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ARTICLE

Contribution to the knowledge of gasteroid fungi (Agaricomycetes, Basidiomycota) from the state of Paraíba, Brazil

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ABSTRACT: (Contribution to the knowledge of gasteroid fungi (Agaricomycetes, Basidiomycota) from the state of Paraíba, Brazil). There are few studies that have reported gasteroid fungi from the state of Paraíba, in northeastern Brazil. Collections of basidiomycetes were made in an area of *restinga* in Mataraca, Paraíba, in May and September of 2009. Eight species of gasteroid fungi were identified, which belong to the Agaricaceae, Geastraceae, Nidulariaceae, Phallaceae and Sclerodermataceae. Six species are new records for Paraíba: *Aserö floriformis*, *Cyathus limbatus*, *Geastrum lageniforme*, *G. saccatum*, *Morganella pyriformis* and *Phallus indusiatus*. Descriptions of the specimens, taxonomic remarks and illustrations are provided for each species.
Key words: Gasteromycetes, Brazilian mycota, fungal taxonomy.

RESUMO: (Contribuição ao conhecimento de fungos gasteróides (Agaricomycetes, Basidiomycota) no Estado da Paraíba, Brasil). Existem poucos registros na literatura sobre a ocorrência de fungos gasteróides no Estado da Paraíba, nordeste do Brasil. Coletas de basidiomicetos foram realizadas em uma área de restinga em Mataraca (Paraíba), nos meses de maio e setembro de 2009. Oito espécies de fungos gasteróides foram identificadas, correspondendo às famílias: Agaricaceae, Geastraceae, Nidulariaceae, Phallaceae e Sclerodermataceae. Seis espécies constituem primeiros registros para o estado da Paraíba: *Aserö floriformis*, *Cyathus limbatus*, *Geastrum lageniforme*, *G. saccatum*, *Morganella pyriformis* e *Phallus indusiatus*. Descrições dos espécimes, discussões taxonômicas e ilustrações são fornecidas para cada espécie.
Palavras-chave: Gasteromycetes, micota brasileira, taxonomia de fungos.

INTRODUCTION

Species of gasteroid fungi have been reported from several Brazilian biomes. There are records of these fungi from the Atlantic Forest (Möller 1895, Rick 1961, Bononi *et al*. 1984, Baseia *et al.* 2003, 2006, Cortez *et al*. 2008, Trierveiler-Pereira *et al*. 2010), Amazonia (Capelari & Maziero 1988, Trierveiler-Pereira *et al.* 2009a), *cerrado* (Baseia & Milanez 2001, 2002, 2003), *caatinga* (Baseia & Galvão 2002, Baseia 2005a) and the grasslands of southern Brazil, which are also known as *pampas* (Cortez 2009). However, there are records of gasteromycete species from only sixteen of the twenty-six Brazilian states (Trierveiler-Pereira & Baseia 2009a).

The first records of gasteroid fungi from the state of Paraíba (in the Northeast Region of Brazil) are from the beginning of the 21st century. Baseia & Galvão (2002) reported four xerophyle gasteromycetes from dry areas of *caatinga*: *Astraeus hygrometricus* (Pers.) Morgan, *Myriostoma coliforme* (Dicks.) Corda, *Podaxis pistillaris* (L.) Fr. and *Tulostoma exasperatum* Mont. Recently, a survey in João Pessoa resulted in one record of *Tulostoma obesum* Cooke & Ellis (Silva *et al*. 2007). In the same year, Leite *et al*. (2007) reported the occurrence of *Geastrum setiferum* Baseia from Paraíba. Gurgel *et al*. (2008), based on a study of the taxonomy of *Scleroderma* in northeastern Brazil, reported *S. citrinum* Pers. and *S. nitidum* Berk. from this state.

Continuing our objective to better understand the diversity of gasteroid fungi from the Northeast Region of Brazil (Trierveiler-Pereira & Baseia 2009b, 2010, Trierveiler-Pereira *et al*. 2009b, 2010), we present results of our investigations about gasteroid fungi collected in the state of Paraíba.

MATERIALS AND METHODS

The diversity of gasteroid fungi was investigated in the city of Mataraca, in the state of Paraíba, in the Northeast Region of Brazil. Collections were made in May and September of 2009, in *restinga* (sandy coastal vegetation) at different stages of succession. The study site was an 800 ha parcel of land, located in the northern par of the state (6º29'S, 34º56'W), which belongs to Mineradora Millennium Inorganic Chemicals do Brasil S.A (Vasconcellos *et al.* 2005).

Macro and microscopic characteristics of the basidiomata were examined following traditional techniques

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used in taxonomic studies of gasteroid fungi (Miller & Miller 1988). Colors were coded according to Kornerup & Wanscher (1978). Vouchers were dried slowly and were deposited in the URM herbarium (Holmgren & Holmgren 1998).

RESULTS AND DISCUSSION

Agaricaceae

1. *Morganella pyriformis* (Schaeff.) Kreisel & D. Krüger, Mycotaxon 86: 175, 2003. Fig. 1A, 2A.

Basidiomata 1.3–1.6 cm high × 1.8–2.3 cm broad, subglobose to pyriform; subgleba present, well-developed, whitish, distinctly cellular, 0.4–0.6 cm high × 0.5–0.75 cm broad; with whitish rhizomorphs attached at the base, rhizomorphs up to 1 cm in length. Exoperidium granular, olive brown (4D3), peeling off at maturity, almost inexistent on the examined material. Endoperidium papery, grayish yellow (4C3); opening at the apex by an ostiole, irregular in shape. Gleba powdery, olive (3E4). Basidiospores globose, yellowish, 3.5–4.5 (–5) µm diam, finely punctate, ornamentation almost invisible in light microscopy; pedicels very short or completely lacking. Eucapillitium and paracapillitium present; eucapillitial hyphae thick-walled, with true septa, 3–4 µm diam, yellowish, without pits, covered with amorphous material; paracapillitial hyphae slightly thick-walled, 2–3.5 µm diam, hyaline, covered with amorphous material. Growing gregarious on rotten wood.

Distribution in Brazil: Rio Grande do Sul, São Paulo and Minas Gerais (Trierveiler-Pereira & Baseia 2009a).

Specimen examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata desmatada, 06 May 2009, *V.R. Coimbra & F. Wartchow* (URM 82109).

Taxonomic remarks: There are five species of *Morganella* recorded from Brazil. These species are *M. albina* (Cooke) P. Ponce de León, *M. benjaminii* (Rick) Cortez, Calonge & Baseia, *M. fuliginea* (Berk. & M.A. Curtis) Kreisel & Dring, *M. pyriformis* and *M. velutina* (Berk. ex Massee) Kreisel & Dring; however, *M. pyriformis* is the only one with eucapillitium (Trierveiler-Pereira *et al.* 2010). Other distinctive features of this species are the following: subgleba white and composed of small-sized cells, exoperidium granular and deep reddish-brown, eucapillitium without pores, paracapillitium abundant, and basidiospores globose with delicate ornamentation (H. Kreisel – pers. com.). Baseia (2005b) reported this species (as *Lycoperdon pyriformis* Schaeff.: Pers.) from the state of Pernambuco. The examined material was not mentioned in the article, but corresponds to the herbaria numbers UFRN-Fungos 155 and UFRN-Fungos 163. This is the first record of *M. pyriformis* from Paraíba.

Geastraceae

2. *Geastrum lageniforme* Vittad., Monogr. Lycoperd: 16, 1842. Fig. 1B, 2B.

Unexpanded basidiome lageniform, 0.95 cm high × 1.1 cm broad, with whitish rhizophorms attached at the base, rizomorphs up to 0.6 cm in length. Expanded basidiomata 0.7–1.3 cm high × 1.8–2.4 cm broad. Exoperidium non-hygroscopic, split into 5–7 rays, saccate, rays long, slender, external layer glabrous, with longitudinal ridges, grayish yellow (2B4). Endoperidium subglobose, 0.4–0.9 cm high × 0.8–1.4 cm broad, grayish beige (4C2), sessile, without apophysis; peristome fibrillose, grayish brown (5E3), delimited by a whitish line. Gleba pulverulent at maturity, brownish gray (5E2). Basidiospores globose, 3.5–5 µm diam including the ornamentation, yellowish brown in KOH, with columnar ornamentation. Capillitial hyphae straight to more or less sinuous, slightly thick--walled, yellowish in KOH, 2.5–8 µm diam. Growing scattered to gregarious on sandy soil, among litterfall.

Distribution in Brazil: Rio Grande do Sul, Rio de Janeiro and Bahia (Trierveiler-Pereira & Baseia 2009a).

Specimens examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata de 1989, 05 May 2009, *V.R. Coimbra & F. Wartchow* (URM 82112); *ibid*, mata controle, 06 May 2009, *ipse* (URM 82113).

Taxonomic remarks: Recently recorded for the first time from the Northeast Region of Brazil (Trierveiler--Pereira *et al.* 2009b), this species can be recognized in the field by its delimited and fibrillose peristome, sessile endoperidium, arachnoid aspect and longitudinal ridges on the outer face of the exoperidium. Microscopically, it can be separated from *G. saccatum*, a very similar species, because *G. lageniforme* has slightly smaller basidiospores and thin-walled clamped hyphae in the outer mycelial layer (Sunhede 1989). The epithet "lageniform" refers to the immature basidiome, which is bottle-shaped. This is the first record of the species from Paraíba.

3. *Geastrum saccatum* Fr., Syst. mycol. (Lundae) 3(1): 16, 1829. Fig. 1C, 2C.

Unexpanded basidiomata not observed. Expanded basidiomata 0.9–1.5 cm high × 1.6–3.3 cm broad. Exoperidium non-hygroscopic, split into 6–7 rays, saccate, grayish yellow (4C6). Endoperidium subglobose, 0.7–0.9 cm high × 0.9–1.5 cm broad, grayish brown (5D3), sessile, without apophysis; peristome fibrillose, concolor with endoperidium, delimited by a browish line. Gleba pulverulent at maturity, yellowish brown (5F5). Basidiospores globose, 4–5.5 µm diam including the ornamentation, brownish in KOH, ornamented with dense, high columns. Capillitial hyphae straight, thick-walled, covered with amorphous material, yellowish to yellowish brown in KOH, 2–6 µm diam. Growing solitary to gregarious on sandy soil, among litterfall.

Distribution in Brazil: Rio Grande do Sul, Paraná, São Paulo, Bahia, Pernambuco, Rio Grande do Norte and Amazonas (Trierveiler-Pereira & Baseia 2009a).

Specimens examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata de 1989, 05 May 2009, *V.R. Coimbra & F. Wartchow* (URM 82114); *ibid*, mata controle, 06 May 2009, *Coimbra & Wartchow*

(URM 82115, 82116, 82117)

Taxonomic remarks: *Geastrum saccatum* can be characterized by its sessile endoperidium and fibrillose peristome delimited by a white line. Another macroscopically similar species is *G. triplex* Jungh., but the latter has a prominent pseudoparanchymatous collar around the endoperidium, and the basidiomata are usually larger. This is the first record of the species from Paraíba.

4. *Geastrum setiferum* Baseia, Mycotaxon 84: 136, 2002. Fig. 1D, 2D.

Unexpanded basidiomata not observed. Expanded basidiomata 4–4.7 cm high × 3.8–5.5 cm broad. Exoperidium non-hygroscopic, split into 5–7 rays, arched, external layer peeling off at maturity. Endoperidium depressed-globose, 1.2–1.6 cm high × 1.8–2.3 cm broad, yellowish brown (5D5), with a short stipe, up to 1 mm high, apophysis present; endoperidial surface covered with dark brown setae; peristome slightly plicate, darker than endoperidium. Basidiospores globose, 3.5–4.0 µm diam including the ornamentation, brownish in KOH, ornamented with more or less columnar processes. Capillitial hyphae straight to sinuous, thick-walled, solid or with narrow lumen, covered with amorphous material, golden brown in KOH, 2.5–8 µm diam. Growing gregarious on sandy soil, among litterfall.

Distribution in Brazil: São Paulo, Pernambuco and Paraíba (Trierveiler-Pereira & Baseia 2009a).

Specimen examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata controle, 02 September 2009, *L. Trierveiler-Pereira* (URM 82118).

Taxonomic remarks: The species is mainly characte-

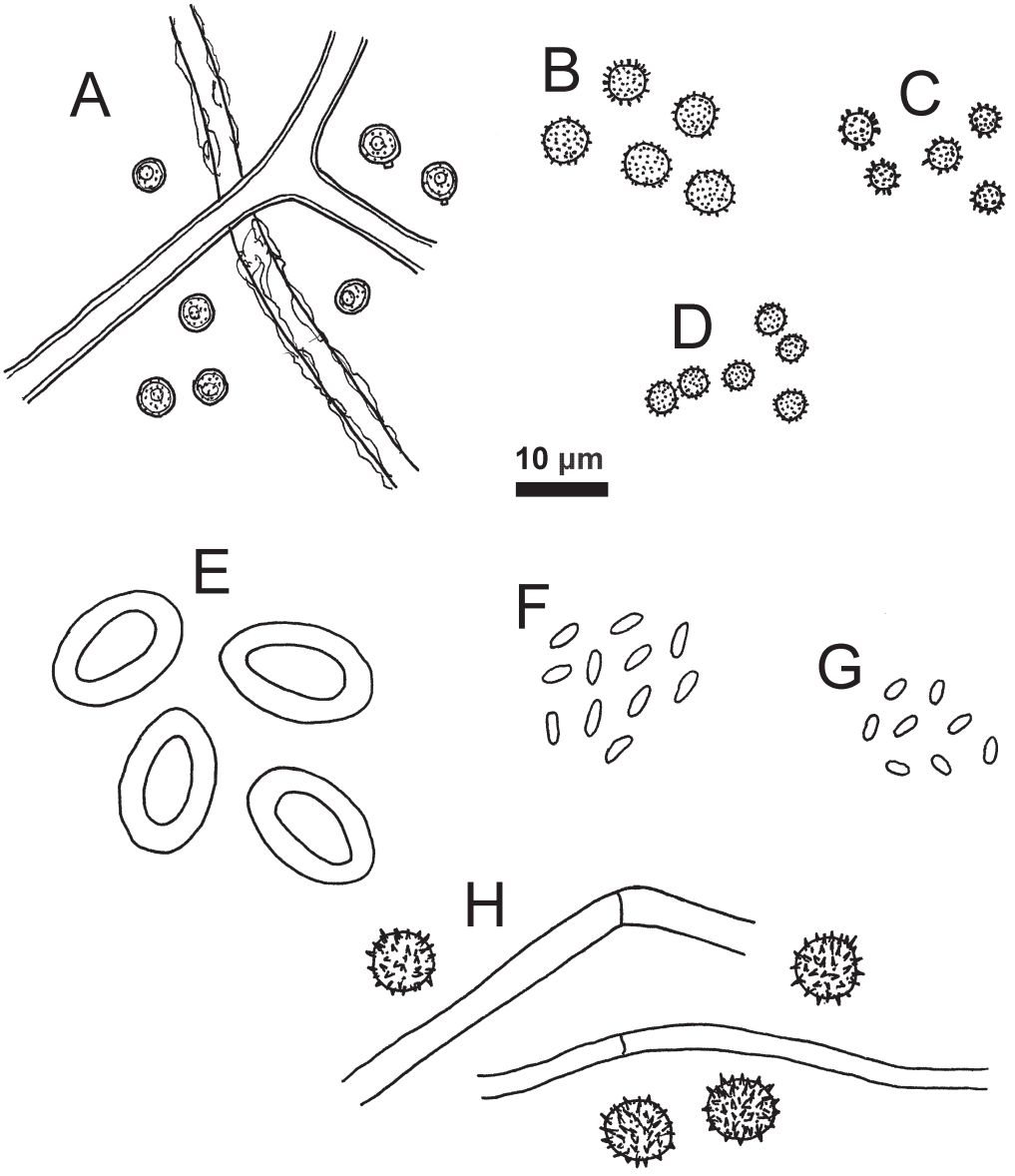

Figure 1. Microscopic structures of gasteroid fungi from Paraíba. **A**. *M. pyriformis*. **B**. *G. lageniforme*. **C**. *G. saccatum*. **D**. *G. setiferum*. **E**. *C. limbatus*. **F**. *A. floriformis*. **G**. *P. indusiatus*. **H**. *S. nitidum*.

rized by the presence of dark setae on the endoperidial surface. *Geastrum lloydianum* Rick resembles *G. setiferum*, due to the arched rays in mature basidiomata. However, the former lacks setae on the endoperidium and the peristome is distinctly deeply plicate. *Geastrum setiferum* was previously recorded from Paraíba by Leite *et al*. (2007).

Nidulariaceae

5. *Cyathus limbatus* Tul. & C. Tul., Annls Sci. Nat., Bot., sér. 3 1: 78, 1844. Fig. 1E, 2E-F.

Basidiomata obconic, slender obconic to funnel-shaped, 6–7 mm high and 3.5–7 mm wide at the mouth; exoperidium plicate, yellowish brown (5E5) to dark brown (6F6), with dense short hairs covering all the surface, with distinct basal emplacement; endoperidium plicate, brownish gray (7D2) to brownish beige (6E3), shiny. Peridioles triangular to irregular in outline, grayish, shiny, 2 mm diam., cortex two-layered with tunica. Basidiospores ellipsoid, colorless, 15–18 × 9–12 µm, thick-walled (2–3 µm). Growing scattered to gregarious on rotten wood.

Distribution in Brazil: Paraná, São Paulo, Pernambuco and Amazonas (Trierveiler-Pereira & Baseia 2009a, 2009b).

Specimens examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata desmatada, 06 May 2009, *V.F. Coimbra & F. Wartchow* (URM 82104); *ibid*, mata controle, 01 September 2009, *L. Trierveiler-Pereira* (URM 82105).

Taxonomic remarks: The species is characterized by a plicate peridium, and large peridioles with a two-layered cortex. *Cyathus limbatus* is macroscopically similar to *C. poeppigii* Tul. & C.Tul., but the latter has basidiospores up to 40 µm (Brodie 1975, Trierveiler-Pereira & Baseia 2009b). This is the first record of the genus *Cyathus* from Paraíba.

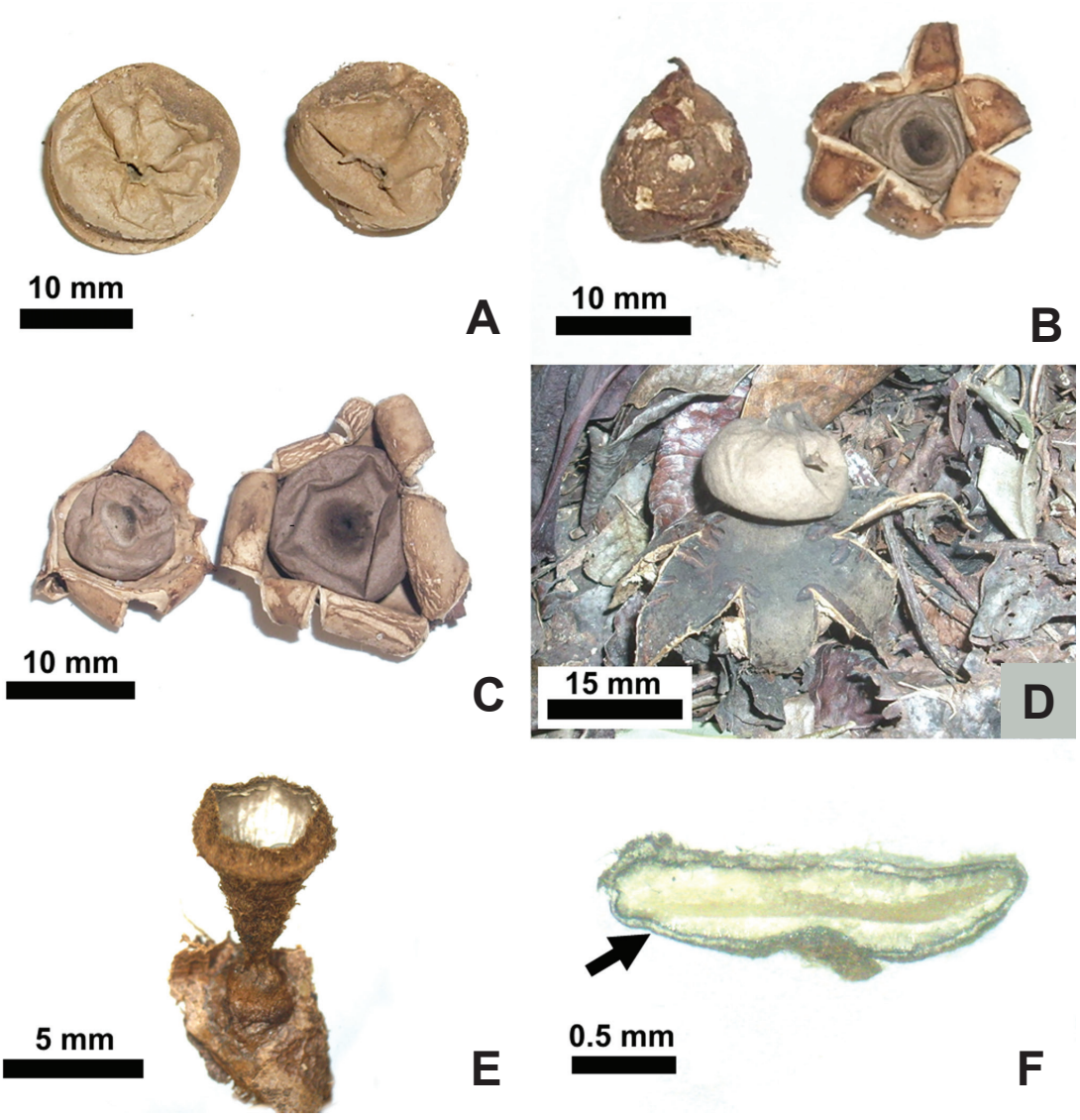

Figure 2. **A**. Basidiomata of *M. pyriformis*. **B**. Imature (left) and mature (right) basidiomata of *G. lageniforme*. **C**. Basidiomata of *G. saccatum*. **d**. Basidiome of *G. setiferum in situ*. **E-F**. *C. limbatus*. **E**. Basidiome. **F**. Transverse section of a peridiole (arrow = cortex with double layer).

Phallaceae

6. *Aseröe floriformis* Baseia & Calonge, Mycotaxon 92: 170, 2005. Fig. 1F, 3A-B.

Basidiome 3.2 cm high, with several whitish rhizomorphs attached at the base, rhizomorphs up to 5.1 cm length. Volva subglobose, saccate, 1.1 cm high × 1 cm broad, yellowish white (1A2). Pseudostipe cylindrical, spongy, grayish red (1B2), 2.1 cm high × 0.9 cm broad. Receptacle applanate, sunflower-shaped, light orange (5A4), becoming reddish orange (7B8) at the center, 3.7 cm diam, perforated at the center where the receptacle is attached to the pseudostipe. Gleba viscous, olive (3F4), foetid. Basidiospores cylindrical to oblong ellipsoid, hyaline to greenish, 3–4 × 1–1.5 µm, smooth. Growing solitary on sandy soil.

Distribution in Brazil: Rio Grande do Norte, Ceará and Bahia (Trierveiler-Pereira & Baseia 2009a, Bezerra *et al*. 2009).

Specimens examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata desmatada, 06 May 2009, *V.R. Coimbra & F. Wartchow* (URM 82106); *ibid*, 02 September 2009, *L. Trierveiler-Pereira* (URM 82107).

Taxonomic remarks: *Aseröe floriformis* can be separated from the other species of the genus (*A. arachnoidea* E. Fisch., *A. coccinea* Imazeki et Yoshimi ex Kasuya, and *A. rubra* Labill.) because of its yellowish or orange basidiome and fused arms, originating in a sunflower-shaped receptacle (Baseia & Calonge 2005, Kasuya 2007). Since the species has been recorded only from the Northeast Region of Brazil, Bezerra *et al*. (2009) concluded that *A. floriformis* is endemic to that region. However, there are photos of a basidiome collected in the state of São

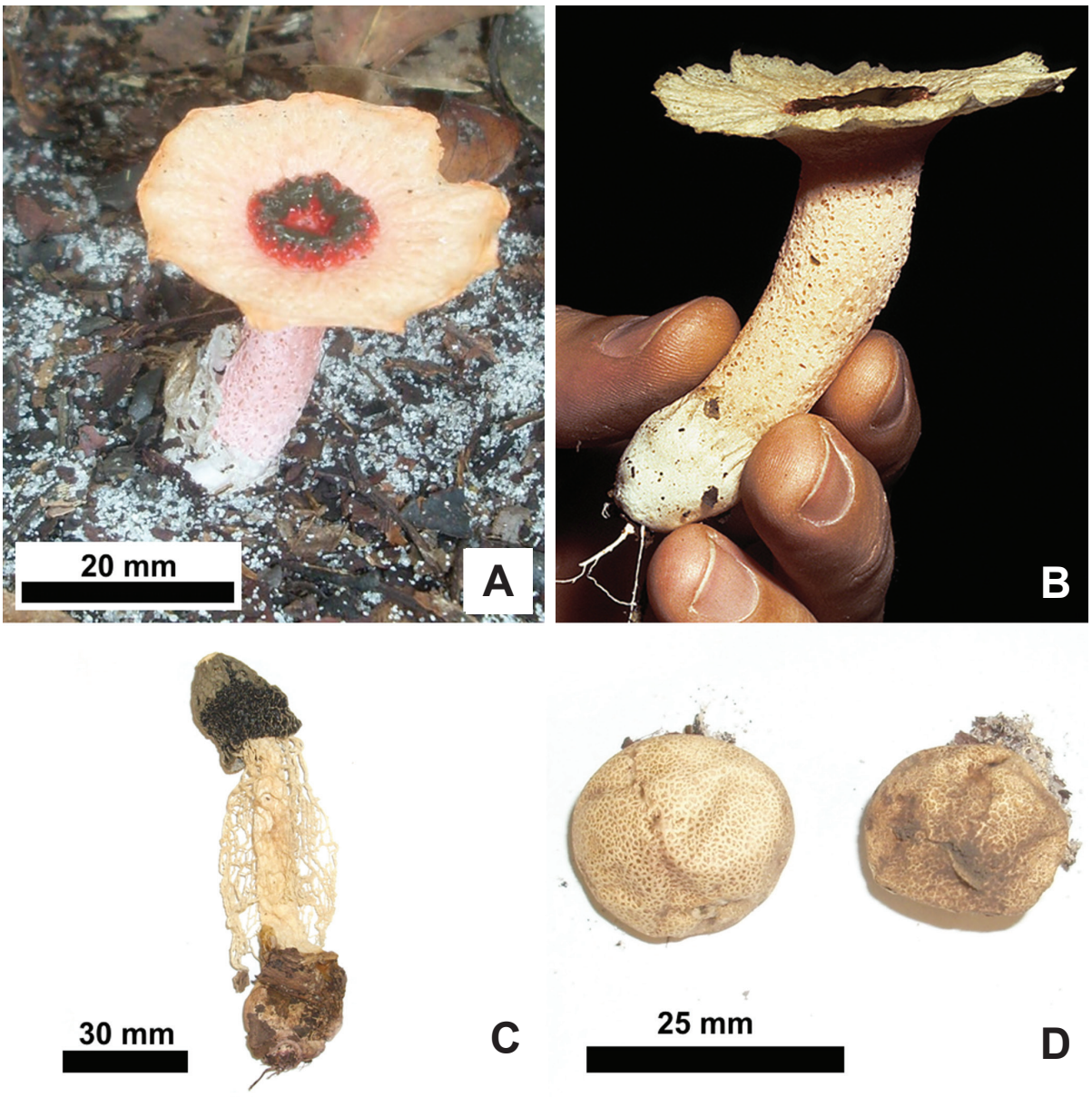

Figure 3. **A-B**. *A. floriformis*. **A**. Basidiome *in situ*. **B**. Basidiome from the state of São Paulo photographed by George J. Shepherd. **C**. Basidiome of *P. indusiatus*. **D**. Basidiomata of *S. nitidum*.

Paulo (city of São Sebastião), which were taken in 1979 by George J. Shepherd (Fig. 3B) and look similar to this species. Therefore, it is possible that *A. floriformis* occurs throughout the range of the Atlantic Forest.

7. *Phallus indusiatus* Vent., Mém. Inst. Natl. Sci., Sci. Math. 1: 520, 1798. Fig. 1G, 3C.

Basidiome 13.4 cm high, with a whitish rhizomorph attached at the base, rhizomorph 1.3 cm length. Volva subglobose, saccate, 3.9 cm high × 2.9 cm broad, pale yellow (2A3), with a disciform base, basal disc with purplish pigments. Pseudostipe cylindrical to subcylindrical, spongy, greenish gray (1B2), 9.8 cm high × 2 cm broad; indusium well developed, pendulous, pale yellowish (1A3), 6.7 cm long. Receptacle campanulate, pale yellowish (1A3), 3.9 cm high × 2.9 cm broad, with superficial folds forming a network (reticulate), apex perforated. Gleba viscous, grayish green (1D5), foetid. Basidiospores cylindrical to oblong ellipsoid, hyaline to greenish, 3–4 × 1–1.5 µm, smooth. Growing solitary on sandy soil, among litterfall.

Distribution in Brazil: Rio Grande do Sul, Paraná, São Paulo and Rio Grande do Norte

(Trierveiler-Pereira & Baseia 2009a).

Specimen examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata de 1989, 05 May 2009, *V.R. Coimbra & F. Wartchow* (URM 82108).

Taxonomic remarks: *Phallus indusiatus* is recognized by its well-developed light-colored indusium, reticulate receptacle, and violet pigments in the volva. *Phallus duplicatus* Bosc, a macroscopically similar species, has a pinkish indusium and occurs in temperate North America and tropical Africa (Calonge 2005, Kreisel 1996). In the Northeast Region of Brazil, *P. indusiatus* was only known from the state of Rio Grande do Norte (Baseia et al. 2006). This is the first record of *P. indusiatus* from Paraíba.

Sclerodermataceae

8. *Scleroderma nitidum* Berk., Hook J. Bot. 6: 173, 1854. Fig. 1H, 3D.

Basidiomata subglobose to depressed-globose, 0.8–1.5 cm high × 1.0–2.3 cm broad, with abundant rhizomorphs attached at the base, rhizomorphs whitish, up to 1 cm length, with debris attached; subgleba absent. Peridium less than 0.5 mm thick, peridium surface grayish yellow (2B4, 3C5). Gleba powdery to floccose, olive (3F5), exposed by an irregular rupture of the peridium. Basidiospores globose to subglobose, yellowish to light brown in KOH, 8–11 µm diam, with spiny ornamentation. Capillitial hyphae slightly thick-walled, with simple septa, 2.5–4 µm diam, hyaline in KOH. Growing scattered to gregarious, among litterfall.

Distribution in Brazil: Bahia, Pernambuco, Paraíba and Rio Grande do Norte (Trierveiler-Pereira & Baseia 2009a).

Specimens examined: BRAZIL. PARAÍBA: **Mataraca**, Mineradora Millenium (Cristal), mata controle, 06 May 2009, *V.R. Coimbra & F. Wartchow* (URM 82110); *ibid*, mata desmatada, 06 May 2009, *ipse* (URM 82111).

Taxonomic remarks: According to Guzmán *et al*. (2004), *S. nitidum* is frequently confused with *S. verrucosum* Pers., but the former has a pantropical distribution, while the latter is a temperate species. Other features that separate these two species are the subgelatinous patches on the peridium and the smaller basidiospores of *S. nitidum*. Guzmán & Tapia (1995) transferred *S. nitidum* to the genus *Veligaster* Guzmán, due to the presence of subgelatinous patches of the upper part of the stipe and base of the globose peridium. However, we still prefer to keep this species in *Scleroderma*, because this may not be an important character for segregating these genera. The species was previously recorded from Paraíba by Gurgel *et al*. (2008).

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