Zootaxa 3866 (2): 246–260
www.mapress.com/zootaxa/
Copyright © 2014 Magnolia Press

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3866.2.4
http://zoobank.org/urn:lsid:zoobank.org:pub:1688B0D1-5304-4728-8215-66B01A6C5C0D

A new species of *Riama* Gray, 1858 (Squamata: Gymnophthalmidae) from the Tropical Andes

VANESSA AGUIRRE-PEÑAFIEL[1], OMAR TORRES-CARVAJAL[1,*], PEDRO M. SALES NUNES[2,3], MIKA R. PECK[4] & SIMON T. MADDOCK[5,6]

[1]*Museo de Zoología, Escuela de Ciencias Biológicas, Pontificia Universidad Católica del Ecuador, Av. 12 de octubre y Roca, Aptdo. 17–01–2184, Quito, Ecuador.*
[2] *Universidade de São Paulo, Instituto de Biociências, Departamento de Zoologia. Caixa Postal 11.461, CEP 05422–970, São Paulo, SP, Brazil.*
[3]*Universidade Federal de Pernambuco, Centro de Ciências Biológicas, Departamento de Zoologia, Av. Professor Moraes Rego, s/n. Cidade Universitária CEP 50670-901, Recife, PE, Brazil.*
[4]*Department of Life Sciences, University of Sussex, Brighton, BN19QJ, UK.*
[5]*Department of Life Sciences, The Natural History Museum, London, SW7 5BD, UK.*
[6]*Department of Genetics, Evolution and Environment, University College London, London, WC1E 6BT, UK.*
[*]*Corresponding author. E-mail address: omartorcar@gmail.com*

Abstract

A new species of *Riama* lizard from the western slopes of the Andes in northern Ecuador is described herein. Morphologically, *Riama yumborum* **sp. nov.** can be distinguished from all other congenerics by having an incomplete nasoloreal suture and a cylindrical hemipenial body with diagonally orientated flounces on its lateral aspect. Phylogenetic analyses of mitochondrial and nuclear DNA support the monophyly of the new species and its sister taxon relationship with *R. labionis*, which occurs allopatrically.

Key words: Cloudforest, DNA, Ecuador, neotropics, systematics

Introduction

The Neotropical lizard genus *Riama* Gray, 1858 includes 30 recognized species that occur throughout the Andes of central Peru, Ecuador, Colombia, Venezuela, the Cordillera de la Costa of Venezuela and Trinidad and Tobago (Doan & Castoe 2005). Similar to other gymnophthalmid lizards, the alpha diversity of *Riama* seems to be underestimated as revealed by the large percentage of species (26%) described in the last decade alone (Doan & Schargel 2003; Köhler & Lehr 2004; Rivas *et al*. 2005; Arredondo & Sánchez-Pacheco 2010; Sánchez-Pacheco 2010a; Sánchez-Pacheco *et al*. 2011, 2012). Moreover, none of these descriptions are based on molecular evidence, which has been shown to accelerate the discovery of undetected diversity (Bickford *et al*. 2007).

Riama lizards occur mostly along the Tropical Andes, the world's leading hotspot in diversity and endemism of terrestrial vertebrates and vascular plants (Myers *et al*. 2000). A large percentage of this diversity is concentrated on the slopes of the Andes, including high elevation cloudforests. Here we contribute to the knowledge of the diversity of the Tropical Andes by describing a new species of *Riama* from a cloud forest in northwestern Ecuador based on morphological and molecular evidence.

Material and methods

Morphological data. Specimens examined in this study are listed in Appendix 1 and are deposited in the herpetological collection of Museo de Zoología (QCAZ), Pontificia Universidad Católica del Ecuador, Quito, Ecuador. We follow the terminology of morphological characters proposed by Kizirian (1996). Data for some species were obtained from the literature (Peters 1862; Boulenger 1908; Uzzell 1958; Doan & Schargel 2003;

 Accepted by S. Carranza: 3 Sept. 2014; published: 23 Sept. 2014

Köhler & Lehr 2004; Rivas *et al*. 2005; Arredondo & Sánchez-Pacheco 2010; Sánchez-Pacheco 2010a, b). Bilateral variation is reported as left/right. Snout-vent length (SVL) and tail length (TL) measurements were taken with digital calipers and recorded to the nearest 0.1 mm. Sex was determined by noting the presence/absence of hemipenes. Numbers of femoral pores in males were counted on a single specimen because the skin on the ventral side of the thighs for the remaining specimens had been removed for tissue extraction.

The left hemipenis of a single individual (QCAZ 11079) of the species described herein (see results) was prepared following the procedures described by Manzani & Abe (1988) (modified by Pesantes 1994, and Zaher 1999). The retractor muscle was manually separated, and the everted organ filled with stained petroleum jelly. The organ was immersed in an alcoholic solution of Alizarin Red for 24 hours in order to stain eventual calcified structures (e.g., spines or spicules), in an adaptation proposed by Nunes *et al.* (2012) on the procedures described by Uzzell (1973) and Harvey & Embert (2008). The terminology of hemipenial structures follows previous literature (Dowling & Savage 1960; Savage 1997; Myers & Donnelly 2001, 2008; Nunes *et al*. 2012).

DNA sequence data. Total genomic DNA was digested and extracted from liver or muscle tissue using a guanidinium isothiocyanate extraction protocol. Tissue samples were mixed with Proteinase *K* and 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 ddH_2O.

We amplified 1939 nucleotides (nt) encompassing three mitochondrial loci, 12S rRNA (*12s*, 398 nt), 16S rRNA (*16s*, 539 nt), and NADH dehydrogenase subunit 4 (*nd4,* 615 nt); and the nuclear locus oocyte maturation factor MOS (*c-mos*, 387 nt) from two individuals each of *Riama cashcaensis* (Kizirian & Coloma 1991), *R. labionis* (Kizirian 1996), and the new species described here, as well as five individuals of *R. meleagris* (Boulenger 1885), four of *R. stigmatoral* (Kizirian 1996), nine of *R. unicolor* Gray, 1858, and one each of *Petracola ventrimaculata* (Boulenger 1900) and *Pholidobolus montium* (Peters 1862). Primers and protocols follow Arevalo *et al*. (1994), Pellegrino *et al*. (2001), and Blair *et al*. (2009). Additionally, we used sequences of *R. colomaromani* (Kizirian 1996) and *R. simotera* (O'Shaughnessy 1879) from GenBank. 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 v.5.3 (Drummond *et al*. 2010). Phylogenetic relationships were assessed using Bayesian inference in MrBayes v.3.2.1 (Ronquist & Huelsenbeck 2003). Genes were combined into a single dataset with eight partitions: one per non-coding gene, and codon partitions for *nd4* and *c-mos*. The most suitable models of nucleotide substitution for each partition were obtained from JModeltest (Posada 2008) under the Akaike information criterion. Four independent analyses were performed to reduce the chance of converging on a local optimum. Each analysis consisted of five million generations and four Markov chains with default heating values. Trees were sampled every 1000 generations resulting in 5000 saved trees per analysis. Stationarity was confirmed by plotting the log-likelihood scores per generation in the program Tracer v.1.2 (Rambaut & Drummond 2004). Additionally, the standard deviation of the partition frequencies and the potential scale reduction factor (Gelman & 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, 500 trees were discarded as burn-in from each run. Because the four analyses reached stationarity at a similar likelihood score and topologies were similar, the resultant 18,000 trees were used to calculate posterior probabilities (PP) for each bipartition on a 50% majority rule consensus tree.

Results

Riama yumborum sp. nov.

Proposed common name in English: Yumbo riamas
Proposed common name in Spanish: palos de los Yumbos

Holotype. QCAZ 10827 (Figs. 1, 2, 3), an adult male from Nanegal, Santa Lucía Cloud Forest Reserve, 0.11778° N; 78.607555° W (DD, WGS84), 1580–1591 m, Provincia Pichincha, Ecuador, collected on 9 March 2010 by B. Tolhurst, P. Mafla-Endara, S. Ryan, and X. Cueva.

TABLE 1. Voucher specimen numbers, locality data and GenBank accession numbers of taxa and gene regions included in this study. All localities are in Ecuador unless otherwise indicated, and are preceded by province names.

Taxon	Voucher	Locality	Genbank accession number			
			16s	*12s*	*nd4*	*c-mos*
Riama cashcaensis	QCAZ10686	Bolivar: road Guanujo-Salinas	KJ948122	KJ948180	KJ948162	KJ948210
Riama cashcaensis	QCAZ10754	Bolivar: road Guanujo-Salinas	KJ948126	KJ948181	KJ948163	KJ948219
Riama colomaromani	KU217209	Carchi: 26.9-27.3 km E Maldonado on road to Tulcan	AY507871	AY507853	AY507888	AY507899
Riama labionis	QCAZ10411	Cotopaxi: Naranjito	KJ948120	KJ948171	KJ948147	KJ948218
Riama labionis	QCAZ10412	Cotopaxi: Naranjito	KJ948121	KJ948172	KJ948148	KJ948207
Riama meleagris	QCAZ9840	Tungurahua: Mucubí	KJ948129	KJ948182	KJ948164	KJ948214
Riama meleagris	QCAZ9841	Tungurahua: Mucubí	KJ948130	KJ948185	KJ948165	KJ948211
Riama meleagris	QCAZ9842	Tungurahua: Cotaló	KJ948131	KJ948191	KJ948166	KJ948198
Riama meleagris	QCAZ9845	Tungurahua: El Triunfo	KJ948132	KJ948184	KJ948167	KJ948197
Riama meleagris	QCAZ9846	Tungurahua: El Triunfo	KJ948133	KJ948183	KJ948168	KJ948212
Riama simotera	KU217207	Carchi: 15.3 km W Tulcan on road to Tufiño	AY507875	AY507856	AY507890	AY507902
Riama stigmatoral	QCAZ7374	Cañar: Mazar	KJ948128	KJ948187	KJ948161	KJ948217
Riama stigmatoral	QCAZ9946	Cañar: Biblián	KJ948123	KJ948192	KJ948160	KJ948208
Riama stigmatoral	QCAZ11412	Azuay: San Vicente	KJ948124	KJ948189	KJ948158	KJ948209
Riama stigmatoral	QCAZ11415	Azuay: San Vicente	KJ948127	KJ948190	KJ948159	KJ948215
Riama unicolor	QCAZ8405	Imbabura: Intag	KJ948139	KJ948173	KJ948149	KJ948201
Riama unicolor	QCAZ8407	Imbabura: Intag	KJ948135	KJ948175	KJ948151	KJ948206
Riama unicolor	QCAZ8409	Imbambura: Tumbambiro	KJ948136	KJ948179	KJ948152	KJ948199
Riama unicolor	QCAZ8411	Imbabura: Intag	KJ948141	KJ948178	KJ948153	KJ948200
Riama unicolor	QCAZ8800	Pichincha: Quito	KJ948134	KJ948174	KJ948155	KJ948203
Riama unicolor	QCAZ9664	Carchi: Huaca	KJ948119	KJ948196	KJ948150	KJ948222
Riama unicolor	QCAZ9681	Imbabura: Cotacachi	KJ948140	KJ948177	KJ948154	KJ948202
Riama unicolor	QCAZ9682	Imbabura: Cotacachi	KJ948138	KJ948188	KJ948157	KJ948205
Riama unicolor	QCAZ9684	Imbabura: Cotacachi	KJ948137	KJ948176	KJ948156	KJ948204
Riama yumborum **sp. nov.**	QCAZ10822	Pichincha: Nanegal	KJ948125	KJ948186	KJ948169	KJ948213
Riama yumborum **sp. nov.**	QCAZ10827	Pichincha: Nanegal	KJ948142	KJ948195	KJ948170	KJ948216
Petracola ventrimaculata	CORBIDI 9235	PERU: Cajamarca	KJ948144	KJ948193	KJ948145	KJ948220
Pholidobolus montium	QCAZ8056	Cotopaxi: Chugchillan	KJ948143	KJ948194	KJ948146	KJ948221



FIGURE 1. Holotype of *Riama yumborum* **sp. nov.** (QCAZ 10827, male) in dorsal (left) and ventral (right) views. Scale bar = 5 mm. Photographs by D. A. Paucar.

Paratypes (5). ECUADOR: Provincia Pichincha: QCAZ 10822, female, same collection data as holotype; QCAZ 11077, 11079, 11080, 11081, males from Nanegal, Santa Lucía Cloud Forest Reserve, 0.11928° N; 78.59647° W (DD), 1585 m, Provincia Pichincha, Ecuador, collected on September 2009 by S. Maddock.

Etymology. The specific epithet, a noun in the genitive plural case which translates to "of the Yumbos," honors the Yumbo culture (800–1660 A.D.), a pre-Incan civilization that inhabited the same area where *Riama yumborum* was discovered (Chávez 2007).

Diagnosis. In addition to the molecular data discussed below, *Riama yumborum* can be distinguished from its congeners by the combination of two characters: incomplete nasoloreal suture and a cylindrical hemipenial body with diagonally orientated flounces on its lateral aspect. In addition, males of the new species seem to have a large number (13 per leg; n = 1) of femoral pores.

Other species with an incomplete nasoloreal suture in some individuals include *Riama anatoloros* (Kizirian 1996), *R. colomaromani*, *R. simotera*, *R. stigmatoral*, and *R. columbiana* (Andersson 1914). From *R. anatoloros* (character states in parentheses), the new species can be distinguished by usually having a single, anterior superciliary (usually complete series of four superciliaries), 13 femoral pores in males (femoral pores 7–11), and by lacking both dorsolateral stripes (such stripes present) and scales between medialmost femoral pores in males

(4–12 scales). From *R. colomaromani* (character states in parentheses), the new species differs in having 22–23 transverse rows of ventral scales (18–21 rows), 13 femoral pores in males (femoral pores 7–9), and by lacking both scales between medialmost femoral pores in males (2–4 scales) and by lacking femoral pores in females (one pore on each side). From *R. simotera* (character states in parentheses), the new species can be distinguished by having usually a single, anterior superciliary (complete series of 3–4 superciliaries), striated dorsal scales (dorsals smooth), 27–29 longitudinal dorsal scale rows (19–26 rows), 13 femoral pores in males (femoral pores 5–7), and by lacking scales between medialmost femoral pores in males (2–3 scales), and by lacking femoral pores in females (5–7 pores on each side). From *R. stigmatoral* (character states in parentheses), *R. yumborum* differs in having 13 femoral pores in males (femoral pores 8–11), an average SVL = 54.5 mm (79 mm), and in lacking anterior cloacal plate scales in males (0-2). From *R. columbiana* (character states in parentheses) the new species is different in having striated dorsal scales (dorsals with low, rounded keel), 13 femoral pores in males (femoral pores 10), and in lacking scales between medialmost femoral pores in males (5–6 scales).

Other species of *Riama* with 13 or more femoral pores on each side in males are *R. orcesi* (Kizirian 1995), *R. unicolor,* and *R. luctuosa* (Peters 1862). The new species differs from them in having an incomplete (usually one) series of superciliaries. From *R. orcesi* (character states in parentheses), *R. yumborum* can be distinguished further by having an incomplete (complete) nasoloreal suture, dorsal scales keeled (dorsal scales striated), longitudinal dorsal scale rows in males 28–29 (13–23), and lateral scale rows 2–3 (4–8); from *R. unicolor* (character states in parentheses) by having 28–29 (20–26) longitudinal dorsal scale rows in males; from *R. luctuosa* by having an incomplete nasoloreal suture (complete in *R. luctuosa*).

Hemipenial morphology can be used to distinguish *Riama yumborum* from all other species of *Riama* for which hemipenial morphology is known, except *R. balneator* (Kizirian 1996), *R. cashcaensis,* and *R. unicolor*, by having the lateral aspect of the hemipenial body ornamented with columns of diagonal flounces instead of chevron-shaped or transverse flounces. It differs from *R. balneator* in having rows of diagonal spinulate flounces (non-spinulate flounces in *R. balneator*). In lacking one or more isolated transverse spinulate flounces at the base of the asulcate side it differs from *R achlyens* (Uzzell 1958), *R. afrania* (Arredondo & Sánchez-Pacheco 2010), *R. crypta* (Sánchez-Pacheco *et al.* 2011), *R. hyposticta* (Boulenger 1902), *R. laudahnae* (Köhler & Lehr 2004), and *R. orcesi*. The new species can be further distinguished from *R. crypta*, *R. hyposticta,* and *R. laudahnae* by lacking distal filiform appendages on the hemipenial lobes. In having a cylindrical hemipenial body, it differs from *R. achlyens*, *R. anatoloros*, *R. afrania*, *R. cashcaensis*, *R. colomaromani*, *R. crypta*, *R. hyposticta*, *R. laudahnae*, *R. striata* (Peters 1862), *R. simotera,* and *R. unicolor*, which have an elongate, globose or conical hemipenial body.

Description. *Riama yumborum* possesses the following characteristics: (1) SVL in adult males 51.5–59.1 mm (n = 4), in females 53.7 mm (n = 1); (2) frontonasal similar in length to frontal; (3) prefrontals absent; (4) nasoloreal suture incomplete; (5) supraoculars four; second, third and fourth in contact with ciliaries; (6) usually one superciliary (specimen QCAZ 11080 has two); (7) supralabial-subocular fusion absent; (8) postoculars three; (9) postparietals two; (10) usually two supratympanic temporals (specimen QCAZ 10827 has three on right side); (11) genials in two pairs; (12) dorsal scales rectangular, juxtaposed, striated; (13) nuchal scales smooth; (14) longitudinal dorsal scale rows in males 28–29; (15) transverse dorsal scale rows 36–40; (16) ventral scales smooth, in 22–23 transverse rows; (17) lateral scale rows two or three; (18) femoral pores in males 13 (n = 1, left side only), absent in females (n = 1); (19) scales between medialmost femoral pores in males absent; (20) subdigital scales on Toe I 4–5; (21) anterior cloacal plate absent in males, present and paired in females (n = 1); (22) dorsum dark brown, with some light-brown scales, or scales with light-brown margins; white lateral dots on neck and anterior portion of body; ventral scales dark brown with orange borders; caudal scales orange with brown pigmentation medially.

Hemipenial morphology. The left organ of QCAZ 11079 (Fig. 4) is about five subcaudal rows and six millimeters long. Hemipenial body is roughly cylindrical, ending in two symmetric small and partially everted lobes surrounded by folds; a shallow sulcus spermaticus, central in position, originates at the base of the organ and proceeds in a straight line towards the lobes.

The sulcus spermaticus ends with no clear division in independent branches as a single channel emarginated by lobular folds at the lobular crotch. Parallel to the sulcus spermaticus, two narrow nude areas bordered by rows of comb-like spicules that also ornament the lateral and asulcate sides of the hemipenial body are present.



FIGURE 2. Head of holotype of *Riama yumborum* **sp. nov.** (QCAZ 10827, male) in dorsal (top), ventral (middle), and lateral (bottom) views. Scale bar = 5 mm. Photographs by D. A. Paucar.



FIGURE 3. Ventral view of pelvic region showing cloacal plate of *Riama yumborum*. Left: QCAZ 10827, male, holotype; right: QCAZ 10822, female paratype. Photographs by D. A. Paucar.

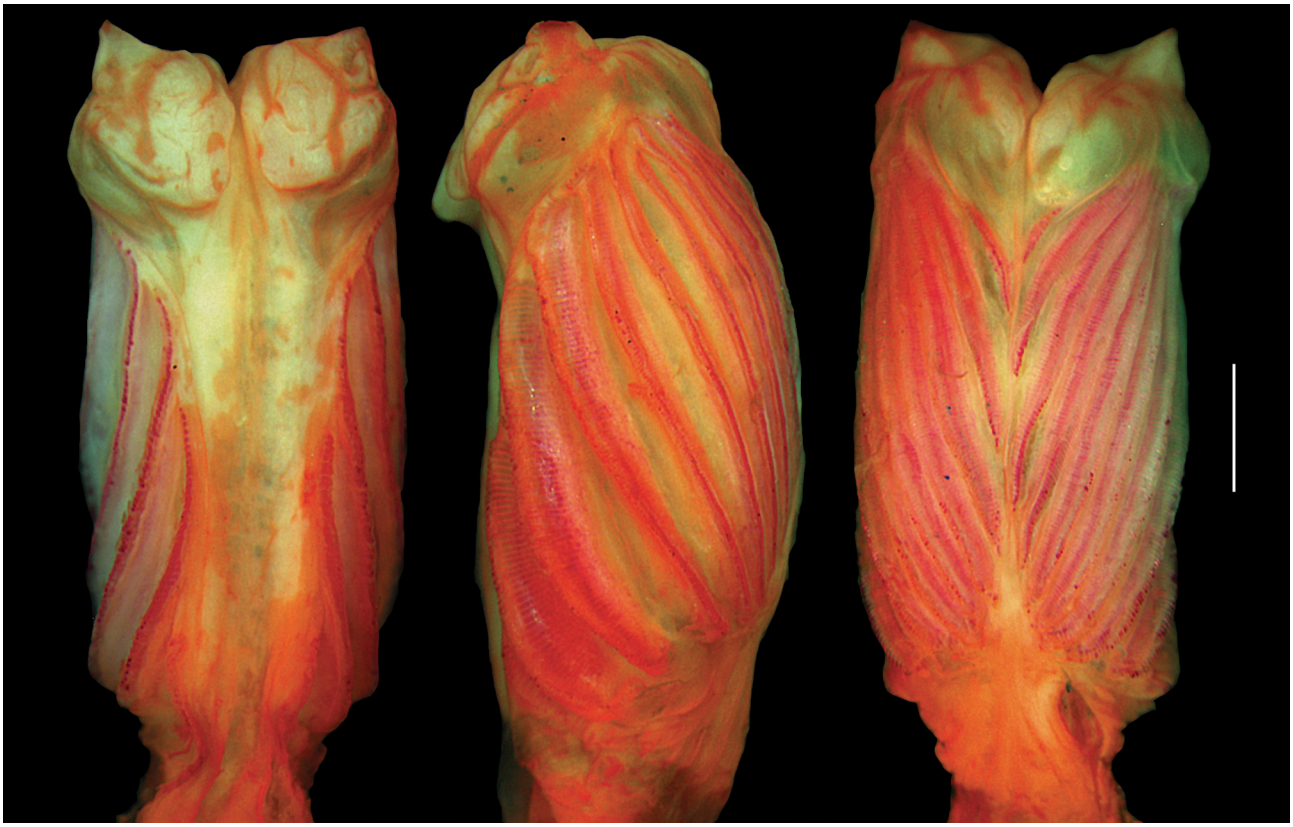


FIGURE 4. Left hemipenis of *Riama yumborum* **sp. nov.** (QCAZ 11079) in sulcate (left), lateral (middle), and asulcate (right) views. Scale bar = 1 mm. Photographs by P. Nunes.

The hemipenial body has two columns of 12 diagonal spinulate flounces ("comb-like flounces") on each side. These flounces extend from the borders of each nude area contiguous to the sulcus spermaticus to the central asulcate face, with the five last flounces almost contacting the ones on the opposite side, forming a V-shaped structure at the sagittal region of the asulcate face. The proximal and distal flounces (in the sulcate and asulcates faces, respectively) are much reduced when compared with the intermediate ones, located on the sides of the organ.

Description of holotype (QCAZ 10827; Figs. 1, 2, 3, 5). Male, SVL 56.5 mm, tail (complete) length 64.9 mm; head scales smooth; rostral wider than long, higher than adjacent supralabials, in contact posteriorly with nasal, frontonasal and anteriormost supralabials; frontonasal nearly rectangular in shape, widest posteriorly, similar in length to frontal, in contact laterally with nasals and posteriorly with frontal; prefrontals absent; frontal longer than wide, widest anteriorly, anterior suture slightly convex, lateral sutures slightly concave, posterior suture angular with point directed posteriorly, in contact with first and second supraoculars laterally, and frontoparietals

posteriorly; frontoparietals pentagonal, in contact with second and third supraoculars laterally, parietals posterolaterally, and interparietal posteromedially; interparietal hexagonal, longer than wide, in contact with parietals laterally, and postparietals posteriorly; parietals hexagonal, in contact with third and fourth supraoculars anterolaterally, dorsalmost postoculars laterally, dorsalmost temporals posterolaterally, and postparietals posteriorly; postparietals two, longest laterally, in contact medially; supraoculars four, with second, third and fourth in contact with ciliaries; nasoloreal suture incomplete; superciliary single, located anteriorly and situated between nasal, frontal, first and second supraoculars, and anteriormost ciliaries, barely extending onto dorsal surface of head; palpebral disc semitransparent and divided into three large unpigmented scales; frenocular nearly trapezoidal in shape, in contact with nasal anteriorly; six circumorbitals between posteriormost supraocular and frenocular; postoculars three; temporals smooth; supratympanic temporals 2/3; supralabials five; infralabials four; mental wider than long, in contact with anteriormost infralabials laterally and postmental posteriorly; postmental roughly pentagonal, posterior suture angular, with angle directed posteriorly, in contact with first and second infralabials laterally; genials in two pairs, anteriormost pair roughly quadrangular, in contact with second and third infralabials; posterior pair polygonal, in contact with third and fourth infralabials; scale rows between genials and collar fold (along midventral line) eight; medialmost scales of posteriormost scale row distinctly enlarged, smooth; posteriormost gular row enfolded posteriorly, concealing three small scale rows; lateral neck scales squarish or rounded, smooth.

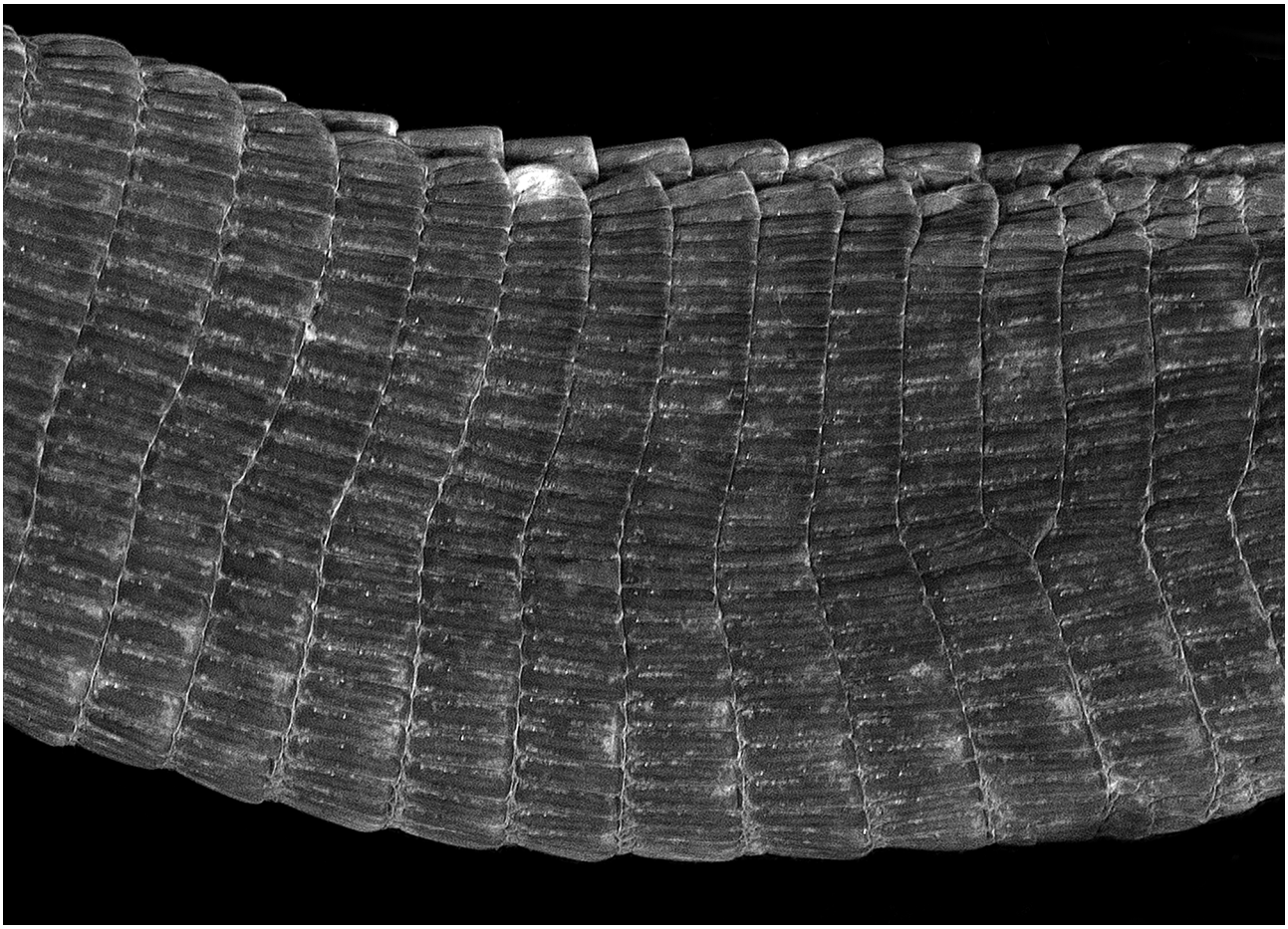


FIGURE 5. Close-up of dorsum of holotype of *Riama yumborum* **sp. nov.** (QCAZ 10827, male). Photograph by D. A. Paucar.

Dorsal scales rectangular, longer than wide, juxtaposed, striated, in 38 transverse rows on the left side (one of them incomplete) and 39 on the right one (two of them incomplete); longitudinal dorsal scale rows at fifth transverse ventral scale row 21, at 10th transverse ventral scale row 27, at 15th transverse ventral scale row 28; lateral scale rows at fifth transverse ventral scale row 7, at 10th transverse ventral scale row three, at 15th transverse ventral scale row three; lateral scales on body near insertion of forelimb small to granular; ventral scales smooth; complete transverse ventral scale rows 22; longitudinal ventral scale rows at midbody 12; anterior cloacal

plate scales absent; posterior cloacal plate scales five; scales on tail rectangular and juxtaposed; midventral subcaudals smooth, wider than adjacent scales, nearly squared; femoral pores on left hind limb 13 (right limb damaged); scales between medialmost femoral pores absent. In general, limb squamation as described for congeners (e.g., Kizirian 1996).

Coloration of holotype (Figs. 1, 2, 5). In preservative (70% ethanol), dorsal ground color dark brown with scattered light brown irregular marks, more abundant on dorsal aspect of head; lateral aspect of neck and body (anteriorly) with scattered white dots; ventral scales of gular region, body, and limbs dark brown with cream borders that form a reticulate pattern; the dark pigment becomes scarce on the ventral aspect of head and tail.

Variation. The paratypes consist of a female (SVL = 53.7 mm) and four males (SVL = 31.5–59.1 mm). The paratypes are similar to the holotype with the following noteworthy exceptions. All paratypes have two supratympanic temporals on both sides (three on right side in holotype); QCAZ 10822, 11079 and 10827 have a small scale between the superciliary and adjacent ciliaries (small scale on left side only in holotype); QCAZ 11080, 11081 have two postocular on the right and left sides, respectively (three postoculars in holotype). The only female examined (QCAZ 10822) has a paired anterior cloacal plate (absent in males). In addition, QCAZ 11080 differs from all other type specimens in having a second, small superciliary (similar in size to adjacent ciliaries) in contact with the fourth supraocular on the right side, and third and fourth supraoculars on the left side.



FIGURE 6. Paratype of *Riama yumborum* **sp. nov.** (QCAZ 10822, female) in dorsal (top) and ventral (bottom) views. Photographs by L. Bustamante.

Coloration in life of female paratype QCAZ 10822 (Fig. 6) was similar to the coloration in preservative of the holotype described above. The main difference was that in this paratype the scales of the gular region and ventral aspect of body and limbs were bordered with orange, and the tail was bright orange ventrally, with brown irregular marks.

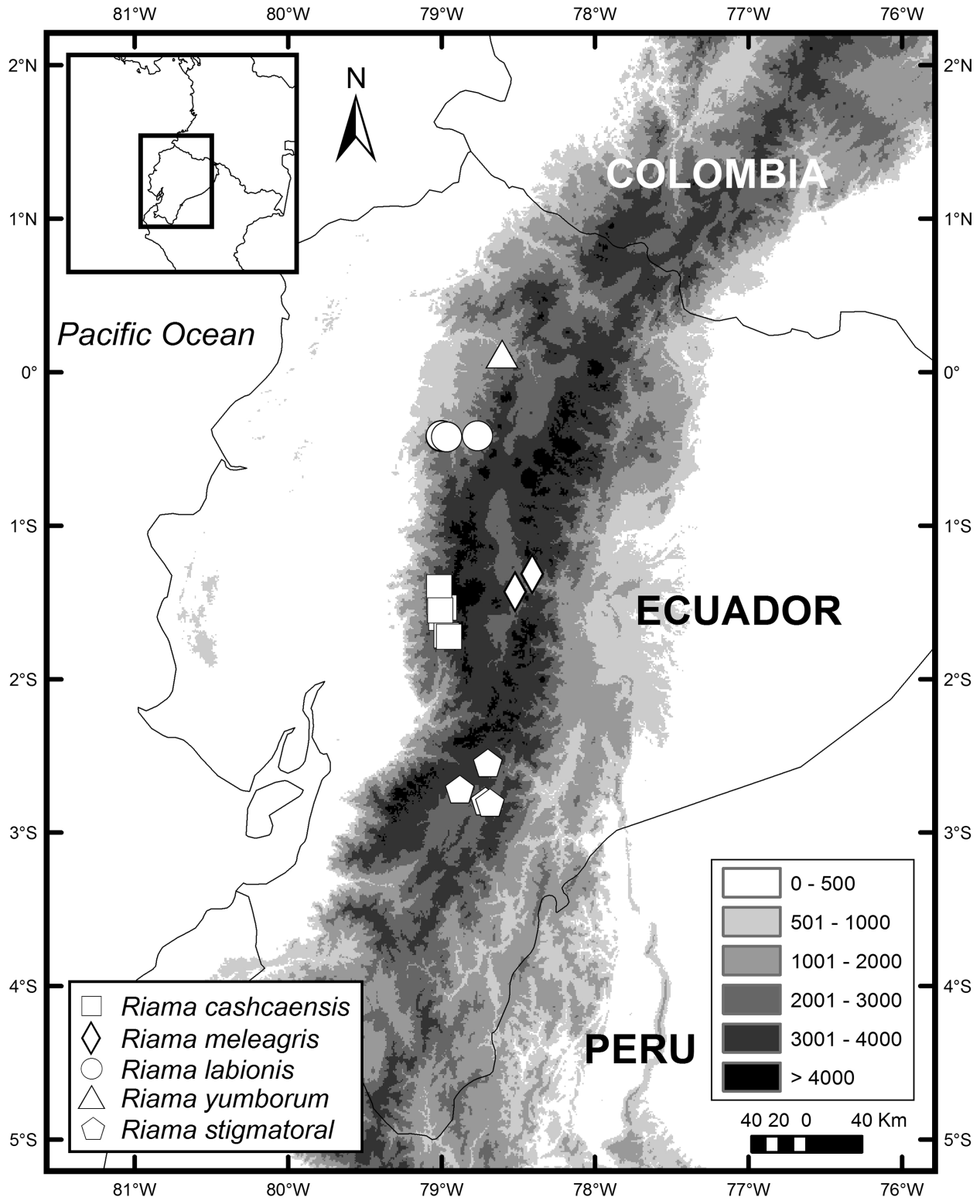


FIGURE 7. Distribution of five species of *Riama* in Ecuador. These species form a clade sister to *R. unicolor* (see Fig. 8).

Distribution. *Riama yumborum* inhabits high-elevation cloudforests on the Pacific slopes of the Andes in northwestern Ecuador (Fig. 7). It is known from Lower Montane Evergreen Forest of the Western Andes (Iglesias *et al.* 2013) at elevations of 1580–1591 m in the province of Pichincha. This species occurs in sympatry with *R. oculata* (O'Shaughnessy 1879), whereas *R. unicolor* occurs allopatrically at higher elevations (> 1775 m) (Maddock *et al.* 2011) in the same region. Other species of small ground lizards collected in the same area include the sphaerodactylid gecko *Lepidoblepharis conolepis* Avila-Pires 2001, and the gymnophthalmids *Alopoglossus viridiceps* Torres-Carvajal & Lobos 2014, *Cercosaura vertebralis* O'Shaugnessy 1879 and *Echinosaura brachycephala* Köhler *et al.* 2004.

Phylogenetic relationships. Selected models of evolution of gene regions used in phylogenetic analyses were TIM2+I+G for *12S* and *16S*; GTR+I+G, TIM3+I+G, TIM2+I+G for first, second, and third codon positions of *ND4*, respectively; and HKY, TPM1uf+I, TPM3uf for first, second, and third codon positions of *c-mos*, respectively. The inferred phylogenetic tree (Fig. 8) is generally concordant with the phylogenetic tree of Castoe *et al.* (2004), although their analyses did not include *Riama yumborum*, *R. labionis*, *R. meleagris*, and *R. stigmatoral*. Our tree strongly supports (PP = 1) the monophyly of *Riama* and a clade consisting of *R. yumborum*, *R. labionis*, *R. stigmatoral*, *R. meleagris*, *R. cashcaensis*, and *R. unicolor*. Relationships among these inner taxa are less supported (PP < 0.89), except the sister species relationship of *R. meleagris* and *R. stigmatoral*, and *R. colomaromani* and *R. simotera* (PP = 1). The sister taxon of *R. yumborum* is *R. labionis* (PP = 0.88); and both are sister (PP = 0.85) to the *R. meleagris-stigmatoral* clade (Fig. 8).

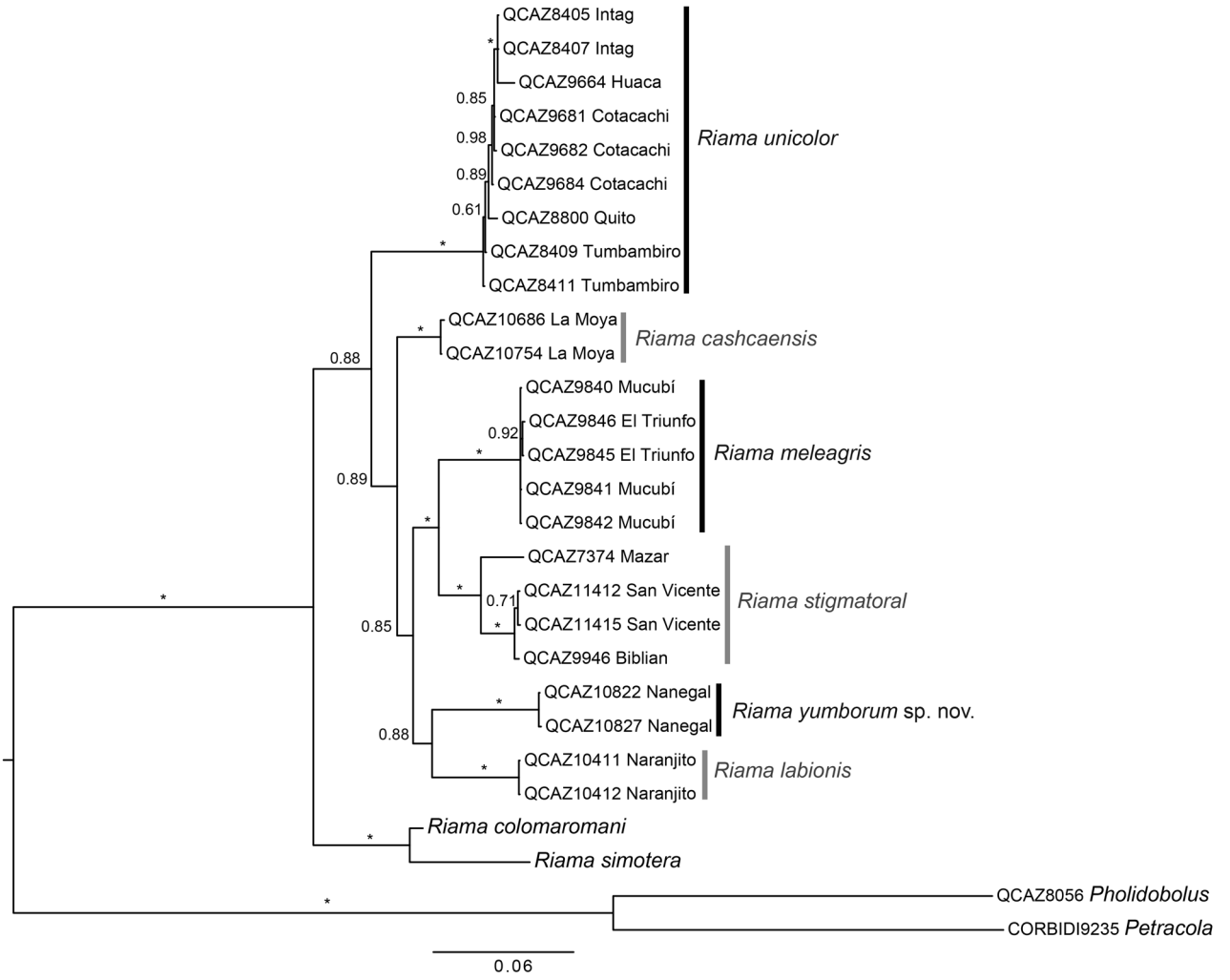


FIGURE 8. Majority rule (50%) consensus tree of 18,000 trees obtained from a Bayesian analysis of three mitochondrial (*12s, 16s, nd4*) and one nuclear gene (*c-mos*) from 26 specimens. Numbers next to branches correspond to posterior probability values (asterisks indicate values > 0.99). For sequences generated in this study, voucher museum numbers followed by locality of collection are indicated for each terminal.

Discussion

Riama yumborum differs morphologically from its sister species, *R. labionis* (character states in parentheses) in having an incomplete nasoloreal suture (suture absent), striated dorsal scales (dorsals with rounded keel), usually three postoculars (two postoculars), and in lacking a supralabial-subocular fusion (supralabial and subocular scales fused). *Riama labionis* occurs allopatrically 70 km SW from the known distribution of *R. yumborum* between 1500–2000 m (Fig. 7).

The geographically closest species that is morphologically similar to *Riama yumborum* is *R. unicolor*; however, these species are knowingly separated by an elevational range: whereas *R. yumborum* occurs at 1580–1591 m, *R. unicolor* is found above 1775 m (Maddock *et al.* 2011). These two species are clearly distinct from each other based on both morphology and molecular data, with *R. unicolor* forming the sister species to a clade containing *R. yumborum*, *R. labionis, R. stigmatoral, R. meleagris* and *R. cashcaensis*. Although the sympatric species *R. oculata* was not analyzed herein, unpublished data strongly suggest that this species is distantly related to *R. yumborum*.

The presence of 13 femoral pores on the left leg of the holotype of *Riama yumborum* is potentially a useful character for distinguishing the new species from many conspecifics; however, as only a single leg from a single male had undamaged pores that could be counted, this character should be treated with caution.

The recent discoveries of the gymnophthalmid *Alopoglossus viridiceps* (Torres-Carvajal & Lobos 2014) and the new species of *Riama* described in this paper increase our knowledge about the biodiversity of northwestern Ecuador and provides more support for conserving the threatened forests (Cerón *et al.* 1999) of the region. It is likely that further surveys will reveal additional undescribed species. The forests surrounding the town of Nanegal have now been found to harbor two endemic *Riama* species (*R. yumborum* and *R. oculata*).

Acknowledgments

A tissue sample of *Petracola ventrimaculata* was donated by P. Venegas from Corbidi, Lima, Peru. This manuscript was greatly improved by reviews from D. Kizirian, G. Köhler, and S. Sánchez-Pacheco. Special thanks to D. A. Paucar and P. Mafla for providing valuable comments and contributions. To B. Tolhurst, S. Ryan, and X. Cueva for assistance in the field. To D. A. Paucar and L. Bustamante for providing photographs, and P. Santiana and A. Varela for helping with the edition of photographs and figures. To the local people and staff of Santa Lucía Cloud Forest Reserve for their support and interest in the conservation and study of biodiversity. We would like to thank B. Tolhurst and the staff at the Santa Lucía Reserve for opportunities and assistance, and Earthwatch Institute for providing fieldwork funds. This study was supported by grants from Secretaría Nacional de Educación Superior, Ciencia, Tecnología e Innovación del Ecuador SENESCYT (Nº PI-C08-00470) and Dirección General Académica of the Pontificia Universidad Católica del Ecuador. PMSN is grateful to Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for financial support (Grant # 2012/00492-8).

References

Andersson, L.G. (1914) A new *Telmatobius* and new teiid lizards from South America. *Arkiv för Zoologi*, 9, 1–12.

Arredondo, J.C. & Sánchez-Pacheco, S.J. (2010) New endemic species of *Riama* (Squamata: Gymnophthalmidae) from northern Colombia. *Journal of Herpetology*, 44, 610–617. http://dx.doi.org/10.1670/09-218.1

Arévalo, E.S., Davis, S.K. & Sites, J.W. Jr. (1994) Mitochondrial DNA sequence divergence and phylogenetic relationships among eight chromosome races of the *Sceloporus grammicus* complex (Phrynosomatidae) in central Mexico. *Systematic Biology*, 43, 387–418. http://dx.doi.org/10.2307/2413675

Avila-Pires, T.C.S. (2001) A new species of *Lepidoblepharis* (Reptilia: Squamata: Gekkonidae) from Ecuador, with a redescription of *Lepidoblepharis grandis* Miyata, 1985. *Occasional Paper of the Sam Noble Oklahoma Museum of Natural History*, 11, 1–11.

Bickford, D., Lohman, D.J., Sodhi, N.S., Ng, P.K.L., Meier, R., Winker, K., Ingram, K.K. & Das, I. (2007) Cryptic species as a window on diversity and conservation. *Trends in Ecology and Evolution*, 22, 148–155.

http://dx.doi.org/10.1016/j.tree.2006.11.004
Blair, C., Méndez de la Cruz, F.R., Ngo, A., Lindell, J., Lathrop, A. & Murphy, R.W. (2009) Molecular phylogenetics and taxonomy of leaf-toed geckos (Phyllodactylidae: *Phyllodactylus*) inhabiting the peninsula of Baja California. *Zootaxa*, 2027, 28–42.
Boulenger, G.A. (1885) *Catalogue of the lizards in the British Museum (Natural History)*, Vol. II. Second edition. London, 497 pp.
Boulenger, G.A. (1900) Descriptions of new batrachians and reptiles collected by Mr. P. O. Simons in Peru. *The Annals and Magazine of Natural History*, 6, 181–186. [Series 7]
Boulenger, G.A. (1902) Descriptions of new batrachians and reptiles from northwestern Ecuador. *The Annals and Magazine of Natural History,* 9, 51–57. [Series 7]
Boulenger, G.A. (1908) Descriptions of new batrachians and reptiles discovered by Mr. M. G. Palmer in south-western Colombia. *The Annals and Magazine of Natural History*, 2, 515–522. [Series 8]
Castoe, T.A., Doan, T.M. & Parkinson, C.L. (2004) Data partitions and complex models in Bayesian analysis: the phylogeny of gymnophthalmid lizards. *Systematic Biology*, 53, 448–469.
http://dx.doi.org/10.1080/10635150490445797
Cerón, C., Valencia, P.W. & Sierra, R. (1999) Las formaciones naturales de la costa del Ecuador. *In:* Sierra, R. (Ed.), *Propuesta preliminar de un Sistema de Clasicación de Vegetatión para el Ecuador Continental.* Proyecto INEFAN/GERF-BIRF y Ecociencia, Quito, Ecuador, pp. 55–73.
Chávez, H.J. (2007) *Tulipe y la Cultura Yumbo: Arqueología Comprensiva del Subtrópico Quiteño.* Fonsal, Quito, 20 pp.
Doan, T.M. & Schargel, W.E. (2003) Bridging the gap in *Proctoporus* distribution: a new species (Squamata: Gymnophthalmidae) from the Andes of Venezuela. *Herpetologica*, 59, 68–75.
Doan, T.M. & Castoe, T.A. (2005) Phylogenetic taxonomy of the Cercosaurini (Squamata: Gymnophthalmidae), with new genera for species of *Neusticurus* and *Proctoporus*. *Zoological Journal of the Linnean Society*, 143, 405–416.
http://dx.doi.org/10.1111/j.1096-3642.2005.00145.x
Dowling, H.G. & Savage, J.M. (1960) A guide to the snake hemipenis: a survey of basic structure and systematic characteristics. *Zoologica*, 45, 17–28.
Drummond, A.J., Ashton, B., Buxton, S., Cheung, M., Cooper, A., Duran, C., Field, M., Heled, J., Kearse, M., Markowitz, S., Moir, R., Stones–Havas, S., Sturrock, S., Thierer, T. & Wilson, A. (2010) Geneious v.5.5. Available from: http://www.geneious.com/ (accessed 7 September 2014)
Gelman, A. & Rubin, D.B. (1992) Inference from iterative simulation using multiple sequences. *Statistical Science*, 7, 457–511.
http://dx.doi.org/10.1214/ss/1177011136
Gray, J.E. (1858) Description of *Riama*, a new genus of lizards, forming a distinct family. *Proceedings of the Zoological Society of London*, 1858, 444–446.
http://dx.doi.org/10.1111/j.1469-7998.1858.tb06398.x
Harvey, M.B. & Embert, D. (2008) Review of Bolivian *Dipsas* (Serpentes: Colubridae), with comments on other South American species. *Herpetological Monographs*, 22, 54–105.
http://dx.doi.org/10.1655/07-023.1
Iglesias, J., Santiana, J. & Chinchero, M.A. (2013) Bosque siempreverde montano bajo de Cordillera Occidental de los Andes. *In*: Ministerio del Ambiente del Ecuador, *Sistema de Clasificación de los Ecosistemas del Ecuador Continental*. Ministerio del Ambiente del Ecuador. Quito, pp. 86–88.
Kizirian, D.A. (1995) A new species of *Proctoporus* (Squamata: Gymnophthalmidae) from the Andean Cordillera Oriental of Northeastern Ecuador. *Journal of Herpetology*, 29, 66–72.
http://dx.doi.org/10.2307/1565087
Kizirian, D.A. (1996) A review of Ecuadorian *Proctoporus* (Squamata: Gymnophthalmidae) with descriptions of nine new species. *Herpetological Monographs*, 10, 85–155.
http://dx.doi.org/10.2307/1466981
Kizirian, D.A. & Coloma, L.A. (1991) A new species of *Proctoporus* (Squamata: Gymnophthalmidae) from Ecuador. *Herpetologica*, 47, 420–429.
Köhler, G. & Lehr, E. (2004) Comments on *Euspondylus* and *Proctoporus* (Squamata: Gymnophthalmidae) from Peru, with the description of three new species and a key to the Peruvian species. *Herpetologica*, 60, 501–518.
http://dx.doi.org/10.1655/03-93
Köhler, G., Böhme, W. & Schmitz, A. (2004) A new species of *Echinosaura* (Squamata: Gymnophthalmidae) from Ecuador. *Journal of Herpetology*, 38, 52–60.
http://dx.doi.org/10.1670/164-02A
Maddock, S.T., Aguirre-Peñafiel, V., Torres-Carvajal, O., Morales, J.N. & Peck, M.R. (2011) *Riama unicolor* (NCN). Feeding and new altitudinal range. *Herpetological Review*, 42, 278.
Manzani, P.R. & Abe, A.S. (1988) Sobre dois novos métodos de preparo do hemipênis de serpentes. *Memórias do Instituto Butantan*, 50, 15–20.
Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, 403, 853–858.

http://dx.doi.org/10.1038/35002501
Myers, C.W. & Donnelly, M.A. (2001) Herpetofauna of the Yutajé-Corocoro Massif, Venezuela: second report from the Robert G. Goelet American Museum-Terramar Expedition to the northwestern Tepuis. *Bulletin of the American Museum of Natural History*, 261, 1–85.
http://dx.doi.org/10.1206/0003-0090(2001)261<0001:HOTYCM>2.0.CO;2
Myers, C.W. & Donnelly, M.A. (2008) The summit herpetofauna of Auyantepui, Venezuela: report from the Robert G. Goelet American Museum-Terramar Expedition. *Bulletin of the American Museum of Natural History*, 308, 1–147.
http://dx.doi.org/10.1206/308.1
Nunes, P.M.S., Fouquet, A., Curcio, F.F., Kok, P.J.R. & Rodrigues, M.T. (2012) Cryptic species in *Iphisa elegans* Gray, 1851 (Squamata: Gymnophitalmidae) revealed by hemipenial morphology and molecular data. *Zoological Journal of the Linnean Society*, 166, 361–376.
http://dx.doi.org/10.1111/j.1096-3642.2012.00846.x
O'Shaughnessy, A.W.E. (1879) Description of new species of lizards in the collection of the British Museum. *The Annals and Magazine of Natural History*, 4, 295–303. [Series 5]
Pellegrino, K.C., Rodrigues, M.T., Yonenaga-Yassuda, Y. & Sites, J.W. Jr. (2001) A molecular perspective on the evolution of microteiid lizards (Squamata, Gymnophthalmidae), and a new classification for the family. *Biological Journal of the Linnean Society*, 74, 315–338.
http://dx.doi.org/10.1006/bijl.2001.0580
Peracca, M.G. (1904) Viaggio del Dr. Enrico Festa nell'Ecuador et regioni vicine. *Bollettino dei Musei di Zoologia ed Anatomia Comparata della Università di Torino*, 19, 1–41.
Pesantes, O.S. (1994) A method for preparing the hemipenis of preserved snakes. *Journal of Herpetology*, 28, 93–95.
http://dx.doi.org/10.2307/1564686
Peters, W. (1862) Über *Cercosaura* und die mit dieser Gattung verwandten Eidechsen aus Südamerika. *Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin,* 1862, 165–225.
Posada, D. (2008) JModelTest: Phylogenetic Model Averaging. *Molecular Biology and Evolution*, 25, 1253–1256.
http://dx.doi.org/10.1093/molbev/msn083
Rambaut, A. & Drummond, A.J. (2004) Tracer version 1.2. Available from: http://tree.bio.ed.ac.uk/software/tracer (accessed 7 September 2014)
Rambaut, A. & Drummond, A.J. (2010) TreeAnnotator version 1.6.1. Available from: http://beast.bio.ed.ac.uk (accessed 07 September 2014)
Rivas, G., Schargel, W.E. & Meik, J.M. (2005) A new species of *Riama* (Squamata: Gymnophthalmidae), endemic to the peninsula de Paria, Venezuela. *Herpetologica*, 61, 461–468.
http://dx.doi.org/10.1655/04-96.1
Ronquist, F. & Huelsenbeck, J.P. (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics*, 19, 1572–1574.
http://dx.doi.org/10.1093/bioinformatics/btg180
Sánchez-Pacheco, S.J. (2010a) A new "Microteiid" lizard (Squamata: Gymnophthalmidae: *Riama*) from southwestern Colombia. *Herpetologica*, 66, 349–356.
http://dx.doi.org/10.1655/09-033.1
Sánchez-Pacheco, S.J. (2010b) Lectotype designation and redescription of the Gymnophthalmid lizard *Riama columbiana* (Andersson, 1914) with notes on the type locality. *Papéis Avulsos de Zoologia*, 50, 31–41.
http://dx.doi.org/10.1590/S0031-10492010000200001
Sánchez-Pacheco, S.J., Kizirian, D.A. & Nunes, P.M.S. (2011) A new species of *Riama* from Ecuador previously referred to as *Riama hyposticta* (Boulenger, 1902) (Squamata: Gymnophthalmidae). *American Museum Novitates*, 3719, 1–15.
http://dx.doi.org/10.1206/3719.2
Sánchez-Pacheco, S.J., Aguirre-Peñafiel, V. & Torres-Carvajal, O. (2012) Lizards of the genus *Riama* (Squamata: Gymnophthalmidae): The diversity in southern Ecuador revisited. *South American Journal of Herpetology*, 7, 259–275.
http://dx.doi.org/10.2994/057.007.0308
Savage, J.M. (1997) On terminology for the description of the hemipenis of squamate reptiles. *Herpetological Journal*, 7, 23–25.
Torres-Carvajal, O. & Lobos, S.E. (2014) A new species of *Alopoglossus* lizard (Squamata, Gymnophthalmidae) from the tropical Andes, with a molecular phylogeny of the genus. *ZooKeys*, 410, 105–120.
http://dx.doi.org/10.3897/zookeys.410.7401
Uzzell, T.M. (1958) Teiid lizards related to *Proctoporus luctuosus*, with the description of a new species from Venezuela. *Occasional Papers of the Museum of Zoology, University of Michigan*, 597, 1–15.
Uzzell, T.M. (1973) A revision of lizards of the genus *Prionodactylus*, with a new genus for *P. leucostictus* and notes on the genus *Euspondylus* (Sauria, Teiidae). *Postilla*, 154, 1–37.
Zaher, H. (1999) Hemipenial morphology of the South American Xenodontine snakes, with a proposal for a monophyletic Xenodontinae and a reappraisal of colubroid hemipenis. *Bulletin of American Museum of Natural History*, 240, 1–168.

APPENDIX I. Specimens examined.

Riama anatoloros.—ECUADOR: *PROVINCIA NAPO*: Trail to Volcán Sumaco, 8 km from Pacto Sumaco, Refugio El Mirador, 0.61497ºS 77.59065ºW, 1771 m (QCAZ 9039); Santa Rosa, Reserva de Biósfera Sumaco, 0.13403ºS, 77.46708ºW, 1321 m (QCAZ 9201).

Riama cashcaensis.—ECUADOR: *PROVINCIA BOLIVAR*: Road Guanujo-Salinas, near Río Moya, La Moya, 1.49601ºS, 79.01630ºW, 3273 m (QCAZ 10686, 10754).

Riama colomaromani.—ECUADOR*: PROVINCIA CARCHI*: El Goatal, Morán 0.77294ºN, 78.05597ºW, 2825 m (QCAZ 8752–53); *PROVINCIA COTOPAXI*: Sigchos, 0.70124ºS, 78.88795ºW (QCAZ 11058); *PROVINCIA PICHINCHA*: Cooperativa El Porvenir, Finca El Cedral, 0.11400ºN, 78.56993ºW, 2297 m (QCAZ 10503).

Riama kiziriani.—ECUADOR: *PROVINCIA AZUAY*: San Antonio, 2.89495ºS, 79.40528ºW, 1900 m (QCAZ 9667).

Riama labionis.—ECUADOR: *PROVINCIA COTOPAXI*: Naranjito, Reserva de Bosque Integral Otonga, 0.41940ºS, 79.00345ºW, 1985 m (QCAZ 10411–12).

Riama meleagris.—ECUADOR: *PROVINCIA TUNGURAHUA*: Cotaló, trail to Comunidad Mucubí, 1.42951ºS, 78.51743ºW, 2626 m (QCAZ 9842); El Triunfo, Zona El Calvario, 1.31327ºS, 78.40776ºW, 2406 m (QCAZ 9845); Mucubí, 1.43010ºS, 78.52058ºW, 2770 m (QCAZ 9840–41).

Riama simotera.—ECUADOR: *PROVINCIA CARCHI*: Comunidad El Frailejón, 2–3 km from Páramo de Los Frailejones, 0.71840ºN, 77.67427ºW, 3313 m, (QCAZ 11019, 11023).

Riama stigmatoral.—ECUADOR: *PROVINCIA AZUAY*: San Vicente, road to the antennas, 2.80600ºS, 78.68366ºW, 2715 m (QCAZ 11412, 11414, 11415); *PROVINCIA CAÑAR*: Biblián, 2.71784ºS, 78.88160ºW, 2798 m (QCAZ 9946); Mazar, Reserva Mazar, La Libertad, 2.54658ºS, 78.69837ºW, 2895 m (QCAZ 6657, 7374, 7884).

Riama unicolor.—ECUADOR: *PROVINCIA CARCHI*: outskirts of Huaca, 0.64421ºN, 77.72302ºW, 2925 m (QCAZ 9664); *PROVINCIA IMBABURA*: Intag, 0.31939ºN, 78.39847ºW, 3279–3311 m (QCAZ 8405, 8407); Reserva Ecológica Cotacachi-Cayapas, trail near Cuicocha Lake, 0.29297ºN, 78.35184ºW, 3082–3101 m (QCAZ 9681–82, 9684); Tumbabiro, Hacienda Ecológica on the road to Piñan, 0.40366ºN, 78.32716ºW, 3411 m (QCAZ 8409, 8411); *PROVINCIA PICHINCHA*: Quito, PUCE, 0.20877ºS, 78.49157ºW, 2810 m (QCAZ 8800).