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A new species of harlequin frog (Anura: Bufonidae: *Atelopus*) from the northern Cordillera Central, Peru

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Abstract: A new species of harlequin frog, genus *Atelopus*, is described from the northern portion of the Cordillera Central, Department of San Martín, Peru (2860 m above sea level). The only known specimen, a male, is characterized by snout-vent length 38.0 mm, presence of scattered warts on the dorsal surfaces of head and body, conspicuous vertebral neural process, well defined *coni* in dorsolateral region and on flanks, dorsally uniform green with tan vermiculation, and ventrally orange with black vermiculation. The new species is similar to *A. angelito*, *A. bomolochos*, *A. epikeisthos*, *A. eusebianus*, *A. minutulus*, *A. muisca*, *A. nepiozomus*, *A. petriruizii*, *A. peruensis*, *A. planispina*, *A. pulcher*, *A. sanjosei*, and *A. simulatus* by sharing green dorsal coloration, but differs from all these species by having tan dorsal markings and different skin texture.

Key words: *Atelopus*, Bufonidae, Cordillera Central, new species, Peru.

Resumen: Una nueva especie de rana arlequín (Anura: Bufonidae: *Atelopus*) del norte de la Cordillera Central, Perú. – Una nueva especie de rana arlequín, género *Atelopus*, es descrita para la porción norte de la Cordillera Central, Departamento de San Martín, Perú (2860 m sobre el nivel del mar). Esta nueva especie es conocida únicamente por un espécimen macho, caracterizado por poseer una longitud hocico-cloaca de 38.0 mm, presencia de verrugas dispersas en la superficie dorsal de la cabeza y del cuerpo, espinas neurales de las vertebrae pronunciadas, verrugas cónicas bien definidas en la región dorsolateral y flancos, dorso verde con vermiculado castaño y vientre naranja con vermiculado negro. Esta nueva especie es similar a *A. angelito*, *A. bomolochos*, *A. epikeisthos*, *A. eusebianus*, *A. minutulus*, *A. muisca*, *A. nepiozomus*, *A. petriruizii*, *A. peruensis*, *A. planispina*, *A. pulcher*, *A. sanjosei* y *A. simulatus* por compartir una coloración dorsal verde, pero se diferencia de estas por poseer marcas castañas dorsales y por la diferente textura de su piel.

Palabras clave: *Atelopus*, Bufonidae, Cordillera Central, especie nueva, Perú.

INTRODUCTION

The Neotropical bufonid genus *Atelopus* Duméril & Bibron, 1841 includes more than 100 species from Central and South America, most of which are diurnal, mostly riparian species (LA MARCA *et al.*, 2005). Due to their often striking colorations these amphibians are commonly known as harlequin frogs. Most *Atelopus* species occur in montane

habitats above 1500 m and display relatively restricted distributions (e.g. LÖTTERS, 1996). Generally speaking, the entire genus is highly threatened and most species may be on the brink of extinction (LÖTTERS *et al.*, 2004a; LA MARCA *et al.*, 2005).

The *Atelopus* from Peru include 11 nominally described species. However, the taxonomy of the genus in this country is still poorly understood. In addition, at least 17

Atelopus forms which may represent undescribed species have been reported by LÖTTERS *et al.* (2005). According to LÖTTERS *et al.* (2005) most of the unnamed harlequin frogs from Peru may also be drastically threatened.

The goal of this paper is to formally describe one of the new Peruvian *Atelopus* species. It is known from a single specimen which was collected in a rapid faunal inventory carried out in the area of the Los Cóndores lake and Los Chilchos valley in San Martín Department, during December 2003. Although descriptions based on such a limited number of specimens are currently rare, we are convinced of the importance of describing this species because (i) it is clearly different from other *Atelopus*, and (ii) given the current crisis affecting the genus, we want to acknowledge the existence of the new species.

MATERIAL AND METHODS

The holotype of the new species was fixed in 10% formalin and later stored in 70% ethanol. Geographical coordinates, habitat notes and data on live coloration were taken in the field; photographs were also taken. The description format follows that of LÖTTERS & HENZL (2000). We describe the phalangeal formula of the hand based on external examination and webbing formulae using the system of SAVAGE & HEYER (1967), as modified by MYERS & DUELLMAN (1982) and SAVAGE & HEYER (1997). The sex of the holotype was determined by external characters, which are sexually dimorphic in the genus *Atelopus* (e.g. forearm in males are proximally wider than distally, cornified pads on the first finger, number or size of warts) (see LÖTTERS, 1996). Morphometric data to nearest 0.1 mm were taken with dial calipers, following character definitions by GRAY &

CANNATELLA (1985). Abbreviations of measurement used are: snout vent length (SVL), tibia length (TIBL), foot length (FOOT), head length from the squamosal (HLSQ), head length from the exoccipital (HLEX), interorbital width (ITOR), head width (HDWD), eye diameter (EYDM), eye to nostril distance (EYNO), internarial distance (ITNA), hand length (HAND), and thumb length (THBL).

Data on other *Atelopus* species were taken from the literature and from examination of preserved material (Appendix I). All specimens examined are deposited in the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (MUSM), Lima, Peru.

Atelopus pyrodactylus sp. nov.

(Figs. 1-3)

Holotype: MUSM 19521, an adult male, collected along the trail from Los Chilchos to Leymebamba (06° 41' 19" S, 77° 41' 48" W, WGS 84; 2860 m above sea level), Provincia Mariscal Cáceres, Department of San Martín, Peru; collected by J. Barrio, 8 December 2003.

Diagnosis: The new *Atelopus* can be distinguished from other species by the following combination of characters: (1) a relatively slender taxon with known adult male SVL 38.0 mm; (2) hind limbs relatively short, when the leg adpressed forward along body, tibiotarsal articulation reaches to the temporal region; (3) phalangeal formula of hand 1-2-3-3 (externally examined), hand webbing absent; (4) foot shorter than tibia; (5) foot webbing formula I(0) – (1)II(1) – (3)III(2) – (3+)IV(3+) – (2+)V; (6) plantar and palmar surfaces areolated, with ill-defined subarticular tubercles on majority of phalanges, outer metatarsal tubercle more protruding than inner metatarsal tubercle, both being of comparable size; outer metacarpal tubercle rounded, larger than

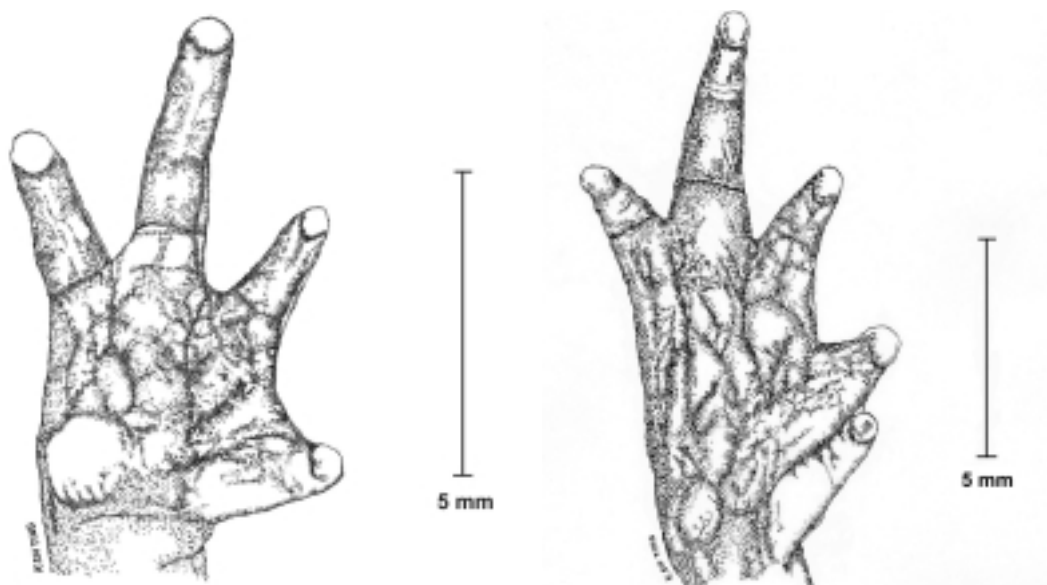


FIGURE 1. Palm and sole of holotype *Atelopus pyrodactylus*. Bar = 5 mm.

FIGURA 1. Palma de la mano y planta del pie del holotipo de *Atelopus pyrodactylus*. Barra = 5 mm.

elliptical inner metacarpal tubercle; (7) tympanic membrane absent; (8) dorsum with scattered rounded warts (dense in scapular region, limbs, hand, and foot) dorsolaterally and on flanks with well defined *coni*, dorsal view of head with few scattered small rounded warts including dorsal surfaces of snout and upper eyelids; (9) in life, dorsally uniform green with tan vermiculation; ventrally orange with black vermiculation and blotches; bright yellow ring around the pupil, and (10) gular region with dense warts and some *spiculae*.

Atelopus pyrodactylus shares similarities in coloration and morphology with *A. epikeisthos* Lötters, Schulte & Duellman, 2004 (Cordillera Central, northern Peru), *A. peruensis* Gray & Cannatella, 1985 (Cordillera Occidental, northern Peru), *A. pachydermus* (Schmidt, 1857) (Andes of northern Peru), *A. pulcher* (Boulenger, 1882) (northeastern Andean versant of Peru), and *A.*

reticulatus Lötters, Haas, Schick & Böhme, 2002 (Cordillera Azul central Peru) (GRAY & CANNATELLA, 1985; LÖTTERS *et al.*, 2002a, b, 2004b; P.J. Venegas & J. Barrio, unpublished data). Of these five species, *A. peruensis* and *A. epikeisthos* are most similar to *A.*



FIGURE 2. Lateral view of male holotype of *Atelopus pyrodactylus* sp. nov.

FIGURA 2. Vista lateral del holotipo macho de *Atelopus pyrodactylus* sp. nov.



FIGURE 3. Ventral view of male holotype of *Atelopus pyrodactylus* sp. nov.

FIGURA 3. Vista ventral del holotipo macho de *Atelopus pyrodactylus* sp. nov.

pyrodactylus by sharing a green dorsal coloration. They differ from the new species by having a more robust body, inconspicuous vertebral neural processes, a gular region lacking warts, and the absence of *coni* in dorsolateral region and on flanks. Other distinguishing characters of *A. peruensis* include black flanks with white or yellow warts and uniform yellow to pale orange venter. Distinguishing characters of *A. epikeisthos* also include completely green dorsum without tan vermiculation and venter mostly yellowish tan. *A. pachydermus* and *A. pyrodactylus* are similar in skin texture. The two are distinguished by adult size (*A. pachydermus* male SVL is larger than 49.0 mm); the former has a more robust body than *A. pyrodactylus* and is mainly black with yellow marks or blotches on the dorsal side and yellow with black blotches on the ventral side. *A. reticulatus* is similar to *A. pyrodactylus* in having a slender body and in

part green dorsal coloration. The former differs from the new species through absence of dorsolateral *coni* and by having a red-colored venter in males. *A. pulcher* is similar to *A. pyrodactylus* by displaying in part green dorsum and in body size. This species differs from *A. pyrodactylus* in having completely smooth skin and a cream-colored venter in males, usually with a posterior reddish area.

In coloration, *A. pyrodactylus* is similar to four Ecuadorian species: *Atelopus bomolochos* Peters, 1973 (Cordillera Oriental), *A. ignescens sensu stricto* Cornalia, 1849 (Andes in northern Ecuador), *A. nepiozomus* Peters, 1973 (Cordillera Oriental), and *A. planispina* Peters, 1973 (Cordillera Oriental) (PETERS, 1973; LÖTTERS, 1996; COLOMA *et al.*, 2000). *A. bomolochos* differs from *A. pyrodactylus* through having the dorsolateral area of the neck with heavy glandular folds, the sides wrinkled and folded with white or yellow warts, and a yellowish white or yellow venter. *A. ignescens* differs from the new species in possessing a more robust body, black *coni* on the forelimbs, flanks and dorsal surfaces of thighs, a uniform black dorsum, and bright orange to red venter. *A. nepiozomus* differs from *A. pyrodactylus* in having the dorsal surfaces of the head flat, the flanks with rounded warts, and a yellowish venter. *A. planispina* is distinguished from *A. pyrodactylus* by exhibiting *spiculae* in the forelimbs and hind limbs, only some warts in the flanks, and a yellowish white venter.

Seven Colombian species are similar to *A. pyrodactylus* in coloration and skin texture. These include *A. angelito* Ardila-Robayo & Ruiz-Carranza, 1998 (Cordillera Central), *A. eusebianus* Rivero & Granados, 1993 (Cordillera Central), *A. minutulus* Ruiz-Carranza, Hernández-Camacho & Ardila-Robayo, 1988 (Cordillera Oriental), *A. muisca* Rueda-Almonacid & Hoyos, 1991

(Cordillera Oriental), *A. petriruizii* Ardila-Robayo, 1999 (Cordillera Oriental), *A. sanjosei* Rivero & Serna, 1989 (Cordillera Occidental), and *A. simulatus* Ruíz-Carránza & Osorno-Muñoz, 1994 (Cordillera Central) (RUÍZ-CARRÁNZA *et al.*, 1988; RIVERO & SERNA, 1989; RUEDA-ALMONACID & HOYOS, 1991; RIVERO & GRANADOS, 1993; RUÍZ-CARRÁNZA & OSORNO-MUÑOZ, 1994; ARDILA-ROBAYO & RUÍZ-CARRANZA, 1998; ARDILA-ROBAYO, 1999). *A. angelito* differs from *A. pyrodactylus* by having smooth dorsal surfaces on head and body, black flanks with relatively large white warts, and a white or cream-colored venter with irregular black blotches. *A. eusebianus* is distinguished from *A. pyrodactylus* by having a smooth dorsal surface of the head, inconspicuous vertebral neural processes, a dark green dorsum with black marks, and a black venter with yellow blotches. *A. minutulus* differs from *A. pyrodactylus* by having a smaller size (SVL of adult males around 19.9 mm), having inconspicuous vertebral neural processes, a green dorsum with tan reticulation, and an orange venter with brown blotches. *A. muisca* differs from *A. pyrodactylus* through presence of relatively large yellow dorsolateral warts, small yellow warts on the flanks, an entirely emerald green dorsum, and a green venter with black blotches. *A. petriruizii* differs from *A. pyrodactylus* by having fine *coni* on all surfaces of the dorsum and limbs, relatively large warts on flanks, dark green dorsum with brown wine irregular blotches, and a yellow venter with brown wine blotches. *A. sanjosei* differs from *A. pyrodactylus* by exhibiting *coni* on dorsal surfaces, warts with yellow crowns in the dorsolateral region, and a white or yellow venter, occasionally with a few small brown blotches. *A. simulatus* differs from *A. pyrodactylus* by having a smooth dorsal surface of head, grayish to cream with

brown markings venter and smaller size (SVL of adult males around 26.6 mm SVL).

Description: Holotype relatively large and slender; neural spines conspicuous; head longer than wide; head length less than one third SVL; snout acuminate with tip gently rounded and dorsally depressed; in lateral aspect upper jaw extending beyond lower; nostrils lateral, not visible from above; tongue about three times as long as wide, reaching its broadest point anteriorly, free for two thirds of its length; *canthus rostralis* slightly curved from nostril to tip of snout, slightly concave and longer from nostril to anterior corner of eye (most concave immediately anterior to eye); eye width greater than the distance from nostril to anterior corner of eye; loreal area barely concave; upper lip fleshy; immediate lateral postorbital area slightly concave, becoming leveled at temporal area; tympanic membrane absent (so are apparently tympanic *annulus* and other ear bones); dorsal postorbital crest slightly developed; postorbital region with *spiculae*. Tibia relatively long, but less than half SVL, tibiotarsal articulation reaching eye when hind limb is adpressed forward alongside body; foot shorter than tibia; relative length of toes I < II < III < V < IV; outer metatarsal tubercle well defined, protruding, inner metatarsal tubercle ill-defined, equal in size to outer metatarsal tubercle but not protruding; rest of sole areolated with numerous small tubercles; ill-defined subarticular tubercles at joints of phalanges of Toes III-IV; foot webbing formula I(0) – (1)II(1) – (3)III(2) – (3+)IV(3+) – (2+)V. Forearm relatively short, i.e. less than one third of SVL, proximally wider than distally; relative length of fingers I < II < IV < III; outer metacarpal tubercle well defined, rounded, larger than elliptical inner one; rest of palm with numerous small tubercles and with ill-defined subarticular tubercles at

joints of phalanges of Finger II-IV; thumb short, distance from tip to outer edge of palmar tubercle less than half hand length; keratinized nuptial pads absent.

Dorsal surfaces of body, including head, with few scattered warts, except in scapular region where warts are concentrated; dorsal surfaces of extremities including hands and feet densely warted; dorsolateral region and flanks with numerous well defined *coni*; ventral surfaces of throat with numerous small warts and some *spiculae* in the inferior region; chest, belly and undersides of limbs with wrinkles and warts.

Measurements (mm) and proportions: SVL 38.0, HDWD 9.7, HLSQ 9.2, EYDM 3.6, ITNA 3.5, EYNO 2.7, TIBL 13.7, FOOT 13.3, HAND 7.7, THBL 5.1; HDWD/SVL 0.25, HDWD/HLSQ 1.05, HLSQ/SVL 0.24, FOOT/TIBL 0.10, TIBL/SVL 0.36, THBL/HAND 0.66.

Coloration: In life (Figs. 2-3), the dorsal surfaces of the holotype were green with some tan vermiculation (mainly in the scapular and dorsolateral regions); upper eyelids tan; dorsal surfaces of limbs were green with yellow tubercles and pale orange and tan spots; side of head tan with green labial bar and orange conical tubercles in the auricular region; flanks were green with a relatively long tan vermiculated mark; the throat, chest and belly were orange with black long vermiculation; ventral surfaces of limbs were black with oblong orange blotches; palmar and plantar surfaces were orange with green flecks; metatarsal and metacarpal tubercles and fingers and toes were orange; eyes were black with bright yellow ring around the pupil.

In preservative, the holotype is dorsally dark brown on head and body, with the upper eyelid black and with black vermiculation in the scapular and dorsolateral regions; dorsal surfaces of the limbs are black; the side of the

head is black; flanks are dark brown; throat, chest and belly are white with some dark black vermiculation; ventral surfaces of limbs are black with oblong white blotches; palmar and plantar surfaces are white with black flecks, and fingers and toes are white.

Etymology: The specific name originates from the Greek nouns *pyrós*, meaning fire and *dáctylos* meaning finger. The specific name was given in reference to the light orange fingers and toes of the species, resembling fire.

Distribution and ecology: *Atelopus pyrodactylus* is only known from the type locality (Fig. 4). It is located in the northern section of the río Huallaga basin, at a ridge between two tributaries of the río Chilchos. *A. pyrodactylus* was collected on the eastern slope of the Cordillera Central (2860 m above sea level), in the northwestern portion of the Department of San Martín, Peru.

The holotype was found at the end of the dry season (December), by late morning (around 10:00 am) during a slight rain. The frog was spotted at the edge of a trail, hidden beneath a mud trail-cut-wall. After discovery, it moved slowly towards the open area of the trail where it was caught. Prevalent vegetation in the area is evergreen montane forest (CDC, 2003), mostly continuous with small clearings next to the trail; some larger clearings were noticed. The clearings are embedded in the matrix of montane forest; however, the forest is currently under high human pressure (CDC, 2003). The land is being cleared mostly for cropland but cattle ranching is also an issue, and both are the cause of increased human migration into the area.

Remarks: The current human pressure on the type locality and the current status of most *Atelopus* species throughout the genus' range (LA MARCA *et al.*, 2005; LÖTTERS *et al.*, 2005; see also <http://www.globalam>

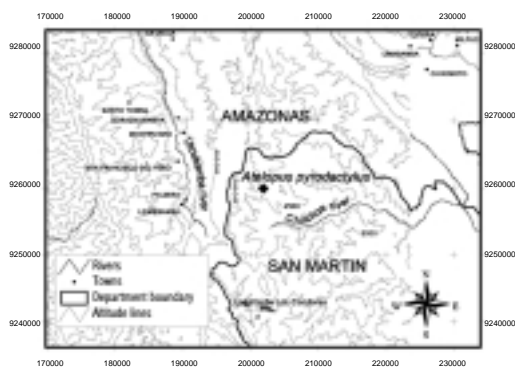


FIGURE 4. Type locality of *Atelopus pyrodactylus* (diamond). Coordinate system UTM, zone 18 south, Datum WGS 84.

FIGURA 4. Localidad tipo de *Atelopus pyrodactylus* (diamante). Sistema de coordenadas UTM, zona 18 sur, Datum WGS 84.

phibians.org) are probably valid reasons to presume that *A. pyrodactylus* is already endangered, if not critically endangered. Following criteria for IUCN Red List categories (IUCN, 2001), *A. pyrodactylus* should be placed in the Data Deficient category, as is the case in three other species of *Atelopus* (LÖTTERS *et al.*, 2004a). However, considering that the majority of the Andean *Atelopus* species (61 species) are in the Critically Endangered category (LÖTTERS *et al.*, 2004a), we strongly suggest the assignment of the new species under the tentative conservation status of Critically Endangered. Thus, we believe that given the critical situation facing the genus, it is necessary to have some notion of the conservation status of the entire species.

We also have to take into account that the entire area includes several endemic and rare species of amphibians (e.g. *Centrolene lemniscatum*, *Eleutherodactylus bromeliaceus*, *E. melanogaster*, *E. pataikos*, *E. schultei*, *Telmatobius atahualpai*, *T. truebae*, *Phrynopus carpish*), and other taxa such as

birds (e.g. *Iridosornis reinhardti*, *Leptosittaca branickii*, *Loddigesia mirabilis*, *Picumnus steindachneri*) and mammals (e.g. *Dinomys branickii*, *Lagothrix flavicauda*, *Thomasomys incanus*, *Tremarctos ornatus*). The idea of developing a protected area that encompasses the locality of the discovery is thus appealing (BARRIO & VENEGAS, 2004).

The Cordillera Central in northern Peru (Departments of Amazonas and San Martín) has been surveyed by personnel from the University of Kansas over the past three decades. These expeditions resulted in the discovery of a diversity of anurans of the following genera: *Bufo* (DUELLMAN & SCHULTE, 1992), *Colostethus* (DUELLMAN, 2004), *Gastrotheca* (DUELLMAN, 1987; DUELLMAN & VENEGAS, 2005), *Hyla* (DUELLMAN, 1982), *Phyllomedusa* (CANNATELLA, 1982), *Scinax* (DUELLMAN & WIENS, 1993), *Eleutherodactylus* (summarized by DUELLMAN & PRAMUK, 1999), *Phrynopus* (CANNATELLA, 1984; DUELLMAN, 2000), *Phyllonastes* (DUELLMAN, 1991), *Telmatobius* (WIENS, 1993), and the family Centrolenidae (DUELLMAN & SCHULTE, 1993). If we take into account those species that are currently being described, there are 30 species of amphibians which are known from elevations over 1500 m, with the highest number of endemic species (83% of endemism) in the Andes of northern Peru (DUELLMAN & VENEGAS, 2005). However, the future of this amphibian diversity is threatened by the fast expansion of agricultural practices and cattle ranching, both of which destroy and fragment the montane forest habitat.

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APPENDIX I

Material examined in addition to the new species.

APÉNDICE I

Material adicional examinado.

Atelopus pachydermus sensu stricto: PERU: Departamento Cajamarca: Grutas Cutervo MUSM 17027-17031; Departamento Amazonas: Camporeondo MUSM 6524. *Atelopus peruensis*: PERU: Departamento Cajamarca: Cajamarca Hacienda Taulis MUSM 13602-3, Yanac MUSM 13604-6, Cumbe MUSM 13813-13816, Cordillera de Kunulka MUSM 1904-12; Departamento Ancash: Yurayacu MUSM 1920-29, Charco MUSM 6596-6610, MUSM 7128-7131. *Atelopus pulcher*: PERU: Departamento San Martín: Tarapoto MUSM 1249-50, Cataratas de Ahuashiyacu MUSM 6019-23.

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