

Natural history and intraspecific variation
of the Ecuadorian Blue Glassfrog
Cochranella mache GUAYASAMIN & BONACCORSO, 2004
(Anura: Centrolenidae)

Biologie und innerartliche Variabilität des Ekuadorianischen Blauen Glasfrosches
Cochranella mache GUAYASAMIN & BONACCORSO, 2004
(Anura: Centrolenidae)

D. F. CISNEROS-HEREDIA & J. DELIA & M. H. YÁNEZ-MUÑOZ
& H. M. ORTEGA-ANDRADE

KURZFASSUNG

Die Autoren präsentieren neue Erkenntnisse zur Biologie und innerartlichen Variabilität von *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. Die nachtaktive Art kommt entlang kleiner Bäche in Primär- und alten Sekundärwäldern der Cordillera Mache-Chindul vor, und ist ein Endemit der saisonal immergrünen Wälder West-Ecuadors. Die intraspezifische und geschlechtsdimorphe Variabilität zahlreicher Merkmale einschließlich der Textur der Rückenhaut, der Ausprägung von Hautfalten, Kloakalarmatur und Supratympanalfalte sowie der Ausdehnung der Iridophoren auf dem Leberperitoneum, wird dargestellt. Es wird über einen tiefgreifenden, für Centrolenidae einzigartigen Farbwechsel berichtet, bei dem das Farbmuster des Rückens von bläulich-grün mit einem blaßgelben Fleck auf dem Kopf und zahlreichen gelben Tupfen zu einer lavendelfarben-hellblauen Grundfarbe mit hellgelbem Kopffleck und zahlreichen orangefarbenen Punkten wechselt. Um künftigen Untersuchern hilfreiche Informationen zur Charakterisierung der Art an die Hand zu geben, werden die neuen, für *Co. mache* diagnostischen Merkmale übersichtlich aufgezählt.

ABSTRACT

We present new information on the natural history and intraspecific variation of *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. It is a nocturnal species associated with small streams across primary and old-secondary forests in the Cordillera Mache-Chindul, endemic to the Seasonal Evergreen forests of the West Ecuadorian Region. Intraspecific and sex-related variation is noted in several characters, including dorsal skin texture, expression of the dermal folds, cloacal ornamentation, expression of the supratympanic fold, and extent of iridophores on the hepatic peritoneum. Dramatic chromatic changes in life are reported, showing a unique pattern in Centrolenidae, its dorsal pattern changes from bluish-green with a dull yellow patch on the head and abundant yellow spots, to a lavender/light blue dorsum with a bright yellow patch on the head and abundant orange spots. In order to provide future researchers with useful information to characterize the species, we present a numbered diagnosis for *Co. mache* that includes all new information.

KEY WORDS

Amphibia: Anura: Centrolenidae; *Cochranella mache*; morphological variation, morphology, coloration; sexual dimorphism, systematics, biology, natural history; Ecuador

INTRODUCTION

The glassfrog *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004 was described from three male specimens collected at one locality on the eastern slope of Cordillera Mache-Chindul (= Montañas de Mache), a rather isolated mountain range in the northern portion of Cordillera de la Costa in western, coastal Ecuador (GUAYASAMIN & BONACCORSO 2004; CISNEROS-

HEREDIA & MCDIARMID 2007). *Cochranella mache* is considered a threatened species and remains poorly understood (GUAYASAMIN 2007). Recent surveys carried out in the province of Esmeraldas, Ecuador, have yielded new information on *Co. mache* including data on aspects of its natural history and intraspecific variation, which we present herein.

MATERIALS AND METHODS

Characters and terminology follow definitions and proposals by CISNEROS-HEREDIA & MCDIARMID (2007). Terminology for the webbing formula follows the method of SAVAGE & HEYER (1967) as modified by SAVAGE & HEYER (1997) and latter summarized by GUAYASAMIN et al. (2006) and CISNEROS-HEREDIA & MCDIARMID (2007). Sex was determined by direct examination of the gonads and by noting the presence of secondary sexual characters (i.e., vocal slits, nuptial pads). Internal anatomy was examined by dissection of recently euthanized specimens. The following measurements and their abbreviations are cited in the text; all were taken with electronic digital callipers (0.05 mm accuracy, rounded to the nearest 0.1 mm) as described by CISNEROS-HEREDIA & MCDIARMID (2006, 2007): 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), width of disc of

the third finger (3DW), tibia length (TL), and foot length (FL). The following abbreviations are used along the text: *Ce.* = *Centrolene*, *Co.* = *Cochranella*, *H.* = *Hyalinobatrachium*, and *N.* = *Nymphargus*. The three Glassfrog species from southeastern Brazil and northern Argentina were excluded from *Hyalinobatrachium* by CISNEROS-HEREDIA & MCDIARMID (2007) and left as *incertae sedis*. They are listed here as "*Hyalinobatrachium*" *eurygnathum* (LUTZ, 1925), "*Hyalinobatrachium*" *parvulum* (BOULENGER, 1895), and "*Hyalinobatrachium*" *uranoscopum* (MÜLLER, 1924) to denote that they are not formally attached to any genus within Centrolenidae. Institutional abbreviations used are as follows: DHMECN — División de Herpetología, Sección Vertebrados, Museo Ecuatoriano de Ciencias Naturales, Quito; DFCH-USFQ — Universidad San Francisco de Quito, Quito. Classification of vegetation formations in Ecuador follows SIERRA (1999) as modified by CISNEROS-HEREDIA (2006; 2007).

RESULTS

Expeditions to three localities in the Province of Esmeraldas, Ecuador, found one specimen of *Cochranella mache* each: DHMECN 2611, an adult male collected at night while perched on a herbaceous plant about 1.6 m above a small stream at Monte Saino, Punta Galeras region (00°42'N, 80°01'W, 100 m elevation), on 21 October 2004; DFCH-USFQ LQ23, an adult male found at night perched on a low broadleaf shrub about 1 m above a small stream in old secondary forest about 3 km NW from the town of Quininde (00°21'N, 79°29'W, about 150 m elevation), on 23 March 2005; and, DHMECN 3560, an adult female encountered at night perched on broadleaf herbaceous vegetation (0.87 m above forest floor) about 2.30 m from the edge of a small stream (depth 0.11 m; width 0.89 m) in old secondary forest at the Reserva Biológica Canandé (00°26'N, 79°08'W; c. 270 m elevation), on 24 June 2005. The specimen (DHMECN 3560) collected at

Canandé is the first known female of the species. It had unpigmented eggs and was collected at the end of the local dry season. No reproductive activity (calls, territorial males, or females with eggs) was observed for any other centrolenid at the site at that time. When found, the female was using its hind leg to kick an approaching cockroach. *Cochranella mache* was sympatric with *Centrolene prosoblepon* (BOETTGER, 1892), *Ce. ilex* (SAVAGE, 1967), *Co. albomaculata* (TAYLOR, 1949), and an undescribed species of *Cochranella* at Canandé; with *Ce. prosoblepon*, *Co. pulverata* (PETERS, 1873), and *Hyalinobatrachium fleischmanni* (BOETTGER, 1893) at Monte Saino; and with *Ce. prosoblepon*, *Ce. litorale* RUIZ-CARRANZA & LYNCH, 1996, *Co. albomaculata*, and *H. fleischmanni* at the surroundings of Quininde. At its type-locality, Bilsa, *Co. mache* was sympatric with *Ce. prosoblepon*, *Co. albomaculata*, and *H. fleischmanni*.

Table 1: Variation of measurements (in mm) of one female and two male specimens of *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. For abbreviations see 'Materials and Methods'.

Tab. 1: Morphologische Meßwerte (in mm) bei einem Weibchen und zwei Männchen von *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. Abkürzungen siehe 'Materials and Methods'.

Parameter	DHMECN 3560 Female / Weibchen	DHMECN 2611 Male / Männchen	DFCH-USFQ LQ23 Male / Männchen
SVL	28.0	22.0	23.5
HW	8.4	7.5	7.6
HL	8.4	7.6	7.7
ED	2.7	2.7	2.6
IOD	3.8	3.4	3.5
EN	2.7	2.1	2.3
IN	2.6	1.7	1.6
3DW	0.9	0.9	0.9
TL	16.3	13.8	14.1
FL	13.6	11.2	11.6

The original description of *Cochranella mache* (based solely on males, GUAYASAMIN & BONACCORSO 2004) is adequate, thus we will not repeat general details about the species' morphology. Instead, we provide information on characteristics of the first female specimen known, additional variation observed, and morphometric and chromatic accounts. The adult female is similar to males in most characters of their general morphology. The main differences include (male characters in parentheses): (1) dorsal skin shagreen and with warts but without spicules (dorsal skin shagreen, usually with numerous minute spicules and warts with protruding spicules); (2) ventrolateral edges of fingers IV, forearms, elbows, toe V, tarsi, and heels with low dermal folds with flat, white [= enameled]

tubercles, but sometimes becoming so inconspicuous that just the tubercles are apparent (dermal folds present, conspicuous, with large white tubercles on ventrolateral edges of finger IV, forearms, elbows, toe V, tarsi, and heels); (3) cloacal opening bordered laterally by low, fleshy, tuberculated horizontal flaps but not n-shaped; flat, large, fleshy cloacal enameled tubercles located posterior to cloacal slit and towards the vent (cloacal opening bordered laterally by fleshy tuberculated n-shaped fold; cloacal tubercles small, fleshy, located immediately posterior to cloacal slit); and (4) white coloration restricted to the points of finger I and II, points of toes I and II, but also on the margins of webbing between fingers and toes (entire fingers I and II and toes I and II white, and no white on webbing). Sexual

Table 2: Variation of proportions of one adult female and two male specimens of *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. For abbreviations see 'Materials and Methods'.

Tab. 2: Körperproportionen bei einem Weibchen und zwei Männchen von *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. Abkürzungen siehe 'Materials and Methods'.

Proportion	DHMECN 3560 Female / Weibchen	DHMECN 2611 Male / Männchen	DFCH-USFQ LQ23 Male / Männchen
HW/HL	1.00	0.99	0.99
HW/SVL	0.30	0.34	0.32
HL/SVL	0.30	0.34	0.33
EN/HL	0.32	0.28	0.30
ED/HL	0.32	0.35	0.34
IOD/ED	1.39	1.28	1.35
EN/ED	1.00	0.79	0.88
EN/IOD	0.72	0.62	0.66
3DW/ED	0.31	0.32	0.35
TL/SVL	0.58	0.63	0.60
FL/SVL	0.48	0.51	0.49



Fig. 1: Alive female *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004 (DHMECN 3560) showing a blue dorsum with a yellow patch on the head and abundant small orange spots. Photographed by Jesse DELIA.
 Abb. 1: Im Leben zeigt das Weibchen von *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004 (DHMECN 3560) einen blauen Rücken mit einem gelben Fleck auf dem Kopf und zahlreiche kleine orangefarbene Flecken. Photo: Jesse DELIA.

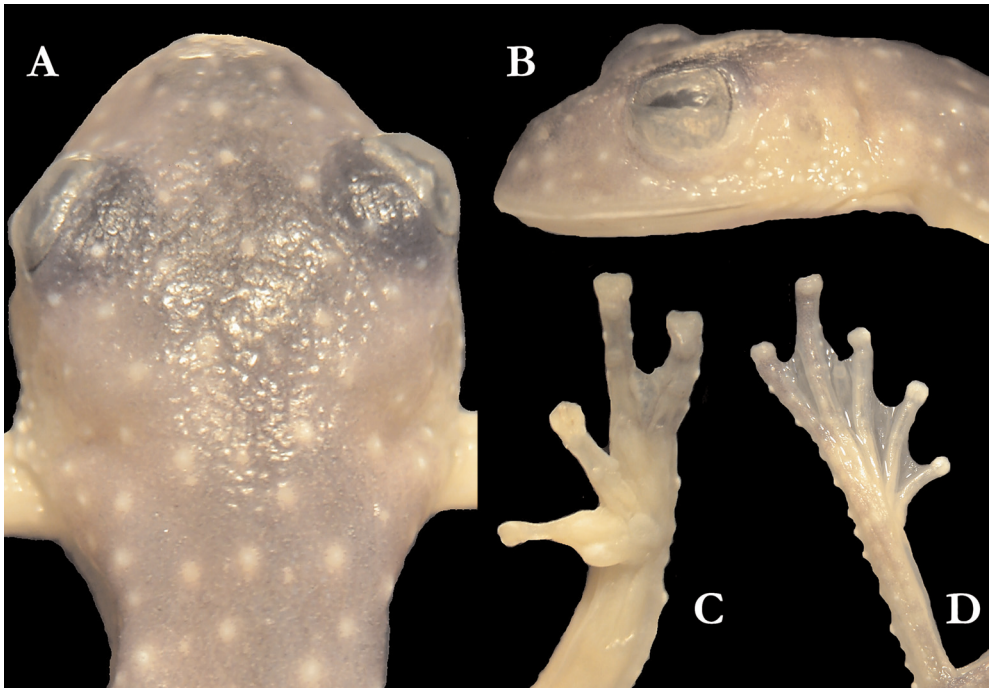


Fig. 2: Preserved male *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004 (DHMECN 2611, SVL: 22.0 mm). A - dorsal view of the head, B - lateral view of the head, C - palmar view of the hand, D - dorsal view of the foot.

Abb. 2: Konserviertes Männchen von *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004 (DHMECN 2611, Kopf-Rumpflänge: 22,0 mm). A - Kopf von dorsal, B - Kopf von lateral, C - Hand von palmar, D - Fuß von dorsal.

dimorphism in size is evident, being that the female is larger than known males. No other relevant morphometric differences in gross measurements or proportions were found among males and female but the small sample size prevents conclusive assessment (Tables 1 and 2).

A low supratympanic fold, obscuring the posterodorsal portion of the tympanic annulus, was reported in the type series. Intraspecific variation on this character is noted as some specimens lacked the supratympanic fold in life, and the entire perimeters of their tympanic annuli were apparent. There is variation on the relationship between the first and second fingers, both can be of approximately the same length (as reported in the original description) or finger I slightly longer than finger II. All examined specimens of *Co. mache* have iridophores covering the parietal peritoneum,

pericardium, and the peritonea covering the esophagus, stomach, intestines, and gonads, as reported originally. However, two specimens (DHMECN 3560 and DFCH-USFQ LQ23) show iridophores forming isolated small patches on the ventral and lateral surfaces of the hepatic peritoneum (not covering the entire liver as in *H. fleischmanni*). The type-series and specimen DHMECN 2611 lack iridophores over the hepatic peritonea (pers. obs., GUAYASAMIN & BONACCORSO 2004). In addition, two specimens have the renal capsules covered by iridophores (DHMECN 2611 and DHMECN 3560).

Continuous observations on specimen DHMECN 3560 while alive revealed that *Cochranella mache* performs profound chromatic changes. Originally, *Co. mache* was described as having a green dorsum (better described as bluish-green

by analyzing the photos of the holotype available at AmphibiaWeb) with small yellow spots, upper lip with thin white margin, throat and ventral surfaces of limbs bluish-green, iris white with fine black reticulation, and a narrow golden ring around pupil. When collected, DHMECN 3560 showed a similar coloration to the original description. A particular feature became apparent, the presence of a large dull yellow-colored patch on the top of the head. This patch is also observed on the photograph of the holotype of *Co. mache*,

but it was not mentioned in the original description. After been taken to the laboratory for analysis, the background coloration of the individual turned completely light blue (slightly lavender towards the sides), the patch on the head bright yellow, the iris light lavender with dark lavender reticulations and the pupillary ring became less evident by turning white with a blue hue (Figure 1). The dorsal spots varied from ochre yellow to bright orange, always becoming brighter towards the head.

DISCUSSION

Cochranella mache is a nocturnal species associated with small streams across primary and old-secondary forests in the Cordillera Mache-Chindul, endemic to the Seasonal Evergreen Forest of the West Ecuadorian Region. Although just one female specimen is currently available, some preliminary tendencies about the sexual dimorphism in the species are observed. *Cochranella mache* shows the same SVL dimorphism present in most glassfrogs, with females larger than males (the only known exception in the family is *Centrolene geckoideum* JIMÉNEZ DE LA ESPADA, 1872). The presence of spicules on the skin of breeding males, but absent in females, is also a widespread condition in centrolenids, and many other frogs (e.g., *Osteocephalus*). Variation in the expression of dermal folds and cloacal ornaments has been reported in several species of centrolenids, not necessarily related to sexual dimorphism (e.g., HEYER 1978, 1985). It is worthwhile to mention that the intraspecific variation herein reported for *Co. mache* is parallel to the differences used to distinguish *Cochranella phryxa* AGUAYO & HARVEY, 2006 from *Cochranella resplendens* (LYNCH & DUELLMAN, 1973) by AGUAYO & HARVEY (2006), suggesting that in fact, *Co. phryxa* could be a synonym of *Co. resplendens* (CISNEROS-HEREDIA & MCDIARMID 2007).

The presence of iridophores on the hepatic peritoneum was a condition conceived by RUÍZ-CARRANZA & LYNCH (1991) as restricted only to the genus *Hyalinobatrachium*. However, further research has

showed that it is a widespread condition in most genera currently recognized in the family Centrolenidae (absent in *Nymphargus*), and even across Hyliid genera (NOONAN & HARVEY 2000; DUELLMAN & SEÑARIS 2003; CISNEROS-HEREDIA & MCDIARMID 2006). Apart from species of the genus *Hyalinobatrachium* (*sensu* CISNEROS-HEREDIA & MCDIARMID 2007), twelve centrolenid species have iridophores on the hepatic peritoneum: *Centrolene gorzulai* (AYARZAGÜENA, 1992), *Ce. lema* DUELLMAN & SEÑARIS, 2003, *Ce. mariaelenae* CISNEROS-HEREDIA & MCDIARMID, 2006, *Ce. papillahallicum* NOONAN & HARVEY, 2000, *Cochranella antisthenesi* (GOIN, 1963), *Co. amelie* CISNEROS-HEREDIA & MEZA-RAMOS, 2007, *Co. castroviejo* AYARZAGÜENA & SEÑARIS, 1997, *Co. helenae* (AYARZAGÜENA, 1992), *Co. pulverata* (PETERS, 1873), "*Hyalinobatrachium*" *parvulum*, "*Hyalinobatrachium*" *eurygnathum*, "*Hyalinobatrachium*" *uranoscopum* (RUÍZ-CARRANZA & LYNCH 1991; NOONAN & HARVEY 2000; DUELLMAN & SEÑARIS 2003; SEÑARIS & AYARZAGÜENA 2005; CISNEROS-HEREDIA & MCDIARMID 2006, 2007; CISNEROS-HEREDIA & MEZA-RAMOS 2007). However, all these taxa have iridophores covering the entire surface of the hepatic peritoneum; while the two specimens of *Co. mache* herein reported just have isolated patches — a condition previously reported only in *Co. phryxa* (AGUAYO & HARVEY 2006). The presence of iridophores on the hepatic peritonea of *Co. mache* is subjected to intraspecific variation, and apparently, not equivalent to the

complete liver coverage present in the twelve species previously listed.

Cochranella mache was originally described as having a green dorsal coloration in life (GUAYASAMIN & BONACCORSO 2004); a feature shared with most glassfrogs, which usually show different shades of green in their background coloration (CISNEROS-HEREDIA & MCDIARMID 2007). Although a few centrolenid species have been described as having different colours, usually shades of brown, e.g., *Nymphargus anomalus* (LYNCH & DUELLMAN, 1973) and *N. rosada* (RUIZ-CARRANZA & LYNCH, 1997), and *Cochranella granulosa* (TAYLOR, 1949) shows a bluish-green background dorsal color; a deep blue glassfrog has not been reported before (CISNEROS-HEREDIA & MCDIARMID 2007). While searching images of centrolenids on the internet, we found a photograph of *Cochranella euknemos* (SAVAGE & STARRETT, 1967) showing a completely blue dorsal background (GARDNER 2007). *Cochranella mache* has been hypothesized to be closely related to *Cochranella granulosa* (member of the former “*Co. granulosa* species-group”; RUIZ-CARRANZA & LYNCH 1991; GUAYASAMIN & BONACCORSO 2004; CISNEROS-HEREDIA & MCDIARMID 2007). Although that former group is not monophyletic (as suggested by the different reproductive patterns of some of its members, CISNEROS-HEREDIA & MCDIARMID 2007), we agree that *Co. mache* is related to *Co. granulosa* and *Co. euknemos*, and probably the sister-species of the last one. All three species share an apparently similar chromatophore organization that gives them a bluish-green to blue dorsal coloration (KUBICKI 2007, this work). Further, *Co. mache* and *Co. euknemos* show three unique characters (synapomorphies) that support our conclusion: the presence of a yellow-colored patch on the top of the head, the presence of iridophores on the fingers and toes, usually in the points (see photos of *Co. euknemos* presented by KUBICKI 2007), and the capacity of changing their dorsal background coloration from bluish-green to deep blue.

The original description of *Co. mache* compared it only with other members of the former “*Co. granulosa* species group”. During the herpetological surveys where *Co. mache* was collected, some specimens

of *Co. pulverata* were also found (see BUS-TAMANTE et al. 2007). Both species may be confused, particularly in preservative, thus we provide some diagnostic characters to differentiate between them. *Cochranella pulverata* differs from *Co. mache* by having the parietal peritoneum entirely clear (without iridophores), while the hepatic peritoneum is completely white (covered by iridophores); the dorsal spots are white in life (never yellow or orange), and more abundant and smaller than those present in *Co. mache*; the webbing of *Co. pulverata* between finger II and III is slightly more extended; its enameled cloacal ornamentation does not show a n-shaped or horizontal flap, and the cloacal folds are low and not fleshy; males of *Co. pulverata* have low dermal folds on the ventrolateral edges of fingers IV, forearms, elbows, toe V, tarsi, and heels, less pronounced than those in the males of *Co. mache*. The dorsal coloration of *Co. pulverata* is green in life (without any bluish tint and without a yellow head patch) and turns light lavender-cream after a short time in preservative. While *Co. pulverata* is externally similar to some species currently considered as related to *Co. granulosa* (especially by its snout that is gradually inclined in lateral aspect), it clearly differs by the iridophores conditions on its peritonea. *Cochranella pulveratum* was placed together with *Co. antisthenesi* in the former “*H. pulveratum* species-group” by RUIZ-CARRANZA & LYNCH (1991), but both species do not seem to be closely related to each other or to *Hyalinobatrachium* (CISNEROS-HEREDIA & MCDIARMID 2006; 2007).

In order to provide taxonomists with data useful in characterizing *Co. mache*, a numbered diagnosis is provided including new information reported in this paper: (1) vomerine teeth present; (2) snout subacuminate in dorsal view, and gradually sloping in lateral view (Figure 2); (3) tympanic annulus evident, oriented dorsolaterally with slight dorsal inclination; and supratympanic fold weak or absent; (4) dorsal skin shagreen with warts — usually corresponding to light spots; males (in reproductive condition) with numerous minute spinules and protruding spicules on the warts, females without spinules or spicules; (5) ventral skin granular; several round, flat or large enam-

eled warts tubercles on ventral surfaces of thighs below vent, and around the cloacal opening; and fleshy, tuberculated, enameled cloacal fold present, large and n-shaped fold in males but low and horizontal flaps in females; (6) anterior 1/3 of parietal peritoneum covered by iridophores (white); iridophores over pericardium and visceral peritonea (digestive tract, and gonads); hepatic peritoneum clear or with small, isolated patches of iridophores; and renal capsules covered by iridophores in some specimens; (7) liver tetralobed; (8) humeral spine absent in adult males; (9) webbing on hand, absent between fingers I and II, II (1⁻–1⁺)–(3⁻–3⁺) III (2⁻–2⁺)–(1–1⁺) IV (Figure 2); (10) webbing on foot, I (1–1⁻)–(2–2⁻) II (1–1⁻)–2 III (1–1⁻)–2⁻ IV (2–2⁻)–(1–1⁻) V (Figure 2); (11) ventrolateral edges of fingers IV, forearms, elbows, toe V, tarsi, and heels with dermal enameled folds and tubercles; conspicuous folds and large tubercles in males (Figure 2); and low or inconspicuous folds and low tubercles in females; (12) large nuptial pad Type I, concealed prepollex; (13) first finger slightly longer or about the same length of second finger; (14)

eye diameter larger than width of disc on finger III; (15) color in life, dark olive-green to blue-lavender or light blue dorsum with numerous small yellow to orange spots, large dull to bright yellow patch on top of head; fingers I and II and toes I and II entirely (males) or partially (females) white; and webbing on hands and feet white in females; (16) color in preservative, dorsal surfaces pale lavender with small white or cream spots; tubercles on dermal folds of limbs, fingers, and toes cream-white; inner fingers and toes white or unpigmented (Figure 2); (17) iris white to pale lavender with fine black to dark lavender reticulations; and a narrow golden ring apparent in some specimens; (18) melanophores present along the entire dorsal surfaces of fingers and toes except for areas covered by iridophores on inner fingers and toes; (19) males called from upper side of leaves over streams; (20, 21, 22, 23) advertisement call, fighting behavior, egg clutches, and tadpoles unknown; and (24) snout-vent length in adult males 22.0–24.0 mm (n = 5); in adult female 28.00 mm (n = 1).

ACKNOWLEDGMENTS

JD is thankful to Carl TOMOFF for mentoring his senior thesis, to Fundación Jocotoco for supplying room and board at Canandé, and to the Prescott College Student Union for funding materials at Canandé. MYM is thankful to Marco ALTAMIRANO, director of the Museo Ecuatoriano de Ciencias Natural, and to Fundación Jocotoco for their constant support. MOA is grateful to Carlos AULESTIA and Julieta BERMINGHAM from Bilsa Biological Station, and Mario LARREA, manager of Reserva Monte Saino, for providing access to fieldwork facilities, and to Antonio ORTIZ, Cecilia TOBAR, Mónica ARELLANO, Fernanda ARMAS, Raúl CABRERA, and Fabricio NARVÁEZ for their support. DFCH is grateful to María Elena HEREDIA, Laura HEREDIA, and

Roy W. MCDIARMID for their continuous support. We are grateful to Juan Manuel GUAYASAMIN and Greg VIGLE for useful comments and information. This study was supported by the Museo Ecuatoriano de Ciencias Naturales, the Iniciativa de Especies Amenazadas (managed by EcoCiencia, Conservation International, and the Netherlands Royal Embassy, grants to MOA and DFCH), and the Russel E. Train Education for Nature Program, WWF (grant to DFCH), for their support. Research and collecting permits N° 018 -IC-FAU-DNBAP/MA (2003-2004) and N° 010 -IC-FAU-DNBAP/MA (2005-2006) were provided by Ministerio del Ambiente del Ecuador, granted to the Museo Ecuatoriano de Ciencias Naturales.

REFERENCES

- AGUAYO, R. & HARVEY, M. B. (2006): A new glassfrog of the *Cochranella granulosa* group (Anura: Centrolenidae) from a Bolivian cloud forest.– *Herpetologica*, Austin; 62 (3): 323–330.
- AYARZAGÜENA, J. (1992): Los Centrolenidos de la Guayana Venezolana.– *Publicaciones de la Asociación de Amigos de Doñana*, Sevilla; 1: 1–48.
- AYARZAGÜENA, J. & SEÑARIS, J. C. (1997 “1996”): Dos nuevas especies de *Cochranella* (Anura; Centrolenidae) para Venezuela.– *Publicaciones de la Asociación de Amigos de Doñana*, Sevilla; 8: 1–16.
- BOETTGER, O. (1892): Katalog der Batrachier-Sammlung im Museum der Naturforschenden Gesellschaft in Frankfurt a. M. Frankfurt a. M. (Knauer), pp. 73.
- BOETTGER, O. (1893) Ein neuer Laubfrosch aus Costa Rica.– *Berichte der Senckenbergischen naturforschenden Gesellschaft*, Frankfurt am Main; 1893: 251–252.
- BOULENGER, G. A. (1895 “1894”): Third report on additions to the batrachian collection in the Natural History Museum.– *Proceedings of the Zoological Society of London*, London; 1894: 640–646.

- BUSTAMANTE, M. R. & CISNEROS-HEREDIA, D. F. & YÁNEZ-MUÑOZ, M. H. & ORTEGA-ANDRADE, H. M. & GUAYASAMIN, J. M. (2007): Amphibia, Centrolenidae, *Cochranella pulverata*, *Hyalinobatrachium aureoguttatum*: Distribution extension, Ecuador. Check List, São Paulo; 3 (3): 271-276.
- CISNEROS-HEREDIA, D. F. (2006): Distribution and ecology of the western Ecuador frog *Leptodactylus labrosus* (Amphibia: Anura: Leptodactylidae).— Zoological Research, Kunming; 27 (3): 225–234.
- CISNEROS-HEREDIA, D. F. (2007): Distribution and natural history of the Ecuadorian snake *Dipsos andiana* (BOULENGER, 1896) (Colubridae: Dipsadinae) with considerations on its conservation status.— Russian Journal of Herpetology, St. Petersburg; 14 (3): 199-202.
- CISNEROS-HEREDIA, D. F. & McDIARMID, R. W. (2006): A new species of the genus *Centrolene* (Amphibia: Anura: Centrolenidae) from Ecuador with comments on the taxonomy and biogeography of Glassfrogs.— Zootaxa, Auckland; 1244: 1–32.
- CISNEROS-HEREDIA, D. F. & McDIARMID, R. W. (2007): Revision of the characters of Centrolenidae (Amphibia: Anura: Athesphatanura), with comments on its taxonomy and the description of new taxa of glassfrogs.— Zootaxa, Auckland; 1572: 1–82.
- CISNEROS-HEREDIA, D. F. & MEZA-RAMOS, P. (2007): An enigmatic new species of Glassfrog (Amphibia: Anura: Centrolenidae) from the Amazonian Andean slopes of Ecuador.— Zootaxa, Auckland; 1485: 33–41.
- DUPELLMAN, W. E. & SEÑARIS, J. C. (2003): A new species of glass frog (Anura: Centrolenidae) from the Venezuelan Guayana.— Herpetologica, Austin; 59 (2): 247–252.
- GARDNER, C. (2007) Glass frog photography website. [online]. < <http://www.glassfrogphoto.com/> >. [Last accessed on December 2007].
- GOIN, C. J. (1963): A new centrolenid frog from Venezuela.— Acta Biologica Venezuelica, Caracas; 3 (18): 283–286.
- GUAYASAMIN, J. M. (2007): *Cochranella mache*. 2007 IUCN Red List of Threatened Species. [Online]. Cambridge (IUCN Species Survival Commission). < <http://www.iucnredlist.org> >. [Last accessed on 14 October 2007].
- GUAYASAMIN, J. M. & BONNACORSO, E. (2004): A new species of glass frog (Centrolenidae: *Cochranella*) from the lowlands of northwestern Ecuador, with comments on the *Cochranella granulosa* group.— Herpetologica, Austin; 60 (4): 485–494.
- GUAYASAMIN, J. M. & BUSTAMANTE, M. R. & ALMEIDA-REINOSO, D. & FUNK, W. C. (2006): Glass frogs (Centrolenidae) of Yanayacu Biological Station, Ecuador, with the description of a new species and comments on centrolenid systematics.— Zoological Journal of the Linnean Society, London; 147: 489–513.
- HEYER, W. R. (1978): Variation in members of the *Centrolenella eurygnatha* complex (Amphibia: Centrolenidae) from Serra do Mar and Serra da Mantiqueira, Brasil.— Papéis Avulsos de Zoologia, São Paulo; 32 (2): 15–33.
- HEYER, W. R. (1985): Taxonomic and natural history notes on frogs of the genus *Centrolenella* (Amphibia: Centrolenidae) from southeastern Brasil and adjacent Argentina.— Papéis Avulsos de Zoologia, São Paulo; 36 (1): 1–21.
- JIMÉNEZ DE LA ESPADA, M. (1872): Nuevos batracios americanos.— Anales de la Sociedad Española de Historia Natural, Madrid; 1: 85–88.
- KUBICKI, B. (2007): Ranas de vidrio de Costa Rica / Glass frogs of Costa Rica. Santo Domingo de Heredia (Editorial INBio), pp. 304.
- LUTZ, B. (1925): Batraciens du Brésil. Comptes Rendus des Séances de la Société de Biologie et de Ses Filiales, Paris; 93: 137–139, 211–214.
- LYNCH, J. D. & DUELLMAN, W. E. (1973): A review of the Centrolenid frogs of Ecuador, with descriptions of new species. Occasional Papers, University of Kansas Museum of Natural History, Lawrence; 16: 1–66.
- MÜLLER, L. (1924): Neue Laubfrösche aus dem Staate Santa Catharina, S. O. Brasilien.— Zoologischer Anzeiger, Jena; 59: 233–238.
- NOONAN, B. P. & HARVEY, M. B. (2000): A new species of glassfrog (Anura: Centrolenidae) from the highlands of Guyana.— Herpetologica, Austin; 56 (3): 294–302.
- PETERS, W. C. H. (1873): Über eine neue Schildkrötenart, *Cinosternon Effeldtii* und einige andere neue oder weniger bekannte Amphibien.— Monatsberichte der Königlich preussischen Akademie der Wissenschaften, Berlin; 1873: 603–618.
- RUIZ-CARRANZA, P. M. & LYNCH, J. D. (1991): Ranas Centrolenidae de Colombia I. Propuesta de una nueva clasificación genérica.— Lozania, Bogotá; 57: 1–30.
- RUIZ-CARRANZA, P. M. & LYNCH, J. D. (1996): Ranas Centrolenidae de Colombia IX. Dos nuevas especies del suroeste de Colombia. Lozania, Bogotá; 68: 1–11.
- RUIZ-CARRANZA, P. M. & LYNCH, J. D. (1997): Ranas Centrolenidae de Colombia X. Los centrolenidos de un perfil del flanco oriental de la Cordillera Central en el Departamento de Caldas.— Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales, Bogotá; 21 (81): 541–553.
- SAVAGE, J. M. (1967): A New Tree-Frog (Centrolenidae) from Costa Rica. Copeia, Lawrence; 1967 (2): 325–331.
- SAVAGE, J. M. & HEYER, W. R. (1967): Variation and distribution in the tree-frog genus *Phyllomedusa* in Costa Rica, Central America.— Beitrage zur Neotropischen Fauna, Stuttgart, Jena; 5: 111-131.
- SAVAGE, J. M. & HEYER, W. R. (1997): Digital webbing formulae for anurans: a refinement.— Herpetological Review, New Haven; 28: 131.
- SAVAGE, J. M. & STARRETT, P. H. (1967): A new fringe-limbed tree-frog (family Centrolenidae) from lower Central America.— Copeia, Lawrence; 1967 (3): 604–609.
- SEÑARIS, J. C. & AYARZAGÜENA, J. (2005): Revisión taxonómica de la Familia Centrolenidae (Amphibia; Anura) de Venezuela. Sevilla (Publicaciones del Comité Español del Programa Hombre y Biosfera – Red IberoMaB de la UNESCO), pp. 337.
- SIERRA, R. (1999): Propuesta preliminar de un sistema de clasificación de vegetación para el Ecuador Continental. Quito (Proyecto INEFAN/GEF-BIRF EcoCiencia), pp. 194.
- TAYLOR, E. H. (1949): Costa Rican frogs of the genera *Centrolene* and *Centrolenella*.— University of Kansas Science Bulletin, Lawrence; 33: 257–270.

RESUMEN

Presentamos nueva información sobre la historia natural y variación intraespecífica de *Cochranella mache* GUAYASAMIN & BONACCORSO, 2004. Esta es una especie nocturna que vive asociada a riachuelos pequeños en bosques primarios y secundarios en la Cordillera Mache-Chindul, siendo una especie endémica a los Bosques Siempreverdes Estacionales de la región biogeográfica del Oeste Ecuatoriano. La variación intraespecífica y dimórfica es observada en varios caracteres, incluyendo la textura de la piel dorsal, la expresión de los pliegues dérmicos, la ornamentación cloacal, la expresión del pliegue supratimpánico y la extensión de los iridóforos en el peritoneo hepático. Cambios cromáticos dramáticos en vida son reportados, mostrando un patrón único en Centrolenidae, su patrón dorsal cambia de verde azulado con un parche amarillo pálido en la cabeza y abundantes puntos amarillo, hacia un dorso lavanda/celeste con un parche amarillo brillante en la cabeza y abundantes puntos naranja. Con el objetivo de proveer a futuros investigadores con datos útiles para caracterizar la especie, presentamos una diagnosis numerada para *Co. mache*, incluyendo toda la nueva información.

DATE OF SUBMISSION: December 11, 2007

Corresponding editor: Heinz Grillitsch

AUTHORS: Diego F. CISNEROS-HEREDIA, King's College London, Department of Geography, Strand, London WC2R 2LS, UK, <diegofrancisco_cisneros@yahoo.com> or <diegofrancisco.cisneros@gmail.com>; and Museo Ecuatoriano de Ciencias Naturales, División de Herpetología, Quito, Ecuador; Jesse DELIA, Prescott College, Department of Ecological Research, Prescott, Arizona 86301, USA; Mario H. YÁNEZ-MUÑOZ & H. Mauricio ORTEGA-ANDRADE, Museo Ecuatoriano de Ciencias Naturales, División de Herpetología, calle Rumipamba 341 y Av. de Los Shyris, Quito, Ecuador