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A NEW SPECIES OF GLASSFROG (ANURA: CENTROLENIDAE) FROM THE FOOTHILL ANDEAN FORESTS OF ECUADOR AND PERU

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ABSTRACT: We describe a new species of glassfrog assigned to the genus *Cochranella* (Amphibia: Anura: Athesphatanura: Centrolenidae) from the Foothill Evergreen forests on the southeastern Andean slopes of Ecuador and northeastern Andean slopes of Peru. The new species is characterized by its moderate-sized body (25.4–26.9 mm in adult males), medium-sized eyes (eye diameter/third disc width = 1.4–1.9), distinctive coloration in life (olive green with light spots) and in preservative (grayish lavender with pale spots), dorsal skin covered with flat warts and low tubercles, parietal peritoneum mostly white (covered by iridophores), thick ulnar folds, and extensive hand and foot webbing. In addition, we provide the first record of *Nymphargus posadae* from Peru, found in sympatry with the new species at the Cordillera del Cóndor.

RESUMEN: Describimos una nueva especie de rana de cristal asignada al género *Cochranella* (Amphibia: Anura: Athesphatanura: Centrolenidae) de los bosques Siempreverdes Piemontanos de la vertiente Andina suroriental de Ecuador y nororiental de Peru. La nueva especie se caracteriza por su tamaño corporal moderado, ojo de tamaño medio, coloración distintiva en vida (verde oliva con puntos amarillos) y en preservado (grisácea lavanda con puntos pálidos), piel dorsal cubierta con verrugas y tubérculos, peritoneo parietal completamente o casi completamente blanco, pliegue ulnar grueso y extensa palmeadura en las patas anteriores y posteriores. Adicionalmente, proporcionamos el primer registro de *Nymphargus posadae* para Perú, encontrada en simpatría con la nueva especie en la Cordillera del Cóndor.

Key words: Amphibia; Centrolenidae; *Cochranella mcdiarmidi* new species; Contrafuerte de Tzunatza; Cordillera del Cóndor; Cordillera Oriental; Ecuador; *Nymphargus posadae*; Peru

RECENT accounts on the centrolenid frogs from South America show that they are widely distributed along the Andean slopes of Venezuela, Colombia, Ecuador, Peru, and Bolivia (Acosta-Galvis, 2000; Aguayo and Harvey, 2006; Cisneros-Heredia and McDiarmid, 2006*a*; 2007; Duellman and Schulte, 1993; Frost, 2007; Guayasamin et al., 2006; Rodríguez et al., 1993; Ruiz-Carranza and Lynch, 1997; Señaris and Ayarzagüena, 2005; Torres-Gastello et al., 2007). A notable gap in our knowledge of the diversity of glassfrogs occurs in southeastern Ecuador and northeastern Peru. Just eight described species have been reported from the southeastern Andean slopes of Ecuador, while at least 18 species occur in the northeastern region (Cisneros-Heredia, 2007; Cisneros-Heredia and McDiarmid, 2005, 2006*a*,*b*, 2007; Cisneros-Heredia and Meza-Ramos, 2007; Guayasamin et al., 2006). The southeastern Andean slopes of Ecuador, as herein defined, are politically divided among the provinces of Morona-Santiago, Zamora-Chinchipe, and Loja. The first glassfrog reported from this region was *Centrolene buckleyi* from Zamora-Chinchipe (Lynch and Duellman, 1973). Twenty-one years later, Wild (1994) described *Centrolene bacatum* and *Nymphargus cariticommatus* from Morona-Santiago. Subsequently, *Centrolene durrellorum*, *Centrolene mariaelenae*, *Hyalinobatrachium pellucidum*, *Nymphargus cochranae*, and *Nymphargus posadae* have been reported from the southeastern Andean slopes of Ecuador (Cisneros-Heredia, 2007; Cisneros-Heredia and McDiarmid, 2005, 2006*a*, 2007). The situation in northeastern Peru is even less encouraging. The region of the northeastern Andean slopes of Peru, as herein defined, is

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politically divided among the departments of Cajamarca, Amazonas, and San Martin. Only one study, Duellman and Schulte (1993), has dealt with the diversity of glassfrogs in the area, reporting eight species: *Centrolene fernandoi*, *Ce. lemniscatum*, *Ce. muelleri*, *Cochranella croceopodes*, *Co. saxiscandens*, *Co. tangarana*, *Hyalinobatrachium lemur*, and *Nymphargus chancas*.

The low diversity of glassfrogs in southeastern Ecuador and northeastern Peru is certainly unexpected, and it is likely an artifact of collections since several taxa remain undescribed or unreported and many regions unexplored (Cisneros-Heredia and McDiarmid, 2006*a*, 2007; D. F. Cisneros-Heredia and P. J. Venegas, personal observation). We herein describe a new species of glassfrog that inhabits the Foothill Evergreen Andean forests on the Cordillera Oriental and Contrafuerte de Tzunantza in southeastern Ecuador and the Cordillera del Condor in northeastern Peru.

Materials and Methods

Characters, terminology, and numbered sequence of diagnostic characters follow definitions and proposals by Cisneros-Heredia and McDiarmid (2007). We use the evolutionary species concept in this paper (Wiley, 1978). Terminology for webbing formula follow the method of Savage and Heyer (1967) as modified by Savage and Heyer (1997) and Guayasamin et al. (2006) and summarized by Cisneros-Heredia and McDiarmid (2007). Nuptial excrescences and hand ornamentation classification follow the proposals by Cisneros-Heredia and McDiarmid (2007). Morphology of the terminal phalanges and the third metacarpal was determined through dissection. We use the term "lateral stripe", following the definition by Wild (1994), for the light-colored stripe—usually white, broad, and continuous, found across the flanks of some centrolenids (e.g., *buckleyi*, *posadae*) from the insertion of the upper arm (behind the tympanum) to the groin, separating the dorsum from the venter. Examined specimens were fixed in formalin and preserved in ethanol. Sex was determined by direct examination of the gonads and by noting the presence of secondary sexual characters (i.e., vocal slits, nuptial pads). Measurements were taken as described by Cisneros-Heredia and McDiarmid (2006*a*, 2007), and are as follows: 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); horizontal tympanum diameter (TD); width of disc on the third finger (3DW); tibia length (TL); and foot length (FL). To number the fingers we use the widespread and standardized nomenclature used in most anuran publications, from I–IV. The following abbreviations are used along the text: *Ce.* = *Centrolene*, *Co.* = *Cochranella*, and *N.* = *Nymphargus*.

Classification of vegetation formations follows the proposal by Sierra (1999). Relevant examined specimens are listed in the Appendix; a more detailed list of additional examined specimens was cited by Cisneros-Heredia and McDiarmid (2007). The following collections and their abbreviations are cited in the text: División de Herpetología, Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (DHMECN); Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN); The University of Kansas, Natural History Museum, Lawrence, USA (KU); Museo de Historia Natural San Marcos, Lima, Peru (MUSM); Museum of Comparative Zoology, Harvard University, Cambridge (MCZ); Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador (QCAZ); National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (USNM); Universidad San Francisco de Quito, Quito, Ecuador (DFCH-USFQ).

Species Description

Cochranella **mcdiarmidi** *sp. nov.*

Figs. 1–3, Tables 1–2

Holotype.—DFCH-USFQ D132, an adult female (Fig. 1–2) taken along a small rivulet tributary of the Jambue River, ca. 6 km S from Zamora (ca. 04° 03′ S, 78° 56′ W, 1150 m), on the western slope of Contrafuerte de Tzunantza, Cordillera Oriental, eastern slopes of the Andes, Provincia de Zamora-Chinchipe, República del Ecuador, on 29 March 2002 by F. Smith and L. Wesch.

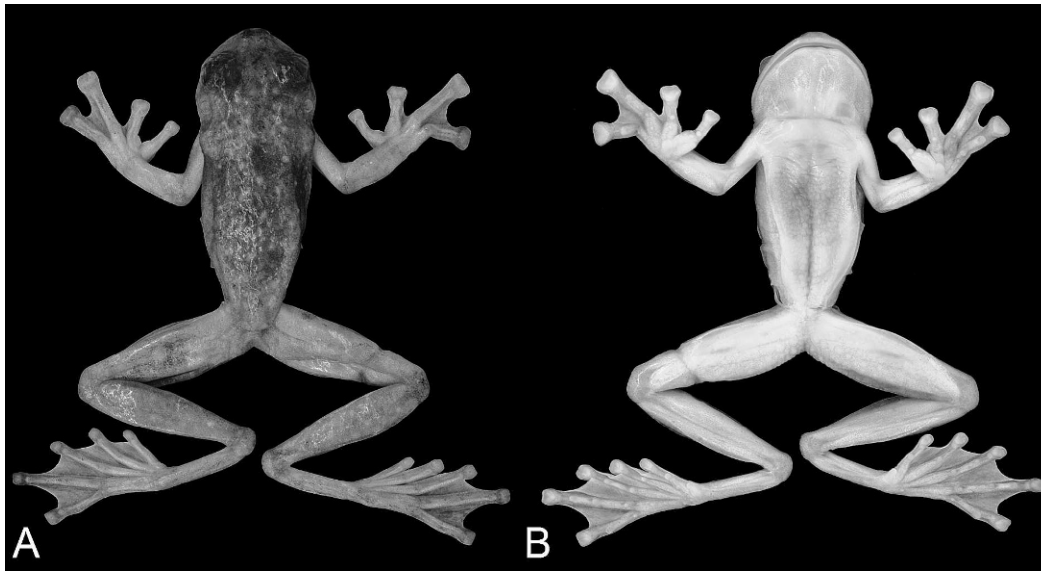

FIG. 1.—Dorsal (A) and ventral (B) views of the holotype of *Cochranella mcdiarmidi* (DFCH-USFQ D132), SVL = 29.9 mm, adult female. Photos by Sebastián Cruz. Images in full color can be visualized by accessing the supporting online material available at <http://www.cisneros-heredia.org/centrolenidae/mcdiarmidi/mcdiarmidi.html>.

Paratypes.—MUSM 26322, an adult female, and MUSM 26323–4, two adult males, all taken along a stream that drains into the Chinchipe River (ca. 05° 25′ 16.5″ S, 78° 35′ 23.2″ W, 1210 m), on the extreme southwestern slope of the Cordillera del Condor and the eastern slopes of the Andes, Provincia de Jaen, Departamento de Cajamarca, República del Perú, on 25 November 2005 by P. J. Venegas, N. Monsalve, and A. Chupicoma. DFCH-USFQ AL15, an adult female collected along a stream on the km 90 of the Gualaceo – Indanza – Cochay road, ca. 1 Km SW of Conchay (ca. 03° 06′ S, 78° 25′ W, 1100 m), Cordillera Oriental, eastern slopes of the Andes, Provincia de Morona-Santiago, República del Ecuador, on 03 August 2007.

Diagnosis.—This new species is diagnosed from all other Centrolenidae by having: (1) vomerine teeth present; (2) snout rounded to subtruncate in dorsal view (Fig. 1) and rounded to subtruncate in profile; nostrils slightly elevated producing an slight depression in the internarial area; loreal region concave; (3) tympanic annulus evident, oriented dorsolaterally; very weak supratympanic fold above the tympanum; (4) dorsal skin rather smooth to shagreen (microgranulated under magnification) covered with flat warts and low tubercles; (5) ventral skin coarsely granular; subcloacal area coarsely granular, with abundant low, flat warts; other cloacal ornamentation absent; (6) parietal peritoneum white, iridophores covering the entire or almost the entire abdomen to the level of groin (condition P4 of Cisneros-Heredia and McDiarmid, 2007); pericardium white, all other visceral peritonea clear (condition V1 of Cisneros-Heredia and McDiarmid, 2007); (7) liver lobed (condition H0 of Cisneros-Heredia and McDiarmid, 2007); (8) humeral spine absent; (9) webbing absent between fingers I and II, basal between II and III, outer fingers III 2^{-} – 1^{-} IV (Fig. 2); (10) webbing on feet I 1^{-} – 1^{+} II 1 – $1^{1}/_{3}$ III 1^{-} – 2^{+} IV 2^{-} – 1 V (Fig. 2); (11) thick, non-enameled, non-crenulated ulnar fold; low, short inner tarsal fold; (12) nuptial excrescences Type-I in adult males; concealed prepollex; (13) first finger slightly shorter than second; (14) eye diameter larger than width of disc on finger III; (15) color in life, dorsal surfaces dark olive green with diverse darker shadows, and creamy yellow or light yellowish orange or light green spots corresponding to warts and tubercles, bones green (Fig. 3); (16)

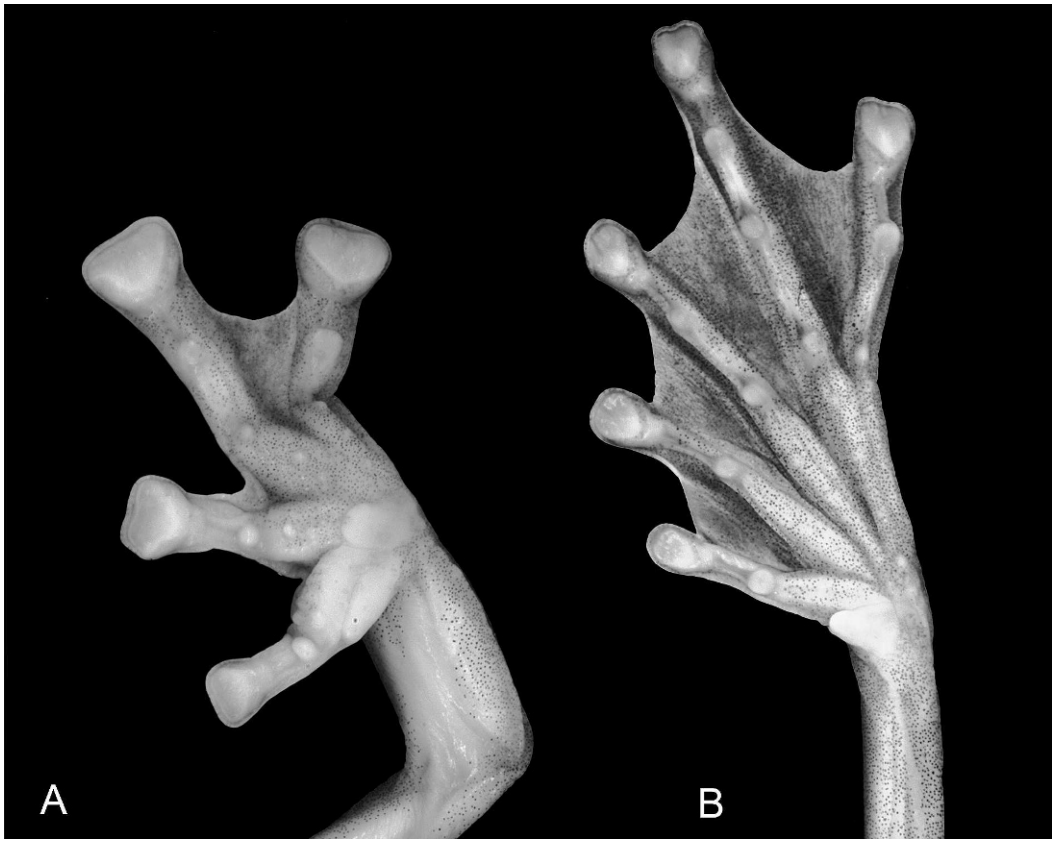

FIG. 2.—Left hand (A) and left foot (B) of *Cochranella mcdiarmidi* (DFCH-USFQ D132). Photos by S. Cruz.

color in preservative, dorsal surfaces tan gray, pale brown, or grayish lavender with khaki and tan shadows, diffuse light tan spots corresponding to warts and tubercles (Fig. 1); (17) iris olive-brown with fine dark reticulations in life; in preservative dark brown with or without fine reticulations (Fig. 3); (18) abundant melanophores widespread on all fingers and toes, including the discs; (19) males call from rocks on the borders of streams and waterfalls, advertisement call unrecorded; (20) fighting behavior unknown; (21) egg clutches unknown, parental care unknown; (22) tadpoles unknown; (23) snout–vent length in adult males 25.4–26.9 mm ($n = 2$), and in adult females 28.4–29.9 mm ($n = 3$).

Comparisons.—*Cochranella mcdiarmidi* differs from all other centrolenid frogs by the moderate-sized body, medium-sized eyes, distinctive coloration, dorsal skin covered with flat warts and low tubercles, parietal peritoneum completely white, presence of thick ulnar folds, and extensive hand and foot webbing. Medium-sized eyes (ED/3WD = 1.10–1.70) is an uncommon character in centrolenids, and otherwise known to occur only in *Centrolene acanthidiocephalum*, *Ce. medemi*, *Ce. petrophilum*, *Ce. tayrona*, *Cochranella euhystrix*, and *Co. orejuela*. *Centrolene acanthidiocephalum* differs from *Co. mcdiarmidi* by having a subacuminate snout in dorsal view and sloping in profile, abundant white dorsal dots in preservative (orange in life), and humeral spines in adult males; *Ce. medemi* has a dark purple dorsum with large light spots in preservative and humeral spines in adult males; *Ce. petrophilum* is dark lavender in preservative, has white lines on the upper lip and ulnar region, lacks ulnar folds, and exhibits humeral spines in adult males; *Ce. tayrona* is slightly lavender in

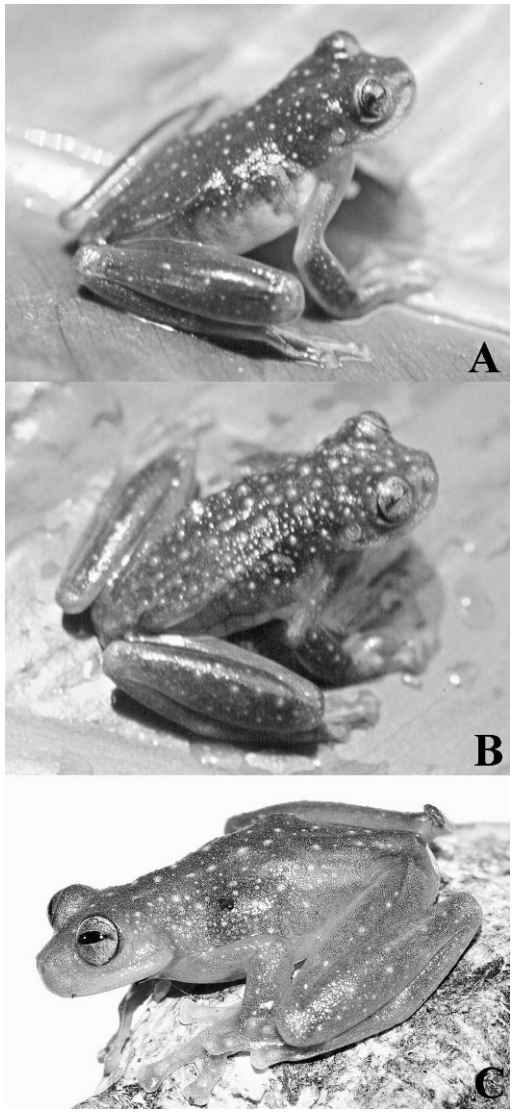

FIG. 3.—*Cochranella mcdiarmid* in life: (A) Adult male paratype (one of MNHSM 26323–24). Photo by P. Venegas. (B) Adult female paratype (MNHSM 26322). Photo by P. Venegas. (C) Male (not collected) from the southwestern slope of Cordillera del Cóndor, Perú. Photo by R. Schulte.

preservative, has a finely granular dorsal skin, and humeral spines in adult males; *Co. euhystrix* from the Pacific versant of Peru (Fig. 4) is dark gray in preservative, has a truncate snout in profile, less webbing on hand, the dorsal skin covered by relatively large and prominent tubercles with spicules (there are tubercles and spicules in adult males of *Co. mcdiarmidi* but they are never as large or prominent as those observed in *Co. euhystrix*), lacks light dorsal spots, and lacks ulnar folds; and *Co. orejuela* lacks light dorsal spots and has a protruding snout in lateral view. Additional differences between *Co. mcdiarmidi* and other species of the genera *Centrolene*, *Cochranella*, and *Nymphargus* from the eastern Andean slopes of Ecuador and northern Peru are: lavender or purple dorsal coloration in preservative in *Ce. audax* (with yellow dorsal flecks, smaller body size, and humeral spines in adult males), *Ce. bacatum* (with white tubercles beneath the eye and humeral spines in adult males), *Ce. buckleyi* (with white lips, less hand webbing, white lateral stripes, and humeral spines in adult males), *Ce. durrellorum* (uniform lavender dorsum), *Ce. fernandoi* (with cream flecks and humeral spines in adult males), *Ce, lemniscatum* (with white lateral stripes, smaller body size, and humeral spines in adult males), *Ce. pipilatum* (with dark and light dorsal flecks and humeral spines in adult males), *Co. croceopodes* (uniform lavender dorsum with white lateral stripes), *Co. flavopunctata* (with yellow dorsal flecks and smaller body size), *N. cariticommatus* (with yellow dorsal flecks and smaller body size), *N. cochranae* (with dorsal ocelli), *N. laurae* (with dark ocelli), *N. megacheirus* (with dark blue dorsal flecks and less hand webbing), *N. posadae* (uniform lavender dorsum, less hand membrane, and white lateral stripes), *N. siren* (with yellow dorsal flecks and smaller body size), *N. wileyi* (uniform lavender dorsum), *Co. amelie* (uniform lavender dorsum, transparent parietal peritoneum, and white visceral peritonea), *Co. puyoensis* (reticulated with yellow dorsal marks and less hand and foot webbing), *Co. saxiscandens* and *Co. tangarana* (uniform dark purple dorsum, lack ulnar folds, and smaller body size). *Nymphargus anomalus* has a brown dorsum with dorsal ocelli. *Centrolene mariaelenae* has smaller body size, cream-lavender dorsum with dark lavender punctuations and flecks in preservative and yellowish-green dorsum with dark punctuations and flecks in life, transparent parietal peritoneum, white visceral peritonea, and small humeral spines in adult males. *Centrolene muelleri* and *N. chancas* have a dorsal

TABLE 1.—Variation of measurements (in mm) of adult *Cochranella mcdiarmidi*. See text for abbreviations.

Specimen	DFCH-USFQ D132	MUSM 26322	DFCH-USFQ AL15	MUSM 26323	MUSM 26324
Sex	Female	Female	Female	Male	Male
SVL	29.9	28.4	28.8	25.4	26.9
HW	11.4	10.5	10.8	9.7	9.9
HL	9.8	8.8	9.3	8.8	8.5
ED	3.8	3.6	3.4	2.9	2.9
IOD	5.1	4.1	5.0	3.0	2.9
EN	2.7	2.4	2.4	2.1	2.4
IN	2.6	2.6	2.6	2.1	2.3
TD	1.3	1.1	1.3	0.9	0.9
TL	17.5	16.6	17.1	16.4	16.8
FL	15.7	14.0	15.4	13.2	13.6
3DW	2.4	1.9	2.4	1.5	1.5

pattern slightly similar to *Co. mcdiarmidi*, but they have less webbing on hands and feet; further *Ce. muelleri* has scalloped dermal folds on forearms and tarsus and humeral spines in adult males, and *N. chancas* lacks vomerine teeth, has a brownish background coloration in life, and the light dorsal spots are smaller.

Description of the holotype.—Adult female moderate-sized, SVL = 29.9 mm (Fig. 1). Body stout, head fairly distinct, wider than long, and slightly wider than body; HW/HL = 1.16, HW/SVL = 0.38, HL/SVL = 0.33. Snout short, rounded in dorsal view and in profile (Fig. 1), EN/HL = 0.28; nostrils slightly elevated producing an slight depression in the internarial area; loreal region concave; canthus rostralis low, almost indistinct, a shallow platform between the canthus rostralis; concave loreal region; lips slightly flared (Fig. 1). Medium-size eyes, ED/HL = 0.39, directed anterolaterally at about 50° from midline, eyes can be seen when viewed from below, interorbital area wider than eye diameter, IOD/ED = 1.34, EN/ED = 0.71, EN/IOD = 0.53. Tympanic annulus evident, oriented dorsolaterally; very weak supratympanic fold above the eye, tympanum separated from orbit by distance larger than tympanum diameter (TD/ED = 0.34). Dentigerous processes of vomers present, oblique, convergent; choanae small sized, rounded, widely separated, closest to the distal margin of the vomerine teeth than to the margin of mouth; tongue rounded, not indented posteriorly; vocal slits absent.

Skin of dorsal surfaces of head smooth, dorsal surfaces of limbs slightly shagreened,

TABLE 2.—Variation of proportions of adult *Cochranella mcdiarmidi*. See text for abbreviations.

Specimen	DFCH-USFQ D132	MUSM 26322	DFCH-USFQ AL15	MUSM 26323	MUSM 26324
Sex	Female	Female	Female	Male	Male
HW/HL	1.16	1.19	1.16	1.10	1.16
HW/SVL	0.38	0.37	0.38	0.38	0.37
HL/SVL	0.33	0.31	0.32	0.35	0.32
EN/HL	0.28	0.27	0.26	0.24	0.28
EN/HW	0.24	0.23	0.22	0.22	0.24
EN/ED	0.71	0.67	0.71	0.72	0.83
EN/IOD	0.53	0.59	0.48	0.70	0.83
ED/HL	0.39	0.41	0.37	0.33	0.34
ED/HW	0.33	0.34	0.31	0.30	0.29
ED/3DW	1.58	1.89	1.42	1.93	1.93
IOD/ED	1.34	1.14	1.47	1.03	1.00
IOD/HW	0.45	0.39	0.46	0.31	0.29
IN/IOD	0.51	0.63	0.52	0.70	0.79
TD/ED	0.34	0.31	0.38	0.31	0.31
TL/SVL	0.59	0.58	0.59	0.65	0.62
FL/SVL	0.53	0.49	0.53	0.52	0.51

FIG. 4.—Dorsal view of the paratype (MNHSM 3502) of the saxicolous centrolenid *Cochranella euhyxtrix* and ventral view of its right hand (insert upper right). Note the medium-sized eyes, large discs, very dark dorsal background coloration, and presence of abundant melanophores on the hands and feet, both in dorsal and ventral views. Photos by J. Suárez-Segovia.

dorsal surfaces of body smooth covered with flat warts and low tubercles, and with microgranulations; ventral surfaces coarsely granular. Cloacal opening directed posteriorly at upper level of thighs; no distinct cloacal sheath; subcloacal area coarsely granular, with abundant low, flat warts (not enamelled, at least in preservative); other cloacal ornamentation absent.

Upper arm thin, forearm moderately robust, breadth of upper arm about half that of forearm. Humeral spine absent; thick ulnar fold present. Relative lengths of fingers III > IV > II > I; webbing absent between fingers I and II, basal between II and III, outer fingers III 2^{-} – 1^{-} IV (Fig. 2); bulla absent; finger discs wide, truncate; disc on third finger larger than those on toes, and shorter than eye diameter, ED/3DW = 1.58; subarticular tubercles fairly large, rounded, and elevated except for the distal subarticular tubercle of fourth finger that is large and oval, supernumerary tubercles present; palmar tubercle large, rounded, flat; thenar tubercle large, elliptic. Concealed prepollex, nuptial excrescences absent.

Leg and tarsus slender, thigh fairly stout. When heels of adpressed limbs are held perpendicular to body they touch but do not overlap. TL/SVL = 0.59, FL/SVL = 0.53. Short inner tarsal fold; inner metatarsal tubercle large, flat, elliptical; outer metatarsal tubercle indistinct. Subarticular tubercles rounded and elevated; few, small, elevated supernumerary tubercles (one or two) around

the inner metatarsal tubercle. Webbing on feet I $1^- - 1^+$ II $1 - 1^1/_3$ III $1^- - 2^+$ IV $2^- - 1$ V (Fig. 2); disc on toe I round not expanded, all other discs rounded to fairly truncate, all discs lack pointed projections.

Measurements.—Measurements in millimeters of the holotype are presented followed in parenthesis by the range, and mean ± standard deviation of the entire type series ($n = 5$). Details are presented in Table 1. Variation of measurements and body proportions is described in the next paragraph and given in Tables 1 and 2.

Snout–vent length, 29.9 (25.4–29.9, 27.9 ± 1.8 mm); head width, 11.4 (9.7–11.4, 10.5 ± 0.7 mm); head length, 9.8 (8.5–9.8, 9.0 ± 0.5 mm); horizontal eye diameter, 3.8 (2.9–3.8, 3.3 ± 0.4 mm); inter-orbital distance, 5.1 (2.9–5.1, 4.0 ± 1.1 mm); eye-nostril distance, 2.7 (2.1–2.7, 2.4 ± 0.2 mm); internarial distance, 2.6 (2.1–2.6, 2.4 ± 0.2 mm); horizontal tympanum diameter 1.3 (0.9–1.3, 1.1 ± 0.2 mm); tibia length, 17.5 (16.4–17.5, 16.9 ± 0.4 mm); foot length, 15.7 (13.2–15.7, 14.4 ± 1.1 mm); width of disc on the third finger, 2.4 (1.5–2.4, 1.9 ± 0.5 mm).

Coloration in life.—(Fig. 3) The holotype had the dorsal surfaces dark olive green suffused with darker grayish green shadows and with yellowish cream spots. The paratypes have a background dorsal coloration in life from light olive green with brownish suffusions (MUSM 26322–26324), to dark olive green suffused with darker grayish green shadows (DFCH-USFQ D132), to dark gray green (DFCH-USFQ AL15). Coloration in life of the dorsal spots on warts and tubercles varies from yellowish cream (DFCH-USFQ AL15, MUSM 26322), to light yellow (DFCH-USFQ D132), to light green (MUSM 26323–4). Males have consistently smaller and less abundant dorsal spots than females (Fig. 3).

Coloration in preservative.—(Fig. 1) The holotype has all dorsal surfaces between tan gray and pale brown with khaki and tan shadows (produced by a variable network of melanophores); nostrils darker, while arms and legs lighter. Diffuse tan spots, lighter than dorsum, corresponding to dorsal warts and tubercles. Upper eyelid dark grayish lavender. Throat, chest, and lower surfaces of legs cream, finely covered by a grey shadow of melanophores; venter completely cream. Bones white in preservative (green in life based on paratypes). Parietal peritoneum entirely covered by iridophores (white) to the level of groin; pericardium white, all other peritonea lack iridophores (including gastric, visceral, renal, and hepatic peritonea). Background coloration in preservative of the Peruvian specimens (MUSM 26322–4) is grayish lavender and less dark than the holotype, while the Ecuadorian paratype (DFCH-USFQ AL15) has a purplish-gray dorsum, much darker than the holotype. In preservative, the coloration of the dorsal spots of all paratypes is lighter than in the holotype, and their borders are more defined and more elevated. The borders of the fingers and toes of the Peruvian paratypes were yellow, and those of the Ecuadorian paratype light yellowish-brown (coloration data based on field notes and photographs by P. Venegas, F. Smith, L. Wesch, and D. F. Cisneros-Heredia). The presence of iridophores on the parietal peritoneum is always extensive (reaching at least below the level of the intestines), but in some specimens it does not completely cover the venter to the level of the groins.

Morphological variation.—Gross morphological features are fairly invariant. Hand webbing does not vary; the toe-webbing formulae vary as follows: I $(1^-–1^+) - (1^-–1^+)$ II $1 - 1^1/_3$ III $1^- - (2^-–2^+)$ IV $2^- - 1$ V. The slightly elevated nostrils in some specimens make the snout form in dorsal and lateral views look subtruncate (MUSM 26323–4) rather than completely rounded. Males have nuptial excrescences Type-I and spicules on the dorsal surfaces.

Distribution and natural history.—*Cochranella mcdiarmidi* is known from specimens collected at two localities separated by ca. 120 km (by air) in southeastern Ecuador (provinces of Morona-Santiago and Zamora-Chinchipe) and one in northeastern Peru at ca. 155 km NNE from the type locality (Department of Cajamarca) (Fig. 5). Additional individuals were observed and photograph in an area ca. 1.3 km NW from the locality of the Peruvian paratypes (Fig. 3), also in the southwestern slopes of the Cordillera del Condor (05° 24′ 36.67″ S, 78° 35′ 3.66″ W; ca. 1500 m; Fig. 5).

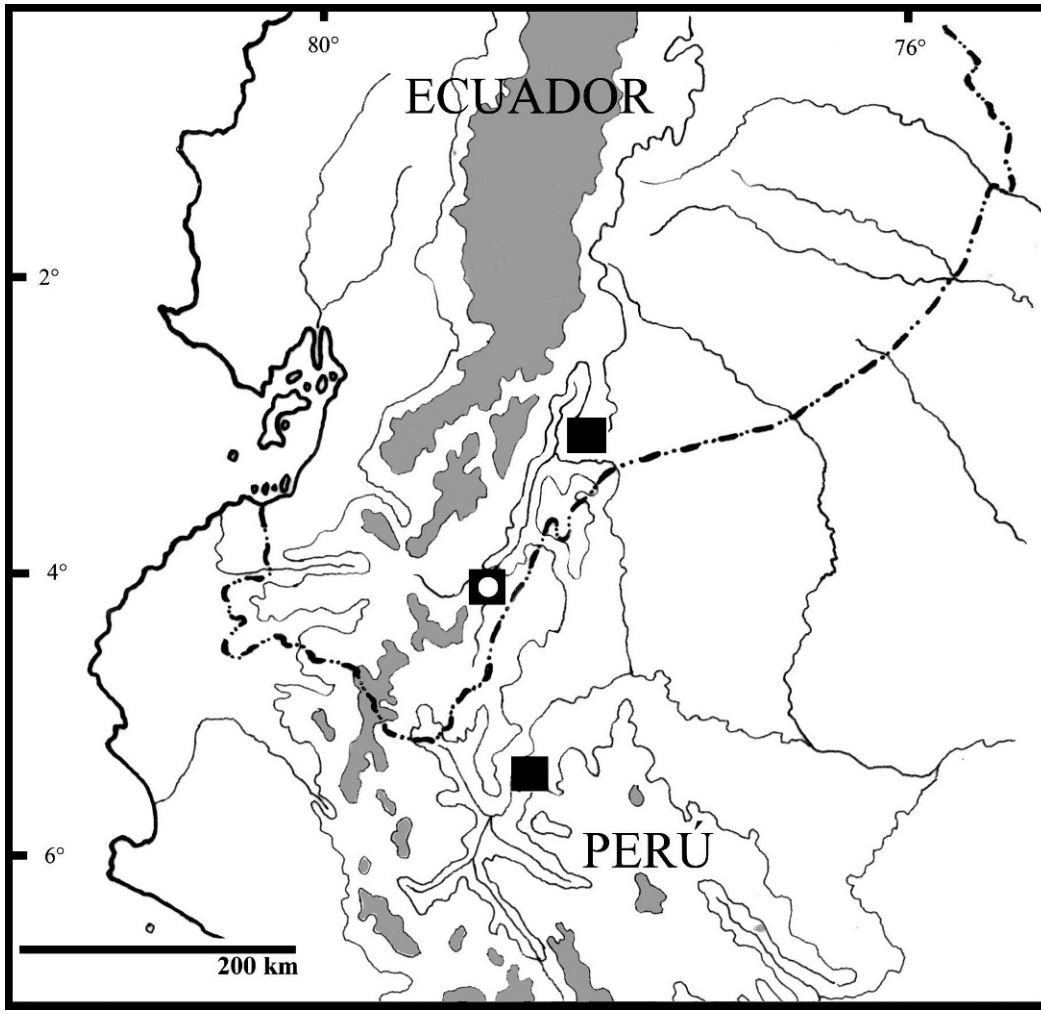

FIG. 5.—Schematic map of southeastern Ecuador and northeastern Peru showing the known localities of *Cochranella mcdiarmidi*. The type-locality is marked by a circle. The Peruvian locality also corresponds to the first-known locality of *Nymphargus posadae* in the country. Precise locations can be visualized in Google Earth by downloading the supporting online material available at http://www.cisneros-heredia.org/centrolenidae/mcdiarmidi/mcdiarmidi.html.

The holotype was collected at night while active on a rock in the spray zone of a small waterfall part of a rivulet in primary Foothill Evergreen Forest at an elevation of 1150 m. The small rivulet where the holotype was collected is a tributary of the Jambue River, ca. 6 km S of Zamora-Chinchipe. The Jambue River is located on the western slope of the Contrafuerte (Cordillera) de Tzunantza, a ridge part of the Cordillera Oriental, on the southeastern Andean slopes of Ecuador. The paratypes (one adult female and two adult males) were found active at night. The males were calling from mossy rocks in the spray zone of a waterfall in the transition of Thorn Forest to secondary Foothill Evergreen Forest at 1210 m elevation. The waterfall where the paratypes were found is part of a rivulet that drainages to the Chinchipe River. This rivulet is located in the southwestern extreme of the Cordillera del Condor, on the northeastern Andean slopes of Peru. The individuals observed and photographed (but not collected) at the second Peruvian locality were also found on the borders of a waterfall.

The adult female holotype and one of the adult female paratypes (DFCH-USFQ AL15), captured in the months of March and August respectively, have convoluted oviducts and dark oviductal eggs. *Cochranella mcdiarmidi* was found in sympatry with *Centrolene durrellorum* at the type locality (Cisneros-Heredia, 2007) and with *Nymphargus posadae*, *Hyalinobatrachium* sp., *Eleutherodactylus percnopterus*, and *Eleutherodactylus lymani* at the Peruvian localities (field notes by P. Venegas and R. Schulte). *Cochranella mcdiarmidi* corresponds to the species cited as "*Cochranella* sp. N4" by Cisneros-Heredia and McDiarmid (2006a). The altitudinal distribution of *Cochranella* sp. N4 was cited by mistake in the range between 1300 and 1900 m elevation by Cisneros-Heredia and McDiarmid (2006*a*).

Etymology.—This new species of Glassfrog is named *Cochranella mcdiarmidi* in honor of Roy W. McDiarmid, in recognition of his contributions to the understanding of Neotropical herpetology over the past decades. His constant support, friendship, and guidance have been invaluable to DFCH.

First Record of *Nymphargus posadae* from Peru

Tadpoles and recently metamorphosed frogs of *Nymphargus posadae* were found in the same stream where the Peruvian paratypes of *Cochranella mcdiarmidi* were collected, near to the waterfall in the rocks and low vegetation of the shore of stream. Two of the metamorphosed frogs were preserved (MUSM 26325–6) and six were kept in captivity at INIBICO until they reached adult age. Only voucher photographs of the adult specimens are available as none were preserved, but those individuals had all external characteristics of *N. posadae* including the large size, uniform green dorsal coloration with white borders on the limbs, fingers and toes, and absence of hand webbing (Fig. 6). These records constitute the first report of *N. posadae* in Peru. The presence of *N. posadae* in northeastern Peru was expected, and the new locality herein presented is ca. 145 km to the south from the southernmost known Ecuadorian locality (Cisneros-Heredia and McDiarmid, 2007). *Nymphargus posadae* is thus distributed across the eastern Andean slopes from central and southeastern Colombia, across eastern Ecuador down to northeastern Peru (Cisneros-Heredia and McDiarmid, 2007; Guayasamin et al., 2006; Ruiz-Carranza and Lynch, 1995).

Discussion

Cochranella mcdiarmidi is placed in the family Centrolenidae by the presence of T-shaped terminal phalanges and a dilated process on the medial side of the third metacarpal (Cisneros-Heredia and McDiarmid, 2006*a*, 2007; Frost et al., 2006; Hayes and Starrett, 1980; Taylor, 1951). The genus *Cochranella* is currently distinguished from *Centrolene* by the state of a single sexually-dimorphic character, the presence of humeral spines in *Centrolene* adult males. Both genera are nonmonophyletic and their current definitions will certainly change in the future (Cisneros-Heredia and McDiarmid, 2007; Frost et al., 2006; Guayasamin et al., 2006). *Cochranella* is diagnosed from the recently described *Nymphargus*, an apparently monophyletic group, by having extensive webbing between the outer fingers. The relationships of *Cochranella* are currently uncertain and further phylogenetic studies will certainly change its arrangement in the future (D. F. Cisneros-Heredia and M. Rada, personal observations; J. M. Guayasamin, personal communication). Since *Co. mcdiarmidi* is known only from few specimens and no molecular data are available, it is assigned to *Cochranella* as a matter of convenience based on the absence of humeral spines in adult males and the extensive webbing between the outer fingers, but further research must determine its relationships.

Medium-sized eyes, in relation to the size of the disc on third finger (ED/3WD < 1.70), is an uncommon condition in centrolenid frogs. The large size of the discs (Fig. 1, 4) is a feature probably related to saxicolous habits in the spray zone of waterfalls (similar to *Ce. geckoideum*, *Ce. medemi*, *Ce. petrophillum*, *Co. euhystrix*, and *Co. orejuela*; Cisneros-Heredia and McDiarmid, 2007; M. Rada, personal observation). The presence of iridophores covering almost the entire parietal peritoneum (to the level of groin) is a

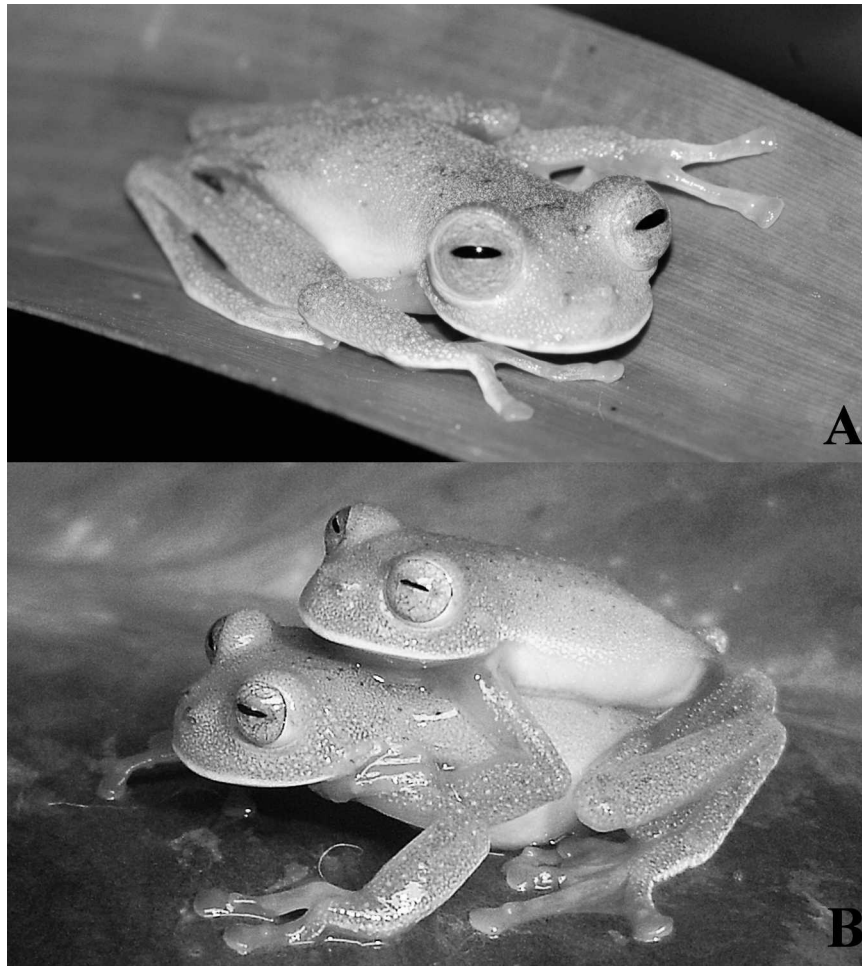

FIG. 6.—(A) *Nymphargus posadae* from the extreme southwestern slope of the Cordillera del Cóndor (ca. 05° 25′ 16.5″ S, 78° 35′ 23.2″ W, 1210 m), Peru. Photo by R. Schulte. (B) *Nymphargus posadae* from Valle de Sibundoy, Colombia, for comparison. Photo by J. J. Mueses-Cisneros.

condition otherwise known only in *Ce. acanthidiocephalum*, *Ce. geckoideum*, *Ce. medemi*, *Ce. paezorum*, and *Co. euhystrix*, almost all inhabitants of rocky borders along Andean streams. In addition, other conditions observed in *Co. mcdiarmidi* are also observed in all saxicolous species, the presence of very dark dorsal background coloration and the presence of abundant melanophores on the venter (Fig. 1, 4). Most centrolenid species lack chromatophores on the ventral skin (Schwalm and McNulty, 1980; Cisneros-Heredia and McDiarmid, 2007), but *Ce. geckoideum*, *Ce. medemi*, *Ce. petrophillum*, *Co. euhystrix* (Fig. 4), *Co. flavopunctata*, *Co. orejuela*, *Co. spiculata*, *Co. saxiscandens*, *Co. tangarana*, and an undescribed species from northeastern Ecuador similar to *Co. spiculata* have extensive melanophores distributed across the ventral skin, from the throat to the vent (Cisneros-Heredia and McDiarmid, 2007; Duellman and Schulte, 1993; D. F. Cisneros-Heredia and M. Rada, personal observations). No information is available about the egg clutches and tadpoles of *Co. mcdiarmidi*, but we hypothesized that the egg clutches are placed on rocks along the borders of waterfalls and streams, similar to other saxicolous species.

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Appendix I

Specimens Examined

Centrolene acanthidiocephalum: COLOMBIA: ICN 5285 (holotype), ICN 5429, 5274, 5283–4. *Centrolene audax*: ECUADOR: KU 143290, 143292 (paratypes); DHMECN 1246; USNM 286622–24, 286620–22; MCZ A97807–8. *Centrolene bacatum*: ECUADOR: KU 202807–12 (paratypes); QCAZ 16212, 17807, 22386–87. *Centrolene buckleyi*: ECUADOR: USNM 286626–31, 288423–24, 288428, 311113–14; DHMECN 0868–93, 1246. *Centrolene durrellorum*: ECUADOR: DFCH-USFQ D131 (holotype), DFCH-USFQ D291. *Centrolene fernandoi*: PERU: KU 211771–75 (paratypes). *Centrolene geckoideum*: ECUADOR: DHMECN 0900; USNM 167018; COLOMBIA: ICN 5559–63, 8694–97. *Centrolene lemniscatum*: PERU: KU 217300 (holotype). *Centrolene mariaelenae*: ECUADOR: DFCH-USFQ D125 (holotype), DFCH-USFQ ZZ2; QCAZ 18618–19, 21252, 22363, 31729. *Centrolene medemi*: COLOMBIA: USNM 15227 (holotype); ICN 13600–07, 17857–59, 20005; KU 164493–94. *Centrolene muelleri*: PERU: KU 217301 (holotype). *Centrolene paezorum*: COLOMBIA: ICN 11866 (holotype). *Centrolene petrophilum*: COLOMBIA: ICN 9567 (holotype). *Centrolene pipilatum*: ECUADOR: KU 143279–82 (paratypes); ICN 23756 (paratype); USNM 286717; MCZ A-97803. *Centrolene tayrona*: COLOMBIA: ICN 12997 (holotype), ICN 130003, 12866, 20299–300 (paratypes); KU 169750–52.

Cochranella amelie: ECUADOR: DHMECN 3066 (holotype), DHMECN 3591 (paratype). *Cochranella croceopodes*: PERU: KU 211804 (holotype), KU 211799 (paratype). *Cochranella flavopunctata*: ECUADOR: KU 121048 (holotype), KU 121041, 121043–46 (paratypes). *Cochranella orejuela*: COLOMBIA: KU 145081 (holotype), KU 145090 (paratype); ECUADOR: DHMECN 4309, DHMECN (MYM)1412–1413. *Cochranella euhystrix*: PERU: USNM 292587–8 (paratypes). *Cochranella puyoensis*: ECUADOR: DFCH-USFQ D285; QCAZ 7104, 7499; USNM 291298.

Nymphargus anomalus: ECUADOR: KU 143299 (holotype). *Nymphargus cariticommatus*: ECUADOR: KU 202806 (holotype), KU 202805 (paratype); USNM 288435–36; DHMECN 1974, 2429. *Nymphargus chancas*: PERU: KU 211778 (holotype). *Nymphargus cochranae*: ECUADOR: USNM 284304–06, 286632–36, 288452; DFCH D10 0–01; KU 121033–35. *Nymphargus laurae*: ECUADOR: USNM 288453 (holotype). *Nymphargus megacheirus*: ECUADOR: KU 143246–70 (paratypes); USNM 286701. *Nymphargus posadae*: COLOMBIA: ICN 11307 (holotype), ICN 7447–50 (paratypes); ECUADOR: USNM 288464-5; DFCH-USFQ. *Nymphargus siren*: ECUADOR: KU 146611–23 (paratypes); USNM 286740. *Nymphargus wileyi*: ECUADOR: QCAZ 26024, 26028–29, 26057.