SVL=0.18; TBL/SVL=0.19); digits well developed, inflected at basal interphalangeal joints; subdigital lamellae transversely expanded proximal to joint inflections, all bearing slightly curved claws; basal subdigital lamellae nearly as broad as digits; subdigital lamellae on manus I(13) II(14) III(16) IV(17) V(15), not including ventral claw sheath; count of subdigital lamellae on pes I(16) II(15) III(19) IV(20) V(18), not including ventral claw sheath; relative length of fingers IV>III>V>II>I and toes IV>V> III> II> I, the first toe is very short.

Tail cylindrical but broken at the tip; dorsally tubercles keeled from the base of tail to approximately 1/3 tail length. The tubercles are arranged in 11 irregular rings with each ring consisting of four tubercles with each separated by seven to nine small transverse scale rows; ventrally transversely enlarged median subcaudal scales arranged in a single row, these scales are smooth and hexagonal in form (Fig. 6A); three postcloacal tubercles on each side of tail base.

Coloration in Life. A strikingly marked *Cyrtodactylus*. Ground color of dorsum uniformly velvety brown, tubercles the same color as background. Four pairs of overlapping "><" shaped irregular yellow transverse bands between nape and base of tail and 10 similar markings on the tail, the first three being more or less similar to the dorsal pattern, the remainder less distinct in form with yellow spots and crosses. The areas within the overlapping "><" shaped marks are lighter compared to the dorsum. A yellow line borders the posterior margin of the head. Limbs with irregular yellow bands or spots at various angles; distinct yellow bars at the metacarpal-phalangeal joint; head coloration slightly lighter than dorsum, faintly marbled with yellow spots which are variable in size, a yellow line running along superciliaries to occiput, enclosing parietal region of head and posterior part of canthus rostralis; nape with a broad dark V-shaped bordered by yellow; rostral as dark as body coloration with yellow spots; iris greenish metallic during daylight (Fig. 3); lateral surfaces similar to dorsum but with yellow tubercles, sparsely arranged on the flanks, strongly contrasted with velvety black base color; venter and undersides of limbs uniformly blackish, ventral scales with numerous fine purple flecks covering otherwise pale scales. Pattern remains clearly evident in preserved specimens (Fig. 2), although yellow areas fade to white.

Variation. For other detailed measurements and character states for the entire type series see Table 1.

Natural History. All specimens were collected from secondary forest in various microhabitats such as on vegetation along streams, along rivers and foot paths, and on tree trunks and fallen logs (Fig. 7). *Cyrtodactylus hitchi* appears to have a relatively narrow elevational range corresponding to hill forest habitat ranging from 900–1100 m asl. We did not encounter the species above 1200 m asl and below 900 m asl. It is replaced below 500 m by *C. jellesmae*.

Etymology. The specific epithet is a noun in the genitive singular case, honoring Dr. Alan Thomas Hitch for his friendship and as the field leader of expeditions to the Mekongga.

Species comparisons. *Cyrtodactylus hitchi* **sp. nov.** is distinguished from all other congeners from Sundaland, Wallacea, and Eastern Indonesia except *C. batik*, *C. jellesmae*, *C. wallacei* by having the following unique

combination of characters: no precloacal groove, no precloacal or femoral pores and absent enlarged femoral scales.

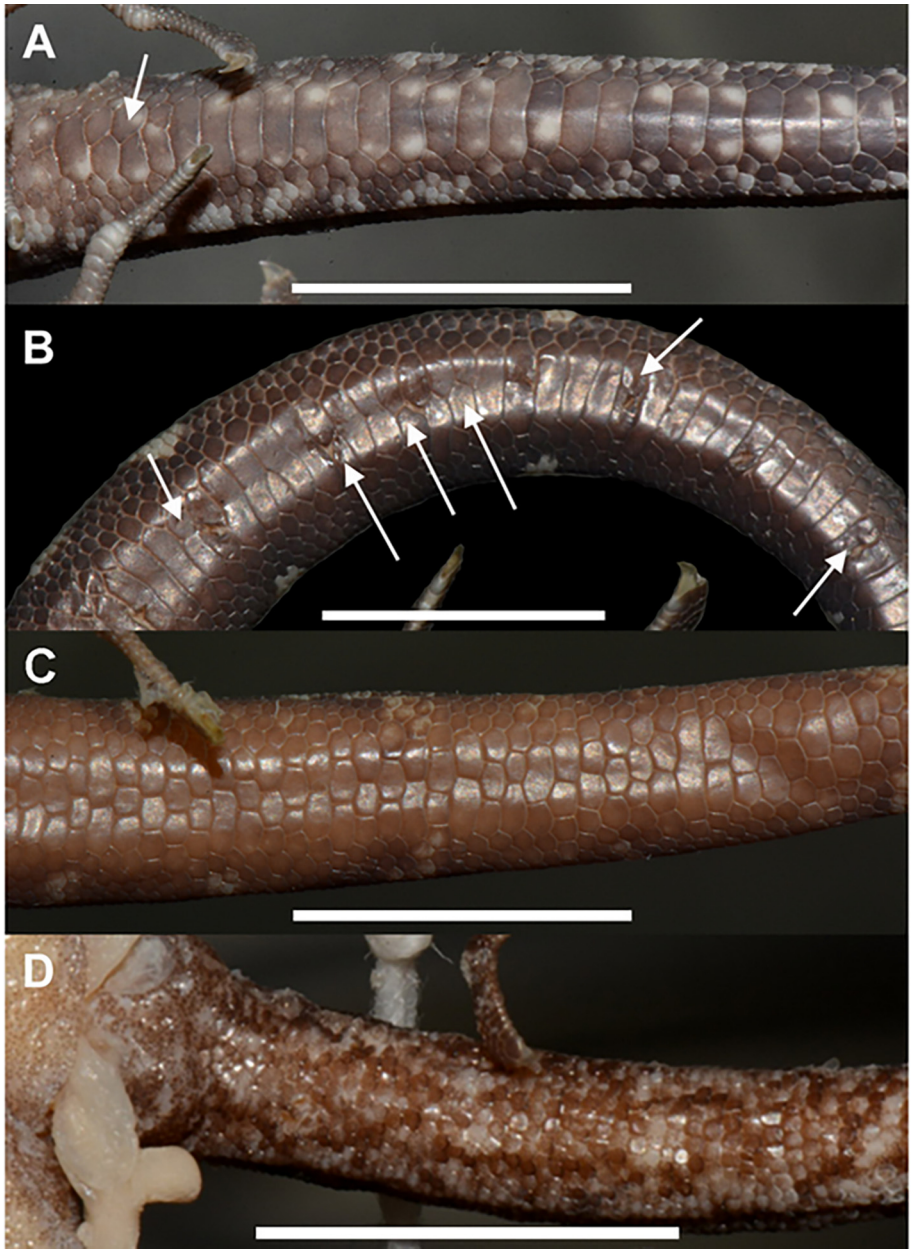

FIGURE 6. Comparison of subcaudal between the new species and other Sulawesi members. (A). *Cyrtodactylus hitchi* **sp.nov.** (holotype: MZB.Lace.8642). (B) *C. batik* (holotype: MZB.Lace.8511). (C) *C. wallacei* (paratype: MZB.Lace.4264). (D) *C. jellesmae* (MZB.Lace.6943). Bar = 10 mm.

The new species differs from *C. batik* in having a smaller SVL (79 mm *versus* 114.6 mm), fewer dorsal tubercles (18–20 *versus* 23–26), fewer lamellae under fourth toe (18–21 *versus* 24–27) and transversely enlarged median subcaudal scales arranged in a single row (as opposed to transversely enlarged median subcaudal scales in single row mixed with paired median subcaudal scales, Fig. 6A,B). It is distinguished from *C. fumosus* in having "><" shaped dorsal pattern (as opposed to blotched dorsal pattern), lacking a precloacal groove, absence of precloacal and femoral pores, absent enlarged femoral and precloacal scales, elongated primary postmentals that contact medially for 40% of their posterior sections (as opposed to having ~70% contact posteromedially), smooth transition between rows of large and small postfemoral and ventral femoral scales (as opposed abrupt); and have transversely enlarged median sub-caudal scales arranged in a single row (as opposed absent). Distinguished from *C. jellesmae* in having enlarged median subcaudal scales and "><" shaped dorsal pattern (as opposed to "V" shaped pattern) and transversely enlarged median subcaudal scales with arrangement in a single row (as opposed to a

fragmented pattern, *see* Fig. 6A,D). It is distinguished from *C. spinosus* in having fewer dorsal tubercles (18–20 *versus* 25–30), lacking a precloacal groove, lacking precloacal pores, lacking spines on the ventrolateral folds, and having primary postmentals in contact medially (as opposed to separated, see Fig. 4A,D) and having "><" shaped dorsal pattern (as opposed to "V" shaped pattern). Finally it is distinguished from *C. wallacei* in having smaller maximum SVL (79 mm versus 113.6 mm), fewer lamellae under fourth toes (18–21 *versus* 24–25) and transversely enlarged median subcaudal scales with arrangement in a single row (as opposed to smaller, variable size scales, see Fig. 6A,C).

Cyrtodactylus hitchi **sp. nov.** lacks a precloacal groove which separates it from several species including: *C. aurensis* Grismer, *C. astrum* Grismer Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels, *C. autralotitiwangsaensis* Grismer, Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels, *C. bintangtinggi* Grismer, Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels, *C. bintangrendah* Grismer, Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels, *C. cavernicolus* Inger & King, *C. durio* Grismer, Anuar, Quah, Muin, Onn, Grismer & Ahmad, *C. fumosus*, *C. halmahericus* (Mertens), *C. hikidai* Riyanto, *C. klakahensis* Hartmann, Mecke, Kieckbusch & Kaiser, *C. langkawiensis* Grismer, Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels, *C. lekaguli* Grismer, Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels, *C. macrotuberculatus* Grismer & Ahmad, *C. marmoratus* (Gray), *C. metropolis* Grismer, Wood, Onn, Anuar & Muin, *C. nuaulu* Oliver, Edgar, Mumpuni, Iskandar & Lilley, *C. papuaensis* (Brongersma), *C. payacola* Johson, Quah, Anuar, Muin, Wood , Grismer, Greer, Onn, Ahmad, Bauer & Grismer, *C. pubisulcus* Inger, *C. pulchellus* Gray, *C. semenanjungensis* Grismer & Leong, *C. spinosus* Linkem, McGuire, Hayden, Setiadi, Bickford & Brown, *C. stresemanni* Rösler & Glaw and *C. trilatofasciatus* Grismer, Wood, Quah, Anuar, Muin, Sumontha, Ahmad, Bauer, Wangkulangkul, Grismer & Pauwels.

Cyrtodactylus hitchi **sp. nov.** lacks precloacal pores which separates it from: *C. aurensis*, *C. baluensis*, *C. batucolus* Grismer, Onn, Grismer, Wood & Belabut, *C. boreoclivus* Oliver, Krey, Mumpuni & Richards, *C. brevipalmatus* (Smith), *C. cavernicolus*, *C. consobrinus* (Peters), *C. deveti* (Brongersma), *C. durio*, *C. elok* Dring, *C. fumosus*, *C. halmahericus*, *C. hikidai*, *C. ingeri* Hikida, *C. irianjayaensis* Rösler, *C. lateralis* (Werner), *C. klakahensis, C. leegrismeri* Chan & Norhayati, *C. loriae* (Boulenger), *C. majulah* Grismer, Wood & Lim, *C. malayanus* (de Rooij), *C. marmoratus*, *C. novaguineae* (Schlegel), *C. seribuatensis* Youmans & Grismer, *C. matsuii* Hikida, *C. nuaulu*, *C. papuensis* (Brongersma), *C. pantiensis* Grismer, Onn, Grismer, Wood & Belabut, *C. peguensis* Boulenger, *C. petani* Riyanto, Grismer & Wood, *C. pubisulcus* Inger, *C. pulchellus*, *C. psarops* Harvey, O'connell, Barraza, Riyanto, Kurniawan & Smith, *C. quadrivirgatus* Taylor, *C. semicinctus* Harvey , Barraza, Riyanto, Kurniawan & Smith, *C. seribuatensis*, *C. stresemanni*, *C. wetariensis* (Dunn) and *C. yoshii* Hikida.

Cyrtodactylus hitchi **sp. nov.** lacks femoral pores in both sexes which differs from the condition seen in *C. astrum*, *C. australotitiwangsaensis*, *C. baluensis* (Mocquard), *C. batucolus*, *C. bintangtinggi*, *C. bintangrendah*, *C. brevipalmatus*, *C. consobrinus*, *C. deveti*, *C. fumosus*, *C. halmahericus*, *C. irianjayaensis*, *C. klakahensis, C. lekaguli*, *C. loriae*, *C. macrotuberculatus*, *C. marmoratus*, *C. novaguineae*, *C. petani*, *C. pullchelus*, *C. seribuatensis*, *C. trilatofasciatus*, *C. wetariensis* and *C. zugi* Oliver, Tjaturadi, Mumpuni, Krey & Richards,

Cyrtodactylus hitchi **sp. nov.** possesses enlarged median subcaudal scales unlike *C. batucolus*, *C. brevipalmatus*, *C. cavernicolus. C. durio*, *C. elok*, *C. fumosus*, *C. gunungsenyumensis* Grismer, Wood, Anuar, Davis, Cobos & Murdoch, *C. jarakensis*, *C. jellesmae*, *C. klakahensis, C. laevigatus*, *C. lateralis*, *C. loriae*, *C. majulah*, *C. marmoratus*, *C. matsuii*, *C. metropolis*, *C. naulu*, *C. novaguineae*, *C. pantiensis*, *C. papuaensis*, *C. payacola*, *C.* petani, C. *psarops*, *C. pubisulcus*, *C. quadrivirgatus*, *C. rosichonariefi* Riyanto, Grismer & Wood, *C. semenanjungensis*, *C. semiadii* Riyanto, Bauer & Yudha, *C. semicintus*, *C*, *seribuatensis*, *C. sermowaensis*, *C. stresemanni*, *C. wetariensis* and *C. yoshii*.

Cyrtodactylus hitchi **sp. nov.** lacks an abrupt transition between rows of large and small postfemoral and ventral femoral scales thus differing from *C. astrum*, *C. australotitiwangsaensis*, *C. aurensis*, *C. baluensis*, *C. batucolus*, *C. bintangtinggi*, *C. bintangrendah*, *C. brevipalmatus*, *C. fumosus*, *C. gunungsenyumensis*, *C. klakahensis. C. leegrismeri*, *C. lekaguli*, *C. langkawiensis*, *C. macrotuberculatus*, *C. marmoratus*, *C. metropolis*, *C. seribuatensis*, *C. matsuii*, *C. pantiensis*, *C. payacola*, *C. petani*, C. *psarops*, *C. pulchellus*, *C. semicinctus*, *C. stresemanni*, *C. tebuensis*, *C. trilatofasciatus*, *C. wetariensis* and *C. zugi*.

TABLE 1. Morphometric characters of the type series of *Cyrtodactylus hitchi* **sp. nov.**

Catalog number	MZB											MWFB	
	8642 Holotype	8635	8636	8640	8641	8643	8644	8645	8646	8647	8648	1116	1054
Collecting date	3-xii-10	25-xi-10	25-xi-10	2-xii-10	3-xii-10	3-xii-10	4-xii-10	5-xii-10	5-xii-10	5-xii-10	7-xii-10	25-xi-10	5-xii-10
Sex	Male	Male	Female	Female	Female	Female	Female	Female	Male	Female	Male	Male	Male
SuL (Right/left)	12/12	11/12	11/11	11/12	11/11	11/10	11/11	10/11	10/12	18/12	11/12	10/10	10/11
InL (right/Left)	10/10	9/9	9/9	10/10	11/10	9/9	9/9	9/9	9/10	10/10	10/9	9/9	9/9
DT	20	20	20	20	20	19	20	20	18	19	19	20	20
PVT	29	30	30	30	28	29	30	27	30	28	29	30	30
VS	42	39	40	44	45	44	43	42	44	45	41	40	40
F1	13	11	11	14	13	12	12	12	13	12	11	12	13
F2	14	14	13	15	14	15	14	16	14	16	15	13	13
F3	16	16	15	16	16	17	16	16	16	17	17	15	16
F4	17	17	15	17	15	15	16	16	16	17	16	16	17
F5	15	15	14	16	14	16	15	16	16	15	15	15	16
T1	16	11	14	15	14	14	15	15	14	12	15	13	15
T2	15	15	15	16	16	16	15	16	16	15	16	15	15
T3	19	19	18	18	17	19	19	18	18	17	19	17	18
T4	20	20	20	21	18	19	19	19	21	20	20	18	18
T5	18	19	19	20	18	19	20	18	broken	19	18	18	20
SVL	70.3	62.4	65.9	69	78.7	79	73.4	74.6	73.5	72	65.1	71	68
TL	53.8 broken	82.9	93.7	78.4	104.6	79.9	103.7	79.6	100.6	11.6 broken	71.9	92	94
HL/SVL	0.30	0.28	0.31	0.27	0.31	0.30	0.29	0.29	0.29	0.30	0.29	0.30	0.29
HW/HL	0.65	0.68	0.58	0.59	0.64	0.65	0.63	0.66	0.64	0.68	0.60	0.66	0.63
HD/HL	0.39	0.40	0.35	0.32	0.38	0.37	0.38	0.41	0.38	0.40	0.37	0.38	0.36
ES/HL	0.44	0.46	0.37	0.42	0.39	0.38	0.38	0.40	0.40	0.41	0.38	0.48	0.41
ED/ES	0.63	0.53	0.64	0.73	0.65	0.71	0.65	0.65	0.71	0.68	0.69	0.59	0.57
EE/ED	0.93	1.23	1.10	0.93	1.05	1.09	1.08	1.05	1.05	0.92	0.98	1.02	1.08
ED/HL	0.28	0.24	0.24	0.31	0.25	0.27	0.24	0.26	0.28	0.28	0.26	2.27	0.24
EarL/HL	0.15	0.11	0.12	0.13	0.08	0.08	0.10	0.09	0.09	0.06	0.10	0.06	0.07
AGL/SVL	0.45	0.42	0.39	0.42	0.43	0.42	0.43	0.46	0.44	0.50	0.45	0.50	0.46
FL/SVL	0.18	0.17	0.16	0.14	0.16	0.17	0.16	0.17	0.16	0.14	0.16	0.15	0.16
TBL/SVL	0.19	0.21	0.21	0.19	0.20	0.18	0.19	0.20	0.20	0.20	0.19	0.19	0.18

FIGURE 7. Habitat type of *Cyrtodactylus hitchi* **sp. nov.** in near Camp 3, desa Tinukari, kecamatan Wawo, kabupaten Kolaka Utara, Mekongga Mountains, South East Sulawesi Province, Indonesia. Photo by H. Kurniati.

Discussion

Among Sulawesi *C. hitchi* **sp. nov.** is rather unique in coloration and meristic characters. Although we cannot speculate relationships, morphologically it shares several traits with *C. batik*. However, unlike several species recently described in Sulawesi from the *C. jellesmae* group, through genetic analysis, (Linkem *et al.* 2008), *C. hitchi* **sp. nov.** has clear external traits that distinguish it from all other Sulawesi bent-toed geckos. Also with little exploration of South East Sulawesi, we are not certain of the overall distribution of this species on the peninsula or if it is a Mekongga endemic. Based on results of our elevational study in the Masembo Watershed, *Cyrtodactylus* is a low elevation group found below 1200 m. Two species were encountered; *C. jellesmae* was observed at sea level in Tinukari, and collected up to an elevation of 500 m. It is well adapted to anthropogenic habitats including gardens, houses, cacao plantations and degraded forest edge. *Cyrtodactylus hitchi* **sp. nov.**was found above 900 m and was associated with more intact forest habitat and secondary forest, including forest-edge habitats. Both species were a common component of the herpetofauna at their respective elevations. As with other regions of Sulawesi, the two species of *Cyrtodactylus* recorded in the Mekongga Mountains appear allopatric. *Cyrtodactylus hitchi* is a small species, and as a result may be range restricted by the larger *C. jellesmae* found at lower elevations. Its upper elevation limits may be restricted by temperature or other abiotic factors. However, more study is needed to understand the distribution and ecology of *C. hitchi* **sp. nov.**

Discovery of a distinctive species such as *C. hitchi* **sp. nov.** underscores the underestimated herpetological diversity on the island of Sulawesi (Koch 2011). Several have predicted that numbers of species will dramatically increase due in part to discovery of cryptic species and the exploration of under-surveyed regions (Iskandar & Tjan 1996; Brown *et al.* 2000; Evans *et al.* 2003a,b; Linken *et al* 2008; Hayden *et al.* 2008;Amarasinghe *et al.* 2015). South East Sulawesi remains one of the island's least biologically explored areas and still contains some of the most intact forest systems found on the island. Thus, the ICBG expeditions have yielded numbers of new species across all taxa that are still being analyzed and formally described. As new species from our work come to light, necessitating an analysis of relationships and biogeographic patterns on the landscape and an assessment of the role the Mekongga Mountains play in regional and island-wide speciation.

TABLE 2. Comparison of selected mensural and meristic characters among the four most distinctive *Cyrtodactylus* of Sulawesi. A—from Linken *et al.* (2009); B—from Iskandar *et al.* (2010); C—from Grismer *et al.* (2012).

	Cyrtodactylus hitchi **sp nov.**	*Cyrtodactylus batik*	*Cyrtodactylus fumosus*	*Cyrtodactylus jellesmae*	*Cyrtodactylus spinosus*	*Cyrtodactylus wallacei*
Reference	This study	B, n=1	C	n=2	A, n=3	n=3
Maximum SVL (in mm)	79	114.6	70	64.8	83.2	113.6
DT	18–20	23–26	16–18	18–20	25–30	23–25
PVT	27–30	33–40	30–33	28–35	7–9	29–31
VS	40–45	48–57	35–40	40–50	38–44	46–48
Precloacal groove	no	no	yes	no	yes	no
PP (PFP)	0	0	yes	0	12–13	0
Ventrolateral fold	with tubercles	with tubercles	with tubercles	with tubercles	spinose scales	with tubercle
Transversely enlarged median subcaudal	single row	mostly single row mix with double	no	fragmented	no	variable in size
Lamellae under 4th toe	18–21	24–27	20–22	20–23	19–21	24–25
Dorsal pattern	“><” shaped	“><” shaped	blotched	“V” shaped	“V” shaped	“><” shaped
Abrupt transition between rows of large and small postfemoral and ventral femoral scales	no	no	yes	no	no	no

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APPENDIX 1. Specimens examined.

Cyrtodactylus batik: MZB.Lace.8511 (holotype), female, Central Sulawesi, Indonesia.
Cyrtodactylus consobrinus: MZB.Lace.4355, MZB.Lace.8851–52, males, Martabe, South Tapanuli, North Sumatra, Indonesia.
Cyrtodactylus deveti: MZB.Lace.7956, 8164-65, males, Halmahera, Indonesia
Cyrtodactylus halmahericus: MZB.Lace. 13250, 6086-87, males, Halmahera. Indonesia
Cyrtodactylus jellesmae: MZB.Lace.5686, 5688, males, South Sulawesi; MZB.Lace.6943, Minahasa, Indonesia.
Cyrtodactylus malayanus: MZB.Lace.2928-29, males, East Kalimantan; MZB.Lace.8854–57 males, North Sumatra, Indonesia.
Cyrtodactylus marmoratus: MZB.Lace.12902, 12905, 12907, 12924, males, West Java; MZB.Lace. 12912– 12913, males, Central Java, Indonesia.
Cyrtodactylus petani: MZB.Lace.12899 (holotype), 11707–11710 (paratypes), males, East Java, Indonesia.
Cyrtodactylus semiadii: MZB.Lace.9104 (holotype), 9105 (paratype), males, East Java, Indonesia.
Cyrtodactylus spinosus: MZB.Lace.7024 (holotype), male, 7028-29 (holotypes), females, Central Sulawesi, Indonesia.
Cyrtodactylus wallacei: MZB.Lace.4264 (paratype), adult female, South East Sulawesi, Indonesia.
Cyrtodactylus zugi: MZB.Lace.6454, adult male, Waigeo Island, Indonesia.