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Distribution, natural history, and morphology of the rare snake, *Caaeteboia amarali* (Serpentes: Dipsadidae)

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The monotypic genus *Caaeteboia* was recently described to accommodate *Liophis amarali* Wettstein, 1930 (Zaher et al. 2009). This species is a small-sized, aglyphous, and oviparous snake with a small body size and moderately long tail. *Caaeteboia amarali* is diurnal, has a diet consisting of frogs, and exhibits dorsal flattening and cloacal evacuation as defensive behaviours (Marques et al. 2001). It is endemic to the Brazilian Atlantic Forest domain, occurring in coastal lowlands of the states of Bahia, São Paulo, Paraná, and Santa Catarina with an additional isolated record from the state of Minas Gerais (Wettstein 1930, Peters & Orejas-Miranda 1970, Bérnils et al. 2004).

The type locality was given as Belo Horizonte in the state of Minas Gerais, which is located at the western limit of the Atlantic Forest domain (sensu Ab'Sáber 1977). However, Moura-Leite (2001) expressed doubts about the provenance of the holotype because it is the only record amongst fifteen known localities lying outside the coastal lowlands of eastern Brazil (see below). Despite the wide distribution of *C. amarali*, a geographical gap of about 715 km (airline) exists between Jussari (15°12'S, 39°32'W) in the state of Bahia (Argôlo 2009) and Belo Horizonte (19°56'S, 44°03'W) in the state of Minas Gerais (Wettstein 1930), and about 430 km between Belo Horizonte and Caraguatatuba (23°37'S, 45°25'W) in the state of São Paulo (Marques et al. 2009). On the other hand, if the type locality record were in error, then the geographical gap in the species' distribution would amount to about 1130 km between Jussari and Caraguatatuba.

Caaeteboia amarali is scarcely represented in herpetological collections and, to date, no more than fifteen specimens have been reported in the literature (Wettstein 1930, Marques et al. 2001, Moura-Leite 2001, Bérnils et al. 2004, Morato 2005, Sena 2007, Argôlo 2009, Marques et al. 2009). Due to this apparent rarity, Marques et al. (2009) considered the species as threatened in the faunal list of the state of São Paulo, Brazil. Besides the known vouchered records of *C. amarali* (Wettstein 1930, Moura-Leite 2001, Argôlo 2009, Marques et al. 2009) and general biological (Marques et al. 2001) and morphological (Wettstein 1930, Zaher et al. 2009) information about this species, virtually no data exists on morphological variability within the species. The hemipenis of *C. amarali* was briefly described by Zaher et al. (2009), but the organ was not illustrated, for which reason certain details should be added to its general morphology. Furthermore, most records of, and data for, *C. amarali* are available only in unpublished dissertations and theses (Moura-Leite 2001, Morato 2005, Sena 2007, Argôlo 2009, Bérnils 2009).

Distribution and natural history

Herein, we report on the 16th and 17th vouchered specimens of *C. amarali,* inventoried in the Museu Biológico Mello Leitão (MBML 56), collected in December 1997, from the Reserva Biológica de Sooretama (19°11'S, 40°05'W), municipality of Linhares, state of Espírito Santo, and in the Instituto Butantan (IBSP 67331), from the municipality of Búzios (22°50'S, 42°00'W), state of Rio de Janeiro, respectively; both localities are in the lowlands of southeastern Brazil. These records fill a gap of about 410 km from the municipality of Belo Horizonte, state of Minas Gerais, east of Sooretama; 400 km from Jussari, state of Bahia, southwest of Sooretama; about 450 km from Sooretama southwest of Búzios; and about 380 km from Búzios southwest of Caraguatatuba (Fig. 1). Based on these new records, the distribution of *C. amarali* no longer appears to be disjunct, contradicting earlier impressions (Bérnils et al. 2004).

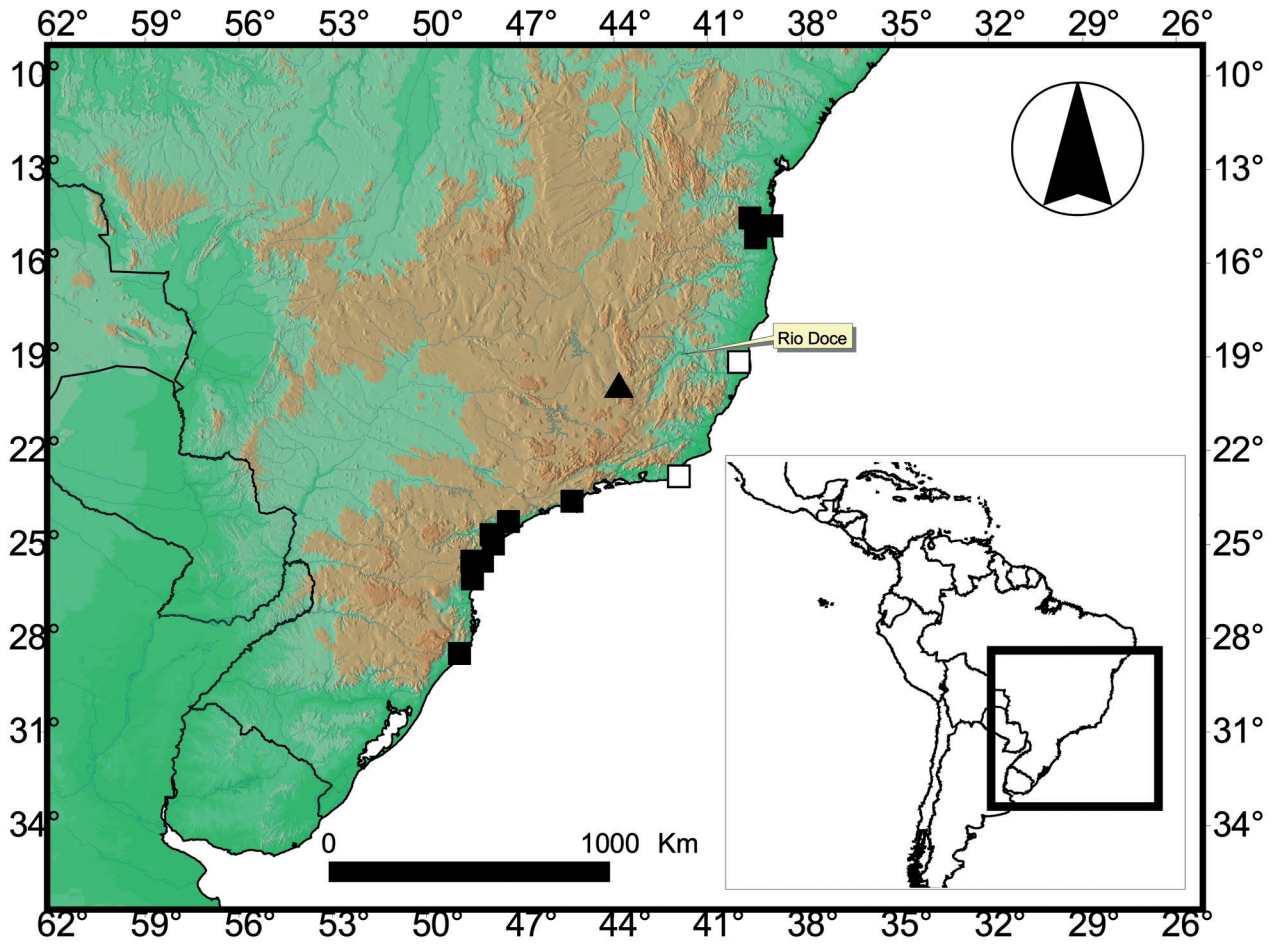

Figure 1. Known distribution of *Caaeteboia amarali*. Open squares represent the new records and the triangle denotes the type locality of the species. Literature records (solid squares) refer to the following sources: Argôlo (2009): municipalities of Ilhéus, Jussari and Uruçuca, all in the state of Bahia; Marques et al. (2009): municipalities of Caraguatatuba, Cananéia, Jacupiranga and Miracatu, all in the state of São Paulo; Bernils et al. (2004): municipalities of Itapoá and Tubarão (Santa Luzia), in the state of Santa Catarina and Paranaguá (Alexandra and Ilha do Mel), in the state of Paraná.

This species is still poorly represented in herpetological collections, whether owing to its apparent rarity in nature, or because of undersampling as a result of its secretive habits.

Both individuals reported here are adult males, with MBML 56 having a snout–vent length (SVL) of 386 and a caudal length (CL) of 188 mm, and IBSP 67331 with an SVL of 341 and a CL of 172 mm. IBSP 67331 was collected on 5 July 2006 by Claudia Maria de Carvalho Barros. This snake was active in an urban area near a secondary Atlantic Forest remnant and contained an adult male *Hemidactylus mabouia* (Moreau de Jonnès, 1818) in its stomach. The prey item, which had an SVL of 77 mm and a tail length of 55+ mm, had been ingested headfirst and was partially digested. MBML 56, which lacked specific collection data, contained in its stomach remains of *Dendropsophus sencilus* (Cope, 1868) including a right forelimb (hand, radius, ulna, and partially digested humerus) and four partially digested vertebrae. Using the measurements of the hand plus those of the forelimb (16.8 mm), we estimated the SVL of the prey specimen by means of linear regression (Hirai & Matsui 2001) to be 34.3 mm, based on 33 adult individuals (12 from RPPN Serra do Caraça, municipality of Catas Altas, state of Minas Gerais and 21 from Reserva da Vale, municipality of Linhares, state of Espírito Santo) housed in the Museu Nacional (MNRJ). The sex of the prey cannot be accurately determined on the basis of the forearm length and SVL estimations, but we believe it was an adult male because the SVL ranges for adults of *D. seniculus* are 36–43 mm for females and 29–43 mm for males (Lutz 1973).

The widespread alien species *H. mabouia* is frequently associated with human habitations and it is well known that these lizards utilize areas around artificial light sources as hunting grounds (Howard et al. 2001). However, individuals of *H. mabouia* also use bromeliads, rocks, trees, fallen trunks and branches of forested regions as substrates (Carvalho et al. 2007). Howard et al. (2001) found that the mean perch height for individuals with SVL > 40 mm

(subadults and adults) was significantly greater than the mean for specimens with SVL < 40 mm (juveniles). Furthermore, these authors showed that the time of activity was positively correlated with size, indicating that larger individuals are more likely to remain active throughout the night. Small individuals appeared to limit their activity almost entirely to the evening hours before midnight when temperatures were higher (Howard et al. 2001).

The treefrog *D. seniculus* is a nocturnal (vocalizing between 20.00 to 04.00 h; Abrunhosa 2005), opportunistic explosive breeder (Bertoluci 1998, Abrunhosa et al. 2007), with a distribution ranging from Porto Seguro in the State of Bahia, south to Guaraqueçaba in the State of Paraná and west to Catas Altas in the State of Minas Gerais in the Atlantic Forest domain (Canelas & Bertoluci 2007, Conte et al. 2009). These frogs occur in temporary and permanent ponds at forest edges, usually associated with shrubs and trees near marshy patches, and their breeding season extends from September to January (Bertoluci 1998, Prado & Pombal 2005, Abrunhosa et al. 2007, Conte et al. 2009). Bokermann (1966) observed reproductive males active on shrubs during dry nights and underground during rainy nights. Conte et al. (2009) found about 30 calling males perched between 0.4 to 1.40 m above the ground.

Marques et al. (2001) consider *C. amarali* a diurnal and terrestrial species that feeds on frogs. Despite the presence of a round pupil in *C. amarali*, the natural history features of its prey species suggest that *C. amarali* might also be active in the twilight and forage in an arboreal environment in which adults of *Hemidactylus mabouia* and *Dendropsophus seniculus* are usually active. Although the possibility exists that individuals of *C. amarali* might locate both prey species in shelters on the ground (see Vanzolini et al. 1980 for microhabitat data of the *H. mabouia*), the relative eye size (more than twice as high than the distance of the eye to the labial border), tail length (about 50% of SVL), and the laterally compressed anterior region of the body of *C. amarali* suggest arboreal foraging habits for this species. Among the scant amount of data available with respect to this species' habitat, there is one record of a specimen that was donated by local people from an arboreal Restinga in the municipality of Cananéia, state of São Paulo, Brazil (Sena 2007).

Morphometrics and scalation

Detailed morphological data for IBSP 67331 cannot be provided because it was probably lost during the tragic fire that occurred in the Instituto Butantan on 15 May 2010. Morphological data for MBML 56 are as follows: SVL 386 mm; CL 188 mm (49% SVL); body diameter 5.2 mm (1.6% SVL); head length 13.6 mm (3.5% SVL); head width 6.1 mm (45% head length); cervical constriction distinct; interorbital distance 4.3 mm; rostro–orbital distance 3.6 mm (84% interorbital distance); naso–orbital distance 2.8 mm; distance between ventral margin of eye to labial border 0.8 mm; head flattened in lateral view, rounded in dorsal view; canthus rostralis distinct in lateral view; snout truncate in lateral and dorsal views; rostral sub-triangular, 2.0 mm wide, 1.1 mm high, well visible in dorsal view; internasals 1.3 mm long, 1.2 mm wide; prefrontal 1.6 mm long, 2.3 mm wide; frontal sub-pentagonal in dorsal view, 3.6 mm long, 2.3 mm wide; supraocular sub-rectangular in dorsal view, 2.9 mm long, 1.1 mm wide; parietal 5.0 mm long, 3.0 mm wide; nasal divided; nostril connected to prenasal; prenasal 0.8 mm long, about twice as long as high; postnasal 0.9 mm long, 0.8 mm high; loreal absent, prefrontal in contact with second and third supralabials; preocular 1.5 mm high, 0.9 mm long; eye diameter 2.0 mm; pupil round; postoculars 2/2, upper postocular 1.2 mm high, about twice as high as long; lower postocular much reduced in size; temporals 2+2/2+1; first upper temporal 1.6 mm long, 0.6 mm high; supralabials nine and eight on the left and right sides, respectively, fourth and fifth in contact with the orbit; seventh or eighth supralabials higher and longer than the remaining supralabials; symphysial triangular, 1.6 mm wide, 1.2 mm long; nine infralabials, with the first four in touch with the first pair and the fourth and fifth

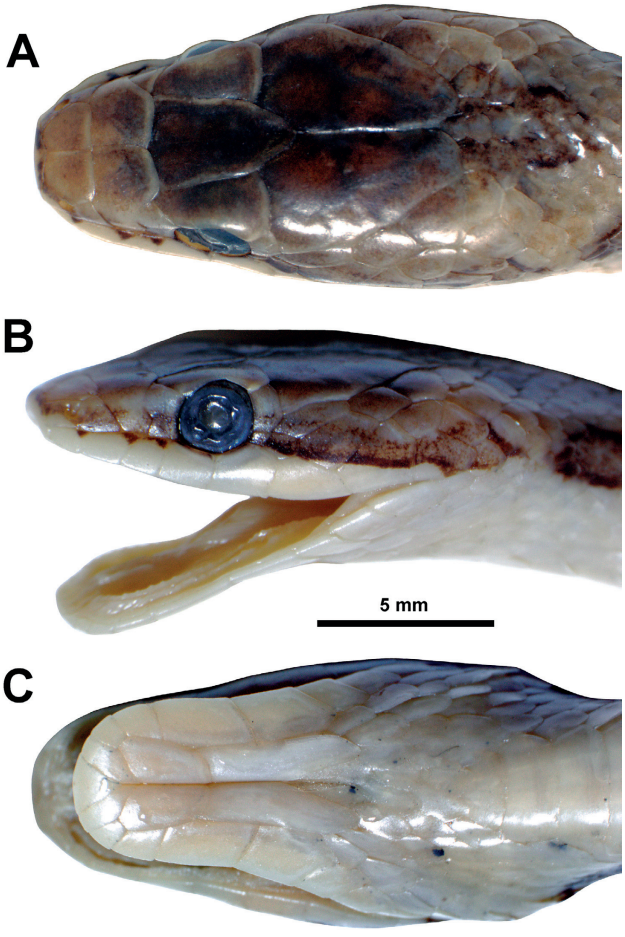

Figure 2. Dorsal (A), lateral (B), and ventral (C) views of head of MBML 56 from Sooretama, municipality of Linhares, state of Espírito Santo, Brazil.

with the second pair of chinshields; first pair of chinshields 2.5 mm long, 1.0 mm wide; second pair of chinshields 4.3 mm long, 0.8 mm wide; mental well developed; five gular scale rows; 17/17/17 dorsal scale rows; dorsals smooth, lacking apical pits, supra-anal tubercles, and keels; eight dorsal tail scale rows at the level of second subcaudal; four preventrals; 184 ventrals; 117 subcaudals; caudal spine long, conical and acuminate (Fig. 2).

Colouration after preservation

Upper side of head mostly brown, with the snout region (rostral, internasals, and anterior portion of prefrontals) being lighter brown; a conspicuous dark brown stripe on each side of head, extending from postnasal to occipital region, covering the dorsal portions of the nasals and the rostral, most of the postnasal and lower postoculars, the ventral portion of prefrontal, preocular, the upper postocular, the lower temporals and occipitals; dorsal margins of the first five supralabials dark brown and the remaining portions of the labials cream white; infralabials, gular region, and venter uniformly cream white; dorsal ground colour light brown, with an anterior vertebral stripe and lateral blotches; vertebral line extends from the first to the tenth dorsal scale; vertebral stripe 3–4 scales wide on first five scales and 1 scale wide after the fifth scale; 12–13 dark brown blotches (2–4 scales long and 3–4 scales high), decreasing in size posteriorly and covering the fourth to sixth dorsal scales rows of the anterior third of the body; the interspaces among dorsal blotches (1–2 scales long) give the impression of the lateral head stripe extending onto anterior dorsal scale rows in an interrupted manner; paraventral series of anterior body scales (first to fourth dorsal scale rows just above the dark brown blotches) uniformly cream white; region posterior to lateral blotches uniformly light brown; tail with a corresponding dorsal and ventral pattern, respectively (Fig. 2).

Colouration in life

Dorsum of head light brown with a medium to dark brown lateral stripe starting at rostral scale and extending to the occipital region; posterior region of parietal scattered with brown blotches or dots usually connected to a poorly defined brown vertebral stripe; ground colour of body light brown, with medium to dark brown lateral blotches that are occasionally fused to form a lateral stripe anteriorly; supralabials, genial region and venter cream white; oral mucosa cream; tongue red with black tips (Fig. 3).

Figure 3. Views of head (A) and body (B) of a live specimen of *Caaeteboia amarali* from Pindaúba, municipality of Jacupiranga, state of São Paulo, Brazil. Photo by M. Duarte.

Figure 4. Sulcate (A) and asulcate (B) views of the hemipenis of *Caaeteboia amarali* (MBML 56).

Hemipenis

The retracted organ is bifurcated at the level of the eighth and extends to the level of the ninth subcaudal; organ moderately bilobate, semicapitate, and semicalyculate; lobes distinct and limited to distal portion of capitulum; lobes clavate, with a lateral expansion on the asulcate side of hemipenis; lobes and capitulum ornamented with small, ill-defined spinulate calyces, restricted to the sulcate and lateral surfaces of the lobes; spinules progressively replaced by papillae toward tip of lobes; capitulum with irregular calyces, not constituting defined transversal flounces on both sides of organ; capitular crotch indistinct on sulcate and well marked on asulcate side of hemipenis, just below the bifurcation of the lobes; capitular crotch running medially to the inner side of each lobe; capitulum located above the division of the sulcus spermaticus; capitulum with a length equivalent to that of the hemipenial body on the sulcate side and restricted to the lobes on the asulcate side; sulcus spermaticus divided in the middle of hemipenis; sulcus spermaticus branches with centrolinear orientation, almost running to the tip of the lobes; margins of sulcus stout and slightly larger below the point of bifurcation, and narrower along the lobes; edges of sulcus bordered with spinules, distally replaced by papillae; hemipenial body subcylindrical and ornamented with enlarged hooked spines and smaller spines; six enlarged hooks located laterally on each side of the hemipenial body; small spines decreasing in size toward the basal region of the organ; basal portion of hemipenial body slightly narrower than lobular portion, with three enlarged lateral hooked spines; naked pocket absent; proximal portion of hemipenis with longitudinal plicae and irregular spinules (Fig. 4).

Type locality

Wettstein (1930) described *Liophis amarali* on the basis of a specimen from the municipality of Bello Horizonte (= Belo Horizonte), state of Minas Gerais, donated by P. Branchhardt to the Naturhistorisches Museum Wien in 1929 (Figs. 5–7). Moura-Leite (2001) doubted the provenance of the holotype, because Wettstein (1930) commented that the Austrian consulate at Rio de Janeiro, which gave this specimen to Branchhardt, is located on the Brazilian coast and there was the possibility of a wrong label. Although the lowland records reported here reinforce the suggestion of Moura-Leite (2001), we highlight that the Sooretama record is within the Rio Doce drainage, which comprises a gallery forest extending well into the state of Minas Gerais (Fig. 1). Hence, the distribution of *C. amarali* along the Rio Doce drainage may, at least in the past before extensive deforestation of southeastern Brazil, have extended to the western limits of the Atlantic Forest biome.

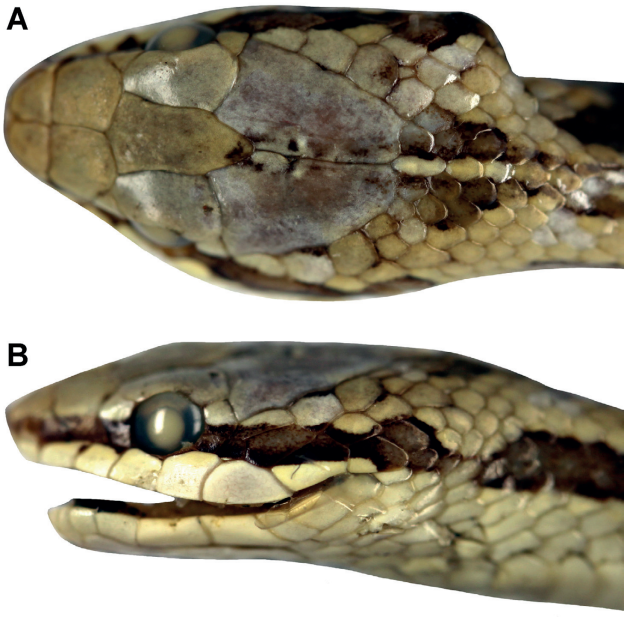

Figure 6. Dorsal (A) and lateral (B) views of the head of the holotype of *Liophis amarali* (NMW 23107). Photos by H. Grillitsch.

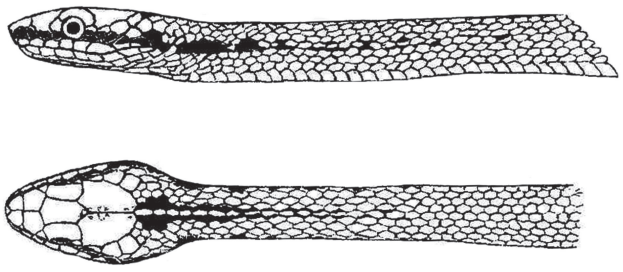

Figure 5. Original plate depicting *Liophis amarali,* modified from Wettstein (1930).

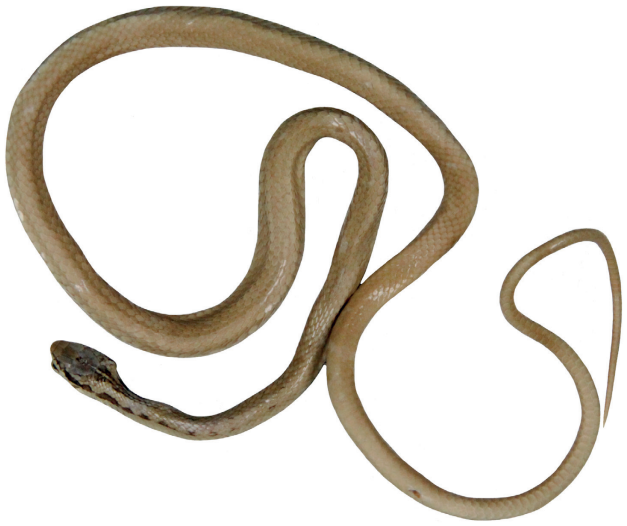

Figure 7. View of the holotype of *Liophis amarali* (NMW 23107). Photo by H. Grillitsch.

This may indeed have been the case, as the city of Belo Horizonte used to house only administrative services for the state of Minas Gerais prior to its transformation into an industrial and urban capital, thus precipitating a high level of deforestation beginning after 1930. Moreover, this region represents the western limits of occurrence for some snake species endemic to the Atlantic Forest biome, such as *Atractus zebrinus* (Jan, 1862) and *Tricheilostoma salgueiroi* (Amaral, 1954) (see Passos et al. 2010; Costa et al. 2009). Furthermore, we point out that the northeastern portion of the state of Minas Gerais was historically poorly researched and the herpetofauna in this region has been systematically sampled only in recent years (e.g., Rodrigues et al. 2009).

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