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Journal of Natural History

Publication details, including instructions for authors and
subscription information:

<http://www.tandfonline.com/loi/tnah20>

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Version of record first published: 26 Mar 2013.

To cite this article: R. R. Silva , R. M. Feitosa , C. R.F. Brandão & A. V.L. Freitas (2013): The first
Leptanilloides species (Hymenoptera: Formicidae: Leptanilloidinae) from eastern South America,
Journal of Natural History, DOI:10.1080/00222933.2012.763058

To link to this article: <http://dx.doi.org/10.1080/00222933.2012.763058>

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The first *Leptanilloides* species (Hymenoptera: Formicidae: Leptanilloidinae) from eastern South America

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(Received 14 April 2012; final version received 21 November 2012)

We describe a species of the exclusively Neotropical dorylomorph ant genus *Leptanilloides* (Leptanilloidinae), *Leptanilloides atlantica* sp. nov., based on workers collected in the Atlantic Forest, São Paulo, south-eastern Brazil. The 11 species of *Leptanilloides* described are known from relatively high altitudes in western America (from the Andes foothills in Bolivia to Sierra Morena in Mexico). The discovery of a *Leptanilloides* species in south-eastern Brazil represents a significant range extension for the genus; this new species shares characters with *Leptanilloides biconstricta* (Bolivia), *Leptanilloides femoralis* (Venezuela) and *Leptanilloides gracilis* (Mexico) and may be distinguished based on a combination of traits. The hypogaecic habits of Leptanilloidinae combined with inefficient collecting techniques may explain the paucity of information and of specimens of this group in most museum collections as well as its present apparent disjunct distribution. We compare *Leptanilloides* distribution to that of other organisms that show similar disjunct patterns in the Andes and montane sites in the Brazilian Atlantic Forest.

<http://www.zoobank.org/urn:lsid:zoobank.org:pub:E7E334AA-58C0-455D-A0A6-724D29226DD0>

Keywords: ants; Atlantic Forest; taxonomy; disjunct distribution; Brazil

Introduction

The Neotropical subfamily Leptanilloidinae comprises three genera of predominantly small hypogaecic blind ant predators with subterranean legionary habits (Brandão et al. 1999; Longino 2003; Donoso et al. 2006; Ward 2007; Ward and Brady 2009; Borowiec and Longino 2011). Fifteen Leptanilloidinae species have been described so far; 11 in *Leptanilloides* (western South America, Central America and Mexico), three in *Asphinctanilloides* (south-eastern Brazil and central Amazon), and one in *Amyrmex* (northern Argentina and Rondonia, western Brazilian Amazon). *Amyrmex* is still known only from males and may be a senior synonym of a species of *Asphinctanilloides* (Ward and Brady 2009). Borowiec and Longino (2011) described three different unassociated *Leptanilloides* males from Central America, without giving them specific names.

Most leptanilloidine species were described from workers collected in a single event in one locality, with meagre biological information (Brandão et al. 1999; Donoso et al. 2006; Borowiec and Longino 2011). This results in the absence of knowledge on

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morphological patterns of variation within and among species and on natural history details. For most described species, the males, larvae or reproductive females are not known. Gynes and workers of leptanilloidine ants show expression of army ant syndrome and their study may help to understand the early stages of army ant evolution (Donoso et al. 2006). The type series of *Asphinctanilloides anae* Brandão, Diniz, Agosti and Delabie workers were recorded preying on an unidentified arthropod on the soil surface, showed an army ant foraging pattern (Brandão et al. 1999). The presence of similar-sized larvae of *Leptanilloides legionaria* Brandão, Diniz, Agosti and Delabie along with workers of the type-series and also numerous larvae in the same stage found during collections of *Leptanilloides nomada* Donoso, Vieira & Wild and *Leptanilloides nubecula* Donoso, Vieira and Wild (Donoso et al. 2006), suggests synchronization of immature production, which is part of the army ant syndrome (Brandão et al. 1999; Donoso et al. 2006).

In the present paper we describe the first *Leptanilloides* species for the Brazilian Atlantic Forest, expanding the known distribution of the genus 2500 km east of all other known samples. We discuss this finding and compare the distribution of the genus with that of other organisms that show similar patterns of disjunct distribution in the Andes and in montane sites in the Brazilian Atlantic Forest.

Material and methods

All individuals were collected in a single pitfall trap inside the forest in the Paranapiacaba Biological Reserve, Santo André, south-eastern Brazil.

Observations were made at 60 × magnification with a Leica MZ95 stereomicroscope. Worker measurements and indices are based on Brandão et al. (1999) and Borowiec and Longino (2011).

Abbreviations used throughout text: HL, head length, measured in full-face view, from the anterior median clypeal border to the median vertexal border; HW, maximum head width in full-face view; SL, scape length excluding the condylar bulb; ML, mesosoma length from the base of anterior slope of pronotum to the lower posterior angle of propodeum, taken in side view; PW, pronotal width, maximum width in dorsal view; FFeL, length of the fore femur; FFeW, maximum width in lateral view of the front femur; HFeL, length of the hind femur; HTiL, length of the hind tibia; PL, petiole length, measured along a parallel line to the tergo-sternal suture, from the anteriormost to posteriormost visible portions of tergite; PPL, postpetiole length, measured along a parallel line to the tergo-sternal suture, from anteriormost to posteriormost visible portions of tergite; AIVW, fourth abdominal tergite width (maximum width taken in dorsal view); CI, cephalic index ($HW \times 100/HL$); SI, scape index ($SL \times 100/HW$).

Specimens were imaged with LEICA APPLICATION SUITE V3 system at MZSP. Images were processed as .tiff files in ADOBE PHOTOSHOP CS3. For scanning electron microscopy of an *L. atlantica* sp. nov. worker, one specimen was washed in a graded series of acetone and critical point-dried before metallization and observation under the MZSP electron microscope. Six non-type specimens were kept in 90% alcohol.

Specimens were deposited in: CASC, California Academy of Sciences, San Francisco, CA, USA; CPDC, Centro de Pesquisas do Cacau, Itabuna, Bahia, Brazil; MCZC, Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA; MZSP, Museu de Zoologia da Universidade de São Paulo, São Paulo, SP, Brazil;

USNM, National Museum of Natural History, Smithsonian Institute, Washington, DC, USA; ZUEC, Museu de Zoologia da Universidade Estadual de Campinas, Campinas, SP, Brazil.

Results

Leptanilloides atlantica sp. nov. Silva, Brandão, Feitosa and Freitas
Figures 1A–D and 2A–F

Holotype worker

BRAZIL, SP, Santo André, Paranapiacaba, Reserva Biológica do Alto da Serra de Paranapiacaba, 23°46'18" S, 46°20'24" W, 800 m above sea level, Atlantic Forest, 12 January 2007; Uehara-Prado M. col.; Pitfall trap #K4; [MZSP].

Paratype workers

Thirty-two point-mounted specimens with the same data as the holotype, [MZSP (26), ZUEC (2), CASC (1), CPDC (1), MCZC (1), USNM (1)].

Worker measurements (holotype): HW 0.25, HL 0.34, SL 0.15, ML 0.41, PW 0.16, PL 0.11, PPL 0.11, FFeW 0.07, FFeL 0.19, HFeL 0.21, HTiL 0.23, AIVW 0.24, CI 74.51, SI 60.53.

Worker measurements and indices (15 measured): HW 0.24–0.25, HL 0.34–0.36, SL 0.14–0.16, ML 0.39–0.41, PW 0.15–0.17, PL 0.11–0.12, PPL 0.09–0.11, FFeW 0.07–0.08, FFeL 0.19–0.20, HFeL 0.20–0.21, HTiL 0.21–0.23, AIVW 0.23–0.25, CI 66.67–73.08, SI 57.89–66.67.

Diagnosis

Leptanilloides atlantica is similar to *Leptanilloides biconstricta* Mann from Bolivia, but can be easily distinguished from it by the uninterrupted mesopleura and metapleura reticulation, versus fine, superficial and interrupted in *L. biconstricta*. *Leptanilloides atlantica* also differs from *L. biconstricta* by the more densely foveolate head, with circa 20–30 foveolae covering a straight transverse line at head midlength, whereas there are only 10–20 in *L. biconstricta*. Additionally, *L. atlantica* can be distinguished from *L. biconstricta* by the petiole as long as the postpetiole (petiole longer than postpetiole in *L. biconstricta*), comparatively smaller body size (best seen in head size and mesosoma length) and sternite on abdominal segment III anteriorly bulging (evenly rounded in *L. biconstricta*). *Leptanilloides atlantica* is also similar to *Leptanilloides femoralis* Borowiec and Longino from Venezuela, with which it shares a relatively enlarged femur (FFeW 0.07–0.08 in *L. atlantica*, 0.08–0.09 in *L. femoralis*), and the fine microreticulate sculpture on the mesopleuron, propodeum and petiole. It can be distinguished from *L. femoralis* by the presence also of a subpetiolar process with an acute anteriorly projecting tooth (absent in *L. femoralis*). *Leptanilloides atlantica* can be differentiated from *L. gracilis* Borowiec and Longino based on the shallow anterior constrictions of abdominal segments IV–VI in *L. atlantica*, whereas

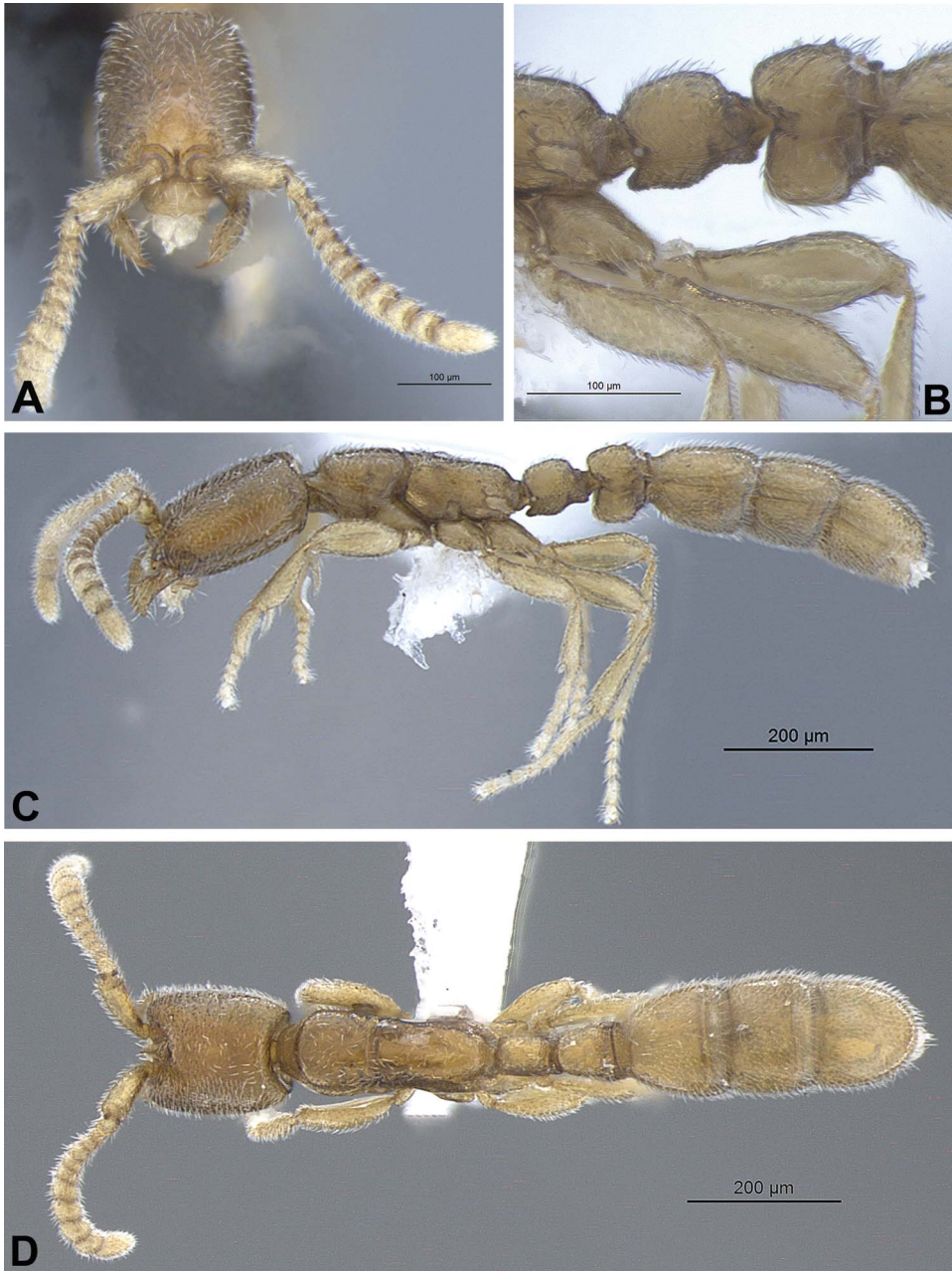


Figure 1. Worker of *Leptanilloides atlantica* sp. nov. from Santo André, Brazil. (A) Head in full-face view; (B) habitus; (C) body in dorsal view; (D) petiole and postpetiole in detail.

they are deeply impressed in *L. gracilis*, and on the anteriorly bulging ventral margin of the abdominal segment III in *L. atlantica*, whereas in *L. gracilis* the ventral margin is evenly rounded (Table 1).

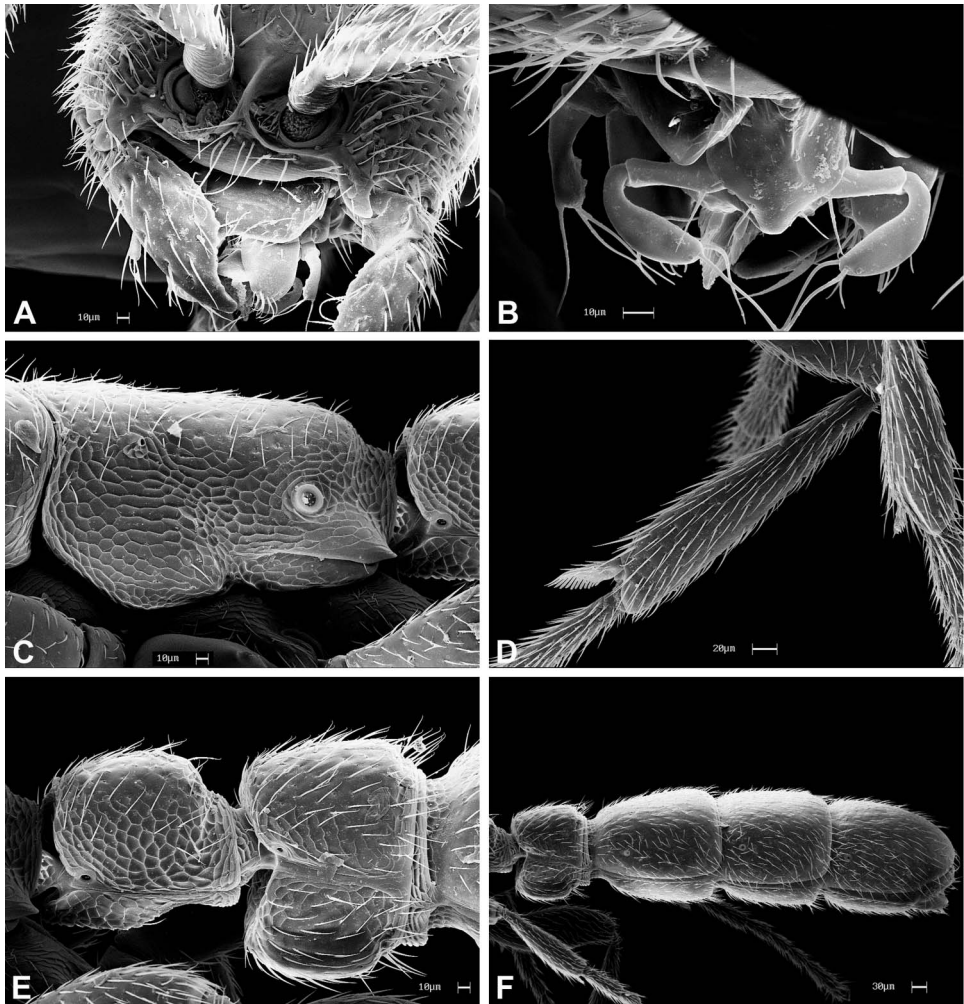


Figure 2. Scanning electron micrographs of *Leptanilloides atlantica*. (A) Detail of clypeal area and antennal insertions; (B) mouthparts in ventral view; (C) lateral view of mesopleuron, metapleuron and propodeum; (D) internal surface of posterior tibia; (E) detail of petiole and postpetiole in lateral view; (F) postpetiole and gaster in lateral view.

Description

With the character states of Dorylomorphs, Leptanilloidinae and *Leptanilloides* (Borowiec and Longino 2011) and with the body and appendages yellowish-brown covered by short, moderately abundant, subdecumbent to appressed hairs; somewhat longer hairs located on the anterior portion of the cephalic capsule. Dorsal surface of head with a longitudinal median line devoid of any sculpture. Head, mesosoma, petiole, postpetiole and gaster comparatively densely foveolate; head with circa 20–30 foveolae covering a straight transverse line at head midlength. Mesopleura and metapleura and propodeum entirely reticulate; petiole reticulate except on the dorsal face. Gaster smooth and shiny.

Table 1. List of informative characters to separate *Leptanilloides atlantica* from similar species in the genus (*L. biconstricta*, *L. femoralis* and *L. gracilis*).

	<i>L. atlantica</i>	<i>L. biconstricta</i>	<i>L. femoralis</i>	<i>L. gracilis</i>
Flange over the metapleural gland	sharply pointed	sharply pointed	rounded	sharply pointed
Mesopleura and metapleura reticulation	not interrupted	interrupted	not interrupted	not interrupted
Petiole length	as long as postpetiole	petiole longer than postpetiole	petiole shorter than postpetiole	petiole shorter than postpetiole
Fore femur width	relatively enlarged	not enlarged (slender)	enlarged	not enlarged (slender)
Abdominal segments IV-VI	separated by shallow constrictions	separated by deep constrictions	separated by deep constrictions	separated by deep constrictions
Anterior subpetiolar tooth	present	present	absent	absent
Ventral profile of subpetiolar process	straight	straight	distinctly bulging medially	distinctly bulging medially
Sternite on abdominal segment III	anteriorly bulging	evenly rounded	posteriorly bulging	evenly rounded

Head longer than broad. Lateral margins of head modestly convex and almost subparallel; occipital corners rounded; vertexal margin slightly convex. Clypeus with some setae projecting anteriorly. Mandibles short, with distinct basal and masticatory margins separated by a rounded angle; masticatory margin concave, bearing minute denticles; external margin of mandibles convex; dorsal surface with scattered piligerous punctures and short setae. Palp formula 2,2 (count *in situ*). Antennal scape short and clavate, about one-third of the total length of head, covered by evenly distributed piligerous punctures; first funicular joint incrassate, slightly longer than the second; apical segment about twice as long as the preceding segment.

Mesosoma subrectangular. Pronotum with the promesonotal suture conspicuous, complete and flexible. Metanotal groove not impressed. Posterior face of propodeum relatively short, meeting the dorsal face in a rounded and unarmed angle. Flange over the metapleural gland opening sharply pointed posteriorly. Tibiae enlarged apically; mid tibia with one simple and hind tibia with one pectinate spur.

Petiole slightly longer than broad; anterior face slightly concave in lateral view; in dorsal view, lateral margins straight; petiolar spiracle small and inconspicuous, set near the anterior rim of tergite subpetiolar process with an acute, anteriorly projecting tooth. Postpetiole relatively large, as long as the petiole, subquadrate in lateral view; anterior face concave medially and straight posteriorly, in dorsal view lateral margins diverging posterad; sternite spiracle set anteriorly on the tergite.

Abdominal segments IV, V and VI similar in length; abdominal segments III and IV broader than long in dorsal view.

Etymology

The type series was collected in a locality in the Atlantic Forest biome, and hence its name.

Comments

The sample includes 39 workers (six in alcohol) captured in a single pitfall trap set on the forest floor, at 800 m altitude. The collection point is a patch of secondary montane Atlantic Forest. The predominant climate in the region is humid, without a well-defined dry season; annual rainfall ranges from *c.*1860 to *c.*4400 mm (see Uehara-Prado et al. 2009 for site details).

Discussion

Leptanilloides atlantica is similar to some other small species of the genus (mainly *L. biconstricta*, *L. femoralis* and *L. gracilis*). It can be identified by the following combination of traits: (1) sharply pointed flange over the metapleural gland, (2) mesopleura and metapleura reticulation not interrupted, (3) densely foveolate head, (4) petiole as long as the postpetiole, (5) enlarged fore femur, (6) abdominal segments IV–VI separated by shallow constrictions, (7) subpetiolar process with an acute, anteriorly projecting, tooth, (8) ventral profile of the subpetiolar process flat, and (9) sternite on abdominal segment III bulging anteriorly.

The description of *L. atlantica* in the Brazilian Atlantic Forest brings new data to the biogeography of *Leptanilloides*. Most described species in the genus are known from the Andes, from the Andean foothills of Bolivia to higher altitudes in Colombia and Ecuador (Brandão et al. 1999; Donoso et al. 2006). Recently described *Leptanilloides* species expanded the range of the genus to Costa Rica (Longino 2003), Mexico and Guatemala (Borowiec and Longino 2011), and Venezuela (Borowiec and Longino 2011). Now, the present study shows that *Leptanilloides* also occurs in montane sites in south-eastern Brazil.

In particular, the first occurrence of *Leptanilloides* in the Brazilian Atlantic Forest implies a disjunct distribution pattern between Andean *Leptanilloides* and *L. atlantica*. Similar biogeographical patterns have been described in studies on montane birds (Ribas et al. 2007), hylid frogs (Faivovich et al. 2005), the leptodactylid genus *Ischnocnema* (Padiá et al. 2005), in rodents (Percequillo et al. 2011), and in butterflies (Brown 1987). Literature examples suggest a historical relationship between the Atlantic Forest Serra do Mar and Austral Andean centres of endemism for hylid frogs, between Serra do Mar and the Peruvian Andes for rodents, and between Serra do Mar and the Andean Cordillera for birds (see discussion in Percequillo et al. 2011). Ribas et al. (2007) provided evidence that the spatiotemporal distribution of *Pionus* parrots, which display a very similar disjunct pattern, is linked to Andean tectonics and palaeoclimate changes through vicariance. Brown (1987) showed that there is high similarity between the south central Andes and south-eastern Brazil in several butterfly genera, and that this is a legacy of past climatic changes when a 'bridge' of suitable vegetation existed across northern Argentina, linking the Andes to the mountain chains in south-eastern Brazil.

There are also examples of disjunct distribution in plants. Safford (2007), analysing the vascular plant genera of high-altitude grasslands in Brazil, concluded that their floristic similarity is greater with tropical Andean plants than with those of lowland and middle elevation areas of central and south-eastern Brazil. In montane and upper-montane Atlantic Forest areas, bryophytes with restricted distributions are preponderant, including many endemics and some showing disjunct distributions, with populations in the northern Andes and Central America (Santos and Costa 2010), probably reflecting the effects of long-distance dispersal by air currents and climatic similarities between the high-altitude grasslands and the northern Andes (Safford 2007; Santos and Costa 2010).

Despite several cases in the literature in which it was possible to show that the observed disjunct patterns reflect real distributions, we cannot discount the possibility that the apparent disjunct distribution pattern observed in *Leptanilloides* results from an insufficient collecting effort applied to the subterranean environment; these ants may be much more common and widespread than presently known. *Amyrmex* (known only from males) may be identical either to *Leptanilloides* or *Asphinctanilloides* (Ward and Brady 2009); the apparent distribution gap of South American *Leptanilloides* should be reconsidered if *Amyrmex* is synonymous with *Leptanilloides*.

Acknowledgements

We acknowledge support from the Fundação à Pesquisa do Estado de São Paulo, Biota Program (grant 98/05083-0 to C.R.F. Brandão) and research grants to R.R. Silva (10/20570-8 and 10/51194-1), R.M. Feitosa (07/01310-2 and 11/24160-1) and A.V.L. Freitas (11/50225-3).

C.R.F. Brandão and A.V.L. Freitas are fellows of the Brazilian National Council for Science and Technology Development (CNPq). Lara M. Guimarães (MZSP) kindly prepared the scanning electron micrographs; Lívia P. do Prado and Ricardo Kawada prepared the high-definition images. Tatiane Gisele Alves Alves kindly sent us *Leptanilloides atlantica* samples.

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