

A new species of *Anolis* lizard (Squamata, Iguania) from Panama

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Abstract

A new species of *Anolis* lizard (Squamata, Iguania) from Panama. A new species of *Anolis* is described from western Panama and eastern Costa Rica. Populations of the new form were previously allocated to *A. chocorum*. However, the new species differs from *A. chocorum* in characters of color pattern, scalation and proportion.

Keywords: Squamata, Iguania, species description, Panama.

Resumo

Uma nova espécie de lagarto do gênero *Anolis* (Squamata, Iguania) do Panamá. Uma nova espécie de *Anolis* é descrita do oeste do Panamá e leste da Costa Rica. As populações da nova forma foram alocadas previamente em *A. chocorum*. Contudo, a nova espécie difere de *A. chocorum* em características relacionadas ao padrão de coloração, foliose e proporções corporais.

Palavras-chave: Squamata, Iguania, descrição de espécie, Panamá.

Introduction

The distinctive species *Anolis chocorum* was described from the Darién of Panama and northern Colombia by Williams and Duellman (1967). The range of this species was later extended south into central Colombia and north to western Panama and Costa Rica (Myers 1971, Savage 2002). Myers (1971) noted peculiarities of color and scalation in the first known specimen of *A. chocorum* from western Panama, and remarked that the western populations merited further study.

Recent fieldwork has afforded the opportunity to examine putative *A. chocorum* in life from throughout its range. We have collected specimens assignable to *A. chocorum* in western Panama, central Panama, the Darién, and western Colombia (Appendix I). Comparisons of fresh material make it clear that the taxon *A. chocorum* is composed of at least two species. Here we describe specimens from moderate elevations in western Panama and bordering Costa Rica as a new species.

Materials and Methods

We adopt the evolutionary species concept (Simpson 1961, Wiley 1978), and apply this concept by identifying species based on consistent

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differences between populations. That is, we hypothesize that populations that are diagnosable by major differences in the frequencies of traits are distinct evolutionary lineages, or species (see Wiens and Servedio 2000).

Measurements were made with digital calipers to the nearest 0.1 mm and are given in mm throughout the paper. We measured snout to vent length (SVL) from tip of snout to anterior of cloaca; head length (HL) from tip of snout to anterior of ear; head width (HW) at the posteroventral corners of the jugal; femoral length (FL) from midline of body to knee; ear height (EH) vertically on the ear. Scale terminology follows Williams *et al.* (1995) and previous descriptions from Poe and collaborators (e.g., Poe *et al.* 2009).

We used the Mann-Whitney U test to make univariate statistical comparisons. We grouped specimens previously assigned to *A. chocorum* into one of two groups, true *A. chocorum* and the new species, based on geography (west versus east of the Panama Canal) and a geographically correlated and discretely distributed diagnostic trait of color pattern (lateral lines in the new species, lateral ocelli in *A. chocorum*).

Species Description

Anolis ibanezi sp. nov.

(Figures 1A, 2, 3)

Holotype - MSB 72574, an adult male, collected along the trails of Parque Nacional General de División Omar Torrijos Herrera, 5 km North of El Cope, Coclé Province, Panama, 8° 40' 18.9" S, 80° 35' 31.08" W (SA69 datum), by Steven Poe, Erik Hulebak, and Heather MacInnes on August 3, 2005.

Paratypes - MVUP 2002 (hatchling male), same locality and collectors as holotype, collected on August 11, 2004; MSB 72575 (adult male), same locality as holotype, collected by Steven Poe on September 15, 2005; MSB 72576, same locality as holotype,

collected by Steven Poe on September 17, 2005; MCZ-R-186729, same locality as holotype, collected by Eric W. Schaad on December 25, 2008; SMF 89459 collected on Cerro Mariposa, Veraguas, Panama, 8° 30.601' N, 81° 6.993' W, by Leonard Stadler on June 04, 2008. AMNH 103778 collected at Río Teribe, 0.5 miles downstream of Puerto Palanque, Bocas del Toro, Panama, by James Duke on April 20, 1968.

Etymology - *Anolis ibanezi* is named for Dr. Roberto Ibañez of the Smithsonian Tropical Research Institute. Dr. Ibañez has contributed greatly to Panamanian herpetology (e.g., Arosemena *et al.* 1991, Arosemena and Ibañez 1994, Nicholson *et al.* 2001, Ibañez *et al.* 2004, Myers *et al.* 2007). He has facilitated the research of several North American herpetologists working in Panama, enabling dozens of studies in taxonomy, evolution, and ecology of reptiles and amphibians. He has been outstandingly helpful to the Poe lab in particular.

Diagnosis - *Anolis ibanezi* and *A. chocorum* are the only Central American *Anolis* with intermediate adult size (65–95 mm SVL), smooth ventral scales, and green dorsal coloration (Myers 1971, Köhler 2008). *Anolis ibanezi* is most easily distinguished from *A. chocorum* by its dorsolateral pattern (narrow diagonal black lines in *A. ibanezi*; rows of ocelli or spots in *A. chocorum* (Figure 1). *Anolis ibanezi* also possesses longer hindlimbs (mean = 0.32 FL/SVL, range = 0.31–0.33 in *A. ibanezi*; mean = 0.29, range = 0.24–0.30 in *A. chocorum*; $P = 0.002$), fewer loreal rows (mean = 5.9, range = 5–6; mean = 6.8, range = 6–8 in *A. chocorum*; $P = 0.032$) and fewer toe lamellae (mean = 17.6, range = 17–19; mean = 19.6, range = 18–21 in *A. chocorum*; $P = 0.042$). Female dewlap color appears to differ between these species (dark orange in *A. ibanezi*, Figure 3B; dark green in *A. chocorum*), but we have examined only one adult female of *A. ibanezi* and few adult females of *A. chocorum* so we are uncertain of the diagnostic utility of this trait.



Figure 1 - (A) Adult male *Anolis ibanezi* sp. nov. (B) Adult male *Anolis chocorum*.

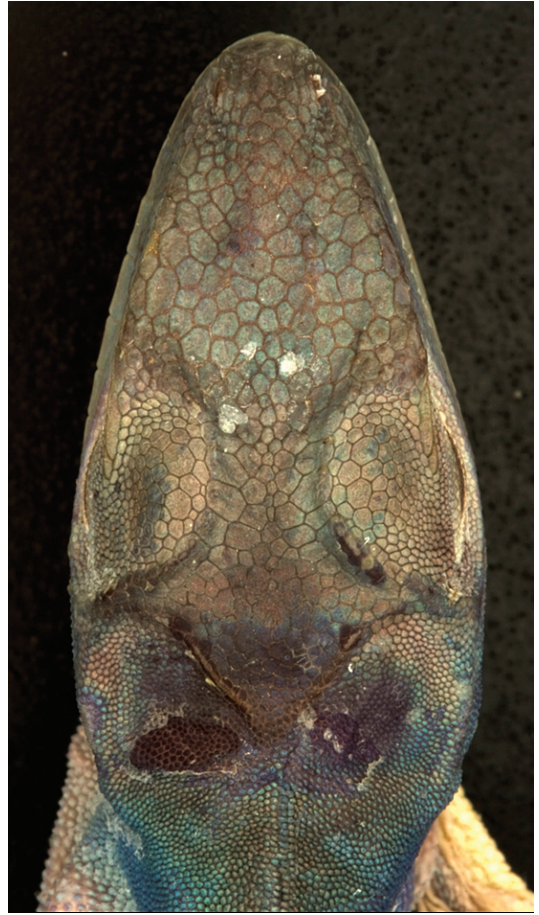


Figure 2 - Head scales of the adult male holotype of *Anolis ibanezi* sp. nov. (MSB 72574).



Figure 3 - Dewlaps of male (A) and female (B) *Anolis ibanezi* sp. nov.

The only other large green anoles in Panama or Costa Rica are *A. biporcatus*, *A. frenatus*, and *A. kunayalae*. *Anolis ibanezi* differs from *A. biporcatus* in its smooth ventral scales (strongly keeled in *A. biporcatus*), from *A. frenatus* in size (up to 84 mm SVL in *A. ibanezi*; 143 mm in *A. frenatus*) and color pattern (lateral lines in *A. ibanezi*; ocelli in *A. frenatus*), and from *A. kunayalae* in toe morphology (expanded toepad on fourth toe with moderately sized claw in *A. ibanezi*; narrow toe with enlarged claw in *A. kunayalae*) and color pattern (dorsum with lateral lines in *A. ibanezi*, male dewlap orange or yellow-orange; dorsum with anterior blue wash and/or white and red reticulations and spots in *A. kunayalae*, male dewlap white with yellow edge).

Description of external morphology of holotype (paratype variation in parentheses; the hatchling specimen is not included here) - Snout to vent length 79.7 (73.7–80.7; largest male: 80.7, female: 73.7); head length 18.8, 0.24 SVL (0.23–0.26); head width 11.1, 0.14 SVL (0.13–0.15); ear height 1.0, 0.01 SVL (0.01–0.02); femoral length 25.8, 0.32 SVL (0.31–0.33); fourth toe length 15.7, 0.20 SVL (0.19–0.20); greatest width of toepad under fourth toe 1.6, 0.02 SVL (0.01–0.02); tail length approximately 195, 2.45 SVL (2.32–2.88).

Overall appearance is gracile, with long narrow limbs and elongate body; dorsal head scales smooth (or slightly wrinkled posteriorly); weak frontal depression; rostral slightly overlaps mental; twelve (9–11) scales across snout between second canthals; three (2–3) scales between supraorbital semicircles; one elongate supraciliary scale followed by a much smaller elongate scale and then several small scales; six (5–6) loreal rows; one or two undifferentiated scales separate naris and rostral; interparietal length 1.5 mm (1.5–1.6); three scales separating interparietal and supraorbital semicircles; eight (7–9) supralabials to center of eye; six (6–8) postmentals; five (6–7) postrostrals; some

enlarged scales present in supraocular disc, decreasing gradually in size, bordered medially by a complete row of small scales; mental is convex (or straight) posteromedially, partially divided, extending posterolaterally beyond rostral; sublabial rows weakly enlarged along infralabials; dewlap reaching posterior to axillae in males, with three rows of scales, each row of scales two to five scales wide; two enlarged postcloacal scales.

Dorsal scales keeled, with 0–2 rows of enlarged middorsal scales, nine (9–10) scales counted longitudinally in 5% of SVL; ventral scales smooth midventrally, faintly keeled laterally, 10 (8–9) scales in 5% of SVL, in transverse and diagonal rows.

Dorsal limb scales multicarinate near the knee, unicarinate medially, larger anteriorly than posteriorly; supradigital scales multicarinate; toepads expanded; nineteen (17–19) lamellae under second and third phalanges of fourth toe; tail with keeled scales and a double middorsal row.

Color in life - Dorsum bright, rich green with two to four narrow black diagonal lines with or without blue centrally on flanks, or solid green (variation within individuals); somewhat yellow-green ventrolaterally; yellow around eye; throat black; iris reddish-brown; male dewlap skin green and white anteriorly, but mostly red-orange (recorded as “yellow-orange” in some specimens), with green scales (Figure 3A, see also Köhler 2008, labeled as *Dactyloa chocorum*). Female dewlap skin green and white anteriorly but mostly dark orange, with green scales anteriorly and white scales posteriorly and on margin (Figure 3B).

Juvenile male (MVUP 2002, SVL = 44.5) is identical in color pattern to adults, including dewlap color.

Distribution and ecology – Specimens of *A. ibanezi* are known from moderate elevation localities (400–900 m) west of the Panama Canal (Figure 4).

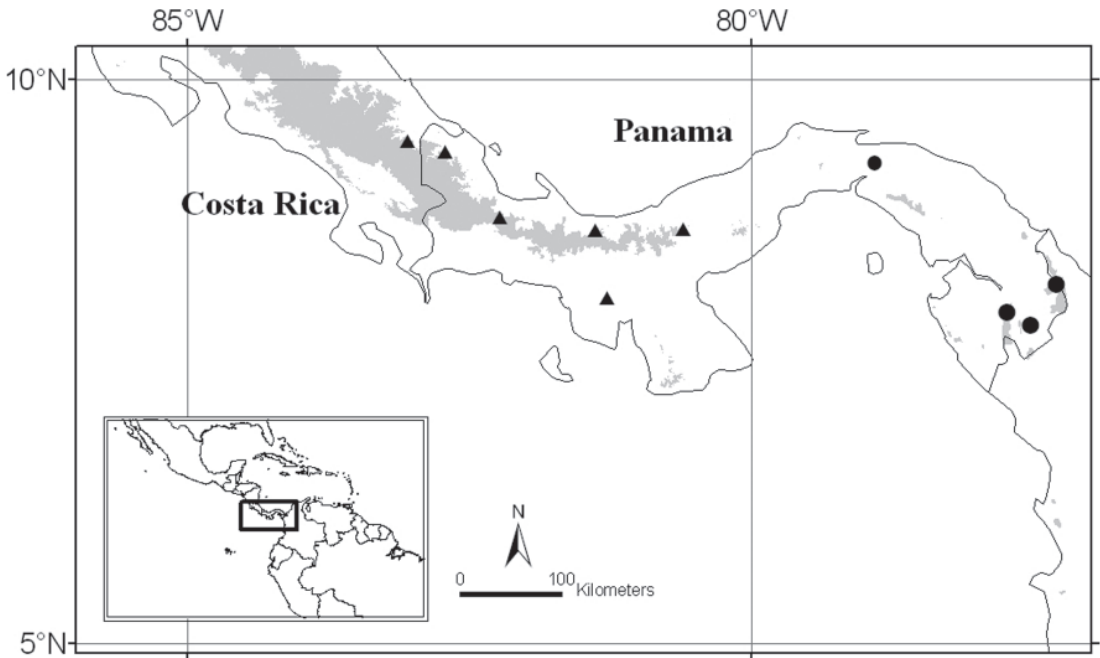


Figure 4 - Distribution of *Anolis ibanezi* sp. nov. (triangles) and *A. chocorum* (circles) in Costa Rica and Panama.

Specimens were found in the following situations:

MVUP 2002 sleeping on a leaf 3 m up well below the canopy;

MSB 72575 sleeping on a leaf 5 m up with both fore and hindlimbs flexed and with its body oriented vertically and head oriented up;

MSB 72576 sleeping on a leaf 4 m up with its fore and hindlimbs flexed and its tail hanging off the leaf;

EWS 45 sleeping exposed on a leaf 3 m up with fore and hindlimbs flexed; its body oriented horizontally to the ground and parallel on the leaf, and its head oriented toward the trunk of a tree less than a meter away; the perch was above moderately dense understory with the canopy four meters above;

MCZ-R-186729 sleeping exposed on a leaf of a sapling tree one meter up with forelimbs flexed and hindlimbs extended; it was oriented

horizontally to the ground and parallel on the leaf with its head oriented toward the trunk of the sapling; ground cover dense below and around the perch and canopy approximately 20 m overhead.

Another specimen observed but not collected was sleeping on a vine 2 m up near a stream.

Discussion

The type locality of Parque Nacional General de División Omar Torrijos Herrera includes primary and secondary forest. An excellent trail system runs through the southern aspect of the park. The senior author found 11 species of *Anolis* along these trails during five nights -*A. ibanezi*, *A. limifrons*, *A. frenatus*, *A. biporcatus*, *A. insignis*, *A. capito*, *A. humilis*, *A. lionotus*, *A. kunayalae*, and two additional undescribed

species. A previous trip by members of Poe's lab found *A. lemurinus* in the park and *A. pentaprion* just south of it. The presence of 12 sympatric species of *Anolis* is more than that found in Soroa, Cuba, which was noted to possess the highest known *Anolis* diversity of any locality (Losos *et al.* 2003). Furthermore, the park is within the range of additional species of *Anolis* such as *A. laevis* and *A. carpenteri*, that are likely to be found there. Clearly, Parque Nacional General de División Omar Torrijos Herrera is an outstanding place for *Anolis* diversity.

Our recent phylogenetic analyses (e.g., Poe *et al.*, unpubl. data) place *A. ibanezi* as the sister species to *A. chocorum* among the clade of South and Central American dactyloid/*latifrons*-group *Anolis* (Etheridge 1959, Poe 2004) based on morphological data. Future work will incorporate DNA sequences of *A. chocorum* and *A. ibanezi* in phylogenetic analyses.

The geographic distribution of the *chocorum-ibanezi* species pair (Figure 4) is similar to the distributions of at least two other species pairs of *Anolis*, *limifrons-apletohallus* (Köhler and Sunyer 2008) and *lionotus-poecilopus* (Köhler 2008). Each of these species pairs may be a set of phylogenetic sister species, as *A. limifrons* and *A. apletohallus* were formerly considered conspecific (Köhler and Sunyer 2008) and *A. poecilopus* and *A. lionotus* are morphologically similar semi-aquatic *Anolis*. In each case the geographic break between species is the Isthmus of Panama, a hypothesized biogeographic barrier for many lineages (Simpson 1950, Ryan *et al.* in press). The isthmus evidently was most recently submerged approximately 3 million years ago (mya; Marshall *et al.* 1979). Future work with DNA sequences will assess whether the timing of the phylogenetic splits between these species pairs of *Anolis* corresponds with an earlier emergence of a trans-American land bridge that was subsequently subdivided by interoceanic contact prior to 3 mya.

The recent addition of several new species to the anoline fauna of Panama (e.g., Hulebak *et al.* 2007, Köhler *et al.* 2007, Poe and Ibañez 2007, Köhler and Sunyer 2008) suggests that despite decades of intensive collecting there remains much to be discovered there. The highlands of Panama, and the trails of Parque Omar Torrijos in particular, provide fruitful opportunities for future taxonomic study.

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References

- Arosemena, F. A. and R. Ibañez. 1994. Un saurio nuevo del genero *Anolis* (Reptilia: Polychridae), grupo *fuscoauratus*, de las Tierras Altas de Chiriqui, Panamá. *Caribbean Journal of Science* 30: 222–227.
- Arosemena, F. A., R. D. Ibañez, F. De Sousa. 1991. Una especie nueva de *Anolis* (Squamata: Iguanidae) del grupo *latifrons* de Fortuna, Panamá. *Revista de Biología Tropical* 39: 255–262.
- Etheridge, R. E. 1959. The relationships of the anoles (Reptilia: Sauria: Iguanidae): an interpretation based on skeletal morphology. Unpublished Ph.D. Thesis, University of Michigan, Ann Arbor, Michigan, USA.

- Hulebak, E., Poe, S., R. Ibañez, and E. E. Williams. 2007. A striking new species of *Anolis* lizard (Squamata: Iguania) from Panama. *Phyllomedusa* 6: 5–10.
- Ibañez, R., R. Condit, G. Angehr, S. Aquilar, T. Garcia, R. Martinez, A. Sanjur, R. Stallard, S.J. Wright, A.S. Rand, and S. Heckadon. 2004. An ecosystem report on the Panama Canal: monitoring the status of the forest communities and the watershed. *Environmental Monitoring and Assessment* 80: 65–95.
- Köhler, G. 2008. *Reptiles of Central America*. Offenbach, Germany. Herpeton. 400 pp.
- Köhler, G. and J. Sunyer. 2008. Two new species of *Anolis* formerly referred to as *Anolis limifrons* (Squamata: Polychrotidae). *Herpetologica* 64: 92–108.
- Köhler, G., M. Ponce, J. Sunyer, and A. Batista. 2007. Four new species of anoles (genus *Anolis*) from the Serranía de Tabasará, west-central Panama (Squamata: Polychrotidae). *Herpetologica* 63: 375–391.
- Losos, J. B., M. Leal, R. E. Glor, K. de Queiroz, P. E. Hertz, L. Rodriguez-Schettino, A. Chamizo-Lara, T. R. Jackman, and A. Larson. 2003. Niche lability in the evolution of a Caribbean lizard community. *Nature* 424: 542–545.
- Marshall, L. G., R. F. Butler, R. E. Drake, G. H. Curtis, and R. H. Tedford. 1979. Calibration of the Great American Interchange. *Science* 204: 272–279.
- Myers, C. W. 1971. A new species of green anole (Reptilia, Sauria) from the North Coast of Veraguas, Panama. *American Museum Novitates* 2470: 1–14.
- Myers, C. W., R. D. Ibañez, and J. E. Cadle. 2007. On the uniquely fragmented distribution of a rare Panamanian snake, *Dipsas nicholsi* (Colubridae: Dipsadinae). *American Museum Novitates* 3554: 1–18.
- Nicholson, K. E., R. D. Ibañez, C. A. Jaramillo, and K. R. Lips. 2001. Morphological variation in the tropical anole, *Anolis casildae* (Squamata: Polychrotidae). *Revista de Biología Tropical* 49: 709–714.
- Poe, S. 2004. Phylogeny of anoles. *Herpetological Monographs* 18: 37–89.
- Poe, S. and R. Ibañez. 2007. A new species of *Anolis* lizard from the Cordillera de Talamanca of Western Panama. *Journal of Herpetology* 41: 263–270.
- Poe, S., J. Velasco, K. Miyata, and E. E. Williams. 2009. Descriptions of two nomen nudum species of *Anolis* lizard from northwestern South America. *Breviora* 516: 1–16.
- Ryan, M. J., K. R. Lips, and J. T. Giermakowski. A new species of *Pristimantis* (Anura: Terrarana: Strabomantinae) from Coclé Province, Panama. *Journal of Herpetology*. In press.
- Savage, J. 2002. *Amphibians and Reptiles of Costa Rica - a herpetofauna between two continents, between two seas*. Chicago. University of Chicago Press. 934 pp.
- Simpson, G. G. 1950. History of the fauna of Latin America. *American Scientist* 38: 261–389.
- Simpson, G. G. 1961. *Principles of Animal Taxonomy*. New York. Columbia University Press. 247 pp.
- Wiens, J. J. and M. R. Servedio. 2000. Species delimitation in systematics: inferring diagnostic differences between species. *Proceedings of the Royal Society B: Biological Sciences* 267: 631–636.
- Wiley, E. O. 1978. The evolutionary species concept reconsidered. *Systematic Zoology* 27: 17–26.
- Williams, E. E. and W. E. Duellman. 1967. *Anolis chocorum*, a new *punctatus*-like anole from Darién, Panama (Sauria, Iguanidae). *Breviora* 256: 1–12.
- Williams, E. E., H. Rand, A. S. Rand, and R. J. O'Hara. 1995. A computer approach to the comparison and identification of species in difficult taxonomic groups. *Breviora* 502: 1–47.

Appendix I. Comparative Material Examined.

Anolis chocorum: KU 96931: Río Tuira at Río Mono, Darién, Panama; 96932-3: Cerro Quia, Darién, Panama; 113110-1: NE slope of Cerro Sapo, La Jarcia ridge, Darién, Panama. MCZ 64256: Pena Lisa, Condoto, Chocó, Colombia; 77457: Lower Río Calima, Valle, Colombia; 85246-7: Río Tuira at Río Mono, Darién, Panama; 115732: upper Río Arquia, Chocó, Colombia; 124404: Ceno Docordo, between Cururrupi and Noanama on Río San Juan, Chocó, Colombia. POE 1944: trails near Pirre Station, Darién, Panama. POE 2144: Nasugundi Road, Panama, Panama. AMNH 18235: Río Quesada, Atrato Region, Colombia; 110568: Km 12.8 on El Llano-Carti Rd, Panama, Panama.

Anolis ibanezi: EWS 045: trails in Parque Nacional General de División Omar Torrijos Herrera, 5 km North of El Cope, Coclé Province, Panama.