

A new species of glassfrog from the elfin forests of the Cordillera del Cóndor, southeastern Ecuador (Anura: Centrolenidae)

Eine neue Glasfroschart aus den Gebirgs-Nebelwäldern
der Cordillera del Cóndor, Südost-Ecuador
(Anura: Centrolenidae)

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KURZFASSUNG

Im vorliegenden Beitrag wird eine neue Glasfroschart der Gattung *Centrolene* (Amphibia: Anura: Athesphatanura: Centrolenidae) beschrieben. Sie stammt aus den Gebirgs-Nebelwäldern der Cordillera del Cóndor, einer isolierten Gebirgskette, die von der Cordillera Oriental der Anden durch das Zamora-Flußtal getrennt ist.

Die neue Art zeichnet sich durch folgende Merkmale aus: Gaumenzähne vorhanden; Schnauze in Dorsalansicht mäßig spitz, im Profil stark abfallend; Annulus tympanicus eher undeutlich; Rückenhaut körnig mit niedrigen Warzen und zahlreichen Spikeln; Kloakalgegend körnig mit mehreren wie emailliert wirkenden Warzen; erwachsene Männchen mit Oberarmdornen; Ulnar- und Metatarsalfalten wie emailliert; entlang der äußeren Tarsalkanten steht eine Reihe deutlicher, wie emailliert wirkender Tuberkel; im Leben ist der Rücken grün mit zahlreichen hellen und dunklen Punkten. Dieses Taxon ist das auffälligste aus einer Artengruppe, welche *Centrolene altitudinale*, *C. buckleyi*, *C. heloderma*, *C. hesperium*, *C. lemniscatum* und *C. venezuelense* umfaßt.

ABSTRACT

We describe a new species of glassfrog of the genus *Centrolene* (Amphibia: Anura: Athesphatanura: Centrolenidae) that inhabits the elfin forests of the Cordillera del Cóndor, an isolated mountain chain separated from the Cordillera Oriental of the Andes by the valley of the River Zamora. This new species is characterized by having vomerine teeth; a subacuminated snout in dorsal view and strongly sloping in profile; a tympanic annulus rather indistinct; shagreened dorsal skin with low warts and abundant spicules; a sublocal area granular with several enameled warts; humeral spines in adult males; enameled ulnar folds; enameled metatarsal folds; a row of distinct enameled tubercles along the outer tarsal edges; and a green dorsum in life with abundant light and dark flecks. This taxon is the most distinct of a phenetic-set of species that includes *Centrolene altitudinale*, *C. buckleyi*, *C. heloderma*, *C. hesperium*, *C. lemniscatum*, and *C. venezuelense*.

KEY WORDS

Amphibia: Anura: Centrolenidae; *Centrolene condor* sp. nov., new species; morphology, systematics, taxonomy, Cordillera del Cóndor, Ecuador

INTRODUCTION

The montane areas of Colombia and Ecuador in the northern Andes are the centre of diversity of the frog family Centrolenidae. Ecuador holds 45 described species of glassfrogs; the largest species richness is concentrated along the eastern Andes with 22 known species (LYNCH & DUELLMAN 1973; CISNEROS-HEREDIA & MCDIARMID 2006a, 2006b, 2007a, 2007b; GUAYASAMIN et al. 2006a, 2006b; CISNEROS-HEREDIA 2007; CISNEROS-HEREDIA & MEZA-RAMOS

2007). The eastern Andean region of Ecuador can be divided in two sections: (1) the Cordillera Oriental (or Cordillera Real) that corresponds to the continuous eastern mountain range of the Andes, and (2) several adjacent and rather isolated mountain chains that either diverge perpendicularly or run almost parallel to the Cordillera Oriental, e.g., Cordillera de Los Guacamayos, Cordillera del Cutucú, Cordillera del Cóndor, Contrafuerte de Tzunantza. The bio-

logical diversity of most of these adjacent mountain chains is poorly known and there are no reports of glassfrogs from the two largest and most isolated ones, Cordillera del Cutucú and Cordillera del Cóndor (DUELLMAN & LYNCH 1988; SCHULENBERG

& AWBREY 1997; CISNEROS-HEREDIA & MCDIARMID 2006a, 2007b). The first centrolenid frog from the Cordillera del Cóndor was recently discovered and is described herein as a new species, due to its conspicuous differences from all other known species.

MATERIALS AND METHODS

General characters and terminology follow definitions and proposals by CISNEROS-HEREDIA & MCDIARMID (2007b). Terminology for webbing formula follows the method of SAVAGE & HEYER (1967) as modified by SAVAGE & HEYER (1997), and summarized by GUAYASAMIN et al. (2006b) and CISNEROS-HEREDIA & MCDIARMID (2007b). Measurements were taken as described by CISNEROS-HEREDIA & MCDIARMID (2006a) and are as follow: snout-vent length (SVL), head width (HW), head length (HL), horizontal eye diameter (ED), inter-orbital distance (IOD), eye-nostril distance (EN), internarial distance (IN), hori-

zontal tympanum diameter (TD), width of disc on the third finger (3DW), tibia length (TL), and foot length (FL). Examined specimens (Appendix I) are deposited in the following collections: Museo de Zoología, Universidad Católica del Ecuador, Quito (QCAZ), División de Herpetología, Museo Ecuatoriano de Ciencias Naturales, Quito (DHMECN), Natural History Museum, The University of Kansas, Lawrence (KU); and the National Museum of Natural History, Washington, D.C. (USNM). Additional examined material was cited by CISNEROS-HEREDIA & MCDIARMID (2007b).

SPECIES DESCRIPTION

Centrolene condor sp. nov.

Holotype: QCAZ 37279 (field number MAM 032), an adult male collected at Destacamento Militar Cóndor Mirador, western slope of the Cordillera del Cóndor, (03°18'25"S, 78°23'36"W, between 1750–1850 m elevation), Provincia de Zamora-Chinchipe, República del Ecuador, on 28 April 2003 by M. A. MORALES-MITE.

Diagnosis: *Centrolene condor* is diagnosed from all other centrolenid frogs by having the following set of characters: (1) vomerine teeth present; (2) snout sub-acuminated in dorsal view and strongly sloping in profile; nostrils slightly elevated, producing a shallow depression in the internarial area; (3) tympanic annulus rather indistinct, vertical, with a slight dorsolateral orientation; tympanic membrane not differentiated from surrounding skin; (4) dorsal skin shagreened with low warts and abundant spicules; (5) ventral skin granular; subcloacal area granular with distinct cloacal

sheath and several enameled warts; (6) upper 2/3 of the parietal peritoneum covered by iridophores, pericardium white, all other peritonea clear, not covered by iridophores; (7) liver lobed; (8) humeral spines present in adult male; (9) webbing absent between fingers I and II, basal between II and III, outer fingers III 2⁺–2 IV; (10) webbing on feet I 1^{1/2}–2⁺ II 1–2⁺ III 1–2 IV 2–1 V; (11) enameled ulnar fold; enameled fringe on edge of toe V that continues into a thin enameled metatarsal fold and then into a row of distinct enameled tubercles along the outer edge of the tarsus; (12) nuptial excrescences present, type-I; concealed prepollex; (13) first finger shorter than second; (14) eye diameter larger than width of disc on finger III; (15) color in life, green dorsum with abundant yellowish-white flecks and abundant dark flecks, green bones; (16) color in preservative, dorsal surfaces greyish with a slight lavender tint, with abundant light and

dark flecks; (17) iris coloration in life cream-yellow with very fine dark reticulations, in preservative, light grey with very fine dark reticulation; (18) melanophores mostly absent from fingers and toes except for a few on the outer fingers and outer toes; (19) males call from upper side of leaves, advertisement call unrecorded; (20, 21, 22) fighting behavior, egg clutches, and tadpoles unknown; and (23) snout-vent length in male holotype 27.6 mm; females unknown.

Comparisons: *Centrolene condor* sp. nov. is similar to *C. altitudinale* (RIVERO, 1968), *C. buckleyi* (BOULENGER, 1882), *C. heloderma* (DUELLMAN, 1981), *C. hesperium* (CADLE & MCDIARMID, 1990), *C. lemnicatum* DUELLMAN & SCHULTE, 1993, and *C. venezuelense* (RIVERO, 1968) by having a sloping snout in lateral view, light labial stripe, and ulnar folds but they differ from *C. condor* by having (*C. condor* characters in parentheses): vomerine teeth absent (present); snout round in dorsal view (subacuminate), slightly sloping to sloping in profile (strongly sloping in profile); slightly less hand webbing, III ($2\frac{1}{2}$ –3[–])–($2\frac{1}{3}$ – $2\frac{2}{3}$) IV in *C. buckleyi* (hand webbing in *C. condor* III 2^+ –2 IV); green dorsum in life with or without light flecks but without dark dorsal flecks (green dorsum with light and dark flecks), lavender dorsum in preservative (greyish), and broad white lateral stripes along the flanks (lateral stripes absent). Furthermore, most of them (except *C. heloderma*) have a medium-sized, straight humeral spine with a rounded point, while *C. condor* has a curved, broad, small humeral spine with a fairly spiny, non-projecting, point; and show different conditions of the metatarsal and tarsal folds, but not a combination of metatarsal folds and tarsal tubercles as *C. condor*. On the eastern Andean slopes and Amazonian lowlands of Ecuador only *Cochranella resplendens* (LYNCH & DUELLMAN, 1973) has a sloping snout in profile, but *C. condor* differs by having humeral spines in adult males, lacking cloacal folds and flaps, and lacking abundant enameled dorsal spots. *Centrolene pipilatum* (LYNCH & DUELLMAN, 1973) has a combination of dark and light dorsal flecks, but differs by having a truncate snout in profile, lacking vomerine teeth, and a smaller body

size (19.5–23.1 mm in adult males). All other species of centrolenids from the eastern Andean slopes have rounded or truncate snouts and dorsum uniformly colored [e.g., *Centrolene durrellorum* CISNEROS-HEREDIA, 2007, *Cochranella amelie* CISNEROS-HEREDIA & MEZA-RAMOS, 2007, *Nymphargus wileyi* (GUAYASAMIN, BUSTAMANTE, ALMEIDA-REINOSO & FUNK, 2006)] or with light marks [e.g., *Centrolene audax* (LYNCH & DUELLMAN, 1973), *Nymphargus siren* (LYNCH & DUELLMAN, 1973), *Cochranella midas* (LYNCH & DUELLMAN, 1973), *Hyalinobatrachium pellucidum*], dark marks [*Centrolene mariaelenae* CISNEROS-HEREDIA & MCDIARMID, 2006, *Cochranella ametarsia* (FLORES, 1987), *Nymphargus megacheirus* (LYNCH & DUELLMAN, 1973)] or ocelli [*Nymphargus laurae* CISNEROS-HEREDIA & MCDIARMID, 2007], but not a combination of light and dark dorsal flecks.

Description of the holotype: Adult male moderate-sized, SVL = 27.6 mm (Fig. 1). Body slender, head fairly indistinct from body, slightly wider than long, and slightly wider than body; HW/HL = 1.04, HW/SVL = 0.34, HL/SVL = 0.33. Snout fairly large, subacuminate in dorsal view and sloping in profile, EN/HL = 0.24; nostrils slightly elevated producing a shallow depression in the internarial area; loreal region concave; canthus rostralis indistinct, a flat platform between the canthus rostralis; lips non-flared (Fig. 1). Eyes small, ED/HL = 0.30, directed anterolaterally at about 45° from midline, not visible from below, interorbital area much wider than eye diameter, IOD/ED = 1.93, EN/ED = 0.82, EN/IOD = 0.42. Tympanic annulus rather indistinct, vertical with a slight dorsolateral orientation; tympanic membrane not differentiated from skin around tympanum, tympanum separated from orbit by distance larger than tympanum diameter (TD/ED = 0.37; Fig. 1). Dentigerous processes of vomers present, horizontal; choanae small sized, oval, convergent, widely separated, closer to the distal margin of the vomerine teeth than to the margin of mouth; tongue elongated, almost spatulate, not indented; vocal slits paired, extending from the medial border of the tongue to the angles of the jaws.

Skin of dorsal surfaces shagreened with microgranulation, low warts spread

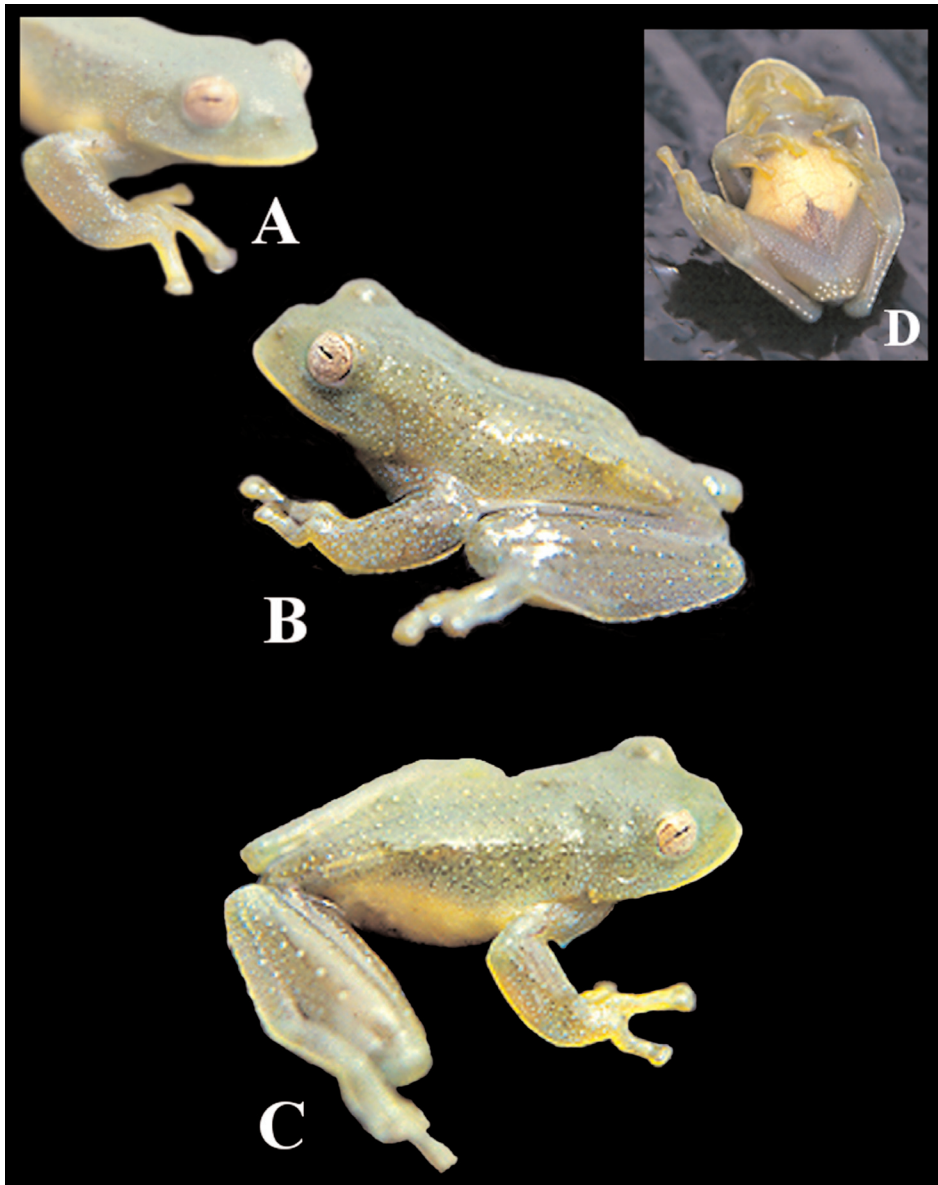


Fig. 1: Holotype of *Centrolene condor* sp. nov. (QCAZ 37279, SVL 27.6 mm) in life.

A - View of the snout and right arm, note the presence of bluish-white warts on the arm;

B and C - Right and left dorsal views, note combination of light and dark flecks, enameled ulnar folds, metatarsal folds, and tarsal tubercles;

D - Ventral view, note ulnar folds, metatarsal folds, tarsal tubercles, and subcloacal warts, all enameled.

Abb. 1: Lebendfoto des Holotyps von *Centrolene condor* sp. nov. (QCAZ 37279, Kopf-Rumpflänge: 27.6 mm).

A - Ansicht von Vorderkörper und rechtem Arm, man beachte die bläulich-weißen Warzen auf dem Arm;

B und C - Dorsalansichten von rechts und links, man beachte die Kombination heller und dunkler Flecken, der wie emailliert wirkenden Ulnarfalten, Metatarsalfalten und Tarsaltuberkel;

D - Ventralansicht, man beachte die Ulnarfalten, Metatarsalfalten, Tarsaltuberkel und Subkloakalwarzen, die allesamt wie emailliert aussehen.

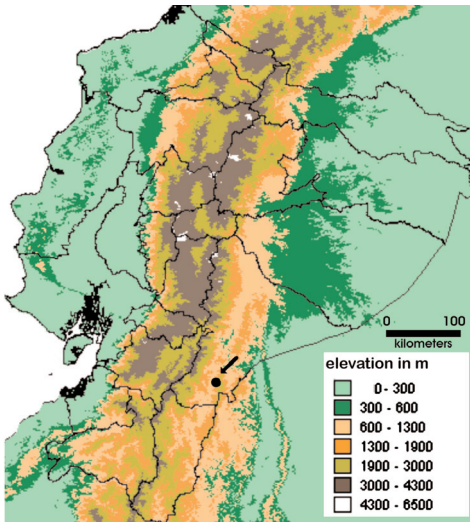


Fig. 2: Schematic map of Ecuador showing the type locality of *Centrolene condor* sp. nov. at the Cordillera del Condor (arrow). Precise locations can be visualized in Google Earth© by downloading the supporting online material available at < <http://www.cisneros-heredia.org/centrolenidae/condor/condor.kmz> >.

Fig. 2: Karte von Ecuador mit der Typuslokalität von *Centrolene condor* sp. nov. in der Cordillera del Condor (Pfeil). Fundortdetails können in Google Earth© nach Download unterstützender Informationen unter < <http://www.cisneros-heredia.org/centrolenidae/condor/condor.kmz> > betrachtet werden.

across the dorsum, larger on the dorsal surfaces of arms and legs (Fig. 1), and abundant spicules over all dorsal surfaces (probably a sexually dimorphic character); ventral surfaces granular. Cloacal opening directed posteriorly at upper level of thighs; subcloacal area granular, with distinct, but low, cloacal sheath, and several enameled warts just below the cloacal opening (Fig. 1).

Upper arm moderately robust, forearm robust, breadth of upper arm about $\frac{2}{3}$ that of forearm. Small humeral spine present (crista ventralis and spine c. 33% of the humerus), curved and broad spine with a fairly spiny, non-projecting, point. Distinct thin enameled metacarpal and ulnar folds present (Fig. 1). Relative lengths of fingers III > IV > II > I; webbing absent between fingers I and II, basal between II and III, outer fingers III 2^+ – 2^- IV; bulla absent; finger discs truncate; disc on third finger larg-

er than those on toes, and shorter than eye diameter, $3DW/ED = 0.59$; subarticular tubercles rounded, and flat, abundant supernumerary tubercles present over a granular palm; palmar tubercle large, elliptical; thenar tubercle indistinct. Concealed prepollex, nuptial excrescences type-I.

Legs slender; heels of adpressed limbs perpendicular to body slightly overlap; $TL/SVL = 0.54$, $FL/SVL = 0.47$. Thin enameled fringe on postaxial edge of toe V that continues into a thin enameled metatarsal fold and then into a row of distinct enameled tubercles on the outer tarsal edge (Fig. 1). Inner metatarsal tubercle large, flat, elliptical; outer metatarsal tubercle indistinct. Subarticular tubercles rounded and flat; supernumerary tubercles present over the granular palm. Webbing on feet I $1\frac{1}{2}$ – 2^+ II 1 – 2^+ III 1 – 2 IV 2 – 1 V; disc on toe I slightly expanded, all other discs rounded to fairly truncate, pointed projections on discs absent.

Coloration in life (Fig. 1): Dark to light viridian to bluish-green dorsum with abundant yellowish-white flecks (usually on low warts and spicules) and abundant dark bluish-black/brown flecks and punctuations. Flanks light green. Enameled (bluish-white) spots and yellowish-white flecks on the arms and legs (on low warts and spicules). Whitish-yellow labial line present. A small clutch of yellowish warts on the corner of the mouth. Thin white (enameled) ulnar fold. Thin enameled fringe on postaxial edge of toe V that continues into a thin enameled metatarsal fold along the outer edge of fifth toe that continues into a series of distinct enameled tubercles along the outer edge of the tarsus. Several enameled warts just below the cloacal opening. Green digits and disks and yellowish interdigital webbing.

Coloration in preservative: Dorsal surfaces greyish with a slight lavender tint, with abundant light flecks and abundant dark flecks. White labial line. Small clutch of enameled warts on the corner of the mouth. Thin enameled ulnar fold and thin enameled fold along the outer edge of the fifth toe that continues into a series of enameled tubercles along the outer edge of the tarsus. Enameled warts below the cloacal opening.

Measurements: Snout-vent length, 27.6 mm; head width, 9.5 mm; head length, 9.1 mm; horizontal eye diameter, 2.7 mm; inter-orbital distance, 5.2 mm; eye-nostril distance, 2.2 mm; internarial distance between the nostrils, 2.4 mm; horizontal tympanum diameter, 1.0 mm; tibia length, 14.9 mm; foot length, 12.9 mm; width of disc on the third finger, 1.6 mm.

Etymology: The name of this new species is in reference to its type locality, Cordillera del Cóndor, a mountain chain shared by Ecuador and Peru and one of the less explored areas in South America.

Distribution and natural history: Known only from its type-locality,

Cordillera del Cóndor, a mountain range that runs parallel to the Cordillera Oriental of the Andes but separated from it by the valley of the River Zamora (Fig. 2). The holotype was collected active at night calling amidst the leaves of riverine vegetation a few centimeters over water, in a mature secondary elfin forest. The species was apparently fairly abundant, judged by the high number of calls heard from the canopy along the stream, but no additional specimens could be collected.

Remarks: *Centrolene condor* corresponds to the species cited as "*Centrolene* sp. N6" by CISNEROS-HEREDIA & MCDIARMID (2006a).

DISCUSSION

Centrolene condor is the first known glassfrog from the Cordillera del Cóndor, but other species may occur in the area. No glassfrogs are known from the isolated Cordillera de Cutucú, to the north of Cordillera del Cóndor, but this could be a collection artifact and further surveys may reveal the presence of undescribed centrolenids in that area. *Centrolene condor* is phenetically similar to six species, especially by having a sloping snout in profile, light labial stripe, and ulnar folds: *Centrolene altitudinale*, *C. buckleyi*, *C. heloderma*, *C. hesperium*, *C. lemniscatum*, and *C. venezuelense* (LYNCH & DUELLMAN 1973; CADLE & MCDIARMID 1990; DUELLMAN 1981; DUELLMAN & SCHULTE 1993; SEÑARIS & AYARZAGUENA 2005; GUAYASAMIN et al. 2006b; pers. obs.). In fact, the morphological characters that separate them are subtle in most cases; with *C. condor* being the most distinctive (see diagnosis). *Centrolene altitudinale* differs from the other species by its dorsal coloration, tarsal ornamentation, and tympanic

annulus condition, and *C. heloderma* by its pustular dorsal skin and projecting humeral spine, but *C. buckleyi*, *C. hesperium*, *C. lemniscatum*, and *C. venezuelense* are practically indistinct. Important geographical barriers occur between the last four species (the Huacabamba depression for south Ecuadorian and north Peruvian populations, the Táchira depression between Venezuelan and north Colombian populations, or the Andes mountains for populations on the western and eastern slopes); these populations have the potential to represent different taxa. Calls of different populations of *C. buckleyi* and *C. venezuelense* show significant differences (BOLÍVAR et al. 1999; SEÑARIS & AYARZAGUENA 2005; GUAYASAMIN et al. 2006b; M. RADA pers. comm., J. M. GUAYASAMIN pers. comm., pers. obs.). Further studies with an integrative approach across the Andes of Venezuela, Colombia, Ecuador and Peru are needed to understand the relationships of the populations assigned to this set of species.

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RESUMEN

Describimos una nueva especie de rana de cristal del género *Centrolene* (Amphibia: Anura: Athesphatanura: Centrolenidae) que habita los bosques achaparrados de la Cordillera del Cóndor, una aislada cadena montañosa separada de la Cordillera Oriental de los Andes por el valle del Río Zamora. Esta nueva especie se caracteriza por tener dientes vomerinos; el hocico subacuminado en vista dorsal y fuertemente inclinado en perfil; el anillo timpánico indistinto; la piel dorsal rugosa con verrugas bajas y abundantes espículas; el área subcloacal granular con verrugas blanquecinas; espinas humerales en machos adultos; pliegues ulnares blanquecinos; pliegues metatarsales

blanquecinos y una fila de tubérculos blanquecinos a lo largo del borde externo del tarso y el dorso en vida verde con abundantes flecos blanco amarillentos y abundantes flecos oscuros. Este taxón es la más diferente de un conjunto fenético de especies que incluye a *Centrolene altitudinale*, *C. buckleyi*, *C. heloderma*, *C. hesperium*, *C. lemniscatum* y *C. venezuelense*.

APPENDIX 1 – Examined materials

Centrolene altitudinale (RIVERO, 1968): USNM 166841 (paratype). *C. buckleyi* (BOULENGER, 1882): DHMECN 0866–93, DHMECN 1246, USNM 286626–31, USNM 288423–4, USNM 288428, USNM 311113–14, KU 148429–30, 155481–92, 164505–16, 178030–81, 202770–83. *C. heloderma* (DUELLMAN, 1981): KU 164715 (holotype), KU 164716–19, USNM 211219–21 (paratypes), USNM 211216–8. *C. hesperium* (CADLE & MCDIARMID, 1990): PERU: USNM 292582–84 (paratypes). *C. lemniscatum* DUELLMAN & SCHULTE, 1993: KU 217300 (holotype).

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