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A New Toad (Anura: Bufonidae) from Uruguay

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ABSTRACT.—A new species of toad is described from small streams in the hills of Cuchilla de Haedo and Cuchilla Grande in northeastern Uruguay. Specimens of the new species were previously mistaken for *Bufo arenarum*; they differ from *B. arenarum* by having elongated parotoid glands and reddish-brown parotoid and cephalic crests. A discriminant analysis resulted in three groups corresponding to *B. arenarum*, *Bufo rufus*, and the specimens herein described as a new species.

Bufonidae is one of the most widely distributed anuran families, reaching all temperate and tropical regions, except Madagascar and Oceania (a species was introduced in Australian and New Guinea; Duellman and Trueb, 1994). Among the genera in this family, *Bufo* is most diverse, with more than 250 species currently recognized.

The species in the *Bufo marinus* group (sensu Duellman and Schulte, 1992) are distributed along Central and South America. This group currently includes six species: *Bufo arenarum*, *Bufo ictericus*, *B. marinus*, *Bufo paracnemis*, *Bufo poeppigii*, and *Bufo rufus*. Only *B. arenarum* and *B. paracnemis* are known from Uruguay (Langone, 1995; Achaval and Olmos, 1997).

Recently, Maneyro and Arrieta (2000) examined external morphological variation in *B. arenarum*. This analysis suggested that two specimens from the hills of northeastern Uruguay were more similar morphologically to *B. rufus* than to other specimens of *B. arenarum*. Subsequent examination of specimens of *B. arenarum* deposited in the herpetological collection at the Facultad de Ciencias, Universidad de la República Oriental del Uruguay, found three additional individuals that differ from *B. arenarum*. More recently, five new specimens have been collected, all of which differ from *B. arenarum*. Herein, we describe a new species of *Bufo* based on these specimens.

MATERIALS AND METHODS

Specimens examined are deposited in the Vertebrates Zoology Collection, Facultad de Ciencias, Uruguay (ZVCB) and Smithsonian Institution (USNM). Specimens were fixed in 10% formalin (commercial grade) and stored in 70% ethanol. Locality data and catalog numbers of examined specimens are given in Appendix 1.

Measurements were taken to the nearest 0.05 mm using vernier calipers under a dissecting microscope. The following measurements were used: snout-vent length (SVL), eyelid height (EH = maximum vertical distance from the eyelid's inner border to the external border of the supraorbital crest), interparietal width (IW = shortest distance between parietal crests around eyes), head width (HW = maximum head width), eyelid length (EL = eyelid length in the inner border), eye-nostril distance (END = minimum horizontal distance between eye and external nares), metacarpal tubercle (MT = length of the inner metacarpal tubercle major axis), length of Finger II (LFII = distance between finger two tip and its basal tubercle). Mean, standard deviation, and range are given in Table 1 ($N = 58$). Additional measurements for type specimens were taken: head length (HL), internarial distance (ID), upper forearm (UF), lower forearm (LF), thigh (TG), and leg (LG).

Measurements were standardized by size using SVL. The transformed matrix was used to perform a Discriminant Analysis (DA) by the forward stepwise method. Group significances associated to DA roots were tested through an ANOVA. Homoscedasticity and normality of the variables were assessed using Bartlett's test and Shapiro-Wilk's test, respectively (Zar, 1999).

Bufo achavali, sp. nov.

Figure 1

Holotype.—ZVCB 3779, an adult female, collected by David Fabius in 1998, at the outskirts of Pueblo Valentines (33°16'S, 55°07'W), Departamento de Treinta y Tres, Uruguay.

Paratypes.—USNM 544984 (field number ZVCB 271b), adult female, collected by Carlos Carbonell on 18 December 1952, at Gruta de los Cuervos (31°36'S, 56°01'W), Departamento de Tacuarembó, Uruguay; ZVCB 3801, juvenile, collected by Federico Achaval and Melitta

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TABLE 1. Morphometrics of *Bufo rufus*, *Bufo achavali*, and *Bufo arenarum*. Abbreviations: snout-vent length (SVL), eyelid height (EH), interparietal width (IW), head width (HW), eyelid length (EL), eye-nostril distance (END), metacarpal tubercle (MT), length of finger II (LFII).

Variables	<i>Bufo rufus</i> N = 12					<i>Bufo achavali</i> N = 10					<i>Bufo arenarum</i> N = 36				
	Mean	SD	max	min	Range	Mean	SD	max	min	Range	Mean	SD	max	min	Range
SVL	94.35	18.04	116.30	61.50	54.80	60.85	28.70	119.00	28.40	90.60	84.34	24.69	115.20	31.40	83.80
EH	5.86	0.80	7.20	4.90	2.30	4.35	1.41	7.00	2.50	4.50	7.18	1.83	10.50	3.20	7.30
IW	14.17	2.34	17.20	10.70	6.50	10.37	4.37	19.40	4.70	14.70	12.10	3.36	17.40	4.60	12.80
HW	32.47	5.20	38.90	23.30	15.60	21.95	10.43	43.90	9.60	34.30	30.25	8.44	42.20	11.80	30.40
EL	10.21	0.83	11.40	8.30	3.10	7.51	2.36	12.60	4.70	7.90	10.75	2.57	14.30	5.10	9.20
END	5.03	0.65	5.90	3.60	2.30	4.20	1.49	6.90	2.50	4.40	4.68	1.28	7.70	2.00	5.70
MT	4.52	0.89	6.30	3.00	3.30	3.08	1.21	5.50	1.80	3.70	6.20	0.90	7.60	3.60	4.00
LFII	5.88	1.13	7.60	4.00	3.60	4.92	2.16	9.50	2.30	7.20	5.16	1.47	7.50	1.60	5.90

Meneghel on 12 April 1999, at Estancia Doña Alba, 16 km northwest of Isla Patrulla (33°02'S, 54°39'W), Departamento de Treinta y Tres, Uruguay.

Additional Specimens (Specifically Not Designated as Types).—ZVCB 77, male, and ZVCB 84, female, both collected by Excursión Zoología Vertebrados in February 1954, at Arroyo de la Invernada, Departamento de Artigas; ZVCB 271a, cleared and stained, collected by C. Carbonell on 18 December 1952 at Gruta de los Cuervos, Tacuarembó; ZVCB 3331, female, collected by G. Wibmer and M. Moratorio from 12–26 January 1971, at Sierra de la Aurora, Rivera; ZVCB 3815, female, collected by I. Etchevitz on 29 March 1999, at Arroyo Yermal Grande, Treinta y Tres; ZVCB 4031, female, collected by F. Achaval and M. Meneghel on 10 April 1999, at Estancia "Doña Alba," Treinta y Tres; ZVCB 4727, male, collected by A. Scolaro in 1999 at Estancia "Doña Alba," Treinta y Tres.

Diagnosis.—A medium-sized toad belonging to the *B. marinus* group possessing the following

characteristics: (1) tibial glands absent; (2) elongated parotoid glands; (3) interorbital skin smooth; (4) ratio between the length of second digit of foot and the length of metacarpal tubercle; more than 1.6×; and (5) cranial crests and parotoid glands reddish-brown.

The new species can be distinguished from other species in the *B. marinus* group inhabiting Uruguay. *Bufo achavali* lack tibial glands, whereas tibial glands are present in *B. paracnemis*. *Bufo achavali* differs from *B. arenarum* by (1) elongated parotoid glands (short in *B. arenarum*); (2) inner margin of parotoid gland slightly convex (inner margin sinuous in *B. arenarum*); and (3) parotoid and cephalic crests reddish-brown in color (gray or brown, but never reddish, in *B. arenarum*). *Bufo achavali* differs from other species in the *B. marinus* group by (1) elongated parotoids (elliptical in *B. ictericus*); (2) ratio parotoid length/parotoid width more than 2.1× (less than 2.1× in *B. marinus*); and (3) ratio of Finger II length/metacarpal tubercle more than 1.6× and a rounded snout (less than 1.6× and a pointed snout in *B. rufus*). We did not have specimens of *Bufo poeppigii* for examination, the only other species in the *B. marinus* group. *Bufo poeppigii* was placed in the synonymy of *B. marinus* by Henle (1985); however, it was recently included as a valid taxon by De la Riva et al. (2000). The taxonomic status of this taxon remains debatable (De la Riva, 2002); however its affinities lie with *B. marinus* and consequently cannot be confused with *B. achavali*.

Description of Holotype.—The holotype (ZVCB 3779) has a robust body; head short and indistinct from neck; interorbital region flat and smooth, without glands or rugosities; cephalic crests distinct; canthal, preorbital, supraorbital, and postorbital crests well developed, parietal crest present but poorly developed; snout short, slightly rounded in dorsal view and truncate in lateral view; nostrils visible, immediately below the tip of the canthal cephalic crest; eyelid length about 1.7× of eyelid height; eye-nostril distance about 2.4× of interorbital distance; canthus

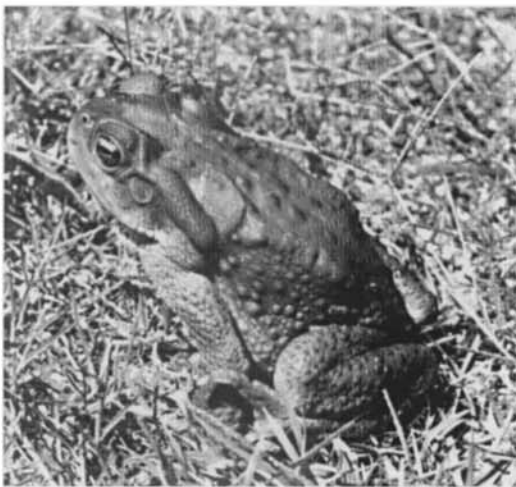


FIG. 1. Holotype of *Bufo achavali* n.sp. (ZVCB 3779).

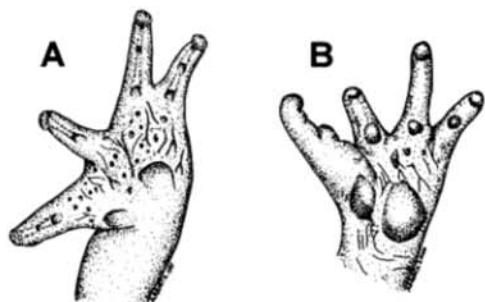


FIG. 2. Left hand of holotype of *Bufo achavali* (A) and *Bufo arenarum* (B) in ventral view. Scale bar = 10 mm.

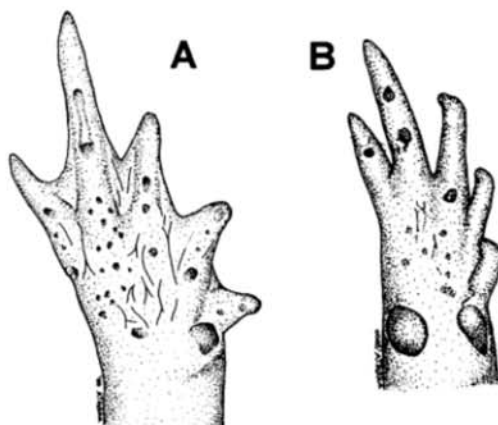


FIG. 3. Left foot of holotype of *Bufo achavali* (A) and *Bufo arenarum* (B) in ventral view. Scale bar = 10 mm.

rostralis and loreal region slightly convex; tympanum distinct, rounded to ovoid; eyelid length about 2.5× the vertical axis of tympanum; dorsal edge of tympanum concealed by postorbital cephalic crest; tongue lanceolate, width of posterior end about twice of anterior tip.

Forelimb short and slender; hand with thick fingers having rows of small glands on both surfaces, more conspicuous in ventral view and particularly in Fingers III and IV. Relative length of fingers $IV < II < I \leq III$; webbing absent (Fig. 2). The hand has two, rounded, palmar tubercles; outer one slightly larger. Subarticular tubercles distinct, round, simple or slightly bifid. Length of foot about 1.5× of the length of the tibia. Relative length of toes $I < II < V < III < IV$ (Fig. 3). Tarsal fold present. Feet with two metatarsal tubercles of about equal size, but the inner metatarsal tubercle is taller than the outer one. Subarticular tubercles are present but less conspicuous than those on the digits of the hand. The feet have a well-developed interdigital membrane, reaching the distal tip of Toes I, II, and III and including most of Toe V. Interdigital membrane reaching only half of Toe IV (the longest toe).

Skin on dorsum of body with numerous scattered glands; ventral skin smoother but uniformly covered with smaller glands that are more conspicuous in the chest and throat regions; lacking distinct dorsal glandular ridges, sometimes a poorly defined glandular ridge is visible posterior to the parotoid gland. Skin of dorsum with tubercles arranged in two series on both sides of the dorsal middle line, extending from behind the head to about half of the length of the body; on the posterior half, these tubercles are scattered randomly.

The parotoid glands are elongate (Fig. 4); their length is about 3× their maximum anterior width and 1.5× of the orbital width. The posterior margin of the parotoid is rounded.

*Measurements of the Holotype (in Millimeters).—*SVL = 119.0; EH = 7.0; IW = 19.4; HW = 43.9;

EL = 12.6; END = 6.9; MT = 5.5; LFII = 9.5; HL = 29.1, HW = 43.9, ID = 7.7, IW = 19.4, UF = 33.0, LF = 39.2, TG = 50.6, LG = 47.4.

Coloration.—In life, coloration is uniformly brown. Parotoid glands and cephalic crests are distinctly reddish-brown. Ventrally, coloration is uniformly light to yellow brown. In preservative, overall coloration is gray to brown; edges of parotoids and of cephalic crests are darker brown maintaining their characteristic reddish tones.

Variation.—Juvenile individuals (ZVCB 84; ZVCB 3331; ZVCB 3801; ZVCB 3815), less than 50 mm in SVL, have several light cream or yellowish spots arranged in two parallel series on the dorsum.

Etymology.—The specific epithet is in honor of Federico Achaval, herpetologist, who recently retired after more than 30 years of encouraging students and developing studies on vertebrate biology.

Eggs, Tadpoles, and Call.—Unknown.

Distribution.—*Bufo achavali* is currently known to inhabit streams in two hill systems (known as

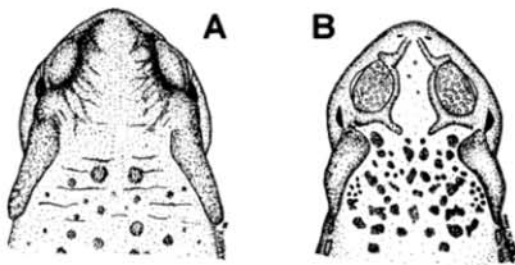


FIG. 4. Head of holotype of *Bufo achavali* (A) and *Bufo arenarum* (B) in dorsal view. Scale bar = 10 mm.



FIG. 5. Map showing the known localities in Uruguay for *Bufo achavali*. 1. Arroyo de la Invernada, Artigas; 2. Gruta de los Cuervos, Tacuarembó; 3. Sierra de la Aurora, Rivera; 4. Pueblo Valentines, Treinta y Tres (type locality); 5. Yermal Grande Stream, Treinta y Tres; 6. Estancia "Doña Alba," Treinta y Tres. Lightly shaded areas are the hills (Cuchilla de Haedo and Cuchilla Grande), dark shaded areas are the main water bodies of Uruguay.

"Cuchillas"; Cuchilla de Haedo and Cuchilla Grande) in northeastern Uruguay (Fig. 5).

Comparisons with Other Species.—Maneyro and Arrieta (2000) presented a morphometric analysis of most species in the *B. marinus* species group. Their results suggested two morphological clusters of species: one consisting of *B. ictericus*, *B. marinus*, and *B. paracnemis*, and the second comprising *B. arenarum* and *B. rufus*.

In spite of the high variability and controversial relationships among the taxa in the *B. marinus*

TABLE 2. Variables in the model for the Discriminant Function Analysis summary. Wilks' Lambda: 0.09433, $F(10,90) = 20.303$, $P < 0.0000$. Abbreviations: metacarpal tubercle (MT), length of Finger II (LFII), eyelid height (EH), eye-nostril distance (END), interparietal width (IW).

	Wilks' Lambda	Partial Lambda	F-remove (2,45)	P
MT	0.123	0.765	6.897	0.002
LFII	0.129	0.731	8.293	0.001
EH	0.117	0.808	5.357	0.008
END	0.107	0.884	2.943	0.063
IW	0.104	0.903	2.411	0.101

TABLE 3. Standardized coefficients for the two roots in the Discriminant Analysis. Abbreviations: metacarpal tubercle (MT), length of Finger II (LFII), eyelid height (EH), eye-nostril distance (END), interparietal width (IW), Eigenvalue (Eig), cumulative proportion (Cp).

	Root 1	Root 2
MT	-0.547	0.277
LFII	0.508	0.469
EH	-0.407	0.492
END	0.247	0.442
IW	0.328	-0.280
Eig	4.011	1.115
Cp	0.782	1.000

group (Slade and Moritz, 1998), *B. achavali* can be easily distinguished from other taxa in this species group (see Diagnosis). *Bufo achavali* is morphologically similar to *B. arenarum* and *B. rufus*. Discriminant Analysis was performed using these three taxa. The results of the Discriminant Analysis on the size-standardized matrix are given in Table 2 (variables in the model) and Table 3 (standardized coefficients). Plotting of the first two roots resulted in three distinct groups: (1) *B. arenarum* cluster; (2) *B. rufus* cluster; and (3) a cluster corresponding to the new taxon, *B. achavali* (Fig. 6). The ANOVA showed significant differences between the three groups ($F = 98.28$, $df = 49$, $P < 0.01$) in Root 1.

Furthermore, *B. achavali* is distinguished from *B. arenarum* by the size and shape of the parotoid glands (elongate with convex inner margin in *B. achavali*, short with sinuous inner margin in *B. arenarum*) and by reddish parotoid and cephalic crests (gray or brown in *B. arenarum*). *Bufo achavali* has ratio Finger II length/metacarpal tubercle of more than 1.6 \times , whereas in *B. rufus*, this ratio is consistently less than 1.6 \times ; in dorsal view, *B. achavali* has a rounded snout, whereas that of *B. rufus* is distinctly pointed.

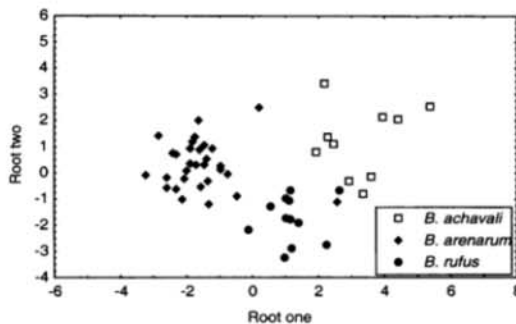


FIG. 6. Graphic representation of the two roots of the Discriminant Analysis.

Bufo achavali and *B. arenarum* differ in habitat preference. *Bufo arenarum* inhabits the coastal plains of southern and northwestern Uruguay (Olmos and Maneyro, 1998), whereas *B. achavali* is confined to small streams on the hill systems of northeastern Uruguay (altitude around 500 m). These hills exhibit a particular hydrographic system and associated vegetation that have other endemic species of bufonid, that is, *Melanophryniscus orejasmirandai*, *Melanophryniscus sanmartini*. Finally, *B. achavali* (referred as *Bufo* sp.) was considered as threatened by Maneyro and Langone (2001) in the analysis of the conservation status of the Uruguayan anurans.

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APPENDIX 1

List of Localities of Specimens Examined

- Bufo arenarum*: BRASIL: MZUSP 27344; 27345; 27346: Tramandaí. Rio Grande do Sul. Col: G. Kloss. 7–9-X-1968; MZUSP 57530; 57531; 57532; 57533: Estação Ecologica Taim. Rio Grande do Sul. Col: N. Gomez. 10-XII-1979 to 10-I-1980. ARGENTINA: ZVCB 519-1; 519-4; 519-6; 519-7; 519-8; 519-9: Laguna Guanaco, alrededores de la Ciudad de Santa Rosa. La Pampa. Col: F. Achaval. 28-X-1967. URUGUAY: ZVCB 143: Aguas Dulces. Rocha. Col: R. Vaz Ferreira. 09-III-1959, ZVCB 278: Puerto del Buceo. Montevideo. Col: C.S. Carbonell. IX-1961, ZVCB 311: Zanja de los Alemanes, próximo a San Carlos. Maldonado. Col: R. Vaz Ferreira. 25-II to 8-III-1965, ZVCB 343: Isla de Flores. Montevideo. Col: F. Achaval. 23-XI-1965, ZVCB 471a; 471b: Cabo Polonio. Rocha. Col: R. Vaz-Ferreira. 11-III-1956, ZVCB 511a; 511b: Carrasco. Montevideo. Col: L. Amaral de Gambardella. 01-X-1967, ZVCB 670: Punta Gorda. Montevideo. Col: J. Cuello. 12-XII-1959, ZVCB 827: Cabo Santa María. Rocha. Col: S. Maytía and Víctor Scarabino. 09-XI-1968, ZVCB 1107: Parque del Plata. Canelones. Col: N. Núñez. 26-XI-1971, ZVCB 1746; 1747; 1748; 1749: Cabo Polonio. Rocha. Col: F. Achaval. 04-I-1981, ZVCB 2441: Playa Carrasco. Montevideo. Col: J. E. García. IX-1971, ZVCB 2758: Puente Internacional. Paysandú. Col: C. Ríos. II-1995, ZVCB 3276: Costa Azul. Canelones. Col: G. Cannesa, O. Mora and C. Martínez. 20 to 30-VIII-1972, ZVCB 3316; 3317: Boca del Arroyo Carrasco. Canelones. Col: A. Langguth. 05-XI-1970, ZVCB 3459: Ciudad de Salto, Club de Remeros. Salto. Col: A. Olmos. 27-II-1998, ZVCB 4027; 4028: Cabo Polonio. Rocha. Col: A. Abella. II-1971.
- Bufo rufus*: BRAZIL: CEPB 675; 5162; 6190; 6217; 6709; 7619; 8216; 10801; 14687; 15710; 17346: Usina Hidroeletrica Corumbá, Caldas Novas, Goiás, Coll: Helder Rodrigues et al.
- Bufo achavali*: URUGUAY: ZVCB 77, Arroyo de la Invernada. Artigas. Col: Exc. Zool. Vertebrados. II-1954; ZVCB 84: Arroyo de la Invernada. Artigas. Col: Exc. Zool. Vertebrados. II-1954; ZVCB 271a; 271b: Gruta de los Cuervos. Tacuarembó. Col: C. Carbonell. 18-XII-952; ZVCB 3331: Sierra de la Aurora. Rivera. Col: G. Wibmer and M. Moratorio. 12 to 26-I-1971; ZVCB 3779: Afueras de Pueblo Valentines. Treinta y Tres. Col: David Fabius. 1998; ZVCB 3801: Estancia "Doña Alba." Treinta y Tres. Col: M. Meneghel and F. Achaval; ZVCB 3815: A° Yermal Grande. Treinta y Tres. Col: Ismael Etchevetz; ZVCB 4031: Estancia "Doña Alba." Treinta y Tres. Col: F. Achaval and M. Meneghel; ZVCB 4727: Estancia "Doña Alba." Treinta y Tres. Col: A. Scolaro. 1999.