

NOTES ON TWO COPRINOID FUNGI (BASIDIOMYCOTA, AGARICALES) FROM THE BRAZILIAN SEMIARID REGION

A. R. P. GOMES¹ & F. WARTCHOW²

Coprinellus phaeoxanthus A.R.Gomes & Wartchow is described as a new species and is characterised by cordiform basidiospores similar to those of the recently described *Coprinellus arenicola*. However, it differs in the presence of voluminous pleurocystidia in the velar elements, which are shorter than in *Coprinellus arenicola*, and in the lack of clamp connections. In addition, exsiccatae of a Brazilian collection identified as '*Coprinus xerophilus*' are analysed, and because of the star-shaped velar patch on the pileus and the non-volvate stipe base, it is considered to be the same as *Coprinus calyptratus*, representing a new record from South America.

Keywords. Agaricomycetes, Agaricomycetidae, *Coprinopsis*, Neotropics, *Parasola*, systematic, taxonomy.

INTRODUCTION

The genus *Coprinus* Pers., described about 200 years ago (Persoon, 1797), was classically characterised by the autolysis of lamellae and the dark pigment of the basidiospores. However, phylogenetic studies have shown this concept of *Coprinus* to be polyphyletic, and some species, including the type, *Coprinus comatus* (O.F.Müll.: Fr.) Pers., have been assigned to the Agaricaceae (Redhead *et al.*, 2001). Therefore, modifications have been proposed, with a number of species reclassified into the Agaricaceae and the rest distributed among three other genera in the Psathyrellaceae (Redhead *et al.*, 2001).

Currently, *Coprinopsis* P.Karst., *Coprinellus* P.Karst., *Parasola* Redhead, Vilgalys & Hopple and *Coprinus* s.s. are considered as having a coprinoid habit which, in addition to the frequent autolytic lamellae and dark basidiospores, is recognised by a highly plicate pileus margin, a saprotrophic habit and the presence of brachybasidia (Redhead *et al.*, 2001; Keirle *et al.*, 2004).

The genera *Coprinopsis* and *Coprinus* s.s. have a cutis-like pileipellis with radially arranged, elongated or somewhat inflated cells, and both have remnants of veil on the surface of the pileus or attached to the stipe and appearing as a ring. However, *Coprinus*

¹ Programa de Pós-Graduação em Biologia de Fungos, Departamento de Micologia, Universidade Federal de Pernambuco, Avenida Nelson Chaves s/n, 50760-420 Recife – PE, Brazil.

² Pós-Graduação em Biologia de Fungos, Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, 58051-970 João Pessoa – PB, Brazil. Author for correspondence. E-mail: fwartchow@yahoo.com.br

is characterised by a more persistent veil with a recurved-floccose appearance on the pileus and sometimes a cottony annulus that adheres basally as a pseudovolva, the absence of pleurocystidia, and peculiar strands suspended in the hollow stipe which extend from the hymenophore primordium, as occur also in *Agaricus campestris* L. (Levine, 1922: 512; Redhead, 2001; Redhead *et al.*, 2001; Vellinga, 2003). *Coprinellus* is characterised by a pileipellis that consists of a hymeniderm or cystoderm of globose or piriform cells, hyaline caulocystidia and pileocystidia, and the presence or absence of a veil. *Parasola* is characterised by a hymeniderm pileipellis, with clavate, loosely arranged cells and the absence of a veil and caulocystidia (Nagy *et al.*, 2013), with the exception of *P. auricoma* (Pat.) Redhead, Vilgalys & Hopple, which exhibits thick-walled hairs at the stipe base (Nagy *et al.*, 2010) and on the pileal surface.

According to Kirk *et al.* (2008), coprinoid fungi are widespread, with about 10 known species of *Coprinus*, 200 of *Coprinopsis*, 100 of *Coprinellus* and 20 of *Parasola*. They occur on several substrates, including bare soil or associated with vegetation, on humus, dung, dead wood or vegetable debris, and are sometimes parasitic on other agarics and plants (Singer, 1986; Uljé, 2005).

In Brazil, there are number of existing records of coprinoid fungi. The first were made by Montagne (1856) under the generic name *Coprinus*, with *C. consobrinus* Mont., *C. matutinus* Mont. and *C. torquatus* Mont. from Mato Grosso. Years later, records were made by Rick (1906, 1930, 1939, 1961) from Rio Grande do Sul, Capelari and Maziero (1988) in Rondônia and Pegler (1997) in São Paulo, among others. More recently, de Meijer (2006) and Richardson (2001) reported some species as new to the country from the states of Paraná and Mato Grosso do Sul, respectively, while Rosa and Capelari (2009) and Sobestiansky (2005) recorded other species from Minas Gerais and Rio Grande do Sul.

In Northeast Brazil, the earliest record was made by Batista (1957), corresponding to *Pseudocoprinus brasiliensis* Bat. Later, Kimbrough *et al.* (1994/1995) and Alves and Cavalcanti (1996) recorded *Coprinopsis brunneofibrillosa* (Dennis) Redhead, Vilgalys & Moncalvo, *Coprinopsis jamaicensis* (Murrill.) Redhead, Vilgalys & Moncalvo and *Coprinopsis nivea* (Pers.: Fr) Redhead, Vilgalys & Moncalvo from the state of Pernambuco. Recently, Magnago *et al.* (2013) reported *Coprinus xerophilus* Bogart from the state of Paraíba, while Gomes and Wartchow (2014) described *Coprinellus arenicola* Wartchow & A.R.Gomes; Melo *et al.* (2016) reported *Coprinellus angulatus* (Peck) Redhead, Vilgalys & Moncalvo, *Coprinellus marculentus* (Britzelm.) Redhead, Vilgalys & Moncalvo, *Coprinopsis cinerea* (Schaeff.) Redhead, Vilgalys & Moncalvo, *Coprinopsis cothurnata* (Godey) Redhead, Vilgalys & Moncalvo, *Coprinopsis pseudoradiata* (Kühner & Joss. ex Watling) Redhead, Vilgalys & Moncalvo, *Coprinopsis stercorea* (Fr.) Redhead, Vilgalys & Moncalvo, *Coprinopsis vermiculifer* (Joss. ex Dennis) Redhead, Vilgalys & Moncalvo and *Coprinus patouillardii* Quél. from Pernambuco.

Here, we describe a new species from Northeast Brazil, collected in the semiarid region of the state of Ceará, and also examine material from JPB (Thiers, [continuously updated](#)) collected in Paraíba.

MATERIALS AND METHODS

The new species was collected in the Trilha da Galinha Choca, located in the municipality of Quixadá in the state of Ceará, Brazil. This area has a semiarid climate and a high concentration of monolith rocks, the predominant vegetation being represented by Leguminosae, Poaceae, Euphorbiaceae, Asteraceae and Convolvulaceae (Araújo *et al.*, 2008).

The exsiccatae named '*Coprinus xerophilus*' deposited at JPB was collected in the municipality of São José dos Cordeiros in the state of Paraíba, Brazil, also in the semiarid in the Reserva particular do Patrimônio Natural (RPPN) Fazenda Almas. This area represents the best-preserved area of Cariri Paraibano, characterised by vegetation ranging from dense tree savanna to more open areas, and a flora comprising Leguminosae, Euphorbiaceae, Bignoniaceae, Convolvulaceae, Rubiaceae, Cyperaceae and Cactaceae, among other families (Barbosa *et al.*, 2007).

Macromorphological features of the fresh basidiome were recorded using the usual methods for agarics (Singer, 1986). Colour codes follow Kornerup and Wanscher (1978). Microscopic observations were made from material mounted in 3% potassium hydroxide, Congo red solution and Melzer's reagent. Measurements and statistics are based on 60 spores. Abbreviations are *av.*, average size of basidiospores measured; *Q1*, the length to width ratio range, as determined from all basidiospores measured in face view; *Q2*, the length to width ratio range, as determined from all basidiospores measured in side view; *Qm1*, the Q value averaged from all basidiospores measured in face view; and *Qm2*, the Q value averaged from all basidiospores measured in side view. Synonyms are based on Moreno and Heykoop (1998). The studied materials are deposited at JPB.

RESULTS AND DISCUSSION

***Coprinellus phaeoxanthus* A.R.Gomes & Wartchow sp. nov.**

Mycobank no. 817947.

Differs from *Coprinellus arenicola* in the dull yellow pileus, absence of clamp connections and presence of voluminous pleurocystidia. – Type: Brazil, Ceará, Quixadá, Lagoa do Cedro, Pedra da Galinha Choca, near to a collection of rocks, on sandy soil, 20 iii 2014, *F. Wartchow* 03/2014 (JPB 61266 holotypus hic designatus!).

Figs 1, 2.

Etymology. From Greek: *phaeo*, dusky; *xanthus*, yellow. Referring to the dull yellow pileus.

Macroscopy. Pileus to 27 mm, convex flattened with centre dull yellow (3B3) and whitish at the margin, surface plicate; veil present only as a few plates in centre, pale to white. *Lamellae* adnexed, greyish (2F1), subclose, 2 mm broad; lamellulae common, having several lengths. *Stipe* to 45 × 5 mm, central, slightly flattened, whitish (1A2), surface smooth, hollow; context thin.

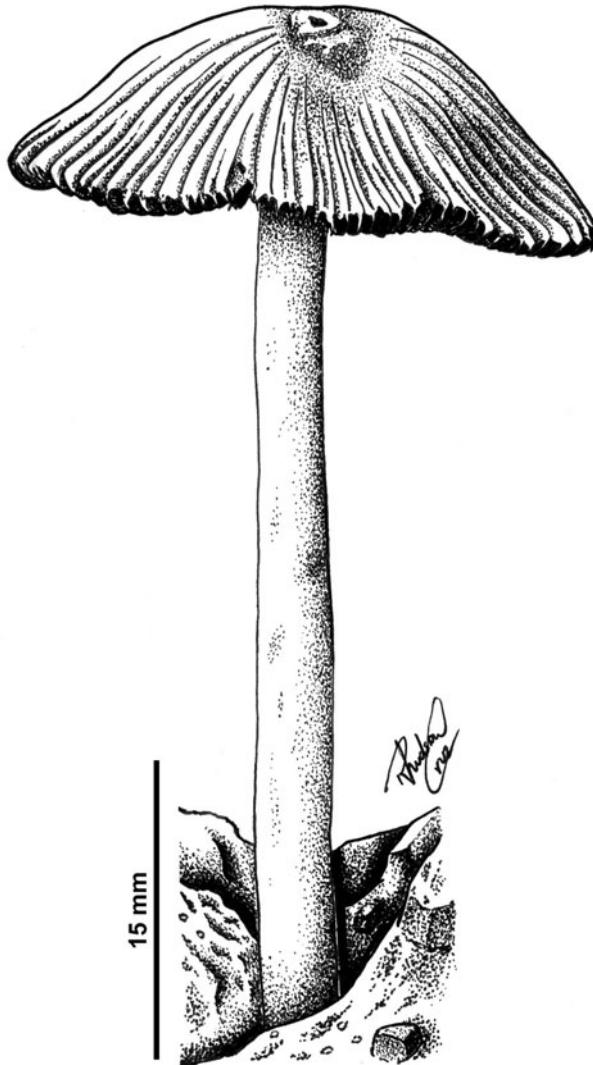


FIG. 1. *Coprinellus phaeoxanthus* A.R.Gomes & Wartchow. Basidioma (holotypus).

Microscopy. *Basidiospores* $7.5\text{--}10.5 \times 6.1\text{--}7.6\text{--}(9.2) \times 4.5\text{--}6.5 \mu\text{m}$ [*av.*, $9.2 \times 6.9 \times 6.1 \mu\text{m}$; Q_1 , $(1.07\text{--})1.10\text{--}1.46\text{--}(1.50)$; Qm_1 , 1.31; Q_2 , 1.50–1.82; Qm_2 , 1.67], dark brown to almost black in 3% potassium hydroxide and reddish brown in Melzer's, flattened, ellipsoid in side view and cordiform in face view with wide base and rounded sides, some tapering toward the germ pore, wall up to $1 \mu\text{m}$, hilar appendix visible, germ pore eccentric small, sometimes visible. *Basidia* $17.5\text{--}33.5 \times 8.5\text{--}13 \mu\text{m}$, clavate, four-spored with sterigmata up to $3 \mu\text{m}$. *Pleurocystidia* $37.3\text{--}53 \times 15.3\text{--}22 \mu\text{m}$, frequent, utriform to sublageniform, hyaline, thin-walled. *Cheilocystidia* $26\text{--}28.1 \times 8.7\text{--}10.7 \mu\text{m}$, very common, utriform and lageniform sometimes broadly clavate, hyaline,

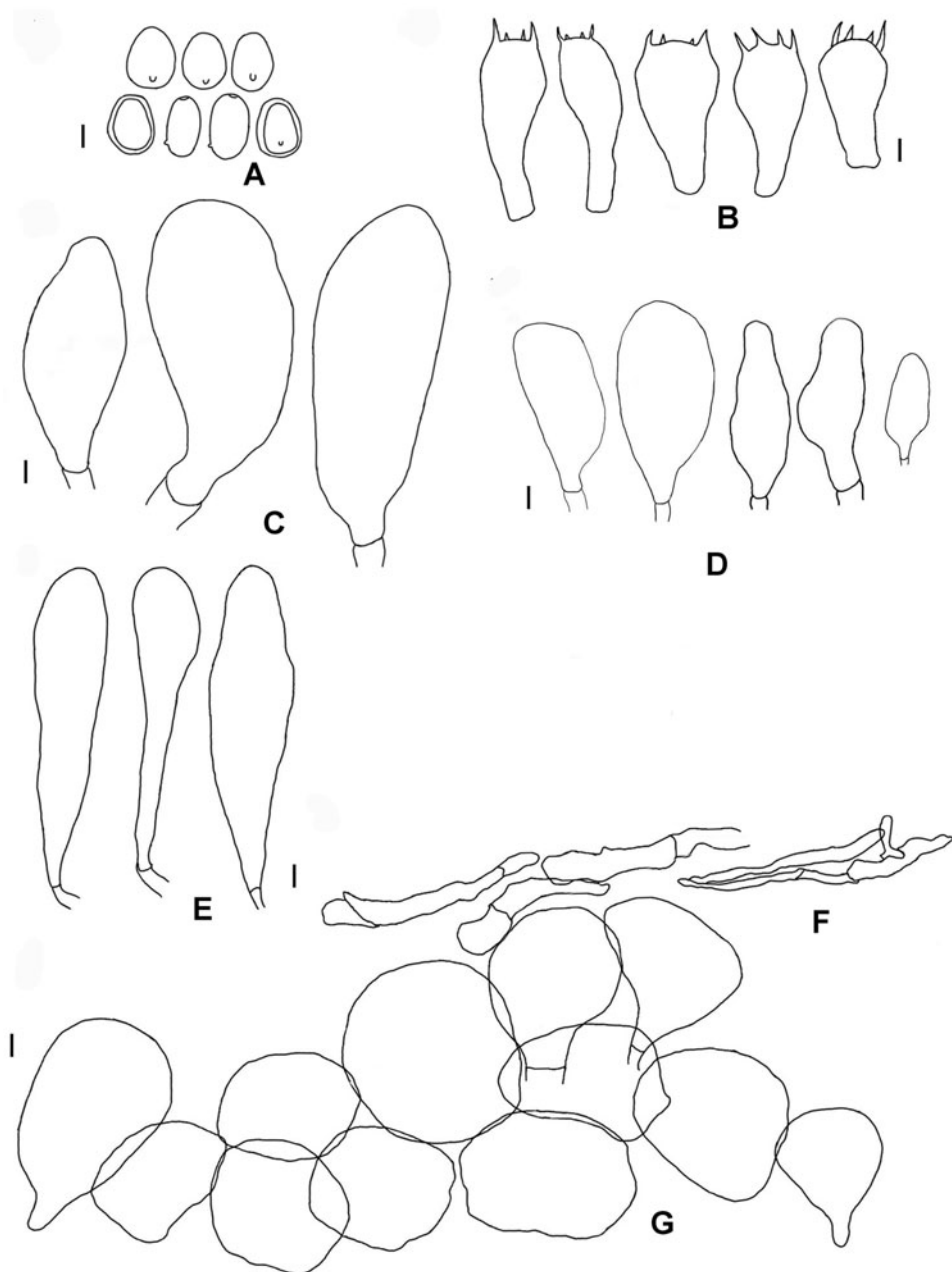


FIG. 2. *Coprinellus phaeoxanthus* A.R.Gomes & Wartchow (holotype). A, Basidiospores; B, basidia; C, pleurocystidia; D, cheilocystidia; E, caulocystidia; F, velar elements; G, pileipellis. Scale bars: 10 μ m.

thin-walled. *Lamellae trama* subregular hyphae 1.5–3.6 μm in width, hyaline or yellowish. *Veil* 13.3–31.1 \times 1.5–5.6 μm , thin-walled elements, slightly elongated, inflated or tapered, yellowish, sometimes shapeless. *Caulocystidia* 43.5–51 \times 5.5–12.2 μm , clavate to slender-clavate, hyaline, thin-walled, clamps lacking. *Pileipellis* consisting of a hymeniderm of hyaline, globose cells, some with pedicel 19.5–37 \times (10.2–)14.8–24.5 μm , wall thickening up to 1.5 μm . *Clamps* absent in all tissues observed.

Habit. On sandy soil among rocks in the Brazilian semiarid region.

The specimen, collected in sandy soil, has a delicate basidiome typical of many coprinoid fungi, with pileus up to 27 mm, convex flattened and plicate surface with few and sparse remnants of veil. The pileipellis consists of a hymeniderm of subglobose cells, some pedicellate – features typical for the genus *Coprinellus* (Redhead *et al.*, 2001; Keirle *et al.*, 2004). In addition, the basidiospores are cordiform and flattened.

Another species with cordiform (heart-shaped) basidiospores is *Coprinus cardi-asperus* Bender, which differs primarily in having the veil consisting of (sub)globose to ellipsoid, smooth to granular cells (Enderle *et al.*, 1986; Ujljé, 2005). Other species currently included in *Coprinopsis*, i.e. *C. cordispora* (T.Gibbs) Watling & M.J.Richardson, *C. ephemeroides* (D.C) G.Moreno and *C. patouillardii* (Quél.) G.Moreno,¹ also have cordiform basidiospores (Enderle *et al.*, 1986; Ujljé, 2005; Melo *et al.*, 2016). However, these taxa obviously do not belong in *Coprinellus*, because the pileipellis is a cutis instead of a cellular hymeniderm. In fact, phylogenetic analyses indicate that their position is uncertain, although they do not belong to *Coprinellus* or *Coprinopsis* (Padamsee *et al.*, 2008; Nagy *et al.*, 2013; Örstadius *et al.*, 2015).

Related to our new species is *Coprinellus arenicola* Wartchow & A.R.Gomes from the Atlantic Forest of Paraíba, which also possesses cordiform basidiospores of a similar size, measuring 7.6–9.2 \times 6.1–7.6 \times 4.6–6.1 μm . However, features differentiating it from our new species are reported here: the pileus colour ranges to buff and the basidiospores are somewhat shorter in Q_1 , (1.07–)1.11–1.28(–1.30), and Q_{m1} , 1.19. In addition, they also differ in the veil elements, with *Coprinellus arenicola* possessing clamp connections, unlike *C. phaeoxanthus*. The most distinct feature differentiating the species is the presence of pleurocystidia in the Ceará material; in *Coprinellus arenicola*, they are completely absent. The presence or absence of pleurocystidia has already been used by Házi *et al.* (2011) for delimiting species within *Coprinellus*. The holotype of *Coprinellus arenicola* was examined, and we confirm the absence of this microstructure in that species.

- Coprinus calyptratus*** Peck, Bull. Torrey. Bot. Club 22: 205–206 (1895). **Fig. 3.**
= *Coprinus vosoustii* Pilát, Stud. Bot. Cech. 5: 207 (1942).
= *Coprinus asterophorus* Long & V.A.M.Mill., Mycologia 37: 120 (1945).
= *Coprinus asterophoroides* Bogart, Mycotaxon 4: 252–254 (1976).

¹ *Coprinopsis cordispora* (T.Gibbs) Watling & M.J.Richardson was published three days before publication of the same combination by Gminder, while *Coprinopsis patouillardii* (Quél.) G.Moreno was published in July 2010, preceding the combination of Gminder in October 2010 (see Article 31.1, McNeill *et al.*, 2012).

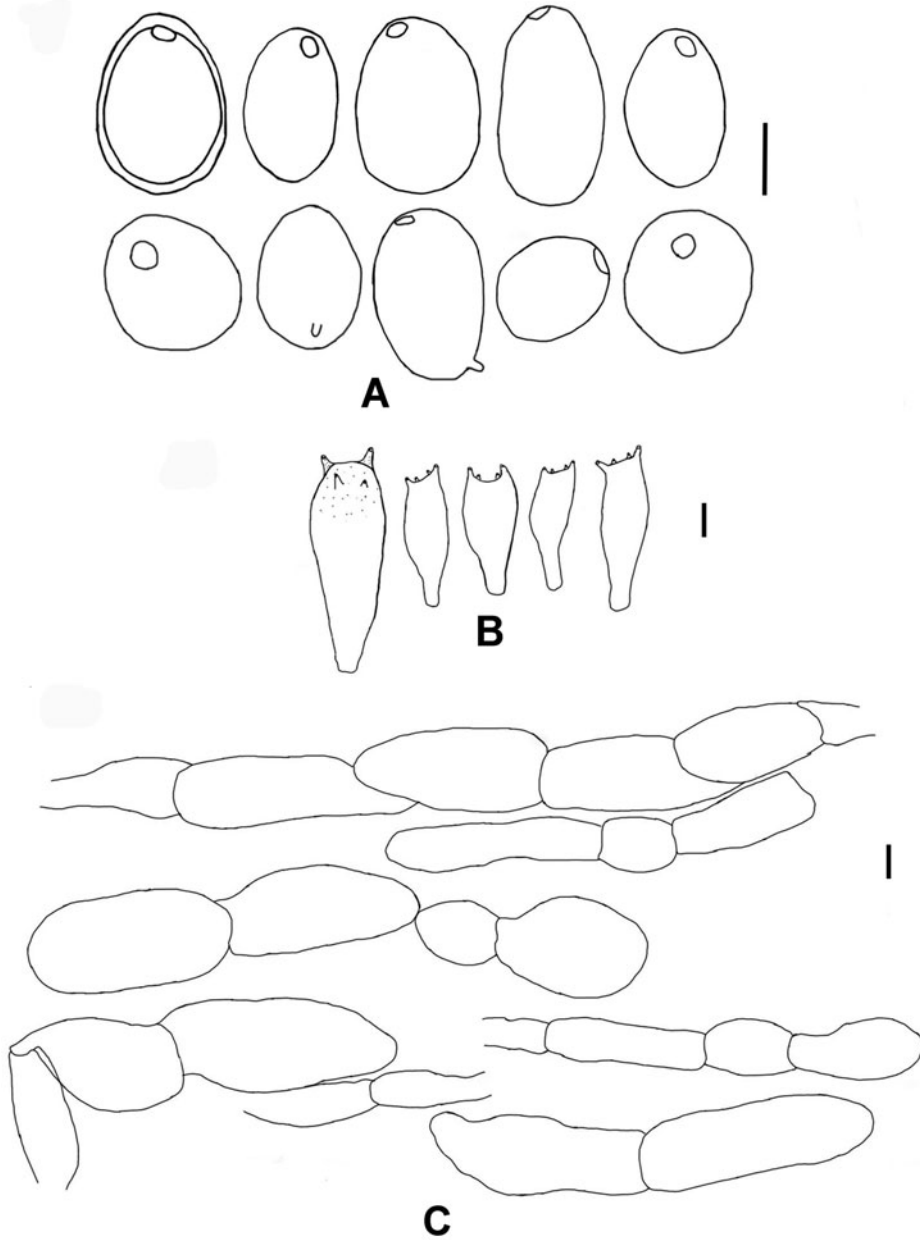


FIG. 3. *Coprimus calyptratus* (JPB 46272). A, Basidiospores; B, basidia; C, velar elements. Scale bars: 10 μ m.

Name misapplied to present species. Coprinus xerophilus Bogart sensu Magnago et al., Guide to the Common Fungi of the Semiarid Region of Brazil: 33 (2013).

Macroscopy. From Magnago *et al.* (2013: 33): “Pileus 3.5–4.0 cm diam., becoming plane, striate plicate, black with whitish scale remnants from the veil concentrated at the centre; margin revolute to lacerate in older specimens. Hymenophore lamellate, lamellae close, free, deliquescent, black when mature; lamellulae present. Stipe 7.0 cm long. 0.6 cm diam., white to gray at the top, central, cylindric, fibrous to fibrillose, hollow, base slightly bulbous. Spores elliptic, 15.0–22.0 × 9.0–12.0 µm, smooth, dark, thick walled, inamyloid. Habit: solitary on sandy soil.”

Microscopy. *Basidiospores* 17–21.4(–22.1) × 12.3–14.3(–15.6) × (9.1–)10.4–13 µm [*av.*, 18.8 × 13.7 × 11.5 µm; Q_1 , (1.22–)1.30–1.45(–1.50); Q_2 , (1.44–)1.47–1.80(–1.82); Qm_1 , 1.36; Qm_2 , 1.64], dark reddish brown, ellipsoid in side view and ovoid in face view with a more flattened base, few differences in frontal and side views, germ pore eccentric up to 2.5 µm in diameter, hilar appendix up to 1 µm, wall up to 1 µm. *Basidia* 18.5–35.7 × 6.5–12.8 µm, hardly visible due to the collapsed hymenophore, clavate, with brown pigment in apex or from middle part to the apex; sterigmata up to 3 µm in height, brown pigmented, and hyaline at sterigmata end. *Cystidia* not seen, due to collapsed lamellae. *Velar elements* 10.2–37.2 × 6.7–16.3 µm, hyaline, ellipsoid to elongated, subglobose, cylindrical cells in chains, with some elements narrower, thin wall, septate, clamp connections not visualised. *Pileipellis* consisting of indistinct cutis, with radially arranged elongated pale hyphae.

Material examined. BRASIL. **Paraíba:** São José dos Cordeiros, RPPN Fazenda Almas. 7°28'46''S, 36°53'00''W, 735 m, 12 vii 2009, A. C. Magnago et al. 247 (JPB 46272, as ‘*Coprinus xerophilus*’).

Coprinus calyptratus is reported as occurring in places with a semiarid environment. It has a solitary or gregarious habit, growing on sandy or gravelly soil. In North America, it was described from Kansas (Peck, 1895), and later found in the states of Arizona (Long & Miller, 1945) and Washington (Bogart, 1976). Moreno and Heykoop (1998) reported it also from the Czech Republic, Mexico and Spain. The revised exsiccatae has very peculiar features among the coprinii: a large star-like patch remnant of veil on the pileus, concentrated in the centre, and a non-volvate stipe base (agreeing with Moreno & Heykoop, 1998). Magnago *et al.* (2013: 33) also did not report a volvate stipe in their description of ‘*Coprinus xerophilus*’, now identified as *C. calyptratus*.

Nonetheless, we conclude that the exsiccatae JPB 46272 (the voucher of *Coprinus xerophilus* published by Magnago *et al.*, 2013) is *C. calyptratus*, presenting a ‘slightly bulbous’ stipe base and a large star-like velar remnant on the pileus (according to Magnago *et al.*, 2013). Here, we report *Coprinus calyptratus* for the first time from South America.

Coprinus xerophilus is the most similar species. It differs in the volvate stipe base and the universal veil on the pileus as patches spread across the entire surface, even along the pileal margin (Bogart, 1976; Moreno & Heykoop, 1998; Uljé & Noordeloos, 2000).

Moreno and Heykoop (1998) used the degree of dissociation of the veil from the pileus surface when mounted under the microscope as an important feature for delimiting both species: the veil of *Coprinus calypttratus* is more difficult to dissociate than that of *C. xerophilus*. However, there is some thought among mycologists that the star-like morphology of the veil remnant is a more reliable character than whether or not it is easy to dissociate under the microscope. We agree with this opinion, confirming the identification of our material as *Coprinus calypttratus*.

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