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A new Andean anole species of the Dactyloa clade (Squamata: Iguanidae) from western Ecuador

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***Abstract.*—We describe a new species of *Anolis* from the western slopes of the Andes of Ecuador, province of Bolívar. It is referred to (1) the *aequatorialis* series based on its moderate size and narrow toe lamellae, and (2) the *eulaemus* sub-group based on having a typical *Anolis* digit, in which the distal lamellae of phalanx III distinctly overlap the proximal subdigital scales of phalanx II. The new species is most similar morphologically to *A. otongae* and *A. gemmosus*, both from similar elevations on the western Andean slopes of Ecuador, but differs from these species in morphology and color patterns. We present a phylogeny based on DNA sequence data as additional evidence supporting delimitation of the new species. The new species and *A. gemmosus* are sister taxa within the "western Dactyloa clade."**

Key words. Clade Dactyloa, DNA, lizard, phylogeny, South America, systematics

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Introduction

With nearly 490 described species, anole lizards (*Anolis*) have proliferated impressively in the Americas (Nicholson 2002; Poe 2004), possibly prompted by ecological opportunity (Losos 2009). Although the diversity of these lizards has been extensively studied in the West Indies (Losos 2009), the same is not true for the mainland radiation, which is probably greater than previously thought. For example, all but two—*Anolis ruibali* Navarro & Garrido 2004 and *A. sierramaestrae* Holáňová et al. 2012—of the 31 new species of *Anolis* described during the last decade (2003–2013) occur in mainland Central and South America (Uetz and Hošek 2014). Improving knowledge concerning the diversity of mainland anoles is crucial to understanding the nature of this radiation.

Anole lizards represent the most species-rich clade traditionally recognized as a genus in Ecuador, with 37 species reported to date (Torres-Carvajal et al. 2014). The diversity of anole lizards in Ecuador is remarkably greater west of the Andes, with more than twice the number of species that occur east of the Andes (25 and 12 species, respectively). Of these, five species have been described during the last six years from both sides of the Andes as a result of both careful examination of existing collections and recent collecting in poorly explored areas. Here we contribute to that growing body of taxonomic knowledge with the description of a new species of *Anolis* endemic to the western slopes of the Andes in Ecuador. We present molecular evidence supporting recognition of the new species by performing phylogenetic analyses of mitochondrial DNA sequence data.

Materials and Methods

Morphological data

All known specimens of the new species described in this paper are included in the type series, and were deposited in the Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito (QCAZ). Specimens of other species of *Anolis* examined in this study are listed in Appendix 1. We follow previously proposed terminology (Williams et al. 1995) for measurements and squamation. Nine morphological measurements were taken with digital calipers and recorded to the nearest 0.1 mm: head length, head width, head height, forelimb length, hindlimb length, snout-vent length, jaw length, axilla-groin length, and snout length. In addition, tail length measurements were taken with a ruler and recorded to the nearest millimeter; regenerated or broken tails were not measured. Sex was determined by noting the presence of hemipenes, which were everted in all male specimens during preparation.

Statistical analyses

Given that the new species is very similar in morphology to *Anolis gemmosus* and *A. otongae* we performed

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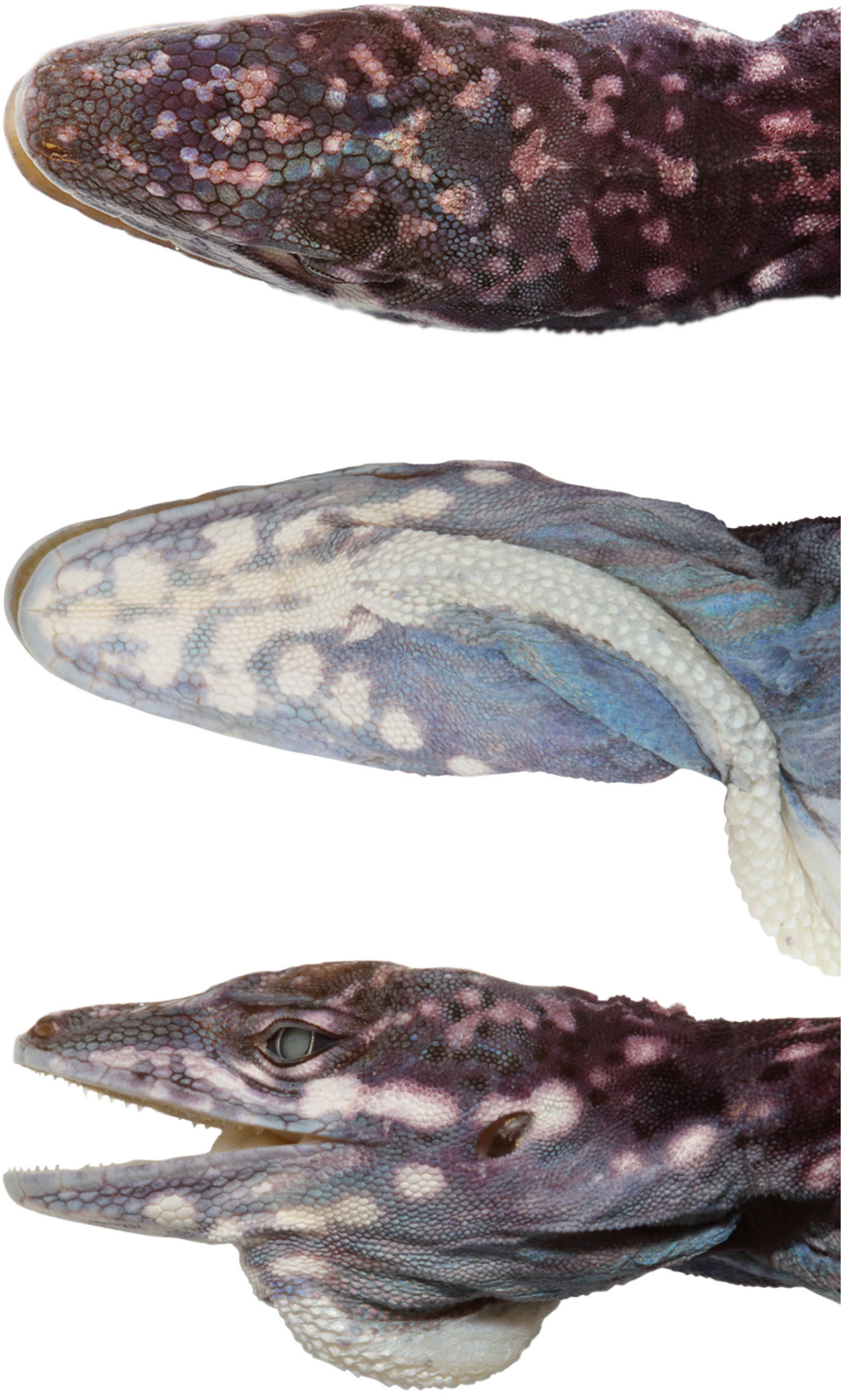

Fig. 1. Head of the holotype (QCAZ 3449) of *Anolis poei* sp. nov. in dorsal (**top**), ventral (**middle**), and lateral (**bottom**) views [Scale bar = 10 mm]. *Photographs by F. Ayala-Varela*.

a Principal Component Analysis (PCA) to determinate whether separation in morphological space between those species was statistically significant. Principal components (PCs) were extracted from a covariance matrix of the raw and rescaled data. The new species is most similar to *A. gemmosus*, for which we also used *t*-tests to evaluate quantitative differences between both species. One of the assumptions of the *t*-test for two samples is that the variances of both samples are equal: therefore, *F*-tests also were performed for each character to test for equality of variances. If the variances were not the same (i.e., $P < 0.05$), an unequal variance *t*-statistic was used. Statistical analyses were performed in SPSS Statistics 17 (SPSS Inc. 2008).

The distribution map was prepared in ArcMap 9.3 (ESRI, Inc.); WGS84 is the datum for all coordinates presented below.

DNA sequence data

Total genomic DNA was digested and extracted from liver or muscle tissue using a guanidinium isothiocyanate extraction protocol. Tissue samples were first mixed with Proteinase K and a lysis buffer and digested overnight prior to extraction. DNA samples were quantified using a Nanodrop® ND-1000 (NanoDrop Technologies, Inc), re-suspended and diluted to 25 ng/ul in ddH2O prior to amplification.

Using primers and amplification protocols from the literature (Folmer et al. 1994; Kumazawa and Nishida 1993; Macey et al. 1997; Schulte and Cartwright 2009) we obtained 2807 nucleotides (nt) representing the nuclear gene recombination-activating gene 1 (RAG1, 811nt), as well as the mitochondrial genes Cytochrome c oxidase I (CO1, 655nt) and a continuous fragment including the NADH dehydrogenase subunit 2 (ND2, 1038 nt), tRNATrp, tRNAAla, tRNAAsn, tRNACys (282nt), and the origin of the light-strand replication (Ol, 29nt). The new sequence data were obtained for three individuals of the new species described herein, two of *A. gemmosus*, and two of *A. otongae*. In addition we used sequence data generated by Castañeda and de Queiroz (2011) for 20 individuals of the clade Dactyloa, as well as one sequence of *A. occultus*, which was used as the outgroup in the phylogenetic analysis. Gene regions of taxa included in phylogenetic analyses along with their GenBank accession numbers are shown in Table 1.

Phylogenetic analyses

Editing, assembly, and alignment of sequences were performed with Geneious ProTM 5.3 (Biomatters Ltd. 2010). Genes were combined into a single dataset with eleven partitions, three per protein coding gene corresponding to each codon position, one with all tRNAs, and one with the Ol. The best partition strategy along with the corresponding models of evolution were obtained in PartitionFinder 1.1.1 (Lanfear et al. 2012) under the Bayesian information criterion.

Phylogenetic relationships were assessed under a Bayesian approach in MrBayes 3.2.0 (Ronquist and Huelsenbeck 2003). Four independent analyses were performed to reduce the chance of converging on a local optimum. Each analysis consisted of 20 million generations and four Markov chains with default heating values. Trees were sampled every 1,000 generations resulting in 20,000 saved trees per analysis. Stationarity was confirmed by plotting the –ln L per generation in the program Tracer 1.6 (Rambaut et al. 2013). Additionally, the standard deviation of the partition frequencies and the potential scale reduction factor (Gelman and Rubin 1992) were used as convergence diagnostics for the posterior probabilities of bipartitions and branch lengths, respectively. Adequacy of mixing was assessed by examining the acceptance rates for the parameters in MrBayes and the effective sample sizes (ESS) in Tracer. After analyzing convergence and mixing, 2,000 trees were discarded as "burn-in" from each run. We then confirmed that the four analyses reached stationarity at a similar likelihood score and that the topologies were similar, and used the resultant 72,000 trees to calculate posterior probabilities (PP) for each bipartition on a 50% majority rule consensus tree.

Systematics

The taxonomic conclusions of this study are based on the observation of morphological features and color patterns, as well as inferred phylogenetic relationships. We consider this information as species delimitation criteria following the general species concept of de Queiroz (1998, 2007).

Anolis poei sp. nov.

urn:lsid:zoobank.org:act:712687F6-CF33-4969-815D-E4600D01FB4C

Proposed standard English name: **Telimbela anoles**
Proposed standard Spanish name: **Anolis de Telimbela**

Holotype

QCAZ 3449 (Figs. 1, 2), adult male, Ecuador, Provincia Bolívar, Telimbela, 01.65789ºS, 79.15334ºW, WGS84 1,354 m, 10 June 2011, collected by Fernando Ayala-Varela, Jorge H. Valencia, Diana Troya-Rodríguez, Francy Mora, and Estefanía Boada.

Paratypes (15)

ECUADOR: Provincia Bolívar: QCAZ 3444−3448, 3451−3455, 4359, same data as holotype, except 0.1658440ºS, 79.157150ºW, 1,310 m; QCAZ 6781−6783 Telimbela, Escuela Elisa Mariño de Carvajal, 0.1665857ºS, 79.172096ºW, 27 July 2004, collected by Edwin Carrillo-Ponce and Morley Read; QCAZ 9219 Guaranda, Salinas, Recinto Tres Cruces, 01.431380ºS,

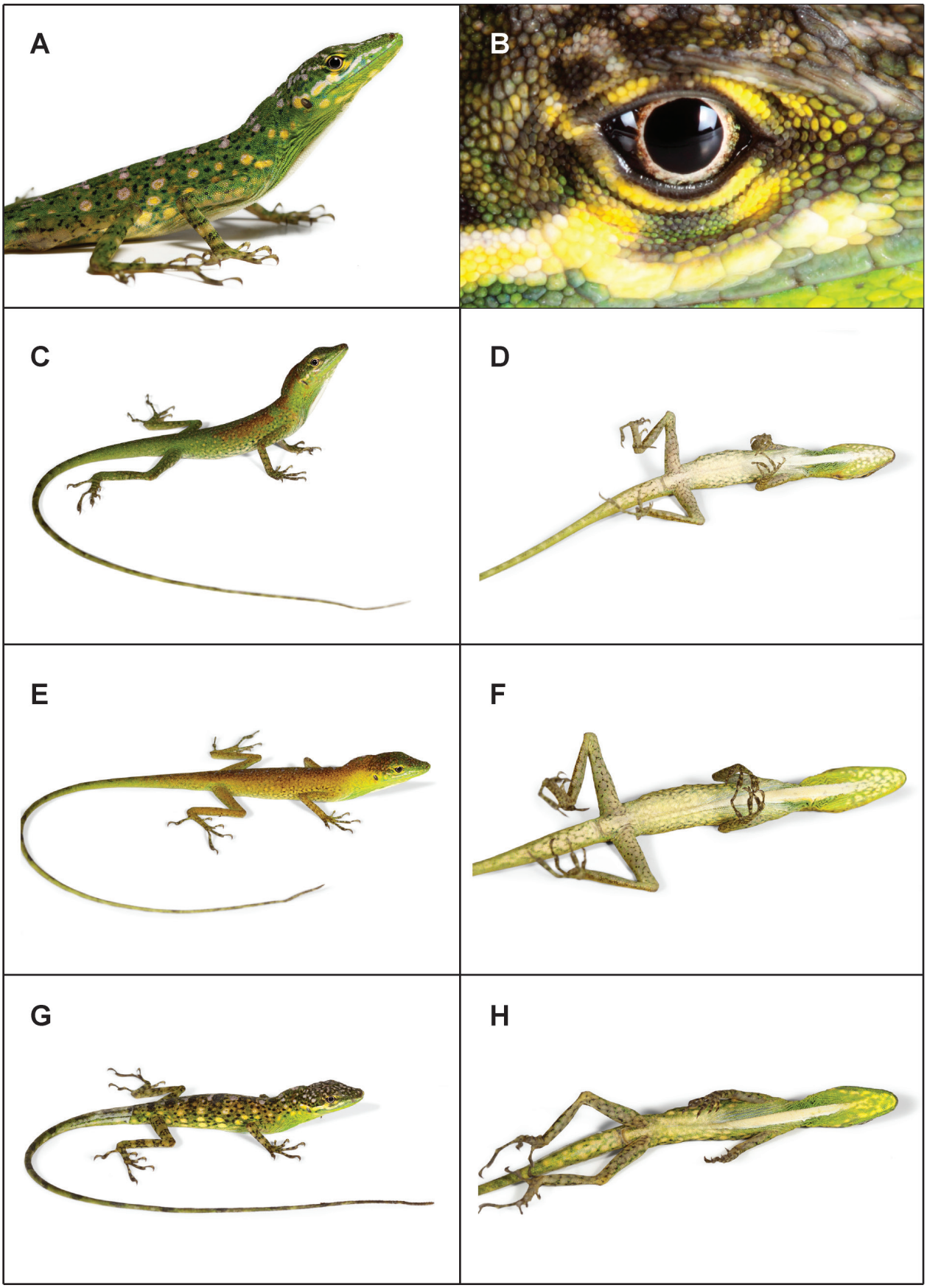

Fig. 2. *Anolis poei* sp. nov. Holotype, adult male (SVL = 59.67 mm, QCAZ 3449, **A**), eye close-up (SVL = 60.31 mm, QCAZ 3448, **B**), subadult male (SVL = 52.12 mm, QCAZ 3455, **C**, **D**), adult male (SVL = 59.02 mm, QCAZ 3451, **E**, **F**), adult male (SVL = 60.31 mm, QCAZ 3448, G, H). *Photographs by L. Bustamante (A), and O. Torres-Carvajal (B, C, D, E, F, G, H).*

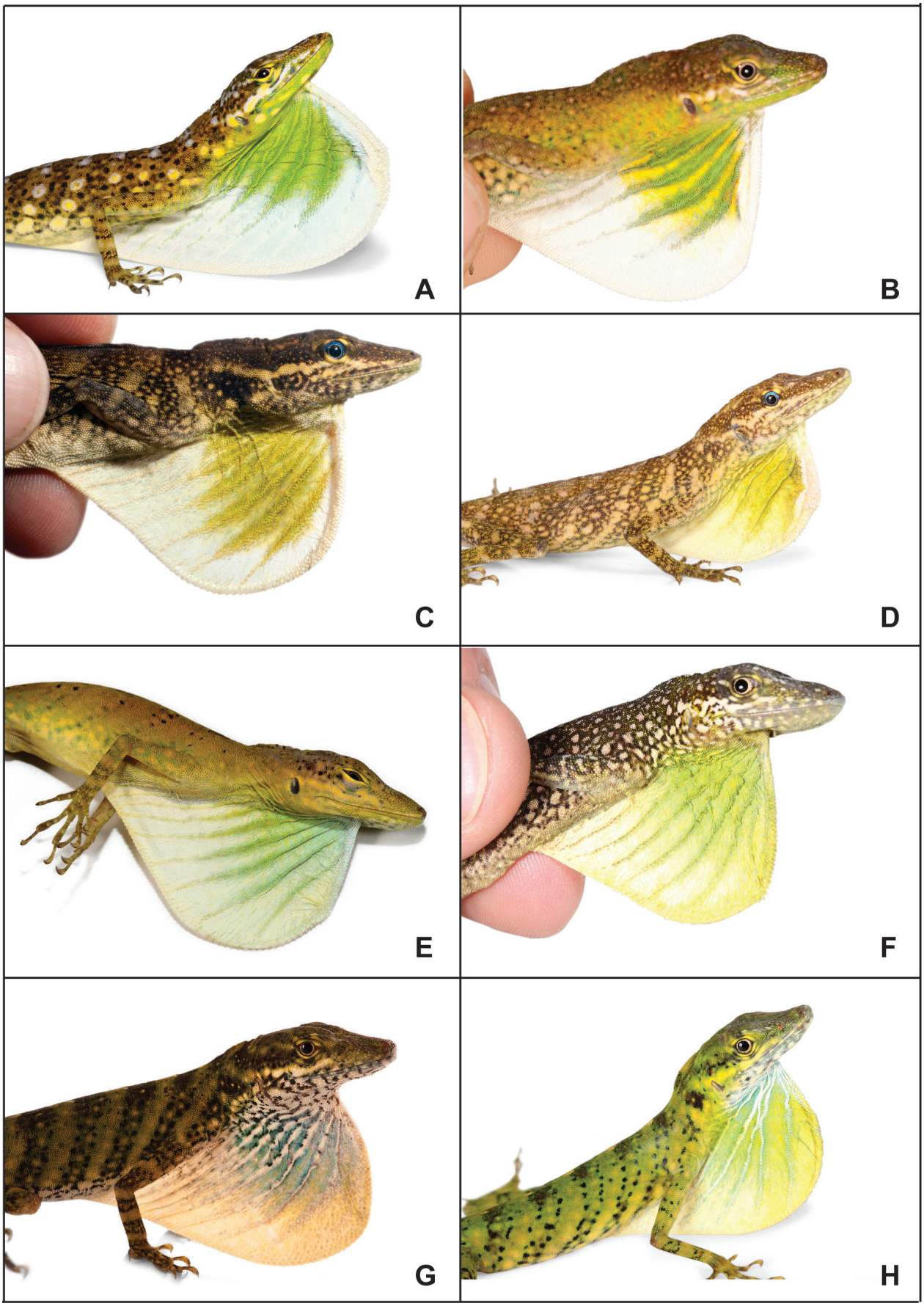

Fig. 3. Male dewlap of *Anolis poei* sp. nov. (holotype, QCAZ 3449, **A**; paratype, QCAZ 3455, **B**); *A. otongae* (QCAZ 4661, **C**; QCAZ 11791, **D**); and *A. gemmosus* (QCAZ 4385, **E**; QCAZ 4352, **F**; QCAZ 9452, **G**; QCAZ 11850, **H**). *Photographs by L. Bustamante (A), O. Torres-Carvajal (B, C, D, E, F, H), and S. R. Ron (G).*

Table 1. Species of *Anolis* sequenced in this study, voucher specimen numbers, collecting localities, and GenBank accession numbers.

Species	Voucher	Locality	GenBank Number
A. gemmosus	QCAZ 4385	Ecuador, Carchi, Río San Pablo near Chical	ND2: KJ854205 COI: KJ854219 RAG1: KJ854212
	QCAZ 4406	Ecuador, Carchi, Maldonado, Teldibi Ecological Trail	ND2: KJ854206 COI: KJ854220 RAG1: KJ854213
A. otongae	QCAZ 11790	Ecuador, Pichincha, Biological Reserve Otonga	ND2: KJ854207 RAG1: KJ854214 COI: KJ854221
	QCAZ 11791	Ecuador, Pichincha, Biological Reserve Otonga	ND2: KJ854208 COI: KJ854222 RAG1: KJ854215
A. poei	QCAZ 3444	Ecuador, Bolívar, Telimbela	ND2: KJ854209 COI: KJ854223 RAG1: KJ854216
	QCAZ 3445	Ecuador, Bolívar, Telimbela	ND2: KJ854210 COI: KJ854224
	QCAZ 3448	Ecuador, Bolívar, Telimbela	ND2: KJ854211 COI: KJ854225 RAG1: KJ854217
	QCAZ 4359	Ecuador, Bolívar, Telimbela	RAG1: KJ854218

79.097970ºW, 2,628 m, 28 May 2009, collected by Elicio E. Tapia, Silvia Aldás-Alarcón, and Eduardo Toral-Contreras.

Diagnosis

We assign *Anolis poei* both to the aequatorialis series, based on moderate to large body size, narrow toe lamellae, small head scales, smooth ventral scales, and uniform dorsal scalation; and to the eulaemus-subgroup, based on a typical *Anolis* digit, in which the distal lamellae of phalanx III distinctly overlap the first proximal subdigital scale of phalanx II (Williams 1976; Williams and Duellman 1984; Castañeda and de Queiroz 2013).

At present ten species are recognized within the eulaemus-subgroup: *Anolis anoriensis* Velasco et al. 2010, *A. antioquiae* Williams 1985, *A. eulaemus* Boulenger 1908, *A. fitchi* Williams & Duellman 1984, *A. gemmosus* O'Shaughnessy 1875, *A. maculigula* Williams 1984, *A. megalopithecus* Rueda-Almonacid 1989, *A. otongae* Ayala-Varela & Velasco 2010, *A. podocarpus* Ayala-Varela & Torres-Carvajal 2010, and *A. ventrimaculatus* Boulenger 1911. *Anolis poei* differs from them mostly in dewlap features. The dewlap in males of *A. poei* has a yellowish-green (or both yellow and green) gorgetal region, light blue border, and white sternal and marginal regions (Fig. 3). It has a blackish gorgetal region, and creamy white sternal region with light brown scales in *A. anoriensis*; brown gorgetal region, and pale brown marginal region in *A. eulaemus*; bluish-gray gorgetal region, orange stripes, pale bluish-rose anterior third, and white sternal region becoming pale blue toward the belly in *A. maculigula*; sepia background, with red narrow and irregular stripes on each side of rows in *A. megalophitecus*; white, pale yellow, or greenish-yellow gorgetal region, with white or pale-yellow marginal and sternal regions in *A. otongae* (Fig. 3); dull yellowish-green or light blue gorgetal region, shading to dull cream, greenish yellow or orange on the marginal region, with white or bluish green gorgetal rows with or without brown spots and with yellowish white, yellow or orange sternal region in *A. gemmosus* (Fig. 3). The dewlap in males of *A. poei* has wide rows of 3−7 scales separated by naked skin; the width of these rows is one scale in *A. fitchi*, 2−5 granular, minute scales in *A. podocarpus*, 1–2 scales in *A. ventrimaculatus*, 3−6 scales in *A. otongae*, and 2−3 scales in *A. gemmosus*. In addition, females of the new species lack a dewlap, which is present in females of *A. anoriensis*, *A. antioquiae*, *A. eulaemus*, *A. fitchi*, and *A. podocarpus*.

Anolis poei is most similar morphologically to *A. otongae* and *A. gemmosus* (Fig. 4). From the former species (character states in parenthesis) *A. poei* differs in having small dorsal chevrons in females (large dorsal chevrons extending onto flanks), pale yellowish-brown iris (iris dark blue), interparietal scale (if present) surrounded by small swollen scales (interparietal scale surrounded by relatively enlarged flat scales), enlarged postanal scales separated by 3−5 scales (postanal scales separated by 1−2 scales), and in lacking a dark stripe on side of head (dark coppery-brown stripe present). Additionally, PCA analyses suggested that specimens of *A. poei* have shorter jaws, as well as lower and narrower heads than *A. otongae* (Table 2, Fig. 5), with PC1 (39% of total variation) represented mainly by head height, head width, and jaw length.

The new species can be distinguished from *A. gemmosus* (Table 3) in having fewer scales between second canthals (11−14, mean = 12.08 and 12−21, mean = 15.25, respectively; t = 5.31, P<0.005); fewer scales between supraorbital semicircles (1−3, mean = 1.62 and 1−5, mean = 3.13, respectively; t = 4.46, P<0.005); more lamellae under phalanges III-IV of fourth toe (18−19, mean = 18.92 and 14−18, mean = 17.33, respectively; t = -7.86, P<0.005); a narrower head (head width = 7.84−8.84, mean = 8.29 and 6.97−17.41, mean = 10.82, respectively; t = -7.03, P<0.005); lower head (head height = 6.54−7.48, mean = 6.92 and 5.42−15.96, mean = 9.51, respectively; t = -6.96, P<0.005); and shorter snout (snout length = 6.75−7.30, mean = 6.92 and 5.79−14.95, mean = 10.58, respectively; t = -11.74, P<0.005).

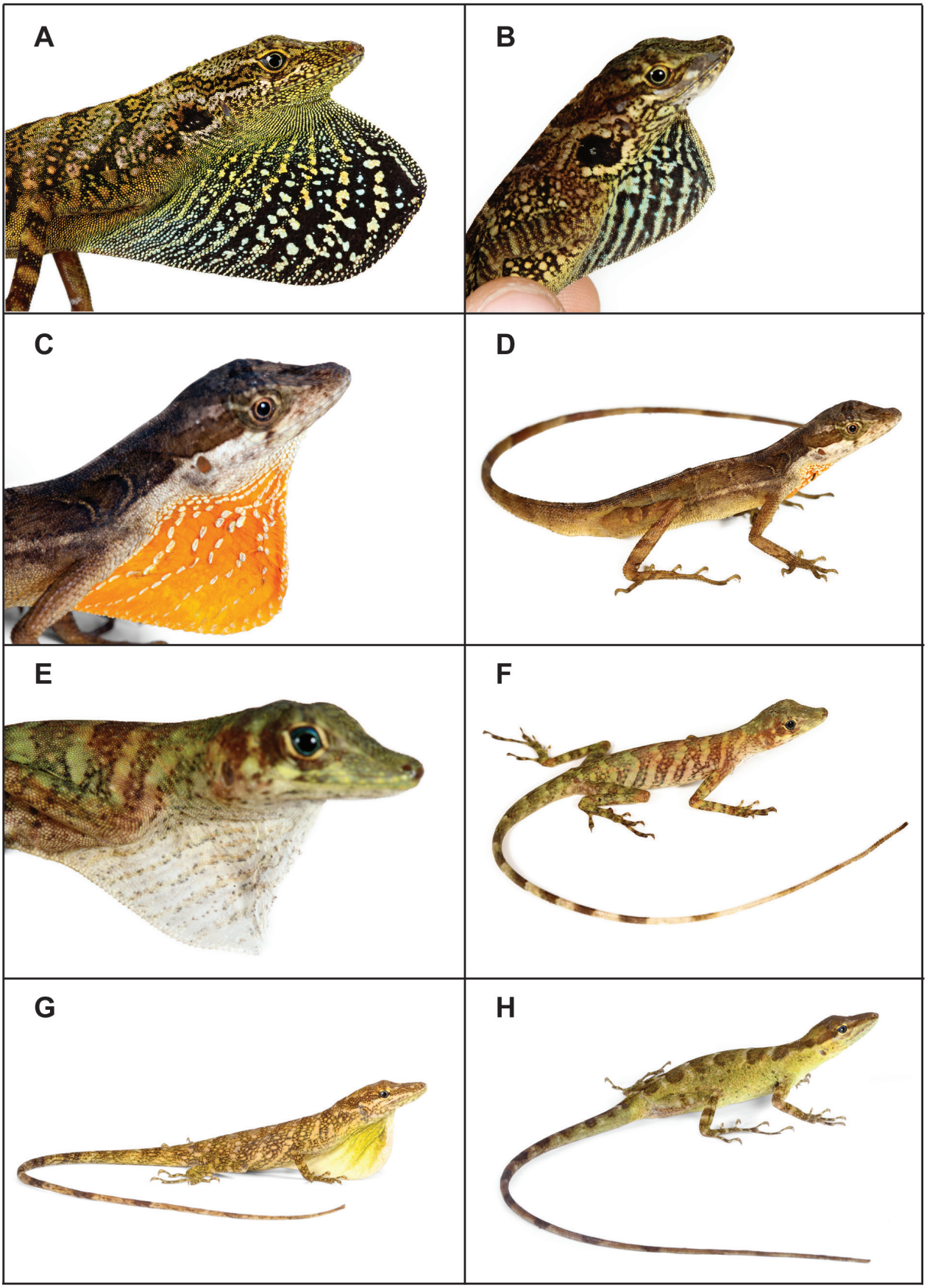

Fig. 4. Part 1. Five species of *Anolis* from western Ecuador. *A. aequatorialis*: male (QCAZ 11861, **A**) and female (QCAZ 3443, **B**); *A. binotatus*: male (QCAZ 3434, **C**, **D**); *A. fasciatus*: male (QCAZ 3450, **E**, **F**); *A. otongae*: male (QCAZ 11790, **G**) and female (QCAZ 11791, **H**).

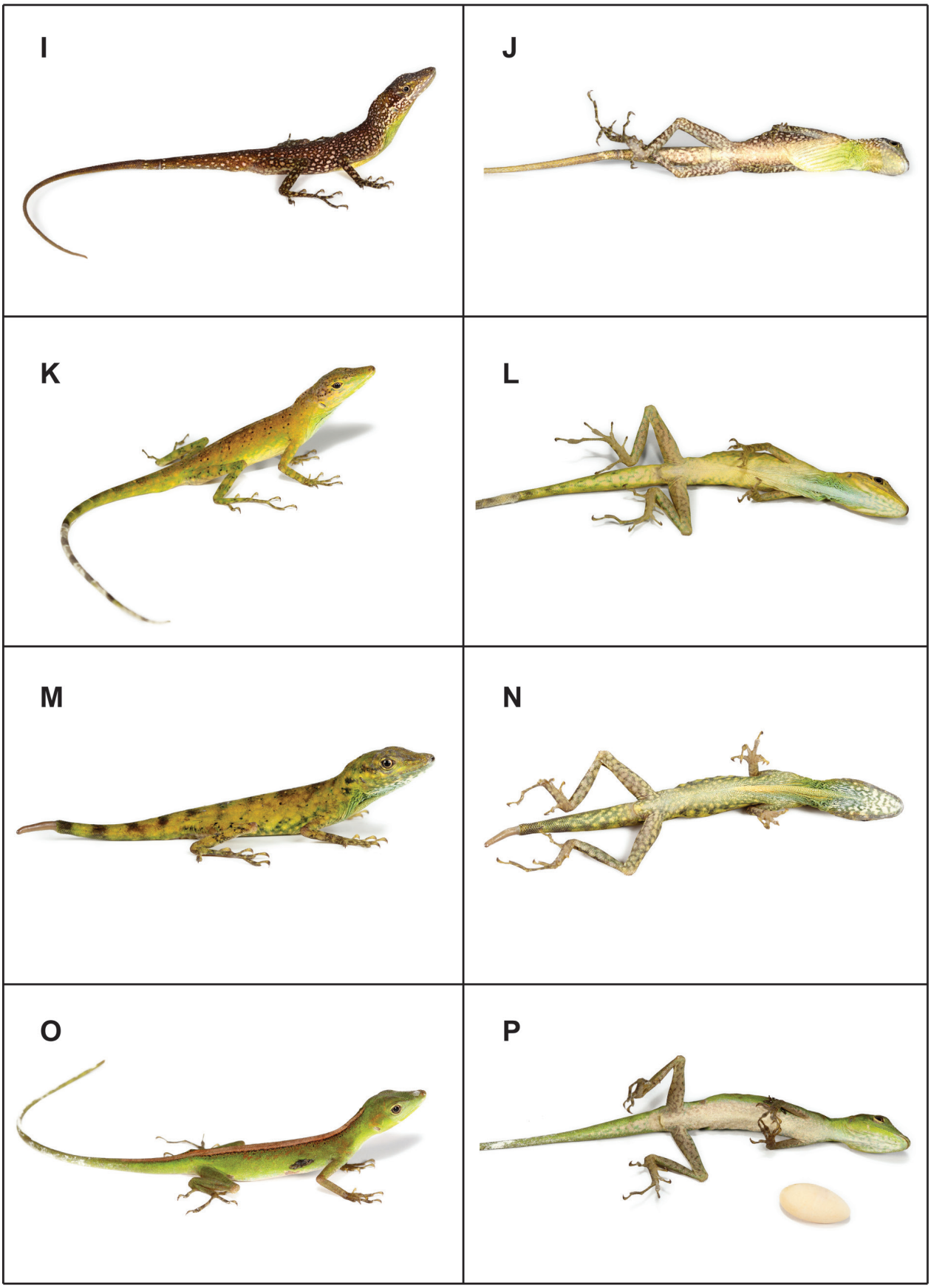

Fig. 4. Part 2. *A. gemmosus*: male (QCAZ 4352, **I**, **J**), male (QCAZ 4385, **K**, **L**), male (QCAZ 11849, **M**, **N**), and female (QCAZ 4393, O, **P**). *All photographs by O. Torres-Carvajal, except A, M, N (S. R. Ron).*

Description of holotype (scores for paratypes in parentheses)

Male (Figs. 1, 2); SVL 59.7 mm (46.5−60.3 mm); tail length 150.2 mm (146.2−163.4 mm); head length 15.9 mm (14.8−16.5 mm); head width 8.4 mm (7.8−8.8 mm); head height 7.2 mm (6.5−7.5 mm); internasal distance 2.0 mm (1.2−2.1 mm); interorbital distance 2.4 mm (2.2−2.5 mm); interparietal absent (present, interparietal length 0.8−0.9 mm; second largest scale length near interparietal 0.3−0.4 mm); ear opening maximum length 1.6 mm (1.6−2.1 mm); snout length 6.8 mm (6.8−7.3 mm); jaw length 11.7 mm (11.7−14.4 mm); axila-groin distance 27.7 mm (27.4−30.6 mm); femur length 14.8 mm (14.4−15.6 mm); 4th toe length 12.5 mm (10.6−12.8 mm); 4th toepad width 1.2 mm (1.0−1.3 mm); forelimb length 36.2 mm (21.8−36.2 mm); hindlimb length 42.6 mm (42.6−52.7 mm).

Head scales multicarinate (same, unicarinate, or rugose) on frontal region and unicarinate (same, multicarinate or rugose) on supraocular disc; 11 (10−14) scales between second canthals; 13 (11−15) scales between first canthals; 6 (5−7) scales bordering the rostral posteriorly; anterior nasal in contact with rostral (same or inferior nasal in contact with rostral); supraorbital semicircles separated by two (0−3) scales; supraocular disk with scales heterogeneous in size; one elongate superciliary followed by a series of granules (same or one small scale instead of granules); 6 (5−8) loreal rows on left side; 49 (25−53) loreal scales; interparietal absent (same or, when present, the interparietal smaller than ear opening, with 4−7 scales between interparietal and semicircles on each side, and 8−15 scales between interparietal and nape scales); suboculars in contact with supralabials; 6 (5−7) supralabials counted up to a point below center of eye; 6 (5−7) infralabials counted up to a point below center of eye; 7 (4−7) postmentals; one enlarged sublabial on each side.

Table 2. PCA loadings conducted on nine morphological variables of *Anolis gemmosus*, *A. otongae* and *A. poei*.

	Raw			Rotated		
	1	2	3	1	2	3
Head height	-0.96	0.21	-0.02	-0.97	0.16	-0.07
Head length	0.24	0.34	0.05	0.22	0.35	0.05
Head width	-0.96	0.20	-0.03	-0.96	0.15	-0.07
Jaw length	0.98	0.06	-0.06	0.98	0.11	-0.03
Snout length	0.82	0.33	-0.07	0.81	0.37	-0.06
Forelimb length	-0.01	0.80	0.04	-0.05	0.80	0.00
Hindlimb length	-0.01	0.85	0.02	-0.05	0.85	-0.03
Axilla-groin length	-0.01	-0.50	-0.02	0.01	-0.50	0.01
Snout-vent length	0.06	-0.04	0.99	0.02	0.01	1.00
Eigenvalue	3.54	1.93	1.00	3.53	1.93	1.01
% var. explained	39.31	21.42	11.16	39.23	21.45	11.21

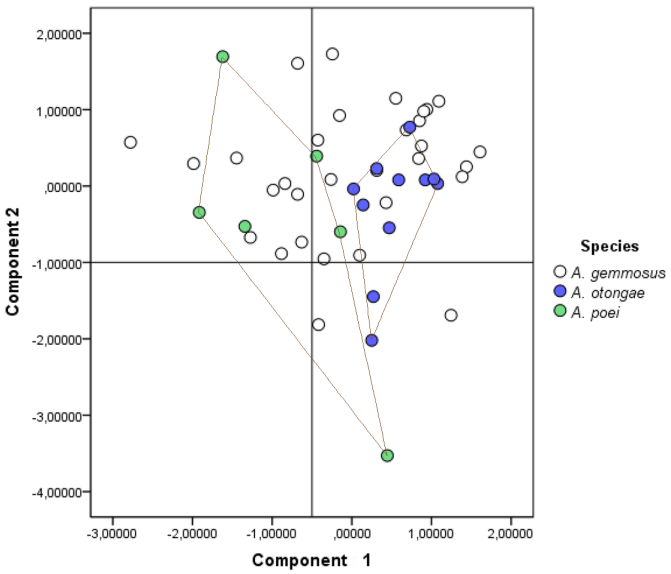

Fig. 5. Distribution of *Anolis gemmosus*, *A. otongae* and *A. poei* sp. nov. along the first and second principal components axes.

Dorsal crest or enlarged middorsal row absent; dorsal scales keeled, 11 (9−11) dorsal scales in 5% the length of SVL contained in the dorsal midline at the level of the forelimbs; flank scales more or less separated by skin; ventrals smaller than dorsals, 13 (8−13) longitudinal rows in 5% the length of SVL; ventrals smooth and granular, arranged in diagonal rows.

Toepads overlap the first phalanx in all toes; 19 (18−19) lamellae under phalanges III and IV of fourth toe (character 27 in Williams et al. 1995 and character 9 in Poe 2004); supradigitals multicarinate; tail with a double row of middorsal scales; postanals present (same or absent), with a slightly enlarged scale laterally on each side.

Nuchal fold present (absent in females and juveniles); dorsal folds absent; dewlap extending posteriorly to a point halfway between fore and hindlimbs (absent in females); dewlap with five longitudinal rows of 3−7 swollen scales, similar size to ventrals, separated by naked skin.

Sexual variation of meristic and morphometric characters in *A. poei* is presented in Table 4.

Color in life

Holotype (QCAZ 3449; Figs. 2, 3): background of head, body, limbs and tail green; head with light bluish green, dark green, and light grey irregular spots dorsally; dorsal surface of body with six light grey, small irregular blotches; dorsal surface of neck with two light grey, small irregular blotches; limbs with dark green and yellowish-cream spots; lateral surface of head with a white stripe extending posteriorly from loreal region, through subocular region, to a point anterior to the tympanum; white blotch with yellow center above tympanum; eyelids yellowish green with first row of upper and lower

palpebrals black, second and third rows both yellow and green; lateral surface of neck with dark green dots; body flanks green, with rows of yellow-centered white spots oriented ventro-posteriorly; ventral surface of head yellowish green with light yellow blotches; ventral surface of body white with bluish-green reticulations; ventral surface of limbs white with several transparent scales and dark brown reticulations; ventral surface of tail white with dark green spots anteriorly, and yellowish-green transverse bands posteriorly; dewlap skin light blue, dark yellowish green on gorgetal region, light blue on sternal region; gorgetal scales light yellowish green; marginals and sternals white; iris dark brown with a white inner ring. When stressed, the dorsal background color switched from green to yellowish brown.

Subadult male (QCAZ 3455, Figs. 2,3, differences from holotype): head with dark green and white irregular small spots dorsally; dorsal surface of body and neck with white and dark green small spots, and larger pale yellow spots; lateral surface of head yellowish green with a white stripe extending posteriorly from loreal region, through subocular region, to upper border of tympanum; lateral surface of body with rows of white and dark green small spots, and larger pale yellow spots; ventral surface of head with white blotches and light blue spots; ventral surface of body with dark green reticulations; ventral surface of limbs with brown or green reticulations; ventral surface of tail with blackish green reticulations anteriorly; dewlap skin white, yellow on gorgetal region, white on sternal region; throat, edge of mouth, and tongue pinkish white (Fig. 6). When stressed, rust-colored blotches appeared on dorsal surface of head, body, limbs and tail.

Adult female (QCAZ 3454, Fig. 7): dorsal surface of head, body and tail yellowish green; dorsal surface of body with six narrow brown chevrons, each one delimited posteriorly by a grayish white blotch; limbs yellowish green with dark green spots arranged in bands, and pale yellowish spots; tail with two brown chevrons anteriorly; lateral surface of head yellowish green; loreal region yellow; lateral surface of neck and body yellowish green with brown dots; ventral surface of head pale yellow with yellowish green reticulations, short white longitudinal stripe on throat; ventral surface of body and tail white with black reticulations laterally; ventral surface of limbs white with some transparent scales and brown reticulations on hindlimbs; ventral surface of tail with brownish green reticulations anteriorly; iris brown with a pale white ring.

Subadult female (QCAZ 3446, Fig. 7, differences with QCAZ 3454): occipital and temporal regions with brown and white small blotches; dorsal surface of neck with a distinct brown chevron delimited posteriorly by a grayish white blotch; lateral surface of body yellowish green dorsally and light blue ventrally, with white or cream spots; dorsal surface of tail with two brown chevrons, each one delimited posteriorly by a grayish white blotch.

Fig. 6. Tongue of *Anolis poei* sp. nov., subadult male (QCAZ 3455, **top**); *A. gemmosus*, adult male (QCAZ 4347, **middle**); *A. otongae*, adult male (QCAZ 4661, **bottom**). *Photographs by S. R. Ron (top), O. Torres-Carvajal (middle, bottom).*

Color in preservative

Holotype (QCAZ 3449): dorsal background of head, body, limbs and tail grayish brown; dorsal surface of head with metallic green, dark green, blue, gray and white cream irregular spots; dorsal surface of body with six black small chevrons, each delimited posteriorly by a white irregular blotch; limbs with dark brown and white spots; lateral surface of head with a white stripe extending posteriorly from loreal region, through subocular region, to a point anterior to the tympanum; upper border of tympanum with a white spot; eyelids purple with first row of upper and lower palpebrals black, second and third rows white and purple; neck flanks with black dots; body flanks grayish brown, with dark brown diagonal

Table 3. Summary of morphological characters of *Anolis poei* sp. nov. and *A. gemmosus* from Ecuador. For each quantitative character, the *F*-value, *t*-value, and corresponding *P*-values are given. Range and sample size (in parenthesis) followed by mean ± standard deviation are given.

Character	*A. gemmosus*	*A. poei* sp. nov.	*F*-value	*P*	*t*-value	*P*
Scales between second canthals	12–21 (24) 15.25 ± 1.98	11–14 (13) 12.08 ± 1.12	2.59	0.12	5.31	<0.005
Postrostrals	5–7 (24) 5.79 ± 0.72	5–7 (13) 5.92 ± 0.64	1.37	0.25	-0.55	0.59
Row of loreals	6–10 (24) 7.25 ± 1.15	5–8 (13) 6.31 ± 1.18	0.03	0.86	2.36	0.02
Scales between supraorbital semicircles	1–5 (24) 3.13 ± 1.23	1–3 (13) 1.62 ± 0.77	5.27	0.03	4.46	<0.005
Scales between interparietal (if present) and semicircles	3–8 (24) 5.67 ± 1.27	4–7 (6) 5.83 ± 1.17	0.18	0.67	-0.29	0.77
Supralabials	5–7 (24) 6.08 ± 0.50	5–7 (13) 6 ± 0.41	1.29	0.27	0.51	0.61
Postmentals	4–8 (24) 6.13 ± 1.03	4–7 (13) 5.77 ± 0.93	0.18	0.67	1.03	0.31
Lamellae under phalanges III-IV of fourth toe	14–18 (24) 17.33 ± 0.92	18–19 (13) 18.92 ± 0.28	8.71	0.01	-7.86	<0.005
Head length	13.23–18.12 (94) 15.46 ± 1.07	14.79–16.5 (7) 15.67 ± 0.51	4.67	0.03	0.93	0.37
Head width	6.97–17.41 (94) 10.82 ± 3.24	7.84–8.84 (7) 8.29 ± 0.36	32.16	<0.005	-7.03	<0.005
Head height	5.42–15.96 (94) 9.51 ± 3.32	6.54–7.48 (7) 6.92 ± 0.38	31.04	<0.005	-6.96	<0.005
Jaw length	7.31–17.43 (94) 12.32 ± 3.02	11.73–14.36 (7) 12.44 ± 0.91	19.25	<0.005	0.26	0.80
Snout length	5.79–14.95 (94) 10.58 ± 2.93	6.75–7.30 (7) 6.92 ± 0.19	41.30	<0.005	-11.74	<0.005
Forelimb length	23.41–34.34 (94) 29.43 ± 2.28	21.84–36.18 (7) 28.57 ± 4.25	0.02	0.89	-0.12	0.90
Hindlimb length	41.51–63.80 (94) 52.82 ± 4.13	42.56–52.68 (7) 49.01 ± 3.33	1.00	0.32	-2.38	0.02
Axilla-groin length	20.73–33.51 (94) 26.74 ± 2.07	27.35–30.61 (7) 28.54 ± 1.30	0.95	0.33	2.26	0.03
Snout-vent length	46.71–66.21 (94) 58.34 ± 3.65	46.47–60.31 (7) 56.87 ± 4.85	0.35	0.56	-1.00	0.32
Tail length	94.94–191 (94) 154.59 ± 18.66	146.21–163.37 (7) 154.74 ± 6.32	3.82	0.05	0.02	0.98

Table 4. Sexual variation in lepidosis and measurements (mm) of *Anolis poei* sp. nov. Range followed by mean ± standard deviation are given.

Character	Males	Females
	n = 4	*n* = 3
Scales between second canthals	11–13 11.75 ± 0.96	12–13 12.67 ± 0.58
Postrostrals	5–6 5.75 ± 0.5	6–7 6.33 ± 0.58
Row of loreals	6–8 7 ± 1.15	5–6 5.33 ± 0.58
Scales between supraorbital semicircles	1–2 1.75 ± 0.5	1–2 1.67 ± 0.577
Scales between interparietal and semicircles	Interparietal absent	6–7 6.50 ± 3.78
Supralabials to below center of eye	6	6
Postmentals	4–7 5.25 ± 1.5	6–7 6.33 ± 0.58
Lamellae under phalanges II-III of fourth toe	19	19
Head length	15.8–16.5 15.95 ± 0.38	14.8–15.62 15.29 ± 0.44
Head width	7.84–8.84 8.31 ± 0.41	8.05–8.66 8.26 ± 0.34
Head height	6.67–7.48 7.02 ± 0.39	6.54–7.27 6.8 ± 0.41
Jaw length	11.73–12.65 12.25 ± 0.38	11.86–14.36 12.70 ± 1.43
Snout length	6.75–7.04 6.87 ± 0.12	7.82–7.30 7 ± 0.26
Forelimb length	27.94–36.18 30.75 ± 3.72	21.84–28.19 25.68 ± 3.37
Hindlimb length	42.56–52.68 49.35 ± 4.59	47.50–49.56 48.57 ± 1.03
Axilla-groin length	27.35–28.17 27.76 ± 0.33	27.94–30.61 29.57 ± 1.43
Snout-vent length	58.80–60.31 59.45 ± 0.68	46.47–58.48 53.43 ± 6.22
Tail length	150.20–163.37 157.89 ± 5.89	146.21–155.38 150.53 ± 4.60

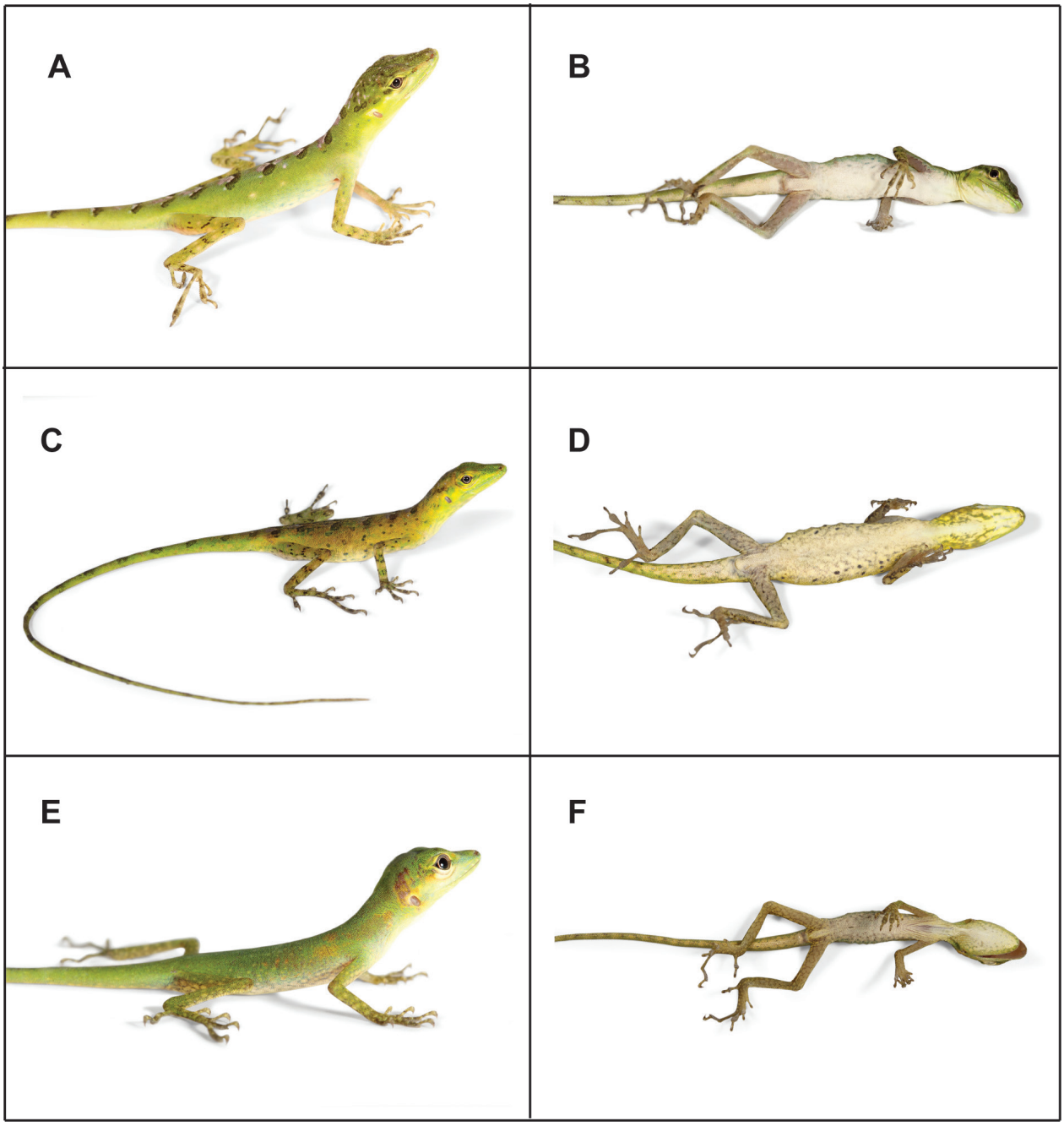

Fig. 7. *Anolis poei* sp. nov. Adult female (SVL = 46.47 mm, QCAZ 3454, **A**, **B**), subadult female (SVL = 47.99 mm, QCAZ 3446, **C**, **D**), juvenile male (SVL = 26.85 mm, QCAZ 3453, **E**, **F**). *Photographs by O. Torres-Carvajal.*

bands oriented ventro-posteriorly and intercalated with white spots; ventral surface of head white with light blue reticulations; ventral surface of body white with faint grayish purple reticulations; ventral surface of limbs grayish cream with dark brown reticulations; ventral surface of tail white anteriorly with a metallic green tint and grayish purple spots, and gray posteriorly; dewlap skin with a turquoise gorgetal region and white sternal region; gorgetal scales light brown with a gold tint internally, and dark brown externally; dewlap marginals and sternals white; throat, edge of mouth and tongue white.

Adult male (QCAZ 6783): dorsal surface of head and body dark brown with gray dots; dorsal surface of limbs dark brown, with gray dots on forelimbs; lateral surface of head dark brown with white cream dots dorsal and anterior to tympanum; body flanks dark brown with faint white dots arranged on diagonal lines that reach venter; ventral surface of head with bluish-purple infralabial and sublabial regions, and light purple gular region with white irregular spots; ventral surface of body white with faint purple reticulations; limbs creamish gray with dark brown reticulations; ventral surface of tail white with

purple mottling anteriorly, and gray posteriorly; dewlap skin with a light blue gorgetal region and white sternal region; gorgetal scales purple; sternal and marginal scales white.

Adult female (QCAZ 3454): dorsal surface of head brown with metallic blue and green frontal and supraocular regions; dorsal surface of body brown with six narrow black chevrons, each one delimited posteriorly by a white blotch; forelimbs bluish brown with white spots arranged in stripes; hindlimbs brown with dark brown bands and dots; tail with two black chevrons anteriorly; lateral surface of head brown with purple tint; labial region light purple; lateral aspect of neck and body purple with black dots; ventral surface of head white with purple brown stripes; ventral surface of body white with dark brown dots laterally; ventral surface of limbs grayish cream with dark brown reticulations on hindlimbs; ventral surface of tail white with dark brown dots.

Subadult female (QCAZ 3446, differences with QCAZ 3454): occipital and temporal regions with dark brown, small blotches; dorsal surface of neck with a distinct dark brown chevron; dorsal surface of body with six distinct, dark brown chevrons; dorsal surface of tail with two dark brown chevrons.

Phylogenetic relationships

The data matrix analyzed in this study contained 1,065 unique site patterns. Of the 2,807 nucleotide characters included in our analysis 1,703 were constant, 224 parsimony uninformative, and 880 were parsimony informative. The 50% majority rule consensus tree resulting from the Bayesian analysis (Fig. 8) is generally congruent with the phylogeny of the clade Dactyloa presented by Castañeda and de Queiroz (2011). Both the new species described here and *A. otongae* are members of the aequatorialis series of Castañeda and de Queiroz (2013), which corresponds roughly to the "western clade" of Castañeda and de Queiroz (2011). Our phylogeny supports strongly (PP = 0.99) a sister taxon relationship between *Anolis poei* and *A. gemmosus*, as well as the exclusivity (de Queiroz and Donoghue 1990; de Queiroz 1998) of both species. They form a clade sister (PP = 0.89) to *A. otongae*. The clade formed by the three species is sister (PP = 1) to a clade formed by *A. aequatorialis* and *A. anoriensis*.

Distribution and ecology

Anolis poei inhabits low montane evergreen forest (Sierra 1999) on the western slopes of the Andes in central Ecuador, Provincia Bolívar, between 1,310–1,354 m (Fig. 9).

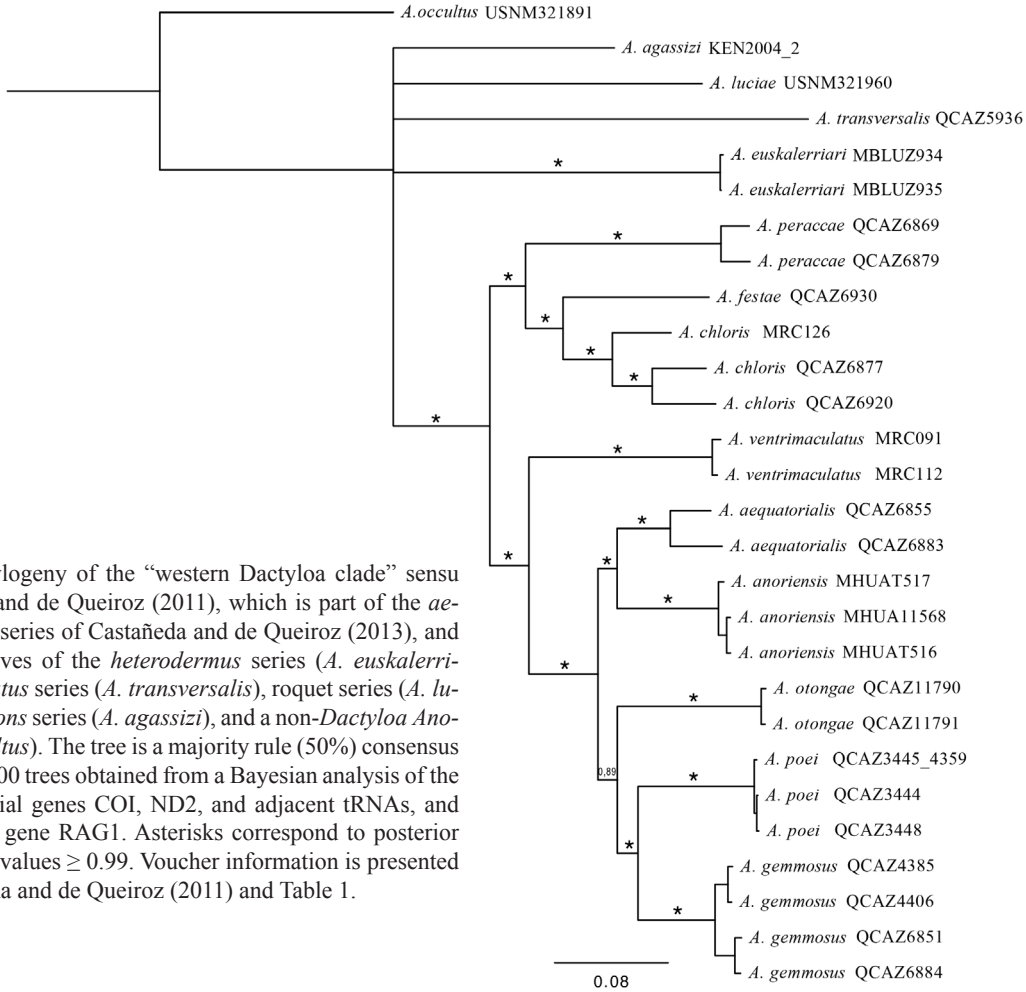

Fig. 8. Phylogeny of the "western Dactyloa clade" sensu Castañeda and de Queiroz (2011), which is part of the *aequatorialis* series of Castañeda and de Queiroz (2013), and representatives of the *heterodermus* series (*A. euskalerriari*), *punctatus* series (*A. transversalis*), roquet series (*A. luciae*), *latifrons* series (*A. agassizi*), and a non-*Dactyloa Anolis* (*A. occultus*). The tree is a majority rule (50%) consensus tree of 72,000 trees obtained from a Bayesian analysis of the mitochondrial genes COI, ND2, and adjacent tRNAs, and the nuclear gene RAG1. Asterisks correspond to posterior probability values ≥ 0.99. Voucher information is presented in Castañeda and de Queiroz (2011) and Table 1.

The new species occurs in sympatry with *A. aequatorialis*, *A. binotatus*, and *A. fasciatus* at its type locality (Fig. 4). Specimens of the new species were collected along the border of a road, close to rivers, in secondary forest, and on shrubs within pastures. All individuals were found between 20h00 and 22h00 sleeping with their heads up, or in a horizontal position on branches or vines, 0.5–4.5 m above ground or streams. The smallest individual QCAZ 3453 (SVL = 26.9 m; TL = 67.6 mm) was collected on 11 June 2011.

Etymology

The specific name is a noun in the genitive case and is a patronym for Steve Poe, who has published important contributions to the systematics and evolution of *Anolis* lizards (Poe 2004, 2011). During his collecting trips to Ecuador in 2009 and 2010, Poe trained several young herpetologists in field collecting techniques and inspired them to explore the diversity of anole lizards. This paper is one of the products resulting from that inspiration.

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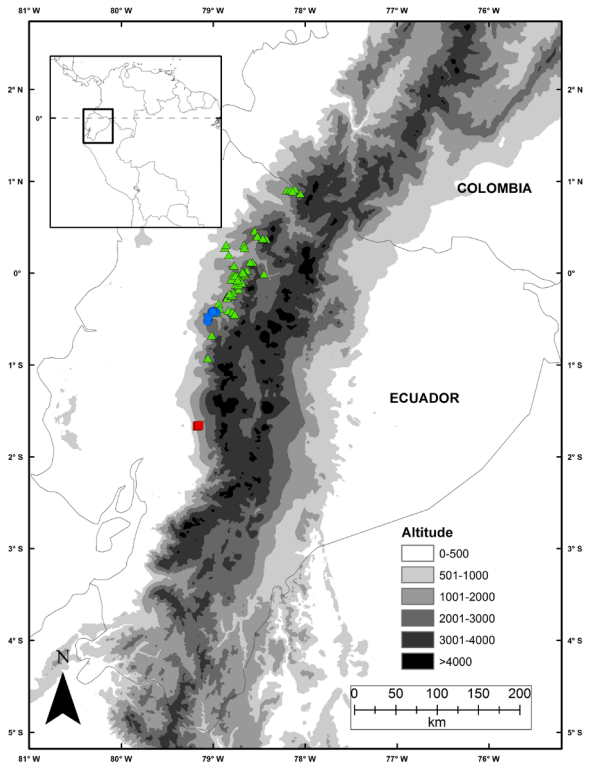

Fig. 9. Distribution of *Anolis gemmosus* (triangles), *A. otongae* (circles) and *A. poei* sp. nov. (squares) in Ecuador.

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Appendix 1

Additional specimens examined

Anolis gemmosus – Ecuador: *Carchi*: Chilma Bajo, Finca de Aníbal Pozo, 0.86397°N, 78.04723°W, 2,022 m, QCAZ 8681-82; Chilma Bajo, Finca de Aníbal Pozo, 0.86495°N, 78.04979°W, 2,071 m, QCAZ 8683; La Centella, 0.89318°N, 78.13471°W, 1,800-2,400 m, QCAZ 11784; Maldonado, Sendero Ecológico Teldibi, 0.91301°N, 78.10782°W, 1,477-1,635 m, QCAZ 12272, 12278, QCAZ 12279-80, 4360, 4406, 4408; Río San Pablo, cerca a Chical, 0.90302°N, 78.16284°W, 1,399 m, QCAZ 4377, 4382, 4385-86,4388; Río San Pablo, cerca a Chical, 0.90327°N, 78.16201°W, 1,429 m, QCAZ 4393; Río Verde and Río Pablo, Río Estrellita, Guapil, 1,428-1,466 m, QCAZ 12289, 12294, 12302; *Cotopaxi*: 115 km Oeste de Pilaló, 0.928°S, 79.057°W, 1,500 m, QCAZ 4072; 18.2 km de Quillutuña, vía a Pucayacu, 0.67843°S, 79.01565°W, 1,420 m, QCAZ 8845-49; Alrededores de San Francisco de Las Pampas, 0.42371°S, 78.96765°W, 1,800 m, QCAZ 1440-47, 2123; Bosque Integral Otonga , 0.4194°S, 79.00345°W, 1,720-2,143 m, QCAZ 2758, 2809-10, 3121, 3126-27, 3131, 3133, 3174, 3180-90, 3863-3866, 3869-71, 3940, 3974-76, 4028-34, 4224-25, 4657, 4663, 4785, 5060, 5063, 5371, 5477-79, 5482-83, 6770-73, 9888, 10424, 10438-39, 10441-42, 10452, 12057, 12060-65, 12067, 12072-73, 12075, 12077-82, Bosque Integral Otonga, a lo largo del río Esmeraldas, 0.46333°S, 79.05027°W, QCAZ 7281-89; Bosque Integral Otonga, alrededores de la estación, 0.41933°S, 79.00336°W, 1,980 m, QCAZ 10697; Bosque Integral Otonga, arriba de la estación, 0.41478°S, 79.00073°W, QCAZ 3867-68; Bosque Integral Otonga, orillas del río Esmeraldas, 0.41932°S, 78.99396°W, 1,719 m, QCAZ 10393, 10395, 10399; Bosque Integral Otonga, sendero a la Estación, 0.41933°S, 79.00336°W, 1,646 m, QCAZ 10696; Cerca a Naranjito, 0.41944°S, 79.00333°W, QCAZ 7825; San Francisco de Las Pampas, 0.42371°S, 78.96765°W, 1,600-1,800 m, QCAZ 63, 68-70, 72-79, 3134-53, 3155, 3175; Vía a Otonga, 0.33183°S, 78.93791°W, 1,476-1,700 m, QCAZ 8412; *Imbabura*: 6 de Julio de Cuellaje, 0.4°N, 78.525°W, QCAZ 4346-47; 6 de Julio de Cuellaje, 0.40107°N, 78.5181°W, 1,886 m, QCAZ 4349; 6 de Julio de Cuellaje, 0.40102°N, 78.51779°W, 1,897 m, QCAZ 4350; 6 de Julio de Cuellaje, punto 8, 0.4°N, 78.525°W, QCAZ 4348; 6 de Julio de Cuellaje, San Antonio, Cordillera de Toisán, 0.45803°N, 78.54722°W, QCAZ 9450-53; Carretera nueva vía a Cuellaje, Sector de Santa Clara, Reserva Alto Choco, 0.37603°N, 78.45857°W, 2,062 m, QCAZ 4352-54; La Mina, Junín, 0.2754°N, 78.6603°W, 1,715 m, QCAZ 3071; Manduriaco, 0.277°N, 78.873°W, 1,330 m, QCAZ 5328; Manduriacu, 7.5 km NE of Bellavista, 0.31006°N, 78.85757°W, 1,177-1,227 m, QCAZ 11606, 12305-314; 12322, 12324, 12326, 12328, 12331; Reserva Siempre Verde, NE de Cotacachi, 0.37167°N, 78.42186°W, 2,468 m, QCAZ 8837; Reserva Alto Choco, Santa Rosa, 0.36939°N, 78.44942°W, 2,109 m, QCAZ 7330-31; *Pichincha*: 1-2 km oeste de Tandayapa, 0.004°S, 78.663°W, 2,000 m, QCAZ 2070-71; 2.9 km de Tandayapa, 0.00952°S, 78.65698°W, 1,820 m, QCAZ 406-10; 5 km E Tandayapa, 0.02°S, 78.651°W, 1,975 m, QCAZ 2066-69; A orillas del Río Chisinche, en la carretera a Conchacato, 0.448°S, 78.76423°W, 1,693 m, QCAZ 6884-89; 30 km E de Santo Domingo, hacia la Reserva de Bosque Integral Otonga, 0.3884°S, 78.92995°W, QCAZ 9769-70; 9775; Bosque Protector Mindo - Nambillo, refugio, 0.106°S, 78.687°W, 1,700 m, QCAZ 2910; Cooperativa El Porvenir, finca El Cedral, 0.114°N, 78.56993°W, 2,297 m, QCAZ 10501-502; Desviación a Mindo, 1-5 km de la intersección hacia abajo, 0.02853°S, 78.75861°W, 1,661 m, QCAZ 9724-31; Estación Científica Río Guajalito, 0.22676°S, 78.82171°W, 1,791-1,814 m, QCAZ 1330, 1333, 1500, 1645, 2682-84, 2786, 2813, 2815-16, 3040-45, 3056-57, 3373, 3385, 4123-25, 4210, 4214, 6413-14, 8859, 8864-65, 9974, 11404, 12088-101; Las Tolas, 0.72818°N, 78.77792°W, 1,200-1,600 m, QCAZ 11848-49; Manuel Cornejo Astorga (Tandapi), frente a la planta de agua potable "El Placer" vía a Conchacato, 0.42471°S, 78.78905°W, 1,500 m, QCAZ 6882; Manuel Cornejo Astorga (Tandapi), vía Atenas a 5 km de la carretera principal, 0.40625°S, 78.83621°W, 1,671 m, QCAZ 5365-70; Mindo, 1,342-1,560 m, QCAZ 12350-53, 12356, 12358, 12365, 12370, 12375-76; Mindo Biology Station, 0.07805°S, 78.73194°W, QCAZ 7518-20, 7522; Mindo, camino entre Mariposas de Mindo y Mindo Garden, 0.06753°S, 78.7535°W, 1,361 m, QCAZ 6851-53, 6858; Mindo Garden, 4 km de Mindo, 0.06901°S, 78.80166°W, QCAZ 2787; Mindo, El Monte, Road to Mindo Garden, 0.07805°S, 78.7319°W, QCAZ 7521; Mindo, Sachatamia Lodge, 0.02638°S, 78.75944°W, 1,700 m, QCAZ 11857-59; Nanegalito, Finca El Cedral, 0.1141°N, 78.57007°W, 2,272 m, QCAZ 9462-63; Pachijal, vía Nanegalito-Los Bancos, 0.13°S, 78.72644°W, 1,741 m, QCAZ 5494-500; Palmeras, 0.244°S, 78.794°W, 1,800 m, QCAZ 871, 881-83,1351-52, 2244, 3004-06; Recinto Chiriboga, Estación La Favorita , 0.21307°S, 78.78421°W, 1,680 m, QCAZ 5383-84; Reserva Ecológica Bosque Nublado "Santa Lucía," 0.11928°N, 78.59647°W, 1,624-1,927 m, QCAZ 10664, 11850-52, 11888-93,11897, 11899; Tandayapa, 0.00591°N, 78.67455°W, 1,670 m, QCAZ 4086. *Locality in error*: Pichincha, San Antonio de Pichincha, 0.00905°S, 78.44581°W, QCAZ 724.

Anolis otongae – Ecuador: *Cotopaxi*: Alrededores de San Francisco de Las Pampas, 0.42371°S, 78.96765°W, 1,800 m, QCAZ 2128; Bosque Integral Otonga , 0.41944°S, 79.00333°W, 1,900-2,300 m, QCAZ 1721, 2050-52, 3129, 3706, 3796, 3872-73, 4025, 4661, 5481, 6219, 11790-91, 12035, 12056, 12058, 12070-71; Los Libres, QCAZ 2781; Peñas Coloradas, 0.52343°S, 79.05908°W, QCAZ 1696; *Pichincha*: La Victoria, 0.47747°S, 79.05336°W, 2,104 m, QCAZ 6394-96.

Fernando Ayala-Varela is the director of the herpetology collection at the Pontificia Universidad Católica del Ecuador in Quito. He received his diploma at the Pontificia Universidad Católica del Ecuador, Quito in 2004. He has been interested in herpetology since childhood and has dedicated a lot of time studying the lizards of Ecuador, specifically the taxonomy and ecology of *Anolis* species. His current research interests include reproductive biology and ecology of lizards and snakes in Ecuador.

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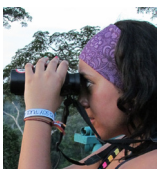

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In accordance with the *International Code of Zoological Nomenclature* new rules and regulations (ICZN 2012), we have deposited this paper in publicly accessible institutional libraries. The new species described herein has been registered in *ZooBank* (Polaszek 2005a, b), the official online registration system for the ICZN. The *ZooBank* publication LSID (Life Science Identifier) for the new species described here can be viewed through any standard web browser by appending the LSID to the prefix "http://zoobank.org/". The LSID for this publication is: urn:lsid:zoobank.org:pub:61380956-F1AC-46C0-84F3-C1ED545C46DC.

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Citations

ICZN. 2012. Amendment of Articles 8,9,10,21 and 78 of the International Code of Zoological Nomenclature to expand and refine methods of publication. *Zootaxa* 3450: 1–7.

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