

Systematics, Morphology and Biogeography

A new species of *Machaerobia* Rübsaamen, 1915 (Diptera, Cecidomyiidae) from Brazil

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ABSTRACT

A new species of *Machaerobia* Rübsaamen, 1915 (Diptera: Cecidomyiidae) from Brazil. *Machaerobia* Rübsaamen, 1915 is a Neotropical genus, until now known from a single species, *M. machaerii* (Kieffer, 1913), described from Brazil (State of Santa Catarina). That species induces spherical leaf galls on *Machaerium* sp. (Fabaceae) and its geographical distribution is still restricted to the type-locality. A new galling species, *Machaerobia gemmae*, associated with *Machaerium macaense* (Fabaceae), is described and illustrated (larva, pupa, male, and female) based on material collected in the Parque Nacional da Serra dos Órgãos (State of Rio de Janeiro, Brazil). The new species is unique for its one or two-segmented palpi, deeply notched aedeagus, pupa with free dorsal abdominal spines, larva with reduced spatula and two apically sclerotized terminal lobes. We synonymize *Anadiplosis* Tavares, 1916 under *Machaerobia* Rübsaamen, 1915. Six wasp species (Hymenoptera) are associated with the galler: *Tanaostigmodes carinatus* La Salle 1987 and *Tanaostigmodes* sp. (Tanaostigmatidae), *Galeopsomyia* sp. (Eulophidae), *Calorylea* sp. (Eurytomidae), and two undetermined species of Eurytomidae.

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Introduction

Machaerobia Rübsaamen, is a Neotropical genus with until now a single species, *M. machaerii* (Kieffer, 1913) described from Brazil (Santa Catarina). It induces spherical leaf galls on *Machaerium* sp. (Fabaceae) and its geographical distribution is still known only from its type-locality.

The tribe Anadiplosini, where *Machaerobia* is included, comprises four other genera, all Neotropical: *Alexomyia* Felt, 1921, *Anadiplosis* Tavares, 1916, *Scopodiplosis* Felt, 1915, and *Ulella* Rübsaamen, 1908. The tribe is characterized by the placement of Rs beyond the midlength of R1, the slightly curved base of M, the short tibiae relative to the femora and tarsi, legs with ventroapical spine on the first tarsomere of each leg, the rudimentary empodia, and the uniquely modified ovipositor that is bulbous basally and tapered beyond. Larvae are distinctive for their caudal lobes, reduced or lost spatula, and reduced papillae. Male antennal flagellomeres have regular, short-looped circumfila and the distal node constricted between the two circumfila whorls. Female flagellomeres are long and constricted near the lower transverse circumfilar ring (Gagné, 1994). Adults of *Machaerobia* and *Anadiplosis* have

simple tarsal claws, two-segmented palpi, and bulbous ovipositor on the basal third, tapered beyond (Gagné, 1994).

Here, we describe a new species of *Machaerobia* based on material (larva, pupa, male and female) collected in the Parque Nacional da Serra dos Órgãos (State of Rio de Janeiro, Southeast Region of Brazil) from spherical, green, hairy, bud galls on *Machaerium macaense* Mendonça, Azevedo and Lima, 2011 (Fabaceae).

Machaerium Pers. is a diverse botanical genus, with about 74 described species in Brazil (Lista de espécies da Flora do Brasil, 2016). It is predominantly Neotropical, and commonly known as “jacarandá”. Its wood is used in civil and rustic constructions, carpentry and mainly as firewood and charcoal. It is also recommended for reforestation, helping in the recovery of degraded areas (Lorenzi, 2002). *Machaerium macaense* is an endemic species in Brazil, recorded only from the State of Rio de Janeiro, in ombrophilous forest (Atlantic Forest) (Lista de espécies da Flora do Brasil, 2016).

The Parque Nacional da Serra dos Órgãos (PARNASO) is situated in the central region of the State of Rio de Janeiro, in the Serra dos Órgãos’ massif and includes the municipalities of Guapimirim, Magé, Petrópolis, and Teresópolis (Fig. 1). The PARNASO comprises about 20,000 hectares of Atlantic Forest at an altitude ranging from 100 up to 2200 m a.s.l. (Radam Brasil, 1983), including the highest peaks of the Serra do Mar (Drummond, 1997). The flora is diverse, with about 2800 plant species. In altitudes of 100–1500 m, the vegetation is classified as montane forest, with trees reaching a height

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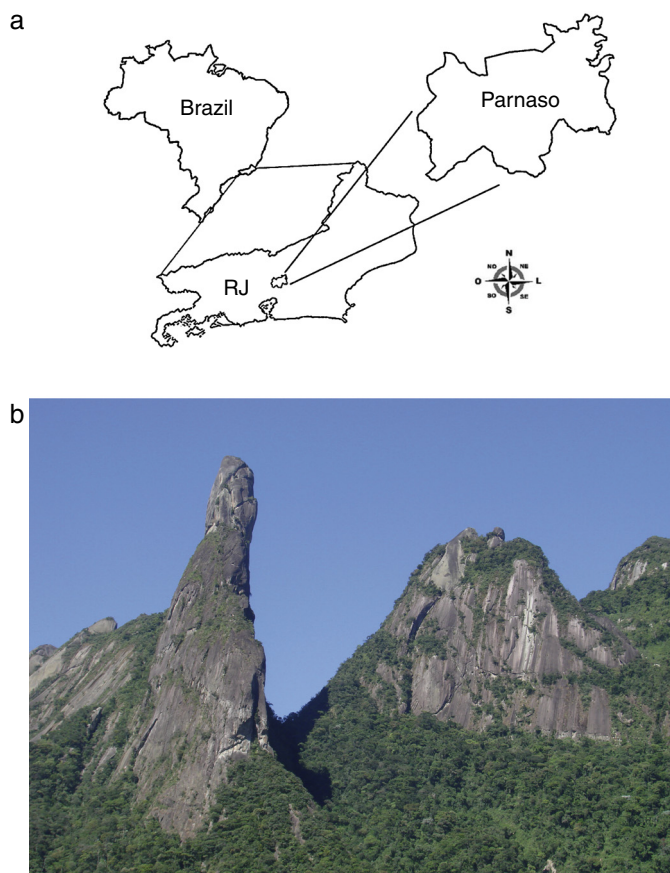


Fig. 1. Parque Nacional da Serra dos Órgãos (PARNASO). 1a. maps of localization; 1b. Panoramic view of the PARNASO.

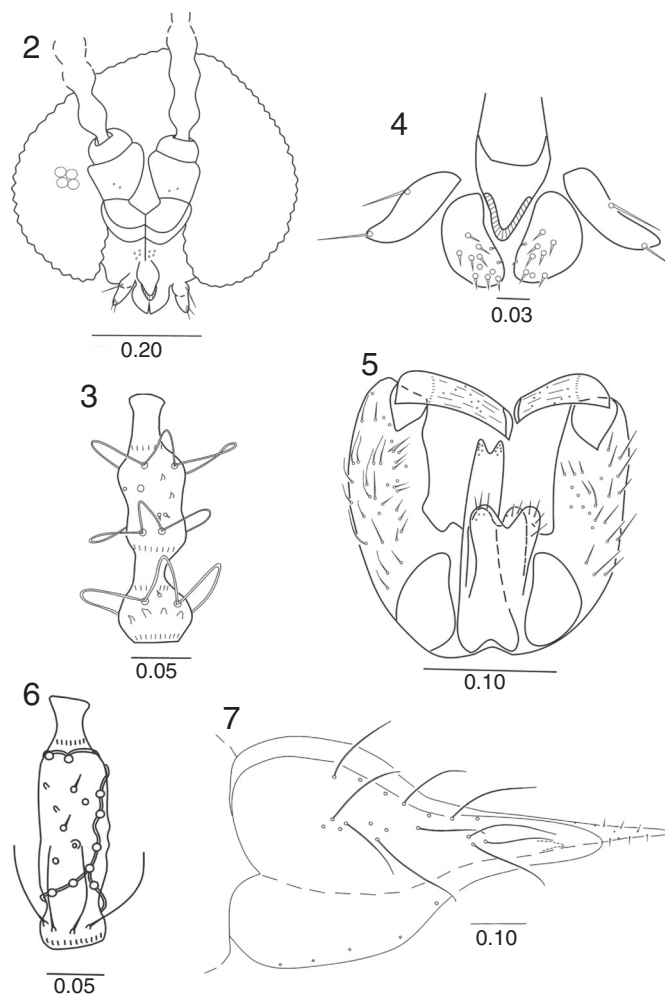
in 40 m. Above 2000 m, there is a predominance of grasses and rock-dwelling species.

Only two cecidomyiid species have been recorded from PARNASO: *Asphondylia moehnei* Skuhřavá, 1989 and *Contarinia ubiquita* Gagné, 2001 (Maia and Barros, 2009). Two other species, *Asphondylia glomerata* Gagné, 2001 and *Mikaniadiplosis annulipes* Gagné, 2001 have been recorded in Teresópolis, but it is unknown if they occur in the PARNASO (Gagné and Jaschhof, 2014).

Material and methods

Galled leaves were collected in September, 2012 and October, 2013 to January, 2014 in PARNASO, Municipality of Teresópolis (S22°25', W42°59') at an altitude of 900 m a.s.l. They were removed from the host plant and transported in plastic bags to the laboratory, where part of the sample was dissected to obtain the galling larvae and part was kept in plastic pots covered by a fine screen to obtain adults and pupal exuviae.

The specimens were first preserved in 70% ethanol and then mounted on microscope slides, following the method outline by Gagné (1994). The gall midge was identified based on the key in Gagné (1994) and on information given by Tavares (1916, 1920). The new species was compared to the descriptions of the known species of *Anadiplosis* and *Machaerobia*. The original drawings are enough to allow the comparison and segregation among them. The most important morphological characters were illustrated using light microscope with camera lucida. Measurements were made using a microscope slide with scale. The terminology of Gagné (1994) was adopted.



Figs. 2–7. *Machaerobia gemmae*, new species. 2. Male head, frontal; 3. male flagellomere 5; 4. male, mouth parts, frontal; 5. male terminalia, dorsal; 6. female flagellomere 5; 7. ovipositor, ventral. Scales in mm.

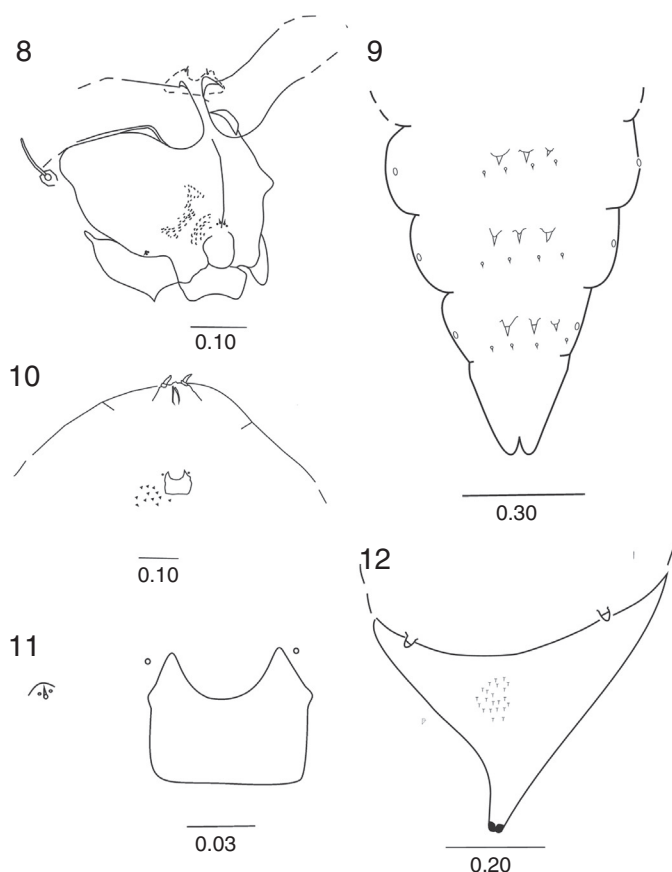
Type-material is deposited in the Diptera Collection of the Museu Nacional (MNRJ)/Universidade Federal do Rio de Janeiro. The field and laboratory works were done by R.F.M. and V.A.C.W., while the description of the new species was done by V.C.M.

Taxonomy

Machaerobia gemmae Maia, **sp. nov.** (Figs. 2–13)

Diagnosis: Adult: palpus one or two-segmented; tarsal claws simple; male hypoproct and cercus similar in shape; cercus slightly longer than hypoproct, aedeagus deeply notched; gonocoxites with rounded mesobasal lobe, ovipositor bulbous with long, flexible lateral setae, female cerci with some sensorial setae, the tapered cerci with a few short setae. Pupa: antennal horns short, abdominal tergites 6–8 with a row of three or four spines. Larva: spatula with two widely separated teeth and reduced shaft; mamelons absent; terminal segment elongate, tapered to apex, sclerotized apically, without apparent papillae.

Adult description. Male. Body length: 3.20–4.60 mm ($n=3$). Head (Fig. 2): eye facets circular, closely approximated. Antenna: scape about as long as large; pedicel: 0.50–0.55 times wider than long; flagellomeres binodal, distal node constricted at middle, tricuspid, circumfilar, circumfila with loops short and regular in length, neck bare (Fig. 3), flagellomere 12 with a setulose apical process. Frontoclypeus with 08–10 setae ($n=3$). Mouthparts (Fig. 4): palpus



Figs. 8–12. *Machaeriobia gemmae*, new species. 8. pupa, head and prothoracic spiracle; 9. pupa, terminal segments, dorsal; 10. larva, head and spatula, ventral; 11. larva, spatula and lateral papillae, ventral; 12. larva, terminal segment, dorsal. Scales in mm.

slightly longer than large, with one or two segments, claviform when one-segmented, first segment globose and second claviform when two-segmented; labrum long-attenuate with one pair of ventral sensory setae; hypopharynx of same shape as labrum, with long, apically directed lateral setulae; labella hemispherical, with several lateral setae and three pairs of short mesal sensory seta. Thorax: Anepimeron with several setae, other pleural sclerites aetose. Wing: 3.60–2.80 mm long ($n = 3$). Halter: 0.60 mm long ($n = 3$).



Fig. 13. Gall of *Machaeriobia gemmae*, new species, general aspect.

Apical projection of first tarsomere 0.016 mm ($n = 3$) long. Legs missing. Abdomen: tergite 1 sclerotized only at distal half; tergites 2–7 rectangular, completely sclerotized; tergites 1–7 with a complete row of posterior setae, two anterior trichoid sensilla and elsewhere with scattered scales. Tergite 8 elliptical, with only two anterior trichoid sensilla as vestiture. Sternites 2–8 completely sclerotized, rectangular, with setae more abundant mesally, a complete row of posterior setae, and two anterior trichoid sensilla. Terminalia (Fig. 5): gonocoxite about 4 times long than large, cylindrical beyond short mesobasal lobe; gonostylus about 5 times as long as wide, cylindrical; cercus setose with margin convex, slightly longer than hypoproct; hypoproct setose, similar in shape to cercus; aedeagus deeply notched at apex. Female: as for male, except for: body length: 5.60 mm ($n = 1$); head: antenna: scape about 2 times wider than long; pedicel: 1.4 times wider than long ($n = 1$); flagellomeres cylindrical with two interconnected circumfilal rings and bare neck (Fig. 6); twelfth flagellomere with setulose apical process. Wing: 4.13 mm long ($n = 1$). Halter: 0.70 mm long ($n = 1$). Abdomen: tergites 1–7 rectangular with a complete row of posterior setae, a row of mesal setae, two anterior trichoid sensilla and elsewhere with scattered scales; tergite 8 unsclerotized, with a pair of anterior trichoid sensilla. Sternites 2–7 rectangular with setae more abundant mesally, a complete row of posterior setae and two anterior trichoid sensilla. Sternite 8 unsclerotized. Ovipositor basally bulbous, tapered beyond with lateral setae, 1.6 times longer than sternite 7, cerci tapered to point, with a few short setae, hypoproct glabrous (Fig. 7).

Pupa. Length: 2.40–2.80 mm ($n = 3$). Head (Fig. 8) with grainy integument and short antennal horns (0.05 mm long) ($n = 3$); pair of cephalic setae very short (0.007 mm long) ($n = 3$); two pairs of lower facial papillae, one aetose, the other with short seta; three pairs of lateral facial papillae, two with short seta, the other aetose. Prothoracic spiracle relatively short (0.12 mm long), setiform (Fig. 8). Abdominal tergites 6–8 each with a single row of three or four dorsal spines, other tergites without spines (Fig. 9).

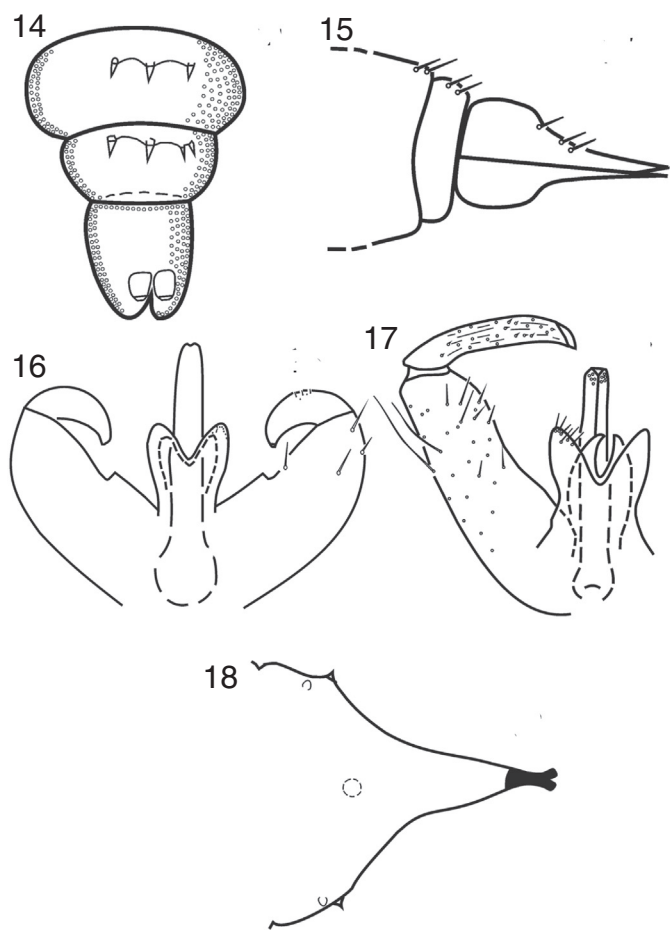
Larva. Body length: 3.20 mm ($n = 1$). Integument covered with pointed verrucae. Spatula: 0.07 mm long ($n = 1$), two-toothed, with very short shaft, three pairs of lateral papillae (Figs. 10 and 11). Terminal segment with a tail-like projection of 0.15 mm of length ($n = 1$); sclerotized apically; terminal papillae not visible (Fig. 12).

Gall. Leaf bud gall, spherical, green or reddish, hairy, one-chambered (Fig. 13) on *Machaerium macaense*.

Type material. Holotype male. Brazil, Rio de Janeiro, Parque Nacional da Serra dos Órgãos, II.2009, Wilson and Monteiro leg., MNRJ. Paratypes, same data as holotype – 2 males, 1 female, and 1 larva; 15.XI.2013 – 2 pupae and 3 pupal exuviae. MNRJ.

Etymology. The name “*gemmae*” refers to the galled plant organ in Latin.

Comments. *Machaeriobia* is very similar morphologically to *Anadiplosis*. Adults of both genera show no essential differences (Gagné, 1994), but according to Tavares (1920), larval characters can separate the two genera. In *Machaeriobia*, mamelons beneath the lateral papillae are absent and the prothoracic spatula is present, while in the species of *Anadiplosis* whose larvae are known, mamelons are present and the spatula is absent. Unfortunately, the larva of *A. pulchra*, the type-species, is still unknown. Among the family Cecidomyiidae, there are some genera whose species may or may not present a spatula, such as *Baccharomyia* Tavares, 1917, *Geraldiesia* Tavares, 1917, *Rhopalomyia* Kieffer & Herbst, 1909, and *Lopesia* Rübsaamen, 1908 (Gagné, 1994; Rodrigues and Maia, 2010). We hereby synonymize *Anadiplosis* Tavares, 1916 under *Machaeriobia* Rübsaamen, 1915 based on similarities of the ovipositor, male cercus and hypoproct of both genera. Among the species previously described as *Anadiplosis* (hereafter referred to as *Machaeriobia*), the new species is morphologically most similar to *M. pulchra*. The pupa of both species has short antennal horns, same complement



Figs. 14–18. *Machaerobia* spp. 14. *M. pulchra*, pupa, abdominal spines (redrawn from Tavares, 1920); 15. *M. pulchra*, ovipositor (redrawn from Tavares, 1920); 16. *M. pulchra*, male terminalia (redrawn from Tavares, 1916); 17. *M. machaerii*, male terminalia (redrawn from Gagné, 1994); 18. *M. machaerii*, larva, terminal segment (redrawn from Gagné, 1994). Original figures without scale bar).

of facial papillae, prothoracic spiracles similar in shape and length and similar number of abdominal spines.

Adults of *M. pulchra* have two-segmented palpi, whereas in the new species they are one or two-segmented. The ovipositor of both species is very similar (Figs. 7 and 15). While there are few differences between the pupae and females of the two species, the male of *M. gemmae* is very different from the male of *M. pulchra*, especially in relation to the terminalia (Figs. 5 and 16). *Machaerobia gemmae* has a markedly more notched aedeagus, and longer and less curved gonostyli than those of *M. pulchra*. Furthermore, the mesobasal lobe of the gonocoxites is rounded in *M. gemmae*, and acute in *M. pulchra*. The larva of *M. gemmae* is unique among its congeners for the presence of spatula, the absence of mamelons and the shape of the terminal segment (elongate, tapered to the apex and without distal lobes).

The new species differs from *Machaerobia machaerii* in the shape of the male hypoproct and cercus (both more acuminate in *M. machaerii*) (Fig. 17), and in the larval terminal segment which

is bilobed in *M. machaerii* (Fig. 18) and simple in the new species. From the first sample of 30 galls collected on September 2012), we obtained only *M. gemmae*, but from the 400 galls collected from October 2013 to January, 91 galls yielded wasps and 10 *M. gemmae*. The reared wasps belonged to six species: *Tanaostigmodes carinatus* La Salle 1987, *Tanaostigmodes* sp. (*Tanaostigmatidae*), *Galeopsomyia* sp. (*Eulophidae*), *Calorylea* sp. (*Eurytomidae*) and two unidentified species of *Eurytomidae*.

Tanaostigmatidae include only gall inquilines, but the other families comprise gallers, parasitoids, and gall inquilines. It was not possible identify their habits as parasitoids or inquilines, but in all cases the cecidomyiid larvae died. We observed that galls attacked by some of these wasps were almost compact, with little space inside, probably due to inner tissue growth making these galls very hard and quite different from those that were not attacked. The high mortality of galling larvae caused by parasitoids or/and phytophagous modifiers has been reported in other similar communities (see Ferraz and Monteiro, 2003). We also observed that the gall development caused the death of the adjacent leaflets.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgments

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References

- Drummond, J.A., 1997. O Parque Nacional da Serra dos Órgãos: uma síntese da Serra do Mar. In: Devastação e preservação ambiental: os parques nacionais do Estado do Rio de Janeiro. EDUFF, Niterói, pp. 183–207.
- Ferraz, F.F.F., Monteiro, R.F., 2003. Complex interactions involving gall midge *Myricomyia maricaensis* Maia (Diptera Cecidomyiidae), phytophagous modifiers and parasitoids. *Rev. Bras. Zool.* 20, 433–437.
- Gagné, R.J., 1994. *The Gall Midges of the Neotropical Region*. Comstock Cornell University Press, Ithaca.
- Gagné, R.J., Jaschhof, M., 2014. *A Catalog of the Cecidomyiidae (Diptera) of the World, 3rd ed, Digital Version 2*.
- Lista das espécies da flora do Brasil, 2016. Jardim Botânico do Rio de Janeiro, Available from: <http://floradobrasil.jbrj.gov.br/> (accessed 05.02.16).
- Lorenzi, H., 2002. *Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil*. Instituto Plantarum, São Paulo, Noca Odessa, pp. 368.
- Maia, V.C., Barros, G.P.S., 2009. Espécies de Cecidomyiidae (Diptera) registradas no Estado do Rio de Janeiro, Brasil. *Arquivos do Museu Nacional* 67, 211–220.
- Radam Brasil, 1983. *Levantamento dos Recursos Naturais*. Ministério das Minas e Energia, pp. 32.
- Rodrigues, A.R., Maia, V.C., 2010. Duas novas espécies de *Lopesia* Rübsaamen (Diptera Cecidomyiidae) do Brasil, com chave para as espécies. *Biota neotropica* 10, 85–99.
- Rübsaamen, E.H., 1915. Beitrag zur Kenntnis aussereuropäischer Gallmücken. *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin*, pp. 431–481.
- Tavares, J.S., 1916. *Cecidomyias novas do Brazil*. *Brotéria (Sér. Zool.)* 14, 36–57.
- Tavares, J.S., 1920. *Anadiplosariae, nouvelle tribu de Cecidomyiinae (Dipt.)*. *Marcellia* 17, 57–72, pl. 1.

Erratum

The authors regret to inform that the affiliation of the second and third authors appeared incorrectly. The correct affiliation is Universidade Federal do Rio de Janeiro, Instituto de Biologia, Departamento de Ecologia, Rio de Janeiro, RJ, Brazil.