



Two sympatric new species of *Phrynopus* (Anura: Strabomantidae) from Yanachaga Chemillén National Park (central Peruvian Andes)

JUAN C. CHAPARRO^{1,3}, JOSÉ M. PADIAL² & IGNACIO DE LA RIVA²

¹Museo de Historia Natural, Universidad Nacional de San Antonio Abad del Cusco. Plaza de Armas s/n (Paraninfo Universitario), Cusco, Peru

²Department of Biodiversity and Evolutionary Biology, Museo Nacional de Ciencias Naturales, CSIC. C/ José Gutiérrez Abascal 2, 28006 Madrid, Spain

³Corresponding author. E-mail: jchaparroauza@yahoo.com

Abstract

Two sympatric new species of *Phrynopus* (Anura: Strabomantidae) are described from elfin forests and puna grasslands (3363–3589 m) of the eastern slopes of the Andes of Departamento Pasco in central Peru. *Phrynopus mirosławae* **sp. nov.** is a medium-sized species characterized by lacking vomerine teeth and tympanic membrane, and by having dorso-lateral folds, areolate ventral skin, dorsum gray with black spots, venter cream with small scattered black blotches, and iris bronze. *Phrynopus nicoleae* **sp. nov.** is a small species characterized by lacking tympanic membrane and by having vomerine teeth, an X-shaped middorsal fold, ventral skin areolate, dorsum tan with black stripes and bluish tubercles, and iris bronze with black reticulations.

Key words: Andes, Anura, new species, Peru, *Phrynopus*

Introduction

Frogs of the genus *Phrynopus* Peters as defined by Lynch (1975) occurred along the Andes of Colombia, Ecuador, Bolivia and Peru, between 1000 and 4400 meters above sea level (m a.s.l.) (Lehr et al. 2005; Lynch 1975; Lehr 2006; De la Riva, 2007). However, the genus proved to be non monophyletic (Darst & Cannatella, 2004; Duellman & Hedges, 2005; Frost et al., 2006; Lehr et al., 2005; Heinicke et al., 2007) and recent molecular data indicate that it is restricted to central Peru only (departments of La Libertad, Huánuco, Pasco, Junín and Ayacucho) (Hedges et al., 2008; Duellman & Hedges, 2008). With 19 species currently recognized, many of them described during the last 15 years, *Phrynopus* is one of the most speciose groups of frogs in humid paramo and cloud forest habitats of the Andes. The actual diversity of this genus is far from being well known, and new species are found as herpetological surveys are carried out in previously unexplored or poorly known areas. Yanachaga Chemillén is a Peruvian National Park in Departamento Pasco, in which there is a remarkable diversity of amphibians. New species of anurans, including *Phrynopus*, have been described from the area (e.g., Hedges, 1990; Duellman & Hedges 2005, 2008). During intensive fieldwork in August and September 2007 in the park, several new species of frogs were discovered, among them, two new *Phrynopus* that are described herein. With these additions, the diversity of the genus *Phrynopus* raises to 21 species.

Material and methods

Specimens were fixed in 10% formalin and preserved in 70% ethanol. The format for the description follows that of Lynch (1975). Specimens examined are listed in the Appendix. Measurements were taken with a digi-

tal caliper to the nearest 0.1mm. Abbreviations are as follows: SVL (snout-vent length), HL (head length, from posterior margin of jaw to tip of snout), HW (head wide, maximum width of head), IND (internarial distance), END (eye-nostril distance, straight line distance between anterior corner of orbital opening and posterior margin of external nares), 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). Coloration in life are based on the field notes by J.C.C. Pictures were taken using a digital camera with a 100 mm. macrolens. Museum abbreviations refer to: Natural History Museum, University of Kansas, USA (KU); Museo de Historia Natural de la Universidad Mayor de San Marcos, Lima, Peru (MHNSM); Museo Nacional de Ciencias Naturales, Madrid, Spain (MNCN); and Museo de Historia Natural, Universidad Nacional de San Antonio Abad, Cusco, Peru (MHNC).

Systematics

Phrynopus miroslawae sp. nov.

(Figs. 1–2)

Holotype. MHNC 6469 (field number JCC 4029), an adult female (Fig. 1) from Santa Bárbara, Distrito de Huancabamba, Provincia de Oxapampa, 3363 m a.s.l. (10° 20' 13.8"S, 75° 38' 47.3"W), Departamento Pasco, Peru, collected by J. C. Chaparro, A. Quiroz and D. Salcedo on 30 August 2007.

Diagnosis. (1) A medium-sized species (SVL 29.1 mm), body robust, legs moderately short (TL+FL 74% SVL); (2) tympanic membrane and annulus absent; (3) first finger slightly shorter than second; (4) tips of digits bulbous, not expanded laterally; (5) toes without basal webbing or fringes; (6) two metatarsal tubercles, inner larger than outer; tarsal fold absent, outer edge of tarsus with a row of subconical tubercles; (7) dorsal skin covered with small, round regular warts, with larger warts towards flanks and occipital region; dorsolateral, occipital and supratympanic folds prominent; ventral skin areolate, throat with small round granules; (8) snout rounded in dorsal view and in profile; (9) dorsum gray with large bold black blotches; (10) venter cream with small, scattered bold black blotches; (11) dentigerous processes of vomers and teeth absent.

Phrynopus miroslawae is unique among other *Phrynopus* by having the combination of warty dorsum with prominent dorsolateral, occipital and supratympanic folds, areolate belly, and grey dorsum with large bold blotches.



FIGURE 1. Living adult female of *Phrynopus miroslawae* sp. nov. (MHNC 6469, holotype, SVL 29.1 mm) in dorsolateral (A), ventral (B) and dorsal (C) views. Photos by J. C. C.

Twenty other species of *Phrynopus* (*auriculatus*, *ayacucho*, *barthlenae*, *bracki*, *bufoides*, *dagmarae*, *heimorum*, *horstpauli*, *juninensis*, *kauneorum*, *kotosh*, *montium*, *nicoleae* sp. nov., *oblivius*, *paucari*, *peruanus*, *pesantesi*, *tauzorum*, *thompsoni*, and *tribulosus*) are currently known. The species most similar to *P. miroslawae* is *P. barthlenae*, but *P. miroslawae* differs from it by having (characteristics of *P. barthlenae* in

parentheses) throat with small granules (absent), toes lacking webbing (basal webbing between all toes), dorsolateral folds present (absent), and venter cream with small scattered black blotches (pale grey and marmorated with black); in addition, *P. miroslawae* occurs in dwarf forest or the upper limits of the cloud forest, while *P. barthlenae* inhabits the puna or grassland. Superficially, *P. miroslawae* is similar to *P. ayacucho*, from which it differs by having continuous dorsolateral folds (discontinuous in *P. ayacucho*), tympanic annulus absent (present), and venter cream with small black blotches (uniformly tan). *Phrynopus miroslawae* differs from *P. horstpauli*, *P. oblivius*, *P. pesantesi*, and *P. tautzorom* by having dorsolateral folds present (absent in these species); *P. miroslawae* lacks vomerine teeth and has digital tips bulbous (vomerine teeth present and digital tips weakly swollen or rounded in *P. dagmarae*, *P. kauneorum*, and *P. kotosh*); *P. miroslawae* has venter, chest, and groin cream, and possesses dorsolateral occipital folds (venter red and yellow and dorsolateral folds absent in *P. heimorum*); *P. miroslawae* has areolate venter (smooth in *P. kauneorum* and *P. juninensis*); *P. miroslawae* lacks tympanic membrane (present in *P. peruanus*); *P. miroslawae* has warty dorsum, conspicuous dorsolateral folds and supratympanic fold (dorsum with conical tubercles, discontinuous dorsolateral folds, and supratympanic fold weak in *P. paucari*); *P. miroslawae* has well-defined dorsolateral folds and small warts on dorsum (heavily warty dorsum, with large round warts forming three longitudinal rows in *P. bufooides*); *P. miroslawae* lacks tympanum and tympanic membrane (ventral part of tympanic annulus visible externally in *P. montium*); *P. miroslawae* has first finger shorter than second and tarsus bearing subconical tubercles (Fingers I and II equal in length and tarsus smooth in *P. thompsoni*). Three species (two of them described recently; Duellman & Hedges, 2008) occur in sympatry not far from the type locality of *P. miroslawae*: *P. auriculatus*, *P. bracki*, and *P. tribulosus* (type locality, 5.5 km E Oxapampa, 2600 m; this locality lies 38 km airline SE Santa Bárbara, on mountains at the opposite side of the Oxapampa valley). From *P. auriculatus* and *P. bracki*, *P. miroslawae* differs by being larger, having dorsal skin coarsely warty with conspicuous dorsolateral folds, venter areolate, and lacking vomerine teeth; from *P. tribulosus* it differs by having dorsal skin coarsely warty with conspicuous dorsolateral folds, and venter areolate. In addition to morphological and color pattern differences, due to the high degree of species endemism in *Phrynopus* (and in similar high Andean genera) it is extremely unlikely that allopatric populations are conspecific (De la Riva, 2007). A sympatric species, *P. nicoleae* **sp. nov.**, described herein, is clearly distinguished from *P. miroslawae* (see diagnosis of *P. nicoleae* **sp. nov.**).

Species from southern Peru and Bolivia formerly placed in *Phrynopus* are now placed in different genera (Hedges et al., 2008), and comparing them with *Phrynopus* from Central Peru is unnecessary.

Description of the holotype. Body robust; dorsal skin coarsely warty, with enlarged warts in occipital region and flanks; small tubercles on upper eyelid; dorsolateral folds prominent, from above arms to the level of sacral region; a pair of oblique prominent occipital folds; a slender middorsal fold; ventral skin areolate; pectoral fold present; head wider than long; HW 39% of SVL, HL 33% of SVL; snout short, rounded in dorsal view and in profile; nostrils prominent, closer to eyes than to snout; canthus rostralis concave in dorsal view, sharp in frontal profile; eye-nostril distance 67% of eye length; loreal region slightly concave; cranial crests absent; tympanic membrane and tympanic annulus absent, skin of the tympanic area covered by low, round subconical tubercles; supratympanic fold prominent; tongue large, oval; choanae round, small, widely spaced; dentigerous processes of vomers absent; limbs moderately short; tips of digits bulbous, not expanded laterally; ulnar tubercle and fold absent; inner palmar tubercle single, elongate, flat, smaller than subtriangular outer; fingers moderately short, not fringed; subarticular tubercles large, round; supernumerary tubercles smaller and less prominent than subarticular tubercles; first finger shorter than second; relative length of fingers $1 < 2 < 4 < 3$; tibia length 35% of SVL; tarsal fold absent; a row of tarsal subconical tubercles; two oval metatarsal tubercles, inner slightly larger than outer; supernumerary tubercles small, poorly defined; subarticular tubercles of toes round; toes lacking basal webbing or lateral fringes; relative length of toes $1 < 2 < 5 = 3 < 4$; foot length 39% of SVL.

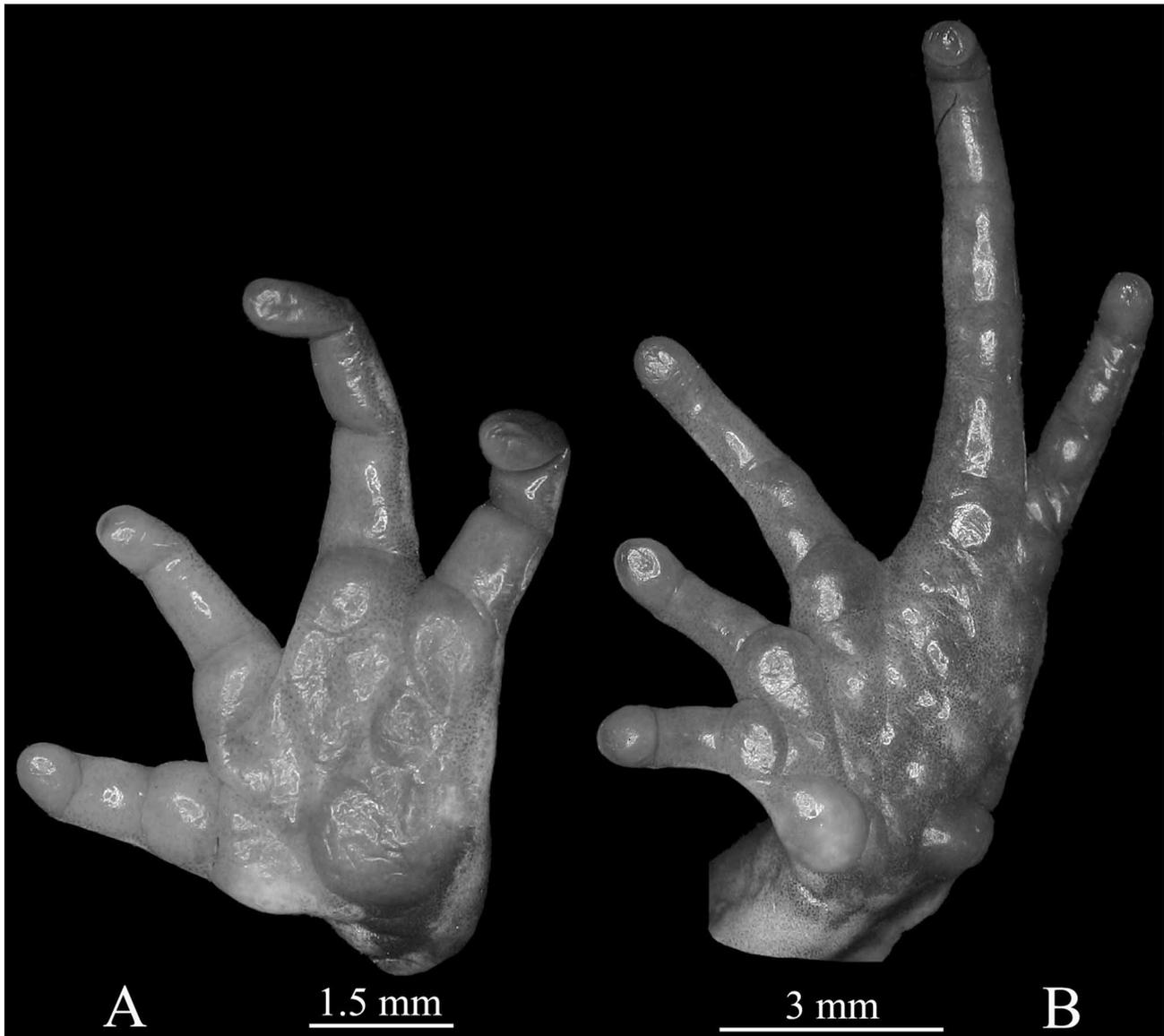


FIGURE 2. Ventral views of hand (A), and foot (B) of adult female *Phrynopus miroslawae* sp. nov. (MHNC 6469, holotype).

In life, the dorsum of the holotype was gray with bold black to dark brown blotches on middorsal regions, occipital region and interocular region. Most surfaces of flanks, ventral surfaces and dorsolateral folds were creamy-gray with few round black blotches; the upper lip was creamy-gray, with a fine brown stripe along the border; the eyelid and supratympanic fold were gray dorsally and bold black ventrally; the throat was cream; the belly, ventral surface of arms and legs were cream with few scattered black blotches; the fingers, toes and plantar surfaces were purplish-gray; the iris was bronze with black reticulations.

In preservative the pattern is similar, with dorsal surfaces, head, and superior extremities dark gray and a black supratympanic stripe; most parts of the belly are cream with small black blotches; the throat is cream with black on the border of the lower lip; the palmar surfaces are creamy-gray; the groin is cream.

Measurements and proportions (in mm): SVL, 29.2; HL, 9.7; HW, 11.4; IND, 2.5; END, 1.9; ED, 2.8; IOD, 4.4; EW, 2.3; TL, 10.2; FL, 11.4; HL/SVL, 0.33; HW/SVL, 0.39; END/ED, 0.67; TL/SVL, 0.35; FL/SVL, 0.39.

Etymology. The name is a patronym for Mirosława Jagielko (Poland) in recognition of her friendship and her support of taxonomic research and nature conservation in Peru.

Distribution and natural history. *Phrynopus miroslawae* is known only from Santa Bárbara, Distrito de Huancabamba, Provincia de Oxapampa, Departamento Pasco, Peru, at 3363 m a. s. l. (Fig. 3). This species inhabits elfin forest or “ceja de montaña” (Fig. 4A). Specimens were collected during the dry season inside moss. Other amphibians found in sympatry were *Gastrotheca griswoldi* and *Phrynopus nicoleae* **sp. nov.**

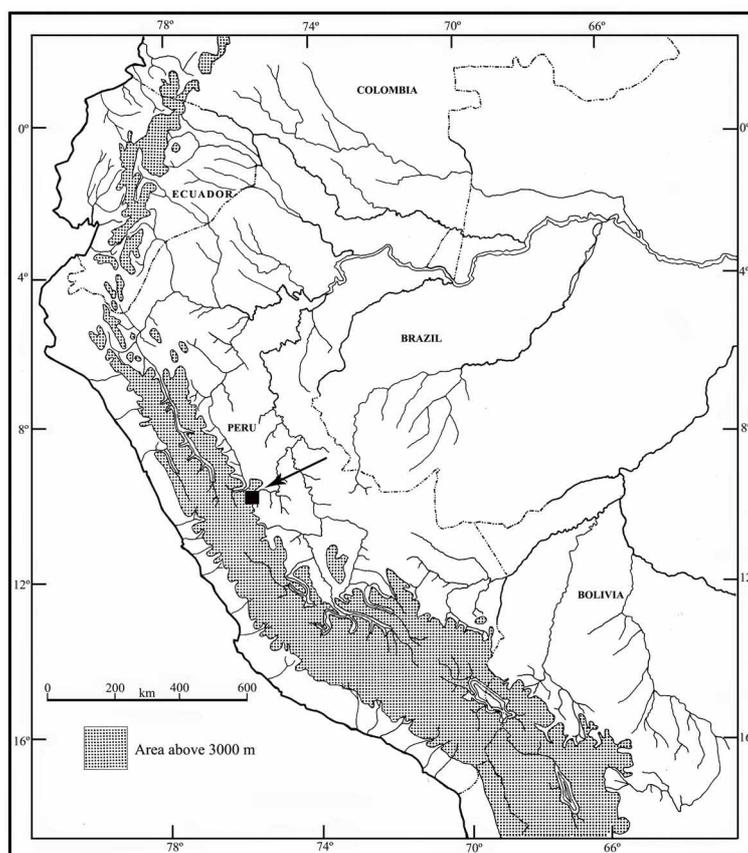


FIGURE 3. Map of western South America with a square indicating the type locality of *Phrynopus miroslawae* **sp. nov.** and *Phrynopus nicoleae* **sp. nov.** in Peru.

***Phrynopus nicoleae* sp. nov.**

(Figs. 5–6)

Holotype. MHNC 6441 (field code JCC 4001), an adult female (Fig. 5) from Santa Bárbara, Distrito de Huancabamba, Provincia de Oxapampa, 3589 m a.s.l. (10° 20' 36.3"S, 75° 38' 17.9"W), Departamento Pasco, Peru, collected by J. C. Chaparro, A. Quiroz and D. Salcedo on 26 August 2007.

Diagnosis. (1) A small species (SVL 21.2 mm), body slim, legs moderately long (TL+FL 90% SVL); (2) tympanic membrane and annulus absent; (3) first finger the same length as second; (4) tips of digits round, slightly swollen, not expanded laterally; (5) toes lacking webbing and fringes; (6) two metatarsal tubercles, tarsal fold absent; (7) dorsal skin finely granular, elongate dorsolateral warts forming a long discontinuous row that does not fuse to form a fold; a conspicuous X-shaped middorsal fold; ventral skin areolate; (8) snout rounded in dorsal view and in profile; (9) dorsum tan with black irregular stripes and bluish-gray tubercles; (10) venter gray, marmorated with small, brown, tan and metallic blue blotches; (11) dentigerous processes of vomers and teeth present.

Phrynopus nicoleae is unique among other *Phrynopus* by having the combination of granular dorsum, a middorsal X-shaped fold, a discontinuous row of elongate dorsolateral warts, tympanic membrane and annu-

lus absent, venter areolate, gray venter with small brown and metallic blue to metallic white spots, yellow fingers and toes, metallic bronze iris, and black tarsus.

Twenty other species of *Phrynopus* (*auriculatus*, *ayacucho*, *barthlenae*, *bracki*, *bufoides*, *dagmarae*, *heimorum*, *horstpauli*, *juninensis*, *kauneorum*, *kotosh*, *miroslawae* **sp. nov.**, *montium*, *oblivius*, *paucari*, *peruanus*, *pesantesi*, *tautzorum*, *thompsoni*, and *tribulosus*) are currently known from the Andes in central Peru. The species most similar to *P. nicoleae* is *P. dagmarae*, whose type locality lies approximately 54 km airline from that of *P. nicoleae*; the new species differs from *P. dagmarae* by having a X-shaped middorsal fold, yellow digits, and first finger equal to second (middorsal fold absent, red digits, and first finger much shorter than second in *P. dagmarae*). Another geographically close and morphologically similar species is *P. kauneorum* (ca. 57 km airline distance between type localities); however, *P. nicoleae* has granular dorsum and areolate venter (dorsum and venter smooth); furthermore, *P. nicoleae* inhabits grassland or puna, while *P. kauneorum* inhabits the elfin forest or “ceja de montaña”. *Phrynopus nicoleae* differs from *P. ayacucho* by lacking a tympanum (present) and having venter gray with tan, brown, and metallic blue blotches (uniformly tan). *Phrynopus nicoleae* differs from *P. barthlenae*, *P. bufoides*, *P. heimorum*, *P. horstpauli*, *P. miroslawae* **sp. nov.**, *P. montium*, *P. oblivius*, *P. paucari*, *P. pesantesi*, *P. tautzorum* and *P. thompsoni* in having vomerine teeth and dentigerous processes (absent). *Phrynopus nicoleae* differs from *P. kotosh* by having dorsal skin finely granular (tuberculate) and a X-shaped middorsal fold (absent). *Phrynopus nicoleae* differs from *P. peruanus* by lacking tympanic membrane (present), and having vomerine teeth (absent). *Phrynopus nicoleae* differs from *P. juninensis* by having areolate venter, granular dorsum and weak supratympanic fold (smooth venter and dorsum, and prominent supratympanic fold). Three species (two of them described recently; Duellman & Hedges, 2008) occur in sympatry not far from the type locality of *P. nicoleae*: *P. auriculatus*, *P. bracki*, and *P. tribulosus* (type locality, 5,5 km E Oxapampa, 2600 m; this locality lies 38 km airline SE Santa Bárbara, on mountains at the opposite side of the Oxapampa valley). From *P. auriculatus*, *P. nicoleae* differs by having dorsal skin granular and venter areolate, and by lacking a tympanum (dorsal and ventral skin smooth, tympanum present). From *P. bracki*, *P. nicoleae* is distinguished by having dorsal skin granular and venter areolate (dorsum strongly tuberculate, venter smooth). *Phrynopus nicoleae* differs from *P. tribulosus* by having dorsal skin granular, venter areolate, and vomerine teeth (dorsal and ventral skin smooth, vomerine teeth absent). In addition to morphological and color pattern differences, because of the high degree of species endemism in *Phrynopus* (and in similar high Andean genera) it is extremely unlikely that allopatric populations are conspecific (De la Riva, 2007).

Description of the holotype. Body slim; dorsal skin granular; dorsolateral fold-like rows of elongated dorsolateral warts; ventral skin areolate; pectoral fold present; head narrower than body, head as wide as long; HW 32% of SVL, HL 28% of SVL; snout rounded in dorsal view and in profile; nostrils not protuberant, closer to snout than to eyes; canthus rostralis concave in dorsal view and sharp in frontal profile; eye-nostril distance 78% of eye length; loreal region slightly concave; cranial crests absent; tympanic membrane and annulus absent; supratympanic fold weak; tongue large, oval; choanae triangular, small, widely spaced; dentigerous processes of vomers and vomerine teeth present; limbs moderately short; tips of digits slightly swollen, not expanded laterally; ulnar tubercle and fold absent; inner palmar tubercle single, oval, flattened, smaller than outer; fingers moderately short, not fringed; subarticular tubercles round, those at the basis of proximal phalanges swollen; first finger of the same length as second; relative length of fingers 1=2<4<3; tibia length 42% of SVL; tarsus with small tubercles, lacking fold; two metatarsal tubercles, oval inner slightly larger than rounded outer; supernumerary tubercles small, poorly defined; subarticular tubercles of toes round, medium-sized; toes not webbed, lateral fringes absent; relative length of toes 1<2<5<3<4; foot length 47% of SVL.

In life, the holotype had the following colour pattern: dorsum tan with poorly defined black blotches associated to dorsal ridges and elongated warts; diffuse black blotches on interocular region; dorsal granules bluish-white; a bold black mask from tip of snout through the supratympanic area to the level of the poststrical area; upper lip with two bold black triangular marks intercalated with bluish-white blotches; subocular region

bold black; flanks and extremities tan with abundant bluish-white spots; groin tan with abundant bluish-white spots and an orange spot; anterior surfaces of limbs dark brown with bluish-white spots; belly and throat gray with small, marmorated, brown and metallic blue blotches; ventral surface of arms and legs grayish-black with bluish metallic-white spots, some of them anastomosed; fingers, toes and distal regions of plantar surfaces yellow, proximal regions grayish-brown; upper iris light bronze and lower iris dark bronze, both parts with black reticulations.

In preservative, the holotype has dorsal surfaces, head and scapular region grayish-tan, extremities brown, and supratympanic stripe black with a white stripe; most parts of the belly and throat are marmorated with grayish-white and dark brown spots; there are brown triangular marks on the upper lip; the palmar surfaces are grayish-white with some dark brown tonalities, and the plantar surfaces are brown with grayish-white toes; the groin is brown with small grayish-white blotches.

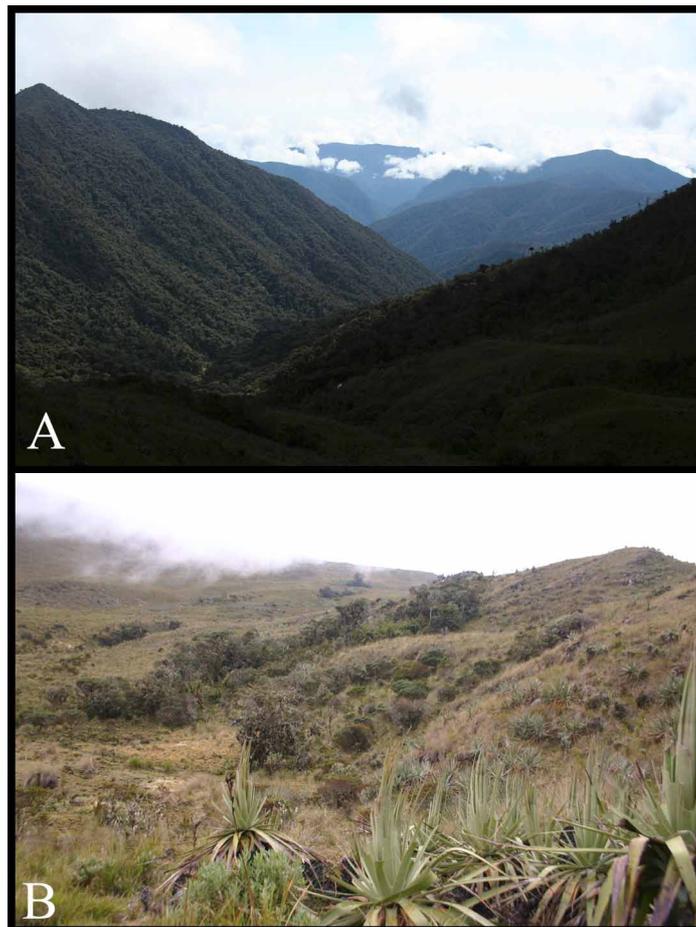


FIGURE 4. Habitat at the type locality of *Phrynopus miroslawae* sp. nov. (A) and *Phrynopus nicoleae* sp. nov. (B) on August 2007.

Measurements and proportions (in mm): SVL, 21.2; HL, 6.1; HW, 6.9; IND, 2.1; END, 1.8; ED, 2.3; TL, 9.0; FL, 10.1; IOD, 3.0; EW, 1.2; HL/SVL, 0.28; HW/SVL, 0.32; END/ED, 0.78; TL/SVL, 0.42; FL/SVL, 0.47.

Etymology. The name is a patronym for Nicole Morciniec (Poland) in recognition of her friendship and support of taxonomic research and nature conservation in Peru.

Distribution and natural history. *Phrynopus nicoleae* is known only from the locality of Santa Bárbara, Distrito de Huancabamba, Provincia de Oxapampa, Departamento Pasco, at 3589 m.a.s.l. (Fig. 3). This species inhabits grasslands or “puna” areas (Fig. 4B). The holotype was collected during the dry season under a big stone. The only additional amphibian species found in sympatry was *Gastrotheca griswoldi*.



FIGURE 5. Living adult female of *Phrynopus nicoleae* **sp. nov.** (MHNC 6441, holotype, SVL 21.2 mm) in dorsolateral (A), ventral (B) and dorsal (C) views. Photos by J. C. C.

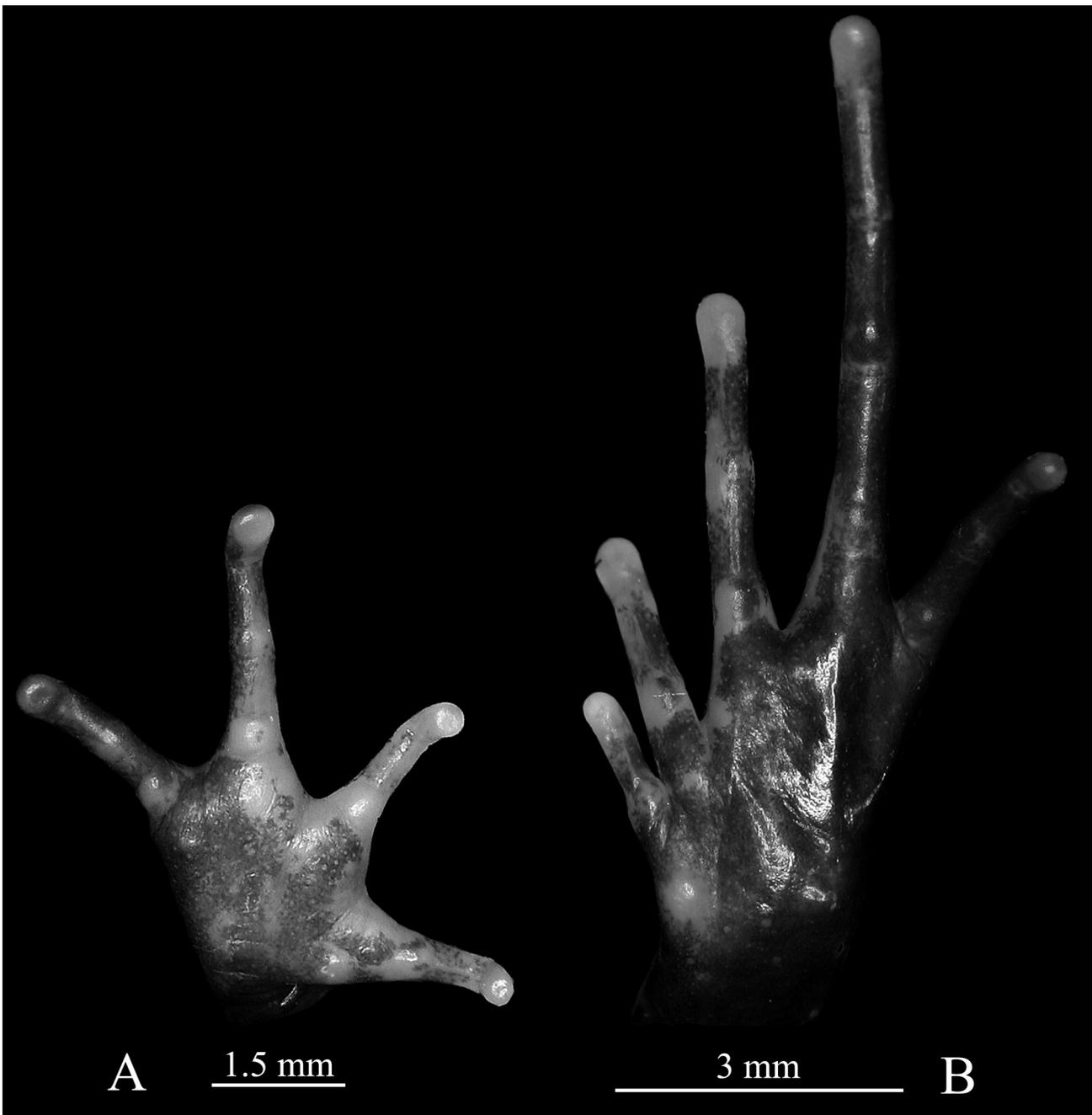


FIGURE 6. Ventral views of hand (A), and foot (B) of adult female *Phrynopus nicoleae* **sp. nov.** (MHNC 6441, holotype).

Discussion

Although we have not performed osteological or molecular analyses to assess the generic assignment of the two newly described species, we tentatively assign these species to the genus *Phrynopus* based on distribution and overall similarity. The phylogenetic relationships of Neotropical direct-developing frogs and their classification have experienced great changes in the last years (see Frost 2007; Heinicke et al., 2007; Hedges et al., 2008). From a morphological standpoint, *Phrynopus* has traditionally been distinguished from other former "eleutherodactylines" by the absence of expanded digital tips with circumferential grooves (Lynch 1975). However, this external character does not always provide a clear distinction (Lehr 2006).

Most species of *Phrynopus* are endemic to glacial valleys of the Andes where often a single species is the exclusive inhabitant of the suitable habitat. Only five cases of sympatry are known to date: *P. horstpauli* and *P. heimorum* (Lehr et al. 2000; Lehr 2001); *P. dagmarae* and *P. kauneorum* (Lehr et al. 2002); *P. barthlenae* and *P. tautzorum* (Lehr & Aguilar 2002, 2003); *P. auriculatus*, *P. bracki*, and *P. tribulosus* (Duellman & Hedges 2008); and *P. mirosławae* and *P. nicoleae* (this work). The last five species live in a small area in Yanachaga, which seems to harbor the highest known diversity of *Phrynopus*.

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Appendix. Type specimens examined

Bryophryne bustamantei: Peru: Cusco: Canchayoc: near abra de Málaga, MHNC 6018 (holotype) 6016, 6017, 6018 (paratypes). *Phrynopus barthlenae*: Peru: Huánuco: Ambo: 15 km southeast of Maraypata, MHNSM 20606 (holotype). *Phrynopus bracki*: Peru: Pasco: Oxapampa: Cordillera Yanachaga, 2.5 km north, 5.5 km east of Oxapampa, MHNSM 4400 (paratype). *Phrynopus dagmarae*: Peru: Huánuco: Pachitea: Palma Pampa, MHNSM 20451 (holotype). *Phrynopus heimorum*: Peru: Huánuco: Ambo: surroundings of Yaurin, MHNSM 20441 (holotype). *Phrynopus horstpauli*: Peru: Huánuco: Ambo: surroundings of Yaurin, MHNSM 20424 (holotype). *Phrynopus kauneorum*: Peru: Huánuco: Pachitea: Palma Pampa, MHNSM 20459 (holotype). *Phrynopus tautzorom*: Peru: Huánuco: Ambo: about 15 km southeast of Maraypata, MHNSM 20612 (holotype).