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A new species of *Adelophryne* (Anura: Eleutherodactylidae) from the Atlantic Forest, southeastern Brazil

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Abstract. We describe a new species of *Adelophryne* from the Parque Municipal da Lajinha in Juiz de Fora, Minas Gerais state, southeast Brazil, constituting the southernmost record of the genus. *Adelophryne meridionalis* sp. n. is differentiated from other *Adelophryne* mainly by the presence of only two phalanges in finger IV, finger I being smaller than or equal to finger IV in dorsal view, and by having the terminal phalanges of its toes less developed. This new species is probably related to *A. pachydactyla* given that (1) both species have only two phalanges in Finger IV, and (2) a phylogenetic study demonstrated that *A. pachydactyla* belongs to a Southern Atlantic Forest clade along with at least three undescribed species.

Key words. Amphibia, Phyzelaphryninae, *Adelophryne meridionalis* sp. n., Atlantic Forest, Minas Gerais, taxonomy, Terrarana.

Introduction

The genus *Adelophryne* Hoogmoed & Lescure, 1984 has a discontinuous distribution in eastern Brazil, the Guiana Shield, and the upper Amazon Basin (Hedges et al. 2008). These minute eleutherodactylid frogs are mainly distinguished by their small size, typically SVL < 20 mm, and unwebbed digits with pointed tips. They are poorly known, and their taxonomy is confused. The genus was erected by Hoogmoed & Lescure (1984) when they defined two Amazonian species (*A. adiastola* and *A. gutturosa*) from northern South America. Thereafter, Hoogmoed et al. (1994) described three additional Brazilian species, *A. baturitensis* and *A. maranguapensis* from isolated Atlantic Forest areas in the state of Ceará, and *A. pachydactyla* from southern Bahia state. More recently, two more species were described: *A. patamona* from the Amazonian region of Guyana (MacCulloch et al. 2008), and *A. mucronatus* from the Atlantic Forest of southern Bahia state, northeastern Brazil (Lourenço-de-Moraes et al. 2012).

Recently, Fouquet et al. (2012) provided a phylogenetic study of the Phyzelaphryninae, revealing an unexpected diversity of these frogs, but also corroborating the monophyly of the group. Besides the current taxonomy, with seven *Adelophryne* species described, Fouquet et al. (2012) found additional seven candidate species, apparently unnamed until now.

During an anuran monitoring exercise in an urban Atlantic Forest fragment in southeast Minas Gerais state, several individuals of a new species of *Adelophryne* were collected. Here we describe this new species and comment on its distribution.

Material and methods

The specimens collected for examination were fixed in formalin and preserved in ethanol. Specimens of species used for comparisons are specified in Appendix 1. Our taxonomy follows Hedges et al. (2008), while the descriptions and measurements follow those in Hoogmoed & Lescure (1984): snout–vent length (SVL); head length (HL); head width (HW); internarial distance (IND); tibia length (TIBIA); interorbital distance (IOD); eyelid width (EW); eye length (EL); and eye-tip snout distance (ETS). To number the fingers, we used the widespread and standardized nomenclature used in most anuran publications, from I–IV. The following collections and acronyms are referred to in the text: Coleção Herpetológica/Anfíbios da Universidade Federal de Juiz de Fora (CAUFJF); Museu de Zoologia da Universidade Federal da Bahia (UFBA); Coleção Herpetológica da Universidade Federal do Ceará (UFC); Museu de História Natural Prof. Adão José Cardoso, Universidade Estadual de Campinas (ZUEC); and Museu de Zoologia João Moojen, Universidade Federal

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de Viçosa (MZUFV). Geographical coordinates were obtained with a GPS receiver (WGS84 datum).

Given the small size of the new species and the absence of external secondary sexual characters or noticeable vocal sacs or slits, we were unable to determine the sexes of our specimens of the new species. Therefore, we preferred to leave ambiguous the sex of the specimens, having decided against the use of invasive procedures that would have been to the detriment of the preserved specimens of the type-series, as suggested by Napoli et al. (2011).

Results

Adelophryne meridionalis sp. n.

Figs. 1–2

Holotype: MZUFV 12625, an adult specimen, from the Parque Municipal da Lajinha (21°47'32"S, 43°22'38", ca. 880 m a.s.l.), Juiz de Fora, Minas Gerais state, Brazil, collected on 22 December 2008 by Celso H.V. Rios.

Paratopotypes: CAUFJF 834, adult specimen, collected on 14 November 2006 by Cecília M.F.R. Magalhães, CAUFJF 838, 783 and MZUFV 12626 adult specimens, collected on 7 November 2008 by Celso H.V. Rios. CAUFJF 835–836, adult specimens, collected on 22 December 2008 by Celso H.V. Rios. CAUFJF 871, adult specimen, collected on 28 January 2009 by Celso H.V. Rios.

Diagnosis: A minute frog characterized by its (1) small adult size (maximum SVL < 11 mm), (2) indistinct tympanum, (3) two phalanges in Finger IV, (4) finger I smaller than or equal to finger IV in dorsal view, (4) terminal phalanges of toes not developed (except toe IV), approximately the same width as the other phalanges, (5) skin on back smooth.

Comparison with other species: *A. meridionalis* can be distinguished from *A. baturitensis*, *A. maranguapensis*, *A. patamona, A. gutturosa* and *A. mucronatus* by having two phalanges in Finger IV (three phalanges in *A. baturitensis*, *A. maranguapensis*, *A. patamona*, *A. gutturosa* and *A. mucronatus*). *A. meridionalis* can be distinguished from *A. baturitensis*, *A. maranguapensis* and *A. mucronatus* by the absence of a visible tympanum (presence of a visible tympanum in *A. baturitensis*, *A. maranguapensis* and *A. mucronatus*), plus, *A. meridionalis* can be distinguished from *A. mucronatus* by the absence of an anal flap (anal flap present in *A. mucronatus*). *A. meridionalis* can be distinguished from *A. adiastola* by the smooth dorsal skin (dorsal skin shagreened to granular in *A. adiastola*), and by its smaller size (SVL 8.97–10.87 in *A. meridionalis*, SVL 13.0–13.9 in *A. adiastola*). *A. meridionalis* can be distinguished from *A. pachydactyla* by the tips of fingers I, II and IV being pointed (tips of fingers I, II and IV bluntly pointed in *A. pachydactyla*), by the tip of finger III being symmetrically pointed (tip of finger III asymmetrically pointed in *A. pachydactyla*), and by the terminal phalanges of the toes not being developed (except toe IV) and approximately the same width as other phalanges (terminal phalanges of all toes distinct, cambered, larger than the other phalanges in *A. pachydactyla*).

Description of the holotype: An adult specimen, 10.12 mm SVL, head slightly longer than wide, as wide as the adjacent part of the body, head width 85.55% of depth. Snout rounded in dorsal and lateral profiles. Distance between snout tip and eye slightly less than eye diameter. Eye–nostril distance approximately the same as internarial distance. Distance between eye and nostril 45.52% of the internarial distance, generally different from the distance between nostril and tip of snout, about 50% of the distance between eye and tip of snout. Canthus rostralis rounded, straight; loreal region sloping steeply to the upper lips. Lips not flaring. Nostrils

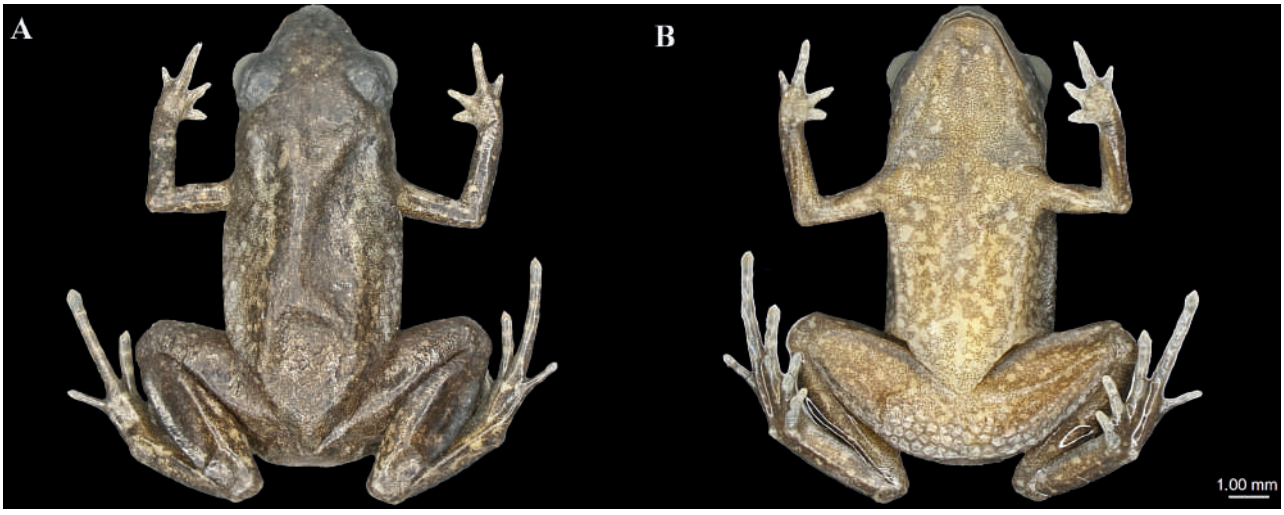

Figure 1. *Adelophryne meridionalis* sp. n., (A) dorsal and (B) ventral views of holotype, MZUFV 12625, adult, SVL 10.87 mm.

directed laterally, not projecting, with rounded opening, visible in dorsal view. Internarial distance slightly less (98%) than the interorbital distance. Interorbital space 2.04 times as wide as upper eyelid, slightly convex. Boundary between head and body undistinguished, tympanum indistinct. Absence of a supratympanic fold. Glandules on body indistinct. Choanae round, placed posterolaterally; prevomerine processes small, transverse, at some distance posterior to the choanae (with 3–8 teeth). Tongue narrow, slightly expanding posteriorly, expanded posterior part not notched behind; completely free, except for its anterior margin. We did not observe vocal slits or a vocal sac. Dorsal skin, venter, throat and limbs smooth. Cloacal opening positioned at mid-level of thighs, no dorsal flap, directed posteriorly.

Measurements: SVL 10.87; HW 3.67; HL 4.29; IND 1.48; TIBIA 4.88; IOD 1.51; EW 0.94; EL 1.33; ETS 1.47.

In life, dorsum brown with a dark brown tracing resembling an hourglass, beginning at the base of the head, covering entire dorsum. The arms have the same brown colouration as the dorsum, and the legs are brown, slightly lighter. Many irregular white and blue dots are visible all over the dorsum and posterior faces of the members. The belly is white-brown, with irregular lighter spots (Fig. 3).

In preservative, variation and colour changes are minor. The blue dots and the eyes turn white, and the general colouration becomes more opaque.

Variation: Our specimens are congruent with respect to their external morphological characteristics, and variation in colouration across individuals was relatively homogenous. The measurements of the adult paratopotypes are provided in Table 1.

Etymology: The specific epithet is derived from Latin and means "southern". It makes reference to the southern-most record known for a species of the genus *Adelophryne*.

Geographic distribution: The new species is currently known only from the type locality, Parque Municipal da Lajinha, Juiz de Fora, Minas Gerais state, Brazil (Fig. 4). *Adelophryne meridionalis* is the fourth species of the genus described from eastern Brazil. The other three named species occur in the Amazon region.

Habitat and natural history: The Parque Municipal da Lajinha, located in the municipality of Juiz de Fora, Zona da Mata, state of Minas Gerais, is a tropical semi-deciduous Atlantic Forest fragment enclave in an otherwise urban area (Fig. 5). The park is managed by the Agência de Gestão Ambiental de Juiz de Fora (AGENDA JF), encompasses 80 ha, and reaches altitudes of 800 to 900 m above sea level. All individuals of *Adelophryne meridionalis* were found between November and January. The site is about

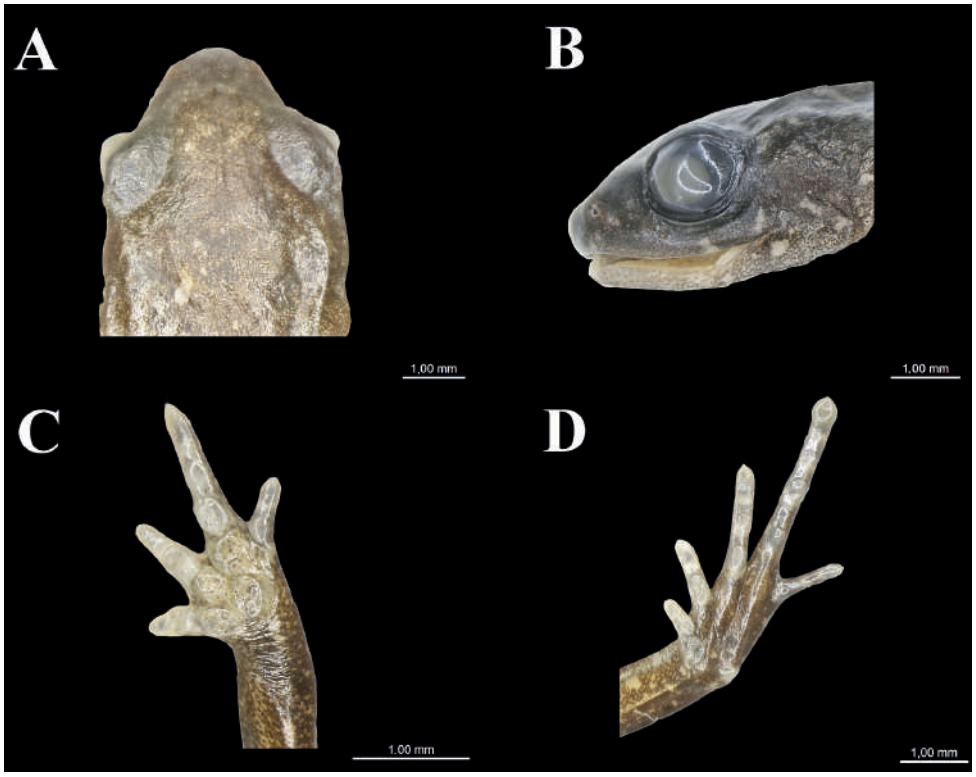

Figure 2. Holotype of *Adelophryne meridionalis* sp. n., MZUFV 12625, adult specimen. Dorsal (A) and lateral (B) views of head; ventral views of hand (C) and foot (D).

Table 1. Measurements (in millimetres) of adult specimens of the type series of *Adelophryne meridionalis* sp. n., from the Parque Municipal da Lajinha (type locality), municipality of Juiz de Fora, state of Minas Gerais, Brazil (abbreviations and acronyms used are deciphered in the Material and methods section). * holotype.

Voucher	SVL	HW	HL	IND	TIBIA	IOD	EW	EL	ETS
CAUFJF783	9.38	3.27	3.66	1.34	4.49	1.35	0.70	1.12	1.35
CAUFJF834	8.97	3.37	3.83	1.41	3.15	1.45	0.85	1.06	1.23
CAUFJF835	10.12	3.46	4.06	1.52	4.51	1.51	0.77	1.45	1.37
CAUFJF836	10.25	3.62	4.17	1.58	4.75	1.42	0.77	1.33	1.43
CAUFJF838	9.66	3.00	3.92	1.38	4.54	1.27	0.69	1.19	1.40
MZUFV12625*	10.87	3.67	4.29	1.48	4.88	1.51	0.94	1.33	1.47
MZUFV12626	9.73	3.30	3.79	1.39	4.46	1.30	0.63	1.18	1.26

150 m from a permanent stream at the forest fragment's edge. Researchers have been monitoring the anuran fauna of the area for seven years, with visual encounter surveys and audio strip transects. However, all individuals were collected with funnel traps, evidencing the secretive habits of the species (Heyer et al. 1994).

Discussion

Despite recent efforts in documenting diversity and relationships among terrarana (Hedges et al. 2008), and amphibians in general (Pyron & Wiens et al. 2011), much ambiguity has remained about the monophyly of *Adelophryne*.

Figure 3. Dorsal view of a live adult specimen of *Adelophryne meridionalis* sp. n. from the type locality (unvouchered specimen).

Recently, Fouquet et al. (2012) provided a molecular-based phylogeny of the Phyzelaphryninae, corroborating its monophyly as well as the monophylies of *Adelophryne* and *Phyzelaphryne.* This study also revealed deep subdivisions within both genera, with three major clades in *Adelophryne* and several cryptic species that represent an unexpected diversity. The three major clades found by Fouquet et al. (2012) are the: North Amazonian Clade (*A. adiastola*, *A. gutturosa*, *A. patamona*, and *A.* sp. 7), North Atlantic Rain Forest Clade (*A. maranguapensis*, *A. baturitensis*, *A.* sp. 1, *A.* sp. 2, *A.* sp. 3) with nominal species within these two groups having three phalanges in finger IV, and South Forest Atlantic Clade (*A. pachydactyla*, *A.* sp. 4, *A.* sp. 5, *A.* sp. 6) with *A. pachydactyla* having been documented to have only two phalanges (Hoogmoed et al. 1994). Fouquet et al. (2012) did not provide morphological diagnoses for the three major clades of *Adelophryne,* though. Nevertheless, we suggest here that the reduction in the number of phalanges in finger IV could represent a synapomorphy of the South Atlantic Forest clade.

Given (1) the similar reduction in phalange numbers in finger IV for *A. pachydactyla* and *A. meridionalis* and (2) the geographical range of *A. meridionalis*, we assume the new species to belong to the South Atlantic Forest Clade. In fact, its proximity in occurrence to populations of *A.* sp. 5 in Minais Gerais (Mariana, Serra do Cipo and Parque Estadual do Rio Doce) suggests they could represent the same species.

However, the recently described *Adelophryne mucronatus* (Lourenço-de-Moraes et al. 2012) inform the Atlantic Forest of southern Bahia (in sympatry with *A. pachydactyla*) is a species with three phalanges in finger IV, and might therefore represent *A.* sp. 2 or *A.* sp. 3 of Fouquet et al. (2012) that are related to *A. maranguapensis* and *A. baturitensis*. Our new species represents the southern-most record for the genus. Fouquet et al. (2012) emphasized that the documented record of *A.* cf. *pachydactyla* from Espírito Santo, Brazil, by Almeida et al. (2011) deserved special attention, as it could refer to an additional candidate species. This record is also relatively close to the documented population of *A.* sp. 5 of Fouquet et al. (2012) and the new species described herein. However, given the differences in morphoclimatic conditions and the associated

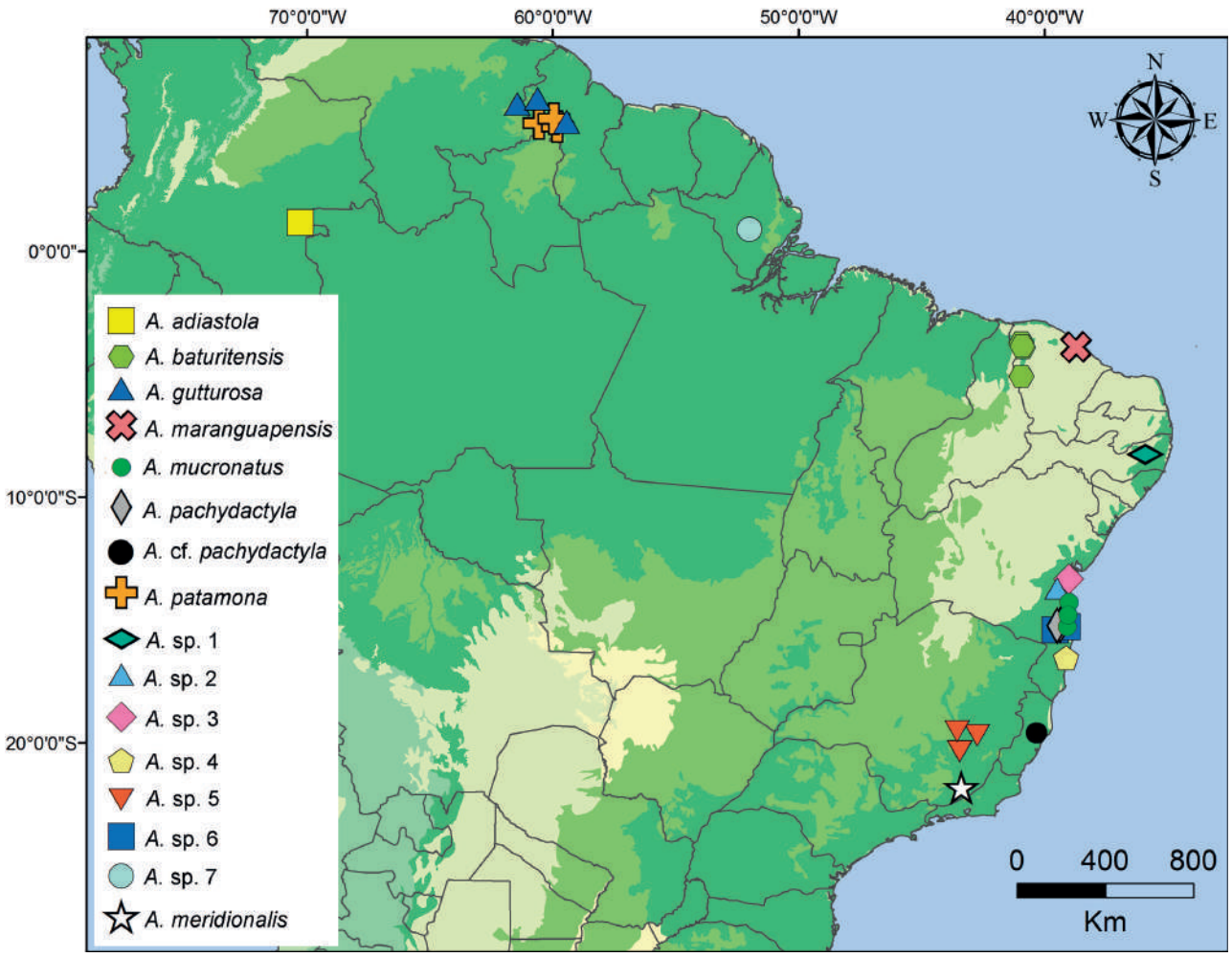

Figure 4. Map showing the approximate known distribution of the genus *Adelophryne* in South America (modified after Fouquet et al. 2012). Candidate species of *Adelophryne* (sp. 1–7) refer to those identified by Fouquet et al. (2012).

Figure 5. Habitat at the type locality of *Adelophryne meridionalis* sp. n. in the Lajinha Municipal Park, Juiz de Fora, Minas Gerais, Brazil.

fauna and flora between the coastal mountains of ES and the semi-deciduous forest of Juiz de Fora as well as the picture provided by Almeida et al (2011), we can rule out the possibility that these populations are conspecific.

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Appendix 1
Additional species examined

Adelophryne baturitensis: BRAZIL: State of Ceará, municipality of Pacoti, Florestinha, Serra do Baturité (CHUFC A3676–3688, A3714, A3728, A3955, topotypes).

Adelophryne maranguapensis: BRAZIL: State of Ceará, municipality of Maranguape, Serra de Maranguape (CHUFC A3919, A3921–3922, topotypes).

Adelophryne meridionalis: BRAZIL: state of Minas Gerais, municipality of Juiz de Fora, Parque Municipal da Lajinha (CAUFJF 784, 966–967, 871, 978, 980–981, 1137–1138).

Adelophryne pachydactyla: BRAZIL: State of Bahia, municipality of Amargosa (MZUFBA 6507–6509); municipality of Itacaré, RPPN Capitão (ZUEC 18213).