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New records of Agaricaceae (Agaricales, Basidiomycota) from Colombia

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Abstract

The Agaricales are the largest clade of mushroom-forming fungi, in Colombia, with 544 species of the approximately 16,000 species currently recognized worldwide in the phylum Basidiomycota. We document seven species of Agaricaceae for the first time from the Colombian Caribbean region. Two of these species are newly recorded from the country: *Leucoagaricus lilaceus* Singer and *Leucoagaricus roseilividus* (Murrill) E. Ludw. Five species are reported from the Colombian Caribbean for the first time: *Agaricus griseorimosus* Pegler, *Chlorophyllum hortense* (Murrill) Vellinga, *Leucoagaricus rubrotinctus* (Peck) Singer, *Leucocoprinus cepistipes* (Sowerby) Pat., and *L. venezuelanus* Dennis.

Keywords

Biodiversity, Macromycetes, macrofungi, tropical dry forest, urban reserve

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Introduction

The Agaricales (Agaricomycetes, Basidiomycota) constitute the largest clade of mushroom-forming fungi, including 40 families, 374 genera, and more than 16,000 species (He et al. 2019; Phookamsak et al. 2019; Wijayawardene et al. 2020). The sexual reproduction structures or basidiomata of the Agaricales are characteristically cap-, umbrella-, or shelf-shaped and with a laminar, porous, or venous hymenophore (Lodge et al. 2004). The taxonomy is determined by the morphology of the hymenophores arranged in sheets that include differential macroscopic characteristics such as size, shape, and texture of each part of the pileus; thickness, edge, color, arrangement, and insertion of the sheets at the foot; morphology, color, appearance, and consistency of the foot; presence or absence of a ring, volvas, or curtain; spore color, in addition to organoleptic qualities (Largent 1986; Singer 1986). Additionally, among microscopic characteristics, the number, morphology, ornamentation, and coloration of the basidiospores are used, as are the shape and location of cystidia, the arrangement of the hyphae

of pileipellis, and reactions against Melzer's reagent, KOH, and ammonia Congo red (Pegler 1983).

In Colombia, Agaricales is the order of fungi with the greatest number of species, with 544 known (Putzke et al. 2020; Vasco-Palacios and Franco-Molano 2021) of the total of 16,071 macrofungi of the phylum Basidiomycota worldwide (He et al. 2019; Wijayawardene et al. 2020). Most species, 83%, are recorded from the Andean region, followed by the Caribbean region with 6%; 11% is distributed in the rest of the country (Franco-Molano and Uribe-Calle 2000; Franco-Molano et al. 2010; Vasco-Palacios and Franco-Molano 2013, 2021). In the Caribbean region, 139 species have been recorded, 127 in the northwestern slope of the Sierra Nevada de Santa Marta and only 12 species in Cesar (Palacio et al. 2015; Vasco-Palacios and Franco-Molano 2013). Here, we report seven Agaricales species from the Colombian Caribbean for the first time. Two of these species are newly recorded from the country. Additionally, we provide illustrations and notes on the characteristics, distribution, and habitat of these species.

Study Area

Our study was located on the campus of the Universidad del Magdalena (Santa Marta, Magdalena, Colombia), which has an area of 52 ha and consists of remnants of native tropical dry forest vegetation (Fig. 1). The study area is 3.5 ha, at 11°13′18″N, 074°11′11″W.

This part of Colombia has a bimodal rain regime with two wet seasons (May–June and September–November) and two dry seasons (December–April and June–August). The annual average rain and temperature are 578 mm and 29 °C, respectively, and the mean relative humidity is 74%, with a semi-arid climate with a high water deficit in the dry season (Rangel and Carvajal 2012).

Methods

We collected of biological material in the rainy seasons from October 2018 to October 2019, following the opportunistic method (Lodge et al. 2004). The specimens were documented and preserved according to standard methods (Lodge et al. 2004), and the type of habitat and associated substrate were recorded. With the fresh material, the characters of taxonomic interest such as basidiomata and spore staining were recorded. Each specimen was photographed with a Nikon D7000 digital camera, and the Methuen Handbook of Colour was used for spore staining (Kornerup and Wanscher 1978).

Microscopic analysis of the collected material was performed with a Nikon stereoscope and a Zeiss Primo Star microscope with a camera. All the measurements and colors described here were obtained from rehydrated material with KOH 5%, alcohol 70%, and water, and Congo Red and Melzer reagent were also used. The preparations were observed with the immersion objective (100×), and the description of the structures was made using standardized techniques (Largent et al. 1977; Largent and Thiers 1977; Largent 1986). Measurements of

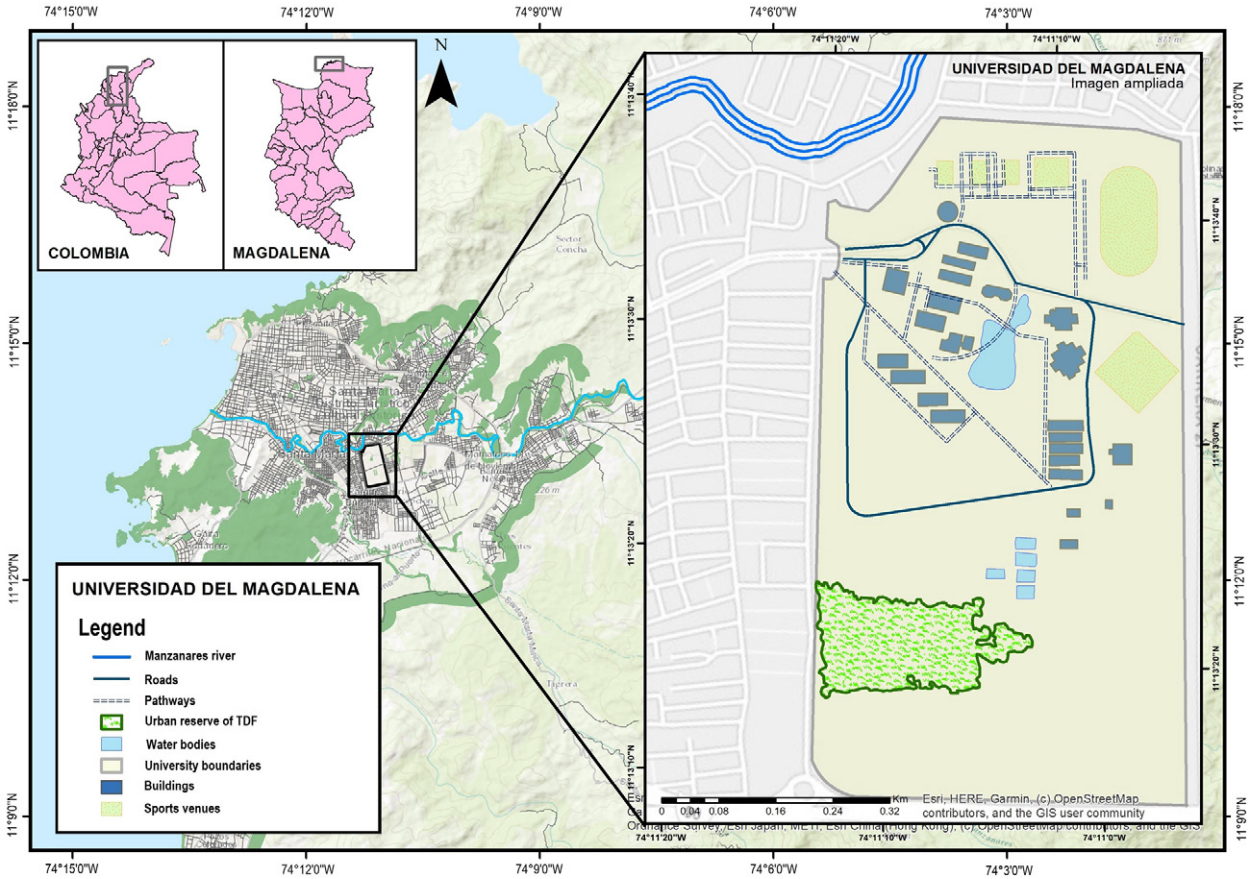

Figure 1. Map of the Universidad del Magdalena campus, located in Santa Marta, Magdalena, Colombia.

microscopic structures were made using ToupView v. 3.7. Forty basidiospores were measured to determine the Q value (length/width ratio), the sample size was determinate by $n = x/y$ (x = number of measured basidiospores, and y = number of basidiomata studied), the mean (X) of the microscopic measurements is also indicated. For the identification of the species, specialized literature was consulted (Pegler 1983; Singer 1986; Kuo 2007; Petersen and Lassoe 2012). Index Fungorum (2020) was consulted for the names of species, synonyms, and authors. The specimens were deposited at the Centro de Colecciones Biológicas de la Universidad del Magdalena (CBUMAG).

Results

Seven species of Agaricaceae were recorded for the first time from the Colombian Caribbean. Two species are documented here for the first time from Colombia: *Leucoagaricus lilaceus* Singer and *L. roseilividus* (Murrill) E. Ludw. The remaining five species are newly recorded from the Colombian Caribbean region: *Agaricus griseorimosus* Pegler, *Chlorophyllum hortense* (Murrill) Vellinga, *Leucoagaricus rubrotinnctus* (Peck) Singer, *Leucoprinus cepistipes* (Sowerby) Pat., and *L. venezuelanus* Dennis.

Agaricaceae

***Agaricus griseorimosus* Pegler**
Figure 2

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′18″N, 074° 11′09″W; 21 m alt.; 12.X.2018; J. Luna-Fontalvo et al. leg.; JL, AB & CA 005; CBUMAG:FUN:1.

Identification. Pileus fleshy, conical to bell-shaped, flat in mature specimen, 60–70 mm in diameter, greyish-brown; smooth and soft surface; decurved to straight margin and rimous edge (Fig. 2A). Lamellae dark chocolate brown, free and tight, with smooth edge, and lamellulae (Fig. 2B). Stipe yellowish-white, 65–70 × 5–6 mm, central, cylindrical, fibrous, and hollow; annulus subapical, white, double, ascending, and peronate; some specimens present stipes with basal torment (Fig. 2B). Trama pale yellow and dark brown, compact, and soft.

Basidiospores dark brown, 4.0–5.4 × 2.6–3.8 µm (X = 11.2 ± 0.3984 × 3.2 ± 0.3095; Q = 1.46 ± 0.1596; n = 50/2), ellipsoid and thick-walled, germ pore absents (Fig. 2C). Basidia were not observed. Cheilocystidia 15–18.2 × 7–9 µm, hyaline and claviform (Fig. 2D). Pileipellis composed of hyphae 2–14 µm in diameter, hyaline, globose, with thin walls (Fig. 2E).

Taxonomic remarks. The macroscopic and microscopic features of the examined material match that described by Pegler (1983) but differ slightly in the size of the basidiospores: 5.3–7.5 × 2.7–3.5 (5.6 ± 0.4 × 3 ± 0,18) µm. In *A. griseorimosus*, the coloration of the stipe, the size of basidiospores, and the presence or absence of cheilocystidia is variable, as in *A. endoxanthus*, *A. moelleri*, *A. moelleroides*, *A. punjabensis*, *A. tephrolepidus*, and *A. volvatulus*. According to Parra et al. (2018), *A. griseorimosus* belongs to the section Xanthodermatei;

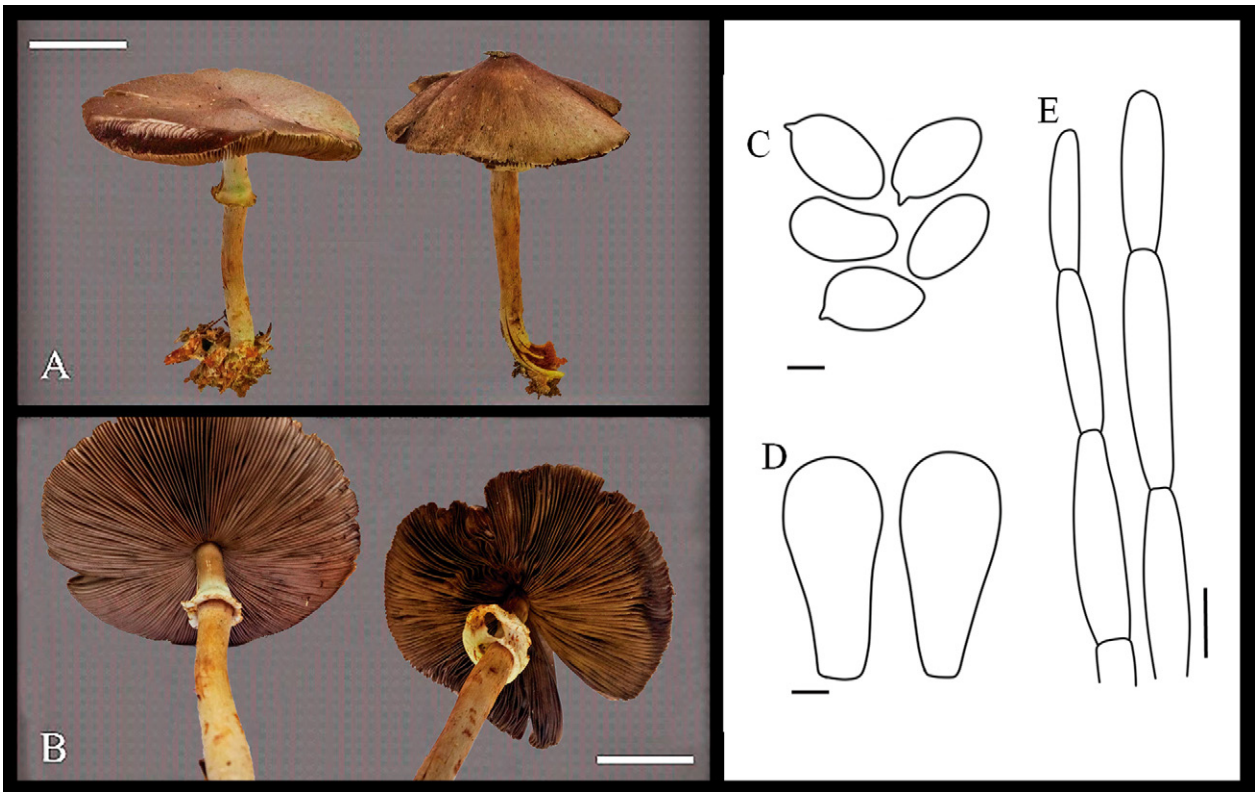

Figure 2. Basidiomata and microscopic structures of *Agaricus griseorimosus* (JL, AB & CA 005). **A.** Whole basidiomata. **B.** Details of the hymenium and stipe. **C.** Spores. **D.** Cheilocystidia. **E.** Pileipelis hyphae. Scale bars: A, B = 2 cm; C = 10 µm; D, E = 20 µm.

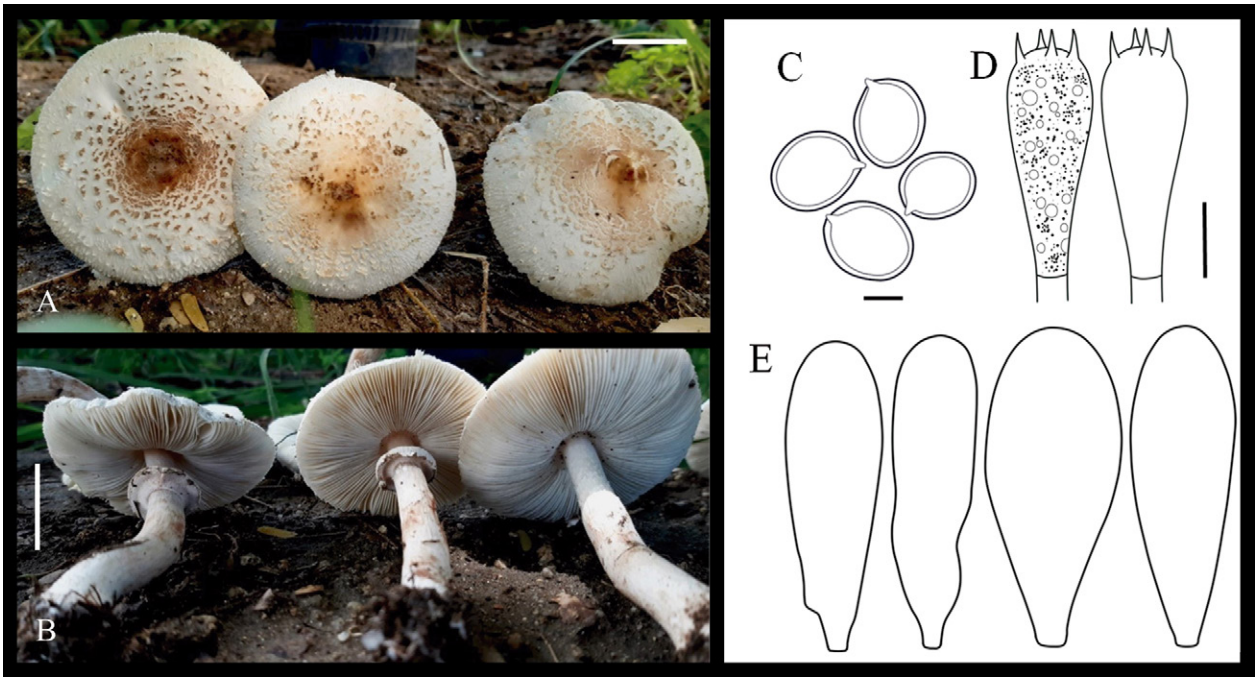

Figure 3. Basidiomata and microscopic structures of *Chlorophyllum hortense* (JL, AB & CA 040). **A.** Apical view of the pileus. **B.** Details of the hymenium and stipe. **C.** Spores. **D.** Basidia. **E.** Cheilocystidia. Scale bars: A, B = 2 cm; C = 10 µm; D, E = 20 µm.

however, it presents a bordered pileus, a single annulus, and longer and narrower spores which distinguishes it from that section.

Habitat and distribution. A terrestrial species, on litter in a tropical dry forest fragment. Collected during the rainy season. *Agaricus griseorimosus* has been recorded in India (Farook et al. 2013), the Lesser Antilles (Angelini et al. 2018), and Colombia, where it was previously known from the Caquetá department (Sánchez 2003). Our record is the first from the Colombian Caribbean.

Chlorophyllum hortense (Murrill) Vellinga

Figure 3

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′31″N, 074° 11′03″W; 21 m alt.; 1.X.2019; J. Luna-Fontalvo et al. leg.; JL, AB & CA 040; CBUMAG:FUN:2.

Identification. Pileus fleshy, convex to flat and slightly umbonate; 50–70 mm in diameter, white with oxide brown scales, dry surface, straight to decurved margin, and torn edge (Fig. 3A). Lamellae white, free, tight, with smooth edge and lamellulae (Fig. 3B). Stipe white with light orange spots, 70–90 × 4–6 mm, central, hollow, cylindrical, fibrous; annulus subapical, concolorous with the stipe, peronate, and ascending; slightly widened base with mycelial laces (Fig. 3B). Trama white, thick, abundant, and consistent.

Basidiospores greyish-green, 7.1–9.2 × 5.2–7.3 µm, broadly ellipsoidal, germ pore absents (Fig. 3C). Basidia hyaline, 29.6–35.7 × 12.0–14.1 µm (X = 8.3 ± 0.4019 × 6.7 ± 0.4067; Q = 1.23 ± 0.057; *n* = 40/5), claviform, tetrasporic and granular contents (Fig. 3D). Pleurocystidia absent. Cheilocystidia with greenish yellow vacuolar pigments, spiked, 32.2–58.6 × 9.3–16 µm (Fig. 3E).

Taxonomic remarks. *Chlorophyllum hortense* is characterized by a small to medium-size basidiome, white with brown central scales, single annulus, spores without germ pore and basidia with two or occasionally four sterigmata (Vellinga 2003; Ge and Yang 2006). However, Pegler (1983) described spores of *C. hortense* with a germ pore. *Chlorophyllum hortense* has similarities with *C. africanum* in the size of the basidiocarp and the shape of the spores and cheilocystidia. However, *C. africanum* has smaller spores and basidia with four sterigmata (Ge et al. 2018). Our Colombian material matches the features described by Vellinga (2003), Ge and Yang (2006), and Nascimento and Alves (2014), who report spores without a germ pore.

Habitat and distribution. A terrestrial species, on scattered pastures. Collected in the rainy season. *Chlorophyllum hortense* has a wide distribution in tropical and subtropical climates and has been recorded in the Lesser Antilles, United States (Pegler 1983), Brazil (Nascimento and Alves 2014; Alves et al. 2016), and Colombia (Franco-Molano et al. 2010).

Leucoagaricus lilaceus Singer

Figure 4

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′18″N, 074° 11′05″W; 20 m alt.; 13.X.2019; J. Luna-Fontalvo et al. leg.; JL, AB & CA 002; CBUMAG:FUN:3.

Identification. Pileus fleshy, convex to flat, 50–70 mm in diameter, white, with a wide greyish ruby scale to dark ruby, scattered throughout the cap; dry surface, straight margin, rimous to lobed edge (Fig. 4A, B). Lamellae yellowish-white, free, tight, ventricose, with smooth edge and lamellulae (Fig. 4C). Stipe white at the apex and

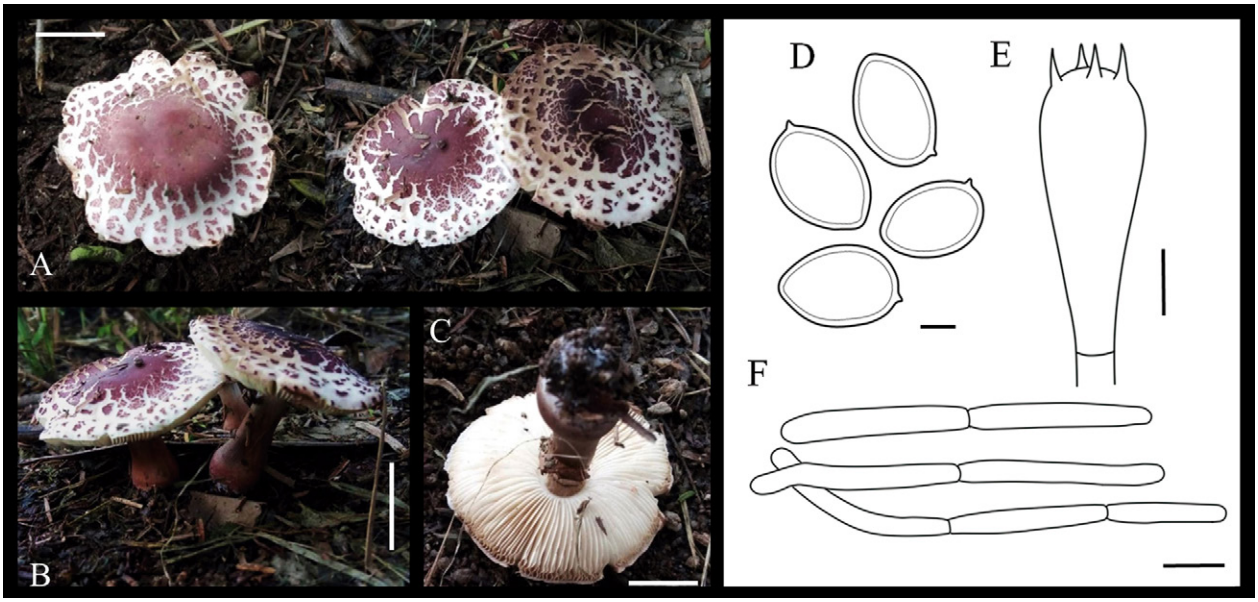

Figure 4. Basidiomas and microscopic structures of *Leucoagaricus lilaceus* (JL, AB & CA 002). **A.** Apical view of the pileus. **B.** Lateral view of the basidiocarp. **C.** Details of the hymenium and stipe. **D.** Spores. **E.** Basidia. **F.** Pileipelis hyphae. Scale bars: A = 2 cm; B = 4 cm; C = 2 cm; D = 10 µm; E, F = 20 µm.

light brown at the base, 50–60 × 6–8 mm, central; annulus fleeting and absent in mature basidiomata; base thickened, with a prominent and rounded bulb (Fig. 4C). Trama white and consistent.

Basidiospores hyaline, 5.32–7.1 × 3.2–4.8 µm (X = 6.2 ± 0.4739 × 4 ± 0.3703; Q = 1.51 ± 0.37; *n* = 40/3), ellipsoid and thick-walled; germ pore absents (Fig. 4D). Basidia 20.3–30 × 6.9–11.61 µm, hyaline, claviform, tetrasporic (Fig. 4E). Pleurocystidia absent; cheilocystidia not observed. Pileipellis composed of prostrate hyphae, 4–21µm wide (Fig. 4F).

Taxonomic remarks. *Leucoagaricus lilaceus* belongs to the section Piloselli (Kühn.) Sing. (1972). The morphological descriptions presented correspond to those of Singer (1986), except for the absence of hyaline , fusiform, ventricose, langeriform, and thin-walled cheilocystidia (Singer 1986; Rother and Da Silveira 2009a; Vellinga et al. 2010; Ferreira and Cortez 2012).

Leucoagaricus lilaceus is considered close to *Lepiota roseolivida* Murrill, as these species both have the pileus with violet tones, but they differ in the size and color of the stipe, which is yellowish in *L. roseolivida*. Also, *L. lilaceus* is related to *Lepiota decorata* Zeller but is distinguished by some microscopic structures, such as cystidia, and *L. decorata* is distributed in temperate zones where it is associated with conifers (de la Fuente et al. 2018). *Leucoagaricus subpurpureolilacinus* Z.W. Ge & Zhu L. Yang also has the pileus with violet color, but the basidiospores are larger, approximately 11 µm, and the context does not change color when it is cut (Ge et al. 2015).

Habitat and distribution. A terrestrial species, solitary, sometimes scattered in tropical dry forest fragments. Collected in the rainy season. *Leucoagricus lilaceus* is newly recorded from Colombia. It was first described in Tucumán, Argentina (Singer and Digilio 1951) and is known from Brazil (Rother and Da Silveira 2009a; Ferreira and Cortez 2012), Paraguay (Flecha-Rivas et al. 2013), and Mexico (de la Fuente et al. 2018).

***Leucoagaricus roseilividus* (Murrill) E. Ludw.**
Figure 5

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′29″N, 074° 11′14″W; 20 m alt.; 11.X.2019; J. Luna-Fontalvo et al. leg.; JL, AB & CA 050; CBUMAG:FUN:4.

Identification. Pileus convex to plane-convex, 42.6–63.9 mm in diameter, white with scales over the entire grey magenta surface, darker towards the center; decurved margin, and entire edge (Fig. 5A, B). Lamellae orangish-white, free, tight, with smooth edge and lamellulae (Fig. 5C). Stipe concolorous, darker towards the base, 53.2–56 × 4–7 mm, central, spiked and fibrillous; annulus superior, white above, and grey magenta below (Fig. 5C). Trama white and consistent.

Basidiospores hyaline, 5–7.3 × 3.2–5 µm (X = 5.9 ± 0.4716 × 3.8 ± 0.2559; Q = 1.55 ± 0.1550; *n* = 40/1), ellipsoid, with thick wall and germ pore (Fig. 5D). Basidia 21.8–29 × 7.3–9 µm, hyaline, claviform, tetrasporic, with smooth and thin walls, some exhibit granular contents (Fig. 5E). Pleurocystides not observed. Cheilocystides 29.8–45.4 × 9.1–16.8, polymorphic, claviform, utriform, cylindrical, wavy, oblong, slightly ventricose, with thickened walls, turning hyaline to yellowish in KOH, with olive-brown vacuolar pigments (Fig. 5F). Pileipellis composed of periclinal hyphae, cylindrical, interlaced, ascending, olive-brown, with terminal elements, 24.7–40.7 × 4.6–10.5 µm (Fig. 5G).

Taxonomic remarks. The morphological features of *L. roseilividus* described here correspond to the original

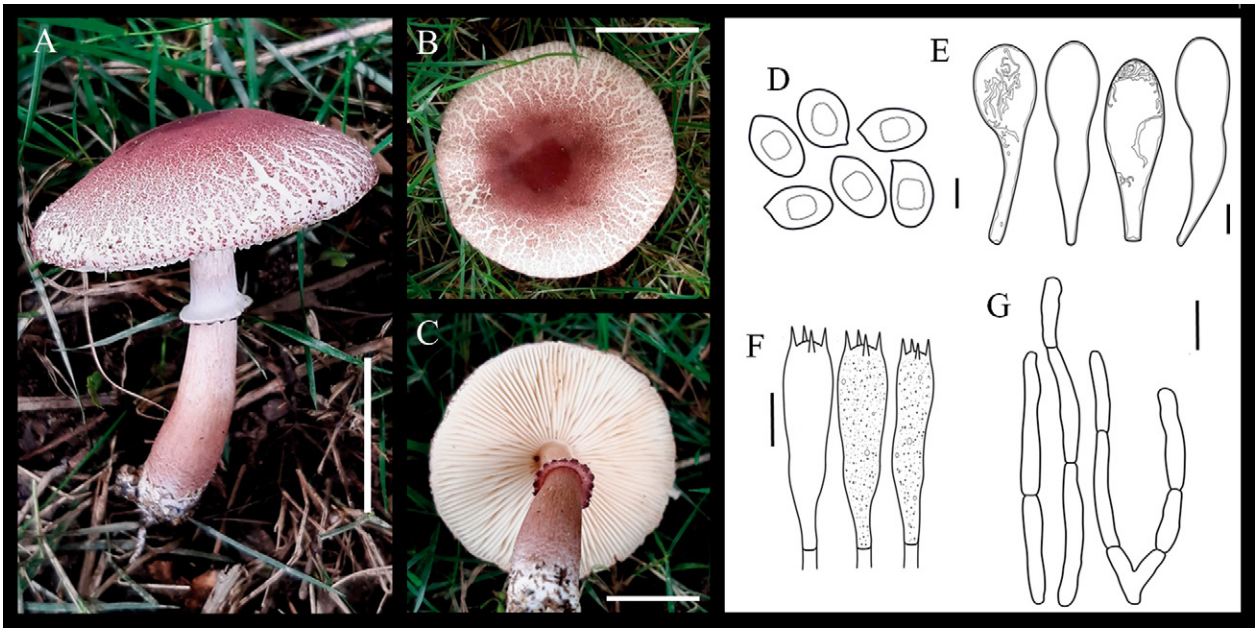

Figure 5. Basidiomata and microscopic structures of *Leucoagaricus roseilividus* (JL, AB & CA 050). **A.** Basidiocarp. **B.** Apical view of the pileus. **C.** Details of the hymenium and stipe. **D.** Spores. **E.** Basidia. **F.** Cheilocystidia. **G.** Pileipelis hyphae. Scale bars: A = 3 cm; B, C = 2 cm; D = 10 µm; E, G = 20 µm.

description by Murrill (1912) and the descriptions by Vellinga (2006) and Cabrera (2015); this species has a reaction in ammonia, but this test was not performed in the sample examined. *Leucoagaricus roseilividus* exhibits delicate, small basidiomata, but the size is variable and, in some habitats, may be more robust (Vellinga 2006).

It has been confused on countless occasions due to its close resemblance to *Leucoagaricus ionidicolor* Bellù & Lanzoni, but it differs in the intensity of the colors, with more bluish tones, a considerably wider pileus, and an unchanging color of the context and lamellae (Vellinga 2006). Our sample agrees with the description by Cabrera (2015) of a Brazilian specimen, specifically the coloration of the cheilocystidia and pileipellis hyphae, which are brown in water and yellowish to hyaline in KOH, with intracellular pigments, and hyphae with fibulae absent.

Habitat and distribution. A terrestrial, solitary species, on grass. Collected in the rainy season. *Leucoagaricus roseilividus* is recorded from Colombia for the first time. It occurs in California, United States (Murril 1912; Vellinga 2006), and Brazil (Cabrera 2015). Ours is the second record from South America.

Leucoagaricus rubrotinctus (Peck) Singer

Figure 6

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′18″N, 074°11′ 10″W; 20 m alt.; 12.VI.2019; J. Luna-Fontalvo et al. leg.; JL, AB & CA 014; CBUMAG:FUN:5.

Identification. Pileus flat to concave; 15–20 mm in diameter; white, covered by tiny, red, radially arranged scales,, darker in the center; surface dry and rough; with an entire edge and straight margin (Fig. 6A). Lamellae white, free, thick, tight, with lamellulae. Stipe 118–20 × 2–4 mm, white, cylindrical, smooth, central, fibrous; annulus central, ascending, and peronate; base with small red scales (Fig. 6B). Trama white and consistent.

Basidiospores hyaline, 5.3–9.2 × 3–5.7 µm (X = 7.3 ± 0.7235 × 4.4 ± 0.6705; Q = 1.68 ± 0.229; *n* = 40/3), ellipsoid and thick-walled; germ pore absents (Fig. 6C). Basidia 17.7–28.2 × 6.7–10 µm, hyaline, claviform and tetrasporic (Fig. 6D). Pleurocystides not observed. Cheilocystides 19.2–35.9 × 7.1–10.9 µm, hyaline, polymorphic, fusiform-langeriform, ventricose, subcapitated (Fig. 6E). Pileipellis composed of periclinal hyphae to irregularly ascending hyphae, 7–15.2 µm wide, occasionally septate, with olive-brown vacuolar pigments (Fig. 6F).

Taxonomic remarks. The taxonomic features of our material studied correspond with the descriptions of *L. rubrotinctus* by Ferreira and Cortez (2012), including a reddish pileus which varies from orange to brown tones depending on the age of the basidiocarp, but remaining always darker in the center. In immature specimens, the pileus displays a uniform color which, when maturing, cracks and gives the impression of small radial scales on a pale background (Ferreira and Cortez 2012). Among the microscopic features, this species presents basidiospores with an inconspicuous to absent germ pore (Verma et al. 2018).

Lepiota rubrotinctoides Murrill and *Leucoagaricus glabridiscus* (Sundb.) have been related with *L. rubrotinctus*; however, they present macroscopic and microscopic differences that have solved the confusion (Ferreira and Cortez 2012). *Lepiota rubrotinctoides* presents smaller basidiospores (7 × 3.5 µm), absence of hairy scales, and more robust basidiomata (Murrill 1912), whereas *L. glabridiscus* is a smaller and fragile fungus,

Figure 6. Basidiomata and microscopic structures of *Leucoagaricus rubrotinctus* (JL, AB & CA 014). **A.** Lateral view of the pileus. **B.** Details of the hymenium and stipe. **C.** Spores. **D.** Basidia. **E.** Cheilocystidia. **F.** Pileipelis hyphae. Scale bars: A =1 cm; B = 2 cm; C = 10 µm; D–F = 20 µm.

whose pileipellis is formed by a double layer of interlaced hyphae (Kumar and Manimohan 2009).

Habitat and distribution. A terrestrial species, solitary, on litter, in a tropical dry forest fragment. Collected during the dry season. Our record is the first from the Colombian Caribbean region. Elsewhere in Colombia this species has been found in the departments of Antioquia and Quindío, between 1800 and 3250 m altitude (Franco-Molano et al. 2010). It is also reported from Bolivia (Melgarejo-Estrada et al. 2020), Brazil (Ferreira and Cortez 2012), and Mexico (Terríquez-Villanueva et al. 2017).

Leucocoprinus cepistipes (Sowerby) Pat. ['cepaestipes']

Figure 7

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′18″N, 074°11′10″W; 20 m alt.; 12.VI.2019; J. Luna-Fontalvo et al. leg.; JL, AB & CA 013; CBUMAG:FUN:6.

Identification. Pileus convex to flat, slightly depressed in mature specimens; 20–30 mm in diameter; white, with a round scale in the center in some specimens, maize-yellow; surface floccose and striated towards the margin, entire edge, straight margin to raised (Fig. 7A). Lamellae white, free, tight, with smooth edge and lamellae (Fig. 7B). Stipe concolorous with hymenium, 40–50 × 3–4 mm, floccose; annulus fleeting, intermediate, membranous, fibular, ascending, with crenate border (Fig. 7C-E). Trama white, soft, and sticky.

Basidiospores hyaline, 5.7–7. × 3.6–4.5 µm (X = 6.3 ± 0.3642 × 4 ± 0.2477; Q = 1.54 ± 0.094; *n* = 40/4), ellipsoid, smooth, with thick wall and germ pore (Fig. 7F). Basidia 27.7–36.4 × 7.8–9.4 µm, hyaline, claviform, tetrasporic, with thin wall, lacking a basal clamp (Fig. 7G). Pleurocystidia not observed. Cheilocystidia 52–78 × 12–15 µm, hyaline, with smooth and thin wall, polymorphic, spiked, ventricose, fusiform, langeriform, and some rostrate (Fig. 7H).

Taxonomic remarks. *Leucocoprinus cepistipes* is characterized by a white basidiocarp covered by cottony scales, which give it a floccose appearance, and a pileus with a plicate-striated margin. Microscopically it presents ellipsoid, oblong basidiospores, with a conspicuous germ pore (Vellinga 2001). Our material agrees with that presented by Rother and Silveira (2009b), in having basidiospores 8.5–10 × 6–7 µm, Q = 1–1.8, basidia 19–24

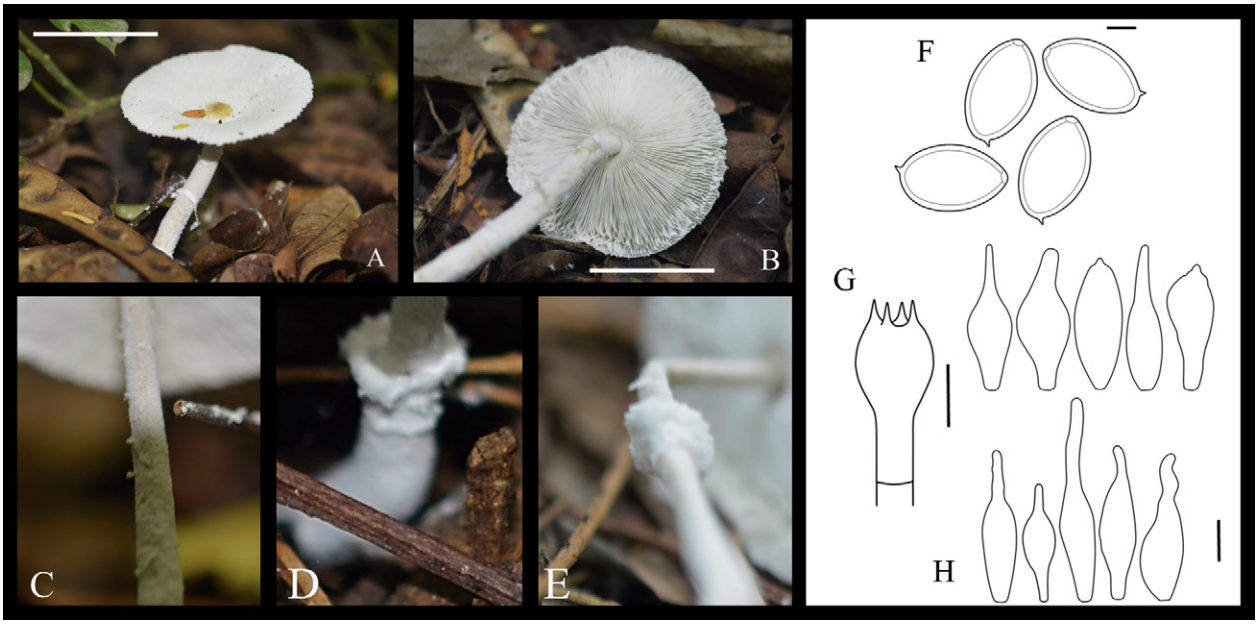

Figure 7. Basidiomata and microscopic structures of *Leucocoprinus cepistipes* (JL, AB & CA 013). **A.** Lateral view of the pileus. **B.** Details of the hymenium. **C.** Stipe details. **D, E.** Annulus details. **F.** Spores. **G.** Basidia. **H.** Cheilocystidia. Scale bars: A, B = 2 cm; F = 10 µm; G, H = 20 µm.

× 9–10 µm, pleurocystidia absent, and cheilocystidia 52–78 × 12 –15, differentiated by slightly smaller spores and slightly larger basidia.

Habitat and distribution. A terrestrial species, scattered, on litter, in a tropical dry forest fragment. Collected in the dry season. Our record is the first from the Colombian Caribbean. This species was previously recorded from Antioquia and Meta departments at 750 m alt. (Franco -Molano et al. 2010). *Leucocoprinus cepistipes* has a pantropical distribution, and in America, it has been recorded in Mexico (Guzmán 1983; de la Fuente et al. 2020), the Lesser Antilles, Martinique, Dominica, Antigua, Trinidad, Jamaica, and the Bahamas (Pegler 1983), Argentina (Campi et al. 2015), Brazil (Rother and da Silveira 2009b), and Paraguay (Campi et al. 2015).

***Leucocoprinus venezuelanus* Dennis**

Figure 8

Material examined. COLOMBIA – **Magdalena** • Santa Marta, Universidad del Magdalena; 11°13′31″N, 074°11′04″W; 21 m alt.; 1.X.2019; J. Luna-Fontalvo et al. leg.; JL, AB & CA 041; CBUMAG:FUN:7.

Identification. Pileus convex to flat, 40–50 mm in diameter, white with cognac-colored scales, fragmented radially towards the edges; striated translucent surface, with straight margin, raised in mature specimens and torn edge (Fig. 8A, B). Lamellae white, free, tight, with a slightly crenate edge and lamellulae (Fig. 8C). Stipe concolorous with hymenium, 52–60 × 5–6 mm, central, hollow and clavate; annulus intermediate, white, and with tiny scales cognac-colored adhered to the margin (Fig. 8C). Trama white and thin.

Basidiospores hyaline, 6.2– 8.4 × 3.7– 5.3 µm (X = 7.2 ± 0.50 × 4.7 ± 0.37; Q = 1.53 ± 0.16; *n* = 40/2), ellipsoids and smooth; germ pore absent (Fig. 8D). Basidia 19.07–25.23 × 7.9–10.72 µm, hyaline, claviform, tetrasporic, and with granular contents (Fig. 8E). Pleurocystidia not observed. Cheilocystidia 26.–32.9 × 10–15 µm, hyaline, fusiform to claviform (Fig. 8F).

Taxonomic remarks. *Leucocoprinus venezuelanus* was originally described by Dennis (1961). Our material matches with the descriptions of this species by Pegler (1983), but with a slight difference in the size of the cheilocystidia. *Leucocoprinus venezuelanus* usually resembles *L. brebissonni* in basidiome morphology, but the former species is differentiated by the presence of brown scales on the annulus margin and by the size of the basidiospores (Plegler 1983; Kumar and Manimohan 2009). *Leucocoprinus submontagnei* also resembles *L. venezuelanus*, but it differs in having brown scales and spores that are slightly smaller, no germ pores, and vermiform cheilocystidia (Deepa et al. 2006).

Habitat and distribution. A terrestrial species, scattered and gregarious, on litter. Collected during the rainy season. This species has a wide distribution, and it has been recorded in Caquetá department, Colombia (Sánchez 2003), the Lesser Antilles (Plegler 1983), Brazil (Karstedt and Stürmer 2008), and Venezuela (Dennis 1961).

Discussion

Seven species of Agaricaceae are newly recorded from the Colombian Caribbean, which brings the number of species to 39 for this region and 551 for Colombia. Two species, *Leucoagaricus lilaceus*, and *L. roseilividus*, are reported from Colombia for the first time. The area studied in Santa Marta city is extremely small, and

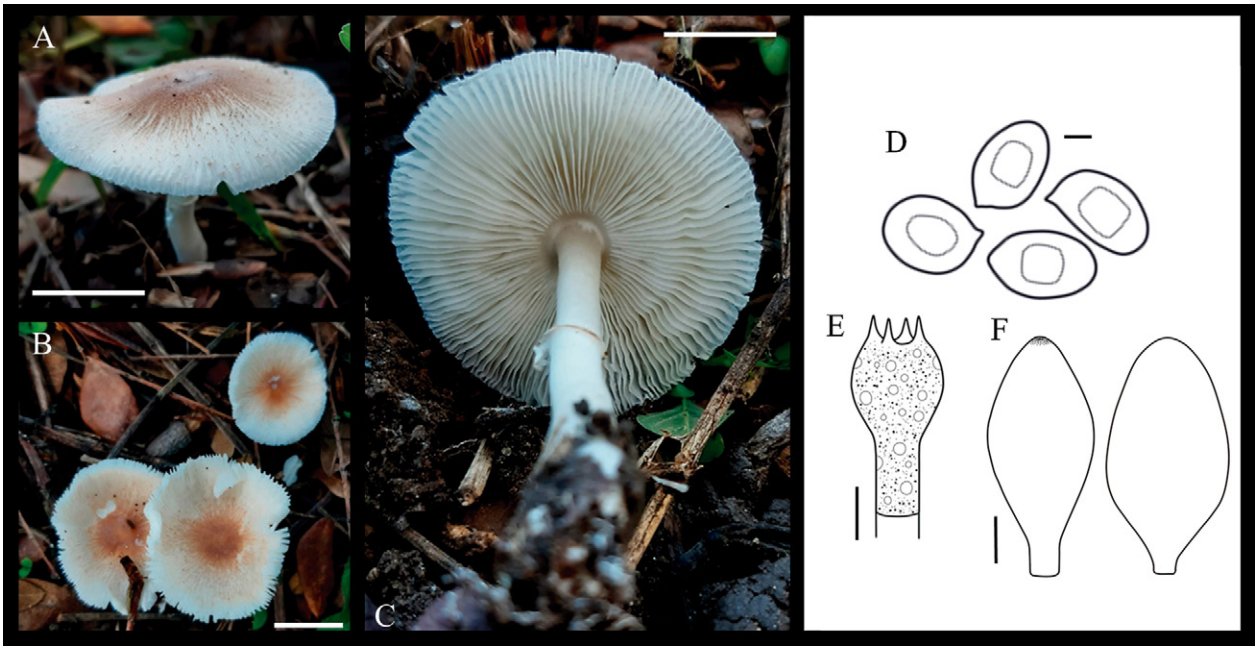

Figure 8. Basidiomata and microscopic structures of *Leucocoprinus venezuelanus* (JL, AB & CA 041). **A.** Scales of the pileus. **B.** Apical view of the pileus. **C.** Details of the hymenium and stipe. **D.** Spores. **E.** Basidia. **F.** Cheilocystidia. Scale bars: A–C = 2 cm; D =10 µm; E, F = 20 µm.

there are still large unexplored areas. In the last 40 years, macro-fungi studies have been concentrated mainly in the Andean region, with 83% of the species from that region and only 6% from the Caribbean region (Pulido 1983; Pineda et al. 1988; Franco-Molano and Uribe-Calle 2000; Franco-Molano et al. 2010; Vasco-Palacios et al. 2013; Palacio et al. 2015; Lombana et al. 2016; Putzke et al. 2020). Therefore, we provide an important contribution to the inventory of Agaricales of the Caribbean Plain biogeographic region where the fungi diversity is high and almost unexplored.

The tropical dry forest exhibits water stress, high luminosity, and high temperatures during some months of the year, in addition to characteristic acidic and nutrient-poor soils. These forests do not have very suitable conditions for many macro-fungi. However, fallen leaves create abundant leaf litter which forms, together with components of the soil, a rich organic substrate and provides a microclimate with appropriate conditions of humidity and temperature that favor the fruiting of fungi (Dix and Webster 1995; Palacio et al. 2015). These conditions are present in the permanent parcel of dry forest at the Universidad del Magdalena (Barranco Pérez et al. 2019).

Mycological studies in dry forests of the tropics are very few, and the sparse data available do not allow for determining with certainty the diversity of fungi in these forests (Palacio et al. 2015). Although our contribution adds important new data on the high biodiversity of macro-fungi in these ecosystems, there is too little information available to make meaningful comparisons. Inventories and long-term monitoring, supplemented with molecular tools, are necessary to expand our knowledge of fungi in tropical dry forests.

According to Rangel-Ch. (2015), of the extra-Andean regions, the Caribbean region is the most biodiverse, but this estimate considered flowering plants, ferns and bryophytes, amphibians, reptiles, mammals, and lichens, but not macro-fungi. This was probably due to a lack of exploration or expert taxonomists in the field. Therefore, more study of macro-fungi in the Caribbean region is needed to better determine the biodiversity of Colombia, evaluate the importance of macro-fungi in ecosystem services, and work towards their conservation.

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