



## A new species of *Proceratophrys* Miranda-Ribeiro (Amphibia: Anura: Cycloramphidae) from central Brazil

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### Abstract

A new species of the *Proceratophrys cristiceps* group is described from central Brazil based on adult morphology and advertisement call. *Proceratophrys vielliardi* **sp. nov.** is mainly diagnosed by its medium size, lack of tubercular sagittal crests from eyelids to coccyx and a multi-noted advertisement call. This is the second species of *Proceratophrys* described from central Brazil.

**Key words:** Cerrado, Lissamphibia, Odontophrynini, State of Goiás, taxonomy, vocalization

### Introduction

As presently defined, the genus *Proceratophrys* Miranda-Ribeiro comprises 22 species (Prado & Pombal 2008; Cruz & Napoli 2010; Frost 2011) distributed throughout Brazil, northeastern Argentina and Paraguay (Frost 2011); it is likely a monophyletic taxon, with *Odontophrynus* Reinhardt and Lütken as its sister group (Frost *et al.* 2006; Amaro *et al.* 2009). Most species of *Proceratophrys* have been placed into one out of the three following phenetic groups:

The *Proceratophrys boiei* species group includes species with long horn-like palpebral appendages, distributed mainly throughout coastal Brazilian Atlantic Forest (reviewed in Prado & Pombal 2008); it comprises *P. appendiculata* (Günther), *P. boiei* (Wied-Neuwied), *P. laticeps* Izecksohn and Peixoto, *P. melanopogon* (Miranda-Ribeiro), *P. moehringi* Weygoldt and Peixoto, *P. paviotii* Cruz, Prado and Izecksohn, *P. phyllostoma* Izecksohn, Cruz and Peixoto, *P. renalis* (Miranda-Ribeiro), *P. sanctaritae* Cruz and Napoli, *P. subguttata* Izecksohn, Cruz and Peixoto and *P. tupinamba* Prado and Pombal. *Proceratophrys rondonae* Prado and Pombal, also included within this group, presents instead of a long horn-like, a short multi-cuspidate palpebral appendage, and occurs in the Amazon Rainforest. *Proceratophrys schirchi* (Miranda-Ribeiro) presents palpebral appendages, but this species is not associated to any group due to its distinct morphological pattern (Prado & Pombal 2008).

The *Proceratophrys bigibbosa* species group includes *Proceratophrys avelinoi* Mercadal de Barrio and Barrio, *P. brauni* Kwet and Faivovich, *P. bigibbosa* (Peters) and *P. palustris* Giaretta and Sazima; these species present postocular swellings and are distributed throughout southern Brazil and adjacent countries, except *P. palustris*, considered a relictual species in southeastern Brazil (reviewed in Kwet & Faivovich 2001).

The *Proceratophrys cristiceps* species group is suggested to subsume species lacking palpebral appendages and postocular swellings and inhabiting mainly seasonally dry open environments (Cerrado and Caatinga domains) of Brazil (Giaretta *et al.* 2000). It presently comprises *Proceratophrys concavitympanum* Giaretta, Bernarde and Kokubum, *P. cristiceps* (Müller), *P. cururu* Eterovick and Sazima, *P. moratoi* (Jim and Caramaschi) and *P. goyana* (Miranda-Ribeiro), the latter being the only species of this genus reported to occur in central Brazil (Brandão & Araújo 2001; Bastos *et al.* 2003; Giaretta *et al.* 2008; Frost 2011).

The monophyletic nature of these groups is still open to be demonstrated, but unfavorable evidence was recently presented based on molecular data (Amaro *et al.* 2009).

In the Municipality of Caldas Novas (State of Goiás, Brazil), we found specimens of *Proceratophrys* that agree in general morphology with the species of the *P. cristiceps* group, but they are different from all other known species of the genus. Based on adult morphology, color pattern and advertisement call, we describe herein these specimens as a new species.

## Material and methods

Specimens of the new species were recorded and collected at the Parque Estadual da Serra de Caldas Novas (PESCAN), Municipality of Caldas Novas, State of Goiás, Brazil (ca. 17°46'S–48°42'W, ca. 1000 m above sea level), from November 2004 to December 2008. All individuals were collected while calling or in amplexus (one couple). The following measurements were taken (using calipers to the nearest 0.1 mm under a stereoscopic microscope): snout-vent length (SVL), head width, head length, eye diameter, internarial distance, interorbital distance, eye-nostril distance, thigh length, shank length, foot length and hand length. Measurements and terminology followed Heyer *et al.* (1990); head length and width were taken from the corner of the mouth.

Advertisement calls were recorded with digital recorders (Boss BR-864 or M-audio Microtrack II) coupled to directional microphones (Sennheiser K6/ME67 or K6/ME66, respectively). All recording devices were set at 44,100 Hz and 16 bits resolution. Sound analyses were made using SoundRuler v. 0.9.6.0 (Gridi-Papp 2007). Audiospectrograms were obtained using the package Seewave (Sueur *et al.* 2008), on the R platform v. 2.10.1 (R Development Core Team 2010); settings for call analyses and figures were: FFT = 256 points resolution, Overlap = 90%. Call terminology and measurements followed Duellman and Trueb (1986) and Gerhardt and Huber (2002). Criteria for interspecific call comparisons (homology) followed Robillard *et al.* (2006).

The diagnosis and comparisons with other species were based on examined specimens (appendix 1) and on the following literature: morphology — *Proceratophrys bigibbosa* species group: Kwet and Faivovich (2001); *Proceratophrys boiei* species group: Prado and Pombal (2008), Cruz and Napoli (2010); *P. concavitympanum*: Giaretta *et al.* (2000), Santana *et al.* (2010); *P. cristiceps*: Miranda-Ribeiro (1926), Vieira *et al.* (2008); *P. cururu*: Eterovick and Sazima (1998); *P. goyana*: Miranda-Ribeiro (1937); *P. moratoi*: Jim and Caramaschi (1980), Brasileiro *et al.* (2008); *P. schirchi*: Miranda-Ribeiro (1937), Izecksohn and Peixoto (1980). Advertisement calls — *P. avelinoi*: Kwet and Baldo (2003); *P. bigibbosa*, *P. brauni*: Kwet and Faivovich (2001); *P. boiei*: Heyer *et al.* (1990); *P. concavitympanum*: Santana *et al.* (2010); *P. cristiceps*: Nunes and Juncá (2006); *P. cururu*: Eterovick and Sazima (1998); *P. melanopogon*: Mângia *et al.* (2010); *P. moehringi*: Weygoldt and Peixoto (1985); *P. moratoi*: Brasileiro *et al.* (2008); *P. paviotii*: Cruz *et al.* (2005); *P. sanctaritae*: Cruz and Napoli (2010).

Two paratypes (AAG-UFU 3207 and 4313) were dissected in order to examine two osteological features, considered by Prado and Pombal (2008) valid diagnostic features to *Proceratophrys*: the relationship between the zygomatic ramus of squamosal and maxilla, and the cervical cotylar arrangement; osteological definitions are according to Lynch (1971) and Prado and Pombal (2008). In order to avoid damages to the holotype, internal oral features were taken from a male paratopotype (AAG-UFU 3207).

Types and additional examined specimens are housed in the following public Brazilian collections: Museu de Zoologia da Universidade Estadual de Campinas (ZUEC), Municipality of Campinas, State of São Paulo; Collection of amphibians of the Universidade Federal de Uberlândia (AAG-UFU), Municipality of Uberlândia, State of Minas Gerais; and Célio F. B. Haddad Collection (CFBH), Universidade Estadual Paulista, Municipality of Rio Claro, State of São Paulo.

## Taxonomic account

### *Proceratophrys vielliardi* sp. nov.

Figures 1–3

**Holotype** (ZUEC 16239): an adult male, collected at the Parque Estadual da Serra de Caldas Novas (PESCAN),

Municipality of Caldas Novas, State of Goiás, Brazil (17°46'S–48°42'W, 990 m above sea level) on 12 November 2008 by A. A. Giaretta.

**Paratopotypes.** Eight adult males (ZUEC 16240, AAG-UFU 3206–3207, 4312–4314, 4360, 4362) and one adult female (AAG-UFU 4361); collected from November 2004 to December 2008, by A. A. Giaretta. AAG-UFU 4312–4313 are vouchers of acoustic recordings.



**FIGURE 1.** *Proceratophrys vielliardi* sp. nov., adult male; holotype (ZUEC 16239). SVL 41.1 mm.

**Diagnosis.** In the genus *Proceratophrys* by lacking nuptial pads on thumb, body without enlarged glands, toes not webbed and fringed laterally, supernumerary tubercles present on hands and feet, dorsal surfaces of fingers and toes wrinkled, zygomatic ramus of squamosal bone in sutural contact with maxilla and cervical cotylar arrangement type II (cotyles closely approximated). In the *P. cristiceps* group by lacking palpebral appendages and postocular swellings. This species is characterized by: (i) medium size (SVL = 39.1–41.9 mm in males); (ii) lack of a pair of tubercular sagittal crests from eyelids to coccyx; (iii) dorsum and flanks with scattered dark brown rounded marks, somewhat anastomosed to each other, and covered by irregularly arranged and sized warts; (iv) advertisement call consisting of 3–20 notes, each one with 4–9 pulses and lasting 40.2–84.7 ms; the last note is longer (83.9–304.2 ms) and with more pulses (9–30) than the others; dominant frequency around 1022–1291 Hz.

**Comparison with other species.** In size, males of the new species (SVL = 39.1–41.9 mm), differ from *Proceratophrys avelinoi* (23.9–29.2 mm), *P. boiei* (39.8–61.9 mm), *P. brauni* (30.0–34.6 mm), *P. laticeps* (59.5–78.0 mm), *P. moehringi* (59.2–62.6 mm), *P. moratoi* from the Municipality of Botucatu (25.8–31 mm) and Municipality of Itirapina (24.7–30.9 mm), *P. palustris* (27.3–33.8 mm), *P. paviotti* (41.9–53.2 mm), *P. phyllostoma* (55.4 mm), *P. rondonae* (62.9 mm) and *P. tupinamba* (52.6–63.4 mm).

The new species differs from all congeneric species (except *P. moratoi*) by lacking a pair of sagittal crests of tubercles on dorsum (also absent in *P. moratoi*; present, but interrupted in the sacral region in *P. cururu*, and present from eyelids to coccyx in the other species). *Proceratophrys vielliardi* sp. nov. also differs from the members of the *P. boiei* species group (*P. appendiculata*, *P. boiei*, *P. laticeps*, *P. melanopogon*, *P. moehringi*, *P. paviotti*, *P. phyllostoma*, *P. renalis*, *P. rondonae*, *P. sanctaritae*, *P. subguttata* and *P. tupinamba*), by lacking palpebral appendages (short, multicuspidate in *P. rondonae* and long, horn-like in the other species of the group; also present, short, in *P. schirchi*) and from the members of the *P. bigibbosa* species group (*P. avelinoi*, *P. bigibbosa*, *P. brauni* and *P. palustris*) by lacking postocular swellings (well-developed and bulbous in *P. bigibbosa*, and more restrained in the other species of the group). From the members of its own group (*Proceratophrys cristiceps* species group), besides the features cited above in this section, the species described herein also differs from *P. concavitympanum* by the

absence of a skin depression defining the tympanic region (present in *P. concavitympanum*), from *P. goyana* by having rounded eyelids (triangular in *P. goyana*) and from *P. moratoi* by lacking a X-shaped stripe on dorsum (present in this species) and by having the zygomatic ramus of squamosal in sutural contact with maxilla (elongated, but not in contact with maxilla in *P. moratoi*).

The advertisement calls of *Proceratophrys vielliardi* **sp. nov.** differ from all calls described for the genus (*P. avelinoi*, *P. bigibbosa*, *P. boiei*, *P. brauni*, *P. convavitympanum*, *P. cristiceps*, *P. cururu*, *P. melanopogon*, *P. moehringi*, *P. moratoi*, *P. paviotii* and *P. sanctaritae*) by its unique structure: it consists of 9.1 (3–20) notes, each lasting 59.2 ms (40.2–84.7) and with 4–9 pulses; the last note is longer (170.2 ms; 83.9–304.2) and with more pulses (9–30) than the others. Calls described for all other species of the genus consist of a single note, longer and with more pulses than those of the new species; the most similar in duration are those of *P. moratoi* from Botucatu (State of São Paulo, southeastern Brazil), with duration of 206.8 ms (146–238) and 17.5 (12–20) pulses per note, almost 350% longer than the common notes of the new species, but similar to its last (longer) notes (nevertheless, these long notes are only emitted in the end of short-note sequences; the advertisement calls of *P. moratoi* have only one note type, which are not grouped in a multi-noted call structure). The dominant frequency of the calls of *P. vielliardi* **sp. nov.** presents an intermediate value for the genus (mean 1133.8 Hz; 1022–1291), the lower in *P. moehringi* (mean 450 Hz; 200–700) and the higher in *P. avelinoi* (mean 1600 Hz; 1050–2300); it is not distinguishable in frequency from the calls of *P. melanopogon* (mean 1179 Hz; 999–1274) and *P. sanctaritae* (mean 1130 Hz; 950–1290), probably due to their similarity in size; it is also not distinguishable from the dominant frequency of the calls of *P. moratoi* from Botucatu (mean 1348.7 Hz; 1153–1420) and Itirapina (mean 1342 Hz; 1174–1444), despite this species being around 30% smaller than *P. vielliardi* **sp. nov.** (nevertheless, the expected variation in frequency between the vocalizations of these species is observed in their lower frequency limit, around 900 Hz in *P. moratoi* versus 643.5 Hz in the new species).

**Description of holotype.** General aspect of body ovoid, stout and warty. Head wider than long, its length 33% and width 48% the SVL (descriptive statistics in table 1); snout rounded viewed from above, obtuse in profile; canthus rostralis barely distinct; loreal region slightly convex, almost plan; nostrils elliptic, slightly elevated, directed dorsolaterally, about midway between eyes and tip of snout; eyes large (39% head length), prominent, directed anterolaterally; eyelids oval and short, bordered by warts and without a horn-like appendage; interorbital distance about double of eye-nostril distance; a tubercular ridge present between eyes and nostrils; tympanum indistinct; no postocular swellings; vocal sac median, subgular. Dorsum and flanks covered by spherical or elliptical tubercles (each one covered by tiny horny granules), irregularly arranged and sized (0.2–2.0 mm), mainly along dorsum; no enlarged glands (temporal and/or parotoid); tubercular crests or ridges absent on dorsum; ventral surfaces also warty, tubercles circular and uniform in size. Forelimbs relatively short, stout; a ridge of 5–7 aligned and enlarged tubercles on ventrolateral surface of forearms; fingers with tubercular fringes on sides and dorsal surfaces wrinkled; webbing absent; no finger disks; inner and outer metacarpal tubercles well-developed; outer divided lengthwise; subarticular tubercles well-developed, nearly squared; supernumerary tubercles present, conical; no nuptial pad on thumb; lengths of fingers: IV<II<I<III. Hind limbs relatively short, stout; shank length 38.7% and thigh length 42.8% SVL; foot and thigh similar in size, slightly larger than shank; tibial gland absent; inner metatarsal tubercle enlarged, sickle-shaped, strongly keratinized, with a warty crest along its inner basis, extending to tarsus (3 enlarged tubercles just behind the inner metatarsal tubercle); outer metatarsal tubercle rounded, small; subarticular tubercles conical; supernumerary tubercles present, smaller and fewer than on hand; no enlarged disks on toes; webbing poorly developed; sides of toes fringed, dorsal surfaces wrinkled; lengths of toes: I<II<V<III<IV.

Internal oral features (paratype AAG-UFU 3207): toothed maxilla; tongue large, approximately half length free and notched posteriorly; vomerine teeth in two patches median to choanae; vocal slits present.

**Color of holotype.** In preservative (70% ethanol), dorsal background light brown, tending to gray in the flanks and to beige in the eyelids and behind head, with dark brown rounded marks, somewhat anastomosed to each other, scattered along the dorsum, flanks and top of head. Belly homogeneously light brown, almost beige. Throat with the same color pattern of belly in its proximal region; blackish brown in its distal portion. Alternated blackish brown and light brown bars on the sides of head and snout (below the nostrils). Dorsal surfaces of limbs with alternated light brown and blackish brown bars, the former tending to be duplicated; ventral surfaces with the same color pattern of belly. In life, the pattern was the same, but the background of dorsum and flanks were reddish brown. Eyes with golden, tending to bronze, iris; pupil black.



**FIGURE 2.** *Proceratophrys vielliardi* **sp. nov.**, adult male; holotype (ZUEC 16239). Above: dorsal view of head and ventral view of left hand. Underneath: lateral view of head; ventral view of left foot. Scale bar = 10 mm.



**FIGURE 3.** Adult male of *Proceratophrys vielliardi* **sp. nov.** in life; holotype (ZUEC 16239). SVL 41.1 mm.

**Variation.** In addition to a few morphometric differences (table 1), the only variation found within the type-series is in the adult female (AAG-UFU 4361), which is 11% larger than the holotype and 13% larger than the male paratopotypes and also lacks vocal slits and black pigmentation on throat.

**TABLE 1.** Descriptive statistics of adult specimens of the type-series of *Proceratophrys vielliardi* **sp. nov.** from the Parque Estadual da Serra de Caldas Novas (PESCAN), Municipality of Caldas Novas, State of Goiás, Brazil. Mean  $\pm$  standard deviation (minimum–maximum). Measurements in millimeters.

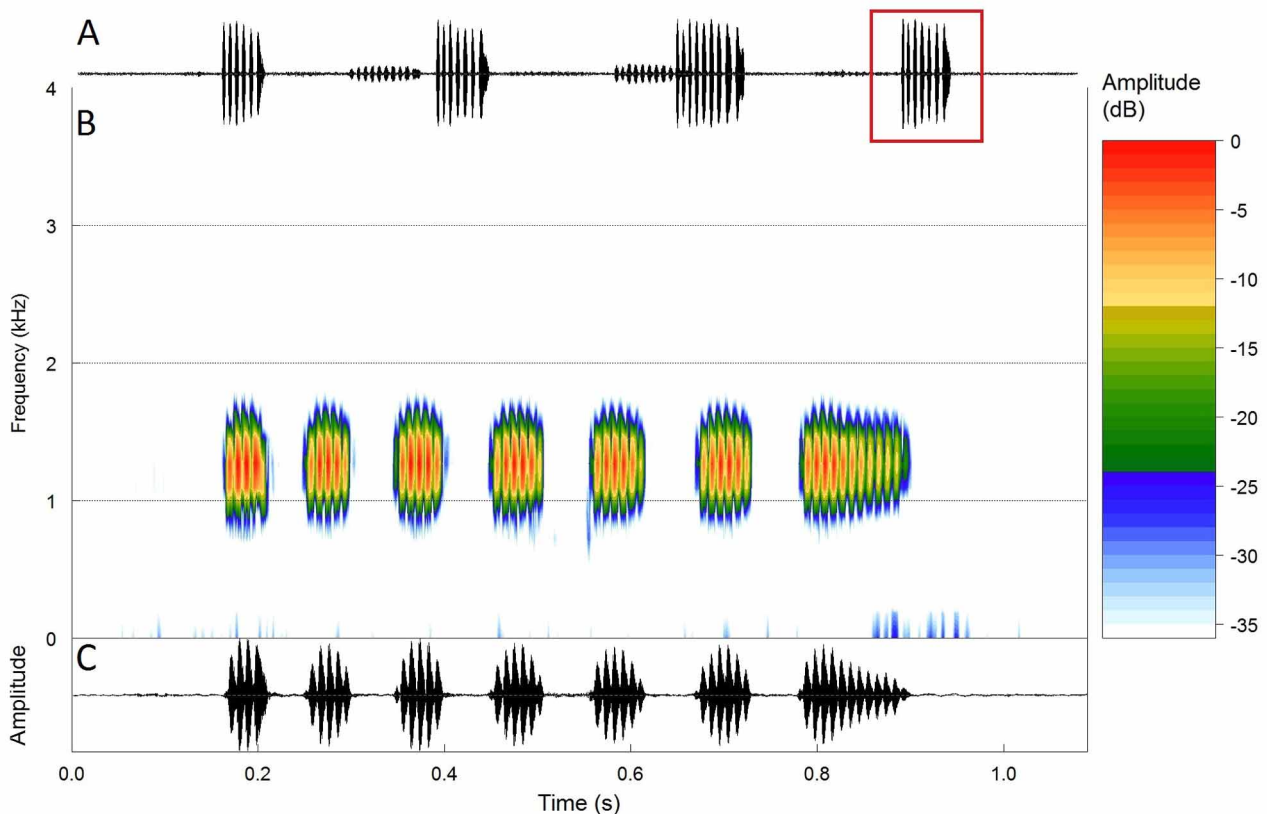
	Males (N = 8)	Female (N = 1)	Holotype
Snout-vent length	40.3 $\pm$ 1.1 (39.1–41.9)	45.5	41.1
Head width	18.0 $\pm$ 0.3 (17.5–18.4)	21.0	18.3
Head length	13.5 $\pm$ 0.4 (13.0–14.0)	14.8	13.5
Eye diameter	5.0 $\pm$ 0.2 (4.6–5.3)	5.5	5.3
Internarial distance	2.9 $\pm$ 0.3 (2.6–3.3)	3.3	3.0
Interorbital distance	6.9 $\pm$ 0.2 (6.5–7.2)	7.7	7.1
Eye-nostril distance	3.3 $\pm$ 0.3 (3.0–3.6)	3.8	3.4
Thigh length	16.8 $\pm$ 0.7 (15.7–17.6)	19.5	17.6
Shank length	15.4 $\pm$ 0.5 (14.4–16)	18.1	15.9
Foot length	17.4 $\pm$ 0.6 (16.2–18)	21.1	18.0
Hand length	11.5 $\pm$ 0.4 (10.8–12)	13.9	12.2

**Advertisement call** (table 2; figure 4): vocalizations were recorded from the type locality. Recorded males and other males heard (N > 30) called alone or in chorus, sometimes superposing their calls with those of the neighbors. Recorded advertisement calls (N = 35 calls; 4 males) are composed by 3–20 pulsed notes (one-noted calls were never heard), each note lasting 40.2–84.7 ms and with 4–9 pulses; the last note is longer (83.9–304.2 ms) and with more pulses (9–30) than the others. Within a note, pulses are not completely separated from each other; those in the beginning and ending are weaker in intensity than the pulses in the middle of the note. Only one frequency band is visible, ranging from 588–772 to 1468–1665 Hz, with dominant frequency around 1022–1291 Hz.

**TABLE 2.** Advertisement call parameters of *Proceratophrys vielliardi* **sp. nov.** from the Parque Estadual da Serra de Caldas Novas (PESCAN), Municipality of Caldas Novas, State of Goiás, Brazil. N = 35 calls, 4 males. Std. Dev. = Standard Deviation.

Parameters	Values		
	Mean	Std. Dev.	Range
Dominant frequency (Hz)	1133.8	93.3	1022.0–1291.0
Lowest frequency limit (Hz)	643.5	73.8	588.0–772.0
Highest frequency limit (Hz)	1622.9	45.8	1468.0–1665.0
Call duration (ms)	992.5	536.6	237.8–2127.6
Notes per call	9.1	5.0	3.0–20.0
Note duration (ms)	59.2	8.3	40.2–84.7
Last note duration (ms)	170.2	46.9	83.9–304.2
Pulses per note	6.4	0.9	4.0–9.0
Pulses per last note	17.8	4.5	9.0–30.0
Pulse duration (ms)	8.8	0.5	7.5–9.6
Pulses per second	107.7	6.2	95.6–118.8
Notes per minute	118.8	69.7	42.0–202.0
Calls per minute	15.8	5.1	10.0–24.0
Inter-note break (ms)	44.8	7.8	30.4–60.2
Inter-call break (s)	3.2	1.9	1.0–10.6

Temperatures: air = 20.8–23.8 °C; water = 24.0–24.7 °C.



**FIGURE 4.** A. waveform section (15s) showing four advertisement calls (plus two calls of a background male) of *Proceratophrys vielliardi* **sp. nov.**, from the Municipality of Caldas Novas, State of Goiás, Brazil; the call marked with the square is detailed in B (audiospectrogram) and C (waveform). Air temperature = 20.8°C; water temperature = 24.7°C. 22:00h; 10 December 2004.

**Natural history.** The new species occurs in open areas of the Cerrado biome (Brazilian savannahs); specimens were found calling at night after rains in summer months (November/December), along small (30 cm wide, 0–40 cm deep) seasonal rocky brooks. Four pairs were observed (3:00h) while egg laying. The couples moved around scattering egg groups in an area of about 30 cm diameter. With half body submerged, the females prepared the place of egg-laying by digging sandy mud of the bottom. Egg groups were completely buried after the couple leaved the egg releasing point. Syntopic species include *Leptodactylus syphax* Bokermann, *L. furnarius* Sazima and Bokermann, *L. labyrinthicus* (Spix), *Pseudopaludicola* aff. *saltica* (Cope) and *Ameerega flavopicta* (Lutz). Other *Proceratophrys* species known in the area (PESCAN) is *P. goyana*, which is restricted to forested environments.

**Geographic distribution.** *Proceratophrys vielliardi* **sp. nov.** is only known from its type locality, the Parque Estadual da Serra de Caldas Novas (PESCAN), Municipality of Caldas Novas, State of Goiás, Brazil.

**Etymology.** The new species is named in honor to the recently deceased ornithologist Dr. Jacques Marie Edme Vielliard (1944–2010), who worked extensively on the bioacoustics of Brazilian fauna, including frogs (e.g. Cardoso & Vielliard 1990; Vielliard & Cardoso 1996). Ariovaldo A. Giaretta is especially sorry for his death, by the loss of his former teacher and a friend.

### Taxonomic remarks

Lynch (1971) differentiated the genera *Proceratophrys* and *Odontophrynus* based mainly on osteological features and by the first four morphological characters presented in our diagnosis. Savage and Cei (1965) also called attention to the smooth dorsal surface of fingers in *Odontophrynus* (wrinkled in the species described herein). Prado and Pombal (2008), revising the *P. boiei* species group, stated two of the osteological features proposed by Lynch (1971) as still valid characters to the diagnosis of the genus *Proceratophrys*: zygomatic ramus of squamosal broad and elongate, in sutural contact with maxilla, and the cervical cotylar arrangement type II (cotyles closely approximated); both features are present in *Proceratophrys vielliardi* **sp. nov.**

The descriptions of *Odontophrynus moratoi* and *O. salvatori* (Jim & Caramaschi 1980; Caramaschi 1996, respectively), made the differentiation between *Proceratophrys* and *Odontophrynus* less clear, since these species showed a composite of features of both genera; nevertheless, as already cited by Caramaschi (1996), external morphological features of both species are more compatible with *Proceratophrys*. With the allocation of *O. moratoi* in *Proceratophrys* based on molecular data, and the suggestion that the same could be valid to *O. salvatori* (Amaro *et al.* 2009), we think the generic diagnosis cited by us remains valid for *Proceratophrys*, and *O. salvatori* still needs a generic revision.

The only species of *Proceratophrys* described from central Brazil is *P. goyana*, which seems to be restricted to gallery forests (Brandão & Araújo 2001; Bastos *et al.* 2003; Giaretta *et al.* 2008), whereas the new species inhabits open rocky areas. *Proceratophrys goyana* has triangular eyelids and well-defined sagittal crests from eyelids to coccyx, a feature absent in the species described herein. Nonetheless, we have collected adult specimens of *Proceratophrys* from the Municipality of Araguari (State of Minas Gerais) that are in agreement with the description of *P. goyana*, but they are considerably larger (SVL = 38.1±1.9; 34.7–39.5 mm; N = 5) than those of the original description (SVL = 26 mm; Miranda-Ribeiro, 1937). We have also collected specimens of *Proceratophrys* from the Municipality of Uberlândia (State of Minas Gerais) (see Araújo *et al.* 2007a,b; Martins and Giaretta 2008), which resembles *P. moratoi* in advertisement call, external morphology and color pattern. All these findings suggest that the richness of *Proceratophrys* species in the Brazilian savannahs (Cerrado biome) is still underestimated. A detailed redescription of *P. goyana* and a broader taxonomic analysis of the known populations are needed to clarify how many species of *Proceratophrys* really occur in this region of Brazil.

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#### APPENDIX 1. Additional examined specimens.

- Odontophrynus americanus*: Brazil, State of Minas Gerais — AAG-UFU 4384–4386 (Municipality of Poços de Caldas). *Odontophrynus carvalhoi*: Brazil, State of Bahia — ZUEC 4029 (Municipality of Maracás); State of Paraíba — ZUEC 8762 (Municipality of Teixeira). *Odontophrynus cultripes*: Brazil, State of Minas Gerais — AAG-UFU 2689, 2690 (Municipality of Perdizes), 2969, 4169 (Municipality of Uberlândia). *Proceratophrys appendiculata*: Brazil, State of São Paulo — CFBH 5414 (Municipality of Ubatuba), 8062 (Municipality of São Luis do Paraitinga), 10752 (Municipality of Cunha). *Proceratophrys avelinoi*: Brazil, State of Paraná — ZUEC 8936 (Municipality of Londrina), 11549 (Municipality of Dois Vizinhos). *Proceratophrys bigibbosa*: Brazil, State of Rio Grande do Sul — ZUEC 10405, 10406 (Municipality of São Francisco de Paula). *Proceratophrys boiei*: Brazil, State of Espírito Santo — CFBH 10812 (Municipality of Domingos Martins); State of São Paulo — CFBH 22266 (Municipality of Piedade). *Proceratophrys concavitympanum*: Brazil, State of Mato Grosso — ZUEC 14874–14876, 16015 (Municipality of Paranaíta). *Proceratophrys cururu*: Brazil, State of Minas Gerais — ZUEC 1649, 4113, 9556, 9559 (paratypes; Serra do Cipó mountain range).
- Proceratophrys cristiceps*: Brazil, State of Paraíba — ZUEC 14388 (Municipality of São José do Bonfim), 8765–68 (Municipality of Teixeira). *Proceratophrys goyana*: Brazil, State of Minas Gerais — AAG-UFU 3102, 3103, 3209–3211 (Municipality of Araguari), 4174 (Municipality of Monte Alegre); State of Tocantins — CFBH 22065, 22066 (Municipality of Taguatinga); State of Goiás — CFBH 26086 (Municipality of Palmeiras de Goiás). *Proceratophrys* cf. *moratoi*: Brazil, State of Minas Gerais — AAG-UFU 3762–3847 (Municipality of Uberlândia). *Proceratophrys moratoi*: Brazil, State of São Paulo — ZUEC 7031–7033 (Municipality of Botucatu). *Proceratophrys palustris*: Brazil, State of Minas Gerais — AAG-UFU 4819, 4820 (Municipality of Poços de Caldas). *Proceratophrys schirchi*: Brazil, State of Espírito Santo — CFBH 23720–23723 (Municipality of Cariacica).