

New morphology data and geographic distribution expansion of *Leposternon mineiro* Ribeiro, Silveira & Santos-Jr, 2018 (Squamata, Amphisbaenia, Amphisbaenidae)

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ABSTRACT

We provide new morphological and geographic distribution data for *Leposternon mineiro*. Fifteen specimens of *L. mineiro* were analyzed (six specimens of the type series and nine additional specimens), in addition to 404 specimens of other species of the genus, used for identification and comparison. Meristic characters, morphometrics, head scale patterns and dentition matched the previously published diagnosis of the species, but we also found some variations compared to the type series. We expanded the ranges of the following diagnostic characters of *L. mineiro*: snout-vent length 221–380 mm, tail length 11.5–23.4 mm, 252–300 dorsal postpectoral half-annuli, 252–280 ventral postpectoral half-annuli, 14–16 caudal annuli, 26–37 dorsal segments and 24–39 ventral segments in a midbody annuli, and 2–4 preloacal pores. The new record from the municipality of Cristalina, State of Goiás, extends the geographic distribution of the species by 148 km west of nearest record.

Key words: Amphisbaenian

RESUMO

Nós fornecemos novos dados morfológicos e de distribuição geográfica para *Leposternon mineiro*. Foram analisados quinze espécimes de *L. mineiro* (seis espécimes da série-tipo e nove exemplares adicionais), além de 404 exemplares de outras espécies do gênero, utilizados para identificação e comparação. Caracteres merísticos, morfométricos, padrões de escamas da cabeça e dentição corresponderam com a diagnose da espécie publicada anteriormente, mas encontramos algumas variações em comparação à série-tipo. Nós ampliamos as variações dos seguintes caracteres diagnósticos de *L. mineiro*: comprimento rostro-cloacal de 221–380 mm, comprimento da cauda de 11,5–23,4 mm, 252–300 meios anéis pós-peitorais dorsais, 252–280 meios anéis pós-peitorais ventrais, 14–16 anéis caudais, 26–37 segmentos dorsais e 24–39 segmentos ventrais em um anel do meio do corpo e 2–4 poros pré-cloacais. O novo registro do município de Cristalina, Estado de Goiás, amplia a distribuição geográfica da espécie em 148 km a oeste do registro mais próximo."

Palavras Chave: Ansfibênios

Introduction

The genus *Leposternon* is a monophyletic group of South American amphisbaenids (Mott and Vieites, 2009;

Ribeiro, 2010; Ribeiro *et al.*, 2011). The species of this genus can be easily identified by the presence of a

relatively large and robust body, head dorsoventrally compressed, nostrils opening on the ventral surface of snout, suture connecting each nostril to the edge of mouth, nasal shield absent, rostronasal shield followed by a sequence of one to five enlarged shields along the dorsal surface of head, gular portion without segmental cover, more than two dermal annuli per vertebrae, tail very short with rounded tip, and autotomic site absent on tail (Ribeiro *et al.*, 2008). Currently, *Leposternon* is composed of 11 species, with the following geographic allocation: Brazil (10 spp.), Argentina (two spp.), Uruguay (one sp.), Paraguay (one sp.), and Bolivia (one sp.) (Ribeiro *et al.*, 2018). Of these species, five have pre-cloacal pores [*L. cerradensis* Ribeiro, Vaz-Silva & Santos-Jr, 2008; *L. kisteumacheri* Porto, Soares & Caramaschi, 2000; *L. maximus* Ribeiro, Nogueira, Cintra, Silva Jr. & Zaher, 2011; *L. mineiro* Ribeiro, Silveira & Santos-Jr, 2018; and *L. polystegum* (Duméril in Duméril & Duméril, 1851)]. It is likely that these pores are responsible for the secretion of products from the epidermal glands, and that both in amphisbaenians and other groups of lizards, they are related to both reproductive activities and to other behaviors, such as inter and intra-specific communication (Antoniazzi *et al.*, 1993; Jared *et al.*, 1999; Ribeiro, 2010; Ribeiro *et al.*, 2018).

Leposternon mineiro was originally described based on six specimens, being split apart from the other species of the group by a combination of characters that include the size and shape of the cephalic shields, the number of half-annuli of the body and dentition form. So far, the species is known only for the municipalities of João Pinheiro (type locality) and Buritizeiro, both in the State of Minas Gerais, Brazil. It is the most recently described species in the genus and the sixth member of the genus from the Brazilian Cerrado, the others being *L. cerradensis*, *L. infraorbitale* (Bertold, 1859), *L. maximus*, *L. microcephalum* Wagler in Spix, 1824, and *L. polystegum* (Ribeiro *et al.*, 2018).

During the faunal monitoring and rescue activities at the Batalha Hydroelectric Power Plant, on the border between the municipalities of Cristalina (State of Goiás) and Paracatu (State of Minas Gerais), near the banks of the São Marcos River, nine specimens of *Leposternon mineiro* were collected and later deposited in the Herpetological Collection of the Pontifícia Universidade Católica de Goiás. These new specimens have characters that slightly modify the existing description and diagnosis of the species,

as well as representing a new geographic record that extends the distribution of the species westwards of the previously known range.

Materials and methods

Fifteen specimens of *Leposternon mineiro* were analyzed [the type series (six specimens) and nine additional specimens] from the following collections (acronyms of scientific collections between parentheses): Herpetological collection of the Centro de Estudos e Pesquisas Biológicas, Pontifícia Universidade Católica de Goiás, Goiânia, Brazil (CEPB); Herpetological Collection of the Universidade de Brasília, Brasília, Brazil (CHUNB); and Museu Nacional, Rio de Janeiro, Brazil (MNRJ). To compare *L. mineiro* with congeneric species (other 10 species), 404 specimens were used (Appendix). Morphological terminology follows Ribeiro *et al.* (2008). The images of illustrated specimen were produced with a stereomicroscope with an attached camera. Morphometric measurements were performed following Ribeiro *et al.* (2011). Bilateral variation is reported as right/left. The dorsal and ventral postpectoral half-annuli were counted on the right side. For the diagnosis of the species, we used a combination of 31 characters, including pre-cloacal pores, pholidosis, morphometric data, tooth form and number, premaxillary foramina, and coloration in preservative. The geographic distribution was based in Ribeiro *et al.* (2018) and from additional specimens (new sample).

Results

With the new sample of *Leposternon mineiro* morphological character data were complemented (see Table 1) and the diagnosis of the species was revised, as presented below.

1. Updated diagnosis

Leposternon mineiro can be distinguished from *L. bagual* Ribeiro, Santos-Jr & Zaher, 2015, *L. microcephalum*, *L. infraorbitale*, *L. octostegum* (Duméril in Duméril & Duméril, 1851), *L. scutigerum* (Hemprich, 1820), and *L. wuchereri* (Peters, 1879) by presence of precloacal pores (*versus* absent) and pectoral portion with many shields, mostly small and diamond-shaped (*versus* pectoral shields with an irregular form, and dermal annuli not regularly arranged). Additionally, *L. mineiro* differs from

Table 1. Pholidosis, dentition, and morphometric data of *Leposternon mineiro*. Pholidoses: PPO = preloacal pores, PEC = pectoral shields, SL = supralabial, IL = infralabial, DOA = dorsal postpectoral half-annuli, VEA = ventral postpectoral half-annuli, TA = tail annuli, DS = dorsal segments in midbody half-annulus, VS = ventral segments in midbody half-annulus, COL = coloration of adult specimens in preservative. Skull: PMXT = premaxilla teeth, MXT = maxillar teeth, DT = dentary teeth, FPMX = foramina of the premaxilla, SVL = snout-vent length, TL = tail length. Morphometric data (expressed as proportions): RL/HL = rostronasal length/head length, RW/HW = rostronasal width/maximun width of head, AZL/HL = azygous shield length/head length, AZW/HW = azygous shield width/posterior height of head, PFL/HL = prefrontal length/head length, PFW/HW = prefrontal width/head width, PFH/PFW = prefrontal length/prefrontal width, FSL/HL = frontal suture length/head length, TPL/HL = temporal length/head length, MB/SVL = midbody diameter/snout-vent length, TL/SVL = tail length/snout-vent length. In parenthesis number of specimens, means, and standard deviation, respectively. N/A = not applicable. N/AN = not analyzed.

Characters	Type series	Present study	General
PPO	2-4	2	2-4
PEC	Many shields, mostly small and diamond-shaped	Many shields, mostly small and diamond-shaped	Many shields, mostly small and diamond-shaped
SL	2/2	2/2	2/2
IL	3/3	3/3	3/3
FPMX	Absent	Absent	Absent
COL	Cream White	Cream White	Cream White or yellow
PMXT	5	N/AN	5
MXT	3/3	N/AN	3/3
DT	6/6	N/AN	6/6
DOA	277-300 (5, 290.6, 9.2)	252-275 (9, 264.8, 7.3)	252-300 (15, 274.4, 14.0)
VEA	270-280 (5, 275.0, 4.4)	252-267 (9, 261.2, 5.4)	252-280 (15, 266.0; 7.93)
TA	15-16 (4, 15.2, 0.4)	14-16 (9, 15.3, 0.8)	14-16 (15, 15.4, 0.7)
DS	26-30 (5, 28.2, 1.5)	33-37 (9, 34.9, 1.5)	26-37 (15, 32.2; 3.7)
VS	24-39 (5, 29.3, 5.3)	28-36 (9, 32.5, 2.7)	24-39 (15, 31.3, 4.0)
SVL	221-358 (5, 304.8, 50.9)	273-380 (9, 332.3, 36.3)	221.0-380.0 (14, 322.0, 42.4)
TL	11.5-20.5 (5, 17.3, 3.1)	18.0-23.3 (9, 20.3, 1.8)	11.5-23.4 (14, 19.3, 2.9)
AZL/HL	36.2-40.6 (6, 38.6, 1.9)	31.5-36.4 (9, 34.4, 1.9)	29.8-40.6 (15, 36.1, 3.0)
AZW/HW	27.4-40.5 (6, 32.1, 4.7)	15.2-27.6 (9, 22.9, 4.4)	22.7-40.6 (15, 36.1, 4.8)
PFL/HL	36.8-40.2 (6, 38.6, 1.5)	22.9-30.8 (9, 26.4, 2.6)	19.2-32.1 (15, 26.0, 4.4)
PFW/HW	24.5-35.8 (6, 28.4, 4.6)	26.5-34.0 (9, 29.5, 2.6)	24.5-29.5 (15, 29.5, 3.4)
FSL/HL	19.2-23.7 (6, 21.2, 1.5)	19.8-25.6 (9, 21.5, 2.0)	20.0-25.7 (15, 22.7, 1.6)
RL/HL	24.4-28.7 (6, 26.7, 1.8)	23.2-30.8 (9, 31.4, 2.5)	23.3-30.8 (15, 26.8, 2.1)
RW/HW	57.5-72.1 (6, 64.4, 5.5)	53.6-60.7 (9, 56.9, 2.4)	55.8-72.1 (15, 61.7, 4.6)
TPL/HL	24.8-29.9 (6, 27.7, 2.3)	21.1-29.0 (9, 24.9, 3.0)	22.6-29.9 (15, 26.4, 2.7)
MB/SVL	2.2-2.6 (5, 2.4, 0.2)	2.7-3.4 (9, 3.0, 0.2)	2.2-3.4 (14, 2.8, 0.4)
TL/SVL	5.2-6.5 (5, 5.7, 0.5)	5.3-6.6 (9, 6.1, 0.4)	5.2-6.0 (14, 6.0, 0.5)

unpored *Leposternon* species by the following combination of morphological characters: **Pholidosis and body coloration**: two supralabials (*versus* three in *L. infraorbitale* and one in *L. octostegum*); three infralabials (*versus* one in *L. octostegum* and *L. scutigerum*; two in *L. infraorbitale* and *L. microcephalum*); rostronasal and azygous shields in contact (*versus* separated in *L. infraorbitale* and *L. microcephalum*); 252-300 dorsal postpectoral half-annuli (*versus* > 352 in *L. octostegum*); 250-280 ventral postpec-

toral half-annuli (*versus* < 230 in *L. bagual* and *L. microcephalum*; and > 340 in *L. octostegum*); 14-16 tail annuli (*versus* < 14 in *L. bagual*, *L. infraorbitale*, *L. microcephalum*, *L. octostegum*, and *L. wuchereri*); 26-37 dorsal segments in midbody half-annulus (*versus* 16-19 in *L. wuchereri*); 24-39 ventral segments in midbody half-annulus (*versus* 16-21 in *L. wuchereri*); adult specimens in preservative with dorsal portion of body whitish (*versus* yellow in *L. infraorbitale* and *L. scutigerum*; dark brown in *L. ba-*

gual and *L. microcephalum*). **Skull** (CEPB 1846): five premaxillary teeth (*versus* seven in *L. microcephalum*; one in *L. octostegum* and *L. scutigerum*), three maxillary teeth (*versus* four in *L. bagual*, *L. infraorbitale*, and *L. microcephalum*; five in *L. scutigerum*); six dentary teeth (*versus* five in *L. octostegum* and *L. scutigerum*; four or five in *L. wuchereri*); premaxillary dorsal and ventral foramina absent (*versus* present in *L. bagual*, *L. infraorbitale*, *L. microcephalum*, and *L. wuchereri*); details in Gans and Montero, 2008 and Ribeiro, 2010). **Morphometrics**: rostronasal width 55.8–72.1% of maximum width of head (*versus* rostral wider in *L. scutigerum*); azygous shield length 31.5–40.6% of head length (*versus* azygous longer in *L. wuchereri*); azygous shield width 22.7–40.6% of maximum width of head (*versus* azygous wider in *L. octostegum* and *L. wuchereri*); prefrontals length 34.9–41.8% of head length (*versus* shorter in *L. bagual*, *L. microcephalum*, and *L. wuchereri*); prefrontals width 24.5–35.8% of maximum width of head (*versus* prefrontals wider in *L. bagual* and *L. wuchereri*); frontals length of suture 20.0–25.7% of head length (*versus* frontals longer in *L. wuchereri*); temporal length 22.6.1–29.9% of head length (*versus* temporal shorter in *L. wuchereri* and *L. bagual*); midbody width 2.2–3.4% of snout–vent length (*versus* midbody wider in *L. infraorbitale*); and tail length 5.2–6.5% of snout–vent length (*versus* tail shorter in *L. octostegum*) (Table 1).

Leposternon mineiro differs from other species of the genus with precloacal pores in having two supralabials in each size of the mouth (*versus* three in *L. polystegum*) and three infralabials (*versus* two in *L. cerradensis*); rostronasal and azygous shields in contact (*versus* separated by an irregular shield in *L. polystegum*); azygous shield with anterior margin almost straight (*versus* anterior margin rounded in *L. kisteumacheri*); 252–300 dorsal postpectoral half-annuli (*versus* > 305 in *L. maximus*); 252–280 ventral postpectoral half-annuli (*versus* > 300 in *L. cerradensis* and *L. maximus*); adult specimens in preservative with dorsal portion of body whitish (*versus* yellow in *L. polystegum*); three maxillary teeth (*versus* two in *L. polystegum*, four in *L. cerradensis* and *L. kisteumacheri*); six dentary teeth (*versus* five in *L. polystegum*); rostronasal length 20.3–23.1% of maximum length of head (*versus* rostronasal longer in *L. cerradensis*); azygous shield length 31.5–40.6% of head length (*versus* azygous shorter in *L. polystegum*) and 22.7–40.6% of maximum width of head (*versus* azygous wider in *L. polystegum*); prefrontals

length 34.9–41.8% of head length (*versus* prefrontals shorter in *L. maximus* and *L. polystegum*); frontals length suture 20.0–25.7% of head length (*versus* frontals longer in *L. polystegum*); midbody width 2.2–3.4% of snout–vent length (*versus* narrower midbody width in *L. maximus*); and tail length 5.2–6.6% of snout–vent length (*versus* tail shorter in *L. polystegum*).

2. Characterization of species (based on 15 specimens, including the type series)

Leposternon mineiro can be characterized by present 2/2 supralabials; 3/3 infralabials; supraocular present (n = 1) and absent (n = 14); snout–vent length 221–380 mm ($\bar{X} = 322.5 \text{ mm} \pm 42.4$; n = 14); head length 7.1–10.9 mm ($\bar{X} = 9.3 \text{ mm} \pm 1.2$; n = 15), representing 2.7–3.4% of snout–vent length ($\bar{X} = 2.9 \pm 0.2$; n = 14); tail length 11.5–23.4 mm ($\bar{X} = 19.3 \pm 2.9$; n = 14), representing 5.2–6.6% of snout–vent length ($\bar{X} = 6.0 \pm 0.5$; n = 14); midbody diameter 5.8–11.3 mm ($\bar{X} = 9.0 \text{ mm} \pm 1.9$; n = 15), representing 2.2–3.4% of snout–vent length ($\bar{X} = 2.8 \pm 0.4$; n = 14); tail diameter (fifth annuli) 5.8–10.7 mm ($\bar{X} = 8.8 \text{ mm} \pm 1.3$; n = 14), representing 2.3–3.2% of snout–vent length ($\bar{X} = 2.7 \pm 0.2$; n = 14); anterior head height 1.4–4.6 mm ($\bar{X} = 2.3 \text{ mm} \pm 0.9$; n = 15), representing 26.1–36.7% of posterior head height ($\bar{X} = 28.9 \pm 3.1$; n = 13); posterior head height 4.9–8.7 mm ($\bar{X} = 7.0 \text{ mm} \pm 1.3$; n = 13); anterior head width 2.2–4.0 mm ($\bar{X} = 3.2 \text{ mm} \pm 0.4$; n = 15), representing 36.3–55.3% of posterior head width ($\bar{X} = 44.3 \pm 5.9$; n = 15); and posterior head width 5.1–9.0 mm ($\bar{X} = 7.2 \text{ mm} \pm 1.2$; n = 15) (Table 1).

Rostronasal approximately as high (1.4–2.7 mm) as long (1.8–3.3 mm), with high representing 66.7–98.9% of length ($\bar{X} = 83.1 \pm 8.6$; n = 15); relatively wide, with length representing 50.1–61.7% ($\bar{X} = 56.2 \pm 3.3$; n = 15) and height 37.6–56.7% ($\bar{X} = 46.7 \pm 5.5$; n = 15) of width, in contact with the first supralabials laterally, and with prefrontals and azygous shield posteriorly.

Azygous shield longer than wide, with width representing 53.8–80.0% of length ($\bar{X} = 63.2 \pm 7.9$; n = 15), anterior portion almost as wide as posterior portion in specimens CEPB 1844 and 1845 with the shield in rectangular shape, while in the other specimens the anterior edge is less wide than the posterior edge, with the shield having a more elongated trapezium shape, the two sides of azygous shields form a straight line in contact with the rostronasal anteriorly, and prefrontals and supraocular laterally

(see Fig. 1), and frontals posteriorly. Prefrontals almost rectangular, longer than wide, with width representing 49.0–69.2% of length ($\bar{X} = 60.1 \pm 7.1$; $n = 15$), in contact with the first supralabials and oculars laterally, and with frontals and temporals posteriorly.

Frontals almost hexagonal, almost as wide (1.6–2.5 mm, $\bar{X} = 2.0 \pm 0.3$; $n = 15$) as long (1.6–2.7 mm suture length, $\bar{X} = 2.0 \pm 0.3$; $n = 15$; 1.6–3.4 mm longer length, $\bar{X} = 2.4 \pm 0.6$; $n = 15$), in contact at midline, with temporals laterally, and with parietals posteriorly. Parietals almost rectangular, relatively small (0.7–1.3 mm suture length, $\bar{X} = 1.0 \pm 0.2$; $n = 14$), representing 7.1–13.7% of head length ($\bar{X} = 10.6 \pm 1.5$; $n = 14$), arranged in a row of four shields between the temporals, except in specimen CEPB 1842, which has two parietals, in contact with temporals laterally, and first dorsal half-annulus posteriorly.

Temporals irregular, relatively long, with length representing 22.6–29.0% of head length ($\bar{X} = 26.5 \pm 2.8$; $n = 15$), in contact with prefrontals anteriorly, oculars and postoculars laterally, and first dorsal half-annulus posteriorly. Supraocular shield absent, except in specimen CEPB 1844 on right side of head. Oculars irregular or almost quadrangular, representing 14.3–20.0% of head length ($\bar{X} = 17.1 \pm 1.4$; $n = 15$), with a larger posterior margin, in contact with the first supralabials anteriorly, second supralabials laterally, and postoculars posteriorly. Eyes visible, placed posteriorly in the superior portion of the ocular shield. Postoculars almost triangular,

in contact with the first postsupralabials laterally.

Two supralabials, the first longer and taller than second, second representing 32.8–66.2% of length of the first ($\bar{X} = 52.0 \pm 9.7$; $n = 15$) and 49.5–74.9% of height of the first ($\bar{X} = 63.5 \pm 7.6$; $n = 14$). First supralabial largest, with 2.3–5.4 mm length ($\bar{X} = 3.2 \text{ mm} \pm 0.8$; $n = 15$) and 1.2–2.1 mm height ($\bar{X} = 1.8 \text{ mm} \pm 0.3$; $n = 15$), in contact with rostronasal anteriorly, prefrontals laterally, and oculars and second supralabials posteriorly. Second supralabial, relatively small, almost rectangular, with 1.1–2.0 mm length ($\bar{X} = 1.6 \text{ mm} \pm 0.3$; $n = 15$) and 0.9–1.5 mm height ($\bar{X} = 1.2 \text{ mm} \pm 0.2$; $n = 15$), in contact with ocular laterally and postsupralabials posteriorly. Two and three rectangular postsupralabials. Three infralabials, first smaller, almost triangular, representing 4.2–9.0% of head length ($\bar{X} = 6.4 \text{ mm} \pm 2.4$; $n = 13$), in contact with mental anterolaterally, postmental laterally and second infralabials posteriorly, except the specimens CEPB 1843 and 1847 that have the anterior edges fused with the mental; second largest, irregular, relatively narrow, anterior margin similar to the width of the first infralabials and narrower posterior margin, representing 32.6–41.5% of head length ($\bar{X} = 37.1 \pm 3.1$; $n = 15$), 4.0–8.0 times longer ($\bar{X} = 5.5 \pm 1.1$; $n = 13$) and 1.3–3.9 times wider ($\bar{X} = 2.2 \pm 0.7$; $n = 15$) than first infralabials, and 1.6–2.9 times longer ($\bar{X} = 2.0 \pm 0.4$; $n = 9$) and 0.3–0.8 times wider ($\bar{X} = 0.6 \pm 0.2$; $n = 9$) than third infralabials, in contact with postmental and malars laterally and third infralabial

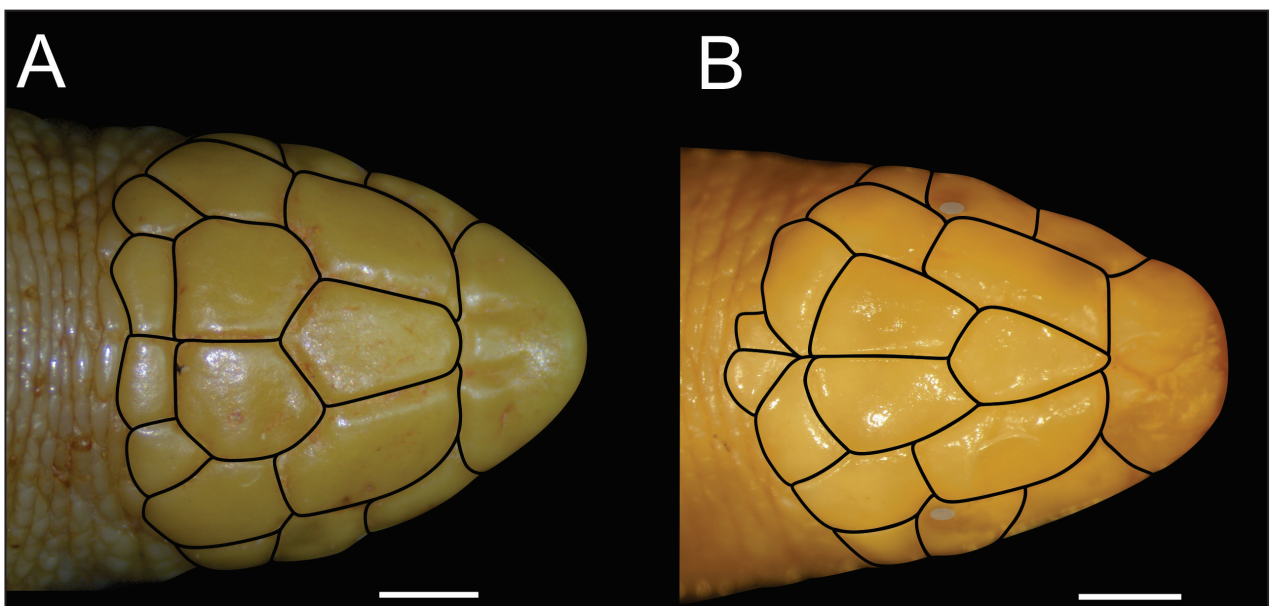


Figure 1. Head dorsal region of *Leposternon mineiro* (A) (CEPB 1847) and *Leposternon kistemacheri* (B) (MNRJ 4042). Scale = 2 mm.

posteriorly; third infralabials relatively small, slightly rectangular, contact lateral malar laterally.

Mental with anterior margin larger and smaller than posterior margin, with variation in shape and form, in contact with postmental posteriorly. Specimen CEPB 1840 has trapezoidal-shaped anterior mental, in a form similar to the holotype, with the anterior portion smaller than the posterior portion, contacting the first infralabial and malar laterally, and the postmental posteriorly; CEPB 1839, 1841, 1842, 1845 and 1846 have the mental with the anterior portion in the shape of a semicircle, followed by a trapezoid, with the anterior widths of the mental relatively larger than the posterior ones; CEPB 1843 has the anterior edges of the two infralabials and the anterior mental fused together; CEPB 1844 has fused anterior and posterior mentals; CEPB 1847 has the two infralabials fused and forming a single shield that contacts the second infralabial laterally, and the anterior mental posteriorly; and CEPB 1839 and 1847 have an rectangular shaped azygous shield that is wider than it is long, contacting the anterior mentalis anteriorly, the posterior mentalis posteriorly and the first malar laterally.

Body with 14–17 anterior half-annuli ($\bar{x} = 15.2 \pm 0.9$; $n = 15$); 252–300 dorsal postpectoral half-annuli ($\bar{x} = 274.2 \pm 14.6$; $n = 14$); 252–280 ventral postpectoral half-annuli ($\bar{x} = 266.4 \pm 8.1$; $n = 14$); 3/5 lateral half-annuli; 14–16 tail annuli ($\bar{x} = 15.4 \pm 0.7$; $n = 14$); 26–37 dorsal segments per half-annulus in midbody ($\bar{x} = 32.2 \pm 3.7$; $n = 15$); 24–39 ventral segments per half-annulus in midbody ($\bar{x} = 31.3 \pm 4.0$; $n = 15$); fifth tail annulus with 37–47 segments ($\bar{x} = 41.8 \pm 2.3$; $n = 15$). Anal flap semicircular with 10–19 cloacal segments; one precloacal pore at each side of the cloaca. Most of the pectoral scales diamond-shaped, with the central scales larger and laterals smaller; pectoral portion with 9.0–14.3 mm of length ($\bar{x} = 11.6 \pm 1.7$; $n = 15$), representing 3.2–4.3% of snout-vent length ($\bar{x} = 3.7 \pm 0.3$; $n = 14$). Lateral grooves separating the body into dorsal and ventral portions, lateral grooves absent on tail, and dorsal groove present.

3. Geographic distribution

Leposternon mineiro is known from the northwest region of the Brazilian State of Minas Gerais (municipalities of Buritizeiro and João Pinheiro), and for the municipality of Cristalina, State of Goiás (the record presented here). All known locations occur the Cerrado domain, within the São Francisco River

Basin and on the left bank of the São Marcos River near the Batalha hydroelectric plant (Fig. 2). Based on existing geographic records, the sample collected in the municipality of Cristalina (17°6'42.36"S; 47°22'29.31"W) extends the distribution of the species by 148 kilometers to the west (Fig. 2) and is the first record of this species for the State of Goiás.

Discussion

The new sample from *Leposternon* from State of Goiás contains some data that diverge from the type series (Table 1): numbers of dorsal and ventral half-annuli, dorsal segments, ratio of prefrontal width and head width, ratio of the diameter of the midbody and snout-vent length, and color pattern. The variables ratio of azygous length to head length and ratio of azygous width to head width are at the limit of variation between populations, with a small margin of overlap (31.5–36.4 vs. 36.2–40.2, and 15.2–27.6 vs. 27.4–40.5, respectively). For the cephalic shields, the presence of a supraocular on the left side of the head was identified, with variation in the number of parietals from 2–4 (vs. 2 of the type series). Geographical variation is commonly observed in squamate reptiles, but the causes of these variations are still topics of investigation, and both environmental and geographic features are likely to be involved. For snake species, geographic variations identified mainly in pholidotic characters from different populations were for many years considered to be related to environmental conditions (temperature, humidity, etc.) during specimen development (Fox, 1948; Alexander and Gans, 1966). However, studies with recent phylogeographic evidence have been correlated such between-population variations with ancient geographic events of habitat fragmentation (Grazziotin *et al.*, 2006). Despite the morphological differences in some characters between the population from the municipality of Cristalina (representing the western-most known distribution of the species) and the population of the São Francisco River basin (the eastern-most), due to the relatively small scale variations in limits of the characters mentioned above (except for the color pattern), we have opted here for a conservative approach, and consider that the observed differences represent geographic variation within the species instead treat the new specimens as an separate species. Additionally, studies involving a greater number of specimens and molecular data might contribute

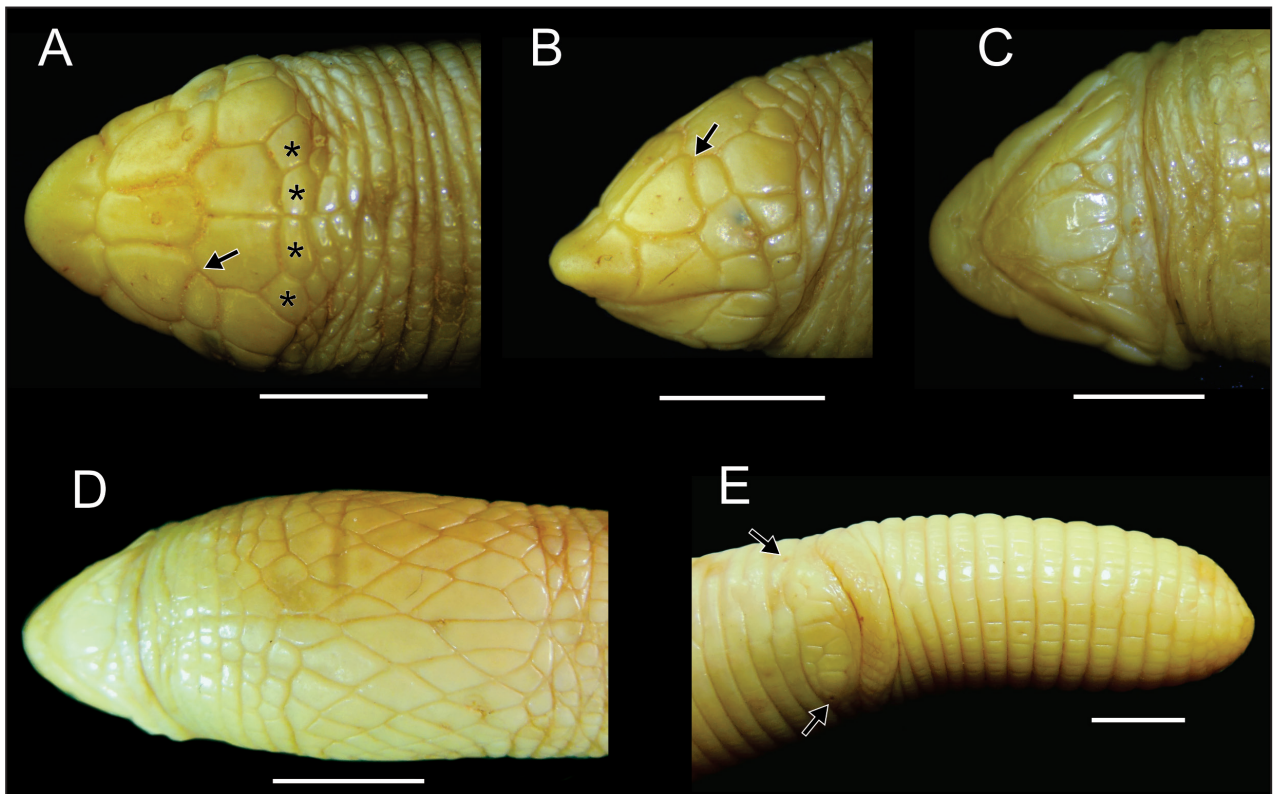


Figure 2. Specimen of *Leposternon mineiro* (CEPB 1844) from municipality of Cristalina, State of Goiás, Brazil. Head region in (A) dorsal, (B) lateral and (C) ventral views. (D) Pectoral region and (E) cloacal and ventral region of the tail. Black arrow in (A) and (B) indicate the presence of a supraocular on the left side; asterisks indicate the specimen's four parietal scutes; and black arrows in (E) indicate the location of pre-cloacal pores. Scale = 5 mm.

further to the clarification of the taxonomic status of the Cristalina population.

Leposternon mineiro can be distinguished from the other species of the genus according to the diagnosis presented in the results. However, with *L. kisteumacheri*, it presents overlapping values of dorsal and ventral postpectoral half-annuli and shares equal numbers of cephalic shields. *L. mineiro* can be easily distinguished from *L. kisteumacheri* by the shape and size of the azygous, as in *L. mineiro* the anterior edge of the azygous is straight, while in *L. kisteumacheri* this edge is curved and anteriorly projected (Fig. 3). More quantitatively, the number of teeth is different in the two species (see diagnosis).

According to Costa *et al.* (2020), one of the main deficits in biodiversity data in the 21st century is the lack of information on species distributions, which therefore constitutes one of the global priorities for reptile conservation. In Brazil, most municipalities (ca. 90%) do not have any records of amphisbaenians (Colli *et al.*, 2016), and 23 amphisbaenian species (28.1% of the national species richness) are represented only by the type series, and/

or specimens from the type locality. Such this lack of detailed knowledge of species distributions is an obstacle to the identification of the risks of species extinction and the definition of priority areas for the conservation. The sample analyzed in the current study expands the knowledge of *L. mineiro* both terms of diagnostic data and for that on geographic distributions. In the most recent extinction risk assessment for the Brazilian fauna ("Livro Vermelho da Fauna Brasileira Ameaçada de Extinção", 2018) organized by the Chico Mendes Institute, 14 species of amphisbaenians were categorized as being Data Deficient (DD), four as Near Threatened (NT) and seven as Endangered (Vulnerable and Endangered). *Leposternon mineiro* was not included in that study because it was in the process of being described. Currently, the distribution is still restricted to three localities within the Cerrado domain and encloses about 7,000 square kilometers including many well-sampled areas, all in use by mechanized agriculture. In addition, one of the records comes a site that was being inundated by the construction of the Batalha Hydroelectric Power Plant, a strongly impacted envi-

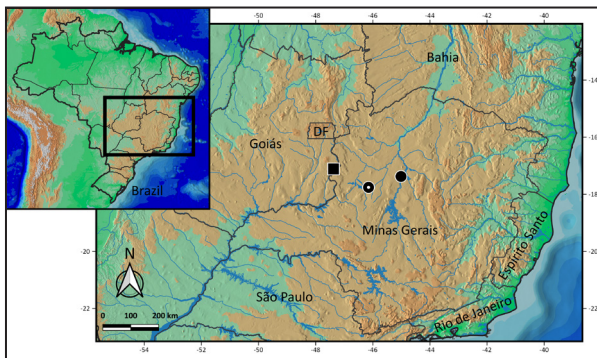


Figure 3. Geographic distribution of *Leposternon mineiro*. Circles represent the locations given in Ribeiro *et al.* (2008) (type locality is the symbol with a white dot in the center) and the square represents the new record for the municipality of Cristalina, Goiás, on the border with the state of Minas Gerais.

ronment. These environmental characteristics place the species in risk of extinction, and it is therefore likely to be categorized as such in future ICMBio assessments.

Acknowledgments

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Literature cited

- Alexander, A.A.; & Gans, C. 1966. The pattern of dermal-vertebral correlation in snakes and amphisbaenians. *Zoologische Mededelingen* 41: 171-190.
- Antoniuzzi, M.M.; Jared, C.; Pellegrini, C.M.R. & Macha, N. 1993. Epidermal glands in Squamata: morphology and histochemistry of the pre-cloacal glands in *Amphisbaena alba* (Amphisbaenia). *Zoomorphology* 113: 199-203.
- Colli, G.R.; Fenker, J.; Tedeschi, L.G.; Barreto-lima, A.F.; Mott, T. & Ribeiro, S.L.B. 2016. In the depths of obscurity: Knowledge gaps and extinction risk of Brazilian worm lizards (Squamata, Amphisbaenidae). *Biological Conservation* 204: 51-62.
- Costa, H.C. 2020. New record and updated distribution map of the rare *Amphisbaena spurrelli* (Amphisbaenia: Amphisbaenidae). *Phyllomedusa* 19: 259-266.
- Fox, W.A.D.E. 1948. Effect of temperature on development of scutellation in the garter snake, *Thamnophis elegans atratus*.

Copeia 1948: 252-262.

- Gans, C. & Montero, R. 2008. An Atlas of Amphisbaenian Skull Anatomy. *Biology of the Reptilia* 21: 621-738.
- Grazziotin, F.G.; Monzel, M.; Echeverrigaray, S. & Bonatto, S.L. 2006. Phylogeography of the *Bothrops jararaca* complex (Serpentes: Viperidae): past fragmentation and island colonization in the Brazilian Atlantic Forest. *Molecular Ecology* 15: 3969-3982.
- Jared, C.; Antoniazzi, M.M.; Silva, J.R.M.C. & Freymüller, E. 1999. Epidermal glands in Squamata: microscopical examination of precloacal glands in *Amphisbaena alba* (Amphisbaenia, Amphisbaenidae). *Journal of Morphology* 241: 197-206.
- Mott, T. & Vieites, D.R. 2009. Molecular phylogenetics reveals extreme morphological homoplasy in Brazilian worm lizards challenging current taxonomy. *Molecular Phylogenetics and Evolution* 51: 190-200.
- Ribeiro, S.L.B. 2010. Revisão sistemática de *Leposternon* Wagler, 1824 (Squamata: Amphisbaenia). *Tese de doutorado, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul*.
- Ribeiro, S.; Vaz-Silva, W. & Santos-Jr, A.P. 2008. New pored *Leposternon* (Squamata, Amphisbaenia) from Brazilian Cerrado. *Zootaxa* 38: 18-38.
- Ribeiro, S.; Silveira, A.L. & Santos-Jr, A.P. 2018. A new species of *Leposternon* (Squamata: Amphisbaenidae) from Brazilian Cerrado with a key to pored species. *Journal of Herpetology* 52: 234-241.
- Ribeiro, S.; Nogueira, C.; Cintra, C.E.D.; Silva, N.J. & Zaher, H. 2011. Description of a new pored *Leposternon* (Squamata, Amphisbaenidae) from the Brazilian Cerrado. *South American Journal of Herpetology* 6: 177-188.

Appendix 1. Analyzed specimens

Scientific collections: Centro de Estudos e Pesquisas Biológicas da Universidade Católica de Goiás, Goiânia, Brazil (CEPB); Coleção Herpetológica da Universidade de Brasília, Brasília, Brazil (CHUNB); Coleção Herpetológica da Universidade Federal do Mato Grosso, Cuiabá, Brazil (UFMT); Coleção Zoológica de Referência of Universidade Federal de Mato Grosso do Sul, Campus de Corumbá, Corumbá, Brazil (CEUCH); Coleção Zoológica da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (ZUFRRJ); Facultad de Ciencias de la Universidad de la República, Montevideo, Uruguay (ZVC-R); Fundación Miguel Lillo, Tucumán, Argentina (FML); Museo Nacional de Historia Natural do Paraguay, Assunción, Paraguay (MNHNP); Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil (MCN-R); Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil (MCP); Museu de Ciências Naturais of Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, Brazil (MCN); Museu de História Natural de Capão da Imbuia, Curitiba, Brazil (MHNCI); Museu Nacional / Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ); Museu Paraense Emílio Goeldi, Belém, Brazil (MPEG); Museu de Zoologia da Universidade Estadual de Santa Cruz, Ilhéus, Brazil (MZUESC); Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP); Museum Für Naturkunde, Berlin, Germany (ZMB); Zoologisches

- Museum, Berlin, Germany (ZSM); Muséum National d'Histoire Naturelle, Paris, French (MNHN).
- Leposternon cerradensis* (n = 20) — BRAZIL: GOIÁS: APORE: CEPB 5377, 5378; MNRJ 16111 (paratype); MZUSP 96347 (holotype), MZUSP 96348, MZUSP 98036 (paratype).
- Leposternon kisteumacheri* (n = 5) — BRAZIL: BAHIA: Jequié: MZUSP 8929; MINAS GERAIS: Januária: MZUSP 6674; Manga: MNRJ 4041 (holotype), 4042, 4044 (paratype).
- Leposternon maximus* (n = 71) — BRAZIL; GOIÁS: MAMBAÍ: MZUSP 99189, MZUSP 99194, MZUSP 99195, MZUSP 99198 (paratype); BURITINÓPOLIS: MZUSP 99198 (paratype); MINAS GERAIS: FORMOSO: MZUSP 93158 (holotype).
- Leposternon mineiro* (n = 15) — BRAZIL: MINAS GERAIS: BURITIZEIRO: CHUNB 44482; MNRJ 15489; MNRJ 15490; MNRJ; 15766; MNRJ 17795; BALANÇA; MNRJ 16198 (holotype); CRISTALINA: CEPB 1841; CEPB 1844; CEPB 1840; CEPB 1839; CEPB 1845; CEPB 1843; CEPB 1846; CEPB 1847; CEPB 1842.
- Leposternon polystegum* (n = 15) — BRAZIL: ALAGOAS: Piranhas: MZUSP 79410, MZUSP 79411, MZUSP 79414, MZUSP 79416, MZUSP 79417; MARANHÃO: Nova Vida: MPEG 11678; Paruá: MPEG 11500, MPEG 11504, MPEG 11756, MPEG 11757; Paraquém: MPEG 11502, MPEG 11755; PARÁ: Belém: MPEG 198, MPEG 199; TOCANTINS: Lajeado: MZUSP 94293.
- Leposternon infraorbitale* (n = 109) — BRAZIL: ACRE: Rio Branco: MZUSP 6387; GOIÁS: Aporé: MZUSP 99233–99242; Aragarças: MPEG 1187; BAHIA: Barra do Choça: MZUESC 5852; Boa Nova: MZUESC 2285, MZUESC 4546; Igrapiúna: MZUESC 4858, MZUESC 4865, MZUESC 5110, MZUESC 5111, MZUESC 5953; Ilhéus: MZUESC 4765, MZUESC 4777; Itabuna: MZUSP 78803; Itacaré: MCP 18180, MZUESC 3939; Itapebi: MZUESC 3274, MZUESC 3276; Santo Antônio de Jesus: MZUSP 57768; Ubaitaba: MCP 18175; MATO GROSSO: Araputanga: UFMT 3029, UFMT 3320, UFMT 3324, UFMT 3825, UFMT 3835, UFMT 3838, UFMT 3951, UFMT 3956, UFMT 3959; Campos Novos dos Parecis: UFMT 3466, UFMT 3471, UFMT 3477; Chapada dos Guimarães: UFMT 370, UFMT 2465, UFMT 2466; Cuiabá: UFMT 3473; Jauru: UFMT 3258–3260, UFMT 3264, UFMT 3322, UFMT 3325, UFMT 3326, UFMT 3332, UFMT 3836, UFMT 3837, UFMT 3952–3955, UFMT 3957, UFMT 3958, UFMT 3960; Nortelândia: UFMT 2915, UFMT 2917; Vale de São Domingos: CEUCH 2177, CEUCH 2179–2186, UFMT 3295, UFMT 3376, UFMT 3401, UFMT 3412, UFMT 3413, UFMT 3451, UFMT 3500, UFMT 3507, UFMT 3524, UFMT 3526, UFMT 3534, UFMT 3552, UFMT 3556, UFMT 3611–3613, UFMT 3617, UFMT 3618, UFMT 3632, UFMT 3633, UFMT 3636–3639; DISTRITO FEDERAL: Brasília: MZUSP 47708, 88123; MINAS GERAIS: Cataguases: MCNR 1026, MCNR 1027; Indianópolis: MCNR 207; Paraopé: MNRJ 1782, MZUSP 13752; Unai: MCNR 1027; MNRJ 10936; PARÁ: MZUSP 95681; RONDÔNIA: Espigão do Oeste: MHNCI 7347; UFAC 1804.
- Leposternon microcephalum* (n = 173) — ARGENTINA: FML 1291; BUENOS AIRES: MNHN 488 (holotype de *Lepidosternon phocaena*); CHACO: Departamento de San Fernando: FML 13544; CORRIENTES: MCN 6068; Departamento Barrio Lomas: FML 15903, FML 15904; SALTA: Departamento Orán: FML 2756, FML 14902; SANTA FÉ: Departamento La Capital: FML 1291. FORMOSA: Departamento de Laishi: FML 11312, FML 11313, FML 11318, FML 11319. BOLÍVIA: BUENA VISTA: Santa Cruz: FMNH 35666, FMNH 35667. BRAZIL: BAHIA: Boa Nova: MZUESC 4547; ESPIRÍTO SANTO: Alfredo Chaves: MZUSP 1943; Santa Leopoldina: MZUSP 6514, MZUSP 6515; Santa Tereza: MZUSP 8811, MZUSP 17448, MZUSP 17449, MZUSP 17451; São José do Calçado: MZUSP 93705; GOIÁS: Luziânia: CHUNB 49955; Minaçu, UHE Serra da Mesa: MZUSP 85220–85224; MATO GROSSO DO SUL: Anastácio: MZUSP 73315; Anaurilândia: MZUSP 16, ZUF RJ 1490; Bataiporá: MZUSP 88860; MINAS GERAIS: MZUSP 6464; Alto Jequitibá: MZUSP 95034; Belo Horizonte: ZUF RJ 797; Cataguases: MCNR 671, MCNR 708; Juiz de Fora: MZUSP 77036; Ouro Branco: MZUSP 6463; Perdões: MCNR 471; Recreio: MNRJ 11280; Sereno: MZUSP 6615; Uberlândia: MZUSP 4638; Viçosa: MZUSP 6560; PERNAMBUCO: Fernando de Noronha: MZUSP 7691. PARANÁ: Adrianópolis: MHNCI 3064; Antonina: MHNCI 11303, MZUSP 3464, MZUSP 3465; Guaraqueçaba: MHNCI 7744; Matinhos: MHNCI 957, MHNCI 2832, MHNCI 9685; Mirador: MHNCI 8275; Morretes: MHNCI 1397, MHNCI 6329; Paranaguá: MHNCI 4134, MZUSP 1265; Pontal do Paraná: MHNCI 5853; Santa Izabel do Ivaí: MHNCI 8263; São José dos Pinhais: MHNCI 7654, MHNCI 7736; Tapira: MHNCI 8272; RIO DE JANEIRO: ZMB 1395 (holotype of *Lepidosternon maximiliani*), ZMB 1396 (holotype of *Lepidosternon petersi*); Campo Grande: ZUF RJ 1676; Duque de Caxias: MZUSP 6394, MZUSP 6397–6399; Florianópolis: MZUSP 6578; Manguinhos: MZUSP 7677, MZUSP 8284; Miguel Pereira: MZUSP 65390; Rio de Janeiro: MZUSP 2426, MZUSP 2676, MZUSP 13762, ZSM 3150 (holótipo); Araquari: MHNCI 7265, MZUSP 7395. SANTA CATARINA: Corupá: MZUSP 1249, MZUSP 6466, MZUSP 6487, MZUSP 6488, MZUSP 6518; Florianópolis: MZUSP 67046, UFRJ 1003; Ilha do Arvoredo: MZUSP 67047; Itapoá: MHNCI 1400. SÃO PAULO: MZUSP 77039; Alecrim: MZUSP 6610; Aparecida do Norte: MZUSP 77538; Assis: MZUSP 77038; Campo limpo: MZUSP 89660; Candido Motta: MZUSP 6577; Cotia: MZUSP 77021; Diadema: MZUSP 77524; Embu: MZUSP 77020; Engenheiro Marsillac: MZUSP 77534; Forte do Itapuí: MZUSP 77030; Guararema: MZUSP 6640, MZUSP 77537; Guarujá: MZUSP 89391; Ilha da Queimada: MZUSP 77031, MZUSP 77032; Ilha dos Alcatrazes: MZUSP 6496; Itirapina: MZUSP 6593; Java: MZUSP 6602–6604; Jundiá: MZUSP 77533; Juquitiba: MZUSP 77539; Marília: MRT 11982–11984; Miracatu: MZUSP 77526; Paratei do Meio: MZUSP 77024; Pedro Toledo: MZUSP 77029; Peruipe: MZUSP 77026, MZUSP 81402; Piquete: MZUSP 1252; Piracicaba: MZUSP 6559, MZUSP 77041; Regente Feijó: MHNCI 3665; Registro: MZUSP 77528; Ribeirão Pires: MZUSP 6561, MZUSP 77525; Rosana: MZUSP 95612; Santo Amaro: MZUSP 77017–77019; Santo Anastácio: MZUSP 6592; São Bernardo do Campo: MZUSP 89803; São Carlos: MZUSP 6554, MZUSP 77536; São Lourenço do

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Turvo: MZUSP 6493; São Paulo: MZUSP 11959, MZUSP 77011–77016, MZUSP 77037, MZUSP 77042, MZUSP 77514–77516, MZUSP 77520, MZUSP 77521, MZUSP 89140; São Sebastião: MZUSP 6525; Taubaté: MZUSP 87545; Tupã: MZUSP 77043; Ubatuba, Ilha do mar Virado: MHNCI 7238, MZUSP 77027, MZUSP 77028, MZUSP 78431. PARAGUAY MNHNP 9446; MNHNP 10378; DEPARTAMENTO CENTRAL: MNHNP 5111; Norte de Nemby: MNHNP 7671; Asunción: MNHNP 8468, MZUSP 28386 (lectotype of *Lepidosternon latifrontalis*); Colônia Nueva Italia: FMNH 42290; Fernando de la Mora: MNHNP 10926; San Lorenzo: MNHNP 5106, MNHNP

5109, MNHNP 5110. URUGUAY: SALTO: ZVC–R 2016, ZVC–R 5906.

Leposternon octostegum (n = 4) —BRAZIL: BAHIA: Camaçari: MCP 18192–18193, MCP 96349; Salvador: MZUSP 96350.

Leposternon scutigerum (n = 5) —BRAZIL: RIO DE JANEIRO: Rio de Janeiro: MNRJ 7186, MNRJ 12452; MZUSP 2519, MZUSP 7075; ZUFRJ 289.

Leposternon wuchereri (n = 4) —BRAZIL: ESPÍRITO SANTO: Santa Tereza: MZUSP 8812; São Mateus: MNRJ 3892; BAHIA: Santa Clara: MCNR 279, 280.

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