

TWO NEW SPECIES OF *BRYOPHRYNE* (ANURA: STRABOMANTIDAE) FROM HIGH ELEVATIONS IN SOUTHERN PERU (REGION OF CUSCO)

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ABSTRACT: We describe two new species of *Bryophryne* from the Region of Cusco, Provincia de La Convención in southern Peru, increasing the number of currently known *Bryophryne* to eight. One of the new species is the second known species of *Bryophryne* that has a tympanic annulus and tympanic membrane. Males of this species have vocal slits, a vocal sac, and call from inside moss. It is readily distinguished from all its congeners by having a blackish-brown venter with yellow, orange, or pale pink blotches. This species is found at elevations of 3800–3850 m in the puna along the road from Vilcabamba to Pampascona. The second new species has the venter orange and pale gray mottled in males, whereas the venter is black and pale gray mottled in the single female. It was found inside bunches of the Peruvian feather grass (*Stipa ichu*) in the puna of Abra Málaga next to the road at an elevation of 4000 m. A map showing the type localities of all currently known species of *Bryophryne* is presented.

RESUMEN: Describimos dos nuevas especies de *Bryophryne* de la Región de Cusco, Provincia de La Convención en el sur de Perú, incrementando a ocho el número de especies conocidas para este género. Una de las nuevas especies es la segunda especie de *Bryophryne* que posee membrana y annulus timpánicos. Los machos de esta especie tienen hendiduras vocales, un saco vocal, y cantan bajo musgos. Se diferencia fácilmente de otras especies del mismo género por su coloración ventral marrón oscura con manchas amarillas, anaranjadas o rosadas. Esta especie se encuentra en la puna a elevaciones de 3800–3850 m a lo largo de la carretera entre Vilcabamba y Pampascona. La segunda especie nueva presenta una coloración ventral moteada anaranjada y gris pálido en los machos, y coloración ventral moteada negra y gris pálido en la única hembra. Esta especie fue encontrada entre manojos de icchu (*Stipa ichu*) en la puna del Abra Málaga, a una elevación de 4000 m. Incluimos un mapa con las localidades tipo de todas las especies de *Bryophryne* conocidas.

Key words: Anura; *Bryophryne*; New species; Puna; Strabomantidae

THE GENUS *Bryophryne* was described by Hedges et al. (2008) and is known from cloud forests and puna habitats in the Regions of Cusco and Puno, southern Peru at elevations of 2350–4000 m. Since the description of the genus, five species have been described or assigned to this genus, that currently comprises the following six species: *Bryophryne cophites* (Lynch), *B. bustamantei* (Chaparro et al.), *B. gymnotis* Lehr and Catenazzi, *B. hanssaueri* Lehr and Catenazzi, *B. nubilosus* Lehr and Catenazzi, and *B. zonalis* Lehr and Catenazzi. Recent fieldwork in the Cordillera Vilcabamba, a mountain range in the northwestern Region of Cusco, led to the discovery of two additional new species, which are described herein.

MATERIALS AND METHODS

Taxonomy follows Hedges et al. (2008) and the format for the diagnosis follows that of Duellman and Lehr (2009), and the description that of Lynch and Duellman (1997). We follow the definition of conditions of the tympanum by Lynch and Duellman (1997). Specimens were preserved by injecting a mixture (5:1000) of 40% formalin and 98% ethanol and stored in 70% ethanol. Specimens not having external sex characters were dissected to determine sex and maturity, and the otic region was dissected in order to determine condition of the tympanic annulus. We measured the following variables to the nearest 0.1 mm with digital calipers under a microscope: snout–vent length (SVL), tibia length (TL), foot length (FL, distance from proximal margin of inner metatarsal tubercle to tip of toe IV), head length (HL, from angle

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of jaw to tip of snout), head width (HW, at level of angle of jaw), eye diameter (ED), interorbital distance (IOD), upper eyelid width (EW), internarial distance (IND), eye–nostril distance (E–N, straight-line distance between anterior corner of orbit and posterior margin of external nares). We did not measure the tympanum diameter because it became indistinct after preservation. We determined comparative lengths of toes III and V by adpressing both toes against toe IV; lengths of fingers I and II were determined by adpressing the fingers against each other. Drawings were made by the senior author with the use of a stereomicroscope with drawing tube attachment. Photographs taken by E. Lehr were used for descriptions of color in life and are available for all types at the Calphoto on-line database (<http://calphotos.berkeley.edu>).

Locality names follow the spelling of the US Board on Geographic Names (<http://earth-info.nga.mil/gns/html/index.html>) and, for localities not listed in this database, according to Cartas Nacionales “Urubamba” (sheet 27-r) and “Pacaypata” (sheet 27-p), Instituto Geográfico Nacional, Lima. We deposited specimens in the herpetological collections of the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos (MUSM) in Lima, Peru, and the Museum für Tierkunde Dresden (MTD). For specimens examined, see Appendix.

SYSTEMATICS

Bryophryne **abramalagae** *sp. nov.*

Figs. 1 and 2

Holotype.—MUSM 27631 (Figs. 1, 2), an adult male from Abra Málaga (13° 07' 23.8" S, 72° 20' 51.2" W) at 4000 m elevation, in the puna next to the road leading to Alfamayo, Distrito de Huayopata, Provincia de La Convención, Región Cusco, Peru, on 31 March 2009 by E. Lehr and J. C. Jahuanchi.

Paratypes.—Five: One female (MTD 47490, no mature ovarian eggs present), three males (MTD 47489, MUSM 27630, 27632), one juvenile (MTD 47491), all collected with the holotype on 31 March 2009 by E. Lehr and J. C. Jahuanchi.

Diagnosis.—A medium-sized species of *Bryophryne* having the following combination of characters: (1) Skin on dorsum shagreen with small scattered tubercles, skin on venter areolate; discoidal fold absent, thoracic fold present; narrow, discontinuous dorsolateral fold; (2) tympanic membrane and tympanic annulus absent; (3) snout rounded in dorsal and lateral views; (4) upper eyelid with enlarged tubercles; width of upper eyelid narrower than IOD; cranial crests absent; (5) dentigerous processes of vomers absent; (6) males lacking vocal slits and nuptial pads; (7) finger I shorter than finger II; tips of digits slightly pointed; (8) fingers without lateral fringes; (9) ulnar and tarsal tubercles present; (10) heel with small tubercles; inner tarsal fold absent; (11) inner metatarsal tubercle ovoid, about half the size of elongate outer metatarsal tubercle; supernumerary plantar tubercles present; (12) toes without lateral fringes; basal webbing present; toes V and III about equal in length, slightly larger or slightly shorter; toe tips slightly pointed, about as large as those on fingers; (13) in life, dorsum olive or orange brown, venter orange mottled with pale gray in males, venter black and pale gray mottled in single female; (14) SVL in single female 20.1 mm, in males 15.9–19.1 mm ($n = 4$).

Bryophryne abramalagae is readily distinguished from species of *Bryophryne* (*B. gymnotis*, *B. flammiventris*) that have a tympanum (absent in *B. abramalagae*). Furthermore, males of *B. abramalagae* lack vocal slits, which are present in *B. bustamantei*, *B. gymnotis*, and *B. flammiventris*. Male *B. abramalagae* (SVL 15.9–19.1 mm, $n = 4$) are smaller than males of *B. cophites* (SVL 18.0–22.7 mm; Lynch, 1975), but larger than males of *B. hanssaueri* (SVL 12.3–18.0, 15.5 ± 2.8 , $n = 4$) and males of *B. nubilosus* (SVL 12.7–18.9, 14.9 ± 2.2 , $n = 5$). *Bryophryne abramalagae* differs from *B. zonalis* in lacking lateral fringes (present in *B. zonalis*). Besides differences in morphological characters, *B. abramalagae* differs in respect of ventral coloration pattern from its congeners. *Bryophryne abramalagae*, *B. hanssaueri*, and *B. cophites* have different amounts of orange on the venter. However, in *B. abramalagae* the throat is orange in all adults, and chest and belly are orange with different amounts of

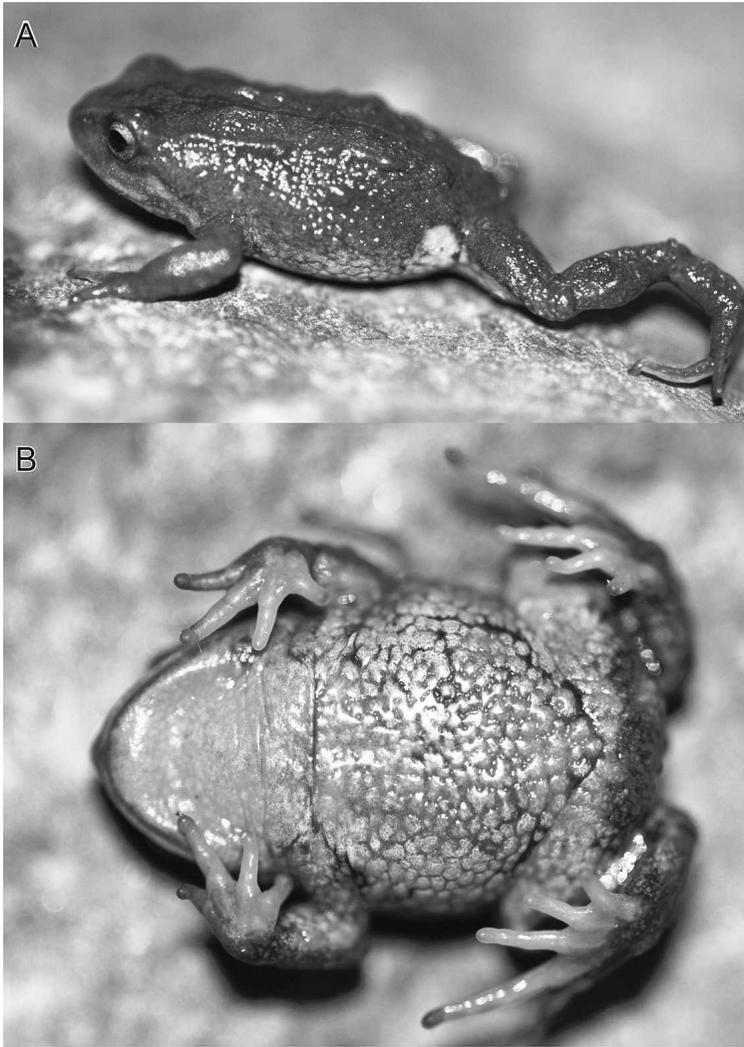


FIG. 1.—Holotype of *Bryophryne abramalagae* in life (MUSM 27631, male, SVL 17.8 mm) in lateral (A), and ventral (B) views. Photos by E. Lehr.

pale gray mottling in males only. In *B. cophites* the orange coloration is restricted to the throats of males, and in *B. hanssaueri* the throat is orange in females, whereas the males have a brownish-orange venter with grayish-white flecks on chest and belly (Lehr and Catenazzi, 2009). Males of both *B. abramalagae* and *B. hanssaueri* lack nuptial pads (present in *B. cophites*), but *B. abramalagae* lacks lateral fringes (present in *B. hanssaueri*). *Bryophryne gymnotis* has the venter dark brown, tan, or reddish brown with pale gray flecks, *B. zonalis* has the throat and chest pale

gray and tan mottled, and the belly black with white flecks, and *B. nubilosus* has the throat mottled of pale and dark brown with pale gray flecks, and chest and belly dark brown with pale gray flecks (Lehr and Catenazzi, 2008, 2009). Furthermore, *B. abramalagae* has toes V and III about equal in length (toe V longer than toe III in *B. nubilosus*), distinct supernumerary tubercles (indistinct in *B. nubilosus*), and outer metatarsal tubercle twice as large as inner (equal in size in *B. nubilosus*). Besides differences in morphology and coloration, *B. abramalagae* is separated from its

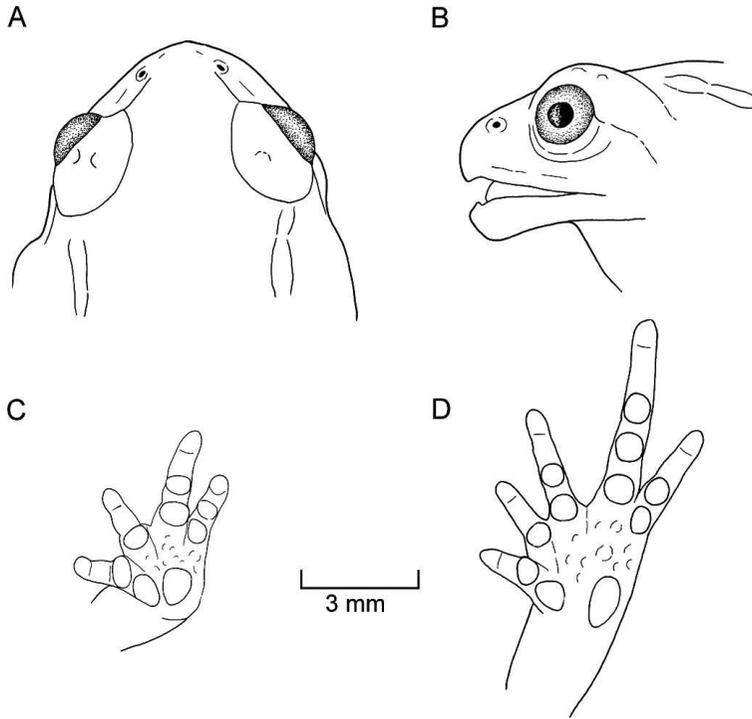


FIG. 2.—Dorsal (A) and lateral (B) views of head and ventral views of left hand (C) and right foot (D) of *Bryophryne abramalagae* (MUSM 27631). Drawings by E. Lehr.

congeners by its geographical and elevational distribution (see Fig. 3, Table 1). Table 1 compares selected characters among species of *Bryophryne*.

Description of holotype.—Head narrower than body, slightly wider than long, HW 98.6% of HL; HW 39.3% of SVL; HL 39.9% of SVL; snout short, rounded in dorsal and

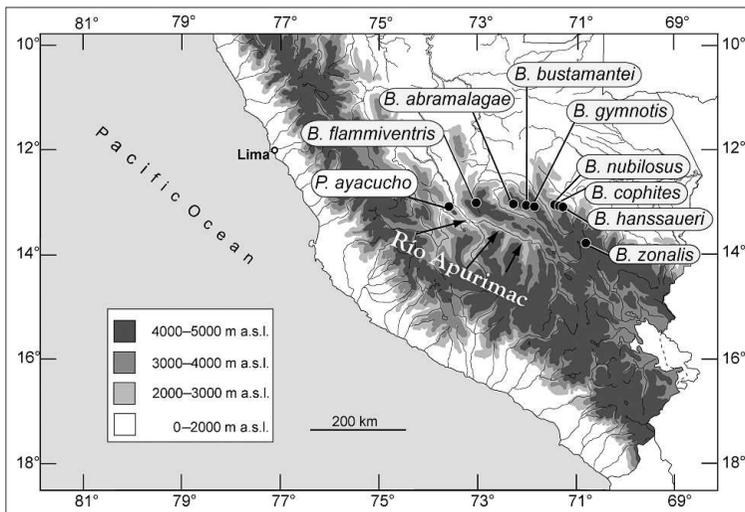


FIG. 3.—Map illustrating the type localities of *Bryophryne* in Peru.

TABLE 1.—Selected characters (+ = character present; - = character absent), character conditions, and elevational distribution among *Bryophryne*.

Characters	<i>Bryophryne abramulgae</i>	<i>B. flammeiventris</i>	<i>B. gymnotis</i>	<i>B. hiansuerti</i>	<i>B. sonalis</i>	<i>B. hastamanuetei</i>	<i>B. cephalites</i>	<i>B. mabilousis</i>
Maximum SVL ^a (mm)	20.1	24.1	22.2	24.6	24.4	23.4	29.3	21.9
Female SVL	20.1	23.7–24.1 (23.9 ± 0.3) <i>n</i> = 2	16.0–22.2 (20.0 ± 2.2) <i>n</i> = 10	18.1–24.6 (21.7 ± 1.8) <i>n</i> = 12	22.2–24.4 (23.3 ± 1.1) <i>n</i> = 3	21.0–23.4 (22.0 ± 1.2) <i>n</i> = 3	21.9–29.3	19.2–21.9 (20.5 ± 1.0) <i>n</i> = 5
Male SVL	15.9–19.1 (17.4 ± 1.4) <i>n</i> = 4	19.0–20.1 (19.7 ± 0.5) <i>n</i> = 4	16.7–19.3 (18.1 ± 0.9) <i>n</i> = 10	12.3–18.0 (15.5 ± 2.8) <i>n</i> = 4	14.8–17.6 (16.0 ± 1.4) <i>n</i> = 3	19.0–22.9 (21.0 ± 2.8) <i>n</i> = 2	18.0–22.7	12.7–18.9 (14.9 ± 2.2) <i>n</i> = 5
Tympanic annulus	-	+	+	-	-	-	-	-
Tympanic membrane	-	+	+	-	-	-	-	-
Dentigerous processes of vomers	-	-	+	-	-	-	-	-
Dorsolateral folds	+, discontinuous areolate	+, discontinuous areolate	+, discontinuous smooth	+, discontinuous areolate	+, discontinuous areolate	+, continuous areolate	+, discontinuous areolate	+, discontinuous areolate
Skin on venter	-	+	+	-	-	+	-	-
Vocal sac	-	+	+	-	-	+	-	-
Vocal slits	-	-	+	+	+	-	-	-
Lateral fringes	-	-	-	-	+	-	-	-
Nuptial pads	-	-	-	-	-	-	+	-
Finger I < II	+	+	+	+	+	+	+	+
Elevational distribution (m)	4000	3800–3850	3272–3354	3266–3430	3129–3285	3555–3950	3195–3650	2350–3215

^a SVL = snout-vent length.

lateral views (Figs. 2A,B), ED larger than E-N distance; nostrils slightly protuberant, directed dorsolaterally; canthus rostralis straight in dorsal view, rounded in profile; loreal region slightly concave; lips rounded; upper eyelid with enlarged tubercles (left two, right one); EW narrower than IOD (EW 54.2% of IOD); supratympanic fold short and low, extending from posterior corner of eye to level of jaw articulation, barely distinguishable in preservation; tympanic membrane and tympanic annulus absent; postrictal tubercles absent. Choanae small, ovoid, posterior half concealed by palatal shelf of maxilla; denticulous processes of vomers absent; tongue three times as long as wide, not notched posteriorly, posterior one half free; vocal slits absent, vocal sac indistinct.

Skin on dorsum shagreen with small scattered tubercles, dorsolateral fold narrow and discontinuous, extending from posterior margin of upper eyelid to sacral region; skin on flanks tuberculate; skin on throat smooth, skin on chest, and belly areolate; discoidal fold absent, thoracic fold present; cloacal sheath short; large tubercles absent in cloacal region. Outer surface of forearm with minute tubercles; outer and inner palmar tubercles low, ovoid, outer about twice the size of inner; few supernumerary tubercles low, ovoid; subarticular tubercles prominent, ovoid in dorsal view, rounded in lateral view, most prominent on base of fingers; fingers without lateral fringes; finger I shorter than finger II; tips of digits slightly pointed, lacking marginal grooves (Fig. 2C).

Hind limbs short, robust, TL 38.2% of SVL; FL 42.1% of SVL; upper surface of hind limbs shagreen with small, scattered tubercles; posterior and ventral surfaces of thighs areolate; heel with small tubercles; outer surface of tarsus with few minute tubercles; inner metatarsal tubercle ovoid, low, about half the size of elongate, elevated outer metatarsal tubercle; plantar supernumerary tubercles ovoid, low, about half the size of subarticular tubercles; subarticular tubercles low, ovoid in dorsal view; toes without lateral fringes; basal webbing absent; toe tips slightly pointed, lacking marginal grooves, about as large as those on fingers; relative lengths of toes: $1 < 2 < 5 = 3 < 4$; toe V about equal in size with toe III on right foot, slightly longer on left foot (Fig. 2D).

Measurements of holotype (in millimeters).—SVL 17.8; TL 6.8; FL 7.5; HL 7.1; HW 7.0; ED 2.1; IOD 2.3; EW 1.7; IND 1.8; E-N 1.4.

Coloration of holotype in life (Fig. 1).—Dorsum uniformly orange brown; canthal and supratympanic stripes absent; narrow tan strip from posterior corner of eye extending diagonally to insertion of arm; upper lip tan; upper two thirds of flanks coloured as dorsum, lower third pale gray and yellowish orange mottled; axilla pale gray, groin yellowish orange with small pale gray flecks; throat orange; chest, belly, extremities (except ventral surfaces of hands and feet, and tarsi), and concealed surfaces of hind limbs orange mottled with pale gray; fingers I–III, and toes I–IV ventrally orange remaining fingers and toes grayish brown; iris pale bluish green with dark gray reticulations, pupil encircled by pale golden ringlet.

Color of holotype in preservative.—As described above with orange brown being gray, and tan and yellowish orange being cream; iris gray.

Variation.—Specimens differ slightly in dorsal and ventral coloration. One male (MUSM 27632) has the dorsum dark grayish brown with small tan flecks, the throat is orange, the chest is pale gray with orange mottling, and toes I–III are orange; one male (MTD 47489) has the venter pale greenish instead of yellowish orange; three specimens (MTD 47489–91) have weakly defined brown canthal and subratympanic stripes and a brown blotch on upper lip at level below eye. Table 2 shows ranges and proportions of the type series.

Etymology.—The specific name *abramalagae* refers to Abra Málaga, a mountain pass with the highest elevation of 4313 m. The new species was found just below the pass at 4000 m elevation next to the road leading to Alfamayo.

Distribution and natural history.—The species is only known from the type locality (Fig. 3). Specimens were found inside bunches of Peruvian feather grass (*Stipa ichu*) and in moss between 1100 and 1300 h. Syntopic anurans include *Gastrotheca excubitor* and *Pleurodema marmoratum*. The latter species has been found to be infected with the pathogenic fungus *Batrachochytrium dendro-*

TABLE 2.—Measurements (in millimeters) and proportions of *Bryophryne abramalagae* and *B. flammiventris*; ranges followed by means and one standard deviation in parentheses.

Characters ^a	<i>B. abramalagae</i>		<i>B. flammiventris</i>	
	Females (n = 1)	Males (n = 4)	Females (n = 2)	Males (n = 4)
SVL	20.1	15.9–19.7 (17.4 ± 1.4)	23.7–24.1 (23.9 ± 0.3)	19.0–20.1 (19.7 ± 0.5)
TL	7.2	5.6–6.8 (6.3 ± 0.6)	7.4–7.8 (7.6 ± 0.3)	7.0–7.6 (7.2 ± 0.3)
FL	7.6	6.3–7.5 (6.9 ± 0.5)	8.2–8.5 (8.4 ± 0.2)	7.3–7.8 (7.6 ± 0.3)
HL	7.3	5.8–7.1 (6.4 ± 0.6)	6.8–7.1 (7.0 ± 0.2)	6.3–6.7 (6.6 ± 0.2)
HW	7.5	5.8–7.3 (6.5 ± 0.7)	7.8–8.0 (7.9 ± 0.1)	6.5–7.4 (7.1 ± 0.4)
ED	2.1	1.7–2.1 (2.0 ± 0.2)	2.0–2.2 (2.1 ± 0.1)	1.8–2.4 (2.1 ± 0.2)
IOD	2.9	2.2–2.4 (2.3 ± 0.1)	2.6–2.9 (2.8 ± 0.2)	2.1–2.7 (2.4 ± 0.3)
EW	1.7	1.3–1.8 (1.6 ± 0.2)	1.9	1.6–1.9 (1.8 ± 0.1)
IND	1.9	1.6–1.9 (1.7 ± 0.1)	2.1–2.3 (2.2 ± 0.1)	1.7–2.2 (1.9 ± 0.2)
E–N	1.5	1.0–1.5 (1.3 ± 0.2)	1.7	1.3–1.6 (1.5 ± 0.1)
TL/SVL	0.36	0.35–0.38	0.31–0.32	0.35–0.38
FL/SVL	0.38	0.37–0.42	0.34–0.36	0.37–0.41
HL/SVL	0.36	0.35–0.40	0.29	0.32–0.35
HW/SVL	0.37	0.36–0.39	0.33	0.32–0.39
HW/HL	1.03	0.97–1.07	1.13–1.15	0.97–1.11
E–N/ED	0.71	0.53–0.71	0.77–0.85	0.62–0.83
EW/IOD	0.59	0.54–0.78	0.66–0.73	0.59–0.86

^a SVL = snout–vent length, TL = tibia length, FL = foot length (distance from proximal margin of inner metatarsal tubercle to tip of Toe IV), HL = head length (from angle of jaw to tip of snout), HW = head width (at level of angle of jaw), ED = eye diameter, IOD = interorbital distance, EW = upper eyelid width, IND = internarial distance, E–N = eye–nostril distance (straight-line distance between anterior corner of orbit and posterior margin of external nares).

batidis in March of 2008. The habitat consists mainly of *Stipa ichu*, moss, and few scattered bushes. Abra Málaga is a private reserve established on 9 March 2007 covering a territory of 1053 ha between Málaga Chico and Río San Luis. Its objectives are to conserve life and resources of water, soil, forest flora, and fauna as well as landscape.

Bryophryne flammiventris sp. nov.
Figs. 4 and 5

Holotype.—MUSM 27613 (Figs. 4, 5), an adult male from 13° 05' 37.6" S, 73° 01' 40.7" W at 3800 m elevation next to road between Vilcabamba and Pampaconas, Distrito de Vilcabamba, Provincia de La Convención, Región Cusco, Peru, on 27 March 2009 by E. Lehr and J. C. Jahuanchi.

Paratypes.—Six: Two females (MTD 46892, MUSM 27612, both containing mature ovarian eggs and convoluted oviducts), three males (MUSM 27614, MTD 46890–91), and one juvenile (MUSM 27615), all (except MTD 46892, MUSM 27614) collected with the holotype on 27 March 2009 by E. Lehr and J. C. Jahuanchi. MTD 46892, MUSM 27614 collected at 13° 05' 59.9" S, 73° 02' 12.1" W at 3850 m elevation next to the road between Vilcabamba and Pampascona, Distrito de

Vilcabamba, Provincia de La Convención, Región Cusco, Peru, on 28 March 2009 by E. Lehr and J. C. Jahuanchi.

Diagnosis.—A medium-sized species of *Bryophryne* having the following combination of characters: (1) Skin on dorsum shagreen with small scattered tubercles, skin on venter weakly areolate; discoidal and thoracic folds present; short, irregularly shaped, discontinuous dorsolateral fold; (2) tympanic membrane and tympanic annulus present; (3) snout acutely rounded in dorsal and lateral views; (4) upper eyelid without enlarged tubercles; width of upper eyelid narrower than IOD; cranial crests absent; (5) dentigerous processes of vomers absent; (6) males with vocal sac and vocal slits, but nuptial pads absent; (7) finger I shorter than finger II; tips of digits slightly pointed; (8) fingers without lateral fringes; (9) ulnar and tarsal tubercles absent; (10) heel with small tubercles; inner tarsal fold absent; (11) inner metatarsal tubercle ovoid, 1.3 times larger than rounded outer metatarsal tubercle; supernumerary plantar tubercles present; (12) toes without lateral fringes; basal webbing absent; toe V shorter than toe III; toe tips slightly pointed, about as large as those on fingers; (13) in life, dorsum dark grayish brown, venter blackish brown with yellow,

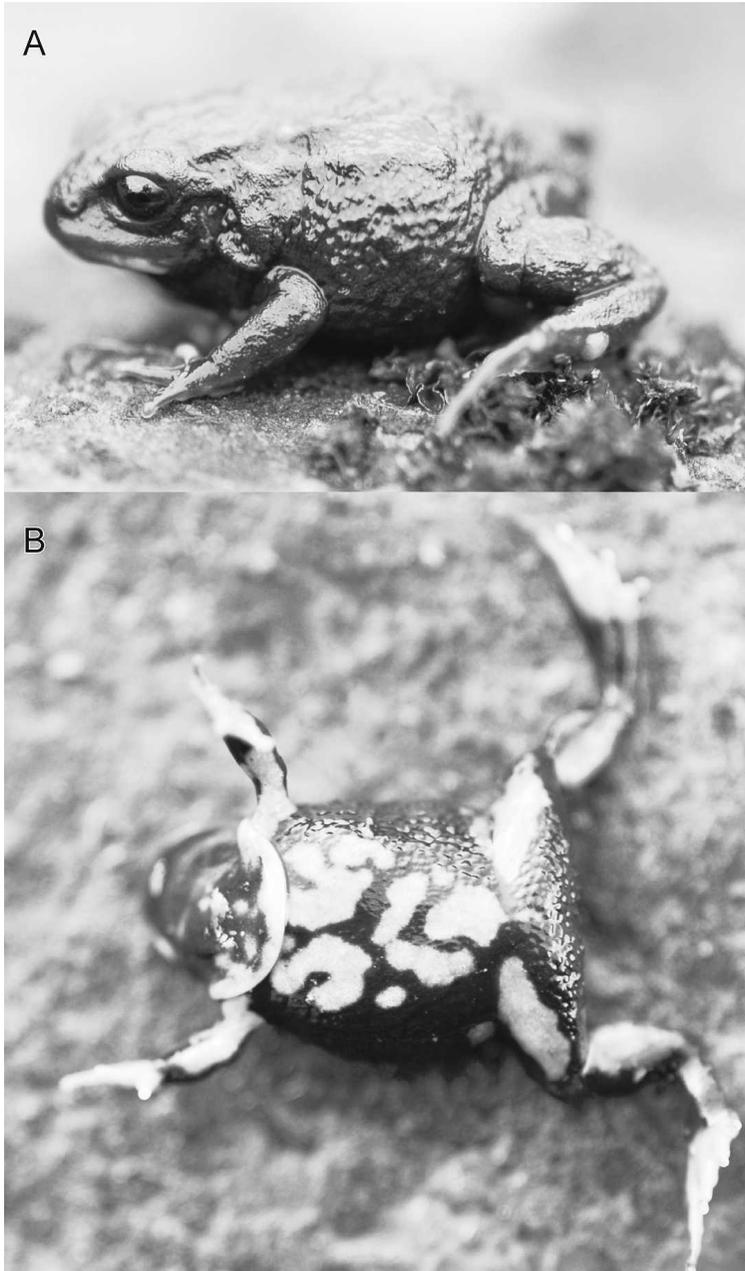


FIG. 4.—Holotype of *Bryophryne flammiventris* in life (MUSM 27613, male, SVL 19.8 mm) in lateral (A) and dorsal (B) views. Photos by E. Lehr.

orange or pink blotches; (14) SVL in adult females 23.7–24.1 mm ($n = 2$), in males 19.0–20.1 mm ($n = 4$).

Bryophryne flammiventris is easily distinguished from its congeners by having a blackish-brown venter with yellow, orange,

or pink blotches, a tympanic membrane and annulus and males with prominent vocal sac and vocal slits. The only other species of *Bryophryne* having the above-mentioned morphological characters is *B. gymnotis*, which is known from San Luis, Provincia de

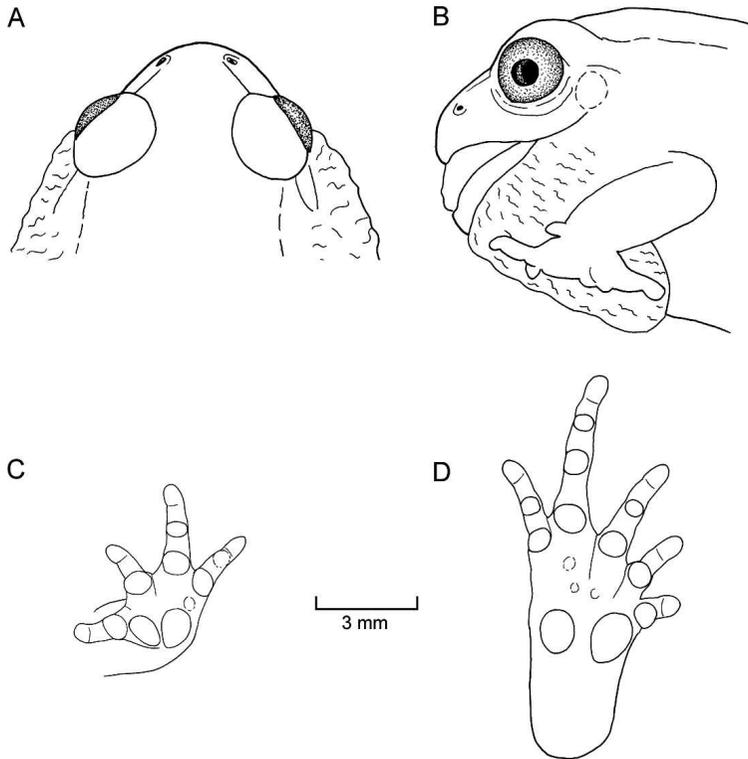


FIG. 5.—Dorsal (A) and lateral (B) views of head and ventral views of left hand (C) and left foot (D) of *Bryophryne flammiventris* (MUSM 27613). Drawings by E. Lehr.

La Convención, 70 km to the east of the type locality of *B. flammiventris*. These two species differ as follows: SVL in male *B. flammiventris* 19.0–20.1 mm, $n = 4$ (16.7–19.3 mm, $n = 10$, in *B. gymnotis*), skin on venter weakly areolate (smooth), discoidal fold present (absent), dentigerous processes of vomers present (absent), fingers and toes without lateral fringes (present), in life, venter black with yellow, orange, or pink blotches (dark brown, tan, or reddish brown with pale gray flecks). Table 1 compares selected characters among species of *Bryophryne*.

Description of holotype.—Head narrower than body, wider than long, HW 106.1% of HL; HW 35.3% of SVL; HL 31.8% of SVL; snout short, acutely rounded in dorsal view, acutely rounded in lateral view (Fig. 5A, B), ED larger than E–N; nostrils not protuberant, directed dorsolaterally; canthus rostralis straight in dorsal view, rounded in profile; loreal region slightly concave; lips rounded;

upper eyelids without enlarged tubercles; EW narrower than IOD (EW 73.0% of IOD); supratympanic fold short, narrow; tympanic membrane and tympanic annulus present, weakly defined, upper margin concealed by supratympanic fold, posterior margin slightly concealed by skin of vocal sac; two enlarged postrictal tubercles on left side of head. Choanae small, round, concealed by palatal shelf of maxilla; dentigerous processes of vomers absent; tongue two times as long as wide, not notched posteriorly, posterior about one-third free; vocal slits curved, located at posterior half of mouth floor between tongue and margin of jaw; vocal sac large, extending on to anterior part of chest and laterally toward tympanic region.

Skin on dorsum shagreen with small scattered tubercles; dorsolateral fold from posterior margin of eye to sacral region, low, discontinuous; skin on flanks tuberculate with tubercles coalescing into short, narrow fold

on upper part on both side of flanks; skin on throat, chest, and belly weakly areolate; discoidal and thoracic fold present; cloacal sheath short; large tubercles absent in cloacal region. Arms short, robust; outer surface of forearm lacking tubercles or folds; outer and inner palmar tubercles large, low, outer ovoid, slightly larger than of inner ovoid palmar tubercle, both nearly in contact at level of carpus; supernumerary tubercles indistinct; subarticular tubercles prominent, ovoid in dorsal view, rounded in lateral view, most prominent on base of fingers; fingers without lateral fringes; nuptial pads absent; finger I shorter than finger II; tips of digits slightly pointed, lacking marginal grooves (Fig. 5C).

Hind limbs short, robust, TL 38.4% of SVL; FL 39.4% of SVL; upper surface of hind limbs shagreen with small, scattered tubercles; posterior and ventral surfaces of thighs areolate; heel with small tubercles; outer surface of tarsus with few, minute tubercles; metatarsal tubercles prominent, elevated, ovoid; inner metatarsal tubercle 1.3 times larger than outer metatarsal tubercle; few, low plantar supernumerary tubercles; subarticular tubercles low, ovoid in dorsal view, most prominent on base of toes; toes without lateral fringes, basal webbing absent; toe tips slightly pointed, lacking marginal grooves, slightly smaller than those on fingers; relative lengths of toes: $1 < 2 < 5 < 3 < 4$; toe V shorter than toe III (Fig. 5D).

Measurements of holotype (in millimeters).—SVL 19.8; TL 7.6; FL 7.8; HL 6.3; HW 7.0; ED 2.4; IOD 2.6; EW 1.9; IND 2.2; E–N 1.6.

Coloration of holotype in life (Fig. 4).—Dorsum dark grayish brown; flanks dark gray; axilla dark gray; groin dark gray with a yellow blotch; sides of head entirely dark grayish brown; margin of lower jaw at level below eye yellow; throat anteriorly dark brown, posterior part of vocal sac yellow; yellow flecks on margin of lower jaw at level below eye; venter blackish brown with irregularly shaped yellow blotches on chest and belly; arms ventrally with large, yellow blotches; legs ventrally with large, yellowish-orange blotches; ventral surfaces of hands and feet yellowish orange; iris black with few golden flecks, pupil surrounded by a golden ringlet.

Coloration of holotype in preservative.—As described above with dark grayish brown and blackish brown being dark gray, and yellow or orange being cream; iris gray.

Variation.—The specimens differ in coloration pattern. One female (MUSM 27612) has the venter nearly entirely blackish brown with few cream flecks, whereas the other female has a ventral coloration as described for the holotype. One male (MTD 46891) has the venter nearly entirely pale reddish orange with few black flecks on the belly. Two specimens (MTD 46891, MUSM 27615) have a yellow blotch in the axilla, and two specimens (MUSM 27612, 27614) have small, yellow spots on the flanks. The two female specimens are larger than the males. All males have large vocal sacs and vocal slits, but nuptial pads absent. The tympana are clearly visible on photos showing the types in live, but less distinct in preservative.

Table 2 shows ranges and proportions of the type series.

Etymology.—The specific name *flammiventris* is composed of the Latin noun *flamma* meaning “blaze, fire,” and the Latin noun *venter* meaning “belly.” The specific name refers to distinct ventral coloration pattern similar to fire.

Distribution and natural history.—*Bryophryne flammiventris* has only been collected along the road between Vilcabamba and Pampaconas (Fig. 3) at elevations between 3800 and 3850 m. Specimens were found between 1200 and 1500 h inside large layers of moss that covered the ground between bushes and rocks or between shrub roots. Both females contained mature, unpigmented, cream-colored ovarian eggs (MUSM 27612: 17, MTD 46892: 22) and convoluted oviducts indicating reproductive season. Males were calling from inside the moss during day (from 1000 to 1600 h). The calls of many males were heard from the opposite side of the valley. The moss was yellow, orange, or reddish, whereas the roots of trunks of bushes covered by moss were dark blackish brown, similar to the ventral coloration of *B. flammiventris*. Close to the type locality (13° 05' 59.9" S, 73° 02' 12.1" W at 3850 m), *B. flammiventris* was found syntopically with *Psychrophrynella* sp. that also called from inside moss.

DISCUSSION

Hedges et al. (2008) analyzed DNA sequences from mitochondrial and nuclear genes of 344 New World frogs to estimate their relationships. This led to the placement of the former species of *Phrynopus* in six genera and in two subfamilies—Strabomantinae (*Isodactylus* Hedges, Duellman and Heinicke, *Lynchius* Hedges, Duellman and Heinicke, *Niceforonia* Goin and Cochran, and *Phrynopus* Peters), and Holoadeninae (*Bryophryne* Hedges, Duellman and Heinicke, and *Psychrophrynella* Hedges, Duellman and Heinicke). Hedges et al. (2008) analyzed genetic sequences of one species of *Bryophryne* (*B. cophites*) and two species of *Psychrophrynella* (*P. usurpator* = *Psychrophrynella* sp., and *P. wettsteini*). In their phylogenetic tree (see Hedges et al., 2008, p. 19, fig. 3), *Bryophryne* and *Psychrophrynella* are positioned in different clades and consequently were described as new genera.

Eight species of *Bryophryne* are currently described and restricted to southern Peruvian Regions of Cusco and an undescribed species from Puno (Lehr and Catenazzi, unpublished data). Of the 20 known species of *Psychrophrynella* (Duellman and Lehr, 2009), only three (*P. bagrecito*, *P. usurpator* from Region of Cusco, and *P. boettgeri* from Region of Puno) are known from Peru, whereas 17 species are known from Bolivia (De la Riva, 2007). Morphologically, *Bryophryne* can be distinguished from Peruvian members of *Psychrophrynella* by having a more robust body, dorsum usually with prominent irregularly shaped dorsolateral folds, by having finger I shorter than finger II (finger I slightly shorter or equal in length to finger II in *Psychrophrynella*), and feet without tarsal tubercles or folds (prominent, elongate, oblique tarsal tubercle in *P. usurpator*, sickle-shaped tubercle in *P. bagrecito*, absent in *P. boettgeri*). Except for the three above-mentioned species (*B. cophites*, *P. usurpator*, *P. wettsteini*), the intra- and interspecific phylogeny of species of *Bryophryne* and species of *Psychrophrynella* are unknown.

Species of *Bryophryne* often share similar or adjacent habitats with species of *Psychrophrynella*. In the upper Manu National Park (Cordillera de Paucartambo), *B. cophites* is

often found syntopically with *P. usurpator* (De la Riva et al., 2008, Duellman and Lehr, 2009) in grassland and ecotonal habitats near Acjanaco. The two forest species of *Bryophryne*, *B. nubilosus* and *B. hanssaueri*, have also been found syntopically in areas with montane scrub and patches of montane forests. In the Cordillera de Vilcabamba, *B. flammiventris* occurs syntopically with a new species of *Psychrophrynella*. In the Cordillera de Vilcanota, *B. zonalis* shares the same montane forest habitat with *P. bagrecito*.

Species of *Bryophryne* have high beta diversity and seem to be separated from their congeners by a combination of habitat preferences and elevational gradients. For example, *B. cophites* and *B. hanssaueri* partially overlap in elevation in the upper Cosñipata valley, although *B. hanssaueri* is almost exclusively restricted to forest habitats between 3200 and 3550 m, whereas *B. cophites* inhabits mostly grassland (puna) habitats and can occasionally be found in forest habitats between 3200 and 3700 m. *Bryophryne bustamantei* and *B. abramalagae* inhabit similar puna habitats near Abra Málaga, but *B. bustamantei* occurs at lower elevations than *B. abramalagae*.

Morphological similarities between *Bryophryne* and *Phrynopus* are obvious. Species of both genera lack finger and toe disks with marginal grooves, and the majority of species lack a tympanum. Both genera are restricted to Peru and are known from high elevation in the Andes (Lehr and Catenazzi, 2008 and this paper: *Bryophryne* 2350–4000 m vs. *Phrynopus* 2200–4400 m; Duellman and Lehr, 2009). Lehr and Catenazzi (2008) hypothesized that the deep valley of the Rio Apurimac is a biogeographic border separating *Phrynopus* from *Bryophryne* and from *Psychrophrynella*. *Bryophryne flammiventris* represents the northernmost record of the genus and is only approximately 60 km (airline) south of the closest species of *Phrynopus* (Fig. 3).

We expect that more new species of *Bryophryne* and *Psychrophrynella* will be discovered from the Andes of southern Peru. Herpetologists who survey puna habitats should pay special attention to moss and the Peruvian Feather Grass, both of which are used as hiding places and for reproduction

(Catenazzi, 2006). Whereas several species were found calling from inside moss (*B. flammiventris*, *B. gymnotis*) or Peruvian feather grass (*Phrynopus peruanus*, Lehr, 2007), others (*B. abramalagae*) were found “accidentally” while investigators were searching for calling *Gastrotheca excubitor*.

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APPENDIX I

Comparative Specimens Examined

Bryophryne bustamantei.—Peru: Cusco: Provincia La Convención: Abra de Málaga: MUSM 24537–38.

Bryophryne cophites.—Peru: Cusco: Provincia de Paucartambo: Distrito Cosñipata: southern slope Abra Acanaco, 14 km NNE Paucartambo, 3400 m: KU 138884 (holotype); northern slope Abra Acanaco, 27 km NNE Paucartambo, 3450 m: KU 138885–908, 138911–5 (all paratypes); 2 km NE of Abra Acanaco, 3280 m: MHNG 2698.24, Tres Cruces, 8.5 km N of Abra Acanaco, 3590 m: MUSM 26283, 26267.

Bryophryne gymnotis.—Peru: Cusco: Provincia de La Convención, Distrito de Huayopata: 1 km east of San Luis at elevations of 3272–3354 m: MUSM 24543 (holotype), MHNG 2710.28, 2710.29, MTD 46860–64, 47288, 47291–92, 47297, MUSM 24541–42, 24544–45, 24546–56, MVZ 258407–10 (all paratypes).

Bryophryne hanssaueri.—Peru: Cusco: Provincia de Paucartambo, Distrito de Cosñipata: Acjanaco, Manu National Park, 3266 m elevation: MUSM 27567 (holotype); from near Acjanaco, Manu National Park at elevations of 3280–3430 m: MHNG 2698.25, MTD 46865–66, 46887–89, MUSM 24557, 27568–69, 27607–11, MVZ 258411–13 (all paratypes).

Bryophryne nubilosus.—Peru: Cusco: Provincia de Paucartambo: Distrito de Cosñipata, 500 m NE of Esperanza, 2712 m: MUSM 26310 (holotype), MUSM 26311; near the type locality, 13° 11' 33.21" S, 71° 35' 25.17" W, 3065 m: MTD 47294; near Hito Pillahuata, 2600 m: MUSM 20970; Quebrada Toqoruyoc, 3097 m: MUSM 26312, MTD 47293; Esperanza, 2800 m: MHNSM 26316–17; 13° 11' 20.2" S, 71° 35' 07.3" W, 2900 m: MUSM 24539–40.

Bryophryne zonalis.—Peru: Cusco: Provincia de Quichichis, Distrito de Marcapata, Kusillochayoc at 3129 m elevation: MUSM 27570 (holotype), MTD 46867, 46869–70, MUSM 27572, 27574–75, 27861, MVZ 258414 (all paratypes); at Puente Colina, 3285 m elevation: MVZ 258415 (paratype).