

Bolivian glass frogs (Anura: Centrolenidae) with a description of a new species from Amazonia

Michael B. Harvey and Brice P. Noonan

(MBH) Natural Sciences Department, Broward Community College, 3501 S.W. Davie Road, Davie, Florida 33314, e-mail: mharvey@broward.edu;

(BPN) Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, Present address: Department of Integrative Biology, 501 WIBD, Brigham Young University, Provo, Utah 84602, e-mail: noonan@byu.edu

Abstract.—We describe a new species of *Cochranella* from the Serranía de Huanchaca, Bolivia. The new species possesses a suite of unusual characteristics, most notably dermal glands along its fingers and toes. *Cochranella spiculata* is reported from Bolivia and we describe the females of that species. New material of *C. bejaranoi* from Chuquisaca collected during the dry season confirms that spicules develop only during the breeding season in this species. Small round clusters of melanophores appear to be germinal in nature and associated developmentally with spicules in *C. bejaranoi*.

Resumen.—Se describe una especie nueva de *Cochranella* de la Serranía de Huanchaca, Bolivia. La especie nueva se distingue de los demás miembros del género por varios caracteres. Es notable que la especie nueva tiene glándulas dérmicas en sus dedos. Por primera vez, reportamos *C. spiculata* de Bolivia y describimos la hembra de la especie. Especímenes de *C. bejaranoi* colectados durante la época seca se carecen de espinas epidérmicas, y eso confirma que las espinas solamente se desarrollan durante la época de reproducción. En especímenes sin espinas, se ven agregaciones de melanoforos. Aparentemente, éstos melanoforos están asociados con el desarrollo de las espinas.

Although speciose in the Andes of Peru, centrolenid frogs were unreported from Bolivia until Cannatella (1980) described *Centrolenella bejaranoi* and *C. bergeri* from the Chapare region of Cochabamba. De la Riva (1990) published color photographs of specimens collected at the type locality of both species, Márquez et al. (1996) described their calls, and Sanchiz & De la Riva (1993) described their tarsal bones. While describing several new species from Colombia, Ruiz-Carranza & Lynch (1991a) proposed a new generic classification of the Centrolenidae. Along with other species of the *ocellata* group, *C. bejaranoi* was referred to *Cochranella* Taylor. A member of the *fleischmanni* group, *C. bergeri* was referred to *Hyal-*

nobatrachium Ruiz-Carranza and Lynch. Shortly thereafter, Reynolds & Foster (1992) described *C. flavidigitata*, but Harvey (1996) showed that the holotype was the first female of *C. bejaranoi*. Outside of Cochabamba, *H. bergeri* extends northward to Ayacucho Department, Peru (Cannatella & Duellman 1982, Rodríguez et al. 1993), and *C. bejaranoi* extends southward through Santa Cruz (Harvey, 1996) to the subtropical montane forests of Chuquisaca (Harvey 1997). Harvey (1996) described *C. nola* from Santa Cruz, and Lötters & Köhler (2000) provided natural history notes, additional localities, and a description of the call for this species. Finally, Köhler & Reichle (1998) discovered *C. pluvialis* in La Paz Department, bringing

the number of centrolenids known from Bolivia to four.

During recent expeditions to the Andean foothills of La Paz and to the Serranía de Huanchaca in eastern Santa Cruz, Harvey collected two additional species new to Bolivia. We take this opportunity to describe these species and to comment briefly on new specimens of *Cochranella bejaranoi*.

Materials and Methods

With a dial caliper under a dissecting scope we measured snout-vent length (SVL), head length (from the rictus to the tip of the snout), head width (at the level of the rictus), eye-nostril distance (from the anterior ocular angle to the posterior edge of the nostril), eye diameter, length of the tympanum, greatest width of the upper eyelid, narrowest interorbital distance, diameters of disks I and III on the hand and disks I and IV on the foot, length of the hand (from the proximal edge of the palmar tubercle to the tip of the third finger), length of the foot (from the proximal edge of the inner metatarsal tubercle to the tip of the fourth toe), and length of the tibia. To observe subtle morphological features, the mouth and skin were stained reversibly with methylene blue in 70% ethanol.

Webbing formulae are in the traditional format of Savage & Heyer (1967) as modified by Myers & Duellman (1982). Modification of this format to accommodate intercalary phalanges (Ruiz-Carranza & Lynch 1997, 1998) has no practical benefit, and we suspect that many readers familiar with the now entrenched traditional method will be misled by any such modification. Except for CBF (Colección Boliviana de Fauna, La Paz, Bolivia), museum abbreviations are those of Leviton et al. (1985).

Species Accounts

Cochranella Taylor

Centrolenid frogs with a humeral spine are placed in *Centrolene*, and those with a

bulbous liver are placed in *Hyalinobatrachium*. The remaining species are placed in *Cochranella*, a possibly paraphyletic genus defined by the absence of synapomorphies. When resurrected from the synonymy of *Centrolenella* (Ruiz-Carranza & Lynch 1991a), the genus contained 32 species. Duellman & Schulte (1993) transferred *azu-lae*, *mariae*, and *puyoensis* to *Centrolene*, and numerous additional species were described by several authors. Sixty-one species of *Cochranella* are currently recognized (Frost 2002).

Cochranella adenocheira, new species

Fig. 1

Cochranella sp. Harvey, 1998:349.

Holotype.—An adult male (CBF 5535, collector's tag M. B. Harvey 5090) collected by Michael B. Harvey on 25 September, 1995 from the northeast base of the Serranía de Huanchaca, Parque Noel Kempff Mercado, Velasco province, Santa Cruz, Bolivia, 13°36'S, 60°55'W, approximately 300 m.

Paratypes.—Two adult males (UTACV 56500, collector's tag M. B. Harvey 5091, and UTACV 56501, collector's tag M. B. Harvey 5092) collected with the holotype by Michael B. Harvey.

Diagnosis.—Using the standardized format of Lynch & Duellman (1973), the new species is diagnosed by the following combination of characteristics: (1) dentigerous process of vomer and teeth present; (2) bones green in life; (3) parietal peritoneum and pericardium white; visceral peritonea of gonads, stomach, and large intestine white; bladder translucent; (4) in life, dorsum green with yellow spots; in preservative, dorsum light gray with white markings; (5) webbing formula of hands **II**2—3.5**III**2—(1.5–2.5)**IV**; (6) webbing formula of feet **I**1—1**III**1.25—2**III**1.25—2**IV**2—1.5**V**; (7) snout round in dorsal view, truncate in profile; (8) dorsal skin smooth (males not in reproductive condition); (9) smooth dermal folds along postaxial edge of antebrachium, manus, and pes; (10) humeral spine absent;



Fig. 1. Holotype (left, dorsal, CBF 5535, SVL 22.4 mm) and paratype (UTACV 56501) of *Cochranella adenocheira*.

(11) lower three fourths of tympanum and its annulus distinct; (12) average snout-vent length of males 22.0 mm; (13) prepollex not enlarged and lacking spine; (14) white glands below vent; para and subcloacal folds absent; (15) Finger I much longer than finger II; (16) liver trilobed; (17) eye diameter roughly $2.3\times$ width of disc of Finger III.

Comparisons.—Species of *Cochranella* are placed in two groups. Species of the *C. granulosa* group have sloping snouts, pale green bones, flared lips, dentigerous processes of the vomers, extensive digital webbing, and white visceral and parietal peritonea. Dermal folds of most species in this group are crenulate (Ruiz-Carranza & Lynch 1991b). With the exception of *C. resplendens* from the Río Putumayo and Río Napo drainages of Colombia and Ecuador and *C. castroviejoi* from the Paria

peninsula of Venezuela, the nine species of this group occur in Colombia and Central America.

The *Cochranella ocellata* group is more heterogeneous: a catchall. We refer *C. adenocheira* to the *C. ocellata* group because it has a truncate snout and smooth dermal folds. Like the new species, seventeen species of *Cochranella* have vomerine teeth and extensive digital webbing between the third and fourth finger. The visceral peritoneum is translucent and lacks guanophores in *C. adiazeta*, *C. flavopunctata*, *C. megistra*, *C. nola*, *C. punctulata*, *C. saxiscandens*, *C. spiculata*, *C. susatamai*, *C. tangarana*, *C. trubae*, and *C. xanthocheridia*, and the parietal peritoneum lacks guanophores in *C. ametarsia*. In the new species, both peritonea have prominent white patches. White visceral and parietal peritonea occur in *C. crocoepodes* and *C. orejuela*.

However, both of these species have uniformly green dorsa and lack tarsal and ulnar folds. Five species were described before the importance of peritoneal pigmentation was fully appreciated. Unlike the new species (characteristics in parentheses), *C. albomaculata* has supernumerary tubercles on its hands (supernumerary tubercles absent), *C. geijskesi* and *C. oyampiensis* both lack ulnar and tarsal folds (smooth, prominent folds present), and *C. spinosa* has a uniformly green dorsum and pollical spine (dorsum green with white spots and pollical spine absent). *Cochranella ritae* is known only from the holotype which has been destroyed (Duellman 1977). Lutz & Kloss (1952) describe the digital pads of this species as enormous and remark that the digital pad of the third finger is double the size of the tympanum. In contrast, the digital pads of the new species are smaller than the tympanum.

Description of holotype.—Body small compared to congeners (SVL 22.4 mm); head wider than body; head length 74% of head width; head length 31% of SVL; snout short; eye-nostril distance 68% of eye diameter; snout round in dorsal view, truncate in profile; nares elliptical, small, and protuberant, closer to tip of snout than to eye; internarial region not depressed; lore sloping; canthus rostralis indistinct; lips not flared; eye large, its diameter 2.3 times that of disc on finger III; eyes widely spaced; eyelid width 83% of interorbital distance; tympanum and tympanic annulus distinct, their upper and posterior margins overlapped by low, rounded supratympanic fold; diameter of tympanum 35% of diameter of eye.

Skin of ventral body, lower flanks, and ventral thigh very weakly areolate; skin of dorsum and gular region smooth; dorsal body surfaces with scattered, white dermal glands; same white glands fusing to form prominent and near continuous fan below vent and forming white folds on lips; skin below vent lacking paired enlarged tubercles; para- and subcloacal folds absent.

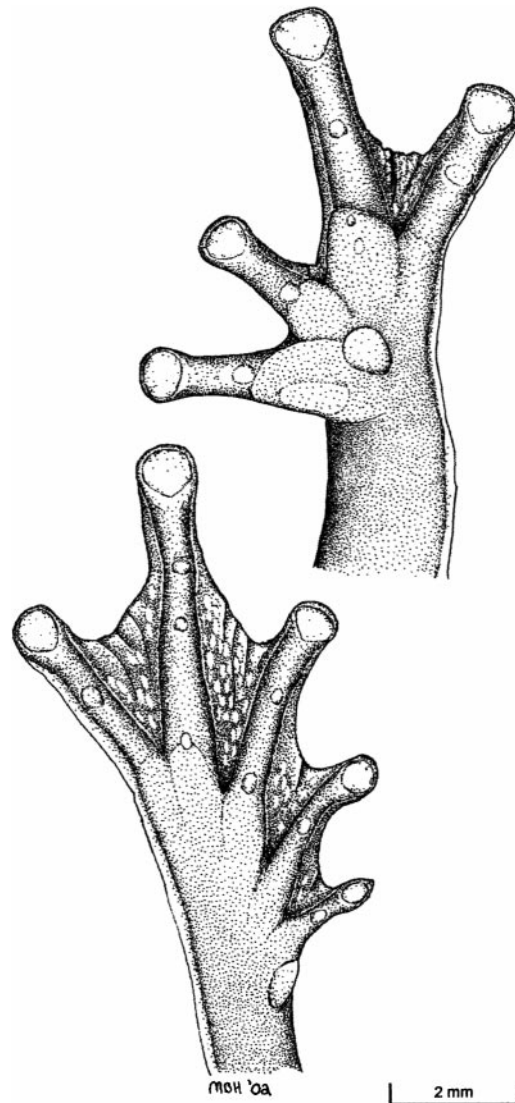


Fig. 2. Plantar and palmar morphology of *Cochranella adenocheira* (CBF 5535).

Arms short; girth of upper arm about half that of forearm; humeral spine absent; low white glandular ridge extending from elbow along postaxial edge of antebrachium to tip of fourth finger; length of hand moderate, 73% as long as foot (Fig. 2); first finger about as long as fourth and noticeably longer than second finger ($\text{finger II} < \text{I} = \text{IV} < \text{III}$); palmar tubercle round in ventral aspect and profile, about half again as large as flat, oval thenar tubercle; subarticular tu-

bercles round and flat; distal subarticular tubercles on digits III and IV more than twice as large as indistinct proximal subarticular tubercles on these same digits; supernumerary tubercles and nuptial excrescences absent; disks of fingers small; disk of finger III 1.4 times as large as disk of finger I, 1.2 times as large as tympanum, and 1.2 times as large as disk of toe IV; digital pads edged by marginal grooves, round on fingers I–II, subtriangular on fingers III–IV; unguis flap smooth and unmodified; dorsal surfaces of finger tips (but not toes) white and glandular; same white glandular substance extending as narrow strip dorsal to the dermal keel and web along edges of fingers (these glandular bands are particularly obvious between digits III and IV where they are noticeably thicker than the webbing); webbing thick, basal between fingers I–II; webbing formula of remaining fingers: **II**—**3.5III**²⁺—**2IV**.

Legs long; length of tibia 55% of snout-vent length; length of foot moderate, 80% as long as tibia; heel smooth; white glandular ridge extending along postaxial edge of tarsus from heel to disk of fifth toe; ventral surface of tarsus smooth; inner metatarsal tubercle flat, oval, and small: about as large as disk of second toe; outer metatarsal tubercle absent; when adpressed, toe I < II < III < V < IV; fourth and fifth toe fused just proximal to phalangeal-metatarsal articulation; subarticular tubercles round and indistinct, much narrower than digits and largest distally; proximal subarticular tubercle absent from fifth toe (i.e., a subarticular tubercle is present between the first and penultimate phalanges, but not below the phalangeal-metatarsal articulation); supernumerary tubercles absent; webbing thin and smooth; pedal webbing formula **I**—**1-II**^{1.25}—**2+III**^{1.25}—**2IV**²—**1.5V**; digital pad of first toe distinctly pointed but lacking papilla; pads of remaining digits round; disks edged by marginal grooves, round on toes I–II, subtriangular on remaining toes; except for postaxial edge of fifth toe, toes

lacking white glandular edging characteristic of fingers.

Choanae subrectangular and large: each choana about as large as disk on third finger; choanae located anteriorly in roof of mouth and medial to lingual shelves of maxillary arcade; dentigerous processes of vomers oval, closely approximating one another medially, positioned medial to choanae; each process bearing four small teeth; tongue round, not free posteriorly; vocal apertures large elongate slits, bordered posteriorly and medially by hyale, and each about one half as wide as tongue; vocal sac single.

White pigmentation of the coelom and morphology of the liver: In the ventral parietal peritoneum, white pigment forms a patch obscuring the heart and the right hepatic lobe and anterior third of the left lobe, but the posterior portion of the left hepatic lobe is visible through the ventral skin. This patch of pigment also completely invests the entire falciform ligament and parietal pericardium. White pigment of the visceral peritoneum on the dorsal surface of the stomach extends across the greater curvature to part of the left ventral surface; the lesser curvature and remaining portion of the ventral surface of the stomach are not pigmented. The visceral peritonea of the large intestine (but not the small) and testes are entirely white. The remaining peritonea, the urinary bladder, and mesenteries lack white pigment.

The liver has two ventral lobes of about equal size, the left partially divided. The ventral lobes are separated from one another by a large gall bladder. A smaller third lobe extends vertically from the left lobe dorsal to the hepatoduodenal ligament to fuse with the dorsal surface of the right lobe.

Coloration in preservative (70% ethanol after unbuffered 10% formalin): The dorsum is gray with numerous, scattered white spots, each smaller than the smallest digital pads. The skin of the upper eyelids is darker gray. Although more diffuse than elsewhere

on the body, melanophores extend onto the dorsal surface of the digits to the pads on fingers III–IV and toes II–V. The dorsal surfaces of the remaining digits are mostly immaculate, however dorsal surfaces of the digital tips of the fingers and toes I–III are white (again, due to the presence of dermal glands). White lines (glandular ridges) extend along the postaxial edges of the limbs, the upper lip, and lower margin of the mandible. Dense white spots coalesce to form a triangular patch below the vent.

Color in life (based on field notes of M. B. Harvey): Dorsum dark green with bright yellow spots; dermal folds and glands white; tympanum and its annulus same color as adjacent dorsal skin; gular skin translucent; tongue green; skin of ventral body translucent; parietal peritoneum white and obscuring heart and liver; intestines visible; visceral peritoneum pigmented; bones green; iris yellow-green.

Measurements (in mm) of the holotype are followed by those of UTACV 56500 then 56501 in parentheses: SVL 22.4 (22.2, 21.4), length of tympanum 1.1 (1.1, 1.0), eye diameter 2.9 (2.8, 2.1), width of upper eyelid 2.1 (2.2, 2.1), interorbital distance 2.5 (2.7, 2.7), head width 9.4 (8.8, 8.8), head length 7.0 (7.5, 8.0), eye-nostril distance 2.0 (2.1, 2.0), hand length 7.4 (6.9, 7.4), foot length 10.0 (8.9, 9.8), length of tibia 12.4 (12.7, 12.7), diameter of disk of finger I 0.9 (0.9, 0.9), diameter of disk of finger III 1.3 (1.2, 1.2), diameter of disk of toe I 0.6 (0.5, 0.5), diameter of disk of toe IV 1.1 (1.0, 0.9).

Distribution, biogeography, and natural history.—The type specimens were perched on vegetation along a sandy stream bed through primary rainforest. The site lies at the base of the Serranía de Huanchaca accessible by a trail from Lago Caimán (13°35'59"S, 60°54'54"W, approximately 300 m elevation), Parque Nacional "Noel Kempff Mercado," Velasco province, Santa Cruz, Bolivia (Fig. 3). Harvey and students participating in a field course sponsored by Conservation International visited the site

numerous times after the type specimens were found; thorough searching failed to produce additional specimens. The stream at the type locality flows off of the rocky face of the Serranía de Huanchaca, and we suspect that it is clear, fast flowing, and shallow during the wet season. In September, water in the streambed was restricted to small, pools less than 5 mm deep. Other anurans found along the streambed include *Adenomera* sp., *Hyla fasciata*, *Osteocephalus lepreurii*, and *Pyllomedusa vaillanti*.

The Serranía de Huanchaca is a sandstone escarpment of the Brazilian Shield formed during the Precambrian. Characterized by steep slopes, it reaches a maximum height of 900 m (Killeen & Schulenberg 1998). Streams at the type locality are tributaries of the Río Iténez which forms the border between Bolivia and Brazil. Precise climatic data for the park are lacking, but data from meteorological stations at nearby Concepción, Magdalena, and San Ignacio indicate that the mean annual temperature at the type locality is 25–26°C (temperatures may range from 3–38°C on an annual basis) and mean annual precipitation is 1400–1500 mm (Killeen 1998). The area experiences a dry season during the austral winter. The climate and geomorphology of the surrounding lowlands has produced a rich mosaic of habitats, ranging from rainforest to flooded savanna and cerrado. These varied habitats support a remarkably diverse assemblage of plants and animals (Killeen & Schulenberg 1998). In numbers of species of reptiles and amphibians, the region exceeds other well-studied sites such as Santa Cecilia, Manu, and Manaus, making it arguably the most diverse herpetological community in South America (Harvey 1998). An ongoing review of the reptiles and amphibians of this region has identified several species new to science (Harvey and Gutberlet 1998, Harvey 1999).

Etymology.—The specific epithet *adenocheira* is a feminine noun in apposition derived from the Greek nouns *Adenos* mean-

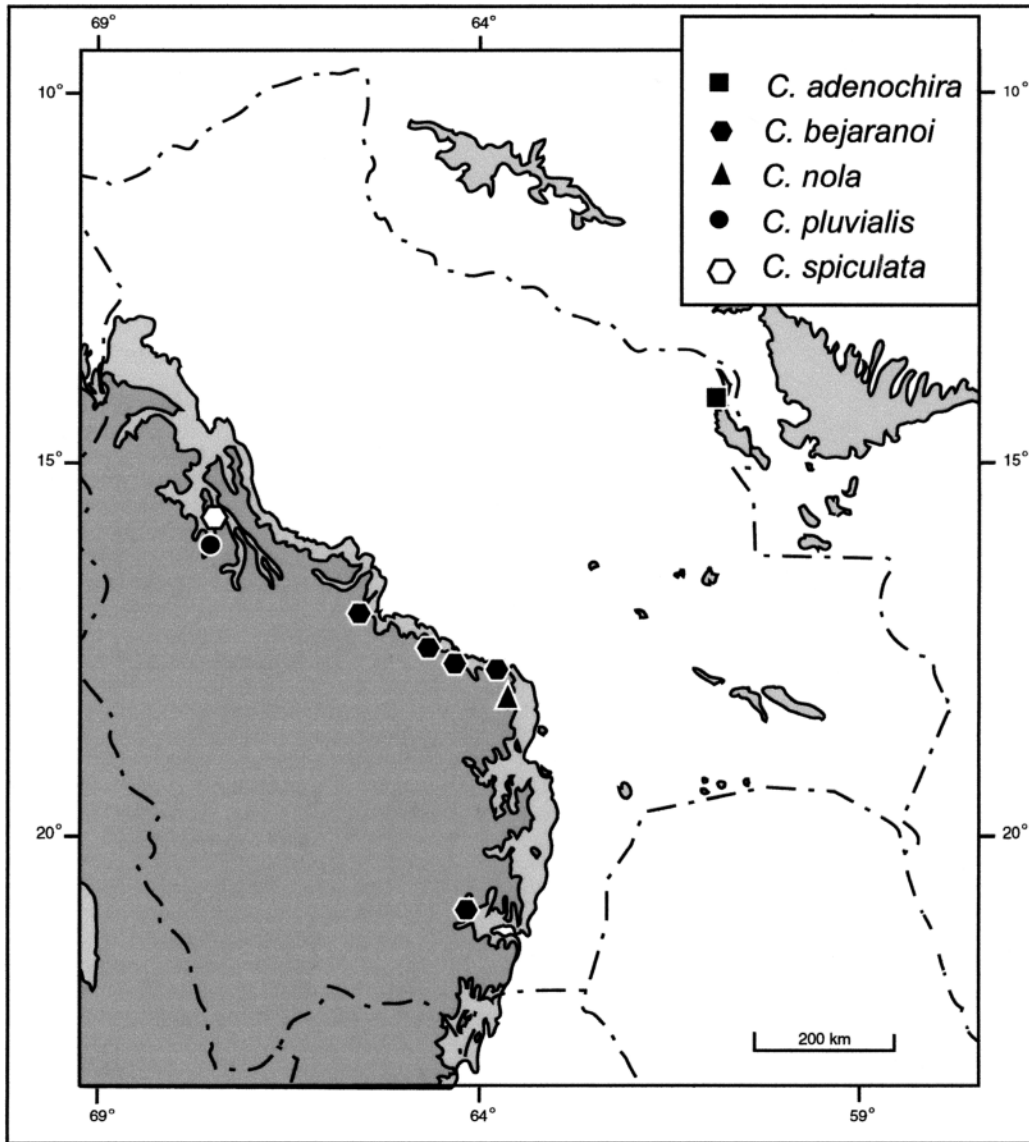


Fig. 3. Distribution of centrolenid frogs in Bolivia. Areas above 500 and 1000 m are shaded gray.

ing gland and Cheir meaning hand. The name calls attention to the distinctive white glands above the webbing and along the fingers of this species.

Cochranella bejaranoi (Cannatella)

Centrolenella bejaranoi Cannatella, 1980: 715. Holotype male (KU 182369, examined) from "58.1 km SW Villa Tunari (by road), 1980 m Chapare province, Co-

chabamba, Bolivia; 17°11'S, 65°50'W." Cannatella & Duellman, 1982:386; Frost, 1985:79; De la Riva, 1990:269.

Centrolenella flavidigitata Reynolds & Foster, 1992:89. Holotype female (USNM 257803, examined) from "road to San Onofre, 3.5 km by road N of the road from Cochabamba to Villa Tunari, at a point 97.5 km from Cochabamba, Chapare Province, Department of Cochabam-

ba, Bolivia, elevation approximately 1601 m.” [added to synonymy by Harvey, 1996]

Cochranella bejaranoi (Cannatella): Ruiz-Carranza & Lynch, 1991a:21; Duellman, 1993:43; Sanchiz & De la Riva, 1993:116; Harvey, 1996:432; Márquez et al., 1996:97; Harvey, 1997:83; Duellman, 1999:300; De la Riva et al., 2000:29; Köhler, 2000:87.

Remarks.—Cannatella (1980) used the presence of spicules on the dorsum to diagnose *Cochranella bejaranoi* from all but four Andean centrolenids (*Cochranella buckleyi*, *C. spiculata*, *C. truebae*, and *C. johnelsi* [= *C. buckleyi*]). Specimens recently collected during the dry season in Chuquisaca, Bolivia (Harvey 1997) suggest that presence of spicules is an unreliable diagnostic character, because spicules are present only in specimens in reproductive condition. The Chuquisaca specimens (UTACV 47252–56) are identical to topotypic *C. bejaranoi* with the exception of having an entirely smooth dorsum (Fig. 4) and lacking a Type I nuptial pad (Flores 1985). During the reproductive season, a nuptial pad covers the preaxial edge of the thenar tubercle and most of the dorsal surface of the first digit. Sexual dimorphism in the distribution of spicules in specimens of *C. bejaranoi* is similar to that described below for *C. spiculata* (Harvey 1996): spicules uniformly cover the dorsum of males and are absent middorsally in females. In *C. bejaranoi* from Chuquisaca, small circular clusters of melanophores (=glands?) visible under high magnification have the same distribution as spicules: they are absent middorsally in females but not in males and appear on the limbs and around the tympanum in both sexes. Because of their distribution and size, we suspect that these melanic structures are germinal and associated with the seasonal appearance of spicules. Nonetheless resolution of this question will require histological studies. We should clarify that this species does not have

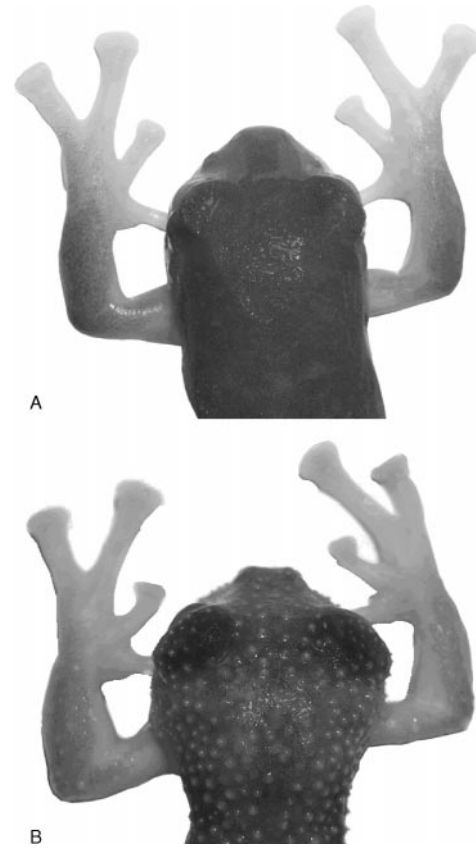


Fig. 4. Comparison of a male *Cochranella bejaranoi* (A, MBH 4648*, head width 8.13 mm) collected during the dry season in Chuquisaca and a male (B, UTACV 47254) in breeding condition from Cochabamba, Bolivia.

“white spots.” When Cannatella (1980) wrote “color in life dark green with minute off-white spots,” he was apparently referring to the spicules of males, which are round and translucent and thus appear off-white in life.

Cochranella spiculata (Duellman)

Centrolenella spiculata Duellman: Holotype male (KU 162284, examined) from “the Río Cosñipata, 4 kilometers southwest of Santa Isabel, Department Cuzco, Perú, 1700 m.” Duellman, 1979:452; Frost, 1985:85.

Cochranella spiculata (Duellman): Ruiz-Carranza & Lynch, 1991a:23; Duellman,

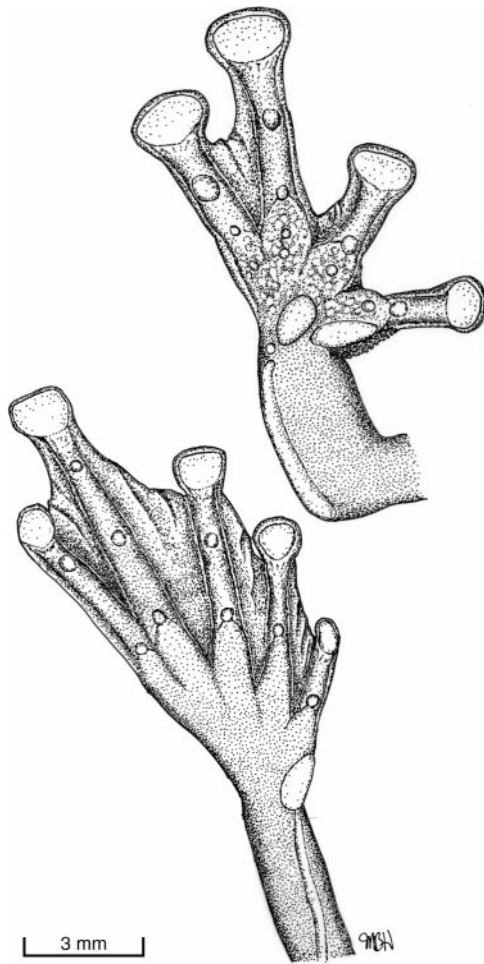


Fig. 5. Plantar and palmar morphology of *Cochranella spiculata* (UTACV 56504).

1993:48; Rodríguez et al., 1993:8; Morales, 1995:3; Duellman, 1999:301.

Description and variation.—To the original description, we would add that a pair of enlarged round glandular tubercles is present below the vent. The palmar tubercle is round in ventral aspect, flat in profile, and about as large as the flat, oval thenar tubercle (Fig. 5). Single supernumerary tubercles lie proximal to the subarticular tubercles on fingers I, II, and IV; two lie proximal to the subarticular tubercle on finger III. Glandular cream-colored nuptial excrescences extend from the phalangeal-metacarpal articulation of digit I, across the

proximal edge of the thenar tubercle, and onto the dorsal surface of the digit. The digital pads are round on finger I and toes I–II and truncate on the remaining digits. A glandular ulnar fold extends from the wrist along the entire length of the forearm. A similar inner tarsal fold extends midventrally from the inner metatarsal tubercle almost to the heel. The fourth and fifth toes fuse just proximal to the phalangeal-metatarsal articulation. The choanae are round and very small: each choana is less than one-fifth the diameter of the disk on the first finger. The choanae are located anteriorly in the roof of the mouth and medial to lingual shelves of the maxillary arcade. Dentigerous processes of the vomers are low, oval, and widely separated from one another medially.

In the ventral parietal peritoneum, white pigment forms a large patch obscuring the heart and most ventral organs. Posteriorly the patch terminates at the level of the urinary bladder which is not covered. White pigment is absent ventral to the gall bladder, leaving a small, oval olive-green patch in three Bolivian specimens. Nonetheless, white pigment uniformly covers the liver and gall bladder in the remaining specimens. Some white pigment is present ventrally in the parietal pericardium; the falciform ligament and visceral peritoneum are unpigmented. The liver is trilobed.

In life (based on field notes of M. B. Harvey), the dorsum is dark green and the venter aquamarine. The spicules are off-white. The bones are green, the parietal peritoneum white, and the inner digits of the hands and feet yellow; as Harvey (1996) points out, melanophores extend to the digital tips of the outer digits of this species making the digits appear dark green in life. The palpebrum is clear and the iris dark copper.

Table 1 summarizes morphometric variation within our sample. Females are larger (Fig. 6) and, consequently, more robust than males, but we note no intersexual differences in snout shape, webbing, body proportions, or other characters commonly as-

Table 1.—Morphometric variation among Peruvian (type series) and Bolivian *Cochranella spiculata* (Appendix I). n parentheses, means \pm standard deviations follow ranges for Bolivian female specimens.

	Type specimens (n = 2)	Bolivian males (n = 2)	Bolivian females (n = 9)
Snout-vent Length (SVL)	21.4–21.5 mm	22.6–23.1 mm	24.0–27.7 mm (26.1 \pm 1.4)
Head length/Head width	86.3–88.0%	86.2–87.8%	76.1–93.3% (86.4 \pm 4.8)
Head length/SVL	32.0–33.6%	32.3–32.4%	28.2–36.2% (31.4 \pm 2.3)
Eye-nostril/Eye diameter	59.0–61.7%	53.3–74.7%	65.1–82.3% (74.9 \pm 6.7)
Eye diameter/Disc Finger 3	196.1–229.9%	159.2–167.0%	139.4–202.4% (165.7 \pm 18.4)
Eyelid width/Interorbital Distance	55.6–58.8%	58.9–76.3%	50.7–67.5% (58.9 \pm 6.2)
Tympanum/Eye diameter	32.5–32.5%	27.5–35.0%	27.6–41.0% (35.2 \pm 4.4)
Hand length/Foot length	71.7%	58.5–69.4%	62.0–70.7% (67.1 \pm 2.8)
Disc Finger 3/Disc Finger 1	134.0–157.1%	139.9–141.5%	137.6–169.4% (157.0 \pm 10.0)
Disc Finger 3/Tympanum	134.0–157.1%	179.4–217.4%	145.2–224.5% (175.7 \pm 30.8)
Disc Finger 3/Disc Toe 4	120.7–133.9%	110.8–126.6%	111.7–136.6% (123.8 \pm 7.8)
Tibial length/SVL	57.7%	58.5–56.6%	55.0–78.3% (59.4 \pm 7.4)
Foot Length/Tibia length	79.9%	87.5–97.1%	64.1–91.9% (86.0 \pm 8.4)

sociated with sexual dimorphism in anurans. In each of the four males, spicules are extensive and densest middorsally; they cover all dorsal body surfaces except the hands and toes I–III. Among females, spicules occur behind the eye above and below the tympanum and on the flanks just above the arm in most specimens. A few specimens lack spicules entirely, and in UTA 56685 spicules extend along the entire length of the flanks and onto the limbs. Middorsally, the skin is smooth in all females.

Natural history and distribution.—The Bolivian sample was collected by M. B. Harvey, J. Aparicio E., and field parties from the Colección Boliviana de Fauna during three expeditions to the Serranía de Bella Vista, La Paz Department, Bolivia, during the rainy season (December and January). In the Serranía de Bella Vista, this

species appears to avoid streamside vegetation; most specimens were collected close to water falls on large, mossy boulders in a deep, fast flowing stream 8 km from Canavi on the road to Sapecho, 1510 m. Notably this species does not appear to occur in the many smaller streams of the Serranía de Bella Vista where *Hyalinobatrachium bergeri* is found. No other species of *Cochranella* is known from the Serranía de Bella Vista. *Hyla armata* and *Bufo veraguensis* breed in the same stream as *C. spiculata*, but both of these species are also abundant in the smaller streams.

Females in our sample are gravid. Ovaries of UTACV 56504 are filled with black pigmented eggs, the largest being 1.8 mm in diameter. To avoid damaging the specimens, we did not attempt to count eggs.

Remarks.—Since its original description, *Cochranella spiculata* has been mentioned

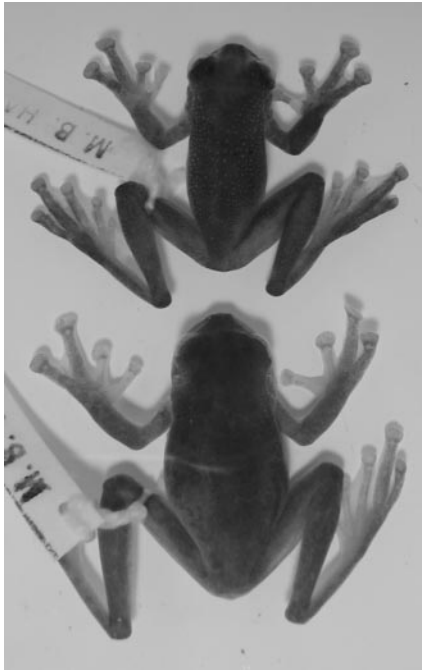


Fig. 6. Male (UTACV 56508, SVL 22.58 mm) and female (UTACV 56504) *Cochranella spiculata* from the Serranía de Bella Vista, La Paz, Bolivia.

only in regional checklists (e.g., Rodríguez et al. 1993, Morales 1995), taxonomic revisions (Ruiz-Carranza & Lynch 1991a), transect analysis (Cadle and Patton 1988), and in brief comparisons sections with related species (it is very similar and likely to be closely related to *C. tangarana* and *C. nola*; Duellman & Schulte 1993, Harvey 1996). Originally known only from the type locality in Cuzco Department, Rodríguez et al. (1993) reported it from Ayacucho Department, Peru. The original description includes a photograph of the paratopotype but lacks any illustrations of the hands and feet. Until now, the female of the species has remained unknown.

While examining the holotype and paratype, we noted several errors in the original description. As described above, supernumerary tubercles, nuptial excrescences, and ulnar and tarsal folds are all present in the type series and in the Bolivian specimens.

Discussion

Most if not all centrolenids are stream breeders with fossorial tadpoles (McDiarmid & Altig 1999). As such, they are adapted to life in montane streams and, not surprisingly, reach their highest diversity in the Andes. Three species of *Hyalinobatrachium* occur in the mountains of southeastern Brazil (Heyer 1985). Centrolenid frogs are rare in the lowlands, and only a few species (e.g., *C. midas* and *C. resplendens* from Santa Cecilia [Duellman 1978] and *C. ametarsia* from Colombia [Flores 1987]), have colonized the Amazonian lowlands adjacent to the Andes. However, except for *C. ritae* from Manaus, the family is unknown from the vast expanse of Amazonia in Brazil and Bolivia. For these reasons, discovery of a centrolenid at the Serranía de Huanchaca comes as a surprise. The Serranía straddles the border between Bolivia and Brazil, and *C. adenocheira* almost certainly occurs in Brazil.

Cochranella adenocheira possesses several noteworthy morphological characteristics. The first toe is noticeably pointed in *C. adenocheira*. To our knowledge, this trait has not been reported previously in *Cochranella*. Similarly pointed first toes occur in *Centrolene papillihallicum* (Noonan & Harvey 2000), but the unguis flap is smooth and the dermal appendage of the Guayanian species is lacking in *C. adenocheira*. Postaxial, antebrachial, and tarsal folds are common in anurans, and these folds are frequently glandular. However, *C. adenocheira* has similar folds along fingers III and IV. These folds might be confused for keels, but the white, glandular folds extend proximally above the web and are clearly distinct from it. When webbing and keels are present, keels are continuous with the web. We have not seen similar glandular folds in other centrolenids or, for that matter, in any other anurans.

Centrolenid frogs are often referred to as glass frogs because their ventral skin is translucent: the heart and other internal or-

gans are visible in some species. Shiny white pigmentation (guanophores) invests the peritonea of many species in each of the three centrolenid genera, and the presence and distribution of this pigment has been used to diagnose species. Review of several recent publications suggests that most authors rely on color notes taken in the field when describing the peritonea. Although some authors have reported fading of the guanophores (Starrett & Savage 1973, Cannatella & Lamar 1986, Ruiz-Carranza & Lynch 1998), the color persists in most preserved material. We note that guanophores are still clearly visible in the type material of *Cochranella spiculata* collected 28 years ago. Color notes taken in the field accompanied by dissection allows for more precise descriptions. Amount of pigmentation in the ventral parietal peritoneum shows intraspecific variation (Harvey 1996); whether similar variation exists in the visceral peritonea is poorly known although Ruiz-Carranza & Lynch (1991a) report little or no intraspecific variation for this character. Ruiz-Carranza & Lynch (1991a) argued that white pigmentation of the visceral peritoneum had evolved more than once within the Centrolenidae. These authors knew of no other anurans with this character; it has also evolved in a group of green, spiculate *Rhacophorus* (Harvey et al. 2002). Nonetheless, this character only occurs in three other species of *Cochranella*, and those species are distantly allopatric from the new species. It is noteworthy that the visceral peritonea of the testes are white in the new species. Ruiz-Carranza & Lynch (1991a) observe that species with white alimentary peritonea also have white testicular peritonea. Color of the testicular peritonea can be a useful character: these peritonea are brown in some leptodactylids of the genus *Phrynopus* (Duellman 2000); they may be white, black, or pink (=unpigmented) in rhacophorid frogs (Harvey et al. 2002).

Although vocal slits are well developed in the type series of *Cochranella adenochira*, the specimens lack some other sec-

ondary sexual characteristics found in many congeners, such as nuptial excrescences and spicules. However, readers should not assume this species never has these structures. As we point out in the account for *C. bejaranoi*, both spicules and nuptial excrescences are seasonally expressed in some species (see also Cannatella & Duellman 1982, Ruiz-Carranza & Lynch 1991a, Harvey 1996). The type series was not calling, and rain had not fallen for at least three weeks prior to its collection.

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Appendix I
Specimens Examined

Cochranella adenocheira (3): **BOLIVIA. Santa Cruz:** CBF 5535, UTACV 56500–01. *Cochranella bejaranoi* (11): **BOLIVIA. Cochabamba:** USNM 257803 (holotype of *Centrolenella flavidigitata*), KU 182370–71 (paratypes), UTACV 47254. **Chuquisaca:** UTACV 47252–56; UTA 56685–86. *Cochranella spiculata* (13): **BOLIVIA. La Paz:** UTACV 47280–83, 56502–08. **PERU. Cuzco:** KU 162283 (paratype), KU 197031.