



A new species of *Gekko* (Squamata: Gekkonidae) from Tà Kóu Nature Reserve, Binh Thuan Province, Southern Vietnam

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Abstract

A new species of *Gekko* Laurenti is described from Tà Kóu Mountain, an isolated granitic peak in Tà Kóu Nature Reserve, Ham Thuan Nam district, Binh Thuan province, southern Vietnam. The species is distinguished from its congeners by its moderate size, with snout to vent length (SVL) reaching a maximum 107.0 mm; dorsal pattern of 5–8 white vertebral blotches between the nape and sacrum and 6–8 pairs of short white bars on the flanks; 11–14 precloacal pores in males; 14–17 longitudinal rows of smooth dorsal tubercles; and 18–20 broad lamellae beneath the fourth toe. *Gekko takouensis* **sp. nov.** is the second endemic gekkonid discovered in the Tà Kóu Nature Reserve, *Cyrtodactylus takouensis* Ngo & Bauer being the first.

Key words: Conservation, *Gekko takouensis* **sp. nov.**, granitic outcrop, Tà Kóu Mountain, Vietnam

Introduction

The last decade has seen a dramatic increase in the number of gekkotan species described from Vietnam and 21 of the 22 new species described since 2000 are endemic (Geissler *et al.* 2009; Grismer & Ngo 2007; Heidrich *et al.* 2007; Hoang *et al.* 2007; Nazarov *et al.* 2008; Ngo 2008; Ngo & Bauer 2008; Ngo *et al.* 2008; Ngo & Ziegler 2009; Nguyen *et al.* 2006; Orlov *et al.* 2007; Orlov *et al.* 2008; Rösler *et al.* 2005; Ziegler *et al.* 2002; Ziegler *et al.* 2008). The majority of these newly described geckos have limited distributions occurring on offshore islands or in isolated, rocky terrain such as karst outcrops and limestone caves. Most have been within the genera *Cyrtodactylus* Gray and *Cnemaspis* Strauch but two new *Goniurosaurus* Barbour, a new *Dixonius* Bauer, Good & Branch and three new *Gekko* Laurenti have also been described (Ngo *et al.* 2009; Ngo & Ziegler 2009; Rösler *et al.* 2005; Rösler *et al.* 2010; Ziegler *et al.* 2008).

There are 14 species of *Gekko* in Indochina (Bauer *et al.* 2008; Bobrov 1995; Darevsky & Orlov 1994; Grossmann & Ulber 1990; Günther 1994; Ngo *et al.* 2009; Ota *et al.* 1995; Rösler *et al.* 2005; Rösler *et al.* 2010; Szczerbak & Nekrasova 1993; Taylor 1962). Eight occur in Vietnam: *Gekko gecko* (Linnaeus), *G. palmatus* Boulenger, *G. ulikovskii* Darevsky & Orlov; *G. badenii* Szczerbak & Nekrasova, *G. grossmanni* Günther, *Gekko scientiadventura* Rösler, Ziegler, Vu, Herrmann & Böhme *Gekko canhi* Rösler, Nguyen, Doan, Ho, Nguyen & Ziegler, 2010 and *G. russelltraini* Ngo, Bauer, Wood & Grismer (Bobrov & Semenov 2008; Ngo *et al.* 2009, Rösler *et al.* 2010). *Gekko chinensis* (Gray) and *G. japonicus* (Schlegel) have historically been listed as occurring in Vietnam but their presence is doubtful (Ota *et al.* 1995).

Recent surveys conducted on Tà Kóu Mountain, an isolated peak in Binh Thuan Province, southern Vietnam, have uncovered two new gecko species. *Cyrtodactylus takouensis* was described by Ngo & Bauer (2008) and here we describe another of the genus *Gekko* from the same region.

Materials and methods

Field surveys were conducted in November 2005 and June – August 2009. Voucher specimens were collected by hand during the day and at night. Geographic coordinates and elevation were recorded using a Garmin III GPS. Photographs were taken using a Panasonic DMC-FZ30 digital camera and Sony DCR-TRV22. Specimens were first euthanized with tricaine methanesulfonate (MS-222) following Conroy *et al.* (2009) and subsequently fixed in 10% neutral buffered formalin, rinsed in water and finally stored in 75% ethanol. Liver samples, for use in subsequent DNA analyses, were stored in 95% ethanol and kept in cool conditions. All type specimens were deposited in the Zoological Collection of the University of Natural Sciences (UNS) in Hochiminh City, Vietnam.

The following measurements were taken with a digital caliper following the methods of Bauer *et al.* (2002; 2003): crus length (CrusL); ear length (EarL); eye to ear distance (EyeEar); forearm length (ForeaL); head depth (HeadD); head length (HeadL); head width (HeadW); internarial distance (Internar); interorbital distance (shortest distance between left and right superciliary scale rows) (Interorb); orbital diameter (OrbD); snout to eye distance (SnEye); nare to eye distance (NarEye); snout–vent length (SVL); tail length (TailL); trunk length (TrunkL). Measurements are reported to the nearest 0.1 mm, but mensural ratios calculated from raw measurements are reported to the nearest 0.01 mm. Measurements and scale counts were taken from the right side of each gecko unless otherwise noted. Scale counts and external observations on morphology were made using an Olympus SZ binocular dissecting microscope. The following meristic values were recorded: number of dorsal scale rows at midbody (MidBod); number of longitudinal rows of tubercles at midbody (TubRow); number of ventral scales between the ventrolateral folds at midbody (VentSc); number of chin scales bordering posterior margin of the first postmental scales (ChinSc); number of supralabials (SupraL); number of infralabials (InfraL); number scales across narrowest point of frontal bone (FrontSc); number of interorbital scale rows (IntOrb); number of subdigital lamellae under digit I of pes (LamPesI); number of subdigital lamellae under digit IV of pes (LamPesIV); number of postanal tubercles at tail base (PAT); number of precloacal pores (PrecP); and the number of middorsal scales rows in the third caudal whorl (Whorl3).

Comparisons were made with specimens in the Zoological Museum of the National University of Hanoi and the Zoological Collection of University of Natural Sciences, as well as original species descriptions and other published faunal and taxonomic treatments (e.g., Bauer *et al.* 2008; Darevsky & Orlov 1994; Grossmann & Ulber 1990; Günther 1994; Ngo *et al.* 2009; Ota *et al.* 1995; Rösler *et al.* 2005; Rösler *et al.* 2010; Szczerbak & Nekrasova 1993; Taylor 1962; Zhou *et al.* 1982).

Systematics

Gekko takouensis sp. nov.

Figs 1–2.

Holotype. Zoological Collection of University of Natural Sciences in Hochiminh City UNS 0491, adult male (Fig. 1A); Tà Kóu Mountain, Ham Thuan Nam district, Binh Thuan Province, Vietnam, approximately 425 m elevation (10°48.815'N, 107°53.718'E), collected by Ngo Van Tri, 30 June 2009.

Paratypes. UNS 0489–90 and 0492–0497 (Figs 1B, C), adult males except for UNS 0495, subadult male, were also collected by Ngo Van Tri with holotype. UNS 0206 and UNS 0208 were collected on 2 November 2005.

Etymology. The specific epithet *takouensis* denotes the name of the mountain and nature reserve where the type series was collected. We suggest the following common names: English — Ta Kou Marbled Gecko; Vietnamese — Thằn lằn đá Tà Kóu.

Diagnosis. A medium sized *Gekko*, maximum SVL 107.0 mm, distinguished from its congeners by the following combination of characteristics: dorsum with 14–17 longitudinal rows of enlarged, smooth tubercles; 83–93 scale rows at midbody; 30–34 ventral scale rows between ventrolateral folds at midbody; 11–14 precloacal pores in males in an angular, continuous series; 18–20 subdigital lamellae on fourth toe; dorsal

pattern of 5–7 whitish vertebral blotches between nape and sacrum, and 6–8 pairs of short, sometimes irregular spots or white bars on flanks between limb insertions.

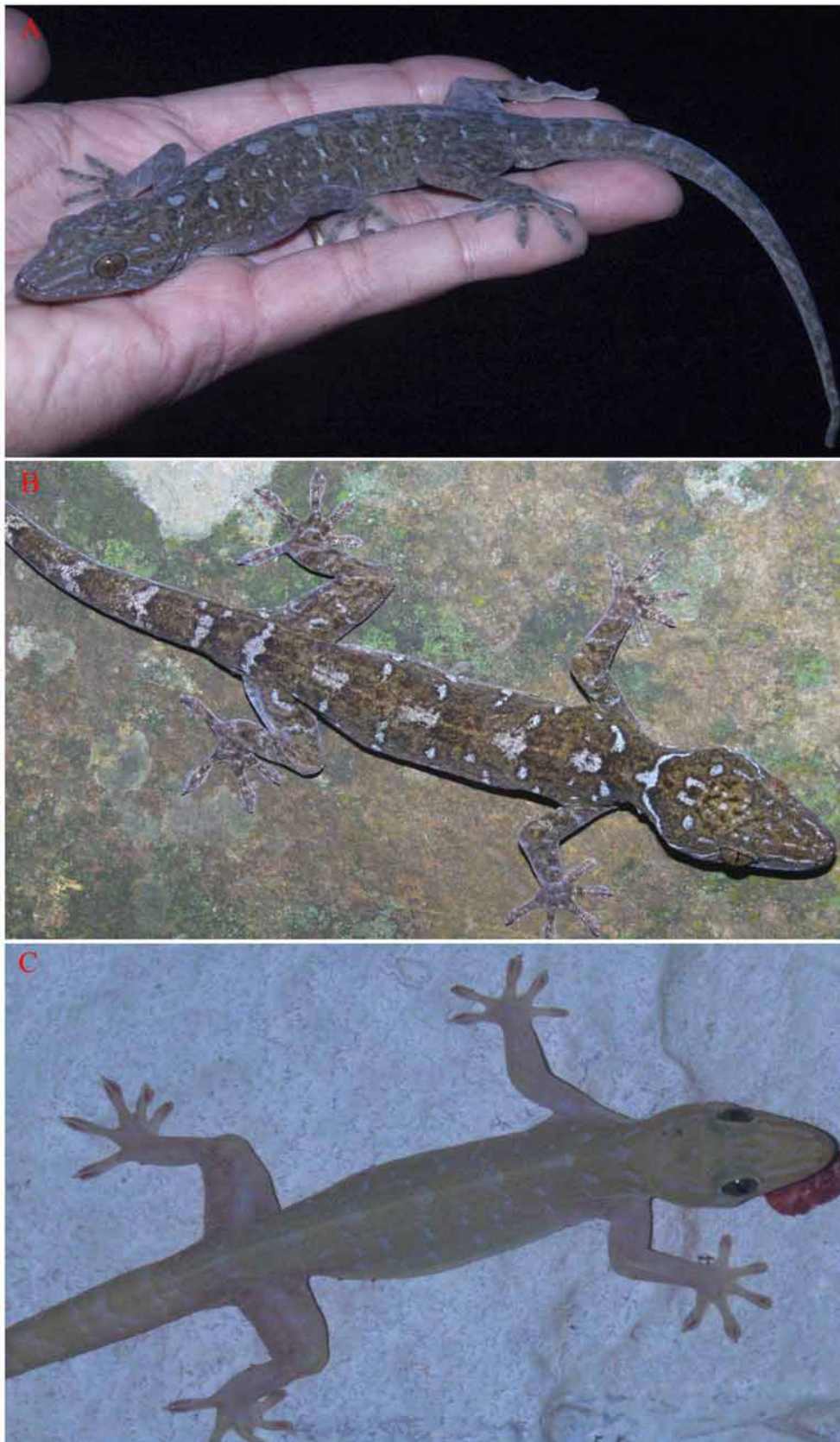


FIGURE 1. *Gekko takouensis* sp. nov. (A) Holotype UNS 0491 in hand; B: Paratype UNS 0492 photographed *in situ*; C: Paratype UNS 0489 showing the lighter coloration often observed at night. Photographed *in situ* under a neon light on the dormitory wall of the Linh Son Pagada on Tà Kóu Mountain.

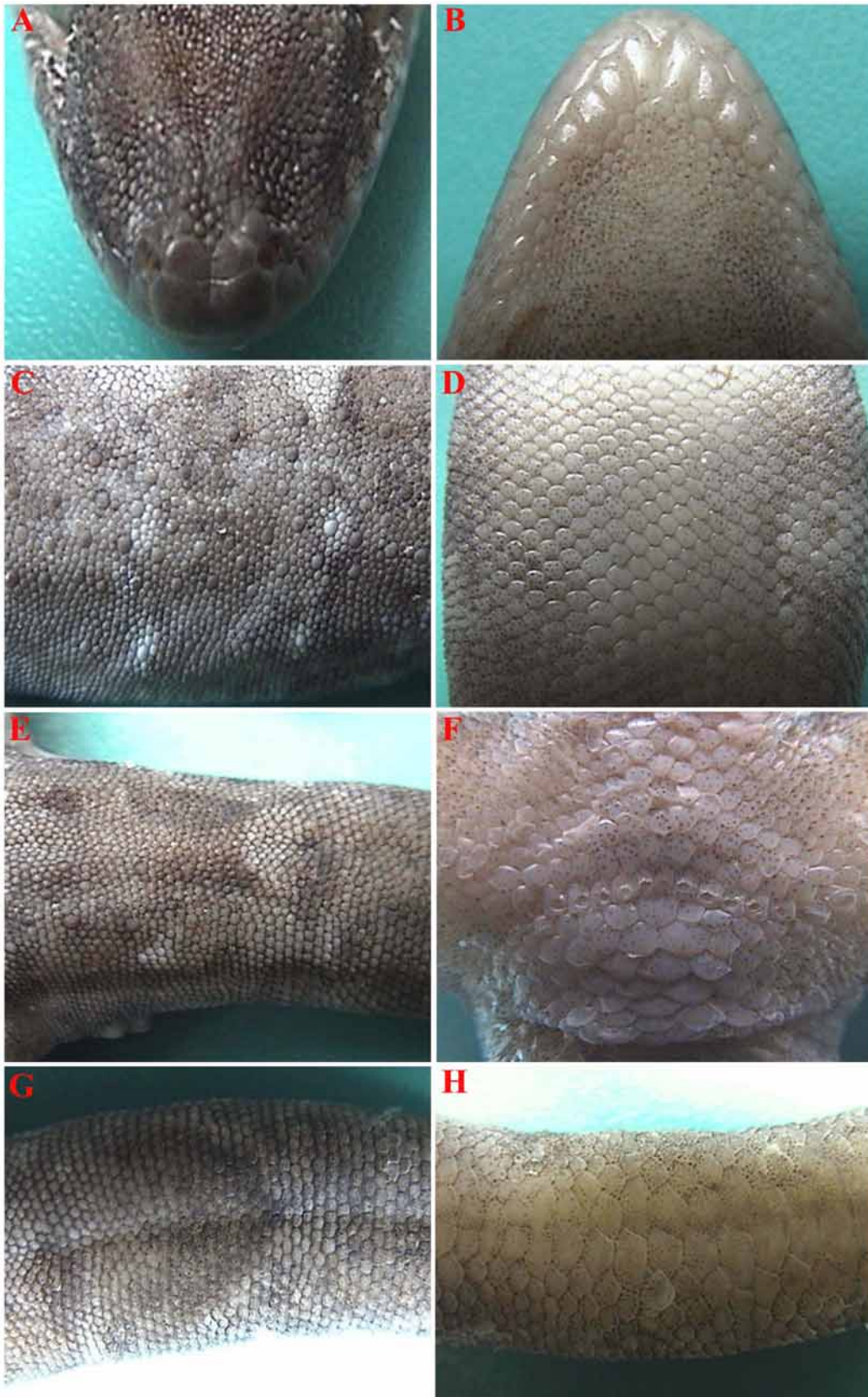


FIGURE 2. Detailed photographs of the holotype of *Gekko takouensis* **sp. nov.**, UNS 0491 (A) Detail of the rostrum, note the small scale in the dorsal cleft of the supralabials; B: Ventral view of the chin illustrating three enlarged postmental scales; C: Dorsal scalation at midbody, note smooth, enlarged rows of tubercles; D: Ventral view at midbody illustrating subimbricate ventral scales; E: Dorsal scalation of the base of the tail showing two smooth, postanal tubercles; F: Ventral view of the colocal area showing 13 preloacal pores; G: Dorsal view of the tail, note segmented scales and lack of tubercles; H: Ventral view of the tail illustrating the enlarged median subcaudal scales.

TABLE 1. Mensural and meristic data for the type series of *Gekko takouensis* sp. nov.

Sex	Holotype		Paratype		Paratype		Paratype		Paratype		Paratype		Paratype		Paratype		Min – Max $\bar{x} \pm$ S.D.
	UNS	M	UNS	M	UNS	M	UNS	M	UNS	M	UNS	M	UNS	M	UNS	M	
SVL	95.5	100.1	97.7	99.2	93.3	107.0	81.3	89.7	97.3	106.5	99.6	81.3 – 107.0 97.0 ± 7.3					
TailL	119.0	118.8	113.2	111.0	91.4 (Reg)	115.5	100.5	102.0	92.7	128.6 (broken)	73.8 (R)	100.5 – 128.6 113.6 ± 3.3					
HeadL	25.0	24.9	24.7	25.5	24.3	28.4	21.1	24.0	26.2	27.5	25.6	21.1 – 28.4 25.2 ± 0.6					
HeadW	16.4	17.9	17.4	16.8	16.5	20.1	13.6	16.5	17.8	19.5	16.7	13.6 – 20.1 17.2 ± 1.7					
HeadD	10.1	10.4	10.3	10.5	10.0	12.7	8.5	9.4	10.3	10.8	10.2	8.5 – 12.7 10.3 ± 1.0					
SnEye	10.4	10.1	10.5	10.5	9.7	11.7	8.8	9.9	10.8	11.7	10.9	8.8 – 11.7 10.5 ± 0.8					
NarEye	8.2	8.1	8.2	8.6	7.7	9.1	6.7	7.8	8.8	9.3	8.8	6.7 – 9.3 8.3 ± 0.7					
OrbD	5.7	6.0	5.8	6.1	5.5	6.2	4.7	5.1	5.7	6.2	5.9	4.7 – 6.2 5.7 ± 0.5					
EarL	2.7	2.7	2.6	2.8	2.7	3.4	2.2	3.0	2.6	3.3	2.7	2.2 – 3.4 2.8 ± 0.3					
EyeEar	8.9	9.3	8.8	9.6	9.0	11.1	7.6	8.7	8.9	10.9	8.7	7.6 – 11.1 9.2 ± 1.0					
Interorb	8.2	8.0	7.9	8.8	8.3	9.8	6.9	8.0	8.5	10.2	8.5	6.9 – 10.2 8.5 ± 0.9					
Internar	2.4	2.9	2.6	2.7	2.5	3.0	2.1	2.2	2.5	2.8	2.6	2.1 – 3.0 6.9 ± 10.2					
ForeaL	12.7	12.9	12.3	12.0	12.5	13.8	10.5	12.4	13.4	13.7	12.5	10.5 – 13.8 12.6 ± 0.9					

continued next page

TABLE 1. (continued)

Sex	Holotype		Paratype		Paratype		Paratype		Paratype		Paratype		Paratype		Min – Max $\bar{x} \pm$ S.D.
	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	UNS	
	0491	0489	0490	0492	0493	0494	0495	0496	0497	0206	0208				
M	M	M	M	M	M	M	M	M	M	M	M				11M
CrusL	16.3	16.4	15.1	14.5	16.5	17.1	13.4	15.4	16.4	18.2	16.2				13.4 – 18.2 16.0 ± 1.3
TrunkL	43.8	44.6	44.3	44.5	43.7	49.7	35.2	42.8	44.0	49.1	43.7				35.2 – 49.7 41.1 ± 3.7
Midbod	83	93	90	90	85	85	83	87	90	92	85				83 – 93
TubRow	16	17	16	16	16	16	14	16	16	16	17				14 – 17
VentSc	31	31	34	30	32	33	30	32	32	31	30				30 – 34
ChinSc	3	4	4	3	3	4	3	3	2	4	3				3 – 4
SupraL	13/15	13/14	14/13	13/13	15/14	14/14	14/14	14/15	14/16	14/14	13/14				13–15/13–16
InfraL	12/12	12/11	12/12	12/12	13/12	12/12	12/11	12/12	12/12	11/12	10/12				10–13/11–12
FrontSc	19	22	20	18	18	24	19	20	18	20	19				18 – 24
IntrOrb	29	29	31	34	27	27	27	28	27	30	27				27 – 34
LamPesI	15	14?	16	14	15	16	16	16	16	15	15				14 – 16
LamPesIV	18	18	18	18	19	18	18	18	19	20	19				18 – 20
PrecP	13	14	12	12	12	12	11	12	11	13	13				11 – 14
Whorl3	10	10	10	10	11	10	11	9	9	11	10				9 – 11

Description of holotype. (Fig. 1A), UNS 0491, adult male. SVL of 95.5 mm. Head relatively long (HeadL/SVL: 0.26), wide (HeadW/HeadL: 0.66), somewhat depressed (HeadD/HeadL: 0.40); head distinct from neck, snout tapering, rounded at tip. Loreal and interorbital regions weakly inflated, frontonasal region strongly concave, snout elongate (SnEye/HeadL: 0.42), pointed, longer than eye diameter (OrbD/SnEye: 0.55); scales on snout and forehead small, granular, homogeneous; scales on snout larger than those on occipital region except for scattered smooth tubercles (approximately 2–3 times size of adjacent scales); 29 interorbital scale rows. Eye large (OrbD/HeadL: 0.23); pupil vertical with crenulated margins when closed and round when opened to maximum; superciliaries smooth, short, bearing several minute conical spines posteriorly. Ear opening oval, obliquely oriented, small (EarL/HeadL: 0.11); eye to ear distance longer than diameter of the eye (EyeEar/OrbD: 1.56). Rostral quadrangular, much wider (3.1 mm) than high (1.3 mm), with a median shallow groove. Supranasals are in broad contact and a small scale lies in the shallow cleft between the dorsal portions of the supranasals (Fig. 2A); rostral in contact with supralabial I and supranasals; nostrils round, each surrounded by supranasal, rostral, first supralabial and two enlarged postnasals; 3–4 rows of small scales separate the orbit from supralabials. Mental triangular, wider (2.4 mm) than deep (2.2 mm); anterior pair of postmentals elongated (2.8 mm long, 0.8 mm wide), each bordered anteromedially by mental, medially in broad contact with other postmental, bordered anterolaterally by first infralabial, laterally by second postmental, posteriorly by three enlarged chin scales (Fig. 2B); 13 (right) to 15 (left) supralabials, 12 sublabials on both sides; 19 scale rows on the frontal bone and 29 interorbital scales in the closest distance between two eye edges.

Body robust, relatively short (TrunkL/SVL: 0.46) with weak ventrolateral folds. Dorsal scales smooth, round, granular and juxtaposed; 83 dorsal scale rows at midbody, intermixed with enlarged, smooth tubercles (2–5 times the size of adjacent scales, smaller on flanks, and smallest in occipital region) extending from occipital region to tail base; tubercles in 16 rows at midbody (Fig. 2C). Ventral scales much larger than dorsals, smooth, relatively hexagonal, and imbricate, largest posteriorly; 31 scale rows across venter between ventrolateral folds (Fig. 2D); gular region with relatively homogeneous, smooth scales. Thirteen precloacal pores arranged in angular series; somewhat enlarged scale rows extending posteriorly from pore-bearing scales to the anterior of cloacal lip (plate 2F); no enlarged femoral scales. Scales on palms and soles smooth, flattened, round, subimbricate without enlarged tubercles; smooth, flattened, subimbricate scales on venter of fore and hind limbs.



FIGURE 3. (A) Habitat of *Gekko takouensis* **sp. nov.** on Tà Kóu Mountain.

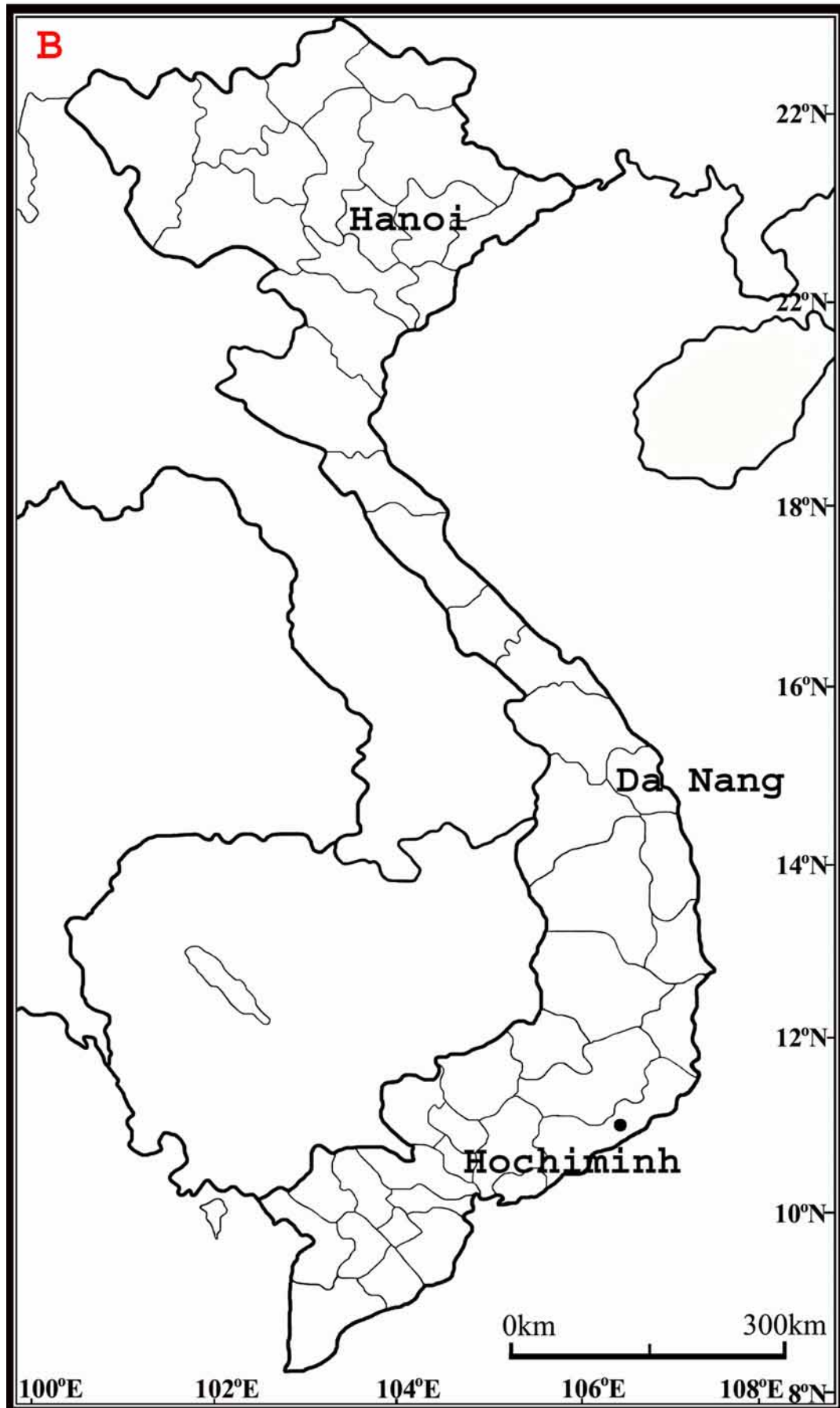


FIGURE 3. (B) Map showing the type locality of *Gekko takouensis* sp. nov. in Binh Thuan province, Vietnam.

Limbs long and relatively robust (ForeaL/SVL = 0.13; CrusL/SVL = 0.17). Digits moderately dilated, all bearing curved claws except the first finger and first toe; the following number of broad lamellae occur beneath each digit (17–13–15–18–14 manus; 15–15–19–18–18 pes); two to five narrow lamellar rows between base and digits; weakly developed interdigital webbing. Length of digits (measurement in mm in parentheses): manus: IV(7.8) > III(7.5) > V(6.3) > II(6.2) > I(4.3); (pes): V(9.6) > IV(9.5) > III(9.0) > II(7.8) > I(5.2).

Original tail relatively robust with shallow groove on its dorsum (Fig. 2G), tapering towards the tip; tail longer than snout vent length (TailL/SVL: 1.25), two smooth postanal tubercles on the right side and three on the left side (Fig. 2E). Tail segmented; each tail segment approximately 10 dorsal scales rows (Fig. 2G) and 3 transversely enlarged subcaudal scales in length; scales on the tail dorsum heterogeneous – rectangular to hexagonal, juxtaposed. Subcaudal region with 80 median enlarged transverse plates (Fig. H).

Coloration. (in preservative). Dorsal color is gray with a series of 5–7 whitish irregular vertebral blotches between the nape and sacrum. The anterior most dorsal blotch is occasionally in contact with a light-colored nuchal loop, although the nuchal loop is not always present. Dorsal blotches extend along the tail, becoming ring-like although not fully encircling the tail and occasionally chevron-shaped. There are 6–8 pairs of light-colored, small, irregular bars or spots along the flanks between limb insertions. The dorsum has scattered dark brown or black flecking. Limbs are colored as dorsum with irregular white or light gray blotches and dark brown to black flecking. Multiple white or light gray, irregular blotches on the head interspersed with dark brown or black flecks and vermiculations. Two whitish, parallel stripes extend from the rostrum to the eye on each side of the head. One is an unbroken stripe from nare to eye while the other is broken and spotty and runs from the nasals to above the orbit. A light-colored nuchal loop is present in some individuals although it is often broken and irregular. Ventral coloration is whitish with occasional, small, dark brown or black speckles under the chin and belly.

In life, dorsal color is light to medium brown, with a green or olive overtone. Limbs are colored as the dorsum with irregular light blotches and dark speckling. Iris color is variable from chestnut brown to slate gray.

Variation. Variation in meristic and mensural characters among the type series is shown in Table 1. All individuals have a single small scale in the shallow cleft between the dorsal portions of the supranasals, except UNS 0492, which has 4 small scales. There is considerable variation in the shape and size of the dorsal blotches (Fig. 1) with some individuals having round or oval shaped blotches (Figs. 1A and C) while another has irregular shaped blotches with jagged edges (Fig. 1B). There is also diel variation in color with some geckos becoming lighter in color at night, a phenomenon that is common among many gecko species (Beebe 1944; Chan *et al.* 2006; Vitt *et al.* 2008).

Natural history. *Gekko takouensis* **sp. nov.** were active mostly at night although some individuals could be observed hiding in rock crevices during the day. The holotype and paratypes UNS 0491–UNS 0497 were collected on the rocky outcropping around the entrance of Hang To cave on Ta Kou Nature Reserve after a heavy rain. UNS 0206 and UNS 0208 were collected during the day while collecting *Cyrtodactylus takouensis* in November 2005. Another individual was observed at dawn and photographed living in the hole of a fig tree with *Gekko gecko*. Eggs, two to a cluster, were found glued on the sides and under large rocks. Several individuals were observed feeding on insects at night under the lamps and neon light on the wall and ceiling of the Linh Son Pagoda close to Hang To cave. *Gekko takouensis* **sp. nov.** is sympatric with the recently described *Cyrtodactylus takouensis* (Ngo & Bauer, 2008). The two species occur in close proximity with each other although *G. takouensis* **sp. nov.** typically occupies the cave entrance while *C. takouensis* lives in deeper parts of the cave, emerging to the mouth of the cave only at night.

Comparisons. Among its Vietnamese congeners, *Gekko takouensis* **sp. nov.** may be distinguished from *G. scientiaventura* by the presence of dorsal tubercles; from *G. palmatus* by the lack of broad webbing between the toes; from *G. gecko* by smaller adult SVL (107 mm maximum SVL vs. 173 mm maximum SVL – from Rösler *et al.* (2005)) and lack of large, mucronate dorsal tubercles; from *G. ulikovskii* and *G. badenii* by lack of narrow bands on dorsum. *Gekko takouensis* **sp. nov.** appears closely related to *G. grossmanni* and *G. russelltraini*, but differs from *G. grossmanni* in the following characters (in adults): larger size (89.7–107.0 mm SVL vs. 71.4–89.4 mm SVL); the number of interorbital scale rows (27–34 vs. 38–48); the number of

scales across the belly between the ventrolateral folds (30–34 vs. 27–30); and the number of dorsal scales at midbody (83–90 vs. 94–115). *Gekko takouensis* **sp. nov.** differs from *G. russelltraini* in the following characters (in adults): larger size (89.7–107.0 mm SVL vs. 70.3–82.9 mm SVL); the number of scales across the belly between the ventrolateral folds (30–34 vs. 28–30); the number of dorsal scales at midbody (83–90 vs. 90–107); the number of precloacal pores (11–14 vs. 8–11); and the number of chin scales that border the first postmental (3–4 vs. 5–7). An additional *Gekko* species, *Gekko canhi*, was recently described from Northern Vietnam. *Gekko takouensis* **sp. nov.** differs from *G. canhi* by the following characters: more precloacal pores (11–14 vs. 5); fewer interorbitals (27–34 vs. 47–50); and fewer ventral scales across the belly between the ventrolateral folds (30–34 vs. 46–51).

Discussion. We have described a new species in the genus *Gekko* from Tà Kóu Mountain, a granitic peak isolated from the Truong Son Mountain range. This new species is sympatric with the recently described *Cyrtodactylus takouensis* (Ngo & Bauer 2008). Tà Kóu Mountain is about 50 – 60km from another isolated peak, Chua Chan Mountain in Dong Nai province, where another pair of cave dwelling *Cyrtodactylus* and *Gekko* were discovered, *Cyrtodactylus huynhi* (Ngo & Bauer 2008) and *Gekko russelltraini* (Ngo *et al.* 2009). Isolated mountains have harbored other recently described geckos (eg: *Gekko badenii* Szczerbak & Nekrasova 1993; *Cyrtodactylus badenensis* Nguyen *et al.* 2006; *Cyrtodactylus nigriocularis* Nguyen *et al.* 2006). Mountain regions have long been known to host endemic species and elevational environmental gradients have been suspected as a contributing factor in the speciation of montane forms (Kozak and Wiens 2007). This phenomenon is thought to be even more important in the tropics where climatic zonation is more extreme than in temperate regions (Janzen 1967). While the exact speciation mechanisms that occur in montane regions may vary (Moritz *et al.* 2000) the importance of mountains to generating and fostering biodiversity is undeniable. Geckos may be particularly subject to montane endemism and diversification due to substrate specificity associated with a highly evolved digital adhesive mechanism. “Substrate islands” have been implicated in the high levels of species diversity of geckos in Southern Africa (Bauer 1999; Bauer *et al.* 2007) and Southeast Asian *Cyrtodactylus* (Bauer 2003; Ngo and Bauer 2008) and could also be important to other Southeast Asian gekkotans.

Conservation status. Habitat surrounding the nature reserve has been degraded by the removal of rocks at the foot of Tà Kóu Mountain for use as building material and the conversion of forest to banana plantations. *Gekko takouensis* **sp. nov.** is also threatened by collecting. Most geckos are hunted for food although some are also taken for the pet trade. Conversations with gecko trappers indicate that the price paid for geckos is 70.000–100.000 VND/kg or \$4–6 USD/kg. Preliminary monitoring of the wild population of *Gekko takouensis* **sp. nov.** since 2005 suggests these activities, particularly hunting, appear to be reducing the size of the wild population. We recommend continued monitoring of the *Gekko takouensis* **sp. nov.** population and a preliminary assessment of its conservation status that considers the potential impact of further habitat loss/alteration and continued commercial exploitation.

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