

A new green, arboreal species of *Pristimantis* (Anura: Strabomantidae) from Amazonian Peru

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> Abstract

We describe a new species of *Pristimantis* from lowland Amazonia of the Region Loreto, northern Peru. The new species is mainly characterized by its size (SVL 26.5 mm in male, 33.0 mm in female), shagreen dorsal skin, absence of dorso-lateral folds, slightly areolate venter, presence of discoidal fold, presence of tympanic membrane including tympanic annulus, absence of vocal slits in males, presence of ulnar and tarsal tubercles, bright green to yellow-green dorsal coloration with irregular pattern of small white spots, brown loreal-tympanic region, brown stripe on flanks sharply outlining dorsal coloration, white to yellow throat, yellow belly, and dark brown palmar and plantar surfaces. The new species is tentatively assigned to the *Pristimantis unistrigatus* Group. It has an arboreal mode of life and inhabits primary and disturbed Amazonian lowland rainforest.

> Kurzfassung

Wir beschreiben eine neue *Pristimantis*-Art aus dem Amazonastiefland der Region Loreto, nördliches Peru. Die neue Art wird hauptsächlich durch ihre folgenden Merkmale charakterisiert: Größe (Kopfrumpflänge 26,5 mm von Männchen, 33,0 mm von Weibchen), dorsale Haut sandpapierartig rauh, fehlende Dorsolateralfalten, Unterseite leicht gekörnt, Discoidalfalte vorhanden, Tympanummembran und Tympanumring vorhanden, Männchen ohne Stimmlitze, Ulnar- und Tarsaltuberkel vorhanden, dorsale Färbung hellgrün bis gelblich grün mit irregulärem Muster aus kleinen weißen Punkten, Loreal- und Tympanumregion braun, brauner Streifen auf den Körperflanken, der scharf die dorsale Färbung abgrenzt, Kehle weiß bis gelb, Bauch gelb und Hand- und Fußflächen dunkelbraun. Die neue Art wird der *Pristimantis unistrigatus* Gruppe zugeordnet. Sie ist arboreal und bewohnt primäre und sekundäre Tieflandregenwälder Amazoniens.

> Key words

Amphibia, Anura, Strabomantidae, *Pristimantis padiali*, new species, Amazonian lowlands, Peru.

Introduction

Recent investigations (e.g., LEHR *et al.*, 2009; LEHR & VON MAY, 2009; LEHR *et al.*, 2010) indicate that the species diversity of strabomantid frogs of the genus

Pristimantis in lowland Amazon rainforest remains underestimated due to unexplored areas and cryptic species (ELMER & CANNATELLA, 2008; PADIAL & DE LA

RIVA, 2009). Of the 45 species of *Pristimantis* known from the Peruvian Amazon Basin (humid tropical forests below 500 m elevation) 29 (64.4%) were reported also from the Iquitos area (Region Loreto) (DUELLMAN & LEHR, 2009; LEHR *et al.*, 2010; this paper). Most of these species inhabit lower forest strata, have terrestrial to semi-arboreal mode of life and possess cryptic brown to olive dorsal coloration. Among the few species of *Pristimantis* from the Amazonian lowlands having a green dorsal coloration – i.e., *P. acuminatus* (SHREWE, 1935), *P. olivaceus* (KÖHLER, MORALES, LÖTTERS, REICHLER & APARICIO, 1998), *P. pseudo-acuminatus* (SHREWE, 1935), and *P. tantanti* (LEHR, TORRES-GASTELLO & SUÁREZ-SEGOVIA, 2007) – two species take shelter in bromeliads and feed almost exclusively on ants. One is *Pristimantis acuminatus* distributed widely in Amazonian Ecuador, northern Peru, and adjacent Colombia and Brazil (RODRÍGUEZ & DUELLMAN, 1994; DUELLMAN & LEHR, 2009), the other represents a new species that previously has been confused with the former. This contribution is aimed at its description.

Material and methods

The format for the description follows LYNCH & DUELLMAN (1997) and diagnostic characters of DUELLMAN & LEHR (2009). Specimens were stored in 70% ethanol. Specimens were dissected to examine the gonads. Measurements, which were taken with digital calipers by the senior author and rounded to the nearest 0.1 mm, are: snou-vent length (SVL), tibia length, foot length (distance from proximal margin of inner metatarsal tubercle to tip of Toe IV), head length (obliquely from angle of jaw to tip of snout), head width (at level of angle of jaw), eye diameter, interorbital distance, upper eyelid width, internarial distance, eye-nostril distance (straight line distance between anterior corner of orbit and posterior margin of external nares). Fingers are numbered preaxially to postaxially from I–IV. Comparative lengths of Toes III and V were determined when both were adpressed against Toe IV; lengths of Fingers I and II were estimated when adpressed against each other. Coloration in life descriptions are based on photos taken by J. MORAVEC, P. PEREZ PEÑA and J.J. LOPEZ ROJAS.

Codes of collections are

FMNH Field Museum of Natural History, Chicago, USA
 KU History Museum, University of Kansas, Lawrence, Kansas, USA

MUSM Museo de Historia Natural Universidad Nacional Mayor de San Marcos, Lima, Perú
 MZUNAP Museo de Zoología de Universidad Nacional de la Amazonía Peruana, Iquitos
 NMP6V National Museum Prague (vertebrates)
 NMP6F National Museum Prague (photographs)
 TCWC Texas Cooperative Wildlife Collection, Texas A&M University, College Station, USA
 USNM National Museum of Natural History, Washington DC, USA

Pristimantis padiali sp. n.

Figs. 1 (A–F), 2 (A–C)

Holotype. MZUNAP-01-792, an adult female (Figs. 1 A–F, 2 A–C), from the vicinity of Mazán (03°32'03" S, 73°10'54.7" W; ca. 110 m a.s.l.), ca. 30 km strait NE of Iquitos, Provincia Maynas, Region Loreto, Peru, collected by J.J. LOPEZ ROJAS on 29 May 2009.

Paratypes. MZUNAP 963, an adult male, and MZUNAP 957, a subadult male from the vicinity of Requena (04°59' S, 073°59' W; ca. 110 m a.s.l.), Provincia Maynas, Region Loreto, Peru, collected by G. GAGLIARDI URRUTIA in 2009.

Referred specimens (photo vouchers). One adult specimen (photo numbers NMP6F 16–17) collected in the area of the type locality by J.J. LOPEZ ROJAS in 2009 (Fig. 1 E); one adult specimen and one subadult specimen (photo numbers NMP6F 18–19) from the vicinity of Puerto Almendras (ca. 03°49' S, 073°22' W; ca. 120 m a.s.l.), ca. 17 km strait SW of Iquitos, Provincia Maynas, Region Loreto, Peru, observed by J. MORAVEC on 9–10 April 2002 (Fig. 1 F); one adult specimen (photo numbers NMP6F 20–21) from the river-basin of río Nanay collected by J.J. LOPEZ ROJAS and P. PEREZ PEÑA in 2009; one subadult specimen (photo numbers NMP6F 22–23) from the area of 26th km of the road Iquitos-Nauta (ca. 03°57'49" S, 073°25'26" W; ca. 135 m a.s.l.), observed by P. Perez Peña in 2009; one adult specimen (photo number NMP6F 24) from 31st km of the road Iquitos-Nauta (ca. 04°00'25" S, 73°26'36" W) observed by P. PEREZ PEÑA in 2009; one juvenile specimen (photo numbers NMP6F 25–26) from the protected area Zona Reservada Allpahuayo-Mishana (ca. 03°57' S, 073°26' W; ca. 130 m a.s.l.), observed by J. MORAVEC on 15 March 2001. One specimen (photo number NMP6F 27) from the area of upper río Itaya (04°13' S, 73°43' W), recorded by JOEL RENGIFO in 2009.

Material compared.

Pristimantis acuminatus: Peru: Loreto: Alto Amazonas, FMNH 109829; Campamento Márquez Pozo Singasapa, MUSM 22211; Centro Unión, TCWC 41521; Quebrada Chingara, MUSM 22221; Quebrada Pushaga, río Morona,



Fig. 1. Holotype of *Pristimantis padiali* sp. n. (MZUNAP-01-792) in life, (A) dorsal, and (B) ventral views. Holotype of *P. padiali* sp. n. (MZUNAP-01-792) in alcohol, (C) dorsal, and (D) ventral views. Referred adult specimens of *P. padiali* sp. n. in life, (E) NMP6F 16 from the type locality, and (F) NMP6F 18 from Puerto Almendras (Loreto, Peru).

FMNH 109829; San Jacinto, KU 221995. San Martín: río Cainarachi, 33 km NE Tarapoto, on road to Yurimaguas, KU 209466; río Shilcayo, Tarapoto, KU 209467; 15.4 km SW Zapatero, KU 217308-10.

Pristimantis galdi: PERU: Piura: Campamento Carlita, río Blanco, MUSM 19391; Quebrada Parramata, río Blanco, MUSM 19385; Santuario Tabaconas-Namballe, MUSM 19919-22.

Pristimantis olivaceus: BOLIVIA: Pando: Palmira (04°59' S, 073°59' W), NMP6V 74067; San Antonio (04°59' S, 073°59' W), NMP6V 74068. PERU: Cusco: Cashiriari-2 (Armihuari), ± 4 km S río Camisea, USNM 538039-43; Cashiriari-3, S of río Camisea, USNM 537805; Konkariari Creek Camp, río Urubamba, USNM 538044-45; Quebrada Morro Le-guia, 55 km [by road] NE Paucartambo, USNM 346334-35.



Fig. 2. (A) Lateral view of head, (B) hand, and (C) plantar views of right foot of the holotype of *Pristimantis padiali* sp. n. (MZUNAP-01-792). Scale bar equals 3 mm.

Pristimantis pseudoacuminatus: PERU: Loreto: Moropón, [TCWC 51325](#).

Pristimantis tantanti: PERU: Cusco: Myaria, [MUSM 23942](#) (holotype), 23943. Madre de Dios: Cocha Cashu Field Station: [MUSM 3848, 9119](#).

Diagnosis. A medium sized species of *Pristimantis* having terminal discs on digits expanded, bearing well defined circumferential grooves, tentatively assigned to the *unistrigatus* species Group having the following combination of characters: (1) skin on dorsum shagreen, dorsolateral folds absent; throat smooth, venter weakly areolate; discoidal fold present; (2) tympanic membrane present, round, about one third of eye length; tympanic annulus present, most obvious anteriorly; supratympanic fold moderately developed, covering dorsal margin of tympanum posteriorly; (3) snout short, acuminate in dorsal view, protruding and inclined posteroventrally in lateral view; (4) upper eyelid lacking tubercles; upper eyelid about half of inter-orbital distance; cranial crests absent; (5) dentigerous processes of vomers small, horizontally arranged, narrowly separated medially; (6) males lacking vocal slits and nuptial pads; (7) Finger I shorter than Finger II; discs on outer fingers elliptical; (8) fingers with basal lateral fringes; (9) ulnar and tarsal tubercles present; (10) heel with minute tubercles; inner tarsal fold absent; (11) inner metatarsal tubercle elongate, more than two times the size of round flat outer metatarsal tubercle, elevated; supernumerary plantar tubercles indistinct; (12) toes without lateral fringes; webbing absent; Toe V longer than Toe III; toe discs smaller than discs of fingers, elliptical; (13) in live, dorsal col-

oration bright green to yellowish green with scattered small white spots; head laterally light brown at night and dark brown by day; flanks white to yellow with dark brown diffuse stripe outlining dorsal coloration, axillar area and groin yellow; throat white to yellow, belly yellow, palmar and plantar surfaces dark brown; iris reddish brown by night and light brown by day; (14) SVL in single female 33.0 mm, in single adult male 26.5 mm.

Comparison with other species. Few species of *Pristimantis* from the Amazonian lowlands have a green dorsal coloration. These are *P. acuminatus*, *P. olivaceus*, *P. pseudoacuminatus*, and *P. tantanti* (Table 1). *Pristimantis padiali* differs in having a bright yellow belly (white in *P. acuminatus* and *P. pseudoacuminatus*, yellowish white in *P. tantanti*, cream yellow in *P. olivaceus*). Additionally, the new species differs from *P. acuminatus* (characters in parenthesis) by having larger males (26.5 mm vs. 22.6 mm in *P. acuminatus*), a differentiated tympanic membrane (undifferentiated), brown loreal-tympanic region (black canthal and post-orbital stripes), dark brown palmar and plantar surfaces in adults (green or yellow green), and by lacking an interorbital stripe (present) (DUELLMAN & LEHR, 2009; material examined); from *P. olivaceus* by its larger size (SVL up to 22.1 mm in males and 25.5 mm in females in *P. olivaceus*), absence of nuptial pads (present), absence of vocal slits (present), absence of dark spots on dorsum (present), and by presence of dark brown palmar and plantar surfaces in adults (greenish yellow) (KÖHLER *et al.*, 1998; material examined); from *P. pseudoacuminatus* by larger size (SVL up to 17.6 mm in males and 22.4 mm in females in *P. pseudoacumina-*



Fig. 3. Holotype of *Pristimantis tantanti* (MUSM 23942) in lateral (A) and ventral (B) views. Photos by C. TORRES.

tus), acuminate snout (rounded), dark loreal-tympanic region (yellow tan canthal stripe), absence of vocal slits (present), presence of discoidal fold (absent), and by presence of dark brown palmar and plantar surfaces in adults (cream to yellow) (LYNCH, 1980; material examined); from *P. tantanti* (Fig. 3) by larger size (SVL up to 21.9 in males and 29.9 in females in *P. tantanti*), snout acuminate in dorsal view (acuminate-triangular), presence of tympanic annulus (absent), presence of tympanic membrane (absent), presence of discoidal fold (absent), absence of ulnar and tarsal folds (present, prominent, see LEHR *et al.*, 2007: Fig 2, p. 96), fingers with basal lateral fringes (lateral fringes broad, not restricted basally; outer fringe of Finger IV continuing to proximal edge of palm with its shape slightly undulated), toes without lateral fringes (broad lateral fringes present, outer fringe of Toe V contacting outer row of fold of plantar surface with its shape undulated) and without webbing (basal webbing present) and by dark brown palmar and plantar surfaces in adults (yellow to yellowish brown) (LEHR *et al.*, 2007; LEHR, 2009; material examined).

Description of the holotype. Head slightly narrower as body, slightly shorter than wide; head width 36% of SVL; head length 35% of SVL; acuminate in dorsal view, protruding and inclined posteroventrally in lateral view (Fig. 2 A); eye diameter slightly longer (115%) than eye-nostril distance; nostrils directed laterally; canthus rostralis straight in dorsal view, and in profile; loreal region weakly concave; lips rounded; upper eyelid smooth, upper eyelid width 51% of interorbital distance; tympanic membrane present, round, 37% of eye diameter; tympanic annulus present, best pronounced anteriorly; supratympanic fold moderately developed, covering tympanum dorsally. Choanae small, oval; dentigerous processes of vomers small, horizontally arranged, at posterior margin of choanae, narrowly sepa-

rated medially; tongue ovoid, not notched posteriorly, posterior half and lateral margins free.

Skin on dorsum shagreen; tubercles and dorsolateral folds absent; skin on venter weakly areolate; weak discoidal fold present, more prominent posteriorly; cloacal opening directed posteriorly at upper level of thighs, low tubercles below vent and on posterior surface of proximal quarter of thighs. Conspicuous ulnar tubercles reaching beyond ulno-humeral articulation, elongate, white; palmar tubercles slightly elevated, outer palmar tubercle bifid, approximately twice the size of oval, inner palmar tubercle; subarticular tubercles well defined, round; supernumerary tubercles indistinct; fingers with basal lateral fringes; Finger I shorter than Finger II; discs oval, broadly expanded, more on outer fingers, least on Finger I; disc of Finger III 1.5x the size of the digit proximal to it; discs on fingers elliptical; ventral pads of fingers well defined by circumferential grooves; relative lengths of fingers $1 < 2 < 4 < 3$; Finger I subequal to Finger II (Fig. 2 B).

Hind limbs slender, tibia length 48% of SVL; foot length 38% of SVL; upper surfaces of hind limbs shagreen; ventral surfaces of thighs weakly areolate; heel with minute white tubercles; outer surface of tarsus with small white tubercles, slightly elevated, reaching outer margin of Toe V; inner tarsal fold absent; inner metatarsal tubercle elongate (1.8 mm), elevated, more than twice the size of round flat outer metatarsal tubercle (0.8 mm); supernumerary plantar tubercles indistinct; subarticular tubercles well defined, round; toes without lateral fringes; webbing absent; discs broadly expanded, oval, slightly smaller than those on fingers, most prominent on Toe IV; toes having ventral pads well defined by circumferential grooves; relative lengths of toes: $1 < 2 < 3 < 5 < 4$; Toe V subequal to Toe III (Fig. 2 C). Oviducts contain 11 and 8 (left/right) unpigmented eggs, largest approximately 3.8 mm in diameter.

Tab. 1. Comparisons of *Pristimantis padiali* sp. n. with other species from the Amazonian lowlands having a dorsal green coloration. Characters were taken from original species description and from the examined material. Presence of a character is indicated by “+”, its absence by “—”.

Species and source	<i>P. padiali</i> this paper	<i>P. acuminatus</i> LYNCH & DUELL- MAN (1980)	<i>P. olivaceus</i> KÖHLER <i>et al.</i> (1998)	<i>P. pseudoacuminatus</i> LYNCH (1980)	<i>P. tantanti</i> LEHR <i>et al.</i> (2007), LEHR (2009)
Male SVL [mm]	26.5 (n = 1)	17.1–22.6 (n = 14)	17.7–22.1	12.7–17.6	19.6–21.9 (n = 2)
Female SVL [mm]	33.0 (n = 1)	25.6–32.3 (n = 14)	20.3–25.5	18.1–22.4	28.8–29.9 (n = 2)
Dorsal skin texture	shagreen	smooth	shagreen	smooth with or without scattered low tubercles	shagreen
Ventral skin texture	areolate	coarsely granular	areolate	areolate	areolate
Discoidal fold	+	+	+	—	—
Tympanic annulus	+	+	+	+	—
Tympanic membrane	+	—	+	+	—
Nuptial pads	—	—	+	—	—
Vocal slits	—	—	+	+	—
Dorsal coloration in life	bright green to yellowish green with white spots	green with small black and white spots, black interorbital bar	olive-green to yellowish green, usually with few dark brown to black spots	pale green to tan, with or without a brown suffusion middorsally or small black or darker greenish tan spots on the head and back	green with white spots
Belly coloration in life	yellow	white	cream yellow	white	yellowish white to greenish yellow
Throat coloration in life	white to yellow	throat greenish yellow	yellow	white, yellow vocal sac in males	greenish yellow
Plantar and palmar surfaces coloration in adults	dark brown	green or yellow green	greenish yellow	cream to yellow	yellow to yellowish brown

Measurements (in mm) of holotype. SVL 33.0; tibia length 15.8; foot length 12.5; head length 11.5; head width 12.0; eye diameter 3.8; tympanum diameter 1.4; interorbital distance 4.7; upper eyelid width 2.4; inter-narial distance 2.6; eye-nostril distance 3.3.

Coloration of holotype in life (Fig. 1 A–B). By day, dorsal coloration of head, body and limbs yellow-green with scattered small inconspicuous yellowish white spots; snout and upper eyelids with traces of irregular brown mottling; loreal-tympanic region and mandible brown with scattered small white dots; anterior surface of proximal part of upper arm brown; flanks with brown bar, starting on tympanic fold, sharply outlining dorsal coloration, bearing minute white dots, fading ventrally and caudally; axilla bright yellow; groin yellow to translucent; dorsal surfaces of fingers and toes dark brown with fine white mottling; throat white to yellow with dense melanophores distributed along mandible, small group of melanophores in the centre of throat; belly bright yellow, translucent caudally; cloacal area brown with white tubercles; ventral surfaces of hind limbs dull yellow to orange;

knee area light brown; palmar surfaces brown with fine white mottling, plantar surfaces dark brown; iris light reddish brown.

Coloration of holotype in preservative (Fig. 1 C–D). Dorsal coloration of head, body and limbs yellowish white with small irregular gray mottling in the area of snout and upper eye lids, dorsal surfaces of fingers and toes light gray to black; loreal-tympanic region dark gray to black with scattered small white dots; mandible with dense melanophores; anterior surface of proximal part of upper arm gray; flanks with dark gray bar sharply outlined against dorsum, fading ventrally and caudally; throat white with dense melanophores in mental and central area; belly white, translucent caudally; cloacal area gray; ventral surfaces of hind legs white; knee area with dense melanophores; palmar and plantar surfaces dark gray to black; iris dark gray.

Variation. Measurements (in mm) of one adult male (MZUNAP 963) and one subadult male (MZUNAP 957) paratypes are as follows: SVL 26.5, 21.0; tibia



Fig. 4. Schematic map of northern and central Peru showing the known distribution of *Pristimantis padiali* sp. n. Square indicates the type locality. Shaded areas indicate elevations above 500 m a.s.l.

length 13.6, 10.6; foot length 11.3, 8.9; head length 8.8, 7.0; head width 9.0, 7.5; eye diameter 3.3, 2.8; tympanum diameter 1.3, 1.0; interorbital distance 4.2, 3.4; upper eyelid width 1.8, 1.7; internarial distance 2.3, 1.8; eye-nostril distance 2.6, 2.2. General coloration of paratypes is similar to that of the holotype; the white dorsal spots are more conspicuous and denser posteriorly. Adult male differs in dense dorsal pigmentation of snout (up to interorbital area), pigmented throat and more intensively pigmented flanks, upper arms and knees. Both paratypes have less dense pigmentation of palmar and plantar surfaces. Juvenile (NMP6F 25–26) and subadult (NMP6F 22–23) specimens differ in round to truncate snout dorsally, denser white spotting, light-green to greenish-brown iris, yellow-green throat and ventral surfaces of limbs including hands and feet, and absence of conspicuous dark pattern on loreal-tympanic region and flanks.

Distribution, ecology and threat status. The documented records of *Pristimantis padiali* are depicted in the Fig. 4. In general, the new species seems to be distributed in wider surroundings of Iquitos where it was recorded in neighboring aluvial zones of río Napo, río Amazonas, río Itaya, río Tahuayo, río Ucayali, río

Buncuya (tributary of río Ucayali), río Nanay, río Tigre and río Pucacuro. *Pristimantis padiali* has an arboreal mode of life and was encountered in more or less preserved primary lowland forest growing both on sandy and clay substrates. Most records come from non-flooded areas, nevertheless, the new species was encountered also in flooded forests (río Napo) and palm swamps called “aguajales” (río Tahuayo).

Nearly all collected specimens of *P. padiali* were found at night sitting on leaves 100–200 cm above the ground (putative conspecific males were heard calling from higher positions). The only exception was the juvenile (NMP6F 25–26) observed by day hidden in a small clump of moss (ca 22 × 8 cm) growing on a horizontal branch 170 cm above the ground and the adult specimen (NMP6F 24) observed by day in terrestrial bromeliad in a humid light forest growing on sand substrata locally called “varillal humedo”. The stomach of the holotype contained ants. Other strabomantid species found in sympatry with *P. padiali* included *Oreobates quixensis* JIMÉNEZ DE LA ESPADA, 1872, *Pristimantis altamazonicus* (BARBOUR & DUN, 1921), *P. lacrimosus* (JIMÉNEZ DE LA ESPADA, 1875), *P. malkini* (LYNCH, 1980), *P. ockendeni* (BOULENGER, 1912), *P. cf. peruvianus* (MELIN, 1941) and *Pristimantis academicus* (LEHR *et al.* 2010).

According to the sparse data available we here classify *P. padiali* as “Data Deficient” according to the IUCN red list criteria.

Etymology. The specific name is a patronym for our colleague and friend JOSÉ MANUEL PADIAL in recognition of his important contributions to strabomantid frogs systematics.

Discussion

Pristimantis padiali seems to be closely related to the recently described *P. tantanti* (Fig. 3). Both species are canopy inhabitants with acuminate snout and bright green dorsum with white spots (LEHR *et al.*, 2007, DUELLMAN & LEHR, 2009). The fact that both adults and juveniles of *P. padiali* were encountered nearly exclusively on vegetation above ground indicates that also this species has an arboreal mode of life. It appears that also in the case of *P. padiali* ants form the main part of the food. It is possible that *P. padiali* can deposit its large unpigmented eggs in bromeliads, moss clumps or other suitable arboreal shelters where they undergo their direct development (typical for *Pristimantis*) and the frogs need not to descend to the forest floor. The mentioned similarity with other arboreal species and a likelihood that most individuals of *P. padiali* are out of reach in higher forest strata can explain why this species remained overlooked for so long despite its close vicinity of Iquitos. This example supports the presumption that the canopy of tropical forests is one of the least known strata with respect to species diversity (GUAYASAMIN *et al.*, 2006). Therefore, we expect that a thorough investigation of less accessible upper forest strata can result in discoveries of other new species of arboreal frogs even in relatively well-explored area.

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