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A new species of arboreal toad (Anura: Bufonidae: *Chaunus*) from Madidi National Park, Bolivia

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Abstract

A new arboreal species of the *Chaunus veraguensis* group is described for the humid montane forest of Madidi National Park, in northern Bolivia. The new species differs from other species in the group by the combination small size, long and slender extremities, webbed hands, conspicuous tympanic membrane, well developed parotoid glands, absence of large glands on dorsum and extremities, nuptial excrescences of males composed of pungent spines on dorsal surface of thumb, greenish-brown coloration on dorsum with red warts in life, and green iris. It is only known from two nearby localities in the Serranía Eslabón, Department La Paz. An operational key for species in the *C. veraguensis* group is provided.

Key words: Anura, Bufonidae, *Chaunus veraguensis* group, Bolivia, Andes, humid montane forest, new species

Resumen

Se describe una nueva especie arborícola del grupo *Chaunus veraguensis* de los bosques montanos húmedos andinos del Parque Nacional Madidi, norte de Bolivia. La nueva especie se diferencia de otras especies del grupo por su pequeño tamaño, por poseer las extremidades largas y delgadas, las plantas de las manos y de los pies palmeadas, la membrana timpánica visible y conspicua, y las glándulas parótidas bien desarrolladas y redondeadas, por la ausencia de otro tipo de grandes glándulas en dorso o extremidades, por las espinas nupciales negras de la región dorsal del pulgar de los machos, por su coloración verdosa en vida y por su iris verde. Sólo es conocida de dos localidades cercanas en la Serranía Eslabón, en el Departamento de La Paz. Se proporciona una clave de identificación para las especies del grupo *C. veraguensis*.

Palabras clave: Anura, Bufonidae, grupo *Chaunus veraguensis*, Bolivia, Andes, bosque húmedo de montaña, new species

Introduction

The Andean foothills of northern Bolivia, mainly protected by the Madidi National Park and the Área Nacional de Manejo Integrado Apolobamba, conform one of the hottest biodiversity corners on earth (Remsem and Parker 1995). However, amphibians have still not received much attention and the scarce information comes from a few expeditions. Only recently, this area has attracted the interest of herpetologists, which resulted in some interesting discoveries including the description of new species (Cortez 2005; De la Riva *et al.* 2005a, b; Padial *et al.* 2005). During a short survey of the Serranía Eslabón in the Madidi National Park, the senior author collected five specimens of a completely arboreal toad similar to species of the *Chaunus veraguensis* group that did not correspond to any known species from northern Bolivia or Southern Peru. Comparisons of this species with museum specimens and original descriptions of other Bolivian and Peruvian species from various groups, convinced us that our specimens belong to an undescribed species. The aim of this article is to describe and name this new species. Moreover, we provide an operational key for the species currently included in the *C. veraguensis* group.

Material and methods

Specimens were fixed in 10% formalin and preserved in 70% ethanol. For morphological and colour characteristics used in the diagnosis and description we follow Duellman and Schulte (1992). Specimens examined are listed in the Appendix. Measurements were taken with a digital calliper to the nearest 0.01mm, but following Hayek *et al.* (2001), for avoiding pseudo precision, we rounded all measurements to only one decimal. Webbing formulae follow Savage and Heyer (1967) as modified by Myers and Duellman (1982) and Savage and Heyer (1997). Abbreviations of measurements are as follows: snout-vent length, SVL; head length (from posterior margin of the lower jaw to tip of snout), HL; head width, HW; upper eyelid width, EW; eye diameter (measured horizontally), ED; eye to nostril distance, EN; distance between narines, IND; distance between the anterior margin of the eyes (eye-eye distance), EE; tympanic membrane height, TYH; tympanic membrane length, TYL; forearm length (from posterior margin of thenar tubercle to elbow), FA; tibia length, TL; thigh length, TH; foot length (from proximal border of inner metatarsal tubercle to tip of fourth toe), FL. Color characteristics were noted in life. Museum abbreviations refer to: Centro de Biodiversidad y Genética, Cochabamba, Bolivia (CBG); Colección Boliviana de Fauna, La Paz, Bolivia (CBF); Museo de Historia Natural Noel Kempff Mercado, Santa Cruz de la Sierra, Bolivia (MNK-A [Amphibian

Collection]); Estación Biológica de Doñana, Sevilla, Spain (EBD); Museo Nacional de Ciencias Naturales, Madrid, Spain (MNCN); United States National Museum of Natural History, Smithsonian Institution, Washington, USA (USNM); and Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK).

Results

Chaunus tacana sp. nov.

Fig 1, 3–4

Holotype

MNK-A 7188, an adult female from Huairuro (14°19'28.2" S, 68°05'36.1" W), path from San José de Uchupiamonas to Apolo, Serranía Eslabón, Madidi National Park, Province Franz Tamayo, Department La Paz, Bolivia (Fig. 2), collected the night of 16–17 December 2003 by José M. Padial (field number JMP 556).

Paratypes

MNK-A 7187 (field number JMP 555), an adult male (Fig. 3) and MNCN 42072 (field number JMP-558), an immature female, both collected with the holotype; an adult male MNCN 42073 (field number JMP-574) and a juvenile MNK-A-7194 (JMP575) collected at Arroyo Huacataya (14°20'12.1" S, 68°5'57.3" W), path from San José de Uchupiamonas to Apolo, Serranía Eslabón, Madidi National Park, Department La Paz, Province Franz Tamayo, Bolivia, collected the night of 17–18 December 2003 by José M. Padial, Pere Comas and Pedro Macuapa.

Etymology

The specific name is a substantive in apposition that refers to the Bolivian indigenous group Tacana, who inhabit the lowlands and foothills of the Madidi National Park. The Tacana people have successfully demonstrated (through management of the Chalalán Ecological Reserve) that community development is compatible with conservation of their cultural and natural heritage.

Diagnosis

A small species of *Chaunus* with long and slender extremities, tentatively assigned to the *C. veraguensis* group *sensu* Duellman and Schulte (1992) based on external characters. The new species is distinguished from other putatively related species by the following combination of characters: (1) canthus rostralis sharp, orbitotympanic and postorbital crest weak; (2) tympanum distinct, oval; (3) parotoid glands large, round, not contacting the tympanic membrane; (4) numerous scattered small, round warts on dorsal surfaces of body; (5) extremities moderately long and slender; (6) a dorsolateral row of round,

enlarged, and elevated warts; (7) tarsal fold absent; (8) webbing on hands and feet fleshy (Figure 3); (9) first finger shorter than second (figure 3); (10) males with vocal slits; (11) small keratinous spines on dorsal surfaces of thumb; (12) iris green in life.

The most similar species is one that is being described by J. A. Chaparro, J. Pramuk and A. Gluesenkamp from Department Cusco, Peru. We examined specimens of this undescribed taxon and compared them with *C. tacana*. Both species are similar in habitus, both are arboreal and inhabit cloud forests and humid montane forests. Nevertheless, *C. tacana* differs from the species from Cusco as follows (characteristics of the latter in parentheses): fingers thin and long (thick and short); webbing of hands and feet less developed, almost absent between Finger I and II (well developed between finger I and II); tarsal fold absent (present); parotoid glands proportionally smaller; parotoid glands and tympanic membrane not in contact (in contact); vocal slits present in males (absent); dorsal coloration in life dorsally pale greenish-brown to brownish-green with brown stripes or spots and red warts (homogeneously black); ventral coloration whitish-cream with light brown reticulation (red with dark blotches); iris green (reddish-orange).

Chaunus tacana can be distinguished from another similar and arboreal species, *C. arborescandens*, mainly by the visible tympanic membrane (absent in the latter), and the concave internarial area (flat). *Chaunus tacana* has visible tympanic membrane while *C. amboroensis*, *C. justinianoi*, *C. quechua*, and *C. veraguensis* lack visible tympanic membrane. *C. fissipes* may have a visible tympanum although barely evident. Nevertheless, *C. fissipes* is larger [mean adult females SVL= 68.1 (range= 65.8–71.9, n=8); see Köhler (2000)] and has two prominent dorsolateral rows of tubercles. Moreover, *C. fissipes* has the first finger longer than second, the parotoid glands are slightly elevated and not protruding laterally, and it presents serrate foot webbing. The new species can be distinguished from *C. multiverrucosus* and *C. chavin* by the nuptial spines on the first finger in breeding males, and by the lack of enlarged glands on dorsum and extremities. *Chaunus tacana* differs from *C. inca* by having the first finger shorter than second. The new species differs from *C. nesiotetes* by having pronounced parotoid glands (low and diffuse in *C. nesiotetes*) and a row of enlarged dorsolateral warts (absent). *C. tacana* differs from *C. rumbolli* by the long and slender extremities, inconspicuous cranial crests and first finger longer than second (shorter in *C. rumbolli*).

Description of the holotype

A small *Chaunus* with long and robust body (for measurements see table 1); head small, slightly broader than long, its width 30% of SVL, length 30% of SVL; snout short, subacuminate in dorsal view, acute in profile, with a vertical keel on the tip; cranial crests absent; skin of head not coossified with underlying cranial bones; internarial area concave; narines not protuberant, very small, oriented laterally; canhus rostralis sharp, concave in dorsal view; lips flat; eye-nostril distance equal to eye length; tympanic membrane visible, conspicuous, oval, surrounded by granules, 70% of eye length; tympanic annulus thin, overlapped with surrounding granules. Forelimb long and slender; hand broad, with short

fingers; relative length of fingers I<II<IV<III; basal webbing fleshy, extending as a fringe on lateral edges of fingers; webbing formula I¹⁻²II^{basal}III^{basal}IV; tips of digits round, not expanded; ulnar region granular with a row of enlarged tubercles; palmar tubercle round and low; prepollical tubercle irregular to ovoid, diffuse; subarticular tubercles ovoid to round, low, diffuse, inconspicuous; supernumerary tubercles round, diffuse, smaller than subarticular. Hind limbs and feet long; tibia length 40% of SVL; foot length 40% of SVL; no tarsal fold; outer metatarsal tubercle ovate, prominent, 1/3 the size of inner; inner metatarsal tubercle large, prominent, ovate; relative length of toes 1<2=5<3<4; webbing fleshy, almost complete, but last phalange free, only basal between toes 4 and 5; webbing formula I^{1/2-1}II^{1/2-1}III^{1/2-3}IV³⁻²V; tip of toes rounded; subarticular tubercles low, round to ovate, diffuse, larger than supernumerary tubercles; supernumerary tubercles abundant, small, irregular or rounded.

TABLE 1. Measurements and proportions of the adult type specimens of *Chaunus tacana* sp. nov. (M, male; F, female; for other abbreviations see Material and Methods).

	NKA-A 7188 (F)	NKA-A 7187 (M)	MNCN 42073 (M)
SVL	34.2	30.6	30.7
HL	9.9	9.2	9.1
HW	10.8	9.7	9.4
EW	2.8	2.5	2.8
ED	3.1	3.3	3.5
EN	3.0	2.9	2.7
IND	2.4	1.9	1.9
EE	5.0	4.8	4.5
TYH	2.7	2.2	2.2
TYL	2.1	2.0	2.0
FA	8.3	7.6	6.8
TL	12.3	12.7	11.6
TH	12.9	11.4	11.7
FL	14.2	14.2	12.6
HW/HL	1.1	1.1	1.0
HW/SVL	0.3	0.3	0.3
HL/SVL	0.3	0.3	0.3
EN/ED	1.0	0.9	0.8
EE/ED	1.6	1.5	1.3
TYL/ED	0.7	0.6	0.6
TL/SVL	0.4	0.4	0.4
FL/SVL	0.4	0.5	0.4

Skin on dorsum of head, body, and limbs bearing abundant small, flat granules of irregular size and low rounded warts, larger than granules; enlarged granules forming an irregular row that resembles a dorsolateral fold; parotoid gland round, large, more displaced to side of the head than to dorsum, almost in contact with tympanic membrane, and in contact with small, short orbitotympanic and postorbital crests composed of granules; enlarged glands absent on limbs. Skin on throat and other ventral surfaces granular. Anal opening slightly protuberant, directed posteroventrally at upper level of thighs.

One choanae small and round, placed anterolaterally, while the other is concealed by the palatal shelf of the maxillary arch; vomerine odontophores absent; tongue cordiform, free behind for about one-third its length.

Color in preservative: Dorsum dark grey, with enlarged light brown warts; interocular, scapular, and central areas of dorsum with a bold black irregular x-shaped stripe; granules forming a dorsolateral row cream; flanks scarcely lighter than dorsum; tympanic membrane dark greyish-brown; head dark greyish-brown, lighter in lower parts; forelegs barred and hind legs greyish-brown with dark brown, almost black, transverse bars; toes barred with dark brown; ventral regions irregularly mottled with brown and cream, lighter at the level of groin; plantar surfaces cream with some brown spots.

Color in life: dorsal coloration pale brown to greenish-brown; scapular and central areas of dorsum with a dark brown black irregular x-shaped stripe with greenish-brown tonalities; granules forming the dorsolateral rows brown or red; tympanic membrane brown; head brown with some red granules and small greenish-brown spots on interorbital region; extremities brown, barred with dark brown to greenish-brown; toes barred with dark brown; ventral coloration whitish-cream with light brown reticulation; iris green, pupil black.

Variation

Little variation is observed. There is little sexual dimorphism in size. Males present nuptial excrescences in form of a single group of black (in life) or white (in alcohol) keratinized spines on the dorsal surface of each thumb. Male specimens present vocal slits lateral to tongue. Males seem to have shorter snout relative to eye length (80%) than females (100%), and also narrower snout (EN 160% of EE distance in females versus 130% in males). In one male (MNCN 42073) both choanae are visible, they are anterolateral and are separated by a distance equal to six times the diameter of a choanae. Most spicules and granules can be concentrated on neck and head, while the flanks have larger granules and warts but density of granules is lower. In MNCN 42073 the parotoid gland is slightly ovate, displaced to the lateral part of the head, where it reaches the level of the lower margin of the tympanic membrane. In MNCN 42073 the foot webbing formula differs slightly from that of the holotype: $I^{1/2-1/2}II^{1/2-1/2}III^{1-3}IV^{3-3}V$. Juveniles are identical to adults in general appearance. Dorsal pattern varies slightly in the intensity and

form of the stripes. Some individuals have more red warts. SVL of two juveniles: 25.3 (MNCN 42072, female) and 21.8 (NKA-A7194, unsexed). NKA-A 7187 lack dorsal pattern and is darker than any other specimen in alcohol (Fig. 3).



FIGURE 1. Adult female holotype of *Chaunus tacana* **sp. nov.** from Serranía Eslabón, Madidi National Park, Bolivia (MNK-A 7188)

Distribution and natural history

This species is known only from two close localities in Serranía Eslabón (Fig. 2), at about 1500 m a.s.l. The habitat is composed by primary humid montane forest with high abundance of arboreal ferns, bromeliads and other epiphytes. Potentially flooded flat surfaces are almost inexistent but there are some small streams. *C. tacana* is a nocturnal species that can be found active on leaves of bushes or on the trunk of trees from 1–4 m height. It climbs gracefully vertical trunks covered by moss. As *C. tacana*, *C. veraguensis* may also show greenish dorsal coloration and has been reported to climb in trees (Köhler 2000). This mimetic coloration could be related to their arboreal habits. The adult female presented convoluted oviducts and small white ova. The call, tadpole and reproductive mode are unknown. Other anuran species that occur in the area are *Atelopus tricolor*, *Epipedobates bolivianus*, *Hyalinobatrachium bergeri*, *Hyloscirtus armatus*, *Hypsiboas balzani*, *Eleutherodactylus danae* and *E. madidi*.

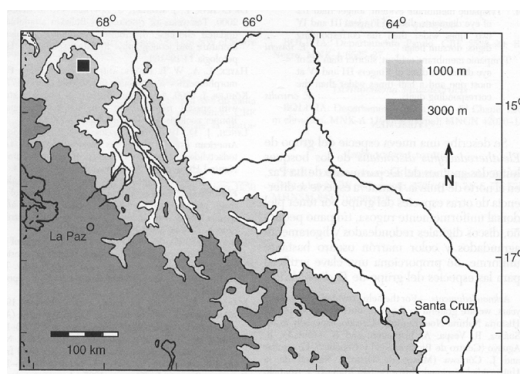


FIGURE 2. Map of Bolivia with a bold square indicating the type locality of *Chaunus tacana* **sp. nov.**

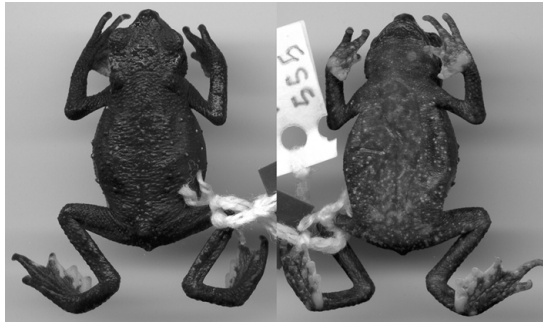


FIGURE 3. Dorsal and ventral view of an adult male of *Chaunus tacana* sp. nov. from Serranía Eslabón, Madidi National Park, Bolivia (MNK-A 7187).



FIGURE 4. Dorsal view of an adult female of *Chaunus* sp. (left) from Department Cusco, Peru and the holotype (adult female) of *Chaunus tacana* sp. nov. (MNK-A 7188).

Discussion

We follow the recent taxonomic rearrangements proposed by Frost *et al.* (2006) for the genus *Bufo*. They recognized the genus *Chaunus* (Wagler, 1828) for a “...major clade of predominantly Neotropical “*Bufo*” (excluding *Rhinella*)...” including the *B. veraguensis* group. Hence, the new species is herein assigned to the *Chaunus veraguensis* species group (former *Bufo veraguensis* species group) because of its external similarity to some of the species assigned to this group by Duellman and Schulte (1992). Thus, the *Chaunus veraguensis* group is currently composed of 12 species; apart from *C. tacana* these are: *C. amboroensis* (Harvey and Smith), *C. arborescandens* (Duellman and Schulte), *C. chavin* (Lehr, Köhler, Aguilar and Ponce), *C. fissipes* (Boulenger), *C. inca* (Stejneger), *C. justinianoi* (Harvey and Smith), *C. nesiotis* (Duellman and Toft), *C. quechua* (Gallardo), *C. multiverrucosus* (Lehr, Pramuk and Lundberg), *C. rumbolli* (Carrizo) and *B. veraguensis* (Schmidt). An additional species of the group is currently being described

from Department Cusco, Peru (J. C. Chaparro, pers. comm.). Seven described species occur in Bolivia (*C. amboroensis*, *C. fissipes*, *C. justinianoi*, *C. quechua*, *C. rumbolli*, *C. veraguensis* and *C. tacana*) and also seven in Peru (*C. arborescandens*, *C. chavin*, *C. fissipes*, *C. inca*, *C. nesiototes*, *C. veraguensis*, *C. multiverrucosus*). Moreover, the presence of *C. tacana* is predicted for southern Peru. Nevertheless, De la Riva *et al.* (2000) already pointed out that some species in this group remain to be described, whereas the taxonomic status of others is doubtful. Hence, the real diversity of this group is still unknown. This assumption is supported by the high number of new species assigned to the *C. veraguensis* group described recently (Duellman and Schulte 1992; Harvey and Smith 1993; Harvey and Smith 1994; Lehr *et al.* 2001; Lehr *et al.* 2005). Moreover, infrageneric divisions, as species group in this case, are mostly based on similarities of external characters and no synapomorphies have been proposed so far. Thus, assignation to species groups is tentative. Nevertheless, the subdivision of genera in species groups helps to work with more manageable units, and there is the hope that some of them actually represent evolutionary units. Indeed, there are already attempts to clarify these phylogenetic relationships (e. g. Pramuk 2006). However, due to the number of new species of *Chaunus* that have been described recently after the exploration of new regions, it is easy to hypothesize that the number of species will increase and, therefore, the hypotheses on relationships among some species and groups would probably change in the near future.

Operational key to the species of the *Chaunus veraguensis* group

1. Tympanic membrane visible 2
 Tympanic membrane not discernible 8
2. Large glands on forearm and hind legs 3
 No such glands 4
3. Dorsum with many, large, elevated, conical glands, all with keratinous tips, skin spiny
 *C. multiverrucosus*
 Dorsum with few large, slightly elevated, ovoid glands, glands with keratinous tips
 restricted to head and neck, skin smooth..... *C. chavin*
4. Parotoid glands diffuse..... *C. nesiototes*
 Parotoid glands evident 5
5. First finger shorter than second 6
 First finger longer than second..... *C. inca*
6. Extremities robust, cranial crests evident..... *C. rumbolli*
 Extremities slender, cranial crest scarcely evident or absent, males with nuptial spines
 7
7. Dorsal coloration greenish, ventral brown and white, vocal slits present, iris green.....
 *C. tacana*
 Dorsal coloration black, ventral red, vocal slits absent, iris orange *Chaunus* sp. (Cusco)

8. Cranial crests absent..... 9
 Cranial crests present 11
9. Foot webbing complete *C. amboroensis*
 Foot webbing rudimentary 10
10. Foot webbing fleshy *C. arborescandens*
 Foot webbing serrated *C. fissipes*
11. First finger shorter than second..... *C. justinianoi*
 First finger longer than second..... 12
12. Supraorbital crest absent; tarsal fold absent; parotoid gland elongate..... *C. quechua*
 Supraorbital crest present; tarsal fold consisting of a single row of granules; parotoid
 gland subtriangular. *C. veraguensis*

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Appendix

Specimens examined

Bufo leptoscelis (= *C. veraguensis*). Peru: Santo Domingo, Carabaya, Department Puno (Holotype: BM 1907.5.7.32).

Bufo ockendeni (= *C. veraguensis*). Peru: Marcapata Valley, Department Puno (Lectotype: BM 1907.2.21.23). Bolivia: Charuplaya (Paralectotypes: BM 1907.2.21.26-27).

Chaunus amboroensis. Bolivia: 12.7 km by road E of El Empalme along road to Khara Huasi, Department Cochabamba (Holotype: MNK-A 953).

Chaunus fissipes. Bolivia: Old Chapare Road, Department Cochabamba (ZFMK 66985).

Chaunus justinianoi. Bolivia: El Chapé, Department Santa Cruz (Holotype: MNK-A950); Old Chapare road, Department Cochabamba (ZFMK 72600-02); Saquisacha, Department Cochabamba (CBG 168-176)

Chaunus quechua. Bolivia: Road from Cochabamba to Villa Tunari, Department Cochabamba (EBD 30249-30252); Sehuencas, Department Cochabamba (CBG 109-127; ZFMK 60255-74).

Chaunus veraguensis. Bolivia: Samaipata, Department Santa Cruz (ZFMK 62832-3, 66884); 45 km W of Río Seco, Department Santa Cruz (ZFMK 67077-8); Serrana de Bella Vista, Department La Paz (MNK-A7270-1); Khara Huasi, Department Cochabamba (CBG 226-236).