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Author(s): Willam E. Duellman and John E. Simmons
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Two New Species of Dendrobatid Frogs, Genus *Colostethus*, from the Cordillera del Cóndor, Ecuador.

WILLAM E. DUELLMAN AND JOHN E. SIMMONS
Museum of Natural History and Department of Systematics and Ecology, The University of Kansas, Lawrence, Kansas 66045

ABSTRACT.—Two new species of *Colostethus* are described from the physiographically isolated Cordillera del Cóndor in southern Ecuador. *Colostethus mystax* is a small species characterized by the absence of webbing and pale longitudinal stripes on the body; *C. shuar* is a large species that also lacks webbing but has an oblique lateral stripe that extends to the orbit. Both species are endemic to the Cordillera del Cóndor [Dendrobatidae, *Colostethus mystax*, *C. shuar*, Ecuador, Cordillera del Cóndor]

In January 1972, one of us (J. E. Simmons) was a member of a botanical expedition to the Cordillera del Cóndor in southern Ecuador. Although the field party spent only 5 days in the cloud forests in this isolated mountain range, 18 species of anurans were collected. The small collection contained many novelties, including *Ischnocnema simmonsi* (Lynch 1974), *Eleutherodactylus condor* (Lynch and Duellman 1980), and three species of *Colostethus*, two of which are described herein; the third species is being named by Duellman and Lynch (1988).

Compared to the dendrobatids of the genera *Dendrobates*, *Epipedobates*, *Minyobates*, and *Phyllobates* (Myers 1987), all of which have toxic skin secretions and usually have bright coloration, frogs of the genus *Colostethus* are rather drab in appearance and lack skin toxins. *Colostethus* is extremely speciose, especially in northwestern South America. The most recent summary (Frost 1985) lists 63 valid species. Subsequently, 10 more species have been named—six from Venezuela (Dixon and Rivero-Blanco 1985, La Marca 1985, Péfaur 1985, Rivero 1984, Rivero et al. 1986), three from Colombia (Lynch and Ruíz Carranza 1985, Rivero and Serna 1986), and one from Ecuador (Frost 1986). Specimens of many new species await descriptions; several of these, including those named herein, were recognized in an unpublished doctoral dissertation (Edwards 1974).

The phylogenetic relationships among this plethora of species remain unknown, and no attempt is made here to determine the relationships of the two new taxa. Until appropriate characters are analyzed critically with respect to suitable out-groups, the systematics of *Colostethus* must remain in the realm of phenetic taxonomy.

METHODS

Edwards (1971) attempted to establish a standard for diagnosing species of *Colostethus*;

he used 21 numbered characteristics of adults and larvae. This standard was followed by Péfaur (1985) and La Marca (1985), but not by authors of other subsequent descriptions. We have reduced the number of "diagnostic" characters of preserved specimens to 15, which we define below.

1. *Size.*— Snout-vent length (SVL) is the straight-line distance from the tip of the snout to the posterior terminus of the body. Tibia or shank length is the distance from the knee to the distal end of the tibia. Foot length is the distance from the proximal edge of the inner metatarsal tubercle to the tip of the fourth toe. Head length is the chord of head length i.e., the distance from the tip of the snout to the posterior edge of the articulation of the jaw. Head width is the greatest width of the head. The eye and tympanum sizes are horizontal measurements, and the eye-nostril distance is measured from the anterior corner of the orbit to the posterior edge of the nostril opening.

2. *Disc on third finger.*— The terminal discs on the fingers may be distinctly dilated and noticeably wider than the diameter of the digit, as in C. dunni Rivero and C. meridensis Dole and Durant, or the discs may be no wider than the fingers, as in *C. anthracinus* Edwards and *C. subpunctatus* (Cope).

3. *Relative lengths of first and second fingers.*— When the first and second fingers are adpressed, the first may be longer than the second (e.g., *C. ramosi* Silverstone), or the fingers may be equal in length (e.g., *C. degranvillei* Lescure). In other species, the second finger may be longer than the first, as in *C. bromelicola* (Test) and *C. chocoensis* (Boulenger).

4. *Fringes on fingers.*—Although the fingers of *Colostethus* never have more than basal webbing, some species (e.g., *C. dunni*) have narrow lateral fringes on the fingers, whereas others (e.g., *C. anthracinus*) lack fringes. The development of fringes on the fingers is variable, so the standard comparison is made with the second finger.

5. *Disc on fourth toe.*—The same variation obtains with the terminal discs on the toes as with those on the fingers (see Character 2).

6. *Fringes on toes.*—In most species of *Colostethus* that have webbing between the toes, lateral fringes extend along the edges of the toes to the terminal discs. However, fringes are present on the toes of some species that lack webbing, as in C. kingsburyi (Boulenger). Other species (e.g., *C. anthracinus*) lack fringes. The standard comparison uses the fourth toe.

7. *Outer tarsal fold.*—A dermal fold along the outer ventral edge of the tarsus is absent in most *Colostethus*, but it does occur in a few species, such as *C. collaris* (Boulenger).

8. *Toe webbing.*—Toes may lack webbing or be webbed to various degrees. The degree of webbing is designated as suggested by Savage and Heyer (1967) and modified by Myers and Duellman (1982). In this system, the digits are numbered in Roman numerals and the number of free segments are numbered in Arabic numbers. If webbing extends to the tip of a digit, the number is "0." Thus, if the webbing extends from the base of the penultimate segment (phalange) of the first toe to the base of the distal segment of the second toe, and from the middle of the penultimate segment of the second toe to the middle of the antepenultimate segment of the third toe, the webbing formula would be I2—1II11/2—21/2III. This system contrasts with that used by Edwards (1974), who gave a value of "0" if webbing was absent.

9-11. *Pale longitudinal stripes.*—The color patterns of most species of *Colostethus* include a combination of pale stripes. The dorsolateral stripe (Character 9) extends from the occiput to the posterior end of the body above the insertion of the hind limb. An oblique lateral stripe (Character 10) extends anteriorly from the inguinal region in front of the hind

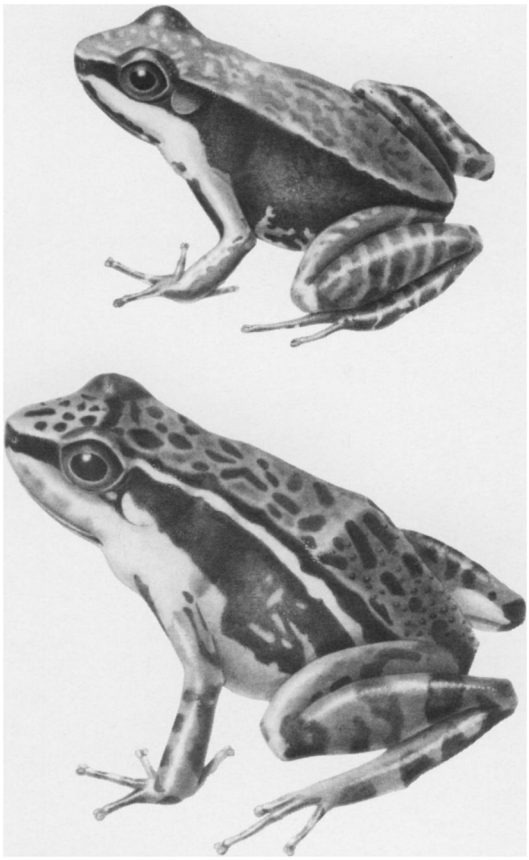

FIG. 1. Top, paratype of *Colostethus mystax*, KU 147098, female, 21.3 mm SVL. Bottom, paratype of *Colostethus shuar*, KU 147092, female, 26.5 mm SVL.

limb to a point on the flank or to the orbit; in some species the stripe is fragmented on the flank. This stripe has been referred to as an inguinal stripe in those species in which the stripe is present only posteriorly. In species that have a dark venter, there may be a ventrolateral stripe (Character 11) that extends from the axilla to the groin. Some species of *Colostethus* have dark stripes in addition to these pale stripes, or have a dark dorsolateral stripe and no pale dorsolateral stripe. To avoid confusion, only the pale stripes are included in the diagnoses.

12-13. *Ventral markings.*—Dark markings may be present on the throat and chest (Character 12), but in most species the thorat and chest are pale. Markings may consist of a distinct transverse bar (collar) as in *C. collaris* or a pair of discrete spots on the chest as in *C. taeniatus* (Andersson). The pattern on the belly (Character 13) may be absent, dark with pale flecks as in C. anthracinus, or pale with dark spots or reticulations, as in C. latinasus (Cope).

14. *Sexual dimorphism in ventral coloration.*—In many species of *Colostethus*, distinct sexual dimorphism in ventral markings is evident in preserved specimens. In such species, males usually have more dark markings (especially on the throat and chest) than females. This characteristic should not be confused with sexual dimorphism in ventral coloration in living individuals, in which males of some species have bright yellow throats in contrast to the pale cream throats of females; such differences usually are not evident in preserved specimens.

15. *Third finger of male.*—In males of some species, such as C. *fraterdanieli* Silverstone and C. *latinasus*, the basal segment of the third finger is distinctly swollen in males.

Museum specimens are referred to by the following abbreviations: ANSP = Academy of Natural Sciences of Philadelphia; KU = Museum of Natural History, University of Kansas.

DESCRIPTIONS

Colostethus mystax new species

Holotype.—KU 147095, an adult male, from the headwaters of the Río Piuntza, 1830 m (approx. 3 30'S,78 20'W), western slope of the Cordillera del Cóndor, Provincia Morona Santiago, Ecuador; obtained on 6 January 1972 by John E. Simmons.

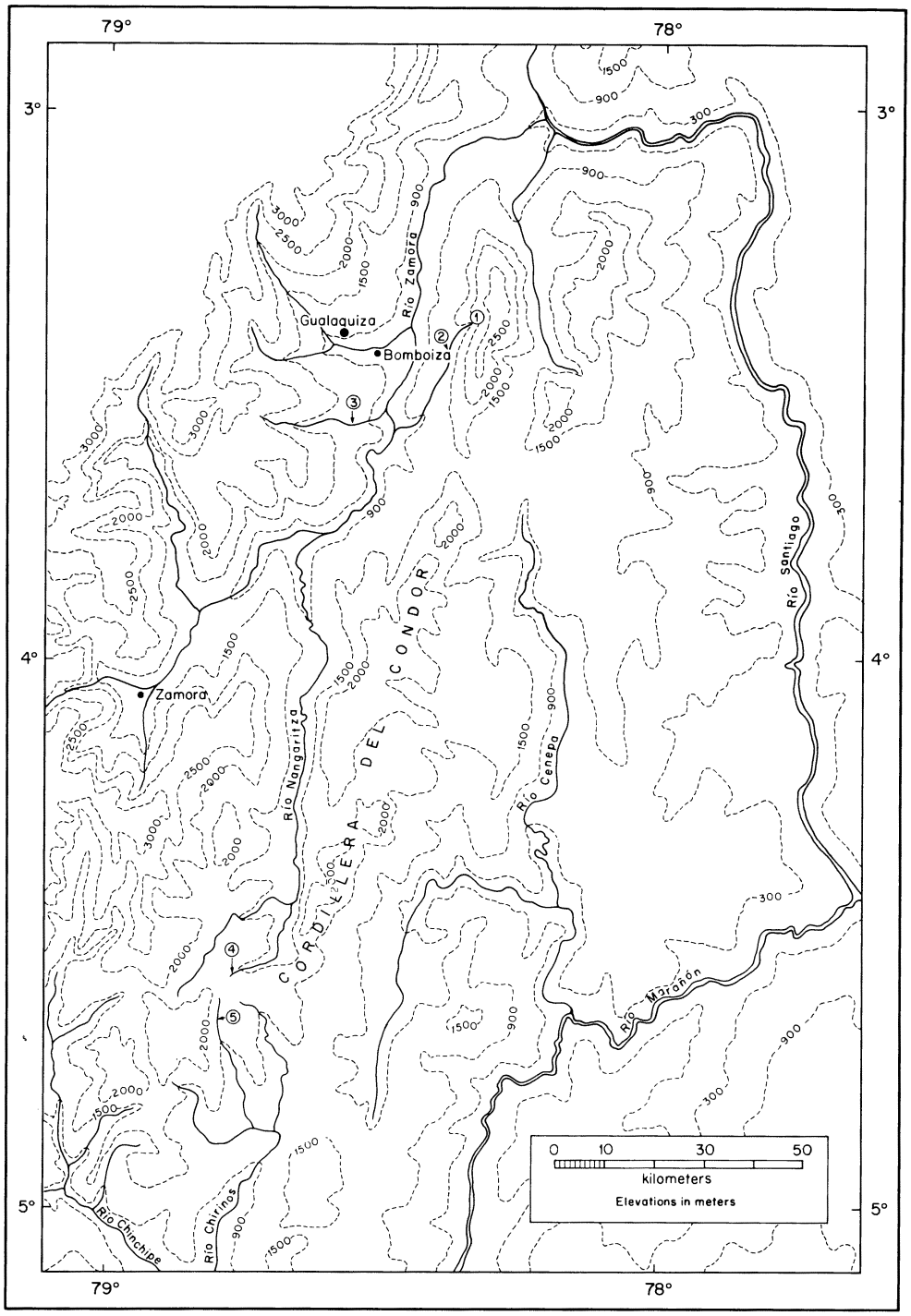

FIG. 2. Map of the Cordillera del Condor and adjacent region in Ecuador showing place names. **1** = campsite at 1830 m at the headwaters of the Río Piuntza. **2** = Río Piuntza (? = Río Quime). **3** = Río Chuchumbleza. **4** = Río Numpatacaimi. **5** = Río Santa Agueda. The Misión Bomboiza is about 2 km west of the town of Bomboiza. The southern end of the Cordillera de Cutucú is shown at the top of the map. Based on a Mercator projection, 1:500,000, by the Instituto Geográfico Militar, Quito, Ecuador, 1979.

Paratopotypes.—ANSP 30590-91, KU 147094, 147096 -98, 147105, two adult males and five adult females, collected on 4 -6 January 1972 by John E. Simmons and Bruce MacBryde.

Diagnosis.—A species of *Colostethus* characterized by (1) small size; SVL in males 19.2-21.7 mm (mean = 20.5, N = 3), in females 19.0-22.1 mm (mean = 20.6, N = 5); (2) disc on third finger wider than diameter of finger; (3) first finger barely longer than second; (4) fringe present on second finger; (5) disc on fourth toe wider than diameter of toe; (6) fringe present on fourth toe; (7) outer tarsal fold absent; (8) toes unwebbed; (9) dorsolateral stripe absent; (10) oblique lateral stripe absent; (11) ventrolateral stripe absent; (12) discrete dark markings usually present on chest; (13) dark spots usually present on belly; (14) no sexual dimorphism in ventral pattern; (15) third finger of male not swollen.

The only other named species of *Colostethus* that lack webbing between the toes and dorsolateral, oblique lateral, and ventrolateral stripes are *C. alagoanus* (Bokermann) and *C. carioca* (Bokermann) from eastern Brazil. Both species differ from *C. mystax* by lacking ventral markings; *C. alagoanus* also differs by having the disc on the third finger no wider than the digit and in lacking a fringe on the fourth toe. An unnamed species from the Pacific slopes of Ecuador is like *C. mystax* in lacking stripes and webbing but differs by having a dark venter with pale spots. From its sympatric congeners, *C. mystax* differs by lacking pale longitudinal stripes and by having a creamy yellow venter with brown spots and creamy white lips with brown edges.

Description of holotype.—An adult male having a SVL of 19.2 mm; body robust; head longer than wide; head length 39.6% of SVL; head width 36.5% of SVL; snout short, bluntly rounded in dorsal view and in profile; loreal region barely concave; nostrils slightly protuberant laterally; eye-nostril distance about three-fourths length of eye; supratympanic fold diffuse, obscuring posterodorsal edge of tympanum; length of tympanum 60% length of eye, separated from eye by distance equal to about one-fourth length of eye.

Forelimbs long, slender; first finger barely longer than second; fingers unwebbed, with narrow lateral fringes; third finger not swollen; terminal discs expanded, about twice width of digit, nearly truncate; subarticular tubercles large, oval; palmar tubercle moderately large, triangular; thenar tubercle small, elliptical; nuptial excrescences absent. Hind limbs robust, moderately long; tibia length 52.1% of SVL; foot length 49.5% of SVL; outer tarsal fold absent; inner tarsal fold weakly sigmoid on distal one half of tarsus; metatarsal tubercle large, round, more than one-half size of elliptical inner metatarsal tubercle; toes unwebbed, with narrow lateral fringes; terminal discs expanded, about twice width of digits; subarticular tubercles small, oval; subarticular tubercles absent.

Skin on dorsum of body and hind limbs weakly granular; skin on flanks more coarsely granular; skin on ventral surfaces smooth; anal opening directed posteroventrally at upper level of thighs; anal flap short. Tongue elongately elliptical, widest and deeply notched posteriorly, free posteriorly for about one-half of its length; vocal slits present; vocal sac single, median, subgular; vomerine odontophores absent.

Color in preservative: Dorsum of head and body brown with dark brown markings consisting of small spot anteromedian to eyes, interorbital chevron, elongated middorsal dashes, and small spots posteriorly; flanks dark brown with cream reticulations ventrally; broad dark stripe from near tip of snout through loreal region to orbit; tympanic region dark brown; upper lip cream with longitudinal brown dashes. Dorsal surfaces of forearms tan with scattered, small brown marks; anterior and posterior surfaces of upper arm

and lateral surfaces of forearm dark brown; dorsal surfaces of hind limbs brown with narrow, dark brown, transverse marks; anterior and posterior surfaces of thighs dark brown, with cream flecks on latter. Venter creamy yellow with small, discrete, dark brown spots on throat, chest, belly, and thighs; margin of lower lip dark brown; palmar and plantar surfaces brown.

Color in life: Dorsum tan with brown bars on hind limbs; flanks dark brown; belly cream with brown spots; ventral surfaces of hind limbs yellow with brown spots (J. E. Simmons field notes, 6 January 1972).

Measurements (mm): SVL 19.2, tibia length 10.0, foot length 9.5, head length 7.6, head width 7.0, length of eye 2.3, eye-nostril distance 1.7, length of tympanum 1.4.

Variation.—The paratypes are like the holotype in structure but exhibit minor differences in coloration (Fig. 1). Two individuals have a narrow, middorsal, dark line; one specimen has a dark spot, instead of a chevron, between the eyes and lacks other dorsal markings. One specimen has small dark spots scattered over the entire dorsum. All have a dark streak on the upper lip, but in three individuals, the streaks are present only anteriorly. The amount of spotting on the venter is variable. Two specimens have small spots only on the throat and chest, and one other individual lacks spots on the thighs. All have a dark brown margin on the lower lip.

Color notes on living individuals reveal that the dorsum is tan to dull orange with dark brown or black markings (with small white flecks in two individuals). The flanks are dark gray to dark brown; the hind limbs are tan to dull orange with dark brown or black transverse bars. The upper lip is white or yellow, and the dark stripe on the side of the head is black. The venter is cream to yellow with brown spots.

Measurements of three males and five females, respectively (means in parentheses), are: SVL 19.2-21.7 (20.5), 19.0-22.1 (20.6); tibia length 10.0-10.8 (10.4), 9.8-10.7 (10.2); head length 7.6-8.0 (7.8), 7.4-8.3 (7.7); head width 7.0-7.5 (7.3), 6.8-7.7 (7.2); length of eye 2.3-2.6 (2.5), 2.6-3.0 (2.8); eye nostril distance 1.7-2.1 (1.9), 1.8-2.0 (1.9); length of tympanum 1.4-1.6 (1.5), 1.5-1.9 (1.7).

Ten topotypic juveniles and subadults (KU 147093, 147099, 147101-04, 147108-11) having SVLs of 12.5 - 16.8 mm (mean = 15.1) resemble the adults in dorsal coloration, but the markings on the hind limbs are less distinct. The upper lip is dusky without distinct dark streaks. The venter is cream with few dark spots anteriorly in six specimens and no dark spots in four individuals.

Distribution and ecology.—*Colostethus mystax* is known only from the type locality, where it inhabits cool montane cloud forest. One male was calling from leaf litter at the base of a tree by day; the call is a rapid series of chirps. Other individuals were active on the ground by day, and one was sleeping on low vegetation at night.

Etymology.—The specific name is a Greek noun in apposition meaning mustache. The name refers to the dark brown longitudinal mark on the anterior part of the pale upper lip.

Colostethus shuar new species

Holotype.—KU 147091, an adult male, from the headwaters of the Río Piuntza, 1830 m (approx. 3 30'S, 78 20'W), western slope of the Cordillera del Cóndor, Provincia Morona Santiago, Ecuador; obtained on 4 January 1972 by John E. Simmons.

Paratopotype.—KU 147092, an adult female, obtained on 6 January 1972, by John E. Simmons.

Diagnosis.—A species of *Colostethus* characterized by (1) medium size; SVL of male 31.2 mm, of female, 26.5 mm; (2) disc on third finger wider than diameter of finger;

(3) first finger barely longer than second; (4) fringe present on second finger; (5) disc on fourth toe wider than diameter of toe; (6) fringe absent on fourth toe; (7) outer tarsal fold absent; (8) toes unwebbed; (9) dorsolateral stripe absent; (10) oblique lateral stripe present, extending to orbit; (11) ventrolateral stripe absent; (12) discrete or diffuse markings present on chest; (13) belly uniformly pale; (14) sexual dimorphism in ventral color pattern; (14) third finger not swollen in male.

Colostethus shuar is distinguished from most species in the genus by its large size and absence of webbing between the toes. Only five other named species (all from Colombia and Venezuela) attain snout-vent lengths of more than 30 mm. *Colostethus guatopoensis* Dixon and Rivero-Blanco, *C. meridensis* Dole and Durant, *C. palmatus* (Werner), and *C. riveroi* (Donoso-Barros) have webbing between the toes; in two of those species (*C. meridensis* and *C. palmatus*) the oblique lateral stripe does not extend to the orbit, and in the other two species the oblique lateral stripe is absent. *Colostethus duranti* Péfaur is large and has basal webbing and an indistinct oblique lateral stripe; furthermore, the discs are not expanded, and the venter is pinkish cream with white flecks on the throat and chest. Sympatric congeners of *C. shuar* are much smaller (<23 mm) and lack oblique lateral stripes.

Description of holotype.—An adult male having a SVL of 31.2 mm; body robust; head about as long as wide; head length 36.6% of SVL; head width 35.6% of SVL; snout short, bluntly rounded in dorsal view, truncate in profile; loreal region barely concave; nostrils slightly protuberant laterally; eye-nostril distance three-fourths length of eye; supratympanic fold diffuse, obscuring posterodorsal part of tympanum; length of tympanum 65% of length of eye; tympanum separated from eye by distance equal to about one-fifth length of eye.

Forelimbs moderately long, slender; first finger barely longer than second; fingers unwebbed, lacking lateral fringes; third finger not swollen; terminal discs expanded, noticeably wider than digits, nearly truncate; subarticular tubercles large, round; palmar tubercle large, nearly square; thenar tubercle small, elliptical; nuptial excrescences absent. Hind limbs moderately robust, short; tibia length 49.7% of SVL; foot length 49% of SVL; outer tarsal fold absent; inner tarsal fold sigmoid on distal two-thirds of tarsus; outer metatarsal tubercle large, round, about one-half size of elliptical inner metatarsal tubercle; toes unwebbed, lacking lateral fringes; terminal discs expanded, about twice width of digits; subarticular tubercles small, round; supernumerary tubercles absent.

Skin on dorsum and flanks granular; small, low tubercles on dorsal surfaces of shanks; skin on ventral surfaces smooth; anal opening directed ventrally at midlevel of thighs; anal flap moderately long. Tongue elongately elliptical, widest and shallowly indented posteriorly, free posteriorly for about two thirds of its length; vocal slits present; vocal sac single, median, subgular; vomerine odontophores absent.

Coloration in preservative: Dorsum brown with faint, darker brown, irregular spots; scattered cream flecks posteriorly on body; dorsum of snout anterior to eyes paler brown; flanks dark brown with cream flecks ventrally; narrow tan stripe across tip of snout and along canthus rostralis and margin of eyelid, continuous with cream oblique lateral stripe extending to groin; tan stripe on snout bordered below by dark brown stripe continuous along loreal region to orbit; broad cream labial stripe continuous across tip of snout. Dorsal surfaces of forelimbs tan; anterior surfaces of thighs pale brown; dorsal and posterior surfaces of thighs dark brown with irregular cream marks, those on distal posterior surfaces longitudinally elongate; dorsal surfaces

of shanks brown with narrow, faint, darker brown transverse bars; dorsal surfaces of tarsi and toes pale brown. Palmar and plantar surfaces dark brown; other ventral surfaces cream; faint gray mottling on throat, chest, and belly; pair of faint grayish brown spots on chest.

Coloration in life: Dorsum dark gray; arms, lateral stripe, and venter yellow (J. E. Simmons field notes, 4 January 1972).

Measurements (mm): Measurements of male holotype followed by those of female paratype; SVL 31.2, 26.5; tibia length 15.5, 13.2; foot length 15.3, 13.0; head length 11.4, 10.3, head width 11.1, 9.2; length of eye 4.0, 3.3; eye-nostril distance 3.0, 2.7; length of tympanum 2.6, 2.2.

Variation.—The female paratype is like the male holotype in structure, but it differs in being marked far more boldly (Fig. 1). Also, the paratype has a brown longitudinal line on the proximal part of the anterior surface of the upper arm, a similar stripe on the posterior surface of the upper arm, and distinct dark brown, transverse bars on the forearms. Longitudinal cream lines are present on the posterior surfaces of the thighs. The margin of the lower lip, except anteriorly, is dark brown. The venter is cream with a pair of elongate, brown spots on the chest.

Distribution and ecology.—Colostethus shuar is known only from the type locality, where it inhabits cool montane cloud forest. The holotype was sleeping on low vegetation at night, and the paratype was active on the ground by day.

Etymology.—The specific epithet is a noun in apposition. *Shuar* is the name of the indigenous people formerly known as Jivaros (Mashinkiash and Tentets 1986). Many Shuar accompanied Simmons into the Cordillera del Cóndor, where they, like *Colostethus*, hunted only by day.

DISCUSSION

The Cordillera del Cóndor is a north-south range of mountains about 250 km long and physiographically isolated from the Cordillera Oriental of the Andes to the west by river valleys (Fig. 2). The northern two-thirds of the range is separated from the main range of the Andes by the valleys of the Río Nangaritza and the Río Zamora. The latter is a tributary of the Río Santiago, which separates the Cordillera del Cóndor from the isolated Cordillera de Cutucú to the north. To the south, the Cordillera del Cóndor is separated from the major range of the Andes by the valleys of the Río Chirinos and the Río Chinchipe, a tributary of the Río Maraõn in northern Peru. Between the headwaters of the Río Numpatacaimi (a tributary of the Río Nangaritza) and those of the Río Santa Agueda (a tributary of the Río Chirinos), the Cordillera del Cóndoris connected to the Cordillera Oriental of the Andes by several ridges in excess of 1500 m in elevation. Throughout the length of the Cordillera del Cóndor, the range is in excess of an elevation of 1500 m, and in several places there are ridges higher than 2500 m.

The field party began the ascent of the western slope of the northern part of the Cordillera del Cóndor from the site of the Tutus rapids in the Río Zamora, 2:25 h downstream by canoe from the mouth of the Río Chuchumbleza. From the rapids a trail existed for about 2 km to the small settlement of San José at an elevation of 870 m. One day's walk from San José brought the party to a campsite in cloud forest at 1550 m; the following day the party traversed a ridge at 2000 m and down to the headwaters of the Río Piuntza, a tributary of the Río Zamora, but not so labelled on any maps that we have studied. According to Cañadas Cruz (1983), the ecological classification (Holdridge, 1964) of the area is *Bosque húmedo pre-montano* to *Bosque muy húmedo*

montano-bajo. His bioclimatic classification of the Cordillera del Cóndor is *Muy húmedo subtropical* at elevations of 250-1800 m (annual temperatures 18-22.8°C; annual rainfall 2000-3000 mm) and Lluvioso temperado above 2000 m (annual temperatures 12 - 18 C; annual rainfall 2000-3000 mm). The campsite at 1830 m was in wet, dense cloud forest. The ground was covered with a packed layer of dead leaves and fallen branches, the depth of which sometimes made walking difficult. The trunks and branches of most of the trees were covered by a thick layer of spongy mosses. The branches forming the canopy were a thick tangle, and the branches of trees supported many epiphytes.

Among the 18 species of amphibians collected at 1800 m in the Cordillera del Cóndor, three species of *Eleutherodactylus* and *Atelopus boulengeri* were active on the ground by day in addition to the species of *Colostethus*. The two new species of *Colostethus* and *Ischnocnema simmonsi* are known only from the Cordillera del Condor. The anuran faunas of the Cordillera del Condor, Cordillera de Cutucú, and Cordillera Oriental of the Andes are compared by Duellman and Lynch (1988).

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