



Coprotus (Thelebolaceae, Thelebolales) in herbivore dung from Brazil

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With 4 figures and 1 table

Abstract: During a survey of coprophilous fungi from different vegetational areas in Pernambuco, Northeastern Brazil, seven species of *Coprotus* were reported. *Coprotus aurora*, *C. disculus*, *C. leucopocillum*, *C. luteus*, and *C. niveus* are new records for Brazil, while *C. lacteus* and *C. ochraceus* are recorded for the first time in the Northeast region of the country. Most species occurred on dung collected in the semi-arid region of the Caatinga biome, and showed no tendencies regarding substrate preference. Descriptions, photographic plates and line drawings are provided, along with an identification key to all known species of *Coprotus* from Brazil.

Key words: Coprophilous fungi, taxonomy, Thelebolales.

Introduction

Species of *Coprotus* Korf & Kimbr. can be characterized by small, sessile, pale to bright yellow apothecia with reduced excipulum, operculate non-amyloid asci and smooth ascospores, usually with a conspicuous de Bary bubble (Kimbrough et al. 1972, Bell 2005). The genus was proposed by Korf (1954), segregated from *Ascophanus* Boudier, and validated by Kimbrough & Korf (1967). The species circumscription were later clarified by Kimbrough (1970), and monographed by Kimbrough et al. (1972), who provided the most useful key for identification of North American species. *Coprotus* is essentially coprophilous, and it usually fruits late on the substrate during incubation (20–25 days) (Piontelli et al. 1981). Species of *Coprotus* are very similar morphologically and their taxonomy can be easily confused (Doveri 2004,

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Bell 2005, Richardson 2005). Doveri (2004) compiled data regarding morphological measurements, spore arrangement and receptacle shape in records of *Coprotus* species worldwide.

The small and usually translucent apothecia of *Coprotus* species can be easily overlooked during stereomicroscopic examination of dung, contributing to the lack of information and records of the genus in surveys worldwide. The lack of records from material collected in different parts of the world, as well as the need for a general revision, was pointed out by Richardson (2004, 2005, 2008) and Bell (2005). Due to the rather difficult species delimitation, some records worldwide remained unidentified to species level (Bell 2005, Richardson 2004, 2005, 2008).

Most records of *Coprotus* come from North America, due to the studies on apothecial ascomycetes by Richard Korf and James Kimbrough (Korf 1954, Kimbrough & Korf 1967, Kimbrough et al. 1972). There are also significant records from Africa (Ebersohn & Eicker 1992, Caretta et al. 1998, Elshafie 2005), Oceania (Bell 1993, 2005), Europe (Aas 1983, Doveri 2004) and Asia (Chang & Wang 2009). Cultural studies of these species are very limited (Kimbrough et al. 1972). The phylogenetic position of the genus, in relation to its monophyly, was recently studied by Hansen et al. (2013). Data on diversity and distribution of *Coprotus* species in Brazil are scarce. The previous records were made by Richardson (2001), during a visit to the country in 1998, who recorded *C. lacteus* from a small number of dung samples collected at Bonito and Pantanal do Rio Negro, Mato Grosso do Sul, providing a brief description. Brazilian material of *C. ochraceus* was reported from Canudos, Bahia State, in cow dung, and studied by Kimbrough et al. (1972) in their monography.

In order to contribute to the worldwide knowledge on the taxonomy and diversity of coprophilous fungi, seven species of *Coprotus* collected in recent surveys in Pernambuco, Northeast Brazil, are described. Descriptions, high resolution images and line drawings, as well as an identification key to Brazilian species are provided.

Material and methods

Dung samples were collected from animal precincts on the campus of the Universidade Federal Rural de Pernambuco (8°00'54"S and 34°56'59"W) and in a Zoological Park at the Reserva Ecológica de Dois Irmãos (8°7'30"S and 34°52'30"W), both in Recife; from farms close to Research Stations of the Instituto Agrônômico de Pernambuco (IPA) in Caruaru (8°01'59"S and 36°06'59"W) and Serra Talhada (7°54'59"S and 38°17'0.14"W), Pernambuco State, Brazil. In these surveys, dung samples of confined camel (*Camelus bactrianus* L.), deer (*Cervus elaphus* L.), llama (*Lama glama* L.), paca (*Cuniculus paca* L.) and waterbuck (*Kobus ellipsiprymnus* L.), and from semi confined cattle (*Bos* sp.), goat (*Capra* sp.) and horse (*Equus* sp.) were collected in clean plastic bags, taken to the laboratory and incubated in moist chambers at room temperature (28 ± 2°C) for at least 60 days under alternating natural light and dark periods. The specimen habit was observed directly from substrate with the aid of a stereomicroscope (Leica EZ4), and fresh apothecia were mounted in tap water for measurements, description and identification using a light microscope (Olympus BX51). Lactophenol with cotton blue was also employed to access the extent of cyanophily on each excipulum. Species were identified based on morphology according to Kimbrough et al (1972), Aas (1983), Bell (1983), Richardson & Watling (1997), Doveri (2004), and Bell (2005). High resolution pictures were taken with an Olympus BX51 microscope equipped with brightfield and Nomarski interference optics. Methods for the digital line drawing illustrations of apothecia and microscopic structures were adapted from Barber & Keane

(2007). Permanent slides were mounted with Polyvinyl-Lacto-Glycerol (PVLG) and deposited at URM (Pe. Camille Torrend Herbarium, Universidade Federal de Pernambuco, Recife, Brazil). Along with the collection of fresh substrata, a careful literature revision was performed, in order to access information regarding older records of the studied genus in Brazil. A survey of national herbaria with representative collections of fungi [Pe. Camille Torrend (URM), Dárdano de Andrade Lima (IPA), Maria Eneyda P. Kaufmann Fidalgo (IBT), Dimitri Sucre Benjamin (JBRJ), Instituto Nacional de Pesquisas da Amazônia (INPA), Instituto Nacional de Pesquisas da Amazônia (INPA), Museu Paraense Emilio Goeldi (MG), Instituto de Biociências, Universidade Federal do Rio Grande do Sul (INC)] was performed as well; exsiccates containing material of *Coprotus* collected in Brazil were searched and, if located, taxonomically revised, in order to implement the present revision.

Results

Seven species were identified based on apothecia fruiting directly on dung. An identification key is provided. No exsiccate containing material of *Coprotus* collected in Brazil was found during the survey in herbaria of the country.

Key to species of *Coprotus* from Brazil

- | | | |
|----|---|-------------------------|
| 1 | Receptacle with colors ranging from yellow to orange in mature apothecia; paler when young. Paraphyses with apex slightly inflated, usually with distinct cytoplasmic content. Excipulum weakly or non cyanophilous | 2 |
| 1' | Receptacle remaining translucent to white in mature apothecia. Paraphyses without inflated apex, and without distinct cytoplasmic content. Excipulum strongly cyanophilous | 4 |
| 2 | Ascospores 16.5–18 × 10–11.5 μm | <i>C. ochraceus</i> |
| 2' | Ascospores smaller | 3 |
| 3 | Ascospores 13–15 × 6.5–9 μm | <i>C. aurora</i> |
| 3' | Ascospores 8.5–10 × 4–5.5 μm | <i>C. luteus</i> |
| 4 | Asci approximately 64-spored..... | <i>C. niveus</i> |
| 4' | Asci 8-spored..... | 5 |
| 5 | Asci 62.5–70.5 × 16–18.5 μm. Ascospores 7.5–10 × 5–7.5 μm..... | <i>C. lacteus</i> |
| 5' | Asci not as above. Ascospores longer..... | 6 |
| 6 | Ascospores 15–17.5 × 8.5–10 μm | <i>C. leucopocillum</i> |
| 6' | Ascospores 12–13.5 × 6–7.5 μm | <i>C. disculus</i> |

Taxonomy

Coprotus Korf & Kimbr., in Kimbrough & Korf, Am. J. Bot. 54(1): 21. 1967.

Leporina Velen., Opera Bot. Čech. 4: 154. 1947.

Coprotus aurora (P.Crouan & H.Crouan) K.S.Thind & Waraitch, Res. Bull. Punjab Univ. 21: 145.1970. Figs 1 A–F, 3 A–D

Ascophanus aurantiacus Velen., Hist. Class. Discom. Eur. (Paris) 76. 1907.

Ascophanus aurora (Cr. & Cr.) Boud. Anns Sci. Nat., Bot., sér. 5 10: 248. 1869.

Peziza aurora P.Crouan & H.Crouan, Florule Finistère (Paris): 53. 1867.

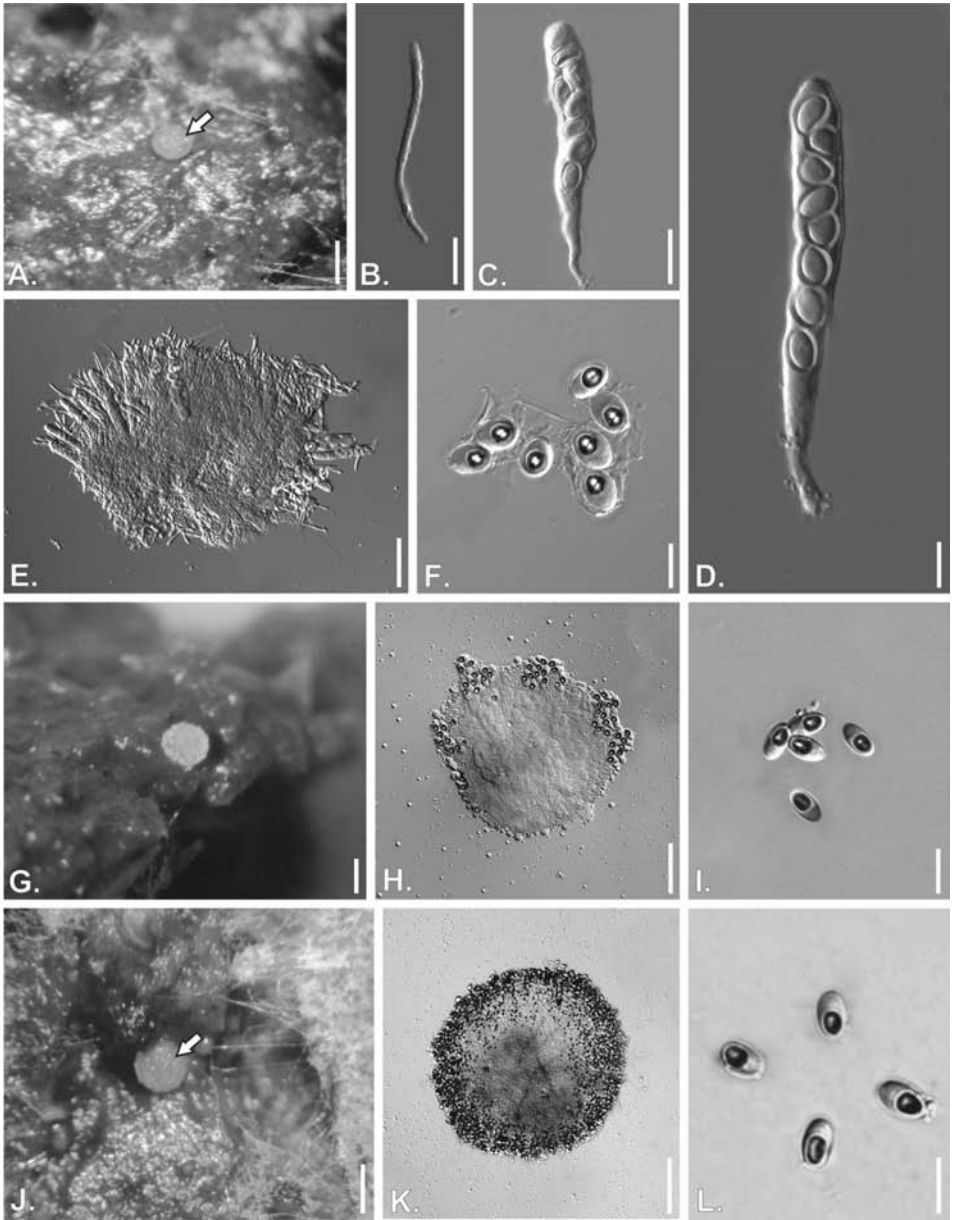


Fig. 1. *Coprotus aurora*. A. apothecium on dung (Bar = 300 μ m), B. simple paraphysis (Bar = 10 μ m), C. mature ascus (Bar = 20 μ m), D. ascus in maturation (Bar = 10 μ m), E. apothecium mounted in water (Bar = 50 μ m), F. ascospores (Bar = 15 μ m). *C. disculus*. G. apothecium on dung (Bar = 300 μ m), H. apothecium mounted in water (Bar = 100 μ m), I. ascospores (Bar = 15 μ m). *C. lacteus*. J. apothecium on dung (Bar = 300 μ m), K. apothecium mounted in water (Bar = 100 μ m), L. ascospores (Bar = 10 μ m).

APOTHECIA scattered to isolated, superficial, sessile, globose at first, then finally discoid when mature, yellowish to orange, 150–450 μm diam., with rough to villose disk due to exposed hyaline spored asci, glabrous, lacking a well delimited margin. HYPOTHECIUM composed of globose, subglobose or elongated cells, barely conspicuous on the material examined. EXCIPULUM composed of globose cells up to 12.5 μm diam., becoming elongated towards the outer layers, weakly cyanophilous. PARAPHYSES numerous, filiform, septate, hyaline, 1.8–2.5 μm thick near the base, broader near the apex, up to 3–5 μm thick, usually branched and/or with somewhat uncinated apices, with yellow cytoplasmic content, visible when mounted in water. ASCI 8-spored, cylindrical to clavate, with a short stipe, 92.5–100 \times 12.5–15 μm . ASCOSPORES usually uniseriate, occasionally partially biseriate, ellipsoid, smooth, hyaline to pale yellow, 13–15 \times 6.5–9 μm , each with a conspicuous de Bary bubble near one of the poles (usually not observed when mounted in water).

MATERIAL EXAMINED: Brazil, Pernambuco, Caruaru, Instituto Agronômico de Pernambuco (IPA), on goat dung, 23 Mar 2012, R.F.R.Melo (URM85926).

HABITAT: Recorded on dung of many herbivores

DISTRIBUTION: Asia (India), Europe, South America (Venezuela) and North America. This is the first record from Brazil.

COMMENTS: *Coprotus aurora* has brightly colored apothecia, an uncommon character in this genus that can lead to an incorrect identification. Similar to *C. ochraceus*, it has apothecia in shades of orange, but can be distinguished in many morphological measurements. It differs from *C. luteus* in having larger ascospores (13–15 \times 6.5–9 μm), more ellipsoid than subglobose. The material examined in Pernambuco shows characteristics slightly different from the North American material examined in Kimbrough et al. (1972), with asci and ascospores measurements slightly larger and predominance of simple paraphyses. Despite the complex taxonomy of *Coprotus* regarding specific morphological delimitations, such features were not considered significant enough to invalidate the present identification or to propose a new species.

Coprotus disculus Kimbr., Luck-Allen & Cain, Can. J. Bot. 50: 962.1972.

Figs 1 G–I, 3 E–H

APOTHECIA usually scattered, superficial, sessile, lenticular to discoid, translucent, becoming white to pale yellow when mature, 350–415 μm diam., glabrous, without margin. DISK villose due to exposed hyaline spored asci. HYPOTHECIUM composed of small angulated cells, hardly observed in mature apothecia. Excipulum poorly differentiated, composed of globose to slightly angulated cells, strongly cyanophilous. PARAPHYSES filiform, septate, hyaline, 3–3.5 μm thick at the base, slightly inflated at the the apex, without any conspicuous cytoplasmic content. ASCI 8-spored, cylindrical, with a short stipe and rounded apex, 80–90 \times 12.5–14 μm . ASCOSPORES usually uniseriate, sometimes biseriate, ellipsoid to somewhat fusoid, non-apiculate, hyaline, 12.5–13.5 \times 6–7.5 μm , each with a conspicuous eccentric de Bary bubble, not observed when mounted in water.

MATERIAL EXAMINED: Brazil, Pernambuco, Caruaru, Instituto Agronômico de Pernambuco (IPA), on goat dung, 16 Oct 2011, R.F.R.Melo (URM85928); Serra Talhada, Instituto Agronômico de Pernambuco (IPA), on horse dung, 13 Sep 2011, R.F.R.Melo (URM85927).

HABITAT: Recorded on dung of cattle, deer, horse, sheep and small rodents.

DISTRIBUTION: Asia (India), Africa (Kenya, Oman, South Africa), Europe (Italy, Norway, Portugal, United Kingdom), North America (Canada, U.S.A.), Oceania (Australia, New Zealand). This is the first record from Brazil.

COMMENTS: When growing directly on the substrate, *Coprotus disculus* appears as small, translucent apothecia, easily overlooked by its size, which may be one of the reasons of its poor representation in species lists. The species can be mainly distinguished by its small white to pale yellow apothecia with ascospores slightly fusoid, showing little to no variation in size in the material examined ($12.5\text{--}13.5 \times 6\text{--}7.5 \mu\text{m}$). *Coprotus disculus* resembles *C. lacteus*, but can be distinguished by its longer asci and yellow pigmented apothecia.

Coprotus lacteus (Cooke & W.Phillips) Kimbr., Luck-Allen & Cain, Can. J. Bot. 50: 965. 1972. Figs 1 J–L, 3 I–L

Ascobolus lacteus Cooke & W.Phillips, Grevillea 5(no. 35): 119. 1876.

Ascophanus lacteus (Cooke & W.Phillips) W.Phillips, Man. Brit. Discomyc. (London): 306.1887.

Helotium lacteum (Cooke & W.Phillips) Masee, Brit. Fung.-Fl. 4: 269. 1895.

APOTHECIA usually scattered, superficial, sessile, pulvinate to discoid, translucent to white or yellow, $250\text{--}375 \mu\text{m}$ diam., glabrous, without a well delimited margin. **DISK** villose due to the exposed mature asci, bearing the same colour and texture of the receptacle. **HYPOTHECIUM** composed of small, elongated cells, usually inconspicuous on the material examined. **EXCIPULUM** with globose to angular cells, becoming elongated towards the outer layers, cyanophilous. **PARAPHYSES** filiform, septate, hyaline, $1\text{--}1.5 \mu\text{m}$ thick at the base, simple or rarely brached, slightly inflated at the apex. **ASCI** 8-spored, cylindrical-clavate, with shortened base and rounded apex, $62.5\text{--}70.5 \times 16\text{--}18.5 \mu\text{m}$. **ASCOSPORES** uni or bisseriate inside the asci, ellipsoid, smooth, hyaline to somewhat pale yellow, $7.5\text{--}10 \times 5\text{--}7.5 \mu\text{m}$, each one with a conspicuous uncentered de Bary bubble, non observed when mounted in water.

MATERIAL EXAMINED: Brazil, Pernambuco, Caruaru, Instituto Agronômico de Pernambuco (IPA), on horse dung, 07 Oct 2011, R.F.R.Melo (URM85929); Serra Talhada, Instituto Agronômico de Pernambuco (IPA), on goat dung, 24 May 2012, R.F.R.Melo (URM85930).

HABITAT: Recorded on dung of many herbivores.

DISTRIBUTION: Asia (India, Japan), Africa (South Africa), North America (Canada, USA), Central America (Mexico, Puerto Rico), Europe (Czech Republic, Denmark, England, Italy, Norway, Poland, Scotland, Spain, The Netherlands), South America (Brazil, Venezuela), Oceania (New Zealand).

COMMENTS: The milky white color of *Coprotus lacteus* receptacle, along with morphological measurements, can be used to distinguish it from other similar species. Morphologically similar to *C. granuliformes*, it differs in having smaller ascospores ($7.5\text{--}10 \times 5\text{--}7.5 \mu\text{m}$) and broader clavate asci. In a dung sampling in Brazil, Richardson (2001) identified *C. lacteus* with pure white apothecia, $200\text{--}300 \mu\text{m}$ diam., asci 8-spored, long-clavate, $65\text{--}100 \times 13\text{--}16 \mu\text{m}$, ascospores 1–2-seriate, ellipsoid,

hyaline, 8–11.5 × 6.5–7 µm, and non-capitate, hyaline paraphyses. The measurements of both Brazilian specimens are very similar. Doveri (2004) compiled data regarding morphological measurements, spore arrangement and receptacle shape in records of *Coprotus* species worldwide. *C. lacteus* is a rather common species.

Coprotus leucopocillum Kimbr., Luck-Allen & Cain, Can. J. Bot. 50(5): 967. 1972. Figs 2 A–D, 3 M–Q

APOTHECIA scattered to gregarious, superficial, sessile, cupulate to discoid, white to pale yellow when young, becoming pale luteous to yellow when mature, 360–495 µm diam., glabrous, without a differentiated margin. DISK slightly granulose to villose due to exposed mature asci, concolorous with the receptacle. HYPOTHECIUM composed of small, globose cells. EXCIPULUM composed of globose to slightly angulated cells, becoming elongated towards the outer layers, strongly cyanophilous. PARAPHYSES slender, filiform, septate, hyaline, 1–1.5 µm thick at the base, slightly inflated at the apex. ASCI 8-spored, cylindrical to slightly clavate, with a short lobate stipe and rounded apex, 90–125 × 13–17.5 µm. ASCOSPORES uniseriate, occasionally partially biseriate, varying from parallel, oblique to perpendicular inclination in relation to the ascus axis, ellipsoid, smooth, hyaline to weakly pale yellow, 15–17.5 × 8.5–10 µm, each with a conspicuous de Bary bubble, not observed when mounted in water.

MATERIAL EXAMINED: Brazil, Pernambuco, Recife, Horto Zoobotânico do Parque Estadual Dois Irmãos, on llama dung, 07 Apr 2010, R.F.R.Melo (URM82309), 09 Aug 2010, R.F.R.Melo (URM 82312); on camel dung, 10 Jul 2010, R.F.R.Melo (URM82310, 82311); Caruaru, Instituto Agronômico de Pernambuco (IPA), on goat dung, 15 Jun 2012, R.F.R.Melo (URM85933); on cattle dung, 27 Aug 2012, R.F.R.Melo (URM85934); Serra Talhada, Instituto Agronômico de Pernambuco (IPA), on cattle dung, 12 Sep 2011, R.F.R.Melo (URM85932); on horse dung, 12 Sep 2011, R.F.R.Melo (URM85931); on cattle dung, 08 Oct 2012, R.F.R.Melo (URM 85935).

HABITAT: Recorded on dung of many herbivores.

DISTRIBUTION: Asia (Taiwan), Africa (Oman, South Africa), Europe (France, Germany, Iceland, Italy, Lithuania, Norway, Pakistan, Puerto Rico), North America (Bermudas, Canada, U.S.A.), Oceania (New Zealand) and South America (Venezuela). Probably cosmopolitan. This is the first record from Brazil.

COMMENTS: *Coprotus leucopocillum*, although easily recorded on the material examined, lack remarkable taxonomic characters that can lead to its identification, resembling other representatives of the genus on asci and ascospore sizes. Similar to *C. ochraceus* in morphological measurements, it differs in having less pigmented apothecia and cylindrical asci, usually with uniseriate ascospores. It was first described by Kimbrough et al. (1972) from material sampled at Bermuda Islands. Despite being the first record, it is the most common species of *Coprotus* found in Brazil so far.

Coprotus luteus Kimbr., Can. J. Bot. 50(5): 966.1972. Figs 2 I–K, 4 A–D

APOTHECIA scattered, superficial, sessile, discoid, yellow to luteous, 200–350(–400) µm diam., glabrous, without a well differentiated margin. DISK rough villose due to exposed mature asci. HYPOTHECIUM composed of small, globose cells, almost inconspicuous on mature apothecia. EXCIPULUM with globose and somewhat angulated cells, slender

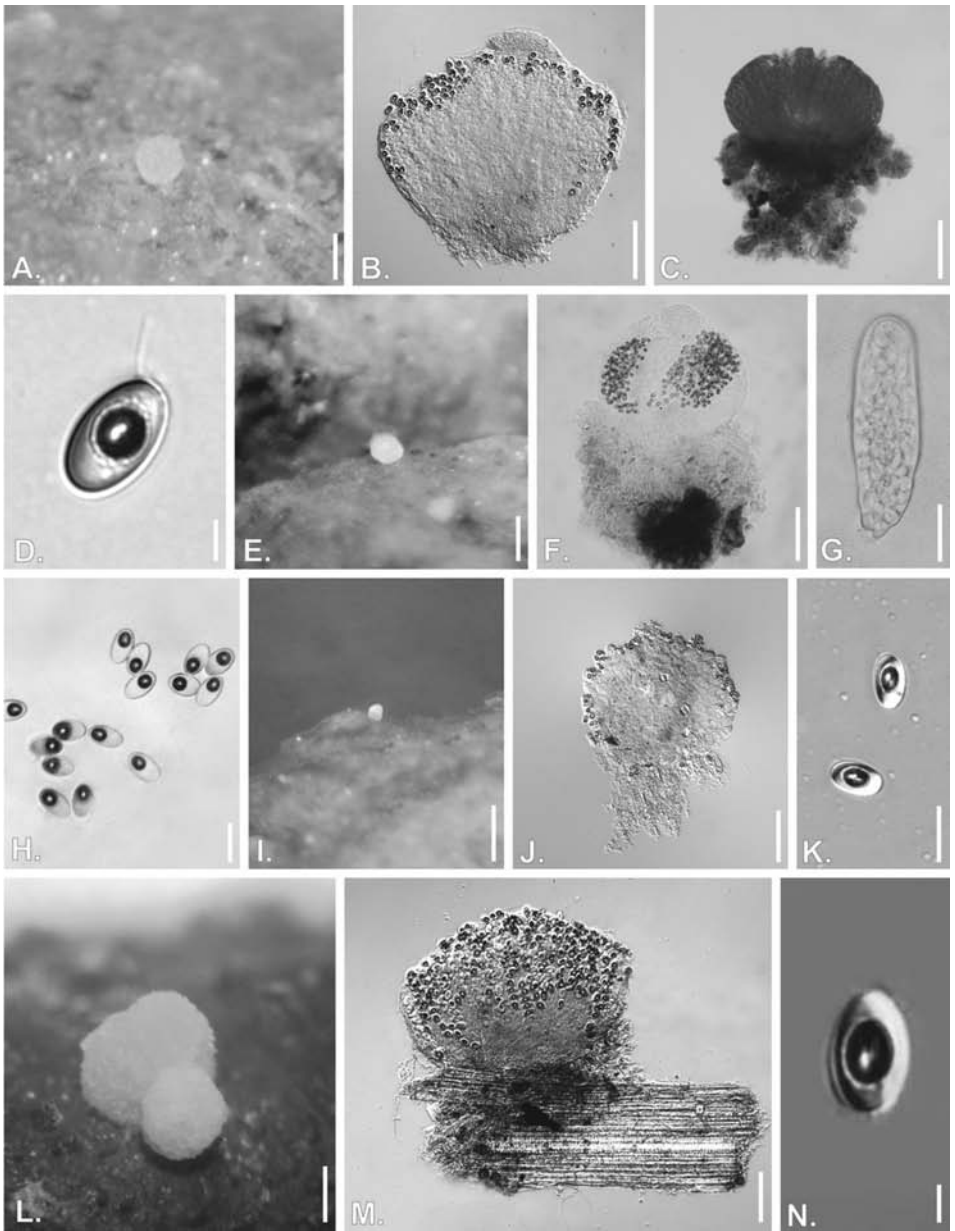


Fig. 2. *Coprotus leucopocillum*. A. apothecium on dung (Bar = 400 μ m), B. apothecium mounted in water (Bar = 100 μ m), C. apothecium mounted in lactophenol with cotton blue, showing the strong cyanophilous excipulum (Bar = 150 μ m), D. ascospore (Bar = 5 μ m), *C. niveus*. E. apothecium on dung (Bar = 500 μ m), F. apothecium mounted in water (Bar = 150 μ m), G. immature ascus (Bar = 25 μ m). H. ascospores (Bar = 10 μ m). *C. luteus*. I. apothecium on dung (Bar = 1000 μ m), J. apothecium mounted in water (Bar = 100 μ m). K. ascospores (Bar = 10 μ m). *C. ochraceus*. L. apothecium on dung (Bar = 500 μ m), M. apothecium mounted in water (Bar = 200 μ m). N. ascospores (Bar = 5 μ m).

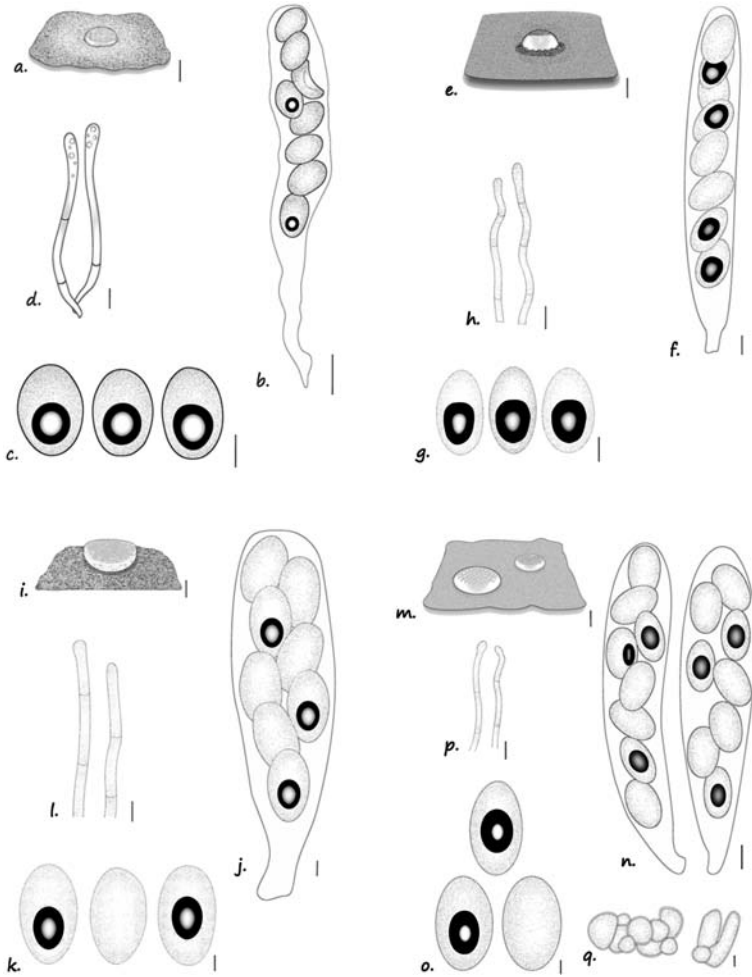


Fig. 3. *Coprotus aurora*. A. apothecium growing on dung (Bar = 200 μ m), B. ascus (Bar = 10 μ m), C. ascospores (Bar = 5 μ m), D. paraphyses (Bar = 5 μ m). *C. disculus* E. apothecium growing on dung (Bar = 400 μ m), F. ascus (Bar = 5 μ m). G. ascospores (Bar = 2 μ m), H. paraphyses (Bar = 10 μ m). *C. lacteus*. I. apothecium growing on dung (Bar = 100 μ m). J. ascus (Bar = 2.5 μ m), K. ascospores (Bar = 1 μ m), L. paraphyses (Bar = 3 μ m). *C. leucopocillum*. M. apothecium growing on dung (Bar = 300 μ m), N. Asci (Bar = 5 μ m), O. Ascospores (Bar = 1 μ m), P. Paraphyses (Bar = 10 μ m), Q. excipular cells (Bar = 5 μ m).

and columnar at the outer layers, weakly to non cyanophilous. PARAPHYSES filiform, septate, hyaline, 1.5 μ m thick at the base, slightly elongated at the apex, usually simple. ASCI 8-spored, cylindrical, short stipitate, with a rounded apex, 62–75 \times 9–12.5 μ m. ASCOSPORES uniseriate, ellipsoid, hyaline, 8.5–10 \times 4–5.5 μ m, each with a conspicuous eccentric de Bary bubble, not observed when mounted in water.

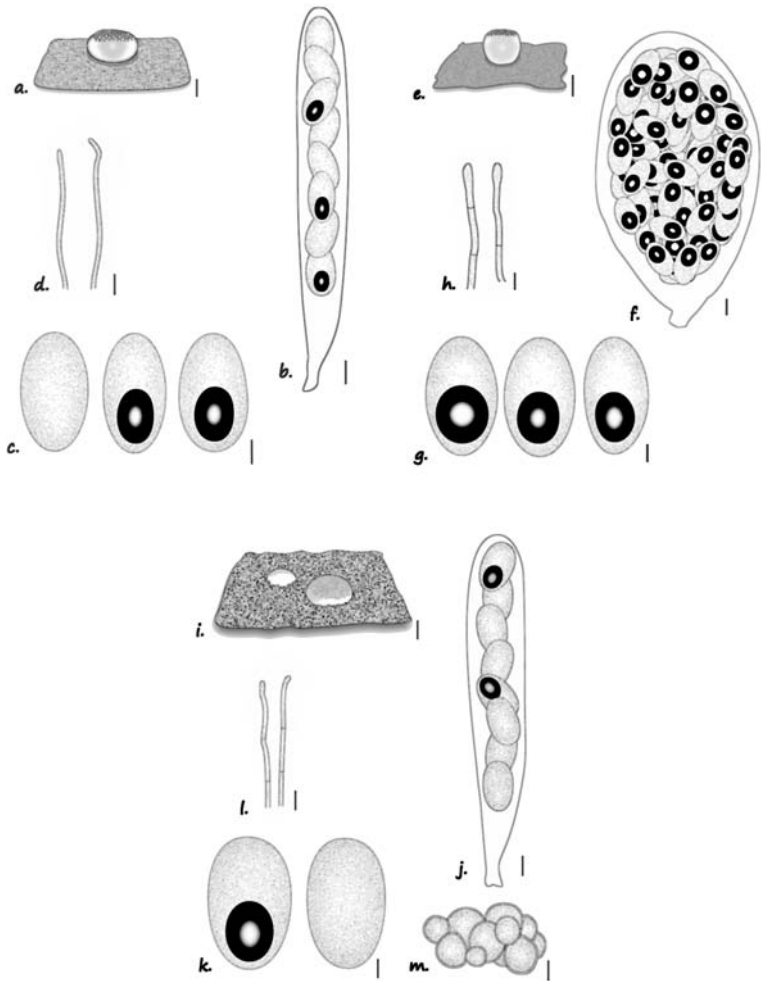


Fig. 4. *C. luteus*. A. apothecium growing on dung (Bar = 150 μ m), B. Ascus (Bar = 5 μ m), C. ascospores (Bar = 1 μ m), D. paraphyses (Bar = 7.5 μ m). *C. niveus*. E. apothecium growing on dung (Bar = 250 μ m), F. ascus (Bar = 5 μ m), G. ascospores (Bar = 1 μ m). H. paraphyses (Bar = 5 μ m). *C. ochraceus*. I. apothecium growing on dung (Bar = 500 μ m), J. ascus (Bar = 5 μ m). K. ascospores (Bar = 2.5 μ m), L. paraphyses (Bar = 10 μ m), M. excipular cells (Bar = 7.5 μ m).

MATERIAL EXAMINED: Brazil, Pernambuco, Serra Talhada, Instituto Agronômico de Pernambuco (IPA), on horse dung, 13 Jul 2012, R.F.R.Melo (URM85936).

HABITAT: Recorded on dung of burro, cattle, horse, deer, goat and moose.

DISTRIBUTION: Africa (South Africa), Central America (Mexico), Europe (Denmark, Finland, Italy, Lithuania, Norway, Sweden), North America (Canada, U.S.A.), South America (Venezuela). This is the first record from Brazil.

COMMENTS: *Coprotus luteus* form small apothecia directly on the substrate. Morphology of asci and ascospores resembles *C. aurora*, from which it can be distinguished by the intensely colored apothecia and smaller ascospores ($8.5\text{--}10 \times 4\text{--}5.5 \mu\text{m}$). Despite the small sample obtained in the present survey, the apothecia observed were usually smaller than those described by Kimbrough et al. (1972) in the U.S.A.

Coprotus niveus (Fuckel) Kimbr., Luck-Allen & Cain, Can. J. Bot. 50: 967. 1972.

Figs 2 E–H, 4 E–H

Ascobolus niveus Fuckel, Hedwigia 5(1): 4. 1866.

Rhyarobius niveus (Fuckel) Sacc., Syll. Fung. (Abellini) 8: 544. 1889.

Ascozonus niveus (Fuckel) Boud. 1907.

APOTHECIA scattered, superficial, sessile, subglobose to cupulate, white to pale yellow, 300–500 μm diam. DISK indistinguishable in colour from the receptacle, roughened to villose due to the exposed asci in maturity. HYPOTECIUM inconspicuous. EXCIPULUM composed of globular cells, becoming elongated and more cyanophilous at the outer layer. PARAPHYSES scarce, filiform, simple or branched, septate, hyaline, 1.5–2 μm thick at the base, reaching 2.5 μm thick at the apex, devoid of observable cytoplasmatic content on the examined material. ASCI approximately 64-spored, clavate to obovoid after spore maturation, with a short stipe and cupulate apex, 90–112 \times 40–55 μm . ASCOSPORES irregularly disposed in the asci, ellipsoid to somewhat fusoid, hyaline, 8.75–10 \times 5–7.5 μm , each with a conspicuous eccentric de Bary bubble, not observed when mounted in water.

MATERIAL EXAMINED: BRAZIL. Pernambuco, Recife, Horto Zoobotânico do Parque Estadual Dois Irmãos, on camel dung, 24 Mar 2010, R.F.R.Melo (URM82313).

HABITAT: Recorded on dung of many herbivores.

DISTRIBUTION: Asia (Pakistan), Africa (Kenya), Asia (Thailand), Central America (Mexico), Europe (Germany, Italy), North America (Canada, U.S.A.) and South America (Venezuela). This is the first record from Brazil.

COMMENTS: The most remarkable character of this somewhat rare species is the multispored asci (approximately 64-spored), organized in a pale colored, cup-shaped apothecia.

Coprotus ochraceus (P.Crouan & H.Crouan) J. Moravec Česká Mykol. 25 (3): 155. 1971.

Figs 2 L–N, 4 I–M

Ascobolus ochraceus P.Crouan & H.Crouan, Florule Finistère (Paris): 57. 1867.

Ascophanus ochraceus (P.Crouan & H.Crouan) Boud., Anns Sci. Nat., Bot., sér. 5 10: 247. 1869.

APOTHECIA scattered to gregarious, sessile, discoid, yellow when young, becoming amber yellow to orange after maturation, 800–1400 μm diam., glabrous, without a margin, sometimes forming gregarious crusts containing 2–5 receptacles. DISK roughened to villose due to the exposed mature asci, concolorous with receptacle. HYPOTHECIA composed of globose cells, barely distinguished from the excipulum surrounding the asci. EXCIPULUM composed of globose cells, becoming elongated at the

Table 1. Sampling data of *Coprotus* species recorded in Pernambuco, Brazil.

Deposit number	Species	Sampling date	Dung type	City	Fruiting (days of incubation)
URM85926	<i>C. aurora</i>	23/03/11	Goat	Recife	15
URM85928	<i>C. disculus</i>	16/10/11	Goat	Caruaru	26
URM85927	<i>C. disculus</i>	13/09/11	Horse	Serra Talhada	10
URM85929	<i>C. lacteus</i>	07/10/11	Horse	Caruaru	17
URM85930	<i>C. lacteus</i>	24/05/12	Goat	Serra Talhada	10
URM85931	<i>C. leucopocillum</i>	12/09/11	Horse	Serra Talhada	14
URM85932	<i>C. leucopocillum</i>	12/09/11	Cattle	Serra Talhada	10
URM85933	<i>C. leucopocillum</i>	15/06/12	Goat	Caruaru	14
URM85934	<i>C. leucopocillum</i>	27/08/12	Cattle	Caruaru	11
URM85935	<i>C. leucopocillum</i>	08/10/12	Cattle	Serra Talhada	13
URM82309	<i>C. leucopocillum</i>	07/04/10	Llama	Recife	20
URM82310	<i>C. leucopocillum</i>	10/07/10	Camel	Recife	10
URM82311	<i>C. leucopocillum</i>	10/07/10	Camel	Recife	10
URM82312	<i>C. leucopocillum</i>	09/08/10	Llama	Recife	11
URM85936	<i>C. luteus</i>	13/06/12	Horse	Recife	19
URM82313	<i>C. niveus</i>	24/03/10	Camel	Recife	15
URM85937	<i>C. ochraceus</i>	07/10/11	Horse	Caruaru	17
URM85938	<i>C. ochraceus</i>	27/07/12	Cattle	Serra Talhada	12

outer layers, weakly to non cyanophilous. PARAPHYSES filiform, septate, hyaline, 1.5–2 μm thick at the base, slightly elongated towards the apex, with yellow cytoplasmatic contents, visible in apothecia mounted in water. ASCI 8-spored, cylindrical, with a short stipe and rounded apex, 140–150 \times 13–17 μm . ASCOSPORES usually uniseriate, usually slightly oblique in relation to the axis, ellipsoid, hyaline to pale yellow, 16.5–18 \times 10–11.5 μm , each with a conspicuous de Bary bubble, not observed when mounted in water.

MATERIAL EXAMINED: Brazil, Pernambuco, Caruaru, Instituto Agronômico de Pernambuco (IPA), on horse dung, 07 Oct 2011, R.F.R.Melo (URM85937); Serra Talhada, Instituto Agronômico de Pernambuco (IPA), on cattle dung, 27 Jul 2012, R.F.R.Melo (URM85938).

HABITAT: Recorded on dung of many herbivores.

DISTRIBUTION: Asia (India, Pakistan, Republic of Tajikistan), Europe (Belgium, Czech Republic, Denmark, France, Germany, Italy, Norway, Poland, Puerto Rico, Sweden, United Kingdom), North America (Bermuda, Canada, U.S.A.), Oceania (Australia) and South America (Argentina, Brazil, Venezuela).

COMMENTS: *Coprotus ochraceus* can be easily recognized among other species of this genus by large, usually strongly pigmented, weakly cyanophilous apothecia, with

yellow cytoplasmatic content in the inflated apex of the paraphyses, and by ascospore size ($16.5\text{--}18 \times 10\text{--}11.5 \mu\text{m}$).

Discussion

Despite the small number of samples, Brazilian species of *Coprotus* recorded in Brazil collected from a vegetational gradient ranging from Atlantic rainforest to Caatinga, in semi-arid rural areas, showed apothecia fruiting on a variety of dung types (Table 1). Regarding substrate preference, Kimbrough et al. (1972) analysed material collected from different kinds of dung collected worldwide, pointing no significant differences from its precedence. In this study, no clear preference for a particular dung type could be accessed from the sampled material. Most species were recorded in Caruaru and in Serra Talhada, located in the semi-arid Caatinga biome. Apothecia of *Coprotus* species from Pernambuco were recorded fruiting between the 10th and the 26th day after collection, and most specimens started the production of apothecia between the 14th and 15th day, usually at the same time as black spored perithecial genera. The species with the highest number of records, *C. leucopocillum*, started beginning between the 10th and the 20th day of incubation.

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