Morphological variation and geographical distribution of *Luetkenotyphlus brasiliensis* (Gymnophiona: Siphonopidae)

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**Abstract**
Morphological variation and geographical distribution of *Luetkenotyphlus brasiliensis* (Gymnophiona: Siphonopidae). The geographical distribution of *Luetkenotyphlus brasiliensis* is reviewed based on data from the literature and examination of specimens recently collected in Brazil. We also provide new information on variation of the vomerine diastema, and meristic and morphometric data for *L. brasiliensis* based on Brazilian specimens.

**Keywords:** Brazil, caecilian, meristic data, morphometry, vomerine diastema.

**Introduction**

*Luetkenotyphlus* Taylor, 1968 is a monotypic genus of Gymnophiona established to accommodate *Siphonops brasiliensis* Lütken, 1851, by original designation. The diagnosis proposed by Taylor (1968) includes the following characters: anterior terminal shield well defined; eyes in sockets that are closer to tentacular apertures than to nostrils; premaxillary-maxillary series of teeth reduced; splenial teeth absent; 131 primary annuli; secondary grooves absent; scales absent. Taylor (1968) described *S. confusionis* to accommodate other specimens previously assigned to *S.*
brasiliensis. However, Nussbaum (1986) interpreted the holotype of S. confusionis as a juvenile L. brasiliensis and placed S. confusionis as a junior synonym of L. brasiliensis. Based on Wilkinson and Nussbaum (2006), a short series of premaxillary-maxillary teeth that does not extend posterior to the level of the choanae, along with the presence of an anterior diastema in the vomerine teeth in adults distinguishes Luetkenotyphlus from Siphonops. Surprisingly, the most recent diagnosis of Luetkenotyphlus brasiliensis presented by Wilkinson et al. (2011) disregarded the vomerine diastema without comment.

Since the description of Luetkenotyphlus brasiliensis based on a single specimen from “Brazil,” few specimens have been reported in the literature. Ihering (1911) cited the occurrence of this species in the states of Minas Gerais and São Paulo in southeastern Brazil, but no voucher specimens were reported. Dunn (1942) cited 21 specimens from south and southeastern Brazil, housed at seven herpetological collections. A record of L. brasiliensis from Argentina (Heer and Lanari 1998) is based on a single specimen collected on September 1947. Nussbaum (1986) cited records from Paraguay, based on two specimens collected between 1980 and 1982 (A. Schmitz pers. comm.). The conservation status of L. brasiliensis is unknown, and currently is defined as Data Deficient on the IUCN red list globally (IUCN 2011), as well as nationally for Paraguay (Motte et al. 2009), Argentina (Lavilla 2001), and the Brazilian states of Minas Gerais (Feio et al. 2008), São Paulo (Garcia et al. 2009) and Paraná (Mikich and Bérnils 2004).

Herein we review the geographic distribution of Luetkenotyphlus brasiliensis based on data from the literature, and from specimens housed at Brazilian zoological collections. We provide information on meristic and morphometric variation and discuss the vomerine diastema for Brazilian specimens. A photograph of a living individual of the species also is provided.

Materials and Methods

We (TM and AOM) have examined the most representative Brazilian collections for specimens of caecilians. Fifteen specimens of L. brasiliensis were found in three zoological collections—Museu de Zoologia João Moojen, Universidade Federal de Viçosa, Minas Gerais (MZUFV); Museu de História Natural Capão da Imbuia, Paraná (MHNCI); and Universidade Estadual Paulista, Campus de Rio Claro, Coleção “Célio F. B. Haddad,” São Paulo (CFBH). All specimens were sexed by direct observation of the gonads and/or the musculus retractor cloacae (of males).

We include literature records and new Brazilian locations reported here to illustrate the geographic distribution for L. brasiliensis. However, we cannot vouch for the taxonomic veracity of the literature records. We used geographic coordinates of the municipal seat of the municipality adopted by the Instituto Brasileiro de Geografia e Estatística (IBGE) (SISCOM 2011) and gazetteer publications (e.g., Paynter Jr. and Traylor-Jr 1991) when necessary.

Results

Historical Records

The first record of Siphonops brasiliensis is known to be from “Brasilien” or Brazil, as reported in its description by Lütken (1851). Subsequently, Ihering (1911) stated that the species inhabits the states of Minas Gerais and São Paulo. In the latter state, the taxon is known from the localities of Franca and Rio Feio, a tributary of upper Rio Paraná, up the Rio Batalha, near the municipality of Presidente Alves (Paynter-Jr and Traylor-Jr 1991). However, no voucher specimens were reported by Ihering.

Three decades later, Dunn (1942) reported 21 specimens from south and southeastern Brazil. The data associated with the vouchers document collection dates between the end of nineteenth
century and the first half of the twentieth century (A. Schmitz [MHNH], C. McCarthy [BMNH], H. Zaher and C. Mello [MZUSP], H. Grillitsch [NHNW], J. Hallermann [ZMH], J. Rosado [MCZ], L. Acker [SMF], M. Gomes [MNRJ], pers. comm.; Appendix I). The data associated with some specimens deposited at MCZ cited by Dunn (1942) have typographical errors—e.g., MCZ 24826 and MCZ 24829 are catalogue numbers for two frogs cataloged as *Hyla* sp. The specimen MCZ 2482 reported by Nussbaum (1986) is the holotype of *S. confusionis* (now in the synonymy of *L. brasiliensis*) (J. Rosado, pers. comm.). Other specimens cited by Dunn (1942) that lack a catalogue number were checked with the help of current curators of the relevant collections (Appendix I).

Taylor (1973) commented that the collector of the holotype of *Siphonops brasiliensis* was “Dr. Langgaard” from “São Paulo.” We think that this person is Dr. Theodoro Johanis Henrique Langgaard (1813–1883), an European doctor who had been based in Brazil since 1842, living in the interior of São Paulo, in the cities of Iperó and Sorocaba (1842–1865), and Campinas (1865–1870). Subsequently, he lived in the municipality of Rio de Janeiro (1870–1883), state of Rio de Janeiro, where he died (Menezes 1978). Because Dr. Langgaard may have received specimens from other regions in the interior of São Paulo state, we cannot affirm that the municipalities of Sorocaba or Iperó would be the type locality of *L. brasiliensis*.

Based on compiled records of *Luetkenotyphlus brasiliensis* (Figure 1), the geographic distribution of this species is mainly associated with the ecorregion of Tropical and Subtropical Moist Broadleaf forests (Olson *et al.* 2001) from eastern Brazil to northeastern Argentina, reaching transition areas with the Cerrado biome (Points 1, 2, and 4 in Figure 1). Two of the specimens examined here were found alive in the Serra do Brigadeiro State Park (20°43'19" S; 42°28'43" W, datum SAD1969, 1350 m elevation), captured by MRM and RNF after a heavy rain, at about 20:00 h on 19 October 2009 and 18:30 h on 09 December 2009. All other records are based on specimens previously housed in Brazilian herpetological collections and inspected by TM and AOM.

**Morphological Variation**

Little morphological variation was found among 15 specimens examined of *Luetkenotyphlus brasiliensis* from seven Brazilian municipalities in four States (Table 1). Nevertheless, an apparent sexual dimorphism was noted when adult males and females with similar total lengths were compared. Males have a larger body and head than females (Figure 2); the morphometric data clearly demonstrate this (Table 1). We also noted a possible indication of geographic variation in size, with individuals from eastern Minas Gerais state being larger than those from other populations (Table 1). In MNHCI 3147 and 3528, the primary grooves are slightly incomplete dorsally. Eyes are visible externally in most specimens, except MHNCI 5508, 6364, and CFBH 2498; in MZUFV 10214 only the right eye is visible. MNHCI 6382 is dehydrated and MZFV 4617 was identified as a juvenile female; it lacks developed gonads, as well as the *musculus retractor cloacae*, which is present in males. The number of primary annuli in *L. brasiliensis* ranges from 119–138 and there is no apparent sexual dimorphism in this character (Table 1).

All specimens have a short series of premaxillary-maxillary teeth that does not extend posterior to the choanae (the diagnostic character of the genus proposed by Wilkinson and Nussbaum 2006), and the tongue is smooth and attached anteriorly to the mandibular mucosa behind the dentary teeth. Four (all from municipality of Araponga, state of Minas Gerais) of the fifteen specimens examined have an anterior diastema between the right and left series of vomerine teeth. Two specimens (MZUFV 10214, 10215; both adult males with total lengths of 320 and 270 mm, respectively) have another diastema within the right and left vomerine series, between the first and the second
tooth; there are no empty sockets or teeth covered by mucosa. A female (MZUFV 2974) and an immature male (MZUFV 3941; Figure 3) have a well-defined anterior diastema between the vomerine series. All other specimens (MHNCI 3147, MHNCI 3528, MHNCI 5508, MHNCI 6364, MHNCI 6382, MZFV 4617, MZFV 4618, MZFV 4656, CFBH 2498, CFBH 3851, and CFBH 3852) lack a diastema. In some specimens (e.g., MHNCI 3147, 3528), a median tooth is present between the right and left vomerine series. Some intact or broken teeth hidden under mucosa in the anterior margin of the vomerine series may lead to misinterpretations about the presence of the diastema (e.g., MHNCI 5508; CFBH 3851).

In life, *Luetkenotyphlus brasiliensis* is uniform lavender dorsally and ventrally, except for the head, which is paler both dorsally and ventrally. The lips and region surrounding the vent can be whitish (Figure 3) or pinkish (Figure 4). Preserved specimens are grayish or brownish. Annular grooves on the sides of the body may be slightly darker than the general body color.
Table 1. Morphometric (mm) and meristic data for Brazilian specimens of *Luetkenotyphlus brasiliensis*.

| Municipality, State | Collection | Sex, maturity (M = mature; J = juvenile) | Total length | Head width at jaw articulation | Head width at level of nostrils | Head height at level of jaw articulation | Snout projection beyond mouth | Body width at midbody | Body width at five folds anterior to vent | Body height at midbody | Internarial distance | Nostril–margin of the mouth distance | Tentacle–nostril distance | Tentacle–margin of the mouth distance | Tentacle–angle jaw distance | Primary annuli | Premaxillary–maxillary teeth | Vomeropalatine teeth | Dentary teeth | Vomerine diastema (+ = present; – = absent) | Ratio of length to width at midbody |
|---------------------|------------|------------------------------------------|--------------|--------------------------------|-------------------------------|----------------------------------------|-------------------------------|-----------------|---------------------------------|---------------------|----------------|-----------------------------|---------------------------|-----------------------------|-----------------------------|--------------|---------------------------|----------------------|----------------|-----------------------------|
| Araponga, MG        | MZUFV      | ♂, M                                      | 260          | 5.8                             | 2.9                          | 7.4                              | 4.3                           | 7.5             | 6.3                             | 6.3                  | 2              | 1.3                         | 2.1                       | 1.3                         | 2.5                         | 127           | 11                       | 13                    | 15           | +                         | 34.6                  |
| Cássia, MG          | MZUFV      | ♂, M                                      | 3941         | 3.9                             | 3.9                          | 4.7                              | 1.1                           | 3.4             | 2.5                             | 2.0                  | 1.4                         | 1.0                         | 1.1                         | 1.6                         | 2.5                         | 127           | 11                       | 13                    | 15           | +                         | 34.4                  |
| Foz do Jordão, PR   | MHNCI      | ♂, M                                      | 10214        | 6.7                             | 4.0                          | 2.8                              | 1.3                           | 6.9             | 2.5                             | 2.2                  | 1.1                         | 1.0                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 46.4                  |
| Cruzeiro do       | MHNCI      | ♂, M                                      | 10215        | 6.6                             | 4.1                          | 6.3                              | 2.3                           | 6.6             | 2.6                             | 3.7                  | 1.7                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 46.1                  |
| Iguaçu, PR         | MHNCI      | ♂, M                                      | 4617         | 2.9                             | 2.0                          | 4.1                              | 1.1                           | 3.3             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 46.5                  |
| Mangueirinha, PR   | MHNCI      | ♂, M                                      | 4618         | 3.3                             | 1.9                          | 3.0                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 46.6                  |
| Ribeirão Branco, SP | CFBH       | ♂, M                                      | 4565         | 2.1                             | 1.5                          | 3.2                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 45.6                  |
| São Dominigos, SC   | CFBH       | ♂, M                                      | 3528         | 1.5                             | 1.5                          | 3.1                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 43.1                  |
| Specimen No.:       |            |                                          | 2974         | 1.5                             | 1.5                          | 3.1                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 43.8                  |
|                     |            |                                          | 3941         | 1.6                             | 1.6                          | 3.2                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 43.5                  |
|                     |            |                                          | 10214        | 1.7                             | 1.7                          | 3.3                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 43.2                  |
|                     |            |                                          | 10215        | 1.8                             | 1.8                          | 3.4                              | 1.3                           | 2.7             | 1.9                             | 2.2                  | 1.1                         | 1.1                         | 1.1                         | 1.6                         | 2.1                         | 127           | 11                       | 13                    | 15           | +                         | 43.0                  |
Figure 2. A female (MHNCI 3528, TL 280 mm) and a male (MZUFV 10215, TL 270 mm) *Luetkenotyphlus brasiliensis* with similar total lengths. (A) Female on the left; male on the right. (B and C) Female on the top and male on the bottom. General aspect, dorsal and lateral views respectively. Note the head proportions. Scale bars = 5 mm.

Figure 3. Palatal region of a juvenile specimen of *Luetkenotyphlus brasiliensis* with 117 mm of total length (MZUFV 3941). Vomerine diastema represented above by the black bar.

Discussion

*Luetkenotyphlus brasiliensis* currently is categorized as Data Deficient in the state of Minas Gerais (Feio et al. 2008), although there is no official record of this species in this Brazilian state. Ihering (1911) cited *L. brasiliensis* as occurring in Minas Gerais, but no voucher specimen was identified. Dunn (1942) reported three specimens (ZMH A00249-A00251) from southern Brazil. However, the catalogue data for these specimens indicate that they were collected from the mountains between states of Espírito Santo and Minas Gerais, Brazil (J. Hallermann, pers. comm.), probably referring to the northern portion of Serra da Mantiqueira, which is located in the boundary between these two Brazilian states. The presence of this species in the municipalities of Araponga (at the Serra do Brigadeiro State Park) and Cássia are new,
vouchered records of *L. brasiliensis* in Minas Gerais. Serra do Brigadeiro mountain, where Serra do Brigadeiro State Park is located, corresponds to northwest region of the Serra da Mantiqueira mountain range, also corresponding to the highest elevation from which the genus is known (i.e., 1350 m). Most records of *Luetkenotyphlus* are from lower-elevation regions, usually less than 500 m (IUCN 2011).

Like many other caecilians, little is known about the geographic distribution of *Luetkenotyphlus brasiliensis*. Most species are fossorial and hard to find; consequently, many are only known from relatively few specimens and localities (Ávila-Pires et al. 2010). In fact, 30% of caecilian taxa from Brazil are known only from their types. Save for the specimens collected in Minas Gerais, we obtained all other *L. brasiliensis*, while a hydroelectric powerplant dam was being filled. Many new fossorial taxa have been described in the last decade as a result of faunal rescue efforts when reservoirs are filled (Mott et al. 2008, Maciel et al. 2009, Strüssmann and Mott 2009). It is alarming to think that such terrestrial habitats are now flooded and that populations of organisms, at best, suffered local reductions if they did not become extinct.

Our discovery of an anterior diastema between the right and left series of vomerine teeth in a juvenile specimen is incongruent with the diagnoses of *Luetkenotyphlus* presented by Nussbaum (1986) and Wilkinson and Nussbaum (2006). Moreover we have demonstrated sexual dimorphism, as well geographical variation, in size in *L. brasiliensis*. Sexual dimorphism in head size (males having wider heads than females) has been reported in other siphonopid genera such as *Brasilotyphlus guarantanus* (Maciel et al. 2009), and *Microcaecilia taylori* (Maciel and Hoogmoed 2011); thus, it seems widespread among caecilians (Kupfer 2009). Although Nussbaum (1986) did not find evidence for sexual dimorphism in the five individuals of *L. brasiliensis* that he examined, we did in our larger sample, but unfortunately, our sample size was insufficient to allow us to conduct statistical analyses. Additionally, we find larger morphometric values for specimens from Araponga (same specimens which presented the vomerine diastema) in relation to specimens from other populations; geographic variation in size has not been reported in any siphonopid. Further, our observation of a vomerine diastema in a diminutive, immature specimen (MZUFV 3941) differs from that of Nussbaum (1986), who inferred an appearance of the diastema late in the ontogeny of *Luetkenotyphlus*. Although we have some indication of variability in this character,
we refrain from making further speculations before examining more specimens.

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References


*Morphological variation and geographical distribution of Lukenotyphlus brasiliensis*
Appendix I. Specimens of *Luetkenotyphlus brasiliensis* cited in literature and/or examined in this work. Acronyms: BHNH (Natural History Museum, London, England); CFBH (Coleção Herpetológica Célio Fernando Baptista Haddad, Universidade Estadual Paulista, São Paulo, Brazil); MACN (Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina); MCT (Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul); MCZ (Museum of Comparative Zoology, Harvard University, Cambridge, EUA); MHNCI (Museu de História Natural Capão da Imbuia, Paraná, Brazil); MHNG (Muséum national d’Histoire naturelle, Paris, France); MNRJ (Museu Nacional, Rio de Janeiro, Brazil); MZUFV (Museu de Zooligia João Moojen, Universidade Federal de Viçosa, Minas Gerais, Brazil); MZUSP (Museu de Zooligia, Universidade de São Paulo, São Paulo, Brazil.); NHNW (Naturhistorisches Museum Wien, Vienna, Austria); SMF (Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt, Germany); ZMH (Zooligisches Museum Hamburg, Universität Hamburg, Hamburg, Germany); ZMUC (Zooligical Museum, University of Copenhagen, Copenhagen, Denmark). Localities previously known as: 1, Colonia Hansa; 2, Pernahyba or Parnahyba; 3, Ypiranga; 4, Ciudad Presidente Stroessner. *Date determined based on date of identification or citation in published paper. – = data not available.

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