

A new species of *Bryophryne* (Anura: Strabomantidae) from the Cordillera de Vilcabamba, southeastern Peruvian Andes

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Abstract

A new species of *Bryophryne* (Anura: Strabomantidae) from the Cordillera de Vilcabamba, southeastern Peruvian Andes. We describe a new species of *Bryophryne* from the Cordillera de Vilcabamba in Department Cusco, in the southeastern Peruvian Andes. The new species differs from all other congeneric taxa, except *B. flammiventris* and *B. gymnotis*, by possessing a weakly defined tympanic membrane and tympanic annulus, by the presence of vocal sac and vocal slits in males, and by producing advertisement calls. The new species is distinguished from *B. flammiventris* and *B. gymnotis* by skin texture, presence of small, oblique dentigerous processes on the vomer, ventral coloration ranging from bluish-gray to whitish-gray with irregular or reticulate dark brown spots, and call composed of two or three notes. The new species is further characterized by having dorsal skin shagreen with tubercles, discontinuous dorsolateral folds, skin smooth on ventral surfaces of the body, and lateral fringes on fingers and toes. This species was found at the transition from montane forest to high Andean puna, where it occurs in moist microhabitats under moss and rocks at elevations from 3519 to 3707 m a.s.l.

Keywords: amphibians, Brachycephaloidea, Choquequirao Archeological Complex, humid grassland, Terrarana.

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Resumen

Una nueva especie de *Bryophryne* (Anura: Strabomantidae) de la Cordillera de Vilcabamba, sudeste de los Andes peruanos. Describimos una nueva especie de *Bryophryne* proveniente de la Cordillera de Vilcabamba, en el Departamento de Cusco, en los Andes del sureste de Perú. La nueva especie se diferencia de las demás especies de *Bryophryne*, excepto por *B. flammiventris* y *B. gymnotis*, por tener membrana y anillo timpánico poco definidos, machos con sacos y hendiduras vocales, y por emitir llamados nupciales; además, se diferencia de *B. flammiventris* y *B. gymnotis* por la textura de su piel, la presencia de procesos vomerianos pequeños y oblicuos, coloración ventral gris azulada a gris clara con manchas marrones irregulares o reticuladas, y llamado nupcial compuesto por dos o tres notas. Los especímenes de la nueva especie se caracterizan además por tener piel dorsal finamente granulada con tubérculos, pliegues dorsolaterales discontinuos, piel lisa en partes ventrales, y presencia de quillas laterales en los dedos de manos y pies. Esta especie habita los bosques altoandinos, entre la puna y el bosque montano, y fue encontrada en ambientes húmedos entre musgo y bajo piedras a elevaciones de 3519 a 3707 m s.n.m.

Palabras clave: anfibios, Brachycephaloidea, Complejo Arqueológico de Choquequirao, pastizales húmedos, Terrarana.

Resumo

Uma nova espécie de *Bryophryne* (Anura: Strabomantidae) da Cordilheira de Vilcabamba, sudeste dos Andes peruanos. Descrevemos uma nova espécie de *Bryophryne* proveniente da Cordilheira de Vilcabamba, Departamento de Cusco, nos Andes do sudeste do Peru. A nova espécie se diferencia das demais espécies do gênero, excepto de *B. flammiventris* e de *B. gymnotis*, por apresentar membrana e anel timpânicos pouco definidos, machos com sacos e fendas vocais e por emitir cantos nupciais; além disso, diferencia-se de *B. flammiventris* e de *B. gymnotis* pela textura da pele, presença de processos vomerianos pequenos e oblíquos, coloração ventral cinza azulado a cinza claro com manchas marrons irregulares ou reticuladas e canto nupcial composto por duas ou três notas. Os espécimes da nova espécie caracterizam-se ainda pela pele dorsal finamente granulada com tubérculos, pregas dorso-laterais descontínuas, pele lisa nas partes ventrais e presença de quilhas laterais nos dedos das mãos e dos pés. Esta espécie habita os bosques altoandinos, entre a puna e o bosque montano, e foi encontrada em ambientes úmidos entre musgos e debaixo de pedras em altitudes de 3519 a 3707 m acima do nível do mar.

Palavras-chave: anfibios, Brachycephaloidea, campos úmidos, Complexo Arqueológico de Choquequirao, Terrarana.

Introduction

The genus *Bryophryne* Hedges, Duellman and Heinicke, 2008 is a group of small frogs endemic to the high Andes of the Peruvian department of Cusco and Puno, where they inhabit the montane forest, montane cloud forest, and wet puna from 2350–4120 m a.s.l. (Chaparro *et al.* 2007, 2015, Lehr and Catenazzi 2008, 2009, 2010, Duellman and Lehr 2009). Hedges *et al.* (2008), based on molecular data, proposed the monophyly of the genus and allocated it to

the subfamily Holoadeninae; *B. cophites* was designated as the type species. Subsequently, the monophyletic status of the genus was corroborated by Chaparro *et al.* (2015), De la Riva *et al.* (2017), Heinicke *et al.* (2017), and Padial *et al.* (2014).

Molecular evidence and distribution patterns have been strongly decisive in designation of new species and regrouping lineages (Hedges *et al.* 2008, Padial *et al.* 2012, Chaparro *et al.* 2015, De la Riva *et al.* 2017). Based on this evidence, the existence of three sympatric species of

Bryophryne by mountain pass has been proposed (Lehr & Catenazzi 2008, 2009). A linear distance of 50 km is sufficient for species divergence (Catenazzi *et al.* 2017). The isolation of species of *Bryophryne* could be explained by geomorphology of the Andes (allopatric speciation), climatic variables, low vagility and semifossorial habits, or by productivity of their environment, which is sufficient to maintain the requirements of their small bodies.

The diversity of high Andean Terrarana has been underestimated. Recent expeditions and published manuscripts show clear evidence of high beta diversity in the eastern slopes of the Peruvian and Bolivian Andes (De la Riva *et al.* 2017, Rodriguez and Catenazzi 2017). Most species of *Bryophryne* have been discovered in the last decade (Chaparro *et al.* 2007, 2015, Lehr and Catenazzi 2008, 2009, 2010, Catenazzi *et al.* 2017, De la Riva *et al.* 2017), increasing the current number to 13 species. Recent field work in the Archeological Complex of Choquequirao, Departamento Cusco has uncovered previously unknown species of Holoadeninae. Here we describe one of these new frogs, the third species of *Bryophryne* possessing a tympanic membrane and annulus and known to produce an advertisement call.

Materials and Methods

All specimens were collected by hand, fixed in 10% formalin and preserved in 70% ethanol. Terminology for diagnostic characters and format description follows Duellman and Lehr (2009) and Lynch and Duellman (1997). Measurements were taken with a digital caliper to the nearest 0.01 mm and rounded to 0.1 to avoid pseudo-precision. Abbreviations for measurements are as follows: SVL (snout-vent length), HL (head length, from posterior margin of jaw to tip of snout), HW (maximum width of head), EL (eye length, measured horizontally), EN (eye to nostril distance), IND (internarial distance), ED (eye diameter horizontal), IOD (interorbital distance), EW (eyelid width), TL

(tibia length), and FL (foot length, distance from posterior margin of inner metatarsal tubercle to tip of fourth toe). We determined comparative lengths of Toes III and V by adressing both toes against Toe IV; lengths of Fingers I and II were determined by adressing these fingers against each other. Sexual condition was determined through morphologic external characters, dissection, and examination of ovarian condition. Comparisons of diagnostic characters are based on species descriptions found in the literature (Chaparro *et al.* 2007, 2015, Hedges *et al.* 2008, Lehr and Catenazzi 2008, 2009, 2010, Catenazzi *et al.* 2017) and the examination of type and referred specimens. Specimens examined are listed in Appendix I; Natural History Museum acronyms are: CORBIDI = Herpetology Collection, Centro de Ornitología y Biodiversidad, Lima, Peru; MUBI = Museo de Biodiversidad del Perú, Cusco; KU = Natural History Museum, The University of Kansas, Lawrence, Kansas, USA; MUSM = Museo de Historia Natural Universidad Nacional Mayor de San Marcos, Lima, Peru; MHNG = Muséum d'Histoire Naturelle, Genève, Switzerland; MTD = Museum für Tierkunde Dresden.

We recorded an unvouchered specimen at the type locality at 10:40 hrs on 20 September 2016 ($T_{\text{air}} = 13.3^{\circ}\text{C}$), along with several unvouchered males, with a digital recorder (Marantz PMD660; WAV format, 44 KHz, 24 bit). We used Raven Pro, version 1.4 (Cornell Laboratory of Ornithology, Ithaca, NY) to analyze call variables. We analyzed a total of three calls. The following variables were measured from oscillograms: note duration and rate, interval between notes or calls, number of pulses, and presence of amplitude modulation (Lehr and Catenazzi 2009). Variables measured from spectrograms included dominant frequency, and presence of frequency modulation or harmonics. Spectral parameters were calculated through fast Fourier transform (FFT) set at a length of 512 points (Hann window, 50% overlap). Averages are reported \pm SD.

Coloration in life is based on field notes and photographs taken by LM using a Canon 550D digital camera with a Canon 100 mm macro lens.

Results

Bryophryne mancoinca sp. nov.

(Figures 1 and 2A, B)

Holotype.—MUBI 11152, an adult female (Figures 1, 2A, B) from Hornopampa sector, near Salkantay Mountain, along the road to the Archeological Complex of Choquequirao, 3707 m a.s.l., (13°18'26" S, 72°44'90" W), Distrito Santa Teresa, Provincia La Convención, Departamento Cusco, Peru, collected by Luis Mamani and Federico Argandoña on 16 September 2011.

Paratypes.—Twelve specimens: Seven adult males: MUBI 11147, 11148, 11149 (Figure 2C, D), 11150 (Figure 2E, F), 11151, 11153 (Figure 2G, H), and 11154; and one juvenile female: MUBI 11159, all from the type locality; three adult females: MUBI 16068 (Figure 2I, J), 16069 (Figure 2K, L), 16074; one juvenile male, MUBI 16083, all from Hornopampa, near Salkantay Mountain, along the road to the Archeological Complex of Choquequirao, 3519 m a.s.l., (13°19'17" S, 72°43'93" W), Distrito Santa Teresa, Provincia La Convención, Departamento Cusco, Peru, collected by Luis Mamani, Alex Ttito and Sergio Mallqui on 19 September 2015.

Generic placement.—The new species is assigned to the genus *Bryophryne* Hedges *et al.* (2008) on the basis of its general appearance (chubby body, short legs and arms), which matches that of other species placed in this genus, and its occurrence southeast of the Apurimac River valley (Lehr and Catenazzi 2008, 2009, 2010, Chaparro *et al.* 2015). Although most species of *Bryophryne* lack the tympanic membrane and annulus, *B. flammiventris* Lehr and Catenazzi, 2010 and *B.*

gymnotis Lehr and Catenazzi, 2009 possess both characters and are likely closely related to *B. mancoinca* sp. nov. (see diagnosis and comments in Discussion).

Diagnosis.—The new species is characterized by: (1) skin on dorsum shagreen with small, conical tubercles; dorsolateral folds continuous only along anterior half of dorsum; skin of venter, throat and chest smooth; discoidal fold present; thoracic fold present; (2) tympanic membrane and tympanic annulus weakly defined; (3) snout short, rounded in dorsal and lateral views; (4) upper eyelid with small tubercles; cranial crests absent; (5) dentigerous processes of vomers small, oblique; vomerine teeth absent; (6) vocal sac and slits present, nuptial pad absent; (7) Finger I slightly shorter than Finger II; tips of fingers rounded; (8) fingers with lateral fringes; (9) ulnar tubercles and tarsal tubercles present, small; (10) heel with small tubercle; tarsal fold absent; (11) inner metatarsal tubercle ovoid, 1.5 times larger than outer; supernumerary plantar tubercles numerous and low, not visible in preservative; palmar tubercle slightly ovoid, thenar tubercle ovoid; supernumerary palmar tubercles few and scattered; (12) toes having lateral fringes; basal webbing present between toes III and IV; Toe V shorter than Toe III; toe tips rounded; (13) in life, dorsal coloration reddish-brown, or grayish-brown, with narrow tan middorsal stripe; ventral coloration gray, or pale bluish-gray with reddish-brown reticulation, throat and chest brown or dark brown; (14) SVL in adult females 23.6–26.5 mm ($N = 4$), in males 19.6–22.9 mm ($N = 2$) (Table 1).

Bryophryne mancoinca sp. nov. is readily distinguished from all other species of *Bryophryne*, except for *B. flammiventris*, *B. gymnotis*, *B. quellokunka*, *B. tocrá*, and *B. wilakunka*, by the presence of a tympanic membrane and tympanic annulus. *Bryophryne mancoinca* sp. nov. differs (characteristics of other species in parentheses) from *B. flammiventris* by having ventral skin smooth

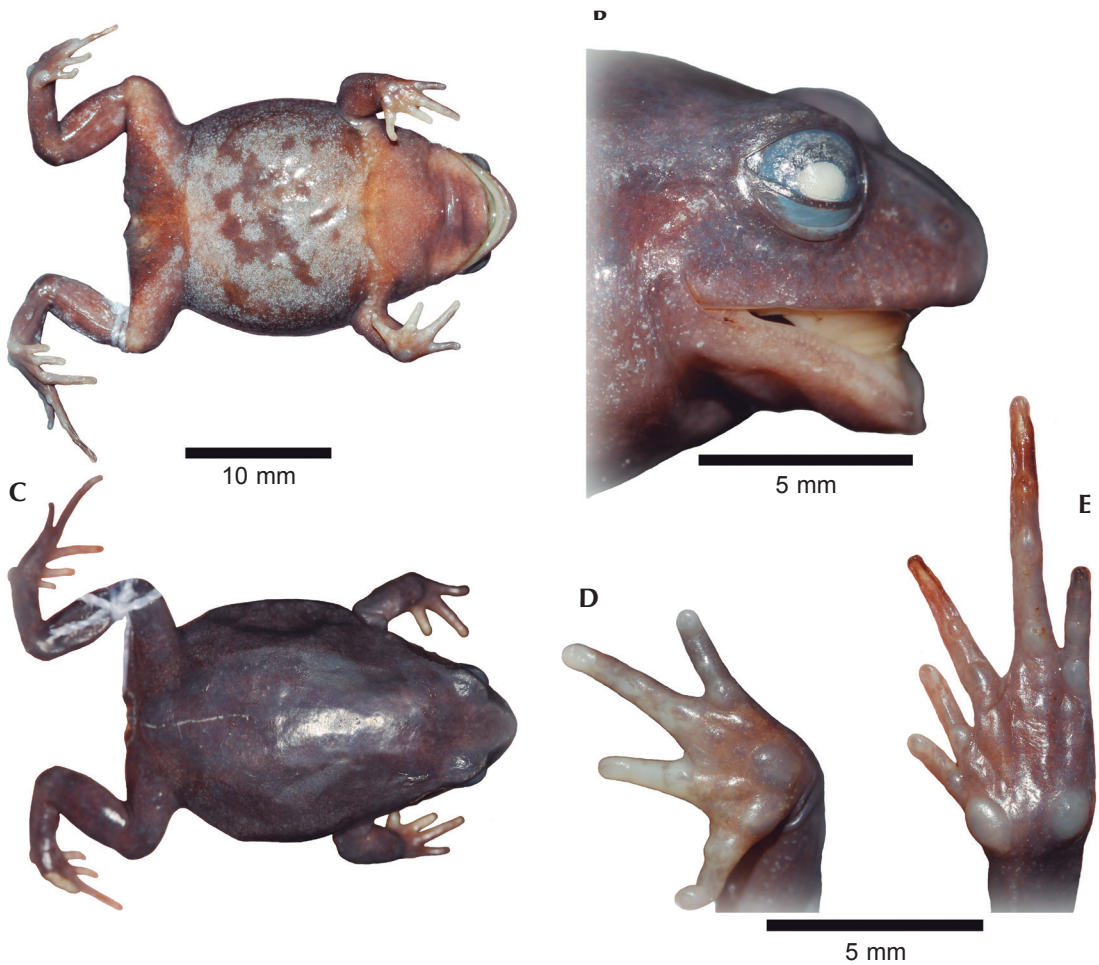


Figure 1. (A) Dorsal, (B) ventral, (C) lateral views of the head, (D) hand, and (E) foot of the adult female holotype of *Bryophryne mancoinca* sp. nov. (MUBI 11152).

(weakly areolate), dentigerous processes of vomer small and oblique (absent), ventral coloration gray with reddish-brown reticulation (black with yellow, orange or pink blotches). *Bryophryne mancoinca* sp. nov. differs from *B. gymnotis* (characteristics of *B. gymnotis* in parentheses) by having skin on dorsum shagreen with tubercles (without tubercles), discoidal fold present (absent), dentigerous processes of vomers small and oblique (rounded), ventral coloration gray with reddish-brown reticulation

(dark brown or reddish-brown with pale gray flecks), and advertisement call composed of three notes with fundamental frequency of ~ 2400 Hz (single note, 3010 Hz). The new species differs from *B. quellokunka* by having ventral skin smooth (weakly areolate), dentigerous processes of vomer present (absent). It differs from *B. totra* and *B. wilakunka* by having ventral skin smooth (areolate) and dentigerous processes of vomer present (absent).



Figure 2. Dorsal and ventral views of adult *Bryophryne mancoinca* sp. nov. **A–B**, female (MUBI 1152, Holotype); **C–D**, male (MUBI 11149); **E–F**, male (MUBI 11150); **G–H**, male (MUBI 11153); **I–J**, female (MUBI 16069); and **K–L**, female (MUBI 16069). Photos by Luis Mamani.

Description of the holotype.—Adult female; body robust; skin on dorsum and flanks shagreen with small, conical tubercles; dorsolateral folds discontinuous (continuous only from head to point of arm insertion to mid dorsum); ventral skin smooth; throat, chest, and belly smooth; discoidal fold present, thoracic fold weak; head narrower than body, wider than long; head width 35% of SVL; head length 26% of SVL; snout short, rounded in dorsal and lateral view (Figure

1); canthus rostralis slightly convex in profile and dorsal view; loreal region slightly convex; lips rounded; upper eyelid without enlarged tubercles; nostril lateral, weakly protuberant; eye–nostril distance 69% of eye length; interorbital region flat, cranial crests absent; tympanic membrane and tympanic annulus present and weakly defined; supratympanic fold an elliptical arc, extending from posterior corner of eye to half distance between eyes and insertion

Table 1. Measurements (in mm) of adult specimens of *Bryophryne mancoïnca* sp. nov.

	MUBI 11153	MUBI 11152	MUBI 11148	MUBI 11150	MUBI 11149	MUBI 11151	MUBI 11154	MUBI 11147	MUBI 11159	MUBI 16083	MUBI 16068	MUBI 16069	MUBI 16074
	Male	Female	Male	Male	Male	Male	Male	Male	Female	Female	Female	Female	Juvenile
SVL	22.9	26.5	22.3	21.8	21.5	22.6	21.4	19.6	17.6	23.6	24.4	24.0	16.2
TL	7.6	8.9	8.0	7.9	7.7	8.0	7.6	7.3	7.0	8.2	8.6	8.7	6.4
FL	8.8	11.1	10.0	9.1	9.2	9.8	9.1	8.7	8.1	10.5	10.6	11.2	7.7
HL	5.8	7.0	6.4	6.1	6.2	6.2	6.0	5.4	5.4	6.3	6.1	6.6	4.7
HW	7.9	9.4	8.3	8.1	7.9	8.4	7.9	7.5	6.6	8.4	8.8	8.8	6.1
ED	2.5	2.8	2.3	2.4	2.4	2.3	2.4	2.3	2.1	2.2	2.5	2.4	1.9
IOD	2.2	2.5	2.4	2.4	2.5	2.5	2.4	2.1	1.9	2.4	2.4	2.5	2.3
EW	1.8	1.9	1.7	1.7	1.8	1.9	1.6	1.7	1.6	1.9	1.8	1.8	1.6
IND	2.2	2.4	2.1	2.1	2.0	2.1	2.1	2.0	1.9	2.2	2.4	2.4	1.9
EN	1.7	1.9	2.0	1.7	1.7	1.7	1.7	1.6	1.4	2.0	2.0	2.0	1.4
TY	1.1	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.0	1.2	1.2	1.3	1.0

of arm; tongue large, oval; choanae small, rounded; dentigerous processes of vomer small, oblique; limbs moderately short; tips of digits rounded, not expanded laterally; ulnar tubercles absent, ulnar fold narrow, low; inner palmar tubercle single, ovoid, outer palmar tubercle slightly ovoid; fingers moderately short, without lateral fringes; subarticular tubercles round; supernumerary tubercles distinct, few, ovoid, small; first finger slightly shorter than second, III > IV = II > I; tips of digits rounded, lacking marginal grooves; tibia length 33% of SVL; tarsal fold absent; inner metatarsal ovoid 1.5 times longer than outer metatarsal tubercle; subarticular tubercles small, ovoid; supernumerary tubercles small, poorly defined; toes having lateral fringes, lacking basal webbing; relative length of toes IV > III > V > II > I, digital tips rounded lacking marginal grooves; foot length 42% of SVL.

Coloration of holotype in life.—Head dorsally reddish-brown, laterally reddish-brown with small yellow blotches, labial bar slightly darker; upper half of iris pale bronze, lower half dark brown; dorsal surface of body reddish brown with small yellow spots and some irregular brown blotches, narrow bronze middorsal stripe extending from cloaca to middle of body; belly pale bluish-gray with reddish-brown reticulations; dorsal surface of limbs similar to dorsal coloration, ventral surface reddish-brown with irregular gray blotches (Figure 2A, B).

Coloration of holotype in preservative.—Dorsal and lateral surface of head and dorsum of body brown, ventral coloration similar to that in life (Figure 1).

Variation.—All specimens have a discontinuous middorsal, bronze stripe extending from cloaca anteriorly to the level of tympanum; in three specimens this stripe extends to the mid dorsum (MUBI 11147, 11152, 16083), while in one specimen (MUBI 11154) it extends sideways

to form a triangle. The ventral coloration is variable, especially the relative size of brown spots which are larger in four specimens (MUBI 11149–11150, 11153, 16069), intermediate in size in seven specimens (MUBI 11147–11148, 11151, 11154, 16068, 16074, 16083), and smaller in two specimens (MUBI 11152, 11159). One specimen (MUBI 11153) has minute yellow spots on the flanks.

Etymology.—The specific epithet *mancoinca* refers to the most important Inca of Vilcabamba, Manco Inca, who was the leader of the last Incan resistance in southeastern Peru.

Vocalization and reproduction.—Males call from bunch grasses in the humid puna, during the day from 10:00 to 16:00 hrs. We did not hear males calling during our evening and night surveys. The advertisement call of unvouchered males consist of three (68% of recorded calls) or two (32% of recorded calls) unpulsed notes resembling whistles, with dominant frequency ~ 2400 Hz (range from 2250 to 2437 Hz; Figure 3, Table 2). Calls with three notes appear to have slightly lower dominant frequencies (Table 2) at the first note, but the difference is not significant ($t = 1.25$, $df = 26$, $p = 0.22$). No frequency modulation occurs within or among calls. The calling rate was 0.115 ± 0.006 calls/second at a temperature of 13.3°C. In all calls, the first note

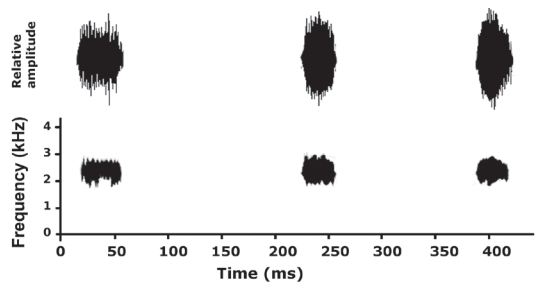


Figure 3. Advertisement call of *Bryophryne mancoinca* sp. nov. (unvouchered specimen) recorded at the type locality on 20 September 2015 ($T_{\text{air}} = 13.3^{\circ}\text{C}$).

is longest, followed by the second note and, when present, the third note. The first note appears to be slightly longer in calls with two notes (85.1 ± 16.5 ms, range 46.0–100.0 ms, $N = 9$) than in calls with three notes (67.8 ± 28.6 ms, range 28–108 ms, $N = 19$), but the difference is not significant ($t = 2.02$, $df = 26$, $p = 0.10$). The second note is similar in duration in all calls ($t = -0.69$, $df = 26$, $p = 0.49$) and averages 30.4 ± 13.0 ms (range 18.0–94.0 ms, $N = 28$), whereas

the third note averages 27.9 ± 5.6 ms (range 16.0–35.0 ms, $N = 19$).

Distribution and natural history.—*Bryophryne mancoinca* sp. nov. is known only from the type locality at elevations from 3519 to 3707 m a.s.l (Figure 4). Specimens were collected during the dry season (September), under rocks, between moss and roots. This species inhabits the transition from the montane forest to

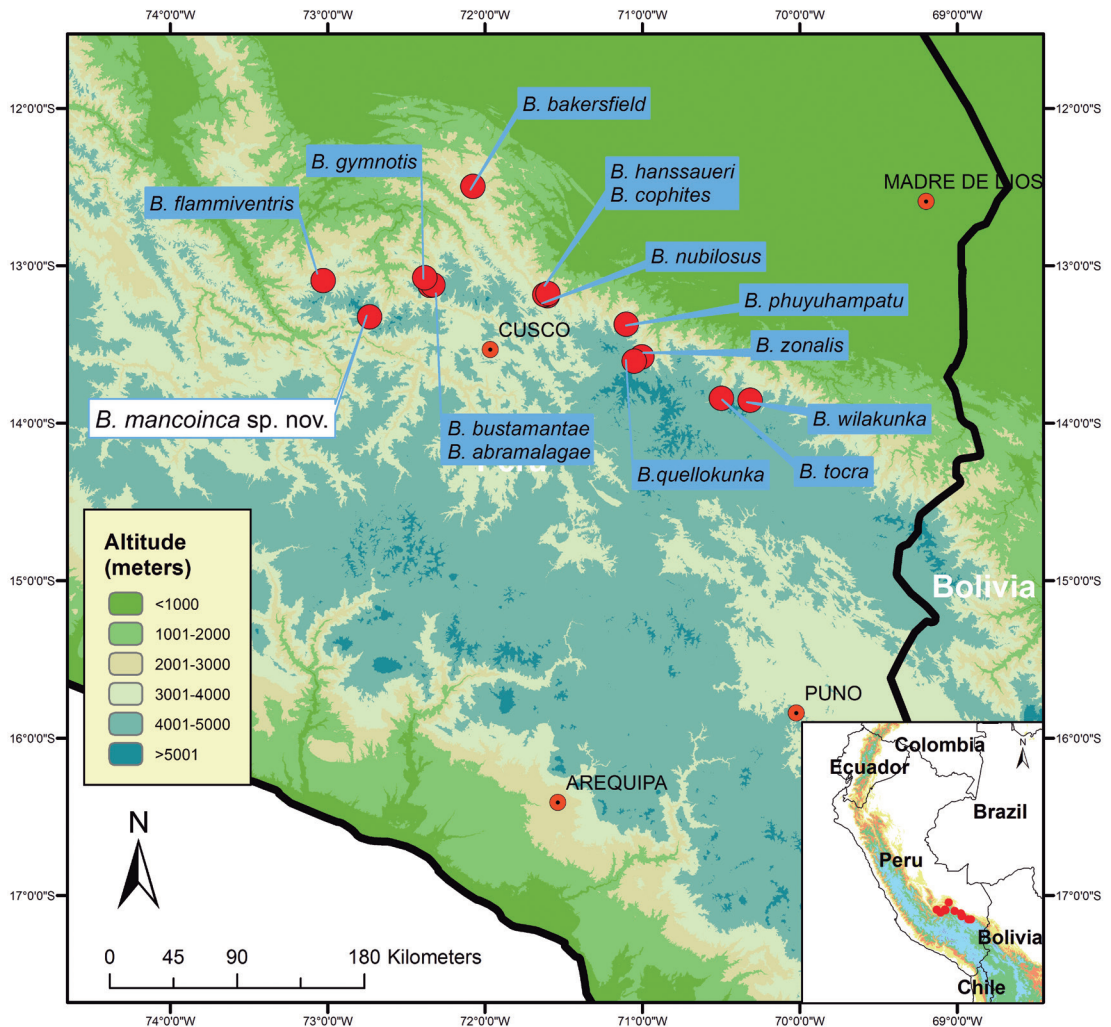


Figure 4. Map of Peru showing the type localities of the species of *Bryophryne*.

the high Andean puna (Figure 5). Sympatric amphibian species include *Gastrotheca excubitor* Duellman and Fritts, 1972, *Telmatobius* sp., *Psychrophrynella* sp., *Pleurodema marmoratum* (Duméril and Bibron, 1840) and *Rhinella spinulosa* (Wiegmann, 1834).

Discussion

In recent years the number of species of Terrarana inhabiting the Peruvian Andes has increased significantly (Chaparro *et al.* 2007, 2015, Lehr and Catenazzi 2008, 2009, 2010,

Table 2. Characteristics of the advertisement call of *Bryophryne manco inca* sp. nov. based on recordings of unvouchered specimens. Values are given as mean \pm SD.

Trait	N	Duration (ms)	Interval (ms)	Dominant Frequency (Hz)
CALL TYPE				
Two notes	9	259.8 \pm 21.1	8150.1 \pm 4572.1	2437.5 \pm 0.0
Three notes	19	398.6 \pm 45.9	9699.1 \pm 4807.4	2407.9 \pm 70.2
NOTES				
First note	28	73.3 \pm 26.3	-	2417 \pm 59.1
Second note	28	30.4 \pm 13.0	145.5 \pm 16.4	2424.1 \pm 49.2
Third note	19	27.9 \pm 5.6	134.5 \pm 8.0	2437.5 \pm 0.0



Figure 5. Type locality and habitat of *Bryophryne manco inca* sp. nov. Photo by Alex Tito (19 September 2015).


Lehr *et al.* 2012, Lehr and Oróz 2012; Mamani and Malqui 2014, Chavez *et al.* 2015, Catenazzi and Tito 2016), contributing to high rates of species discovery for Peru (Catenazzi 2015). Many of these recent discoveries were made in previously unexplored areas, highlighting the importance of filling survey gaps in the Andes. The genus *Bryophryne* is an extreme example of these discovery patterns, because 13 of 14 known species have been discovered over the past 10 years, and because all species are highly endemic with their known geographic distributions restricted to their type localities and immediate surroundings. We therefore expect that additional species will be discovered in the future as researchers explore isolated or remote mountain ranges that are not easily accessible by road.

Bryophryne mancoinea sp. nov. shares the presence of tympanic membrane and annulus, vocal sac and slits in males, and (as far as we know) emission of advertisement calls with only two other congeneric species (*B. flammiventris* and *B. gymnotis*). Furthermore, these three species are distributed in valleys of the Cordillera de Vilcabamba, whereas the other known *Bryophryne* inhabit different ranges of the Cordillera de Vilcanota massif. We hypothesize that *B. flammiventris*, *B. gymnotis*, and *B. mancoinea* sp. nov. might represent a distinct, and currently unrecognized clade from *Bryophryne*, with the main distinguishing feature being the presence of vocal sac and slits, tympanic membrane and annulus, and advertisement call. Members of this clade would be restricted to the upper watershed of the Cordillera de Vilcabamba south of the Apurimac canyon, without overlap with the known geographic distributions of other *Bryophryne* species. Future molecular analyses should test this hypothesis, and are likely to provide insight into diversification patterns in these groups of high-elevation Holoadeninae.

Montane forest frogs in southern Peru have been negatively affected by epizootics of

chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis* Longcore, Pessier and Nichols, 1999 (Catenazzi *et al.* 2011, 2014). This fungus has been reported in a *Pleurodema marmoratum* (Duméril and Bibron, 1840) from the Cordillera de Vilcabamba in 2008 (Catenazzi *et al.* 2011), and has likely caused population declines and local extinctions of several taxa, but appears to be less of a threat for terrestrial-breeding species such as *Bryophryne* than for aquatic-breeding species (Catenazzi *et al.* 2011). However, the population status of *Bryophryne mancoinea* sp. nov. and its vulnerability to chytridiomycosis are presently unknown.

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Appendix I. Type specimens examined.

Bryophryne bakersfieldi: PERU: Departamento Cusco, Provincia La Convención, Distrito Echarate, Roquerio Lorohuachana, 3620 m a.s.l. (12°29'43.8" S, 72°04'35.9" W), MUBI 7972 (holotype).

Bryophryne bustamantei: PERU: Departamento Cusco, Provincia La Convención, Distrito Huayopata, Canchayoc, near Abra de Málaga, 3663 m a.s.l. (13°07'16.2" S, 72°19'53" W), MUBI 6019 (holotype); MUSM 24537–24538.

Bryophryne cophites: PERU: Departamento Cusco, Provincia Paucartambo, Distrito Paucartambo, Abra Acjanaco: KU 138884 (holotype); N slope Abra Acanaco (Acjanaco), 27 km NNE Paucartambo, 3450 m a.s.l.: KU 138885–138908, 138911–138915 (all paratypes); 2 km NE of Abra Acanaco (Acjanaco), 3280 m a.s.l.: MHNG 2698.24, 5.5 km N of Abra Acanaco (Acjanaco), 3523 m a.s.l.: MUSM 27895, Tres Cruces, 8.5 km N of Abra Acanaco (Acjanaco), 3590 m a.s.l.: MUSM 20855–20856, 26283–26284, 26264, 26266–26267, 26313, 26315, 27896, 30414–30417, Pillco Grande, 3865 m a.s.l., near border of Manu NP: CORBIDI 11919.

Bryophryne gymnotis: PERU: Departamento Cusco, Provincia La Convención, Distrito Huayopata, San Luis, near Abra de Málaga, MUBI 14315–14319, 1 km east of San Luis at elevations of 3272–3354 m a.s.l.: MUSM 24543 (holotype), MHNG 2710.28, 2710.29, MTD 46860–46864, 47288, 47291–47292, 47297, MUSM 24541–24542, 24544–24545, 24546–24556, MVZ 258407–258410 (all paratypes), MUBI 14315–14319 (paratopotype) 13°4'12" S, 72°22'50" W, 3539 m a.s.l.

Bryophryne hanssaueri: PERU: CUSCO: Provincia Paucartambo, Distrito Kosñipata: Acjanaco, Manu National Park, 3266 m a.s.l.: MUSM 27567 (holotype); from near Acjanaco, Manu National Park at elevations of 3280–3430 m a.s.l.: MHNG 2698.25, MTD 46865–46866, 46887–46889, MUSM 24557, 27568–27569, 27607–27611, MVZ 258411–25813 (all paratypes).

Bryophryne nubilosus: PERU: CUSCO: Provincia Paucartambo: Distrito Kosñipata, 500 m NE of Esperanza, 2712 m a.s.l.: MUSM 26310 (holotype), MUSM 26311; near the type locality, 13°11'33.21" S, 71°35'25.17" W, 3065 m a.s.l.: MTD 47294; near Hito Pillahuata, 2600 m a.s.l.: MUSM 20970; Quebrada Toqoruyoc, 3097 m a.s.l.: MUSM 26312, MTD 47293; Esperanza, 2800 m a.s.l.: MHNSM 26316–26317; 13°11'20.2" S, 71°35'07.3" W, 2900 m a.s.l.: MUSM 24539–24540.

Bryophryne phuyuhampatu: PERU: CUSCO: Provincia Paucartambo, Distrito Paucartambo, Área de Conservación Privada (ACP) Ukumari Llaqta, Quispillomayo valley, 2795–2850 m a.s.l., CORBIDI 18226 (holotype), CORBIDI 18224–18225, 18227–18228 and MUBI 14654–14655, 14665.

Bryophryne zonalis: PERU: CUSCO: Provincia Quispicanchis, Distrito Marcapata, Kusillochayoc at 3129 m a.s.l.: MUSM 27570 (holotype), MTD 46867, 46869–46870, MUSM 27572, 27574–27575, 27861, MVZ 258414 (all paratypes); at Puente Colina, 3285 m a.s.l.: MVZ 258415 (paratype).

Noblella madreSelva: PERU: CUSCO: Provincia La Convención, Madre Selva (Santa Ana), CORBIDI 15769–15770.

Noblella pygmaea: PERU: CUSCO: Provincia Paucartambo, Kosñipata, MHNG 2725.29–30, MUSM 24535–24536, 26306–26307, 26318–26320, 30423–30424, 30453–30454, MTD 47286–47287.

Psychrophrynella bagrecito: PERU: CUSCO: Quispicanchis: Marcapata, Río Marcapata, below Marcapata, ca. 2740 m, KU 196512 (holotype), KU 196513–196518, 196520–196521, 196523–196525 (all paratypes); La Convención: Hacienda Huyro between Huayopata and Quillabamba, 1830 m a.s.l., KU 196527–196528.

Psychrophrynella chirihampatu: PERU: CUSCO: Área de Conservación Privada (ACP) Ukumari Llaqta, Comunidad Campesina de Japu: CORBIDI 16495 (holotype), CORBIDI 16496–16509, and MUBI 14658, 14661, 14662, 14666–146672 (all paratypes).

Psychrophrynella usurpator: PERU: CUSCO: Provincia Paucartambo, Kosñipata, MUSM 20011, 20873–20881, 20896–20913, 20925–20933, 20946–20947, 20955–20957, 21012–21018, 26272–26273, 26278–26279, 26308, 27592, 27906, 27950, 28033–28047, 30303, 30305, 30396–30400, 30405–30409, 30471–30474.

Phrynopus chaparroi: PERU: Departamento Junin, Provincia Concepcion, Distrito Comas, Canchalpa, 4490 m a.s.l. (11°44'45" S, 74°58'47" W) MUBI 10983 (Holotype).

Phrynopus mirosławae: PERU: Departamento Pasco, Provincia Oxapampa, Distrito Huancabamba, Type locality: Santa Barbara, 3363 m a.s.l., (10°20'13.8" S, 75°38'47.3" W), MUBI 6469 (holotype).

Phrynopus nicoleae: PERU: Departamento Pasco, Provincia Oxapampa, Distrito Huancabamba, Type locality: Santa Barbara, 3589 m a.s.l., (10°20'36.3" S, 75°38'17.9" W), MUBI 6441 (holotype).