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Macrofungi from a Sub-Andean forest in Santander, Colombia

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Abstract: An inventory was conducted in a Sub-Andean forest in the upper basin of the Chucurí River, in the municipality of San Vicente de Chucurí (Santander, Colombia), located in the area of influence of the Serranía de los Yariguíes National Natural Park, the best-preserved remnant of Andean forest in the region. Macrofungi samples were collected in a relict of mixed forest dominated by Andean oaks (*Quercus humboldtii*) and an agroforestry farm on July, October, and November 2023. An opportunistic sampling was used and the samples were identified using morphological features and specialized literature. A total of 86 samples were collected, of which 58 were determined to the species level and 28 to genus level. Two new records of the order Agaricales are recordered for Colombia: *Bovista oblongispora* (Lycoperdaceae) and *Pleurotus albidus* (Pleurotaceae). Likewise, 35 new records are reported for the department of Santander. Based on identifications and literature, 15 species are potentially edible, four have medicinal properties, and one exhibits hallucinogenic effects. A photographic record of the identified species is provided. This is the first study of the macrofungal communities in the municipality on San Vicente de Chucurí and contributes to the knowledge and management of the fungal diversity of Santander department.

Keywords: Ascomycota, Basidiomycota, Eastern Cordillera, Inventory, Serranía de los Yariguíes

Introduction

Mushrooms belong to the kingdom Fungi, a group of heterotrophic eukaryotic organisms with cell walls containing chitin (Garcés de Granada et al. 2003). They obtain nutrients by absorption, through the degradation of organic compounds via exoenzymes (Cepero de García et al. 2012) and are vital for ecosystem integrity and functioning.

These organisms are cosmopolitan, with an estimated global diversity of 2.2 to 3.8 million species (Hawksworth and Lücking 2017), of which over 205000 names are currently accepted according to Species Fungorum (2026). Within this kingdom, macrofungi form an artificial group distinguished by the production of visible structures for sexual reproduction, commonly known as mushrooms. Most macrofungi species belong to the divisions Ascomycota and Basidiomycota, with an estimated global diversity ranging from 53000 to 110000 species (Mueller et al. 2007).

The Fungi kingdom provides direct services that translate into benefits for humans, including multiple medicinal and biotechnological applications (Maldonado and Ibarra 2006; Vargas et al. 2022). There are also edible species that constitute a non-timber forest resource of great importance for local communities, since they represent a food source and an alternative economic income for them (Pérez-Moreno 2012).

The department of Santander is in the northeast of Colombia, on the Eastern Cordillera and has an area of 30537 Km^2 (DANE 2024). It presents important biogeographic units including the valley and plains of the Magdalena River in the Magdalena Medio region, the dry and xerophytic forest ecosystem from the Cañón del Chicamocha, and the high-Andean and Páramo ecosystem (Guerrero et al. 2022). The Serranía de los Yariguíes National Natural Park (N.N.P.) encompasses the best-preserved and largest proportion of Andean forest remnant in the department (Donegan and Huertas 2005). The municipality of San Vicente de Chucurí is located to the west of the department, with an area of 1195 Km^2, and is adjacent to the northwestern boundary of the Serranía de los Yariguíes N.N.P. (Alcaldía Municipal San Vicente de Chucurí 2024).

Nowadays, Colombia has approximately 7619 registered fungal species (Charria-Girón et al. 2023). Most studies and inventories of macrofungal diversity have been carried out in the Andean region, especially in the departments of Antioquia, Cundinamarca, and Valle del Cauca (Gómez-Montoya et al. 2022). In Santander, there have been previous fungal inventories carried out in the municipalities of El Peñón and El Carmen de Chucurí by the Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt (IAvH 2017, 2019). As a result, the department records 66 species of the Basidiomycota mushrooms (Gómez-Montoya et al. 2022) and six species of non-lichenized macro-Ascomycota (Vasco-Palacios and Franco-Molano 2013), indicating the limited knowledge for these groups in this region of Colombia.

To document the diversity of Ascomycota and Basidiomycota macrofungi in a sub-Andean Forest and an agroforestry farm, this study presents an inventory detailing its funga and potential uses, contributing to the mycological knowledge of Santander.

Materials and methods

Study area

This study was carried out in two vegetation coverages of the vereda Pamplona, located in the upper basin of the Chucurí River, at the municipality of San Vicente de Chucurí, with coordinates: 6°45'6.264"N, 73°26'0.491" O and 6°43'45.552" N, 73°25'35.256" O (Fig. 1). These covers are located at the agroforestry farm called La Siberia, with coffee and cocoa crops and a relict of sub-Andean Forest (Holdridge 1978) with the presence of Andean oak *Quercus humboldtii* Bonpl. (Fagaceae), *Miconia* spp. (Melastomataceae), and *Cyathea* spp. (Cyatheaceae). According to the local population, this forest has been in regeneration for 30 years. The sampling site shares a boundary with the northwestern of the Serranía de los Yariguíes N.N.P. and comprises an approximate area of 200 hectares between 1200 and 2000 m (Fig. 2). The highest humidity months are May and October, and the months with the least rainfall are December and January, with minimum temperatures of 18.04°C and maximum temperatures of 25.08°C (Moreno and Tinjaca 2018).

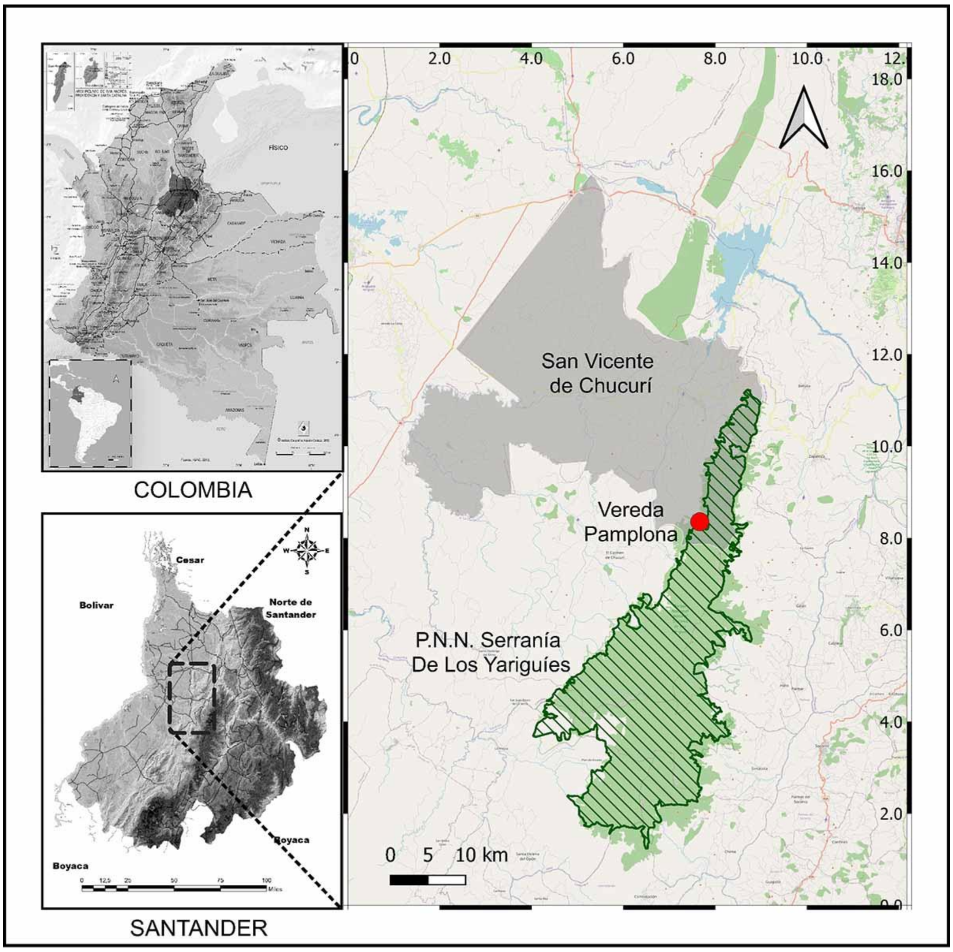

Figure 1. Study area. The red spot indicates the sampling area. The area highlighted in green represents the Serranía de los Yariguíes N.N.P. The area in grey delimits the municipality of San Vicente de Chucurí. Modified from Gobernación de Santander (2024); IGAC (2024).

Collection and determination of fungal samples

Mushroom samples were collected by opportunistic sampling (O'Dell et al. 2004; Palacio et al. 2015). Three field trips of one week each were carried out in July, October, and November of 2023. Each sampling day encompassed four hours of walking along a rural trail of approximately 1.5 Km, sampling three meters on each side of the route. Additionally, the main vegetation coverages were determined by collecting samples of the dominant tree species (Villareal et al. 2004) and those possibly associated with the collected fungal samples. All the specimens were photographed and georeferenced in the field. Then, at the base camp, the spore print was obtained, and the specimens were described macroscopically. Later, the specimens were dehydrated at 50°C following the methodology of O'Dell et al. (2004), and Franco-Molano et al. (2005). The dehydrated samples were transported, catalogued and deposited in the macrofungi collection of the Herbarium of the Universidad Industrial de Santander (UIS). For the microscopic analyses of the different morphological groups a Zeiss Axiolab 5 optical microscope (Jena, Germany) was used following the recommendations of Largent et al. (1977), Miller and Miller (1988), Ryvarden (2004), using water, Ethanol, Congo Red, 3% Potassium Hydroxide (KOH), and Melzer's reagent for the observation and measurements of the microscopic structures, including of 25 spores per sample.

Dichotomous keys, specialized literature on the different morphological groups collected, and FUNGuild (Nguyen et al. 2016), ColFungi (2024), Index Fungorum (2024), and Species Fungorum (2025) databases were used for the taxonomic determination and ecological features. Additionally, uses of the determined species were indicated from a review of specialized literature (Boa 2005; Correa et al. 2005; Maldonado and Ibarra 2006; Moreno-Fuentes and Bautista-Nava 2006; Dávila-Arenas et al. 2013; Jiménez-Zárate et al. 2020; Silva et al. 2020). Finally, the current nomenclature name of the identifications was verified and updated following Species Fungorum (2025) (Table 1).

Figure 2. Sampling area. A: Chucurí River; B: Agroforestry farm La Siberia (at the background the Serranía de los Yariguíes N.N.P.); C-D: Mixed Andean oak forest.

Table 1. List of fungal species recorded in a mixed Andean oak forest and an agroforestry farm from municipality of San Vicente de Chucurí, Santander, arranged by taxonomic category and in alphabetical order.

Taxonomic Category	Substrate	Vegetation cover	Trophic mode	Uses	Collection
ASCOMYCOTA					
Pezizales					
Sarcoscyphaceae					
Cookeina tricholoma (Mont.) Kuntze *	Dw	Af	S	E	AMD21 (UIS)
Phillipsia domingensis (Berk.) Berk. ex Denison *	Dw	Af	S	E, M	AMD102 (UIS)
Xylariales					
Xylariaceae					
Xylaria hypoxylon (L.) Grev.	Dw	Af	S	U	AMD91 (UIS)
Xylaria obovata (Berk.) Berk. *	Dw	Af	S	U	AMD90 (UIS)
Xylaria polymorpha (Pers.) Grev. *	Dw	Oak, Af	S	U	AMD36 (UIS)
Xylaria telfairii (Berk.) Sacc.	Dw	Oak	S	U	AMD62 (UIS)
BASIDIOMYCOTA					
Agaricales					
Agaricaceae					
Agaricus cf. *dennisii* Heinem. *	Ll	Oak	S	U	AMD92 (UIS)
Agaricus sp.	Ll	Oak	-	-	AMD67 (UIS)
Cyathus striatus Willd. *	Dw	Oak, Af	S	U	AMD106 (UIS)
Lepiota sp.1	S	Af	-	-	AMD83 (UIS)
Lepiota sp.2	S	Oak	-	-	AMD08 (UIS)
Leucocoprinus fragilissimus (Ravenel ex Berk. & M.A. Curtis) Pat. *	Ll	Oak	S	U	AMD37 (UIS)
Amanitaceae					
Amanita sp.	S	Oak	Ec	-	AMD98 (UIS)
Cortinariaceae					
Cortinarius cf. *boyacensis* Singer	Ll	Oak	Ec	U	AMD100 (UIS)
Cortinarius iodes Berk. & M.A. Curtis	Ll	Oak	Ec	U	AMD11 (UIS)
Cortinarius sp. 1	Ll	Oak	Ec	-	AMD27 (UIS)
Cortinarius sp. 2	Ll	Oak	Ec	-	AMD99 (UIS)
Cortinarius violaceus (L.) Gray *	Ll	Oak	Ec	Cp	AMD97 (UIS)
Entolomataceae					
Calliderma sp.	M	Oak	-	-	AMD93 (UIS)
Entoloma sp.1	Ll	Oak	-	-	AMD104 (UIS)
Entoloma sp.2	Ll	Oak	-	-	AMD34 (UIS)

Entoloma sp.3	S	Oak	-	-	AMD87 (UIS)
Entoloma sp.4	Ll	Oak	-	-	AMD44 (UIS)
Hygrophoraceae					
Hygrocybe occidentalis var. *scarletina* Pegler & Fiard. *	S	Af	S	U	AMD82 (UIS)
Hygrocybe sp.	Ll	Oak	-	-	AMD10 (UIS)
Hygrophorus sp.	S	Af	-	-	AMD84 (UIS)
Hymenogastraceae					
Gymnopilus junonius (Fr.) P.D. Orton *	S	Af	S	Cp	AMD57 (UIS)
Gymnopilus lepidotus Hesler. *	S	Af	S	U	AMD31 (UIS)
Psilocybe zapotecorum R. Heim. *	S	Af	S	H	AMD38 (UIS)
Psilocybe sp.1	S	Af	-	-	AMD94 (UIS)
Psilocybe sp.2	S	Af	-	-	AMD40 (UIS)
Lycoperdaceae					
Bovista oblongispora (Lloyd) Bottomley **	S	Oak	S	U	AMD69 (UIS)
Calvatia rugosa (Berk. & M.A. Curtis) D.A. Reid.	S	Af	S	U	AMD48 (UIS)
Lycoperdon fuligineum Berk. & M.A. Curtis. *	Dw	Oak	S	U	AMD51 (UIS)
Marasmiaceae					
Clitocybula azurea Singer *	Dw	Oak	S	U	AMD41 (UIS)
Clitocybula sp.	Dw	Oak	-	-	AMD15 (UIS)
Marasmius sp.	S	Oak	-	-	AMD33 (UIS)
Mycenaceae					
Hydropus irroratus (Pat.) Singer *	Dw	Oak	S	U	AMD103 (UIS)
Mycena holoporphyra (Berk. & M.A. Curtis) Singer *	Ll	Oak	S	U	AMD49 (UIS)
Mycena plectophylla (Mont.) Dennis *	Dw	Af	S	U	AMD72 (UIS)
Mycena cf. *carminis* Singer	Dw	Oak	S	U	AMD133 (UIS)
Omphalotaceae					
Gymnopus sp.	Ll	Oak	-	-	AMD86 (UIS)
Physalacriaceae					
Oudemansiella platensis (Speg.) Speg. *	Dw	Oak	S	U	AMD53 (UIS)
Pleurotaceae					
Pleurotus albidus (Berk.) Pegler **	Dw	Oak	S	E	AMD58 (UIS)
Pleurotus cf. *flabellatus* Sacc. *	Dw	Af	S	U	AMD85 (UIS)
Pluteaceae					
Volvariella bombycina (Schaeff.) Singer. *	Lt, Dw	Af	S	E	AMD70 (UIS)
Porotheleaceae					
Gerronema sp.	Dw	Af	-	-	AMD78 (UIS)
Psathyrellaceae					
Psathyrella sp.	S	Af	S	U	AMD39 (UIS)

Schizophyllaceae					
Schizophyllum commune Fr.	Dw	Af	S	E	AMD135 (UIS)
Strophariaceae					
Hypholoma sp.	Dw	Oak	-	-	AMD65 (UIS)
Kuehneromyces cf. *mutabilis* (Schaeff.) Singer & A.H. Sm.	M	Oak	S	E	AMD105 (UIS)
Stropharia sp.	Dw	Oak	-	-	AMD68 (UIS)
Auriculariales					
Auriculariaceae					
Auricularia delicata (Mont. ex Fr.) Henn.	Dw	Oak, Af	S	E	AMD89 (UIS)
Auricularia fuscosuccinea (Mont.) Henn.	Dw	Oak, Af	S	E	AMD79 (UIS)
Auricularia nigricans (Sw.) Birkebak, Looney & Sánchez-García. *	Dw	Af	S	E	AMD81 (UIS)
Boletales					
Boletaceae					
Boletellus ananas (M.A. Curtis) Murrill. *	Lt, Dw	Oak	Ec	U	AMD52 (UIS)
Boletellus sp.	Ll	Oak	Ec	-	AMD54 (UIS)
Phylloporus centroamericanus Singer & L.D. Gómez. *	Lt	Oak	Ec	U	AMD101 (UIS)
Xerocomus subtomentosus (L.) Quél. *	Ll	Oak	Ec	E	AMD64 (UIS)
Boletinellaceae					
Phlebopus cf. *beniensis* (Singer & Digilio) Heinem. & Rammeloo *	S	Af	-	U	AMD137 (UIS)
Dacrymycetales					
Dacrymycetaceae					
Dacrymyces spathularia (Schwein.) Alvarenga *	Dw	Oak	S	E	AMD46 (UIS)
Dacryopinax martinii Lowy. *	Dw	Oak	S	U	AMD55 (UIS)
Hymenochaetales					
Hymenochaetaceae					
Hymenochaete iodina (Mont.) Baltazar & Gibertoni	Dw	Oak	S	U	AMD28 (UIS)
Polyporales					
Irpicaceae					
Flavodon flavus (Klotzsch) Ryvarden. *	Dw	Af	S	U	AMD80 (UIS)
Meripilaceae					
Rigidoporus microporus (Sw.) Overeem	Dw	Oak	S	U	AMD95 (UIS)
Rigidoporus sp. 1	Dw	Af	-	-	AMD18 (UIS)
Rigidoporus sp. 2	Dw	Oak	-	-	AMD43 (UIS)
Panaceae					
Cymatoderma caperatum (Berk. & Mont.) D.A. Reid	Dw	Oak, Af	S	U	AMD19 (UIS)
Panus strigellus (Berk.) Chardón & Toro	Dw	Af	S	U	AMD138 (UIS)
Polyporaceae					
Amauroderma sp.1	S	Oak	-	-	AMD30 (UIS)

Amauroderma sp.2	S	Oak	-	-	AMD09 (UIS)
Amauroderma sp.3	Dw	Af	-	-	AMD71 (UIS)
Cerioporus flavus (Sw.) Zmitr. *	Dw	Oak	S	U	AMD59 (UIS)
Earliella cf. *scabrosa* (Pers.) Gilb. & Ryvarden *	Dw	Af	S	U	AMD75 (UIS)
Fabisporus sanguineus (L.) Zmitr.	Dw	Af	S	M,Cp	AMD06 (UIS)
Favolus tenuiculus P. Beauv. *	Dw	Oak	S	E	AMD29 (UIS)
Fomitella supina (Sw.) Murrill	Dw	Af	S	U	AMD77 (UIS)
Ganoderma cf. *amazonense* Weir	Lt	Oak	S	U	AMD35 (UIS)
Ganoderma applanatum (Pers.) Pat.	Dw	Oak, Af	S	M,Cp	AMD74 (UIS)
Lentinus crinitus (L.) Fr.	Dw	Af	S	E	AMD25 (UIS)
Lentinus cf. *substrictus* (Bolton) Zmitr. & Kovalenko	Dw	Af	S	U	AMD73 (UIS)
Polyporus guianensis Mont. *	Dw	Oak	S	U	AMD56 (UIS)
Trametes elegans (Spreng.) Fr.	Dw	Af	S	M,E	AMD32 (UIS)
Russulales					
Russulaceae					
Russula cf. *emetica* (Schaeff.) Pers.	Ll	Oak	Ec	E	AMD50 (UIS)
Russula cf. *humboldtii* Singer *	Ll	Oak	Ec	U	AMD60 (UIS)
Stereaceae					
Stereum cf. *gausapatum* (Fr.) Fr. *	Lt	Oak	S	U	AMD134 (UIS)

* Abbreviations: Substrate (Lt: Living tree; Dw: Decaying wood; S: Soil; Ll: Leaf litter; M: Mosses), Vegetation cover (Oak: Oak forest; Af: Agroforestry farm), Trophic mode (Ec: Ectomycorrhizal; S: Saprobic), Uses (E: Edible; H: Hallucinogen; M: Medicinal; B: Biotechnology, Cp: Coloring pigments and U: Unknown), Collection: (UIS: Herbario Universidad Industrial de Santander). The new records are indicated by a * and ** for Santander and Colombia respectively.

Results

A total of 86 specimens were collected, of which 58 were determined to species and 28 to genus level. The best-represented division was Basidiomycota with 80 samples and 52 species distributed in seven orders: Agaricales (46 species), Polyporales (20), Boletales (5), Auriculariales (3), Russulales (3), Dacrymycetales (2), and Hymenochaetales (1). The collected specimens belong to 28 families and 53 genera. The most diverse genus were *Cortinarius* (5), *Entoloma* (4), *Mycena* (3), and *Auricularia* (3). On the other hand, Ascomycota was the least represented division, with two families, three genera and six species. The order with the largest number of species was Xylariales (4), while the order Pezizales had two species. Whitin these orders, the most diverse family was Xylariaceae with the genus *Xylaria* (4). The most common substrates for both divisions were decaying wood, leaf litter, and soil, followed by live trees and mosses in smaller proportion. In terms of trophic mode, 12 ectomycorrhizal (EcM) and 50 saprobic morpho-species were identified between Ascomycota and Basidiomycota (Table 1).

The vegetation cover with the highest number of species was the mixed Andean oak forest with 54 samples, where the most frequent species were *Cortinarius iodes*, *C. violaceus*, *Boletellus ananas*, *Russula* cf. *emetica*, *Russula* cf. *humboldtii*, *Auricularia delicata*, and *Xylaria polymorpha*. The agroforestry farm had 32 samples collected into coffee and cocoa crops. The most frequent species were *Cookeina tricholoma*, *Phillipsia domingensis*, *Fabisporus sanguineus*, *Lentinus crinitus*, *Auricularia fuscosuccinea*, *Ganoderma applanatum*, and *Trametes elegans*. Species like *Auricularia delicata*, *A. fuscosuccinea*, *Ganoderma applanatum*, *Cymatoderma caperatum*, *Xylaria polymorpha*, and *Cyathus striatus* were observed in both types of coverage (Table 1).

Among the identified species, two new records of the order Agaricales are proposed for Colombia: *Bovista oblongispora* and *Pleurotus albidus*, and 35 species are listed as new records for the department of Santander, including four Ascomycota and 31 Basidiomycota (Table 1).

Based on identifications and literature, 15 species are potentially edible, four have medicinal properties, four with the potential to extract pigments for dyeing fibers and textiles of natural origin, and one exhibits hallucinogenic effects (Table 1). From the mentioned species, we provide photographs of the new records for Colombia (Figs. 3-4). In addition, photographs of the recorder specimens are provided in Figs. 5 to 9.

Two new records (Agaricales) for Colombia

Bovista oblongispora (Lloyd) Bottomley, Bothalia 4(3): 580 (1948). *Bovistella oblongispora* Lloyd, Mycol. Writ. 5 (45): 632 (1917). Type: South Africa**,** Stellenbosch, *A.V. Duthie* (K-M000837084).

Basidiomes epigeous, globose to subglobose, up to 2 cm diam. Exoperidium dark brown at the top, fading to light beige towards the base, smooth or with tiny whitish warts and grouped as small crystals around the ostiole. Endoperidium thin, ochraceus, up to 1 mm thick, base up to 2 mm length and 6 mm width. White mycelial cords present. Compact gleba, pale yellow to olive-brown at maturity. Columella absent. Spore print olive brown. Basidiospores 4.9-6.5 × 2.8-3.8 µm (Q=1.8), n=25, ellipsoid, pale yellow in water and KOH solution, dextrinoid; thick and apparently smooth walled under the optical microscope; pedicels up to 1.7 µm long and always present. Paracapillitium absent; capillitium type-intermediate, without septa and moderately branched, 2 to 5 µm wide, including the cell wall; dark amber to brown in Melzer's reagent; capillitium pores absent or scarce and isolated (Fig. 3).

Habitat and distribution: Growing scattered to gregarious on soil and open areas on rural path in mixed Andean oak forest. *B. oblongispora* occurs in Mexico in cloud forest at 1300 m altitude (Bautista-Hernández et al. 2012).

Material examined: COLOMBIA, department of Santander, municipality of San Vicente de Chucurí, vereda Pamplona, 6°44'21.804" N, 73°25'42.96" O, 1564 m, 21.X.2023, *A. Martínez and D. Sanín 69* (UIS-22900).

Taxonomic notes: one of the diagnostic characters of *Bovista oblongispora* are its ellipsoidal spores, a character that can be useful to differentiate it from other morphologically similar species within the genera *Bovista* and *Lycoperdon*, which mostly have globose to subglobose spores (Dennis 1953; Miller and Miller 1988; Ortega and Buendía 1985). The characters of the collected specimen correspond with the protologue and the descriptions of Bottomley (1948), Dennis (1953), Ortega and Buendía (1985) for the species *B. oblongispora*. However, De Villiers et al. (1989) and Bautista-Hernández et al. (2012) mention spores with verrucous ornamentation observed under the scanning electron microscope, a character that was not possible to see in optical microscopy, likewise, they report pedicels greater than 2 µm, while in the reviewed material these do not exceed 1.7 µm. On the other hand, Salinas-Rodríguez et al. (2018) mention the presence of white mycelial cords, which corresponds to the reviewed material.

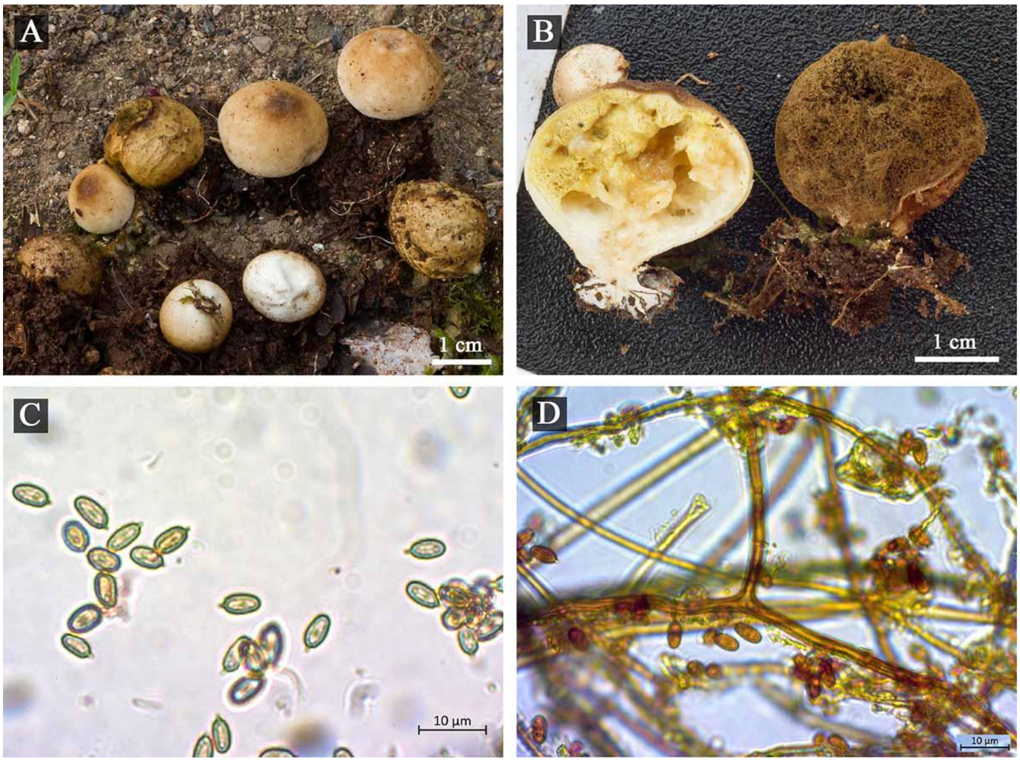

Figure 3. *Bovista oblongispora*. A: Basidiocarps; B: Immature gleba (left) and mature gleba (right); C: Basidiospores; D: Capillitium threads and basidiospores in Melzer's reagent.

Pleurotus albidus (Berk.) Pegler, Kew Bull., Addit. Ser. 10: 219 (1983). *Lentinus albidus* Berk., London J. Bot. 2: 633 (1843). *Pocillaria albida* (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 865 (1891). Type: Brazil, Minas Gerais, Pico do Inficionado, *G. Gardner* (K-M000039315).

Basidiomes omphalioid, clitocyboid to pleurotoid. Píleus convex, flat to infundibuliform in maturity, up to 8 cm diam., surface white to cream, higrophanous, glabrous and dry; margin incurved, slightly sulcate, edge entire to crenate. Basidiocarp light yellow after drying. Pale olive-green KOH reaction on pileus. Context homogeneous, white to cream, up to 0.5 cm thick, unchanging. Lamellae light cream, deeply decurrent and close, arched to segmentiform with smooth to finely crenate lamellae-edge, lamellulae of different lengths. Stipe up to 8 × 0.8 cm, eccentric, usually curved-ascendant; cylindric and solid, surface white, glabrous, dull and sulcate, slightly expanded towards the base and basal mycelium white. Spore prints no obtained. Basidiospores 6.2-8.4 × 2.8-3.9 µm (Q=2.1), n=25, cylindrical to subfusiform, hyaline in water and KOH solution, inamyloid; smooth and thin walled. Hymenophoral trama irregular. Pleurocystidia not seen. Cheilocystidia 16-18 × 4-5 µm, cylindric, flexuous to claviform with a rounded apex, hyaline, smooth and thin walled. Pileipellis a cutis with somewhat intertwined hyaline hyphae, septa and clamp-connexions present (Fig. 4).

Habitat and distribution: Growing gregarious and cespitose, forming numerous colonies on standing dead trunks on mixed Andean oak forest. In South America, the species has been reported from Argentina, Brazil, Panama, and Paraguay (Lechner et al. 2004; Guzmán and Piepenbring 2011; Flecha Rivas et al. 2014; Menolli Jr et al. 2014).

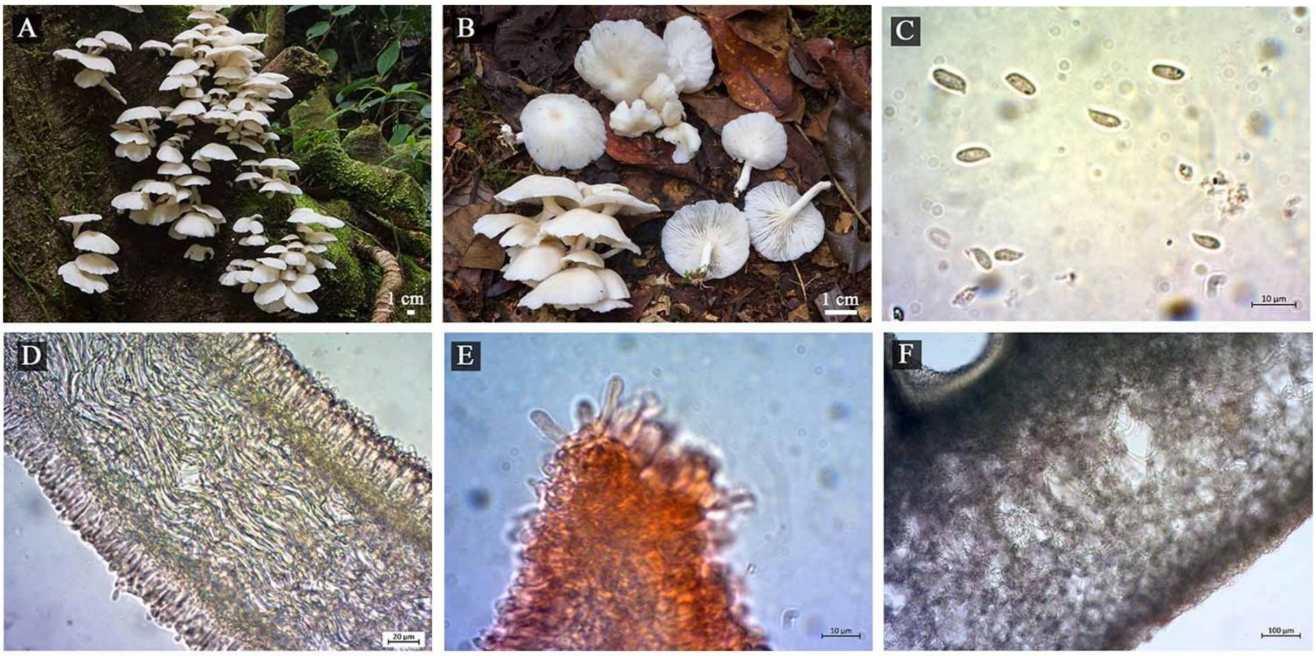

Figure 4. *Pleurotus albidus*. A-B: Basidiocarps; C: Basidiospores; D: Hymenophoral trama; E: Cheilocystidia; F: Pileipellis.

Material examined: COLOMBIA, department of Santander, municipality of San Vicente de Chucurí, vereda Pamplona, 6°44'18.42"N, 73°25'40.584"O, 1544 m, 21.X.2023, *A. Martínez and D. Sanín 58* (UIS-22890).

Taxonomic notes: the material examined is consistent with the protologue and descriptions of Lechner et al. (2004), Moreno-Fuentes and Bautista-Nava (2006), however, these authors report the absence of cystidia, while the material reviewed presents cheilocystidia. In turn, the light yellow color in dehydrated basidiome and the presence of cheilocystidia corresponds to that reported by Flecha Rivas et al. (2014). *Pleurotus albidus* is listed as a species of traditional edible use in Mexico and is known as "Hongo blanco patón" (Moreno-Fuentes and Bautista-Nava, 2006).

Discussion

This is the first study of macrofungi diversity in the municipality of San Vicente de Chucurí, Santander. The best represented division was Basidiomycota with 93% of the total collected, where the most diverse orders were Agaricales and Polyporales (Table 1). This is congruent with Franco-Molano et al. (2010), Sierra-Toro et al. (2011) for montane forests of the Colombian Andean region. Within this division, *Cortinarius* and *Entoloma* were the most diverse genera. These two groups of Agaricales are among the most species-rich in the world, with a distribution ranging from temperate forests to tropical ecosystems (Liimatainen et al. 2022; Noordeloos and Gates 2012). For example, Horak (1978) mentioned that the high diversity of *Entoloma* in conserved forests of South America, becoming even higher and frequent than other genera of Agaricales at certain times of the year. Therefore, it is not surprising that these genera were the most diverse in this study. However, the identification process for these genera was challenging due to the scarce information in the neotropics, as Reschke et al. (2022) stated.

In contrast, Ascomycota was the least represented division, contributing only 7% of the specimens collected. Global studies show that Ascomycota includes more than twice as many described species as Basidiomycota (Wang et al. 2010), nevertheless, most of its species are microscopic organisms. Within Ascomycota, Xylariales was the most diverse order, where the genus *Xylaria* recorded the largest number of species in agreement with López-Quintero et al. (2007), Soto Medina and Bolaños Rojas (2013) for montane forests in Colombia. The high diversity in this group could be explained by their ability to degrade substrates such as cellulose and lignin, abundant components in this type of ecosystems (Rogers 2000).

In terms of trophic modes, and in a general way, saprobic fungi were the most frequent, growing on substrates such as decaying wood, leaf litter, and scarcely on soil. Fifty samples were collected including Ascomycota and Basidiomycota (Table 1). Groups as Polyporales, Agaricales, and Xylariales were the most representative orders. The genera with the most diverse saprobic species were *Entoloma*, *Xylaria*, *Mycena*, and *Auricularia* (Malysheva and Spirin 2017; Nguyen et al. 2016; Noordeloos and Gates 2012; Rogers 2000). This diversity of saprobic species was to be expected, given that forests contribute with a constant accumulation of organic matter forming a humus layer (Dix and Webster 1995).

Figure 5. Fruiting bodies of the Ascomycota and Basidiomycota species recorded in this study: A. *Cookeina tricholoma*; B. *Phillipsia domingensis*; C. *Xylaria hypoxylon*; D. *Xylaria obovata*; E. *Xylaria polymorpha*; F. *Xylaria telfairii*; G. *Agaricus* cf. *dennisii*; H. *Cyathus striatus*; I. *Leucocoprinus fragilissimus*; J. *Cortinarius* cf. *boyacensis*; K. *Cortinarius iodes*; L. *Cortinarius violaceus*. Scale bar: 1 cm.

Figure 6. M. *Hygrocybe occidentalis* var. scarletina; N. *Gymnopilus junonius*; O. *Gymnopilus lepidotus*; P. *Psilocybe zapotecorum*; Q. *Calvatia rugosa*; R. *Lycoperdon fuligineum*; S. *Clitocybula azurea*; T. *Mycena plectophylla*; U. *Hydropus irroratus*; V. *Mycena holoporphyra*; W. *Oudemansiella platensis*; X. *Pleurotus* cf. *flabellatus*. Scale bar: 1 cm.

Figure 7. Y. *Volvariella bombycina*; Z. *Schizophyllum commune*; A1. *Kuehneromyces* cf. *mutabilis*; B1. *Auricularia delicata*; C1. *Auricularia fuscosuccinea*; D1. *Auricularia nigricans*; E1. *Boletellus ananas*; F1. *Phylloporus centroamericanus*; G1. *Xerocomus subtomentosus*; H1. *Phlebopus* cf. *beniensis*; I1. *Dacrymyces spathularia*; J1. *Dacryopinax martinii*. Scale bar: 1 cm.

Figure 8. K1. *Hymenochaete iodina*; L1. *Mycena* cf. *carminis*; M1. *Flavodon flavus*; N1. *Rigidoporus microporus*; O1. *Cymatoderma caperatum*; P1. *Panus strigellus*; Q1. *Cerioporus flavus*; R1. *Earliella* cf. *scabrosa*; S1. *Fabisporus sanguineus*; T1. *Favolus tenuiculus*; U1. *Fomitella supina*; V1. *Ganoderma* cf. *amazonense*. Scale bar: 1 cm.

Figure 9. W1. *Ganoderma applanatum*; X1. *Lentinus crinitus*; Y1. *Lentinus* cf. *substrictus*; Z1. *Polyporus guianensis*; A2. *Trametes elegans*; B2-C2. *Russula* cf. *emetica*; D2. *Russula* cf. *humboldtii*; E2. *Stereum* cf. *gausapatum*. Scale bar: 1 cm.

The agroforestry farm recorded a lower number of samples (32 samples) compared to the Andean oak forest, which suggests that the anthropic intervention for the establishment of crops affects the decrease of fruiting bodies of some species (Pérez-Moreno 2012). Also, the absence of host plant species such as *Quercus* restricts the presence of some ectomycorrhizal macrofungi in this type of vegetation cover (Guzmán and Piepenbring 2011). However, the high frequency of saprobic species such as *Fabisporus sanguineus*, *Cookeina tricholoma*, *Phillipsia domingensis*, *Trametes elegans*, and *Lentinus crinitus* indicates a preference for habitats with considerable levels of disturbance (Guzmán 1994). Nevertheless, longer study periods and more intensive sampling are essential to achieve a more accurate characterization of the funga in these transformed ecosystems.

On the other hand, the Andean oak forest contributed a greater amount of collected samples (54 samples), highlighting 12 ectomycorrhizal (EcM) fungal species. It was expected to obtain a considerable amount of symbiotic species in this type of ecosystems, since these represent an important source of ectomycorrhizal macrofungi associated with the Andean oak *Quercus humboldtii* (Franco-Molano et al. 2010). Specimens from the ectomycorrhizal genera *Amanita*, *Boletellus*, *Cortinarius*, *Phylloporus*, *Russula*, and *Xerocomus* were recorded, consistent with previous reports (Singer 1963; Tedersoo et al. 2010; Trappe 1962; Rinaldi et al. 2008), with *Cortinarius* being the most diverse genus collected in this study (Table 1). Singer (1963) reported the presence of a large number of *Cortinarius* species in montane forests in the neighboring departments of Boyacá and Cundinamarca. Therefore, considering the extension of Andean oak forests along the Eastern Cordillera (Galindo-T. et al. 2003), Santander could also host several species of this and other ectomycorrhizal genera. Nowadays, 19 ectomycorrhizal fungal species have been recorder in Santander associated with *Quercus humboldtii* (Vargas and Restrepo 2020). These findings highlight the importance of this plant species and its habitat for the conservation of macrofungi in Andean forests.

The occurrence of *Cerioporus flavus* (Polyporales) was documented in a transitional zone between oak forest and anthropogenically disturbed areas at an elevation of 1,700 m. This species was previously reported by Gerlach and Loguercio-Leite (2011) in Araucaria forests of Brazil, between 750 and 900 m. Thus, the present record represents a significant upward extension of the known altitudinal range of *C. flavus* in South America.

In regard of direct uses or benefits of macrofungi, there are no known edible species by the local communities in the study area, even though approximately 441 native and non-native useful species have been recorded in Colombia (Gaya et al. 2021). In this study we point out 20 useful species supported by the literature (Table 1). Those species could provide a dietary supplement and a sustainable development alternative for local human population.

The results reveal a high diversity of macrofungi in the region, despite the limited area surveyed and sampling effort. Moreover, the geographical isolation, high potential for endemism, diverse vegetation types, and environmental gradients—such as elevation, climate, and temperature (Donegan and Huertas 2005; Guerrero et al. 2022)—characterizing the Chucurí River watershed and the mountainous areas of the Serranía de los Yariguíes National Natural Park suggest that this area likely harbors a greater number of species. Continued exploration is therefore expected to yield additional records and taxa new to science, thereby contributing to the knowledge base necessary for the sustainable use and conservation of these non-timber forest resources in the region.

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