

A new species of *Anolis* of the *aequatorialis* group (Squamata: Iguania) from the central Andes of Colombia

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We describe a new species of the *Anolis aequatorialis* group from the central Andes of Colombia. The new species, *Anolis anoriensis*, is similar to *A. eulaemus* Boulenger, which occurs in both the western and central Andes, and was positioned in the *eulaemus* subgroup of the *aequatorialis* group. *Anolis anoriensis* differs from *A. eulaemus* in having smaller interparietal scales and a green body coloration with a darker anterior part of the dewlap. We also for the first time describe the coloration of *Anolis eulaemus*, which is almost exclusively brown with a diffused light brown dewlap.

Key words: *Anolis anoriensis* sp. nov., taxonomy, morphology

INTRODUCTION

The Andes of Colombia are a recognized global biodiversity hotspot (Myers et al., 2000). However, many taxonomic groups have been poorly sampled in this region, despite a large number of species discoveries in the last decade. *Anolis* lizards are one of these poorly studied groups, and recent fieldwork has allowed for the discovery of new species and the increase in distributional records (Poe & Yanez-Miranda, 2007; Poe et al., 2008). In Colombia, *Anolis* lizards are represented by two large clades: the putative Dactyloa (*sensu* Guyer & Savage, 1986) and the monophyletic Norops (Nicholson, 2002). Dactyloid anoles are considered the most basal group within the anoline radiation (Poe, 2004; Nicholson et al., 2005) and many species have been discovered recently (Huleback et al., 2007; Poe et al., 2009). There are several taxonomic groupings for the Dactyloa clade that are distinguished by external traits, but no phylogenetic analysis has yet been performed. The newly discovered species have been assigned to these taxonomic groups based on a combination of characters and external similarity with previously discovered ones (Huleback et al., 2007).

The *Anolis aequatorialis* group is such a taxonomic group, and is known to inhabit north-western South America (Colombia and Ecuador). This group is recognized by the following combination of characters (Williams, 1976): 1) dorsal scales uniform in size (enlarged mid-dorsal scales in some species); 2) smooth ventral scales (larger than dorsal scales); 3) keeled head scales (uni- or multicarinate); 4) large male dewlap (extending beyond to forelimbs); 5) narrow toepads; and 6) variable size of interparietal scales (absent in some species). Williams (1985) recognized two subgroups based on the morphology of the toe lamellae. The *eulaemus* subgroup is characterized by toepads that overlap the first phalange (Type I), whereas the *aequatorialis* subgroup has non-overlapping toepads (Type II) (see Williams, 1963). The *eulaemus* subgroup comprises seven species with Andean

distributions in Colombia and Ecuador: *A. antioquiae*, *A. eulaemus*, *A. fitchi*, *A. gemmosus*, *A. maculigula*, *A. megalopithecus* and *A. ventrimaculatus*.

In this paper we describe a new species of *Anolis* of the *eulaemus* subgroup of alpha anoles (Etheridge, 1959), from the Department of Antioquia in the Cordillera Central of Colombia. The new species is very similar to *A. eulaemus* from the central and western Andes of Colombia, and to *A. fitchi* from the Andes of Ecuador. It differs from these species in dewlap scalation, interparietal size and coloration. Due to the lack of a colour description for *A. eulaemus*, and to facilitate comparisons between both species, we also provide life coloration data for *A. eulaemus*.

MATERIALS AND METHODS

The description is based on material deposited in the collection of the Herpetology Museum of Antioquia University (MHUA, Medellín, Colombia). The terminology for external morphology follows Williams et al. (1995). Osteological characters are based on Poe (1998, 2004) and Etheridge (1959), and the evolutionary species concept was used (Wiley 1978). All measurements were taken using digital callipers to the nearest 0.1 mm, and means \pm standard deviation are shown. Sex was determined by the presence of hemipenes in males. Osteological characters were examined on cleared and stained specimens. We compared this new taxon with the other species in the *aequatorialis* group listed in Appendix 1. The following collections and their abbreviations are cited in the text and appendix: Colegio San Jose de Medellín (CSJ); Escuela Politécnica Nacional del Ecuador (EPN); Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN); Instituto Alexander von Humboldt, Claustro de San Agustín, Villa de Leyva, Colombia (IAvH); Pontificia Universidad Católica del Ecuador, Quito, Ecuador (QCAZ); Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (MECN).

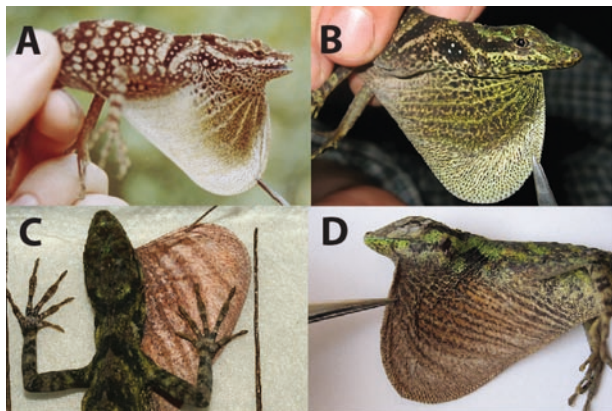


Fig. 1. A) *Anolis anoriensis* adult male, locality type, Municipio de Anorí, Departamento de Antioquia. B) *Anolis anoriensis* adult male, Municipio de Amalfi (Cordillera Central), Departamento de Antioquia. C) *Anolis eulaemus* adult male, from the western Andes, eastern slope, Departamento de Antioquia. D) *Anolis eulaemus* adult male, from Municipio de Filandia, Departamento del Quindío, Cordillera Central.

RESULTS

Anolis anoriensis sp. nov. (Fig. 1A, B)

Anolis “*anoriensis*” – Molina-Zuluaga & Gutiérrez-Cárdenas (2007).

Holotype. MHUA 11719 (field number JAV 218), adult male, collected on 10–13 January 2005 by Julián Velasco, Rosario Castañeda, and Paul D. Gutiérrez.

Type locality. Colombia: Vereda El Retiro, Anorí municipality, Antioquia department, 6°59'00"N, 75°8'05"W, 1374 m.

Paratypes. MHUA 11720 (JAV 220; juvenile male), MHUA 11721 (JAV 217; adult female): same collecting data as holotype. MHUA 11722 (JAV 215; juvenile female), MHUA 11723–11724 (JAV 213–14; juvenile males), MHUA 11725 (JAV 216; juvenile male), MHUA 11728, MHUA 11726 (MRC 080–81; juvenile females) and MHUA 11727 (MRC 088; juvenile male): Vereda El Roble, Anorí municipality, Antioquia department, Colombia, same date and collectors as holotype. MHUA 11263 (PDG 572; adult male) and MHUA 11284 (PDG 570; adult female): Vereda El Roble, Anorí municipality, Antioquia department, Colombia, collected on 20 March 2004 by Paul D. Gutiérrez.

Diagnosis. An *Anolis* of the *eulaemus* subgroup of the *aequatorialis* group, differing from the remainder of the *eulaemus* species by the following combination of characters: body size, presence of interparietal scale, interparietal size, toepad condition and coloration pattern. *Anolis anoriensis* differs from *A. gemmosus* and *A. ventrimaculatus*, *A. mirus* and *A. maculigula* in adult body size (Table 1). *Anolis anoriensis* differs from *A. antioquiæ*

and *A. megalopithecus* in the presence of an interparietal scale; *A. antioquiæ* and *A. megalopithecus* lack the interparietal scale. *Anolis anoriensis* differs from *A. mirus*, *A. parilis*, *A. kunayalae* and *A. aequatorialis* in having narrow toepads that overlap the first phalanx (*A. mirus*, *A. parilis*, *A. kunayalae* and *A. aequatorialis* share the character that the toepad does not overlap the first phalanx (the Norops condition; see Figure 1 of Williams, 1963). *Anolis anoriensis* differs further from *A. aequatorialis* in female dewlap size (*A. aequatorialis* has a dewlap extending posterior to axillae; the dewlap in *A. anoriensis* is smaller, not extending posterior to axillae). *Anolis anoriensis* is very similar to *A. eulaemus* and *A. fitchi* but differs in interparietal size and coloration. *Anolis anoriensis* exhibits an interparietal scale slightly smaller than *A. eulaemus* (*A. anoriensis* mean 1.2 ± 0.1 mm; *A. eulaemus* 1.7 ± 0.1 mm; Mann–Whitney U-test=56, $P=0.03$; Table 1).

Anolis anoriensis differs further from *A. eulaemus* and *A. fitchi* in life coloration pattern (*A. eulaemus* in life is almost exclusively brown, *A. fitchi* is green-yellowish, and *A. anoriensis* is green). Similarly, *A. anoriensis* possesses a darker anterior part of the dewlap, whereas *A. eulaemus* possesses a diffused light brown dewlap (Fig. 1). Furthermore, *Anolis anoriensis* differs from *A. fitchi* in dewlap scalation and female dewlap size. The male dewlap of *A. anoriensis* possesses rows of several scales separated by skin interspersed with scales, whereas the dewlap of *A. fitchi* has single or double rows separated by naked skin. The female dewlap in *A. anoriensis* is small (not extending posterior to axillae) and has two or more scales separated by skin interspersed with a few scales. By contrast, the female dewlap in *A. fitchi* extends posterior to the axillae and exhibits a single or double row of scales separated by naked skin.

Description (scores for holotype in parentheses). Head scales are small and uncarinate; 11–15 scales between second canthals (14); scales of frontal depression uncarinate and multicarinate, anterior frontal scales larger than posterior ones. 5–8 (7) scales bordering the rostral posteriorly; 8–11 (10) scales between supranasals. Anterior nasal in contact with rostral and first supralabial; supraorbital semicircles separated by 4–5 (5) scales, the medial scales smaller than lateral ones; scales of supraocular disc not strongly differentiated, uncarinate, varying continually in size (holotype), or have several enlarged scales (1–3) in MHUA 11725–11726 and MHUA 11727; one elongated superciliary followed by two small scales and a series of granules; 6–10 (7) loreal rows of equal size; temporal and supratemporal scales conical; intertemporal scale row largest and uncarinate. Interparietal larger than surrounding scales, with scales lateral to it about one-half of the size, anterior scales about one-fourth the size, and posterior scales granular. Suboculars and supralabials separated by 1–3 (1) rows of strongly keeled scales. Mental partially divided, wider than deep, extending posterolaterally beyond rostral, serrate posteromedially, in contact with 8–10 (9) postmental scales. Sublabial scales not clearly differentiated. Medial scales of throat small, swollen, conical, increasing in size toward the sides; male dewlap extending beyond axillae to chest; female dewlap

Table 1. Comparative meristic and morphometric characters for some species in the *Anolis eulaemus* group.

Species	Male SVL (mm)	Female SVL (mm)	Scales across snout	Post- rostral scales	Scales		Inter- parietal scale	Inter- parietal length	Lamellae number
					between supraorbital semicircles	Loreal rows			
<i>aequatorialis</i>	92.1±6.5	83.6±6.6	12–17	5–8	2–5	7–11	+/-	1.3±0.2	21.8±1.2
<i>anoriensis</i>	88.1±6.2	78.4±6.1	11–15	5–8	4–5	6–10	+	1.2±0.3	22.7±1.6
<i>antioquiae</i>		76.7±2.0	15–18	7	4–5	9–10	–	absent	22±0.0
<i>eulaemus</i>	87.2±6.9	?	18	8	2–3	7–9	+	1.7±0.2	22.7±1.0
<i>fitchi</i>	87.4±5.1	75.6±6.3	13–16	5–7	2–3	6–10	+	1.5±0.3	23.3±1.4
<i>gemmosus</i>	60.5±1.6	56.8±1.4	12–17	4–6	2–5	6–7	+/-	0.9±0.2	18.4±2.0
<i>kunalayae</i> (holotype)	95.4	?	15	7	4	?	+	1.2	12
<i>maculigula</i>	96.0±11.3	75.9±3.2	13–17	8–10	3–4	8–11	+	2.2±0.3	21.2±1.3
<i>megalopithecus</i>	85.3	77.5	13–19	5	4–5	10	–	absent	23.5±0.7
<i>mirus</i>	102.0	88.1	11	8–9	4–5	5–6	+	1.7±0.2	13±0.0
<i>gemmosus</i> -like new species	63.9±3.4	62.0±6.5	8–12	6–8	3–4	5–9	+/-	1.0±0.3	19.3±1.7
<i>parilis</i> (holotype)	81	?	16	7	?	7	+	?	17
<i>ventrimaculatus</i>	72.8±3.1	65.5±2.1	15–17	6–8	3–5	8–9	+/-	1.2±0.3	19.3±0.9

is small and does not extend beyond axillae. Dewlap in both sexes has rows of several scales separated by skin interspersed with scales. Two enlarged uncarinate mid-dorsal scale rows, juxtaposed and subimbricate. Flank scales uncarinate, subimbricate, juxtaposed, separated by granular scales; ventrals larger than dorsals, subimbricate, smooth, in transverse rows, each bordered posteriorly by 2–3 scales. Anterior forearm scales uncarinate, subimbricate; supradigital scales multicarinate; posterior forearm scales uncarinate, slightly smaller than anterior forearm scales, becoming granular toward the axillae (in juveniles, anterior and posterior forearm scales are of similar size). Anterior femoral scales imbricate, multicarinate; in some juveniles, uncarinate becoming multicarinate towards the knee. Posterior femoral scales relatively small, juxtaposed, with some scales separated by granules, becoming conical. Lamellae under second and third phalanges of fourth toe 20–25 (23). Tail weakly compressed with mid-dorsal rows of similar size to lateral scales, uncarinate, and a pair of enlarged postanal scales in males.

Coloration in life (adapted from field notes and colour photos of paratypes male MHUA 11263 and female MHUA 11284). Both sexes are similar in overall coloration, with females having brighter bands or blotches in the mid-dorsal region, and a brown dorsum with lemon green blotches in the mid-dorsal region that terminate laterally in rows of irregular spots (yellowish green narrow stripes on anterior region of back, posterior lemon green blotches, ending in one or two irregular lemon green spots on the flanks). The head dark brown, with a light green (yellowish green) stripe extending from the eyes to the nape. In some specimens, a large dark brown spot with very small light green dots is present anterior to the insertion of the arms. Males possess flanks with scattered lemon green

spots. Their limbs are pale brown with lime green bands on anterior surfaces. The male dewlap is dark green with brown and anterior black markings, light greenish-cream distally and posterior. Scales are yellow-green. The female dewlap is dark brown with creamy green scale rows. The tail is pale brown with broad posterior black bands bordered with narrow green stripes. The throat and chin are dark brown with greenish spots on the sides. The chest and belly are light brown, sometimes with dark brown reticulations. The iris is black with a whitish ring.

For a better separation between *A. eulaemus* and *A. anoriensis*, we here describe the coloration of *A. eulaemus* from populations in the central and western Andes (Figs 1 and 2). *Anolis eulaemus* was described from a unique male type from Pavas, Cordillera Occidental of the Andes, Department of Valle del Cauca, Colombia. Williams & Duellman (1984) described the body coloration pattern of a preserved female, and the coloration in life of males was not known at that time. *Anolis eulaemus* has a dorsum that varies from light brown to creamy brown, pale green in adults and bright green in young specimens. Dark brown cross-sectional bands in the middorsal region and flanks are found. The head possesses a dark brown stripe that extends from the eyes to the nape. Some specimens have a cross-sectional dark band between the eyes and the snout. The tongue is grey and the iris is creamy yellow. The male dewlap is cream with rows of dark brown on the base. The female dewlap is smaller than the male dewlap, and dark in coloration. The belly is generally light brown or creamy brown, in some specimens with dark points as a prolongation of the bands from the flanks, but more dense. The tail and limbs are banded.

Coloration in preservation. Dark brown dorsum, with darker blotches in the middorsal region coalescing into

rows of spots (in male holotype) or with narrow, creamy brown stripes on flanks. The head is dark brown, with a dark brown stripe extending from the eye to the nape. In some specimens there is a large, dark brown spot in-laid with very small white dots anterior to the forearms. The anterior dewlap in males is blackish, the remainder is creamy white; in females, the dewlap is dark brown with lighter brown scales. The tail is pale brown, banded with black. The throat and chin are dark brown with small blackish spots on the sides. The venter is uniformly light brown, in some specimens with dark reticulations.

Skull (based on MHUA 11283, MHUA 11285). Parietal roof flat; parietal crests Y-shaped; anterolateral corners of parietal crests reach posterolateral corners of frontal; dorsal surface of skull smooth; no crenulation along lateral edges of parietal; parietal casque absent, edges non-overlapping; posterior of skull slopes superiorly; supraoccipital cresting continuous across supraoccipital; pineal foramen within parietal; supratemporal processes leave supraoccipital exposed above; postfrontal present, small; prefrontal in broad contact with nasal; posterior edge of nasal rounded; frontal sutures anteriorly with nasals; parallel crests extend longitudinally down nasals (in MHUA 11283, absent in MHUA 11285); dorsal process of jugal terminates on lateral aspect of postorbital; posterior end of postorbital pronged; contact between jugal and

squamosal absent; posteroventral corner of jugal is anterior to posterior edge of jugal; lacrimal large and rounded in comparison with lateral aspect of prefrontal; epipterygoid in contact with parietal; pterygoid teeth absent; lateral edges of vomer smooth; posterior edges of palatine extend both diagonally and straight; maxilla extends posterior to ectopterygoid, producing a thickened aspect; lateral shelf of quadrate absent and concavity present in anterolateral portion (MHUA 11283 and 11285), quadrate with a lateral process, superior fossa of quadrate relatively enlarged, not penetrated by squamosal; sphenoccipital tubercles variable in size and degree of development; no black pigment on skull; premaxilla overlaps nasals laterally or is flush with them; dentary large, anteriormost aspect of posterior border within mandibular fossa; posterior suture of dentary pronged; splenial present, and terminating anterior to the most anterior aspect of posterior edge of dentary; tooth row extends posterior to anterior inferior alveolar foramen; anteromedial process of coronoid extends anteriorly; suprangular foramen completely in suprangular; coronoid labial processes present, extending both in front of and behind tooth row of mandible; posterolateral aspect of coronoid terminates anterior to suprangular; no jaw sculpturing in adult males; angular bone absent; posterior mylohyoid foramen present; anterior mylohyoid foramen absent.

Postcranial skeleton (based on MHUA 11283, MHUA 11285). Interclavicles arrow-shaped; clavicle without distal flanges; 22–23 presacral vertebrae; three lumbar vertebrae; 8–9 caudal vertebrae with transverse processes anterior, lost posterior (alpha condition); caudal autotomy septa absent; four postxiphisternal ribs, all attached to dorsal ribs (4:0); two sternal and three xiphisternal ribs.

Distribution and ecology. *Anolis anoriensis* is known in three localities in the northern part of the central Andes in the department of Antioquia (Fig. 2). It has been mostly collected in riparian vegetation of primary and secondary forests at night, from several types of perches such as shrubs, ferns, herbs and trees (Molina-Zuluaga & Gutiérrez-Cárdenas, 2007). In the type locality, the new species is probably syntopic with other undescribed species from the *eulaemus* subgroup. The diet of *A. anoriensis* consists mainly of insects (ants, Acrididae, Carabidae, damselflies and cockroaches) and spiders (Gutiérrez-Cárdenas, unpublished data).

Etymology. The specific name *anoriensis* refers to the locality where the new species was found, the municipality of Anorí, a town on the eastern flank of the Cordillera Central in the department of Antioquia (Colombia).

DISCUSSION

The *A. aequatorialis* group is currently composed of 10 species distributed from Panama to Ecuador. Recent phylogenetic analyses based on morphological data found that the position of *A. anoriensis* in the Dactyloa clade was not conclusive, being positioned as a sister species of *A. eulaemus* (Velasco, 2007), or as a sister species of *A.*

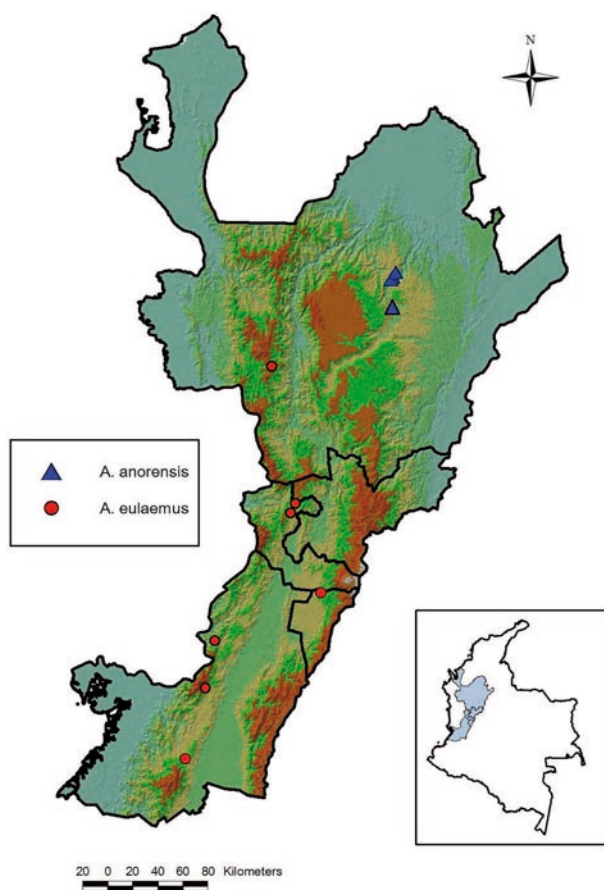


Fig. 2. Map showing type locality and other localities for *Anolis anoriensis* sp. nov. (triangles) and *Anolis eulaemus* (circles).

aequatorialis, nested in a group composed of other species from the *aequatorialis* and *latifrons* groups among the clade of dactyloid *Anolis* (Velasco & Hoyos, in prep.). We considered that similarities in morphology, coloration and distribution would place *A. anoriensis* closer to *A. eulaemus* than *A. aequatorialis*, but further incorporation of DNA sequences and morphological data should provide a better resolution to the phylogenetic position of *A. anoriensis* within the Dactyloa clade, and the monophyletic status of the *aequatorialis* group.

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APPENDIX 1

Specimens of *Anolis aequatorialis* group examined

Anolis antioquiae: ICN 9446; CSJ 310.

A. eulaemus: ICN 3538; MHUA 12087 from San Antonio Forest, km 18 via Cali–Buenaventura, Departamento del Valle del Cauca, MHUA 12088 from Finca Zingara, km 18 via Cali–Buenaventura, Valle del Cauca; MHUA 12089 from Hacienda La Argelia, Vereda La Tulia, Municipio de Bolivar, Departamento del Valle; MHUA 12091–99, 12101–02, 12104 from Parque Regional Natural Barbas-Bremen, Filandia, Departamento del Quindío; MHUA 12100 from Parque Municipal Natural Agualinda, vereda La Linda, Mistrató, Departamento de Risaralda; MHUA 12103 from Parque Municipal Natural Arrayanal, Apía, Departamento de Risaralda.

A. fitchi: QCAZ 0926, 3758, 6742, 6743, 5435, 5438–39, 5442, 5649, 5997; EPN 7590, 7593.

A. gemmosus: QCAZ 0881, 1353, 2066–68, 2070, 6781; MECN 1494–96, 1498, 1502.

A. maculigula: ICN 9962, 9964–70; IAvH (IND-R) 1490–91, MHUA 10041, CSJ 0308, 0824–5.

A. megalopithecus: IAvH 3845–6.

A. ventrimaculatus: ICN 3553–54, 3567, 3662, 3654.

Additional specimens of *Anolis anoriensis* examined, deposited in MHUA: 11152, 11256–61, 11263–64, 11270, 11272, 11278, 11280–11281, 11283, 11285, 12262.