A new toad of the *Bufo typhonius* complex from humid montane forests of Bolivia

*(Amphibia, Anura, Bufonidae)*

Stefan Lötters & Jörn Köhler


A new species of toad referable to the *Bufo typhonius* species complex is described from humid montane forests in the Departamentos Cochabamba and Santa Cruz, Bolivia. The new species is mainly characterised by tuberculate dorsal skin, well developed protrusions at angle of jaws, a lateral row of conical tubercles and absence of neural vertebrae. In addition, we provide diagnostic characters for *Bufo acutirostris* Spix, 1824 and comment on other available names of the complex. Including the new species, at least four different forms related to *B. typhonius* (Linnaeus, 1758) are known from Bolivia.

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Introduction

The taxonomy of Neotropical toads related to *Bufo typhonius* is very chaotic (Hoogmoed 1986, 1989, 1990). In recent years it has become evident that behind the name *B. typhonius* a complex of similar species is hidden (*Bufo margaritifer* complex of some authors), which are distributed over the entire Amazon basin and lower Central America. Nothing is known about their phylogenetic relationships (Frost 1985, Hoogmoed 1986, 1989, 1990, Caldwell 1991, Duellman & Schulte 1992, Hass et al. 1995). Because of the difficulty to assign the many available names and the lack of a comprehensive revision (e.g. Hoogmoed 1990) contributors sometimes simply refer to morphs related to *B. typhonius* without assigning names (e.g. Duellman & Mendelson 1995, Köhler & Lötters 1999).

In recent times, Bolivia has become well known for its diversity in anurans. Due to a remarkable increase in scientific efforts within the last decade, the number of species known has almost doubled (De la Riva et al. 2000). Populations referable to *B. typhonius* repeatedly were reported from this country (Schmidt 1857, 1858, De la Riva 1990, Hoogmoed 1990, Aparicio 1992, De la Riva et al. 1992, 1996, Reynolds & Foster 1992, Köhler et al. 1997, Harvey et al. 1998, Köhler & Lötters 1999, De la Riva et al. 2000). Among them, at least four different species or morphs can be distinguished (for their known distributions see Fig. 1): (1) *Bufo castaneotopicus* and (2) a sympatric form occurring in the Departamento Pando in north-western Bolivia (Köhler & Lötters 1999). Following the diagnosis provided for the latter form by Köhler & Lötters (1999), this morph is somehow similar to *B. acutirostris*, an apparently valid taxon known from eastern Colombia, southern Venezuela and north-western Brazil (Hoogmoed & Gruber 1983). Also Hoogmoed (1986) concluded that populations from Amazonian Bolivia resemble *B. acutirostris*. But he suggested that Bolivian specimens are not conspecific with those from northern Amazonia because of the large intervening area from which such toads are unknown. Currently, it is
impossible to clarify the taxonomic status of the many populations resembling *B. acutirostris*. Therefore, we here apply the name *B. acutirostris* to the holotype only (see Appendix). For the population from north-western Bolivia (*Bufo* sp. A in Köhler & Löters 1999) we use the name *B. cf. acutirostris*. (3) A morph from the central lowlands which at least occurs in the Departamentos Beni, Cochabamba and Santa Cruz. Conspicuity of these populations is supported by the coincidence of advertisement call characters (De la Riva et al. 1996, Köhler et al. 1997; for Departamento Cochabamba, unpubl. data)*. This form may represent an undescribed species (this form is here called *Bufo* sp. 1). But further research involving additional specimens from various lowland sites in Bolivia (Fig. 1) and adjacent countries is needed. (4) A morph reported from humid montane forests in the Departamento Cochabamba by Reynolds & Foster (1992) and Köhler et al. (1997). Reynolds & Foster (1992) suggested it to represent an undescribed species. Although we are aware that the *Bufo typhonius* complex needs rigorous revision, recently collected material supports that non of the available names is applicable to the above mentioned morph from humid montane forests. The purpose of this paper is to describe it as a new species.

* Hoogmoed (1986) proposed that at least sympatric species of the *B. typhonius* complex in Suriname can be distinguished by their vocalisations (although data were not provided). The only other advertisement calls described from species related to *B. typhonius* are those of *B. castaneoticus* (Köhler & Löters 1999) and *B. dapsilis* (Zimmerman & Bogart 1988) which are clearly distinguished from those described by De la Riva et al. (1996) and Köhler et al. (1997).
Material and methods
Specimens examined are deposited in the Colección Boliviana de Fauna (CBF), La Paz; National Museum of Natural History, Smithsonian Institution (USNM), Washington; Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK), Bonn; and Zoologische Staatssammlung München (ZSM).

Geographic positions of localities of the new species were obtained with a Magellan 3000 XL GPS receiver. Colour slides of specimens were taken in the field. Measurements of specimens are in millimetres and were taken to the nearest 0.1 mm with dial callipers. Abbreviations are as follows: SVL (snout-vent length), HW (head width at angles of jaws), HL (head length, distance from tip of snout to angle of jaws), IOD (interorbital distance), TYMD (vertical diameter of tympanic annulus), EYED (horizontal diameter of eye), TIBL (tibia length), FOOT (foot length, distance from proximal edge of outer metatarsal tubercle to tip of third toe), N-N (inter-narial distance), E-N (eye-nostril distance, measured from nostril to anterior corner of eye), PARL (length of parotoid gland), PARW (greatest width of parotoid gland), HAND (hand length, distance from proximal edge of outer metacarpal tubercle to tip of third finger). Despite some modifications, terminology and diagnostic characters generally follow Duellman & Mendelson (1995). Sexes in adults were determined by dissection. For webbing formulae we use the scheme of Savage & Heyer (1967) as modified by Myers & Duellman (1982).

Bufo stanlaii, spec. nov.
Figs 2-4

Bufo sp. – Reynolds & Foster 1992: 89.

Types. Holotype: CBF 3346, an adult female, from a point 3.3 km on the road to San Onofre from the road from Cochabamba to Villa Tunari (17°11'S, 65°45'W), Provincia Chapare, Departamento Cochabamba, Bolivia, 1900 m above sea level; collected on 9 February 1998 by Jörn Köhler and Stefan Löfters (field number JKSL 506). – Paratypes: USNM 257797, an adult male, and USNM 257798, a subadult female, from the same locality as the holotype, collected on 1 and 3 November 1979 by Mercedes S. Foster; ZFMK 67097, juvenile, same locality as holotype; USNM 257796, an adult male, from km 96.7 on the road from Cochabamba to Villa Tunari, Provincia Chapare, Departamento Cochabamba, Bolivia, 1967 m above sea level, collected on 22 September 1979 by Mercedes S. Foster; ZFMK 60464, an adult female, from km 115 on the road from Cochabamba to Villa Tunari, Provincia Chapare, Departamento Cochabamba, Bolivia, 1850 m above sea level, collected on 9 December 1994 by Lutz Dirksen and Jörn Köhler; ZFMK 67096, an adult male, from a point ca. 36 km on the “old” road from Paracito to Cochabamba (17°07'S, 65°35'W), Provincia Chapare, Departamento Cochabamba, Bolivia, 1600 m above sea level, collected on 3 January 1999 by Jörn Köhler and Stefan Löfters; ZSM 144/1999, an adult male, from La Hoyada (17°54'S, 64°08'W), Provincia Florida, Departamento Santa Cruz, Bolivia, 1700 m above sea level, collected on 16 November 1998 by Jörn Köhler and Stefan Löfters.

Etymology. The specific name is a patronym for Mr. Stanley Lai (New York) in recognition of supporting taxonomic research and forthcoming conservation projects in Bolivia.

Diagnosis. A species of the Bufo typhonius complex with the following combination of characters: (1) SVL of three adult males 39.1-54.1 mm (mean 45.8 mm), of two adult females 57.2 and 59.4 mm; (2) snout pointed in dorsal view, acute in lateral view, protruding beyond margin of lip; mouth slightly curved in profile; (3) nostrils protuberant at point anterior to anterior margin of lower jaw; (4) canthal crest not raised, supraorbital and prominent supratympanic crests continuous and prominent (more elevated in females); (5) tympanum rounded in males, ovoid in females, distinct, smaller than eye; (6) well developed bony protrusion at angle of jaws; (7) neural crests of vertebrae absent; (8) well developed parotoid glands ovoid to triangular, protruding laterally and incorporated into lateral row of tubercles; (9) lateral row of tubercles present, rounded in males, conical in females; (10) skin on dorsal and dorsolateral surfaces including all cranial crests tubercular, dorsally most intense on posterior head; (11) skin of limbs tubercular or spinous; (12) first and second finger equal in length, or first finger slightly longer; (13) palmar tubercle large, ovoid, three or four times the size of rounded thenar tubercle; (14) basal webbing between fingers; (15) inner metatarsal tubercle ovoid, twice the size...
of outer rounded metatarsal tubercle; (16) foot webbing formula I 1 – 1* II 1 – 2 III 1 – 4 IV 4 – 0* V; (17) supernumerary tubercles present, numerous; (18) dorsum brown, with irregular dark markings and spots, pale middorsal line or stripe; ventral colours brown and cream; (19) vocal slits absent and nuptial excrescences present in males.

The new species is most similar to B. acutirostris (see Appendix; Fig. 5), B. cf. acutirostris from northwestern Bolivia and Bufo sp. 1 from the Bolivian lowlands. In B. acutirostris and Bufo sp. 1, the bony protrusion at the angle of jaws is weakly developed (well developed in B. stanlaii); in their males, the supratympanic crest is only hardly elevated, its maximum elevation smaller than half the vertical tympanum diameter (although variable in size, the supratympanic crest in B. stanlaii males is always larger than half the vertical tympanum diameter). In B. acutirostris the nostril (although also at point anterior to anterior margin of lower jaw) is situated immediate to the anterior margin of the lower jaw (well anterior to anterior margin of lower jaw in B. stanlaii). In Bufo sp. 1 the snout is straight posterodorsally in profile, or concave respective to eye (snout always convex respective to eye in B. stanlaii). In B. cf. acutirostris from north-western Bolivia neural crests of vertebrae may be present (always absent in B. stanlaii); males possess vocal slits (absent in B. stanlaii).

The other proposed species in the B. typhonius complex (see also discussion) can be distinguished from the new species as follows: Bufo pleuropterus has more pointed toe tips, outer and inner metatarsal tubercle of nearly same size, a more homogeneously tuberculated dorsum and a less pointed snout. Bufo castaneoticus and B. proboscideus lack a prominent supratympanic crest and a lateral row of tubercles; in addition, B. castaneoticus is smaller and B. proboscideus has a very distinctly pointed snout;
B. ceratophrys, B. roqueanus and B. typhonius (including B. margaritifer and B. nasutus) are considerably larger (female SVL > 80.0 mm); B. ceratophrys can be distinguished further by the presence of a triangular dermal projection on the eyelid, and B. roqueanus and B. typhonius by the presence extremely enlarged supratympanic flanges; B. dapsilis almost lacks cranial crests and tubercles; B. nasicus lacks prominent supratympanic crests and has longer legs (Spix 1824, Schmidt 1858, Hoogmoed 1977, 1986, Caldwell 1991, Rodriguez & Duellman 1994).

Description of holotype
Adult female; body robust; head wider than long, head length less than one third of SVL; snout pointed from above, acute in lateral profile, protruding beyond margin of lip, slightly curved posteroventrally in profile (curve convex respective to eye); well developed bony protrusion at angle of jaws; dorsal surface of snout weakly depressed; nostrils lateral at point anterior to anterior margin of lower jaw, protuberant, directed dorsolaterally; canthus rostralis barely concave; loreal region concave, horizontal eye diameter about the same as distance from nostril to anterior corner of eye; temporal area straight; tympanum distinct, ovoid, smaller than eye; canthal crest not raised; supraorbital crest suspicious posterior to eye, continuous with prominent supratympanic crest; parotoid gland well developed, ovoid, slightly triangular, protruding laterally; lateral row of conical tubercles from mid of parotoid gland to area between sacrum and groin; skin on dorsal and dorsolateral surfaces tubercular, partly with conical tubercles; mid-dorsum and area between eyes relatively smooth; all cranial crests, paro-
toid glands and in-between conspicuously tubercular; skin of lateral body and head, upper lip, throat, chest and limbs spinous; skin of belly spinous and tubercular, partly with conical tubercles.

Forelimb relatively slender; relative length of fingers I = II < IV < III; palmar tubercle prominent, ovoid; thenar tubercle rounded, in size about one third of former; subarticular and supernumerary tubercles filling almost all area of palm; basal webbing between fingers, edge of webbing slightly serrate.

Hind limb slender; sole from proximal edge of outer metatarsal tubercle to tip of third toe about the same length as tibia; relative length of toes I < II < III < V < IV; inner metatarsal tubercle distinct, ovoid; outer metatarsal tubercle small, rounded, about half the size of inner; plantar surface with supernumerary tubercles; toes with prominent subarticular tubercles; toes with moderate webbing, edge slightly serrate, webbing formula I 1 - 1* II 1 - 2* III 1 - 4 IV 4 - 0* V.

Measurements and proportions are provided in Table 1.

In preservative, ground colour brown; dorsally with dark brown "dead leaf pattern" from between eyes anterior to cloacal region, with pale middorsal line from snout to cloaca; upper loreal region, lateral side of supratympanic crest and lateral body below row of tubercles dark brown; laterally below eye and on tympanic membrane pale markings, continued on ventrolaterally; limbs with irregular dark brown markings; dorsolateral and lateral tubercles light orange, others brown; spines on limbs brown, light orange, or cream; throat, chest and anterior belly brown with scattered cream spots, posteriorly with irregular cream marbling; posterior belly uniformly brownish cream; cloacal region bordered by cream spots; ventral surfaces of limbs brown with irregular cream markings; palm light brown with cream tubercles; sole brown with cream tubercles; foot webbing light brown with cream borders. Coloration in life differed only in respect to the more intensive reddish colour of lateral and dorsal tubercles. Iris was silvery greenish (taken from colour slides).

**Variation.** For variation in measurements and proportions see Tab. 1. In the female USNM 257798, the head measures slightly more than one third of the SVL. The snout is less pointed in ZFMK 60464. The parotoid gland may be more ovoid or more triangular than in the holotype (even variable within one individual). ZSM 144/1999 (male) in general is less tubercular dorsally and less spinous laterally than
all other specimens. Ventral spines are absent or almost absent in USNM 257796 and ZSM 144/1999. In USNM 257796, ZFMK 67096, and ZSM 144/1999, the limbs are tubercular (versus spinous in the holotype). The male USNM 257796 has remarkably large feet when comparing FOOT and FOOT/SVL with the other type specimens. In ZFMK 60464 (female), the palmar tubercle is four times the size of the thenar tubercle. In the subadult female USNM 257798, the palmar tubercle is two times the size of the thenar tubercle which may reflect ontogenetic variation. ZSM 144/1999 exhibits a somewhat more rounded palmar tubercle.

Sexual dimorphism is indicated by males having smaller size (Tab. 1), a more rounded (versus ovoid) tympanum, somewhat less prominent supratympanic crests and the presence of a lateral row of rounded (versus conical) tubercles. Vocal slits are absent and nuptial excrescences on Fingers I and II present in all males. In the juvenile (ZFMK 67097), cranial crest is less developed while other characters fit those of the adults.

Colour variation includes light or reddish brown ground colour; the “dead leaf pattern” may be absent while the light brown middorsal line (occasionally bordered with dark brown) is always present; few dark brown markings may be present on the posterior dorsum; lateral areas (dark in the holotype) may have the ground colour; tubercles (light orange in the holotype) may be brown or cream; the throat may be cream with irregular brown markings; the cream area on the posterior belly (with irregular brown markings) may reach anteriorly to the chest.

**Distribution and ecology.** *Bufo stanlaii* is known from the localities given in the type series, comprising an elevation range from 1600 to almost 2000 m above sea level. The localities are situated within humid montane rainforest at the Amazonian versant of the Bolivian Andes. The annual precipitation in this area reaches more than 3500 mm, most of which appears from January to March; mean annual temperature can be expected to range between 12 and 15°C (see Lauer & Erlenbach 1987). Specimens were observed active during the day and at night in leaf litter. The holotype, collected in February 1998, and ZFMK 60464, collected in December 1994, each contain masses of tan eggs in their ovaries.

**Tab. 1.** Measurements (in mm) and proportions of adults of type series of *Bufo stanlaii*, spec. nov. For abbreviations see text.

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Fig. 5. Preserved holotype of *Bufo acutirostris* Spix, 1824; male (ZSM 1147/0).

Discussion

Describing a new toad of the *Bufo typhonius* complex is accompanied by certain difficulties with respect to other available names. Most descriptions are imprecise and often type specimens are in poor condition or even lost. In the following we summarise and discuss the taxonomic status of names associated with the *B. typhonius* complex by different authors.

Hoogmoed (1990) stated that 17 forms previously related to the *Bufo typhonius* complex (e.g. Cei 1968, 1972; Frost 1985) “do not have anything to do with it”. As a result, he preliminary considered the following members – besides *B. typhonius* (Linnaeus, 1758) itself – as part of this complex: *B. ceratophrys* Boulenger, 1882, *B. dapsilis* Myers & Carvalho, 1945 and *B. nasicus* Werner, 1903. Moreover, Hoogmoed (1990) proposed that *B. typhonius roqueanus* Melin, 1941 will have to be elevated to the species rank (in a way adopted by Duellman & Schulte 1992 and Morales 1995) and that the names *B. acutirostris* Spix, 1824, *B. margaritifer* (Laurenti, 1768) and *B. proboscideus* Spix, 1824 will have to be re-established. *Bufo margaritifer* was suggested as a possible replacement name for *B. typhonius* because of nomenclatural problems (Hoogmoed 1989, 1990). We do not address to this problem here and treat both names synonymous. *Bufo alatus* Thominot, 1884 from Panama was tentatively suggested to represent a synonym of *B. acutirostris* (Hoogmoed 1986) but may actually represent a valid trans-Andean species (C. M. Vélez, pers. comm.). The type material of *B. nasutus* Schneider, 1799 is apparently lost. Reading its original description (Schneider 1799), we tentatively consider it a synonym of *B. typhonius*. The name *B. naricus* Spix, 1824 is either referable to the *B. typhonius* complex. However, because the type material is lost (Hoogmoed & Gruber 1983) and the original description and the figure therein do not provide significant details (Spix 1824), we consider *B. naricus* a nomen dubium. The taxonomic status of *B. pleuropterus* Schmidt, 1857 (currently considered a synonym of *B. typhonius*) remains unclear. According to the descriptions by Schmidt (1857, 1858) and photographs provided to us of the juvenile holotype (Musaei Zoologici Univ. Jag. Kraków No. 1030), it may possibly represent a valid species. However, the drawing by Schmidt (1858: plate 17) is somewhat misleading with respect to the snout shape. Actually, the snout is considerably less pointed in dorsal view (Fig. 6). The type locality of *B. pleuropterus* was given as “Grenzgebiet von Bolivia gegen Peru, in etwa 3000' Höhe” by Schmidt.
Fig. 6. Preserved holotype of *Bufo pleuropterus* Schmidt, 1857; juvenile (Musaei Zoologici Univ. Jag. Kraków No. 1030; photograph by Krzysztof Smagowicz).

(1858). According to the loss of Bolivian territory in 1909 and the travel route of the collector, J. v. Warszewiez (see Savage 1970), the type locality is probably in present-day Peru. The taxonomic status of *B. sternosignatus* Günther, 1859 was uncertain (Hoogmoed 1990) until recently La Marca & Mijares-Urrutia (1996) redescribed this species as a taxon probably not related to *B. typhonius*.

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Appendix: Diagnostic characters of *Bufo acutirostris*

The following diagnosis is based on the holotype of *Bufo acutirostris* Spix, 1824 (ZSM 1147/0, jar label: “habitat ad flumen, Amazonien/Brasilien”): Adult male (Fig. 5) with (1) SVL 35.3 mm, HW 14.0 mm, HL 11.8 mm, TIBL 13.9 mm; (2) snout pointed in dorsal view, acute in lateral view, protruding beyond margin of lip, slightly curved posteroventrally in profile (curve is convex respective to eye); (3) nostrils protuberant at point immediately anterior to anterior margin of lower jaw; (4) canthal crest not raised, supraorbital and supratympanic crests continuous but weak (maximum elevation of supratympanic crest smaller than half the vertical tympanum diameter); (5) tympanum rounded, distinct, smaller than eye; (6) weak bony protrusion at angle of jaws; (7) neural crests of vertebrae absent; (8) well developed parotoid glands triangular, protruding laterally and incorporated into lateral row of tubercles; (9) lateral row of tubercles present, rounded; (10) skin on dorsal and dorsolateral surfaces (except cranial crests) tubercular, dorsally most intense on anterior dorsum; (11) skin of limbs tubercular and partly spinous; (12) first finger slightly longer than second; (13) palmar tubercle large, ovoid, three times the size of rounded thenar tubercle; (14) basal webbing between fingers; (15) inner metatarsal tubercle ovoid, twice the size of outer rounded metatarsal tubercle; (16) foot webbing formula I I 1 - 1' II 1' - 2' III 1 - 4 IV 4 - 0' V; (17) supernumerary tubercles present, numerous; (18) dorsum dark and posteriorly light brown with irregular dark brown markings; ventral colour cream; (19) nuptial excrescences absent.
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