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Novelties of gasteroid fungi, earthstars and puffballs, from the Brazilian Atlantic rainforest

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Abstract

Alfredo, D.S., Sousa, J.O., Souza, E.J., Conrado, L.M.N. & Baseia, I.G. 2016. Novelties of gasteroid fungi, earthstars and puffballs, from the Brazilian Atlantic rainforest. *Anales Jard. Bot. Madrid* 73(2): e045.

The goal of this study was to increase the knowledge of gasteroid fungi in Atlantic Forest biome, which is considered one of the most important hot-spots of the world. Field expeditions were carried out in the Reserva Biológica Municipal de Santa Rita Mitzi Brandao area, in the southeastern part of Minas Gerais. 39 samples belonging to 11 species of earthstars and puffballs are new record for Minas Gerais, *Geastrum javanicum* Lév., *Bovista cunninghamii* Kreisel, and *Lycoperdon lambinonii* Demoulin are first records for Brazil. Information about the locality, morphological characters, illustrations of the basidiomata, scanning electron microscopy (SEM) of the basidiospores, as well as its distribution in Brazil, are given for all species.

Keywords: Agaricomycetes, Basidiomycota, biodiversity, Geastraceae, Lycoperdaceae, Taxonomy.

Resumen

Alfredo, D.S., Sousa, J.O., Souza, E.J., Conrado, L.M.N. & Baseia, I.G. 2016. Novedades sobre hongos gasteromicetos, estrellas de tierra y pedos de lobo, del bosque pluvial atlántico brasileño. *Anales Jard. Bot. Madrid* 73(2): e045.

Con el objetivo de ampliar el conocimiento de la micobiota del bosque atlántico de Brasil, uno de los más importantes centros de biodiversidad del mundo, se llevaron a cabo varias expediciones de campo en el sudeste del estado de Minas Gerais. 39 muestras pertenecientes a 11 especies de hongos gasteromicetos son registradas por primera vez para Minas Gerais, *Geastrum javanicum* Lév., *Bovista cunninghamii* Kreisel y *Lycoperdon lambinonii* Demoulin se citan, además, por primera vez para Brasil. Para cada especie se aporta información sobre la localidad, los caracteres morfológicos, las fotografías de los basidiomas y de la microscopía electrónica de barrido (MEB) de las basidiosporas, así como su distribución en Brasil.

Palabras clave: Agaricomycetes, Basidiomycota, biodiversidad, Geastraceae, Lycoperdaceae, taxonomía.

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INTRODUCTION

The Atlantic forest biome is considered one of the most important hot-spots of the world (Myers & al., 2000), with a high diversity and richness of endemic species; however, both the increasing deforestation and the intense fragmentation have threatened its biodiversity (MMA, 2007). Originally, the total covering of the Atlantic Forest in Brazil was about 150 million ha, and today Ribeiro & al. (2009) suggest a remainder of 15,719,337 ha. The State of Minas Gerais is the fourth largest territory in Brazil (Fig.1), with 586,519.727 km² (IBGE, 2015) where currently 3.199.378 ha are covered by Atlantic Forest (SOS Mata Atlântica & INPE, 2013). The Atlantic Forest remainders are extremely important reservoirs for biodiversity (Lombardi & Gonçalves, 2000), as yet without any inventory study on gasteroid Basidiomycota. Only two sporadic studies have been carried out for the state of Minas Gerais, from where 3 species of *Geastrum* Pers. were reported by Sydow & Sydow (1907): *Geastrum englerianum* Henn., *Geastrum rickii* Lloyd, and *Geastrum velutinum* Morgan and one more, recently recorded, *Geastrum javanicum* Lév. (Trierweiler-Pereira & al., 2011).

The fungi commonly known as “earthstars” correspond to the family Geastraceae Corda, which is characterized by its star form and a single apical hole bordered by a structure called peristome (Ponce de Leon, 1968; Sunhede, 1989). *Geastrum* is its most representative genus, has a cosmopolitan distribution and is adapted to different habitats (Calonge & Mata, 2004; Zamora & al., 2013; Sousa & al., 2014a). For a long time, various authors considered this genus in Lycoperdales Clem. (Cunningham, 1944; Bottomley, 1948; Pegler & al., 1995; Calonge, 1998). Later, Hosaka & al. (2006), by means of molecular studies, showed the close relationship between the earthstars and the members of a “gomphoid-phalloid clade” and proposed the order Geastrales Hosaka & Castellano. In the last 12 years, this genus has been widely studied in the northeastern Brazil (Baseia & Milanez, 2002; Baseia & Calonge, 2006; Fazolino & al., 2008; Silva & al., 2013; Cabral & al., 2014a, 2014b; Sousa & al., 2014a, c, d), although there is a lack of information about it for the southeastern regions, specially for Minas Gerais.

The puffballs are characterized by their globose to pyriform fruiting bodies, in which the basidiospores remain

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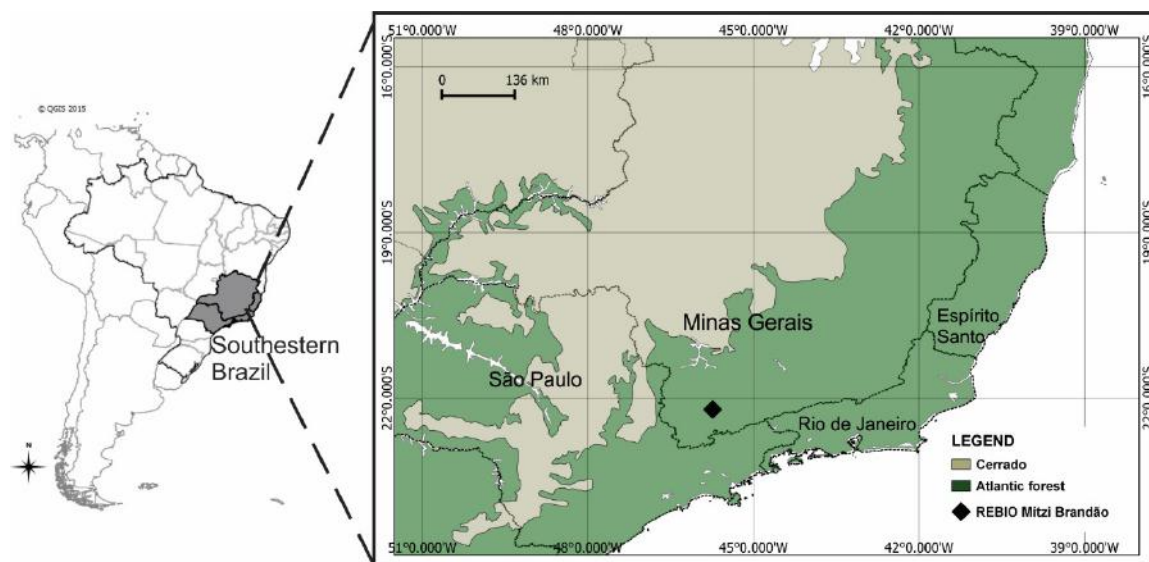


Fig. 1. Map of the Reserva Biológica Municipal de Santa Rita Mítzi Brandão.

protected inside by a powdery gleba until maturation (Cunningham, 1944; Bottomley, 1948). They are represented by the genera *Arachnion* Schwein, *Bovista* Pers., *Calvatia* Fr., *Disciseda* Czern, *Gastropila* Homrich & J.E. Wright, *Langermania* Rostk, *Lycoperdon* Pers., and *Morganella* Zeller (Pegler & al., 1995; Calonge, 1998; Baseia & al., 2014). Traditionally, the puffballs have been included into the family Lycoperdaceae Chevall., but after molecular analyses —nu-rDNA— (Hibbett & al., 1997), they have been transferred to Agaricaceae Chevall. Until the XXth century, these fungi were poorly studied in Brazil (Hennings, 1904a, b; Silveira, 1943; Rick, 1961; Homrich, 1975; Bononi & al., 1981, 1984), but in the last two decades this scenario has changed with the addition of new records (Baseia, 2003; Baseia, 2005a, b; Wartchow & Silva, 2007; Cortez & Alves, 2012; Cortez & al., 2012, 2013; Alves & Cortez, 2014; Baseia & al., 2014) and new taxa (Cortez & al., 2007, 2011; Baseia & Calonge, 2008; Suárez & al., 2009; Alfredo & al., 2012, 2014a, b; Alves & Cortez, 2013; Alfredo & Baseia, 2014).

Thus the goal of this study was to increase the knowledge of gasteroid fungi in Atlantic Forest biome, by means of new expeditions aimed to collect specimens belonging to this group. The study of this material has yielded new records for the species of earthstars and puffballs of Minas Gerais, as well as an important information input which is presented in this paper.

MATERIAL AND METHODS

39 samples were collected during the rainy season of the years 2012 and 2013 from the Municipal Biological Reserve of Santa Rita Mítzi Brandão (*Reserva Biológica Municipal de Santa Rita Mítzi Brandão*), in Minas Gerais (Brazil; Fig. 1). According to Eduardo & Passamani (2009), this area is located at coordinates 22°12'17" S 45°44'19" W, and its vegetation ranges from low tropical montane broadleaf forests to ombrophilous and seasonal semi-deciduous forests, completely inside of Atlantic Forest biome domain, with annual rainfalls averaging 1500 mm. The collection

method is based on Silva & al. (2014). The specimens were photographed *in situ*. The morphological characters were analyzed on dry basidiomata, according to Soto & Wright (2000), Leite & al. (2007a, b), and Sousa & al. (2014a, b, c, d) for earthstars, and to Demoulin (1976), Calonge (1998), Alfredo & Baseia (2014), and Alfredo & al. (2014a, b) for puffballs. The size of earthstar basidiomata were taken from horizontally mounted exoperidia, and the height of the basidiomata includes peristome. For microscopic analysis, free-hand cuts were made in exoperidium sections, separating mycelial, fibrous, and pseudoparenchymatous layers. Blades for microscopic analysis were mounted in 5% KOH, in cotton blue to evaluate if the hyphae were cyanophilic (Cb+) or not (Cb-), and in Melzer's reagent to detect if there was dextrinoid (Melz+) or not (Melz-). For each specimen, 20 basidiospores were randomly selected for measures. The mean of height/width quotient (Q_m) was also calculated. Scanning electron microscopy (SEM) photographs were made according to Cortez & al. (2008a). Color descriptions were based on Küppers (2002). All specimens were deposited at the herbarium of the Universidade Federal do Rio Grande do Norte (UFRN, Brazil).

LIST OF TAXA AND IDENTIFICATION KEY FOR EARTHSTARS

Identification key for the earthstars from Minas Gerais

1. Peristome plicate..... ***G. morganii***
1. Peristome non plicate..... 2
2. Mycelial layer strongly encrusted with debris; peristome non-delimited; endoperidium surface covered by protruding hyphae. 3
2. Mycelial layer not encrusted with debris; peristome delimited; endoperidium surface not covered by protruding hyphae 4

3. Endoperidial body sessile; pseudoparenchymatous layer persistent, papery and non rimose ***G. fimbriatum***
3. Endoperidial body with short pedicel; pseudoparenchymatous layer falling off, coriaceous, and rimose ***G. rufescens***
4. Rays slender, arcnoid-like; mycelial layer with longitudinal cracks ***G. lageniforme***
4. Rays triangular, non arcnoid-like, mycelial layer without longitudinal grooves 5
5. Mycelial layer velutinous or tomentose; subiculum present 6
5. Mycelial layer glabrous; subiculum absent 7
6. Mycelial layer velutinous and coriaceous, not persistent, cup-shaped under the basidioma; basidiomata more than 20 mm wide ***G. javanicum***
6. Mycelial layer tomentose and papery, persistent, not cup-shaped under the basidioma; basidiomata up to 20 mm wide ***G. schweinitzii***
7. Pseudoparenchymatous layer reddish in fresh specimens, forming a collar-like structure around the endoperidium; the mycelial layer reacts in Melzer reagent (Melz+) ***G. triplex***
7. Pseudoparenchymatous layer yellowish in fresh specimens, not forming a collar-like structure around the endoperidium; the mycelial layer does not react in Melzer reagent (Melz-) ***G. saccatum***

Earthstars from Minas Gerais

Geastrum fimbriatum Fr. (Fig. 2a, b)

Basidioma 5-13 × 26-45 mm, saccate, expanded; exoperidium splitting in 6-7 rays, saccate to arched, non-hygroscopic; mycelial layer [papery to felted, encrusted, persistent] strongly encrusted with soil particles and leaf-litter fragments; fibrous layer papery to coriaceous; pseudoparenchymatous layer persistent; endoperidium 4-9 × 8.5-19 mm, subglobose, normally sessile with protruding hyphae; peristome 1.5-2 mm high (Fig. 2a), fibrillose and non-delimited (Sunhede, 1989); basidiospores 2.9-3.7-5.4 × 2.7-3.6-5.2 µm ($Q_m = 1.08$), globose to subglobose, ornamented with columnar warts in SEM (Fig. 2b), yellowish brown in 5% KOH, acyanophilous and non dextrinoid; eucapillitium acyanophilous, non dextrinoid.

Distribution.—This is the first record from Minas Gerais. In Brazil, *Geastrum fimbriatum* has been reported from: Bahia (Trierveiler-Pereira & al., 2009), Paraíba (Trierveiler-Pereira & al., 2011), Pará (Leite & al., 2011; Trierveiler-Pereira & al., 2011), Pernambuco (Leite & al., 2007a; Trierveiler-Pereira & al., 2011), Rio de Janeiro (Berkeley & Cooke, 1876; Hennings, 1904b; Saccardo, 1888), Rio Grande do Norte (Sousa & al., 2014c), and Rio Grande do Sul (Rick, 1961; Lazarotto & al., 2014).

Observations.—This species is recognized by its saccate to arched, non-hygroscopic exoperidium, mycelial layer strongly encrusted with soil particles and leaf litter fragments and a fibrillose and non-delimited peristome (Sunhede, 1989). It is similar to *G. rufescens*, differing by its arched fruiting body, pseudoparenchymatous layer with ridges

(rimose), pedicellate, and with apophysis endoperidium, and larger basidiospores up to 6 µm (Sunhede, 1989). Some specimens of *G. fimbriatum* have a collar in the pseudoparenchymatous layer, as *G. triplex*, however, these species can be distinguished by the size of the basidiomata, larger in *G. triplex*—up to 150 mm—, and a distinctively delimited peristome (Sousa & al., 2014c). The size of spores appears to be variable: Leite & al. (2011) reported *G. fimbriatum* from the Amazon forest with basidiospores 3-3.5 µm, smaller than those belonging to the studied specimens, while Sunhede (1989) described it with larger spores—5-6 µm.

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'4.93"S 45°47'2.251"W, D.S. Alfredo 202 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2322); *ibidem*, D.S. Alfredo 203 (UFRN-Fungos 2319).

Geastrum javanicum Lév. (Fig. 2c, d)

Basidioma, 8-17 × 18-28.5 mm, expanded, saccate; exoperidium splitting in 5-7 rays; mycelial layer ephemeral, coriaceous, cup-shaped under the basidioma; fibrous layer papery, dextrinoid; pseudoparenchymatous layer persistent, glabrous; endoperidium 7-17 × 13-25 mm (Fig. 2c), globose to subglobose, sessile; peristome fibrillose; basidiospores 2.5-4-4.7 × 3.9-4.1-4.5 µm ($Q_m = 1.04$), globose to subglobose, apiculated, ornamented with columnar warts in SEM, brown in 5% KOH, acyanophilous, non dextrinoid, pedicels 5-10 µm, which were revealed in cotton blue. Subiculum delimited.

Distribution.—It is known from the Brazilian states of Amazonas (Leite & al., 2011), Pará (Sotão & al., 2009), Ceará, Paraíba, and Rio Grande do Norte (Sousa & al., 2014c), and has been previously reported from Minas Gerais by Trierveiler-Pereira & al. (2011), initially identified as *G. velutinum* Morgan.

Observations.—It is characterized by its coriaceous, ephemeral mycelial layer, forming a cup under the basidioma, presence of subiculum, delimited, fibrillose peristome and dark and sessile endoperidium (Sousa & al., 2014c). It is similar to *G. fimbriatum* because of its saccate basidiomata and fibrillose peristome, but they differ by the presence of encrustations on the mycelial layer, and a pseudoparenchymatous layer with whitish to beige coloration of fresh basidiomata in *G. fimbriatum* (Ponce de Leon, 1968; Sunhede, 1989). *Geastrum javanicum* is also related to *G. schweinitzii* by their lignicolous habit, but the latter has caespitose and smaller basidiomata up to 20 mm wide, and a persistent mycelial layer (Baseia & al., 2003; Calonge & al., 2005).

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 30 & P. Lavor, 23-II-2012 (UFRN-Fungos 1935); *ibidem*, DSA 31 (UFRN-Fungos 2040); *ibidem*, D.S. Alfredo 38 (UFRN-Fungos 2047); *ibidem*, D.S. Alfredo 39 (UFRN-Fungos 2037); *ibidem*, D.S. Alfredo 40 (UFRN-Fungos 2036); *ibidem*, DSA 41 (UFRN-Fungos 2038); *ibidem*, D.S. Alfredo 42 (UFRN-Fungos 2043); *ibidem*, D.S. Alfredo 43 (UFRN-Fungos 2041); *ibidem*, D.S. Alfredo 44 (UFRN-Fungos 2042); *ibidem*, D.S. Alfredo 45 (UFRN-Fungos 2044); *ibidem*, D.S. Alfredo 46 (UFRN-Fungos 2039); *ibidem*, D.S. Alfredo 47 (UFRN-Fungos 2046); *ibidem*, D.S. Alfredo 48 (UFRN-Fungos 2045); *ibidem*, 22°15'4.93"S

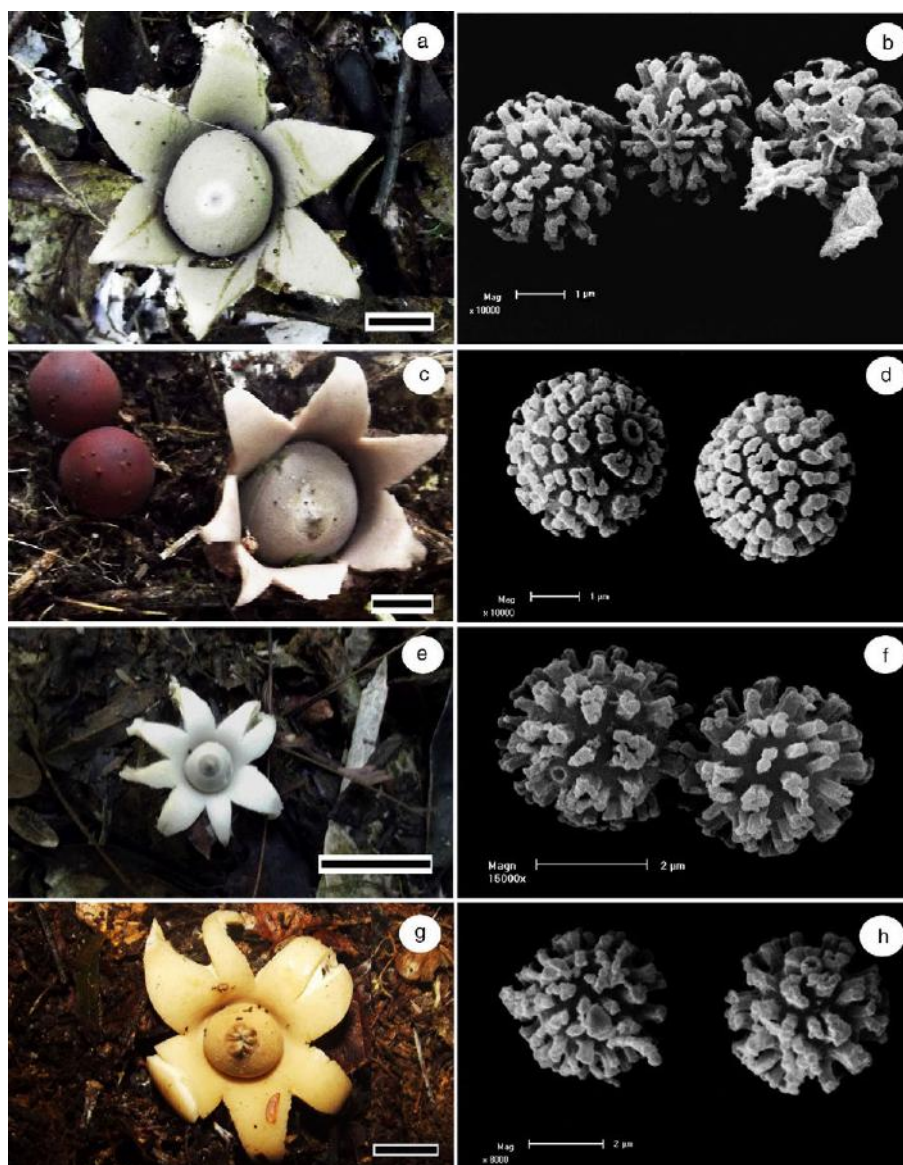


Fig. 2. *Geastrum fimbriatum*: a, basidiomata; b, basidiospores. *G. javanicum*: c, basidiomata; d, basidiospores. *G. lageniforme*: e, basidiomata; f, basidiospores. *G. morganii*: g, basidiomata; h, basidiospores. [a, b, D.S. Alfredo 202 (UFRN-Fungos 2322); c, d, D.S. Alfredo 31 (UFRN-Fungos 2040); e, f, D.S. Alfredo 212 (UFRN-Fungos 2326); g, h, D.S. Alfredo 29 (UFRN-Fungos 1936).] Basidiomata's bar = 10 mm.

45°47'2.51"W, D.S. Alfredo 192 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2323).

Geastrum lageniforme Vittad. (Fig. 2e, f)

Basidiomata 3-11 × 23-53 mm: exoperidium splitting in 7-8 rays; mycelial layer membranous to papery, without incrustation; fibrous layer papery to coriaceous; Pseudoparenchymatous layer up to 2 mm (fresh specimens), persistent, occasional rimose, without collar-like; endoperidium subglobose, sessile, glabrous; peristome 1-1.7 mm (Fig. 2e); basidiospores 3.1-4.2-5.2 × 2.5-4.2-5 µm ($Q_m = 1.07$), subglobose, warty (in LM), ornamented with columnar warty in SEM (Fig. 2f), brown in 5% KOH, acyanophilous and non dextrinoid,

Distribution.— In Brazil it has been previously reported from Bahia (Trierveiler-Pereira & al., 2009), Pernambuco (Trierveiler-Pereira & al., 2011), Rio de Janeiro (Hennings, 1904b), Ceará, Paraíba, Rio Grande do Norte (Sousa & al.,

2014c), and Rio Grande do Sul (Rick, 1961; Cortez & al., 2008b). This is the first record from Minas Gerais.

Observations.—This species is characterized by its saccate basidiomata, the presence of longitudinal ridges on the mycelial layer, rays with elongated slender, arachnoid endings, and fibrillose, strongly delimited peristome (Sunhede, 1989). It is similar to *G. saccatum*, however the latter usually does not present either ridges in the mycelial layer, nor arachnoid rays (Calonge, 1998; Soto & Wright, 2000). This species is similar to *G. morganii*, but differs by the mycelial layer that has no longitudinal ridges and in a sulcate peristome (Hemmes & Desjardin, 2011).

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 183 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2327); *ibidem*, D.S. Alfredo 185 (UFRN-Fungos 2329); *ibidem*, D.S. Alfredo 201

(UFRN-Fungos 2328); *ibidem*, D.S. Alfredo 212, 03-I-2014 (UFRN-Fungos 2326).

Geastrum morganii Lloyd (Fig. 2g, h)

Basidiomata 7-20 × 17-51 mm, expanded, with rhizomorphs, whitish; exoperidium splitting in 5-7 rays (Fig. 2g); basidiospores 4-5.5-6.3 × 3.5-5.5-6.3 µm ($Q_m = 1.03$), globose to subglobose, ornamented with columnar warts (Fig. 2h), brown 5% KOH, acyanophilous, and non dextrinoid. In the specimens studied, only the hyphae of the mycelial and fibrous layer resulted to be acyanophilous with no dextrinoid reaction.

Distribution.—Second record from Brazil and first from the southeastern region of the country. Previously reported from Brazil (Sousa & al., 2014d) and Rio Grande do Norte (Sousa & al., 2014d).

Observations.—*Geastrum lageniforme*, *G. saccatum*, and *G. triplex* share with *G. morganii* a normally saccate basidiomata, a mycelial layer free of encrustations and occasionally with a collar, and a conical and sulcate peristome (Sousa & al., 2014c). *Geastrum reticulatum* Hemmes & Desjardin differs from *G. morganii* by its reticulate ornamentation of the mycelial layer (Hemmes & Desjardin, 2011). It is characterized by its exoperidium free of encrustations, with slender, elongated rays, sessile endoperidium, and conical, sulcate, and non-delimited peristome (Sunhede, 1989).

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 29 & P. Lavor, 23-II-2012 (UFRN-Fungos 1936); *ibidem*, D.S. Alfredo 186 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2324).

Geastrum rufescens Pers. (Fig. 3a, b)

Basidiomata 10 × 38.5 mm; exoperidium splitting in 8 rays, arched, non-hygroscopic (Fig. 3a); basidiospores 3.8-4.6-5.7 × 3.8-4.7-5.7 µm ($Q_m = 1.03$), subglobose, with columnar warts (Fig. 3b), yellowish brown in 5% KOH, acyanophilous, and non dextrinoid and ornate capillitium.

Distribution.—Previously reported from Rio Grande do Sul (Rick, 1961) and São Paulo (Bononi & al., 1981). This is the first record from Minas Gerais.

Observations.—It is characterized by its mycelial layer encrusted with debris, pseudoparenchymatous layer, coriaceous, pedicellate endoperidium with apophysis, surface with protruding hyphae, and fimbriate and non-delimited peristome (Calonge, 1998). Similar to *G. fimbriatum*, which is distinguished by its pseudoparenchymatous layer that breaks apart over time, giving it a rimose aspect, and by its shortly pedicellate endoperidium, that in the specimen studied is smaller (less than 0.5 mm tall) than other specimens reported before (Sunhede, 1989; Calonge, 1998). Dissing & Lange (1962) reported some specimens from the Congo without pedicellate endoperidium, in spite of all the other characteristics are closed to our specimen.

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 184 & P. Lavor (UFRN-Fungos 2325).

Geastrum saccatum Fr. (Fig. 3c, d)

Basidiomata 6-20 × 17-51 mm, saccate, expanded; exoperidium with 5-10 revolute rays (Fig. 3c); mycelial layer not encrusted, with non-hygroscopic rays; endoperidium sessile; peristome well delimited; basidiospores

2.5-4.2-6.5 × 2.5-4.2-5.7 µm ($Q_m = 1.03$), globose to subglobose, warty (Fig. 3d).

Distribution.—Although this taxon is widely known in Brazil: from Rio Grande do Sul (Rick, 1961; Sobestiansky, 2005; Cortez & al., 2008b), Paraná (De Meijer, 2006), São Paulo (Sydow & Sydow, 1907; Bononi & al., 1984; Baseia & al., 2003), Pernambuco (Kimbrough & al., 1994-1995; Baseia & al., 2003; Trierveiler-Pereira & al., 2011) Rio Grande do Norte (Leite & Baseia, 2007), Bahia (Trierveiler-Pereira & al., 2009), Amazonas (Hennings, 1904a; Cabral & al., 2014b), Pará (Leite & al., 2011), Paraíba (Sousa & al., 2014b), this is the first record from Minas Gerais.

Observations.—This species is characterized by its saccate expanded basidiomata, mycelial layer not encrusted, non-hygroscopic rays, sessile endoperidium, and well delimited peristome. It is similar to *Geastrum lageniforme*, *G. fimbriatum*, and *G. triplex*; from the first it differs by its rays with elongated endings, slender and longitudinal ridges (Calonge & al., 2005); from *G. fimbriatum* it differs by its non-delimited peristome and mycelial layer encrusted with sediments and organic material (Sunhede, 1989); and from *G. triplex* by its reddish coloration of the pseudoparenchymatous layer in the fresh specimens, and the formation of the collar (Ponce de Leon, 1968; Sunhede, 1989; Calonge & al., 2005). In the examined specimens the dextrinoid reaction was observed only in the hyphae of the fibrous layer corroborating previous results obtained by Soto & Wright (2000).

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 23 & P. Lavor, 20-II-2012 (UFRN-Fungos 1937); *ibidem*, 22°12'35.46"S 45°43'56.82"W, D.S. Alfredo 32 & P. Lavor, 23-II-2012 (UFRN-Fungos 1938); *ibidem*, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 188 & P. Lavor, 27-XII-2012 (UFRN-Fungos 2330); *ibidem*, D.S. Alfredo 200 (UFRN-Fungos 2331); *ibidem*, 22°12'35.46"S 45°43'56.82"W, D.S. Alfredo 204 & P. Lavor, 03-I-2014 (UFRN-Fungos 2333); *ibidem*, D.S. Alfredo 215 (UFRN-Fungos 2332); *ibidem*, D.S. Alfredo 216 (UFRN-Fungos 2334).

Geastrum schweinitzii (Berk. & M.A. Curtis) Zeller (Fig. 3e, f)

Basidiomata 6-7.5 × 6-11 mm, expanded, gregarious or caespitose; exoperidium splitting in 5-7 rays, non-hygroscopic; endoperidium 2.5-5.5 × 3-6 mm, depressed, globose, sessile; basidiospores 3-4.3-5 × 3.8-4.2-5 µm ($Q_m = 1.16$), globose to subglobose, with columnar warts in SEM (Fig. 3f), brown in 5% KOH, acyanophilous and non dextrinoid.

Distribution.—This is the first record of this taxon from Minas Gerais. In Brazil it has been also reported from Amazonas (Cabral & al., 2014b), Bahia (Trierveiler-Pereira & al., 2009), Pernambuco (Kimbrough & al., 1994-1995; Baseia & al., 2003; Leite & Baseia, 2007; Trierveiler-Pereira & al., 2011), Paraíba and Rio Grande do Norte (Sousa & al., 2014c), Rio Grande do Sul (Cortez & al., 2008b), and São Paulo (Bononi & al., 1981; Baseia & al., 2003).

Observations.—It is recognized by its lignicolous and caespitose habit, growing over a yellowish-white subiculum, saccate basidiomata, delimited fibrillose peristome and sessile endoperidium (Sousa & al., 2014c). *Geastrum hirsutum* and *G. javanicum* also grow on wood (Fig. 3e). *Geastrum hirsutum* differs by its mycelial layer, with long

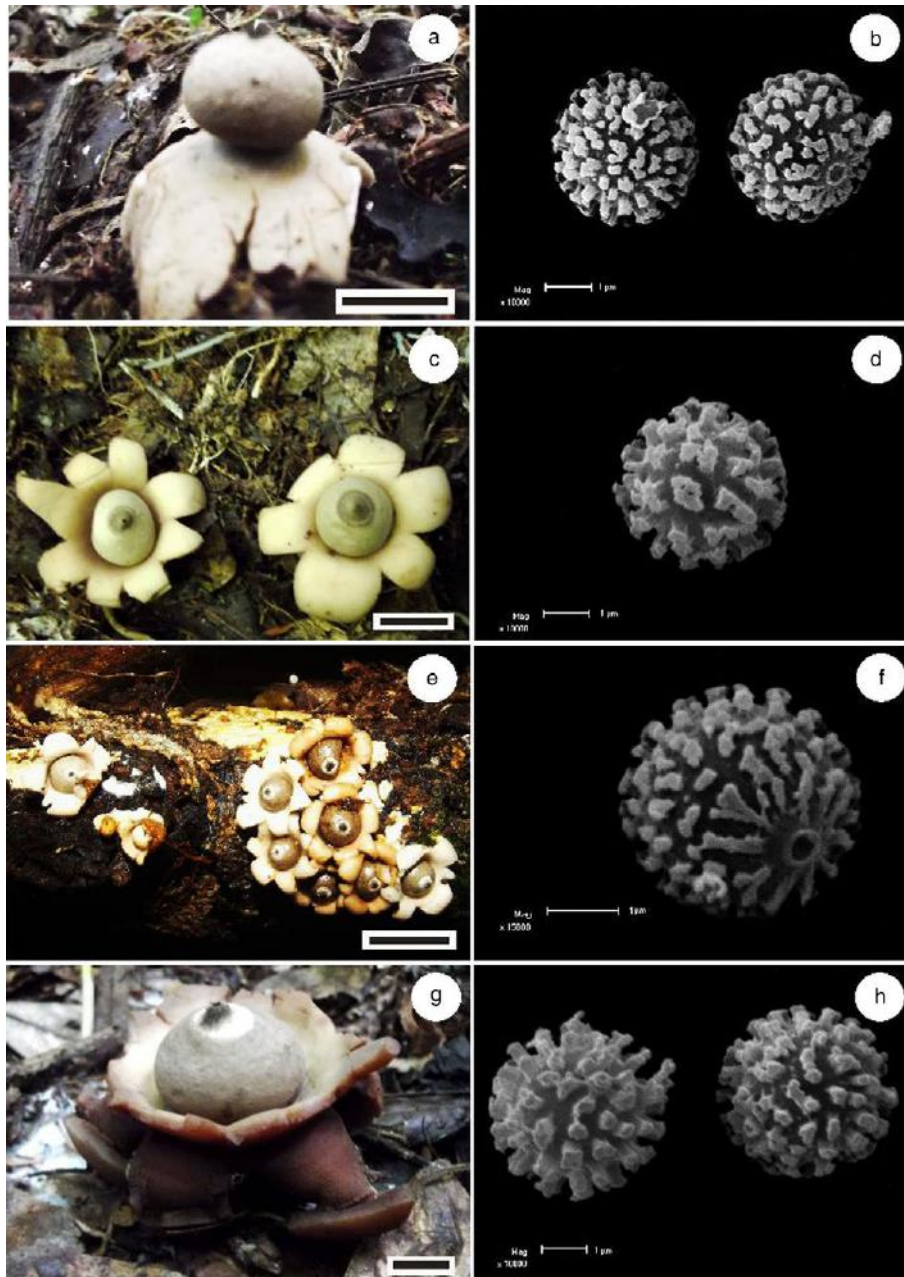


Fig. 3. *Geastrum rufescens*: **a**, basidiomata; **b**, basidiospores. *G. saccatum*: **c**, basidiomata; **d**, basidiospores. *G. shweintzii*: **e**, basidiomata; **f**, basidiospores. *G. triplex*: **g**, basidiomata; **h**, basidiospores. [a, b, D.S. Alfredo 184 (UFRN-Fungos 2325); c, d, D.S. Alfredo 32 (UFRN-Fungos 1938); e, f, D.S. Alfredo 206 (UFRN-Fungos 2317); g, h, D.S. Alfredo 25 (UFRN-Fungos 1941).] Basidiomata's bar = 10 mm.

hairs (1.5-3 mm), the coloration of the basidiomata, and the size ornamentation of the basidiospores (2.3-3 µm) (Baseia & Calonge, 2006); *G. javanicum* differs from *G. schweinitzii* by its growth development and the coloration of the endoperidium, the size of the basidiomata (more than 20 mm wide in *G. javanicum*), and the nature of the mycelial layer, which completely detaches itself in *G. javanicum* (Ponce de Leon, 1968; Calonge & al., 2008). *G. schweinitzii* presented hyphae of the capillitium cyanophilous, a characteristic not presented in the related species.

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo

20 & P. Lavor, 20-II-2012 (UFRN-Fungos 1939); *ibidem*, 22°12'35.46"S 45°43'56.82"W, D.S. Alfredo 33 & P. Lavor, 23-II-2012 (UFRN-Fungos 1940); *ibidem*, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 195 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2318); *ibidem*, D.S. Alfredo 206, 03-I-2014 (UFRN-Fungos 2317).

***Geastrum triplex* Jungh.** (Fig. 3g, h)

Basidiomata 10 × 25 mm, robust; the exoperidium splits in 5 rays (Fig. 3g); scaly mycelial layer formed by branched hyphae and with connection clamps (Soto & Wright, 2000); pseudoparenchymatous layer forming a collar around the base of the endoperidium; peristome fibrillose and delimited; basidiospores 3-6 × 3-6 µm ($Q_m = 1.05$), globose,

apiculated, with columnar warts in SEM (Fig. 3h), brown in 5% KOH, acyanophilous and non dextrinoid.

Distribution.—This is the first record from Minas Gerais. In Brazil it has been previously reported from Amazonas (Cabral & al., 2014 b), Ceará (Sousa & al., 2014a, 2014c), Paraíba (Sousa & al., 2014c), Rio Grande do Norte (Leite & Baseia, 2007), Pernambuco (Drechsler-Santos & al. 2008; Trierveiler-Pereira & al., 2011), Rio Grande do Sul (Rick, 1961), Paraná (De Meijer, 2006), Santa Catarina (Sobestiansky, 2005), and São Paulo (Baseia & al., 2003).

Observations.—It is easily recognizable by its robust basidiomata, pseudoparenchymatous layer forming a collar around the base of the endoperidium, fibrillose and delimited peristome, and scaly mycelial layer formed by branched hyphae and with connection clamps (Soto & Wright, 2000). According to Sunhede (1989), this species is related to *G. lageniforme* and *G. saccatum*, such that the first species differentiates itself by its rays with slender endings, and the

second one by the smaller basidiomata. Both species lack the collar in the pseudoparenchymatous layer (Reid, 1977; Pegler & al. 1995). In the specimens studied, the hyphae of the mycelial and fibrous layer are cyanophilous and dextrinoid, corroborating the results obtained by Soto & Wright (2000).

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, 22°15'35.17"S 45°43'59.41"W, D.S. Alfredo 25 & P. Lavor, 20-II-2012 (UFRN-Fungos 1941); *ibidem*, 22°12'35.46"S 45°43'56.82"W, D.S. Alfredo 210 & P. Lavor, 03-I-2014 (UFRN-Fungos 2338).

Puffballs from Minas Gerais

Bovista cunninghamii Kreisel (Fig. 4a, b)

Fruiting body 10.5 × 9 mm, epigeous, subglobose (Fig. 4a); exoperidium composed of minute spines, falling

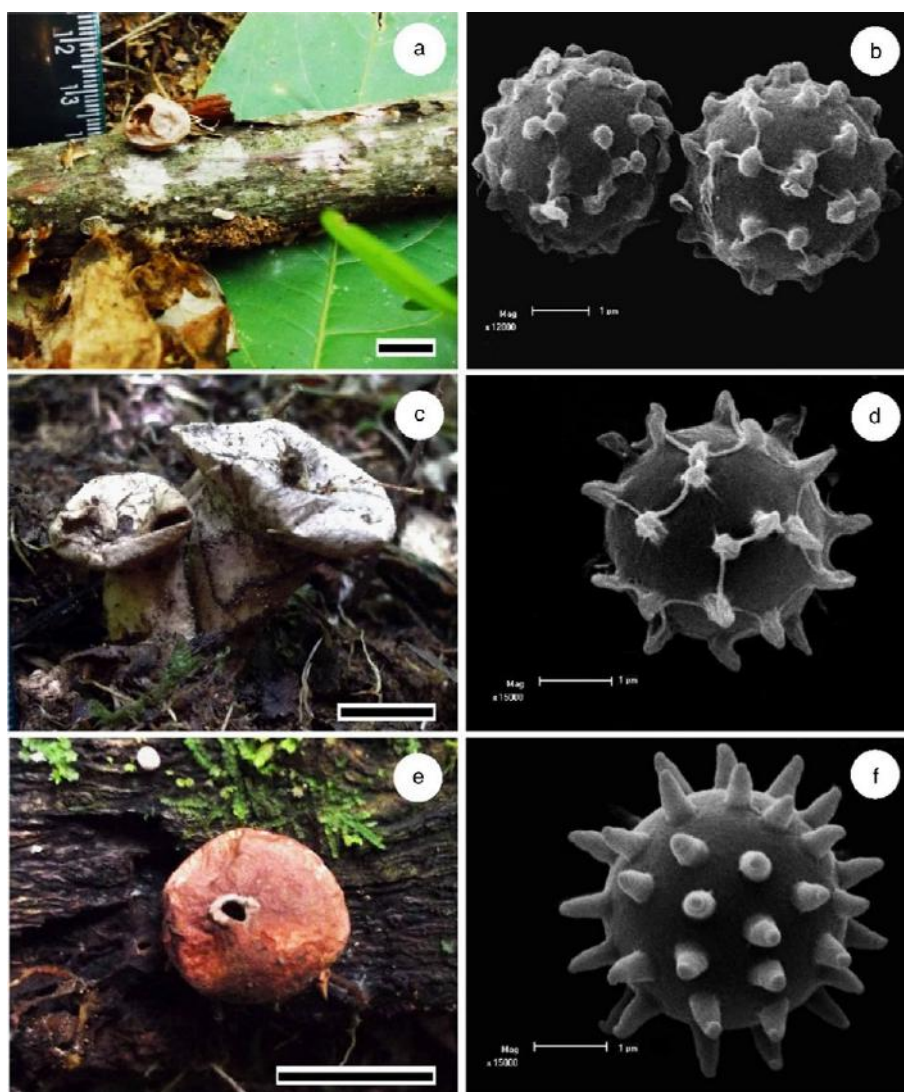


Fig. 4. *Bovista cunninghamii*: a, basidiomata; b, basidiospores. *Lycoperdon lambinonii*: c, basidiomata; d, basidiospores. *Morganella fuliginea*: e, basidiomata; f, basidiospores. [a, b, D.S. Alfredo 194 (UFRN-Fungos 2336); c, d, D.S. Alfredo 198 (UFRN-Fungos 2335); e, f, D.S. Alfredo 199 (UFRN-Fungos 2373).] Basidiomata's bar = 10 mm.

off at maturity, encrusted, yellowish ($N_{20}Y_{70}M_{10}$); sphaerocysts $15\text{--}47 \times 11.5\text{--}20\text{ }\mu\text{m}$, globose, subglobose to pyriform, hyaline in 5% KOH, weakly reaction in Melzer; endoperidium papery, smooth, grayish brown ($N_{20}Y_{30}M_{10}$), dehiscing by an apical plane pore formed by hyphae branched, without septa, $2.5\text{--}13\text{ }\mu\text{m}$, yellowish in 5% KOH and non dextrinoid; subgleba up to 0.5 mm high — according with Calonge & Syvokon (2008) up to 1 mm thick —, reduced, with compacted cells, concolorous with gleba; gleba powdery, brown ($N_{60}Y_{60}M_{30}$); eupillitium $2.5\text{--}4.5\text{ }\mu\text{m}$, intermediate type, smooth, without septa, yellowish brown in 5% KOH, non dextrinoid and non cyanophilous; paracapillitium absent; basidiospores $4\text{--}4.6\text{--}5\text{ }\mu\text{m}$ diam. ($Q_m = 1.02$), globose, asperulate [A] (Fig. 4b), hyaline in 5% KOH, acyanophilous with a weakly reaction in Melzer.

Distribution.—*Bovista cunnighamii* is considered by Calonge & Zamora (2000) to be a species of uncommon occurrence, such that this is the first record from Brazil.

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, $22^\circ 15' 35.17''\text{S}$ $45^\circ 43' 59.41''\text{W}$, D.S. Alfredo 194 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2336).

Lycoperdon lambinonii Demoulin (Fig. 4c, d)

Basidiome $12\text{--}29 \times 19\text{--}25\text{ mm}$, pyriform to turbinate with rhizomorphs; exoperidium composed of minute and caducous spines, becoming furfuraceous at maturity, not encrusted, cream ($N_{00}Y_{10}M_{00}$) to brown ($N_{60}Y_{50}M_{40}$); sphaerocysts $10.5\text{--}32.5 \times 10\text{--}28\text{ }\mu\text{m}$, globose to subglobose, hyaline in 5% KOH, Melz+ (Fig. 4c); endoperidium papery, smooth, gray ($N_{50}Y_{20}M_{00}$), dehiscing by an apical plane rupture, hyphae not branched, without septa, $4\text{--}6\text{ }\mu\text{m}$ diam., hyaline in 5% KOH, dextrinoid; subgleba $14\text{--}16\text{ mm}$ long, well development, cellular, yellowish ($N_{10}Y_{20}M_{00}$), becoming gray ($N_{50}Y_{20}M_{10}$) with age; diaphragm inconspicuous; pseudocolumella absent; gleba powdery grayish brown ($N_{70}Y_{60}M_{40}$); basidiospores $4\text{--}4.3\text{--}5.5 \times 4\text{--}4.5\text{--}5\text{ }\mu\text{m}$ ($Q_m = 1.03$), subglobose, verrucose (B-C), yellowish brown in 5% KOH, non dextrinoid non cyanophilous; eupillitium $3.7\text{--}8.4\text{ }\mu\text{m}$ diam., smooth, pore present, yellowish brown in 5% KOH, Cb-, Melz-; paracapillitium $3.5\text{--}6\text{ }\mu\text{m}$ diam., septate, branched, with amorphous and hyaline incrustation, 5% KOH, Cb+, Melz-; rhizomorphs composed of 2 types of hyphae: thinner and outer (vessel-like) $2.5\text{--}4.5\text{ }\mu\text{m}$ diam., septate, with clamps, hyaline in 5% KOH, Melz+; and thicker and inner $8\text{--}15.5\text{ }\mu\text{m}$ diam., hyaline in 5% KOH, weakly reaction in Melzer's reagent.

Distribution.—This is the first record of this species from Brazil.

Observations.—The specimen found was in an advanced stage of maturity and the exoperidium had almost completely fallen off, exposing the furfuraceous endoperidium, characteristics which were previously described by Demoulin (1972) and Knudsen & Vesterholt (2012). *Lycoperdon lambinonii* differs from *L. molle* and *L. umbrium* by its capillitium with, occasionally, small pores and without septa, and smaller basidiospores (Demoulin, 1972; Calonge & Demoulin, 1975; Martín, 1988). Dominguez de Toledo (1989) describes the presence of the paracapillitium, in addition to the size of the basidiospores that are in accordance with the characteristics of the specimen studied here (Fig. 4d).

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, $22^\circ 15' 35.17''\text{S}$ $45^\circ 43' 59.41''\text{W}$, D.S. Alfredo 198 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2335).

Morganella fuliginea (Berk. & M.A. Curtis) Kreisel & Dring (*Lycoperdon fuligineum* Berk. & M.A. Curtis, basión.; Fig. 4e, f)

Basidiomata up to 30 mm; exoperidium persistent, with a chain of regular hyphae and a reduced sterile base smaller than 5 mm, compact, globose; basidiospores $4.9\text{--}5.6\text{--}6.5 \times 4.7\text{--}5.7\text{--}6\text{ }\mu\text{m}$, globose to subglobose, strongly verrucose [D] (Fig. 4e, f), brown in 5% KOH, acyanophilous, non dextrinoid, with pedicels $1.8\text{--}7.5\text{ }\mu\text{m}$.

Distribution.—It is the first record from the Atlantic rainforest in the State of Minas Gerais; it is known also from Amazonas (Cabral & al., 2014 b), Ceará (Rodrigues & al., 2014), Pernambuco (Trierveiler-Pereira & al., 2010), Rio Grande do Sul (Rick, 1961), as *Lycoperdon fuligineum*, Rondônia (Capelari & Maziero, 1988), and São Paulo (Bononi & al., 1981).

Observations.—It is similar to *M. nuda*, but this species has not a persistent exoperidium when mature, and basidiospores have larger pedicels $3.5\text{--}13\text{ }\mu\text{m}$ — (Alfredo & Baseia, 2014). *Morganella albostipitata* distinguishes itself from *M. fuliginea* by its conspicuous pseudostipe 4 mm long— and the arrangement of the exoperidium's hyphal strands (Alfredo & al., 2012). Studies of the rhizomorphs in *Morganella* are still recent and scarce. Agerer (2002) described the structures of the rhizomorphs of *Lycoperdaceae* and reported them as agaric in form, such that the structures found here resemble the descriptions given by Agerer, including the crystals in the forms of needles.

Studied material.—Brazil. **Minas Gerais:** Santa Rita do Sapucaí, Reserva Biológica Municipal Santa Rita Mítzi Brandão, $22^\circ 15' 35.17''\text{S}$ $45^\circ 43' 59.41''\text{W}$, D.S. Alfredo 199 & P. Lavor, 27-XII-2013 (UFRN-Fungos 2373).

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