

## A new and critically endangered species of *Atelopus* from the Andes of northern Peru (Anura: Bufonidae)

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**Abstract:** Several undescribed species of harlequin frogs, genus *Atelopus*, are known from the Amazonian slopes of the Andes in Peru. Most of these have restricted distributions. Herein we name one of them, which is known from a single site in the eastern Andes of northern Peru. The new species is similar to *A. angelito*, *A. bomolochos*, *A. dimorphus*, *A. eusebianus*, *A. exiguus*, *A. muisca*, and *A. peruensis* by having a uniform green dorsum. These taxa can be distinguished from the new one on the basis of adult size and dorsal skin texture. The male holotype of the new species has a snout-vent length of 38.2 mm and warts on the dorsum. Applying IUCN Red List criteria, we categorize the new species as critically endangered.

**Key words:** Amphibia, conservation, harlequin frogs, new species, taxonomy.

**Resumen:** Una especie nueva y en peligro crítico de extinción de *Atelopus* de los Andes del norte de Perú (Anura: Bufonidae). – Se conocen varias especies no descritas de ranas arlequín del género *Atelopus* de las laderas amazónicas de los Andes en el Perú. La mayoría de ellas tiene distribuciones muy restringidas. En este trabajo nombramos una nueva especie que es conocida de un único lugar en los Andes nororientales del Perú. La nueva especie es similar a *A. angelito*, *A. bomolochos*, *A. dimorphus*, *A. eusebianus*, *A. exiguus*, *A. muisca* y *A. peruensis* por tener un dorso verde uniforme. La nueva especie se distingue de las anteriores por su tamaño más grande y por su textura de la piel diferente. El holotipo (macho) de la nueva especie tiene una longitud rostro-cloacal de 38.2 mm y verrugas en su piel dorsal. Aplicando los criterios de la Lista Roja de la UICN, consideramos la nueva especie como en peligro crítico.

**Palabras clave:** Amphibia, conservación, nueva especie, ranas arlequín, taxonomía.

### INTRODUCTION

The Neotropical bufonid genus *Atelopus* Duméril & Bibron, 1841 contains more than 100 species (LA MARCA *et al.*, 2005). Most of these anurans, commonly known as harlequin frogs, have relatively limited geographic ranges, often confined to single drainage systems in the northern and central Andes of South America. About four fifths of the

species of *Atelopus* occur at elevations above 1500 m above sea level (LÖTTERS, 1996). Probably related to small distributions in montane regions but also to particular life history traits (LIPS *et al.*, 2003), the majority of species of harlequin frogs has suffered from catastrophic extinction trends during the past 20 years (LA MARCA *et al.*, 2005). According to LÖTTERS *et al.* (2004), more than 80% of the described *Atelopus* species

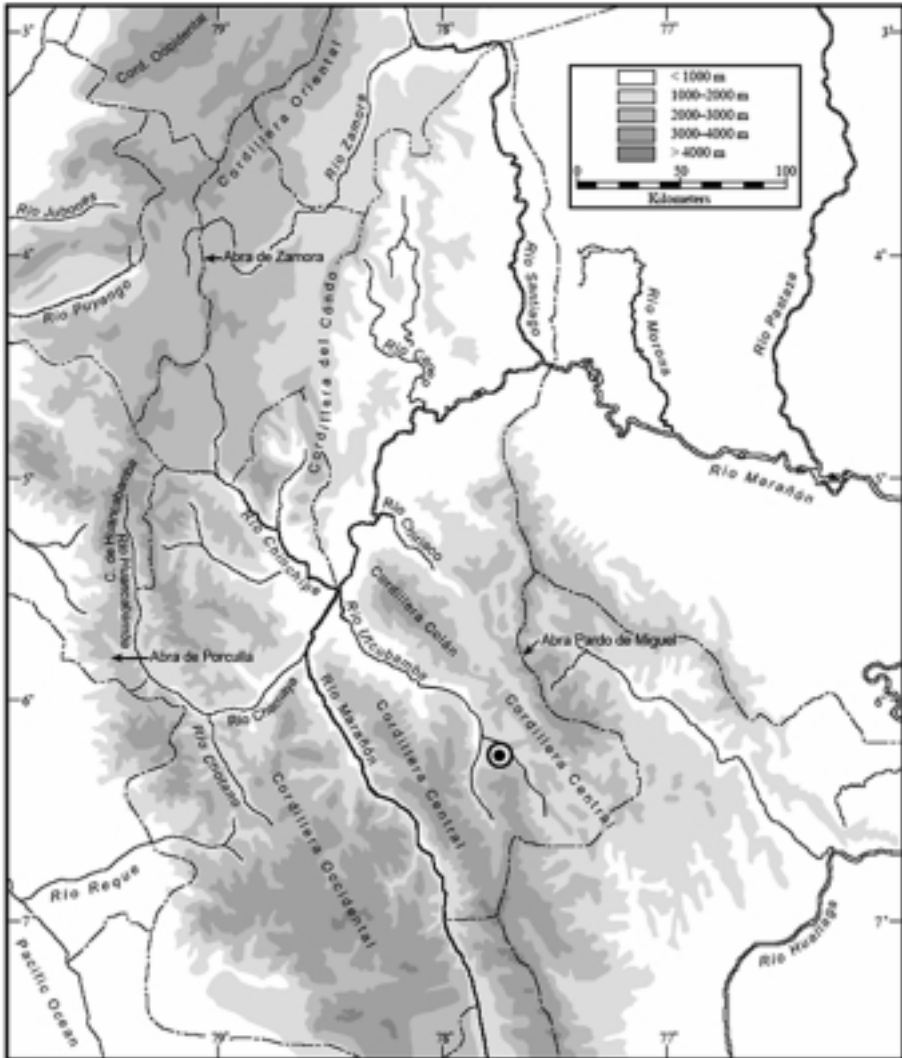


FIGURE 1. Map of the Andes of northern Peru with the type locality of *Atelopus epikeisthos* (circle).

FIGURA 1. Mapa de los Andes del norte del Perú con la localidad típica de *Atelopus epikeisthos* (círculo).

are considered critically endangered or extinct according to IUCN Red List criteria (2001; see also IUCN *et al.*, 2004). Conservation measures (e.g. population monitoring or *ex situ* breeding programs) are suggested for those species that are nearly extinct (LA MARCA *et al.*, 2005).

The situation is probably most dramatic in Peru. LÖTTERS *et al.* (2005) have shown that survival chances for harlequin frogs in this

country are small. The main reason is that conservation measures cannot be effectively undertaken, because survey efforts are limited and the taxonomy of the genus in this country is poorly understood. In addition to the 11 described *Atelopus* (10 of which are valid), the authors reported 18 undescribed taxa. Twelve of these occur on the Amazonian slopes of the Andes and outlying cordilleras.

It is our purpose to bridge this gap between systematics and conservation. In this paper, we name one of the new species. It is known from a single specimen, which was collected in 1989 in a humid montane forest remnant in the eastern portion of the Cordillera Central (see DUELLMAN & PRAMUK, 1999) in northern Peru (Fig. 1) during field explorations by personnel from the University of Kansas. A subsequent visit to the vicinity of the type locality of the taxon described herein by one of us (RS) in February 2002 revealed no additional material of the new species.

#### MATERIALS AND METHODS

Specimens examined are deposited in the following collections: American Museum of Natural History, New York (AMNH); British Museum of Natural History, London (BM); The University of Kansas, Natural History Museum, Lawrence (KU); Rainer Schulte private collection, INIBICO, Tarapoto (CRS); Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima (MUSM); Museo de Vertebrados, Pontificia Universidad Católica del Ecuador, Quito (QCAZ); Forschungs- und Naturmuseum Senckenberg, Frankfurt/Main (SMF); and Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK). All material studied in addition to that of the new species is listed in Appendix I.

The description scheme for the new species follows those of earlier descriptions (e.g. LÖTTERS *et al.*, 2002). Maturity and sex were determined by dissection. Webbing formulae is described in the manner of SAVAGE & HEYER (1967), as modified by MYERS & DUELLMAN (1982) and SAVAGE & HEYER (1997). Measurements were taken to the nearest 0.1 mm with dial calipers and include SVL (snout-vent length), HDWD (head width at widest point), HLSQ (head length from tip of snout to

the squamosal), EYDM (eye diameter), ITNA (internarial distance), EYNO (eye to nostril distance), SW (sacrum width at widest point), TIBL (tibia length), FOOT (foot length from proximal edge of outer metatarsal tubercle to tip of Toe IV), HAND (hand length from proximal edge of outer metacarpal tubercle to tip of Finger III), and THBL (thumb length from outer edge of outer metacarpal tubercle to tip of Finger I). Life color information was obtained from color slides taken of the holotype before preservation. Conservation status was assessed using criteria for IUCN Red List categories (IUCN, 2001).

#### *Atelopus epikeisthos* sp. nov.

(Figs. 2 and 3)

**Holotype:** KU 211684 (field number WED 56865), an adult male from the Cordillera Central, 7 km E Chachapoyas (ca. 06° 16' S, 77° 41' W; 2010 m above sea level), Departamento de Amazonas, Peru; obtained by John J. Wiens on 26 January 1989.



FIGURE 2. Dorsal and ventral views of *Atelopus epikeisthos*.  
FIGURA 2. Vista dorsal y ventral de *Atelopus epikeisthos*.



FIGURE 3. Sole and palm of the holotype of *Atelopus epikeisthos*. Bar = 5 mm.

FIGURA 3. Planta del pie y palma de la mano de *Atelopus epikeisthos*. Barra = 5 mm.

**Diagnosis:** (1) A relatively large and stout species with known adult male SVL 38.2 mm; (2) hind-limb short, with tibiotarsal articulation reaching to temporal region when hind limb adpressed to body; FOOT > TIBL; (3) phalangeal formula of hand 2-2-3-3 (determined by external examination) and THBL/FOOT > 0.50, finger webbing absent; (4) toe webbing formula I (0) – (0) II (0) – (1<sup>-</sup>) III (0<sup>+</sup>) – (2) IV (2) – (1<sup>-</sup>) V; (5) head almost as wide as long; snout acuminate, with tip rounded in dorsal view; upper jaw protruding beyond lower jaw; (6) no ear structures evident externally; (7) all dorsal surfaces with warts (no *spiculae* or *coni*) except head; (8) vertebral neural processes inconspicuous; (9) in life, dorsum uniform bright olive-green and venter mostly yellowish tan without bright red areas on palm, sole or venter; outer metacarpal and metatarsal tubercles yellowish tan surrounded by darker color; golden

ring around the pupil; (10) gular region without warts, *spiculae* or *coni*.

*Atelopus epikeisthos* is most similar to *A. angelito* Ardila-Robayo & Ruiz-Carranza, 1998, *A. eusebianus* Rivero & Granados-Días, 1993, and *A. muisca* Rueda-Almonacid & Hoyos, 1991 from Andean Colombia; *A. bomolochos* Peters, 1973 and *A. exiguus* (Boettger, 1892) from Andean Ecuador; *A. dimorphus* Lötters, 2003 and *A. peruensis* Gray & Cannatella, 1985 from northern Andean Peru (PETERS, 1973; GRAY & CANNATELLA, 1985; RUEDA-ALMONACID & HOYOS, 1991; RIVERO & GRANADOS-DÍAS, 1993; ARDILA-ROBAYO & RUIZ-CARRANZA, 1998; COLOMA *et al.*, 2000; LÖTTERS, 2003). All these harlequin frogs are mostly uniform green dorsally with warts. The new species is distinguished from all these species except *A. angelito* by lacking *spiculae*. In addition, *A. epikeisthos* is larger than *A. angelito*, *A. dimorphus*, *A. eusebianus*, *A. exiguus*, and *A. muisca* (adult male SVL > 38.0 mm vs. < 35.0 mm). FOOT > TIBL and a 2-2-3-3 phalangeal formula in the new taxon distinguish it from *A. dimorphus* (which has FOOT < TIBL, 1-2-3-3). In having pale yellowish tan outer metacarpal- and metatarsal tubercles surrounded by darker color, *A. epikeisthos* is distinct from all of the species mentioned, which have larger light areas including tubercles, or have dark tubercles, with the exception of *A. exiguus* and *A. peruensis*.

*Atelopus andinus* Rivero, 1968, *A. pachydermus sensu stricto* (O. Schmidt, 1856), *A. pulcher sensu stricto* (Boulenger, 1882), and *A. seminiferus* Cope, 1874 are the only other described species known from the Andes of northeastern Peru. The new species is larger than *A. andinus* (adult male SVL > 38.0 mm vs. < 28.0 mm), has a uniform olive-green dorsum (vs. yellowish tan dorsal pattern on darker ground color), and lacks

*spiculae* but has warts on the dorsum (vs. *spiculae* present and warts absent). *Atelopus epikeisthos* is smaller than *A. pachydermus sensu stricto* (adult SVL in the only known specimen, a male, 38.2 mm vs. adult male SVL > 49.0 mm), which usually also lacks uniform olive-green dorsal surfaces (*A. pachydermus sensu stricto* is yellowish tan to olive-green and commonly has a brown or black pattern). The new taxon is distinguished from *A. pulcher sensu stricto* by the presence of dorsal warts (vs. completely smooth), having a uniform olive-green dorsum (vs. brownish to blackish dorsal pattern on greenish ground color), and lacking reddish ventral surfaces including palm and sole, as present in *A. pulcher sensu stricto*. *Atelopus epikeisthos* is larger than *A. seminiferus* (adult male SVL > 38.0 mm vs. < 36.0 mm), has a uniform olive-green dorsum (vs. uniform black), and lacks dense minute *spiculae* but has warts on the dorsum (vs. *spiculae* present and warts absent).

**Description:** Head longer than wide but almost as wide as long (both head length and width almost one third SVL); vertebral neural processes inconspicuous; snout acuminate, tip rounded in dorsal view; in lateral aspect, profile of tip of snout to anterior margin of the jaw protruding; tip of snout with a swollen gland; nostrils not protuberant (barely visible from above), situated slightly behind level of apex of lower jaw; *canthus rostralis* distinct, barely convex, swollen from tip of snout to nostril, straight from nostril to eye; loreal region concave; upper lip not flared, interorbital region and occiput flat, smooth; eyelid flared without distinct tubercles; postorbital crest glandular; tympanic membrane absent and no external evidence of a tympanic annulus (apparently absent; stapes are also expected to be absent); choanae small, rounded, widely

separated; tongue about three times as long as wide, anterior third broadened free.

Forearm relatively short, robust, forearm length less than one-third SVL, proximally almost twice as thick as distally; metacarpal tubercles distinct, outer ovoid, larger than more elongate inner one; supernumerary tubercles numerous; subarticular tubercles present on Fingers III-IV; digital tips not expanded; length of thumb more than half length of hand, with small keratinized area on inner edge; phalangeal formula 2-2-3-3 (determined externally); webbing between fingers absent.

Tibia more than one third SVL, shorter than FOOT; distinct fold on distal half of inner edge of tarsus; metatarsal tubercles distinct, rounded, outer larger than inner; supernumerary tubercles absent; subarticular tubercles present on Toes II-V, proximal ones larger than distal ones; digital tips not expanded; toe webbing formula I (0) – (0) II (0) – (1<sup>-</sup>) III (0<sup>+</sup>) – (2) IV (2) – (1<sup>-</sup>) V, with webbing continuing as lateral fringes in part. Relative lengths of fingers and toes given from shortest to longest I < II < IV < III and I < II < III < IV < V, respectively.

Dorsal surfaces with rounded, flattened warts about 1-2 mm in diameter (neither *spiculae* nor *coni*), irregularly distributed, most dense toward periphery of body and on extremities; no warts on top of sides of head, behind angle of jaw and on postorbital crest. Ventral surfaces wrinkled, no warts, *spiculae* or *coni*, not even around cloacal opening.

**Coloration:** In preservative, dorsum uniform dull olive-green, paler anterior to arm insertion and toward flanks, ventral surfaces uniform cream, including palmar and plantar surfaces; dorsal surfaces of Finger I and Toes I-II cream; few blackish markings on dorsal surfaces of all fingers and toes, on outer edges of palm and sole (continued on metacarpus and metatarsus, with the outer

metacarpal and metatarsal tubercles pale cream), on proximal parts of feet, at knees, and around cloacal opening. In life, colors were similar, with olive-green areas brighter; ventral surfaces including pale tubercles yellowish tan with chest whitish tan, and posterior venter and the inner palm and sole reddish orange; golden ring around pupil.

**Measurements (mm) and proportions:**

SVL = 38.2, HDWD = 11.5, HLSQ = 11.8, EYDM = 3.4, ITNA = 3.8, EYNO = 3.2, SW = 11.3, TIBL = 15.1, FOOT = 15.3, HAND = 10.6, THBL = 5.8, SW/SVL = 0.30, HDWD/SVL = 0.30, HDWD/HLSQ = 0.97, HLSQ/SVL = 0.31, FOOT/TIBL = 1.0, TIBL/SVL = 0.40, THBL/HAND = 0.55.

**Etymology:** The specific name is a Greek adjective meaning “threatened through adverse circumstances” and refers to the conservation status of the new species.

**Distribution and ecology:** *Atelopus epikeisthos* is known only from the type locality in the eastern portion of the Cordillera Central in northern Peru (Fig. 1), a small ravine along the road from Chachapoyas to Molinopampa. The stream in the ravine flows northward into the Río Sonche, a tributary of the Río Utcubamba, which flows into the Río Marañón. The ravine harbors a small remnant of humid montane forest with tree fern vegetation. In 2002, the area was nearly entirely cleared for cattle pasture and corn fields. The holotype was walking on the ground by day; when it was picked up, it displayed the “Unken reflex”.

**Remarks:** Within the last decade, our knowledge of the alpha-level of *Atelopus* systematics has increased. However, efforts to understand phylogenetic relationships among harlequin frogs remain limited and are controversially debated. We go along with previous authors (e.g. COLOMA *et al.*, 2000; COLOMA, 2002), who suggest that it is premature to recognize species in species

groups. Nevertheless, characters, which may probably be identified as synapomorphies, shared by *A. epikeisthos* and other Andean species include FOOT > TIBL as well as presence of bright metacarpal and metatarsal tubercles on darker ground.

The new species is only known from a single individual collected in a remnant of humid montane forest. During a visit in February 2002 to the type locality by one of the junior authors (RS), no additional specimens could be found. Instead, he witnessed that nearly nothing of the original habitat was left. Applying criteria for IUCN Red List categories, we place *A. epikeisthos* in the category Critically Endangered.

Apart from the new taxon, three species of *Atelopus* have been described from the cordilleras bordering the Amazonian lowlands in northeastern Peru. These are *A. pachydermus*, *A. pulcher*, *A. seminiferus*, which are all Critically Endangered (see IUCN, 2004). From sporadic observations of both adults and tadpoles, we are aware of some additional populations of harlequin frogs from this region, which may represent undescribed species. All these putative taxa seem to have restricted geographic ranges and are possibly critically endangered (LÖTTERS *et al.*, 2005). Because of the lack of thorough field surveys, it cannot be ruled out that the genus *Atelopus* is much more diverse in the cordilleras of northeastern Peru (as in other parts of the Andes; cf. LÖTTERS, 1996). Because of the dramatic situation of the entire genus, as mentioned above, we recommend field surveys and taxonomic revision plus subsequent assessment of conservation status of the harlequin frogs in this region. Only after these initial steps, conservation necessities and measures (e.g. habitat protection, monitoring, *ex situ* reproduction) can be adequately undertaken.

Including the species described herein and

*A. pachydermus* (see Appendix I for occurrence), the known anuran fauna at elevations greater than 1500 m above sea level in the northern part of the eastern Andes in Peru consists of 38 species: *Atelopus* (2), *Bufo* (1), *Centrolene* (2), *Colostethus* (5), *Eleutherodactylus* (15), *Gastrotheca* (4), *Hyla* (1), *Phrynopus* (1), *Phyllonastes* (1), *Phyllomedusa* (1), *Scinax* (1), *Telmatobius* (4) (TRUEB & DUELLMAN, 1978; CANNATELLA, 1982, 1984; DUELLMAN, 1982, 1987, 1991, 2000, 2004; DUELLMAN & HILLIS, 1987; DUELLMAN & TRUEB, 1988; DUELLMAN & SCHULTE, 1992, 1993; DUELLMAN & WIENS, 1993; WIENS, 1993; DUELLMAN & PRAMUK, 1999). Most of these species are endemic to the region.

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## APPENDIX I

Material examined in addition to the new species.

*Atelopus andinus*: PERU: Departamento San Martín: upper Río Biabo valley, AMNH A42657 (paratype), A43200 (holotype); Departamento Loreto: Río Pisqui, AMNH A43545 (paratype); border area of Departamentos San Martín-Loreto: Río Cachiyacu (Tocachi), AMNH A42914, A43296-927 (paratypes). *Atelopus bomolochos*: ECUADOR: Provincia Azuay: 3 km east of Sigsig, QCAZ 1893-894; 10 km south of Cutchil, KU 217335-336, 217441-444, QCAZ 1861-669. *Atelopus dimorphus*: PERU: Departamento Huánuco: Cordillera Azul, KU 209387-393 (holo- and paratypes). *Atelopus exiguus*: ECUADOR: Provincia Azuay: Laguna Zurucucho, SMF 4046-051, 3170-171, 3916

## APÉNDICE I

Material adicional examinado.

(lecto- and paralectotypes), KU 120387, QCAZ 3744. *Atelopus pulcher sensu stricto*: PERU: Departamento San Martín: vicinity of Tarapoto, KU 211676-683, 212530, ZFMK 48573, 50680-685, 76243-244; Chyavetas (= Departamento Loreto: Chayahuitas), BM 1947.2.14.80-82 (lecto- and paralectotype). *Atelopus seminiferus*: PERU: Departamento San Martín: Alto Mayo, CRS A4, A5. *Atelopus pachydermus sensu stricto*: PERU: Departamento Cajamarca: Grutas Cutervo, MUSM 5984, 6507; Departamento Amazonas: Camporedoondo, MUSM 6524. *Atelopus peruensis*: PERU: Departamento Cajamarca: 33 km southwest of Celedín, KU 181539-592 (holo- and paratypes).