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ARTICLE

Gasteroid Agaricomycetidae (Basidiomycota) from Parque Estadual São Camilo, Paraná, Brazil

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ABSTRACT: (Gasteroid Agaricomycetidae (Basidiomycota) from São Camilo State Park, Paraná, Brazil). The gasteroid fungi are a polyphyletic group of basidiomycetes, with internal production and maturation of basidiospores, which are passively dispersed. This study was a survey of gasteroid fungi (Agaricomycetidae) from São Camilo State Park, municipality of Palotina, western Paraná state, Brazil. A total of 63 specimens were collected between March 2011 and July 2012, comprising fourteen species belonging to the genera *Arachnion* (1), *Bovista* (2), *Calvatia* (4), *Cyathus* (2), *Lycoperdon* (2) and *Morganella* (3). *Arachnion album, Bovista aestivalis, Calvatia fragilis, Cyathus montagnei, Lycoperdon perlatum, L. pyriforme* and *Morganella afra* were new records for Paraná state. Descriptions, photos of macro- and microstructures are presented, as well ecological data and identification keys for the studied taxa.
Key words: Agaricaceae, gasteromycetes, Lycoperdaceae, Nidulariaceae.

RESUMO: (Agaricomycetidae gasteroides (Basidiomycota) do Parque Estadual São Camilo, Paraná, Brasil). Fungos gasteroides são um grupo morfológico e polifilético de Basidiomycota, com formação e maturação de esporos interna ao basidioma e dispersão passiva. Este trabalho teve como objetivo compilar as espécies de fungos gasteroides (Basidiomycota) no Parque Estadual São Camilo, município de Palotina, oeste do Paraná. As coletas foram realizadas no período chuvoso entre março de 2011 e julho de 2012. Ao todo foram analisados 63 espécimes, representando quatorze espécies, pertencentes aos gêneros *Arachnion* (1), *Bovista* (2), *Calvatia* (4), *Cyathus* (2), *Lycoperdon* (2) e *Morganella* (3). *Arachnion album, Bovista aestivalis, Calvatia fragilis, Cyathus montagnei, Lycoperdon perlatum, L. pyriforme* e *Morganella afra* são novas ocorrências para o estado do Paraná. São apresentadas descrições e imagens de macro- e micromorfologia, dados ecológicos e chaves de identificação para os táxons estudados.
Palavras-chave: Agaricaceae, gasteromicetos, Lycoperdaceae, Nidulariaceae.

INTRODUCTION

Gasteroid fungi, or gasteromycetes, are a morphological assemblage of basidiomycetous macrofungi, defined by the production of basidiospores (statimospores) within an enclosed hymenophore (Miller & Miller 1988). Although they were classified together as a single class (Gasteromycetes) within the Basidiomycota, recent phylogenetic studies changed their classification (Hibbett 2006). Some families of gasteroid and secotioid fungi, e.g. Lycoperdaceae, Nidulariaceae, Podaxaceae and Tulostomataceae, were merged with the Agaricaceae (Hibbett 2006, Vellinga *et al.* 2011).

Gasteromycetes are widely distributed but poorly studied, especially in Brazil where most of the studies addressed southern and northeastern regions. In the state of Paraná, 44 gasteroid fungi are currently known, although most of them are reported from the eastern region of the State where the ombrophilous forests occur (Meijer 2006, 2010). As such, the mycobiota from western areas of the State remains poorly documented (Meijer 2006, 2010). Surveys of neighboring areas (Wright & Wright 2005) provide reports of gasteroid fungi in the seasonal forests of this region.

This study aimed to improve knowledge on the mycobiota from the seasonal semideciduous forests in the western region of Paraná state. This study addresses gasteroid fungi from the region and summarizes the information for gasteroid fungi of the subclass Agaricomycetidae.

MATERIAL AND METHODS

Fieldwork was carried out in the "Parque Estadual São Camilo" (abbreviated onwards as PESC), municipality of Palotina (24º18'00"-24º19'30" S, 53º55'30"-53º55'30" W), western region of Paraná state, in south Brazil (Fig. 1). PESC is comprised of seasonal semideciduous forest, characterized by the dominance of Fabaceae, Apocynaceae, Lauraceae, Meliaceae, Moraceae, a high diversity of ferns and lianas as well as the palm *Syagrus romanzoffiana* (Cham.) Glassman (Roderjan *et al*. 2002).

Specimens were gathered between March 2011 and July 2012 and morphologically analyzed in the laboratory following standard methods established for gasteroid fungi (Miller & Miller 1988). Macroscopic descriptions, color and codes followed those of Kornerup & Wanscher (1978), while the colors noted in microscopic descriptions were from preparations mounted in 5% KOH. All basidiospore measurements included ornamentation when present. Additionally, specimens collected

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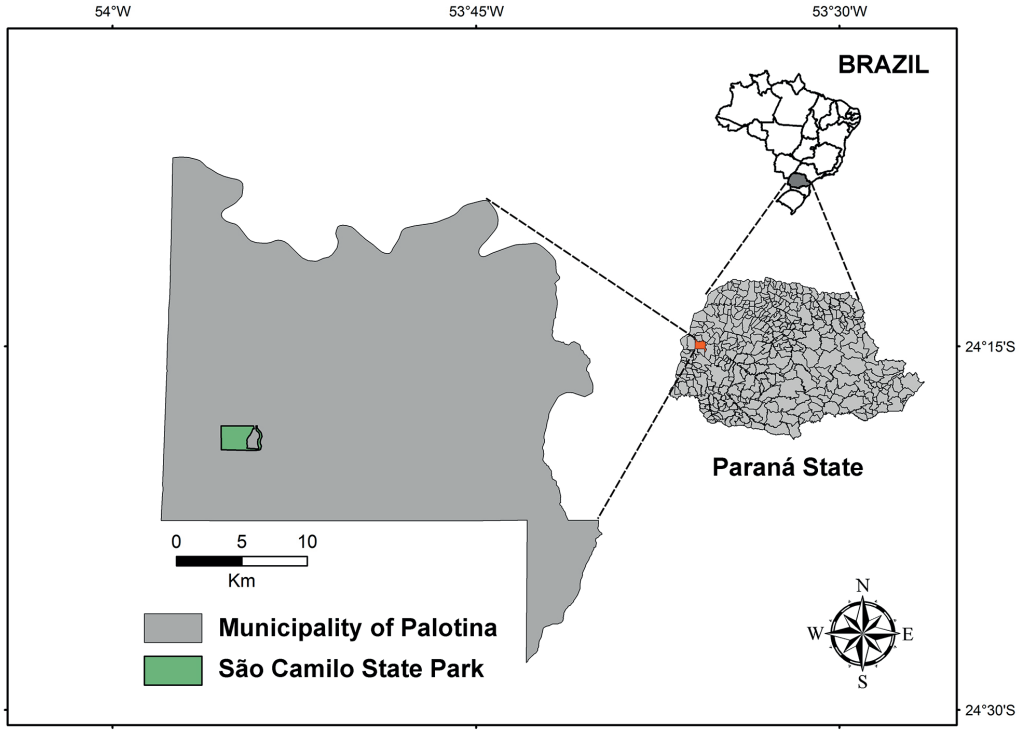

Figure 1. Location of São Camilo State Park, Paraná, Brazil.

during 2010 and 2012 were revised and considered in this survey. Scanning electron microscopy (SEM) was performed at the Center for Electron Microscopy of the Universidade Federal do Paraná (CME/UFPR), with a Jeol JSM-6360LV. All specimens were preserved at the Herbarium of Campus Palotina (HCP) and the Department of Botany (UPCB), both at the Universidade Federal do Paraná (UFPR).

RESULTS AND DISCUSSION

Key to the genera of gasteroid Agaricomycetidae from PESC

1. Basidiomata cup-shaped, with lenticular peridioles, 2-3 mm ..... *Cyathus*
1'. Basidiomata globose, subglobose or pyriform, peridioles absent or, if present, smaller than 1 mm diam…..... 2
2. Peridium dehiscing through a distinct apical pore …….....…..….. 3
2'. Peridium with irregular dehiscence, not forming a pore 5
3. Gleba composed of paracapillitium …..... *Morganella*
3'. Gleba composed of eucapillitium …….....……..….. 4
4. Sterile base present …….....*Lycoperdon*
4'. Sterile base absent …….....*Bovista*
5. Gleba composed of small peridioles < 3mm, resembling sand grains …..... *Arachnion*
5'. Gleba without peridioles, cottony or powdery at maturity …….....*Calvatia*

Arachnion Schwein.

Members of this genus produce globose to subglobose basidiomata, <20 mm in diam., gleba formed of small peridioles similar to sand grains, and the capillitium is absent or poorly developed (Long 1941, Demoulin 1972). *Arachnion* contains seven species, of which *A. album*, *A. foetens* Speg., *A. iriemae* Rick and *A. scleroderma* Lloyd are present in Brazil (Rick 1961).

1. *Arachnion album* Schwein., *Schrift. Naturforsch. Ges. Leipzig, 1*: 59, 1822.

Fig. 2A-B

Basidiomata subglobose, 9-20 mm in height and 10-30 mm in width. Exoperidium smooth to granulose, white (1A1) to pale yellow (1A3) when mature, dehiscence by irregular rupture. Endoperidium smooth, white (1A1). Sterile base absent, with scarce, thin (< 1 mm), short and little branched rhizomorphs attached. Gleba formed of peridioles similar to sand grains, ovoid to subglobose 55.2-83.6(-98.5) × 43.7-52.4(-61.6) µm, white (1A1) when immature to greenish-grey (1C2) at maturity. Subgleba absent. Basidiospores subglobose to ovoid, 3.8-5.4 × 3.5-4.6 µm, pale green to hyaline, smooth-walled, pedicels 0.5-6.5 µm long depending on the stage of development. Eucapillitium and paracapillitium absent. Exoperidium composed of hyphae of irregular shapes, globose to pyriform, 10.3-43.3 × 6.6-29.8 µm, not organized in chains, colorless, with

hyaline and slightly thickened (<1 µm) walls.

Ecology and distribution: Growing on soil, open areas or trails in the forest or forest edges. Known from Europe (Moravec 1958), South Africa, Asia, North and South America (Cortez *et al.* 2010). In Brazil, from the States of Pernambuco, São Paulo and Rio Grande do Sul (Trierveiler-Pereira *et al*. 2010).

Examined specimens: BRAZIL. PARANÁ: **Palotina**, PESC, 27-I-2011, leg. *A.J. Ferreira & V.G. Cortez 17-33* (HCP 207); 23-IV-2012, leg. *C.R. Alves & V.G. Cortez 56* (HCP 206).

Additional examined specimens: BRAZIL. PARANÁ: **Palotina**, Campus UFPR, 29-II-2012, leg. *C.R. Alves 87* (HCP 394).

Notes: Arachnion album occurs as epigeous to partially hypogeous, gregarious to scattered on soil, among grasses or even in coastal sand-dunes (Kasuya *et al*. 2006). It was not a frequently-found species in PESC species but was found growing on soil and in small groups. In spite of being considered a widely distributed species, this was the first reported occurrence in Paraná state.

Bovista Pers.

Bovista is comprised of 55 species world-wide (Kirk *et al*. 2008), of which only three are reported from Paraná: *B. dermoxantha* (Vittad.) De Toni, *B.* aff. *dryina* (Morgan) Demoulin and *B. longispora* Kreisel (Meijer 2006). According to Bautista-Hernández *et al*. (2011), *Bovista* is subdivided in two subgenera: *Globaria,* with a *Lycoperdon* or intermediate eucapillitium (e.g., *B. aestivalis* and *B. dominicensis,* both occurring in PESC) and *Bovista,* with the eucapillitium of *Bovista* type or heteromorphic, as for *B. plumbea* Pers. (Baseia 2005a).

Key to the species of *Bovista* from PESC

1. Basidioma yellowish-brown to light brown, basidiospores echinate, with longer pedicels (<20 µm)..... *B. dominicensis*
1'. Basidioma grayish green, basidiospores verrucose to spiny, with shorter (<1 µm) pedicels ..... *B. aestivalis*

2. *Bovista aestivalis* (Bonord.) Demoulin, *Beih. Sydowia, 8*: 143, 1979.

Figs. 2C-E, 7A

Basidiomata 12 mm in height, 15 mm in width, and subglobose. Exoperidium white (1A1) to greyish-green (1C3) when fresh, yellowish-brown (5D8) when dry, smooth to granulose. Endoperidium smooth, yellowish-brown (5D8). Sterile base absent. Gleba cottony, light brown (5D4). Subgleba reduced, <1 mm height and compact. Basidiospores 4.8-5.8 µm, globose, ornamentation shortly spiny to verrucose, pale green, pedicels short (<1 µm long); under SEM, irregular wall surface, with verrucose ornamentation, scarce membranes connecting warts. Eucapillitium 2.2-5.1 µm in diam., colorless to brownish, little branched, pitted with 0.8-1.2 µm diam. Exoperidium composed by globose to pyriform hyphae, 10.7-22.4 × 10-17.7 µm, not in chains, colorless to brownish, walls hyaline <1 µm thickness.

Ecology and distribution: On soil in open areas. Cosmopolitan (Pegler *et al*.1995, Bates *et al*. 2009). Brazil: known from São Paulo and Pernambuco (Baseia 2005b).

Examined specimen: BRAZIL, PARANÁ: **Palotina**, PESC, 3-III-2011, leg. *V.G. Cortez 17-31*(HCP 208).

Notes: Bovista aestivalis has an intermediate eucapillitium type and verrucose basidiospores, with ornamentation best seen under SEM (Bautista-Hernández *et al*. 2011). According to Calonge (1999), it can be confused with *B. plumbea* and *B. dermoxantha,* but the former has ovoid basidiospores with long pedicels (<18 µm) and the eucapillitium of *Bovista* type (Calonge 1992), while *B. dermoxantha* lacks a subgleba, with more ornamented basidiospores (Bautista-Hernández *et al*. 2011). It is a new record from the State of Paraná.

3. *Bovista dominicensis* (Massee) Kreisel, *Feddes Repert., 69*: 202, 1964.

Figs. 2F-H, 7B

Basidiomata 10-15 mm in height, 10-20 mm in width, and globose to subglobose. Exoperidium smooth to granulose, yellowish-brown (5F8) to light brown (5D6) when fresh. Endoperidium smooth, yellowish-brown (5D5) to light brown (1A5) when dry, with an apical pore. Sterile base reduced, up to 4mm in height, rhizomorphs <1 mm thickness and white (1A1). Gleba cottony to powdery when mature, then yellowish-brown (5E5) at maturity. Subgleba reduced, compact <3 mm height, white (1A1) when immature. Basidiospores 5.2-5.8 µm, globose, spiny, pedicels 4.2-19.7 µm long; under SEM, the ornamentation is composed of conical spines, <0.5 µm long, interconnected by filaments adhered to the basidiospore surface. Eucapillitium 2.1-4.9 µm in diam., brownish, with hyaline walls, slightly branched, pore scarce. Exoperidium hyphae 10-26.1 × 6.3-21.1 µm, irregular shaped, globose to pyriform and elongated, forming aggregates, colorless to brownish, walls hyaline, with 1 µm thickness.

Ecology and distribution: On soil and decomposed wood. Neotropical (Kreisel & Dring 1967, Calonge *et al*. 2005, Bautista-Hernández *et al*. 2011). In Brazil, known from Rio Grande do Sul (Homrich 1969) and Pernambuco (Trierveiler-Pereira *et al*. 2010).

Examined specimens: BRAZIL, PARANÁ: **Palotina**, PESC, 16-II-2011, leg. *V.G. Cortez 18-39* (HCP 210); 23-XI-2011, leg. *C.R. Alves 10* (HCP 211), 13-II-2012, leg. *C.R. Alves 13* (HCP 209). *Additional examined specimens:* BRAZIL. PARANÁ: **Palotina**, Campus UFPR, 29-II-2012, leg. *C.R. Alves 86* (HCP 393).

Notes: Bovista dominicensis is defined by echinate basidiospores with long pedicels (Bautista-Hernández *et al*. 2011). It differs from *B. trachyspora* (Lloyd) Kreisel, which has smaller (0.5 µm) and more densely grouped spines, as well as smaller basidiomata (Kreisel 1967). Trierveiler-Pereira *et al*. (2010) reported the distribution

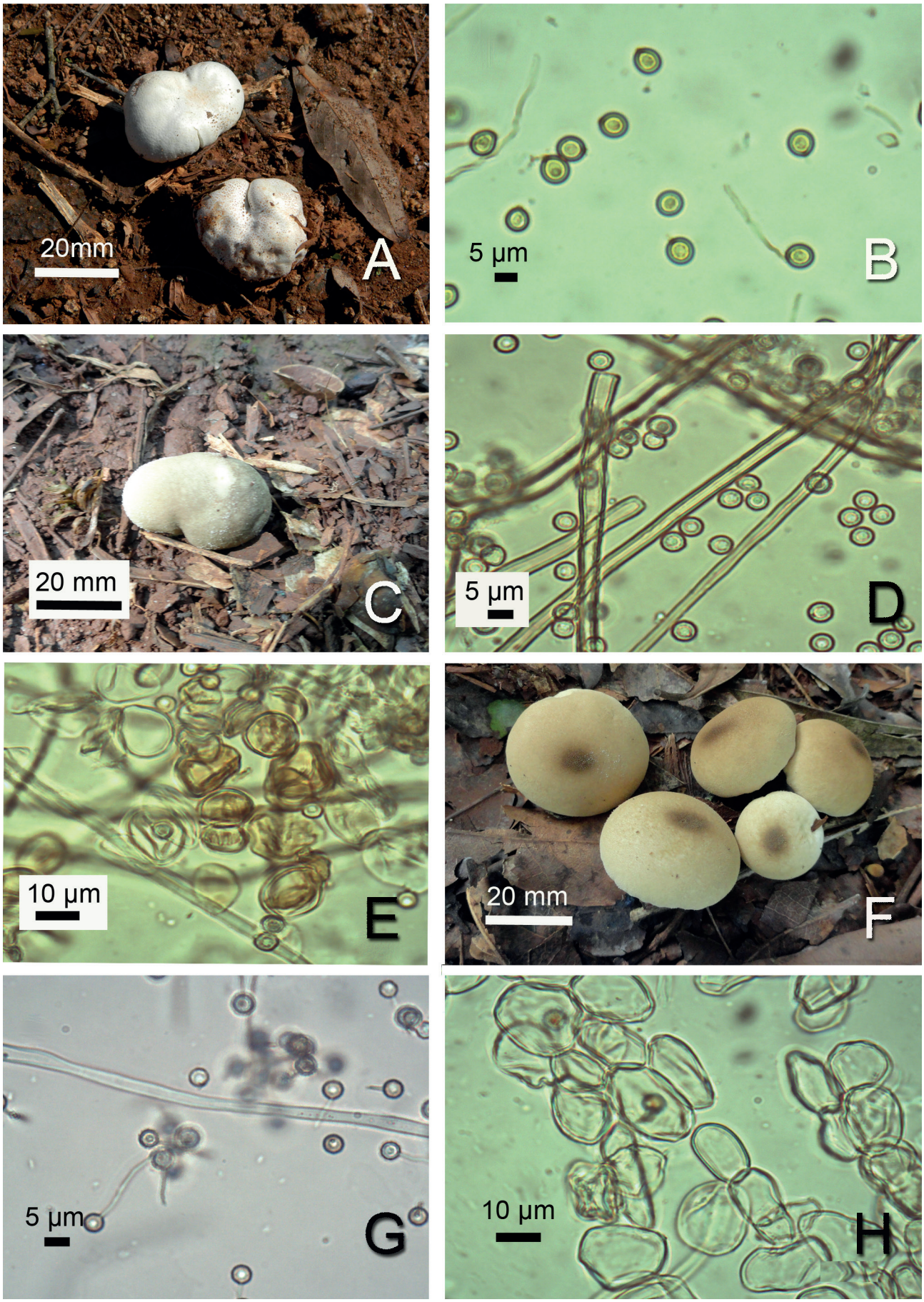

Figure 2. A-B. *Arachnion album*. A. Basidiomata. B. Basidiospores. C-E. *Bovista aestivalis.* C. Basidioma. D. Basidiospores and eucapillitium. E. Exoperidium hyphae. F-H. *Bovista dominicensis*. F. Basidiomata. G. Basidiospores and eucapillitium. H. Exoperidium hyphae.

of this species from Pernambuco to Rio Grande do Sul, but it is a newly described from the State of Paraná.

Calvatia Fr.

Species of *Calvatia* present with large to medium-sized basidiomata, subglobose to pyriform, with a well-developed sterile base, smooth to spiny peridium (Smith 1951, Kreisel 1989, Calonge & Martín 1990), and comprises about 40 species, some of ethnomycological and biotechnological importance (Coetzee & Van Wyk 2009). In Brazil, 10 taxa have been reported (Trierveiler-Pereira & Baseia 2009a, Cortez *et al*. 2012), from which *C. excipuliformis* (Bull.) Kreisel (Silveira 1943, as *C. saccata* (Vahl) Morgan), *C. cyathiformis* and *C. rugosa* (Meijer 2006) were reported from Paraná State.

Key to the species of *Calvatia* from PESC

1. Exoperidium dark brown, densely spinulose ..... *C. guzmanii*
1'. Exoperidium paler, smooth to granulose 2
2. Gleba pale yellow when immature, dark yellow at maturity ..... *C. rugosa*
2'. Gleba white when immature, dark violaceous-brown at maturity 3
3. Basidiospores dark brown, with spines <2 µm long..... *C. cyathiformis*
3'. Basidiospores pale green, with spines <1 µm long..... *C. fragilis*

4. *Calvatia cyathiformis* (Bosc) Morgan, *J. Cincinnati Soc. Nat. Hist., 12*: 168, 1890.

Figs. 3A-C, 7C

Basidiomata 50 mm in height, 55 mm in width, subglobose to pyriform. Exoperidium with irregular dehiscence, smooth to velutinous dried brown (6E4) to dark brown (7F5). Endoperidium not observed. Sterile base prominent, occupying 2/3 of basidioma, 30 mm in height, 20 mm in width. Gleba 10 mm in height, powdery, dark brown (7F5) at maturity. Subgleba cellular, 40 mm height, brownish-grey (6E3). Basidiospores 8.2-9.3 µm, globose, with a strongly echinate ornamentation, dark brown to purplish; under SEM, the surface is wrinkled and ornamentation echinate. Eucapillitium 3.4-4.6 µm diam., brownish, walls hyaline, slightly branched. Exoperidium hyphae 28.2-46.5×14.3-24.6 µm, brownish to purple, subglobose, pyriform to elliptical, scattered or in small groups, with thickened walls (1.2-1.5 µm diam.).

Ecology and distribution: Solitary in the forest. Pantropical (Cortez *et al*. 2012). In Brazil, from Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul and São Paulo (Cortez *et al*. 2012).

Examined specimens: BRAZIL. PARANÁ: **Palotina**, PESC, 31-I-2012, leg. *C. Kozera 4242* (HCP 214).

Notes: The pyriform and robust basidiomata with a large sterile base, violaceous gleba and the dark echinate basidiospores are diagnostic features of *C. cyathiformis* (Urista *et al*. 1985, Calonge *et al*. 2005), considered an edible mushroom in Europe and North America (Coetzee & Van Wyk 2009). According to Cortez *et al*. (2012), it is a common puffball in the Atlantic Forests of Rio Grande do Sul, and observed by Meijer (2006) in Paraná State, where it has been collected in ombrophilous and semideciduous forests. *Calvatia cyathiformis* was also reported from Cerrado (Baseia 2003) and Caatinga (Wartchow & Silva 2007) Brazilian biomes.

5. *Calvatia fragilis* (Vittad.) Morgan, *J. Mycol., 12*: 168, 1890.

Figs. 3D-F, 7D

Basidiomata 50-70 mm in height, 30-100 mm in width, subglobose to depressed globose. Exoperidium smooth, dehiscing irregularly, yellowish-white (3A2) to light brown (5D4). Endoperidium smooth, yellowish-white (3A2). Sterile base 30 mm in height, white (1A1) to yellowish white (1A2). Gleba white (1A1) when immature to dark brown (7F7) and powdery at maturity. Subgleba cellular, 25 mm in height, pale yellow (4A3) when young, light brown (5D4) when at maturity. Basidiospores 6.2-6.9 µm, globose, verrucose to shortly echinate, pale green; under SEM, the irregular surface wall is composed of verrucose warts. Eucapillitium 2.8-3.3 µm in width, brownish, pitted, scarce, <1 µm diam., little septate. Exoperidium hyphae 9.9-34.7×9.5-17.8 µm, subglobose, pyriform, hyaline to brown, scattered or in small groups.

Ecology and distribution: On soil, forest trails. Pantropical (Cortez *et al*. 2012). In Brazil, from Rio Grande do Sul and Rio de Janeiro (Cortez *et al*. 2012).

Examined specimens: BRAZIL. PARANÁ: **Palotina**, PESC, 16-II-2011, *leg. V.G. Cortez 18-33* (HCP 217).

Additional examined specimens: BRAZIL. PARANÁ: **Palotina**, Campus UFPR, 29-IX-2010, leg. *V.G. Cortez 013/10* (HCP 397), 12-IX-2011, leg. *C.R. Alves 04* (HCP 392), 13-IX-2011, leg. *V.G. Cortez* (HCP 391), 23-XI-2011, leg. *C.R. Alves 89* (HCP 398), 29-II-2012, *leg. V.G. Cortez & C.R. Alves* 20 (HCP 215).

Notes: Calvatia fragilis is recognized by the reduced sterile base and pale green basidiospores, with <1 µm long spines, differing from the closely-related *C. cyathiformis* (Cortez *et al*. 2012). Some authors consider them synonymous, however morphological characteristics separate both species when mature specimens are examined. It is a poorly documented species in Brazil (Cortez *et al*. 2012), but frequently collected in gardens and meadows in the region of Palotina, forming fairy-rings. It is newly recorded from the State of Paraná.

6. *Calvatia guzmanii* C.R. Alves & Cortez, *Phytotaxa, 85*: 36.

Figs. 3G-H, 7E

Description: Alves & Cortez (2013b).

Ecology and distribution: Growing on litter and oc-

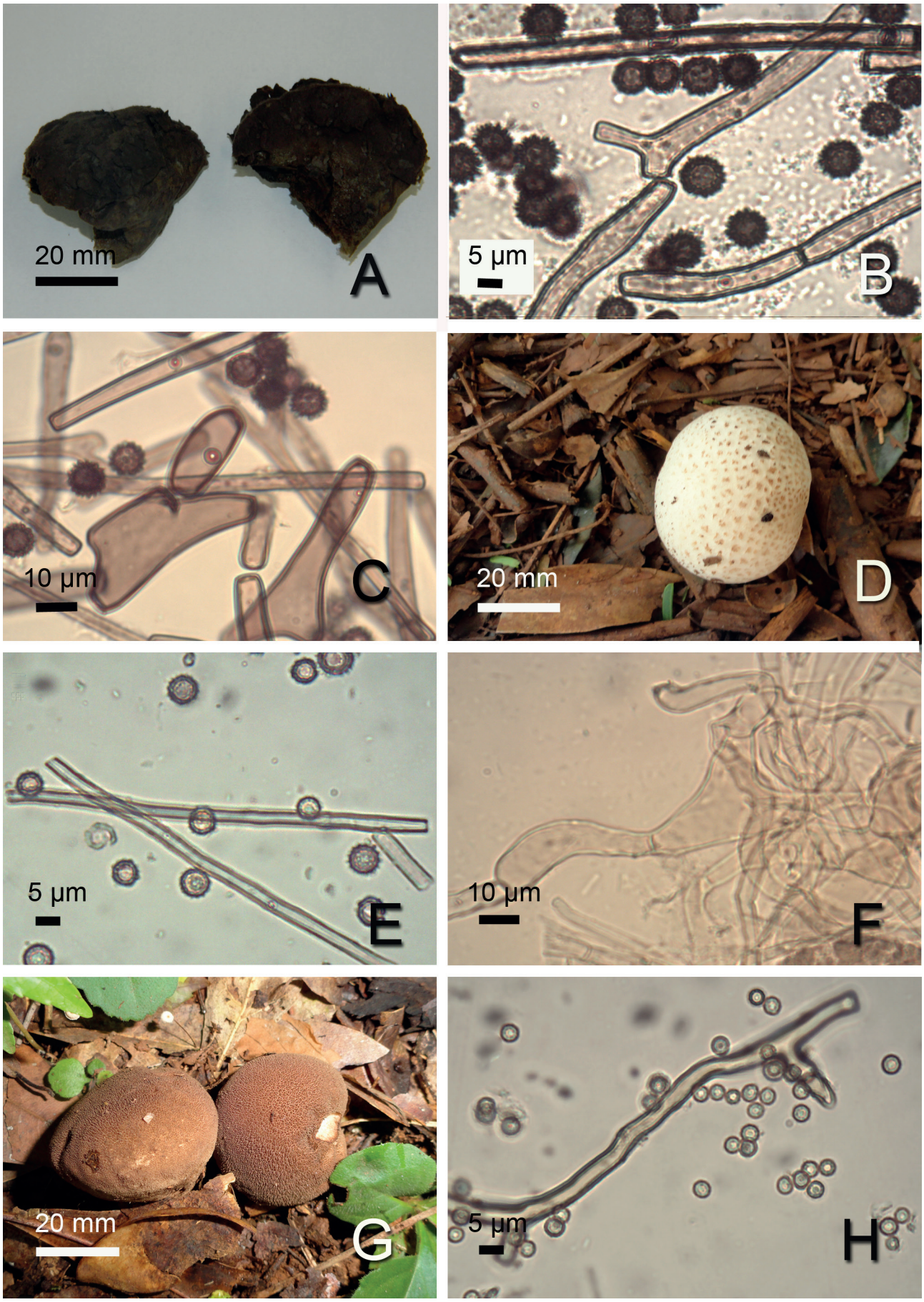

Figure 3. A-C. *Calvatia cyathiformis*. A. Basidioma. B. Basidiospores and eucapillitium. C. Exoperidium hyphae. D-F. *Calvatia fragilis*. D. Basidioma. E. Basidiospore and eucapillitium. F. Exoperidium hyphae. G-H. *Calvatia guzmanii*. G. Basidomata. H. Basidiospores and eucapillitium.

casionally on decomposed wood. Only known from PESC (type locality).

Examined specimens: BRAZIL. PARANÁ: **Palotina,** PESC, 10-XII-2010, leg. *V.G. Cortez 15-39* (HCP 218); 16-II-2011, leg. *V.G. Cortez 18-43* (UPCB 73369, HOLOTYPE); 18-II-2011, leg. *V.G. Cortez 18-30* (HCP 219); 02-III-2011, leg. *V.G. Cortez 19-31* (HCP 222), and *19-32* (HCP 223); 03-IV-2012, leg. *C.R. Alves 22* (HCP 224) and *23* (HCP 225); 17-IV-2012, leg. *C.R. Alves* 25 (HCP 226); 18-IV-2012, leg. *V.G. Cortez & C.R. Alves 38* (HCP 227) and *44* (HCP 228).

Notes: Calvatia guzmanii was recently described as a new species based on the dark brown, velutinous to spiny exoperidium, large subgleba (about 2/3 of basidioma height) and echinate basidiospores with a netted surface (Alves & Cortez 2013b). Other members of the genus are addressed by Alves & Cortez (2013b), where detailed descriptions and illustrations are presented. It was the commonest puffball collected in this survey, occurring mostly on litter and less frequently on wood in advanced decomposition, in forest.

7. *Calvatia rugosa* (Berk. & M.A. Curtis) D.A. Reid, *Kew Bull., 31*: 671, 1977.

Figs. 4A-D, 7F

Basidiomata 20-60 mm in height, 35-70 mm in width, subglobose-depressed to subpyriform. Exoperidium smooth when immature to areolate, slightly velvety and wrinkled at maturity, dehiscence in flakes, light brown (6D5) to greyish-yellow (4C5). Endoperidium smooth, light yellow (4A5) to yellowish-brown (5D6). Sterile base 15-25 mm in height, velutinous when young to smooth when older, yellowish-brown (5D6) with white to yellowish pseudorrhiza, 1-3mm thick. Gleba white (1A1) to pale yellow (1A3), fleshy to compact when immature, becoming gradually cottony and dark yellow (4C8) at maturity. Subgleba cottony, 15-30 mm in height, grayish-yellow (4C7) to dark yellow (4C8). Basidiospores 4.9-5.6 µm, globose, ornamentation verrucose to echinate, pale green; under SEM, the wall surface is smooth and ornamentation strongly echinate, connected by thin filaments, pedicel short (<1 µm long). Eucapillitium 2.8-3.9 µm in diam., brownish, walls hyaline, strongly pitted, 1-1.5 µm diam. Exoperidium hyphae 18.5-39.8 × 9-36.8 µm, elliptical to subglobose, organized in chains, colorless to brownish-yellow.

*Ecology and distribution***:** On soil, among litter, on trails or in the forest. Known from Asia (Zeller & Smith 1964), Europe (Kreisel 1994), Australia and the Americas (Calonge *et al*. 2005). In Brazil, known from Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo (Cortez *et al*. 2012).

Examined specimens: BRAZIL. PARANÁ: **Palotina,** PESC, 02-VI-2010, leg. *A.J. Ferreira & D. Souza 3-16* (HCP 232); 3-V-2012, leg. *C. Kozera 4178* (HCP 234) and *4180* (HCP 236); 15-V-2012, leg. *V.G. Cortez 007/12* (HCP 238), *008/12* (HCP 239) and *009/12* (HCP 240). *Additional examined specimens:* BRAZIL. PARANÁ: **Palotina**, Campus UFPR, 29-II-2012 leg. *C. R. Alves 94* (HCP 413), 01-III-2012, leg. *C.R. Alves 88* (HCP 395), 27-IV-2012 leg. *C.R. Alves 58* (HCP 396), 25-IX-2012, leg. *C.R. Alves 93* (HCP 412). **Iporã**, Parque Iporã, 24-V-2012, leg. *C. Kozera* (HCP 403, HCP 404).

Notes: Calvatia rugosa was originally described as *Lycoperdon rugosum* by Berkeley (1868), who mentioned a globose basidioma with a strongly wrinkled peridium and a distinct sterile base. Reid (1977) discussed the main features of this puffball: pinkish to brown immature peridium, which becomes gradually yellowish to orange at maturity, rupturing in flakes, then exposing the yellow to orange and finally olive gleba. Cortez *et al*. (2012), when discussing southern Brazilian specimens, reported this fungus occurs in several environments, such as ombrophilous and xerophilous forests, urban areas, gardens and lawns (also seen for the specimens in this study). It is one of the few gasteroid fungi previously reported from the western region of Paraná state (Cortez *et al*. 2012, from Foz do Iguaçu).

Cyathus Haller

Cyathus species are mostly lignicolous, small (<15mm) and cup-shaped, the gleba is formed into peridioles which are throwed for spore dispersal, the latter are smooth and usually thick-walled (Brodie 1975). In Brazil, 13 species are known, including the following from Paraná: *C. berkeleyanus* (Tul. & C. Tul.) Lloyd, *C.* cf. *limbatus* Tul. & C. Tul., *C. poeppigii* and *C. stercoreus* (Schwein.) De Toni (Meijer 2006).

Key to the species of *Cyathus* from PESC

1. Basidioma basement present, peridioles with single-cortex and tunica ..... *C. montagnei*
1'. Basidioma basement absent, peridioles double-cortex and no tunica ..... *C. poeppigii*

8. *Cyathus montagnei* Tul. & C. Tul., *Ann. Sci. Nat., 1*: 70, 1844.

Fig. 4E-F

Basidiomata cup-shaped 5-9 mm in height, 3-5 mm in width, conical, with a well-developed and tomentose base. Peridium yellowish-brown (5D5) to brown (6F4), <1 mm thickness, surface hirsute, covered by yellowish-brown (5D5) hairs in tufts, presence of setae in the mouth, inner surface finely to strongly striated, greyish-brown (5D3). Epiphragm membranous, white (1A1) with short and brownish-orange (5C6) granules covering the upper surface. Peridioles <2 mm diam., lenticular, brownish-grey (5E2), bright, containing 7-10 peridioles per basidioma, cortex single-layered with tunica. Basidiospores 18.1-23.9 × 10.2-12.8 µm, ovoid to ellipsoid, wall thickened 2.7-3.6 µm diam., hyaline and smooth.

Ecology and distribution: Gregarious on a fallen logs in the forest. Pantropical (Trierveiler-Pereira & Baseia

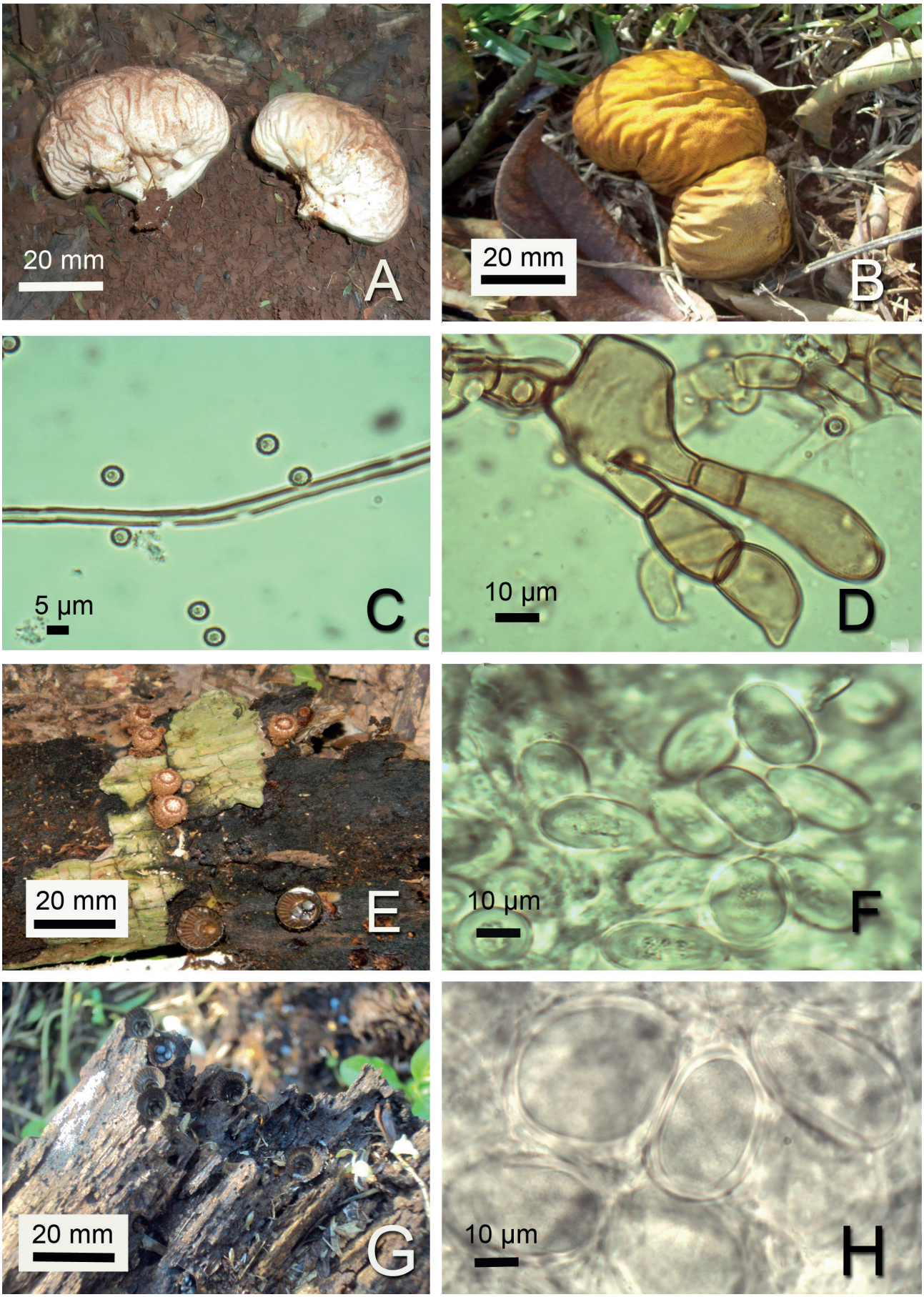

Figure 4. A-D. *Calvatia rugosa.* A. Young basidiomata. B. Mature basidiomata, C. Basiospores and eucapillitium. D. Exoperidium hyphae. E-F. *Cyathus montagnei.* E. Basidiomata. F. Basidiospores. G-H. *Cyathus poeppigii.* G. Basidiomata. H. Basidiospores.

2009b). In Brazil, from Amazonas, Rio Grande do Sul, and São Paulo (Trierveiler-Pereira & Baseia 2009a).

Examined specimen: BRAZIL. PARANÁ, **Palotina**, PESC, 17-IV-2012, leg. *C.R. Alves & V.G. Cortez 24* (HCP 244).

Notes: It is distinguished from other *Cyathus* by the striated peridium (inside and outside), shiny and dark grey peridioles with tunica and large elliptical to ovoid basidiospores with thick walls (White 1902, Reid 1977). According to Reid (1977), when specimens are dried or immersed in water, the striae can be difficult to observe, making identification difficult. In spite of being a common pantropical bird's nest fungus, even in Brazil, *C. montagnei* is reported for the first time from the State of Paraná (Trierveiler-Pereira & Baseia 2009a).

9. *Cyathus poeppigii* Tul. & C. Tul., *Ann. Sci. Nat*., *1*: 77, 1844.

Fig. 4G-H

Basidiomata cup-shaped, 4-8 mm in height, 3-4 mm in width, with a poorly-developed base. Peridium yellowish-brown (5F7), with a hirsute surface, marginal setae present at the mouth, surface striated both internally and externally. Epiphragm not seen. Peridioles 2-3 mm width, lenticular, blackened, cortex double-layered, without tunica. Basidiospores 31.4-42.3 × 21.6-29.6 µm, ellipsoid, walls thickened (2.8-3.2 µm), smooth and hyaline.

Ecology and distribution: On rotting wood. Known from the Americas, Africa and Asia (Brodie 1975). In Brazil, reported from Rio Grande do Sul (Rick 1961), Paraná (Meijer, 2006) and São Paulo (Trierveiler-Pereira & Baseia 2009b).

Material examined: BRASIL. PARANÁ: **Palotina,** PESC, 15-VI-2011, leg. *V.G. Cortez 004/11* (HCP 241).

Notes: Cyathus poeppigii is identified by a strongly striated external peridium surface and large basidiospores (>30 µm, Brodie 1975), and is considered one of the most widely-distributed species in the tropics (Urista *et al*. 1985). *Cyathus morelensis* C.L. Gómez & Pérez-Silva, from México and the Brazilian Amazon Forest is macroscopically similar to *C. poeppigii*, but has smaller (14-19 × 9-13 µm) and ovoid basidiospores, apiculate, and paler striae on the peridium (León-Gómez & Pérez-Silva 1988, Cruz *et al*. 2012).

Lycoperdon Pers.

Members of this genus produce pyriform basidiomata, with an apical peristoma and well-developed sterile base. Comprises about 50 widespread species (Kirk *et al.* 2008), but only *L. marginatum* Vittad. and *L. pseudogemmatum* Speg. are known from the State of Paraná (Meijer 2006).

Key to the species of *Lycoperdon* from PESC

1. On soil, hyphae of exoperidium subglobose to pyriform ..... *L. perlatum*
1'. On wood, exoperidium hyphae with spiny projections ..... *L. pyriforme*

10. *Lycoperdon perlatum* Pers., *Observ. Mycol., 1*: 145, 1796.

Figs. 5A-C, 8A

Basidiomata 15-20 mm in height, 25-20 mm in width, subglobose to depressed and pyriform. Exoperidium granulose, pale grey (1B1) to brownish-grey (5D3), granules falling away at maturity, leaving a reticulated surface on the endoperidium. Endoperidium papery, pitted and reticulated, light grey (1C1). Sterile base poorly developed, up to 7 mm in height, granulose and yellowish-brown (5D5). Gleba cottony to powdery, yellowish-brown (5E5). Subgleba poorly developed, 3-5 mm in height, yellowish-white (1A2). Basidiospores 5.4-6.1 µm, globose, with verrucose ornamentation; under SEM, the surface wall is irregular with ornamentation verrucose to shortly echinate, presence of a membrane connecting spines, and a short pedicel <1 µm. Eucapillitium 3.4-6.7 µm in diam., slightly branched, brownish, pitted. Exoperidium hyphae 12-29.9 × 10.4-27.5 µm, subglobose to pyriform, organized in chains and aggregates, colorless, with hyaline walls.

Ecology and distribution: Solitary or in pairs, on trails. Cosmopolitan. In Brazil, reported from Pernambuco, São Paulo (Baseia 2005b) and Rio Grande do Sul States (Cortez *et al*. 2013).

Examined specimens: BRAZIL. PARANÁ, **Palotina**, PESC, 27-II-2012, leg. *V.G. Cortez & C.R. Alves 17* (HCP 245); 28-V-2012, leg. *V.G. Cortez 010/12* (HCP 246).

Notes: Lycoperdon perlatum is a polymorphic species, with basidiomata of several sizes, including depressed to pseudostipitate forms, exoperidium with deciduous spines which mark the endoperidium, giving a reticulated appearance (Bowerman 1961). The samples examined were fully mature and damaged, not allowing for a complete study, though most of the features for *L. perlatum* could be verified with the exception of the shorter sterile base, which also was reported by Šmarda (1958) and Bates *et al*. (2009). *Lycoperdon pseudogemmatum*, reported by Meijer (2006) from Paraná, may be synonymous to *L. perlatum.* This is the first record of *L. perlatum* from the State of Paraná.

11. *Lycoperdon pyriforme* Schaeff., *Fung. Bavar. Palat. Ratisb. nasc*. *4*: 128, 1774.

Fig. 6C-D

Basidiomata pyriform, 5-10 mm in height, 7-8 mm in diam. Exoperidium smooth to granulose, white (1A1) when fresh, fading to brownish-yellow (5C7) and slightly velvety when dry. Endoperidium not observed. Sterile base up to 3 mm in height, granulose, brownish-yellow (5C7). Gleba compact in dried material and light orange (5A4). Subgleba yellowish-white (2A2), cellular, <3 mm

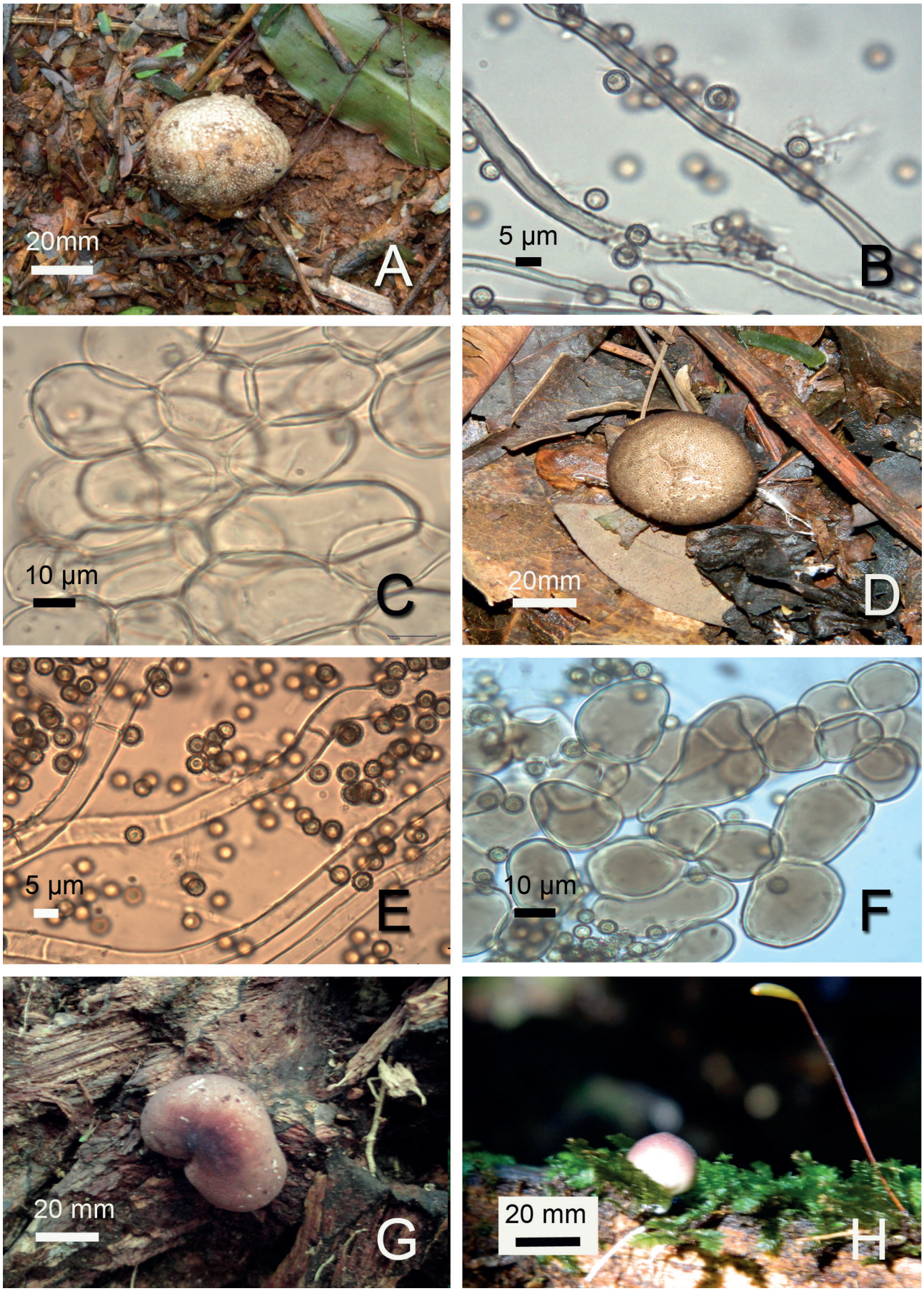

Figure 5. A-C. *Lycoperdon perlatum.* A. Basidioma. B. Basidiospores and eucapillitium. C. Exoperidium hyphae. D-F. *Morganella afra.* D. Basidioma. E. Basidiospores and paracapillitium. F. Exoperidium hyphae. G-H. *Morganella fuliginea.* Basidiomata.

in height. Basidiospores not seen. Eucapillitium 6.3 µm diam., brownish-orange, not pitted. Paracapillitium absent. Exoperidium hyphae 33.4-58.2 × 19.7-24.5 µm, of irregular shape and bearing numerous spiny projections, walls thickened (3-5.9 µm diam.).

Ecology and distribution: Gregarious on fallen trees, cosmopolitan. In Brazil, from Paraíba (Trierveiler-Pereira & Baseia 2011), Minas Gerais, Rio Grande do Sul and São Paulo (Trierveiler-Pereira & Baseia 2009a).

Examined specimen: BRAZIL. PARANÁ: **Palotina**, PESC, 02-III-2011, leg. *V.G. Cortez 19-26* (HCP 257).

Notes: Lycoperdon pyriforme is identified primarily by its pyriform basidiomata and lignicolous habitat (Baseia, 2005b). Kruger & Kreisel (2003) assigned this species to *Morganella* (subgenus *Apioperdon*) base on its lignicolous habitat, unpored eucapillitium and molecular data. However, phylogenetic studies of northern European specimens indicated that it is more closely related to *Lycoperdon* spp. (Larsson & Jeppson 2008). It is a poorly known species in Brazil, collected only once during this survey; the specimen, however, was immature and identification was based on the combination of macroscopic and microscopic features, less basidiospores, which were absent. New record from Paraná State.

Morganella Zeller

Members of this genus have small (10-20 mm) subglobose to pyriform basidiomata, with a velutinous to spiny exoperidium, peristoma present, paracapillitium present, basidiospores globose, verrucose to spiny (Kreisel & Dring 1967). They are mostly lignicolous, but can grow among mosses and palm remnants (Suárez & Wright 1996, Alves & Cortez 2013a), occurring in all tropical/subtropical areas of the world (Ponce de León 1971). From Paraná, *M. fuliginea* and *M.* cf. *purpurascens* (Berk. & M.A. Curtis) Kreisel & Dring (Meijer 2006) are known.

Key to the species of *Morganella* from PESC

1. Peristoma sulcate, exoperidium echinate, with connivent spines ..... *M. sulcatostoma*
1'. Peristoma non-sulcate, exoperidium smooth, granulose or velvety 2
2. Exoperidium granulose, greyish, basidiospores verrucose, warts <0.8 µm ..... *M. afra*
2'. Exoperidium velvety, brownish, basidiospores echinate, spines <1.7 µm …..... *M. fuliginea*

12. *Morganella afra* Kreisel & Dring, *Feddes Repert., 74*: 116, 1967.

Figs. 5D-F, 8B

Basidiomata 10 mm in height, 10-15 mm in diam., depressed-globose to subglobose. Sterile base absent. Rhizomorphs thin, short (<1 mm diam.) and white (1A1). Exoperidium granulose, yellowish-brown (5E5) to olive-grey (3D2), granules dark brown (6F8), falling in maturity, apical pore with irregular margin. Endoperidium smooth, greyish-yellow (4C5) to light brown (5D6). Gleba olive (2D4) to light brown (5D6) at maturity, cottony to powdery. Subgleba absent. Basidiospores 5.1-5.8 µm, globose, verrucose, pale green; under SEM, the wall is irregular, exhibiting verrucose to echinate ornamentation and a short pedicel (<1 µm long). Paracapillitium 4.1-8.8 µm in diam., hyaline, slightly branched. Exoperidium hyphae 15-30.6 × 10-27 µm, subglobose, elongated to pyriform, in chains, hyaline to brownish, walls <1 µm thickness.

Ecology and distribution: On rotting wood and litter, in the forest. Known from Africa (Kreisel & Dring 1967) and Costa Rica (Calonge *et al*. 2005). In Brazil, from Rio Grande do Sul (V.G. Cortez, unpublished data).

Examined specimens: BRAZIL. PARANÁ: **Palotina**, PESC, 3-III-2011, leg. *A.J. Ferreira & V.G. Cortez 17-32* (HCP 247); 23-XI-2011, leg. *C.R. Alves 9* (HCP 248); 16-II-2012, leg. *C.R. Alves 14* (HCP 249); 15-V-12, leg. *V.G. Cortez 011/12* (HCP 250).

Notes: Morganella afra is identified by the small and globose basidiomata, granulose exoperidium, smooth and slightly areolate endoperidium, shortly spiny and pedicellate basidiospores (Kreisel & Dring 1967). It can be confused with *M. subincarnata*, but the latter has a porose endoperidium (Ponce de León 1971). In Brazil, it was known only from Rio Grande do Sul (V.G. Cortez, unpubl. data); a new record from Paraná state.

13. *Morganella fuliginea* (Berk. & M.A. Curtis) Kreisel & Dring, *Feddes Repert., 74*: 113, 1967.

Figs. 5G-H, 6A-B, 8C

Basidiomata 5-10 mm in height, 8-17 mm in width, depressed globose to subglobose, sometimes with a distinctly umbonate apex. Exoperidium light brown (6D4), with a yellowish-white (4A2) base, velvety to occasionally smooth (in older specimens). Endoperidium smooth, yellowish-white (1A2) when immature and fresh, light brown (5D7) when dry. Sterile base absent or much reduced (<1 mm). Rhizomorphs abundant, <30 mm long in some specimens, >1 mm thickness, white (1A1). Gleba yellowish-white (4A2) and compact when immature, then light brown (5D4) and cottony at maturity. Subgleba absent. Basidiospores 5.4-6.6 µm, globose, strongly echinate, conical spines 1.1-1.8 µm long, pale green, pedicels present but seen by SEM, 2 µm long; under SEM, basidiospores surface is smooth to slightly verrucose, with projecting conical spines <2 µm long. Paracapillitium 4.6-6 µm diam., hyaline, smooth and thin-walled. Exoperidium hyphae 13-40 × 8-18 µm, colorless to pale brownish, globose, subglobose to pyriform, arranged in chains, wall hyaline and moderately thickened (<2 µm thickness).

Ecology and distribution: On decomposing wood, commonly among mosses. Neotropical (Suárez & Wright 1996). In Brazil, reported from all regions (Trierveiler-Pereira *et al*. 2009a).

Examined specimens: BRAZIL: PARANÁ, **Palotina**, PESC, 3-IX-2011, leg. *V.G. Cortez 14-12* (HCP 252);

12-IX-2012, leg. *C.R. Alves & V.G. Cortez 02* (HCP 255), 12-IX-2012, leg. *C.R. Alves & V.G. Cortez 03* (HCP 256); 23-IV-2012, leg. *C.R. Alves & V.G. Cortez 49* (HCP 253); 28-V-2012, leg. *V.G. Cortez 012/12* (HCP 251).

Notes: Morganella fuliginea is characterized by depressed-globose to subglobose basidiomata, commonly umbonate, a variably-colored exoperidium with a subvelutinous surface and basidiospores with long and acute spines (Suárez & Wright 1996). With respect to the exoperidium, there is a wide variation in colors and textures, but at present, cannot be stated if such subtle differences were of systematic relevance or not, and requires phylogenetic analysis (molecular) to investigate the relationships among these forms. *Morganella velutina* (Berk. ex Massee) Kreisel & Dring is the most similar species, which differs in the presence of long (>100µm) setoid hyphae in the exoperidium, in contrast to subglobose elements seen in *M. fuliginea* (Suárez & Wright 1996). *Morganella albostipitata* Baseia & Alfredo, from Amazonia, also belongs to this complex, as it shares several morphological features with *M. fuliginea*, but differs fundamentally in the presence of a pseudostipe base (Alfredo *et al*. 2012). *Morganella afra* and *M. fuliginea* were common members of the genus in the area studied, where they grew on wood and mosses.

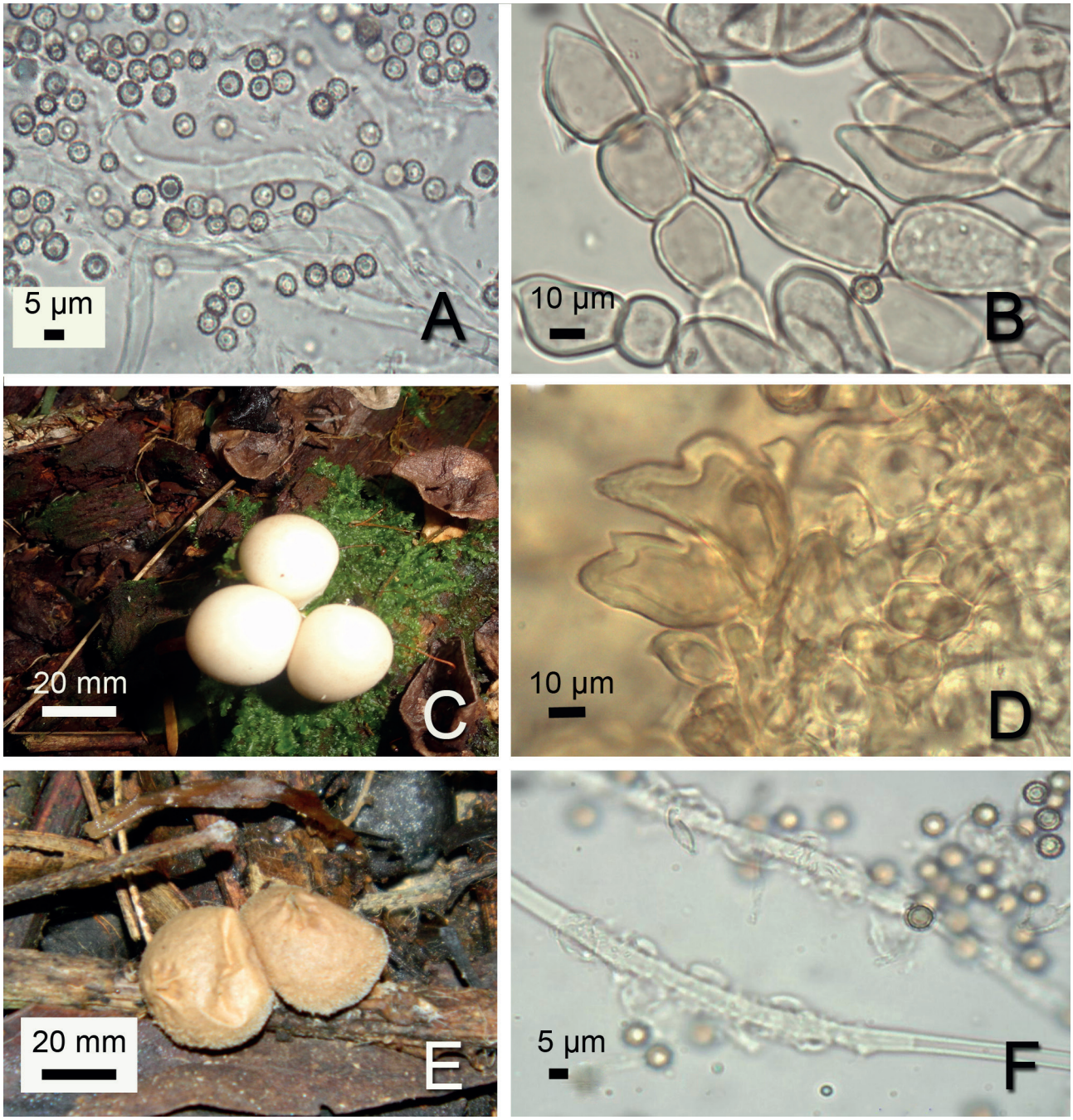

Figure 6. A-B. *Morganella fuliginea.* A. Basidiospores and paracapillitium. B. Exoperidium hyphae. C-D. *Lycoperdon pyriformis.* C. Basidiomata. D. Exoperidium hyphae. E-F. *Morganella sulcatostoma.* E. Basidiomata. F. Basidiospores and paracapillitium.

14. *Morganella sulcatostoma* C.R. Alves & Cortez, *Nova Hedw.,96*: 410, 2013.

Figs. 6E-F, 8D

Description: Alves & Cortez (2013a).

Ecology and distribution: Gregarious, on remnants of Brazilian Queen Palm (*Syagrus romanzoffiana*). Known from Brazil (Paraná) and Argentina (Pappinuti 2014).

Examined specimens: BRAZIL. PARANÁ: **Palotina**, PESC, 27-I-2011, leg. *A.J. Ferreira & V.G. Cortez 17-18* (UPCB 72893 - HOLOTYPE); 28-V-2012, leg. *V.G. Cortez 014/12* (HCP 259).

Notes: The presence of a sulcate peristoma is the diagnostic feature of this remarkable species, which is unique in the genus *Morganella*. The spiny exoperidium is composed of apically connivent spines, another important diagnostic feature (Alves & Cortez 2013a). The species was only known from western Paraná state, but it was recently discovered in Argentina (Papinutti 2014). For a complete discussion, illustrations and description, see Alves & Cortez (2013a).

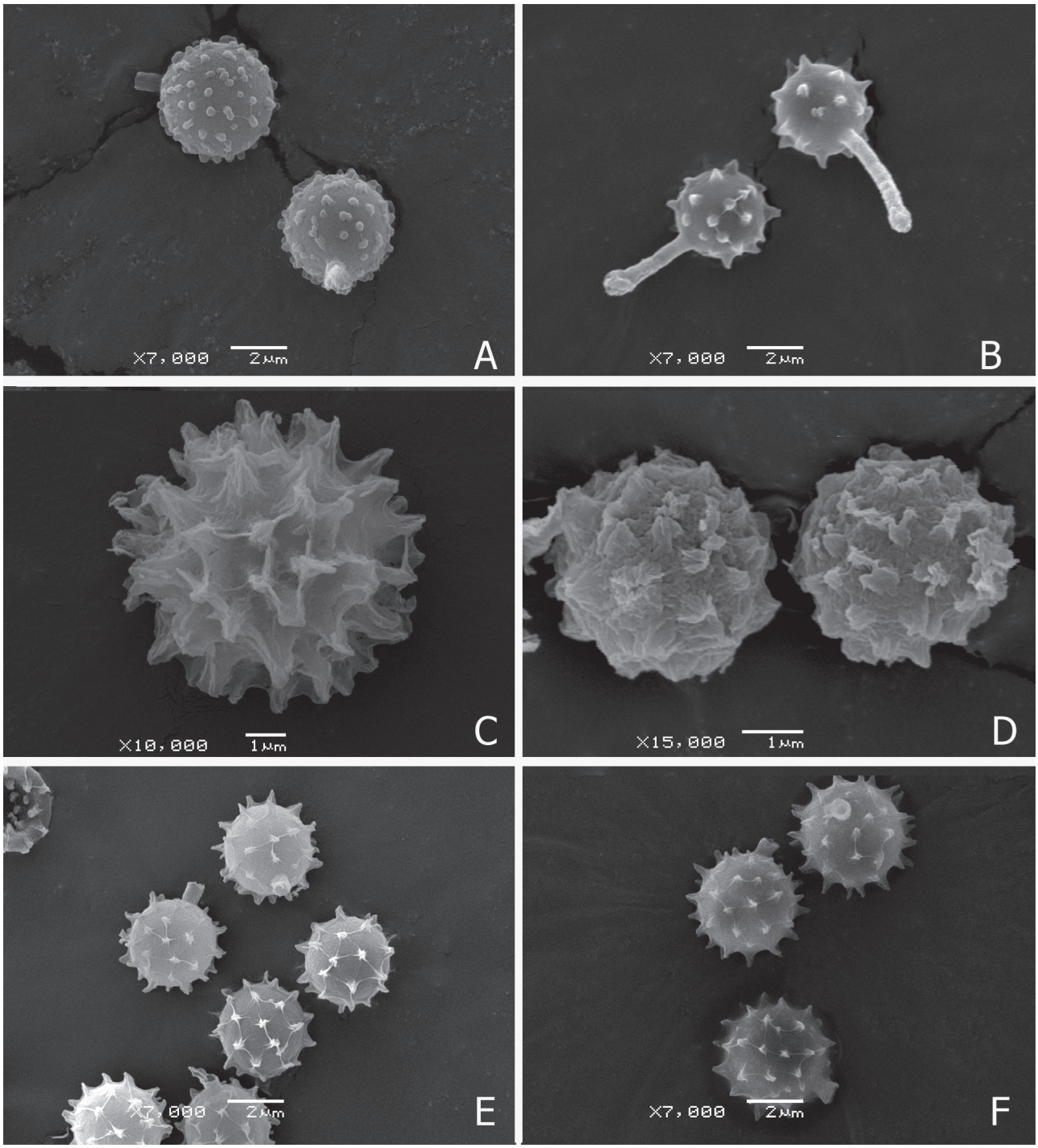

Figure 7. Basidiospores under SEM. A. *Bovista aestivalis*. B. *Bovista dominicensis.* C. *Calvatia cyathiformis.* D. *Calvatia fragilis.* E. *Calvatia guzmanii.* F. *Calvatia rugosa.*

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REFERENCES

ALFREDO, D.S., LEITE, A.G., BRAGA-NETO, R. & BASEIA, I.G. 2012. Two new *Morganella* species from the Brazilian Amazon rainforest. *Mycosphere, 3*: 66-71.

ALVES, C.R. & CORTEZ, V.G. 2013a. *Morganella sulcatostoma* sp. nov. (Agaricales, Basidiomycota) from Paraná State, Brazil. *Nova Hedwigia, 96*: 409-417.

ALVES, C.R. & CORTEZ, V.G. 2013b. *Calvatia guzmanii* sp. nov. from Paraná State, Brazil. *Phytotaxa, 85*: 35-40.

BASEIA, I.G. 2003. Contribution to the study of the genus *Calvatia* (Lycoperdaceae) in Brazil. *Mycotaxon, 88*: 107-112.

BASEIA, I.G. 2005a. *Bovista* (Lycoperdaceae): dois novos registros para o Brasil. *Acta Botanica Brasilica, 19*: 899-903.

BASEIA, I.G. 2005b. Some notes on the genera *Bovista* and *Lycoperdon* (Lycoperdaceae) in Brazil. *Mycotaxon, 91*: 81-86.

BATES, S.T., ROBERSON, R.W. & DESJARDIN, D.E. 2009. Arizona gasteroid fungi I: Lycoperdaceae (Agaricales, Basidiomycota). *Fungal Diversity, 37*: 153-207.

BAUTISTA-HERNÁNDEZ, S., HERRERA, T., AGUIRRE-ACOSTA, E. & ESQUEDA, M. 2011. Contribution of the taxonomy of *Bovista* in Mexico. *Mycotaxon, 118*: 27-46.

BERKELEY, M.J. 1868. On a collection of fungi from Cuba. Part II, including those belonging to the families Gasteromycetes, Coniomycetes, Hyphomycetes, Phycomycetes, and Ascomycetes. *Journal of the Linnean Society, Botany*, *10*: 341-392.

BOWERMAN, C. 1961. *Lycoperdon* in eastern Canada with special reference to the Ottawa district. *Canadian Journal of Botany, 39*: 353-383.

BRODIE, H.C. 1975. *The Bird's Nest Fungi*. Toronto: University of Toronto. 199 p.

CALONGE, F.D. 1992. El género *Bovista* Pers.: Pers. (Gasteromycetes), en la Península Ibérica e Islas Baleares. *Boletín de la Sociedad Micológica de Madrid, 17*: 101-112.

CALONGE, F.D. 1999. *Setas de Madrid (y alrededores) 2: Gasteromycetes*. Madrid: Sociedad Micológica de Madrid. 159 p.

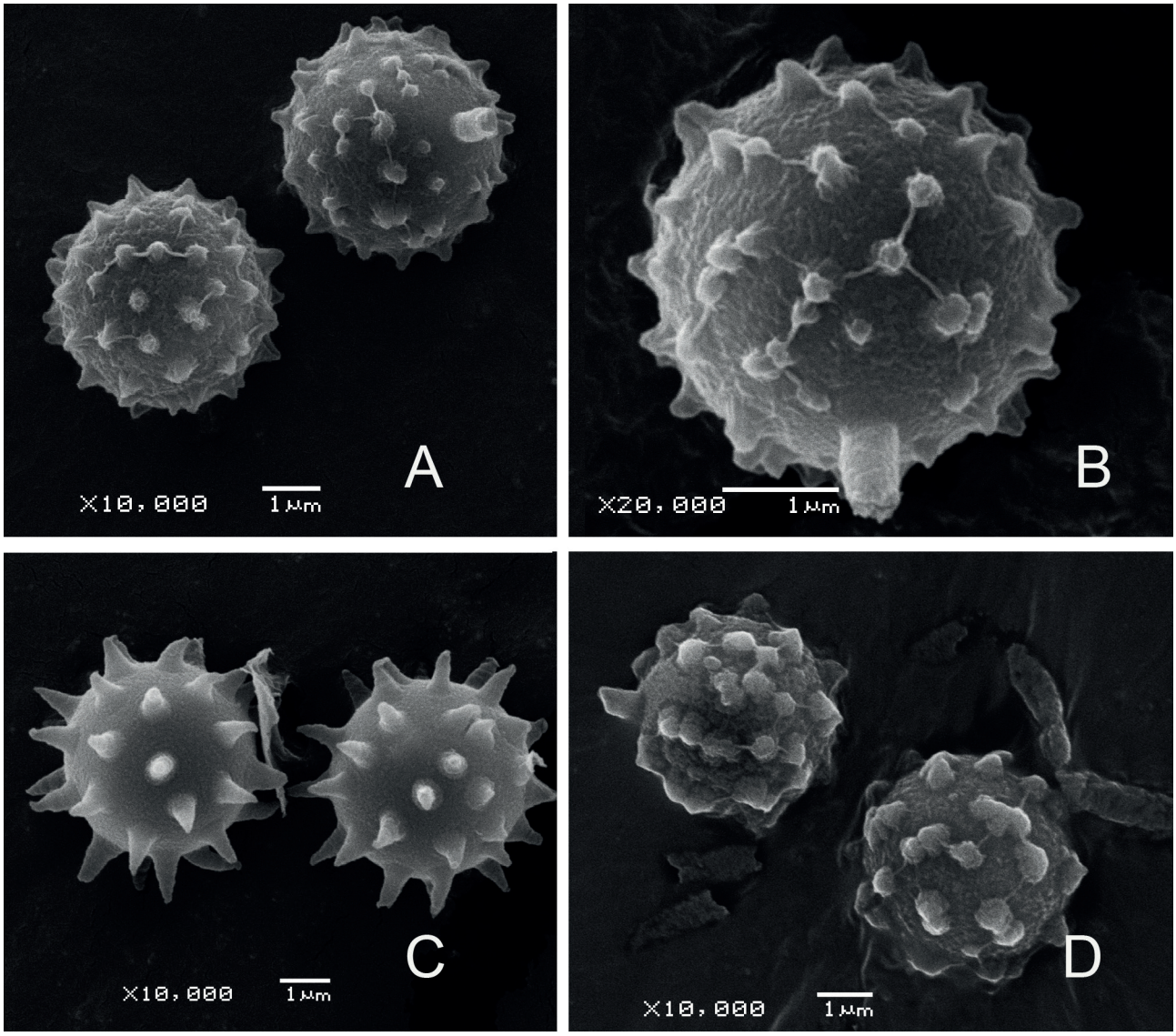

Figure 8. Basidiopores under SEM. A. *Lycoperdon perlatum*. B. *Morganella afra*. C. *Morganella fuliginea.* D. *Morganella sulcatostoma*.

CALONGE, F.D. & MARTÍN, M.P. 1990. Notes on the taxonomical delimitation in the genera *Calvatia, Gastropila* and *Langermannia* (Gasteromycetes). *Boletín de la Sociedad Micológica de Madrid, 14*: 181–190.

CALONGE, F.D., MILAGRO, M. & CARRANZA, J. 2005. Contribución al catálogo de Gasteromycetes da Costa Rica (Basidiomycota, Fungi). *Anales del Jardín Botánico de Madrid, 62*: 23-45.

COETZEE, J.C. & VAN WYK, E. 2009. The genus *Calvatia* ('Gasteromycetes', Lycoperdaceae): A review of its ethnomycology and biotechnological potential. *African Journal of Biotechnology*, *8*: 6007-6015.

CORTEZ, V.G., BASEIA, I.G. & SILVEIRA, R.M.B. 2010. Gasteroid mycobiota do Rio Grande do Sul, Brasil: *Arachnion* and *Disciseda* (Lycoperdaceae). *Acta Biológica Paranaense*, *39*: 19-27.

CORTEZ, V.G., BASEIA, I.G. & SILVEIRA, R.M.B. 2012. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Calvatia*, *Gastropila* and *Langermannia* (Lycoperdaceae). *Kew Bulletin*, *67*: 471-482.

CORTEZ, V. G., BASEIA, I.G. & SILVEIRA, R.M.B. 2013. Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Lycoperdon* and *Vascellum*. *Mycosphere 4*: 745-758

CRUZ, R.H.S.F., LIMA, R.A.A., BRAGA-NETO, R. & BASEIA, I.G. 2012. *Cyathus morelensis*, a rare bird's nest fungus in the Brazilian Amazon rainforest. *Mycosphere 3*: 880-882.

DEMOULIN, V. 1972. Observations sur le genre *Arachnion* Schw. (Gasteromycetes). *Nova Hedwigia, 21*: 641-655.

HIBBETT, D.S. 2006. A phylogenetic overview of the Agaricomycotina. *Mycologia*, *98*: 917-925.

HOMRICH, H. 1969. Etude de qualques Gastéromycètes du Rio Grande do Sul. *Revue de Mycologie 34:* 3-16

LARSSON, E., JEPPSON, M. 2008. Phylogenetic relationship among species and genera of Lycoperdaceae based on ITS and LSU sequence data from north European taxa. *Mycological Research 112*: 4-22.

LEÓN-GÓMEZ, C. & PÉREZ-SILVA, E. 1988. A new species of *Cyathus* from México. *Mycotaxon*, *33*: 419-421.

LONG, W.H. 1941. Studies in the Gasteromycetes III. The family Arachniaceae. *Mycologia, 33*: 350-355.

KASUYA, T., ORIHARA, T., FUKIHARU, T. & YOSHIMI, S. 2006. A lycoperdaceous fungus, *Arachnion album* (Agaricales, Arachinaceae) newly found in Japan. *Mycoscience, 47*: 385-387.

KIRK, P.M., CANNON, P.F., MINTER, D.W. & STALPERS, J.A. 2008. *Dictionary of the Fungi*. 10th ed. Wallingford: CABI. 771 p.

KORNERUP, A. & WANSCHER, J.H. 1978. *Methuen handbook of colour.* 3rd ed. London: Eyre Methuen.

KREISEL, H. 1967. Taxonomisch-pflanzen geographischen Monographie der Gattung *Bovista*. *Beihefte zur Nova Hedwigia, 25*: 1-244.

KREISEL, H. 1989. Studies in the *Calvatia* complex (Basidiomycetes). *Nova Hedwigia, 48*: 281-296.

KREISEL, H. 1994. Studies in the *Calvatia* in the complex (Basidiomycetes) 2. *Feddes Repertorium*, *105*: 369-376.

KREISEL, H. & DRING, D.M. 1967. An emendation of the genus *Morganella* Zeller (Lycoperdaceae). *Feddes Repertorium*, *74*: 109-122.

KRÜGER, D. & KREISEL, H. 2003. Proposing *Morganella* subgen. Apioperdon subgen. nov. for the puffball *Lycoperdon pyriforme. Mycotaxon*, *86*: 169-177.

MEIJER, A.A.R. 2006. Preliminary list of the macromycetes from the Brazilian state of Paraná. *Boletim do Museu Botânico Municipal, 68*: 1-55.

MEIJER, A.A.R. 2010. Preliminary list of the macromycetes from the Brazilian state of Paraná: corrections and updating. *Boletim do Museu Botânico Municipal, 72*: 1-10.

MILLER JR., O. K. & MILLER, H. H. 1988. *Gasteromycetes: morphological and development features*. Eureka: Mad River. 156 p.

MORAVEC, Z. 1958. Arachniaceae. In: PILÁT, A. (ed.). *Flora ČSR: Gasteromycetes*. Praha: Československé Akademie Věd. p. 255-257.

PAPPINUTI, L. 2014. *Morganella sulcatostoma* (Agaricales, Basidiomycota) primer hallazgo en Argentina. *Boletín de la Sociedad Argentina de Botánica*: in press.

PEGLER, D.N., LÆSSØE, T. & SPOONER, B.M. 1995. *British puffballs, easthstars and stinkhorns.* London: Royal Botanic Gardens, Kew. 255 p.

PONCE DE LEON, P. 1971. Revision of the genus *Morganella. Fieldiana, Botany, 32*: 27-44.

REID, D.A. 1977. Some gasteromycetes from Trinidad and Tobago. *Kew Bulletin, 31*: 657-690.

RICK, J. 1961. Basidiomycetes Eubasidii in Rio Grande do Sul. Brasília. 6. *Iheringia, Série Botânica, 9*: 451-480.

RODERJAN, C.V., GALVÃO, F., KUNYOSHI, Y.S. & HATSCHBACH, G. 2002. As unidades fitogeográficas do Estado do Paraná. *Ciência e Ambiente, 24*: 75-92.

SILVEIRA, V.D. 1943. O gênero *Calvatia* no Brasil. *Rodriguésia, 7*: 63-80.

ŠMARDA, F. 1958. Lycoperdaceae. In: PILÁT, A. (ed.). *Flora ČSR: Gasteromycetes*. Praha: Československé Akademie Věd. p. 257-392.

SMITH, A.H. 1951. *Puffballs and their allies in Michigan.* Ann Arbor: University of Michigan. 131 p.

SUÁREZ, V.L, & WRIGHT, J.E. 1996. South American Gasteromycetes V. The genus *Morganella*. *Mycologia, 88*: 655-661.

TRIERVEILER-PEREIRA, L. & BASEIA I.G. 2009a. A checklist of the Brazilian gasteroid fungi (Basidiomycota). *Mycotaxon, 108*: 441-444.

TRIERVEILER-PEREIRA, L. & BASEIA, I.G. 2009b. Revision of the Herbarium URM IV. Nidulariaceae (Basidiomycota). *Nova Hedwigia*, *89:* 361-369.

TRIERVEILER-PEREIRA, L. & BASEIA, I.G. 2011. Contribution to the knowledge of gasteroid fungi (Agaricomycetes, Basidiomycota) from the State of Paraíba, Brazil. *Revista Brasileira de Biociências, 9*: 167-173.

TRIERVEILER-PEREIRA, L., KREISEL, H. & BASEIA, I.G. 2010. New data of puffballs (Agaricomycetes, Basidiomycota) from the Northeast Region of Brazil. *Mycotaxon, 111*: 411-421.

URISTA, E., GARCIA, J. & CASTILHO, J. 1985. Algunas espécies de gasteromicetos del norte de México. *Revista Mexicana de Micología, 1*: 471-523.

VELLINGA, E. SYSOUPHANTHONG, P. & HYDE, K.D. 2011. The family Agaricaceae: phylogenies and two new white-spored genera. *Mycologia, 103*: 494-509.

WARTCHOW, F. & SILVA, S.M. 2007. Primeira ocorrência de *Calvatia cyathiformis* (Basidiomycota) em Caatinga, Estado de Pernambuco, Brasil. *Sitientibus, Série Ciências Biológicas, 7*: 176-177.

WHITE, V.S. 1902. The Nidulariaceae of North America. *Bulletin of the Torrey Botanical Club, 29*: 251-280.

WRIGHT, J.E. & WRIGHT, A.M. 2005. Checklist of the mycobiota of Iguazu National Park (Misiones, Argentina). *Boletín de la Sociedad Argentina de Botánica, 40*: 23-44.

ZELLER, S.M. & SMITH, A.H. 1964. The genus *Calvatia* in North America. *Lloydia*, *27*: 148-186.