Six new records of polypores (Agaricomycetes, Basidiomycota) from Southeast Brazil (Atlantic Forest) and perspectives in basic mycological research

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Key words:
- Hymenochaetales
- Mycology
- Polyporales
- Taxonomy
- Tropical America

Abstract

The present study aims to present six new records of polypores from Southeast Brazil (Atlantic Forest): *Fibroporia gossypium*, *Fomitiporia subtilissima*, *Fuscoporia marquesiana*, *Microporellus terrestris*, *Neodictyopus atlanticae* and *Perenniporia brasiliensis*, as well as to discuss perspectives in basic mycological research through contextual analysis of primary and secondary metadata from inventories, monographs and revisions of existing reference collections. Polypores are wood-inhabiting macrofungi with tubular hymenophores. They play a major role in decomposition within terrestrial ecosystems and hold significant importance for humans. The Atlantic Forest, a biodiversity hotspot with high levels of diversity and endemism, is an ideal source for discovering unknown fungi. Thus, our fungal inventory was built from collections made in the natural remnants of the São Paulo Green Belt Biosphere Reserve, which are strategic sites within the Brazilian Atlantic Forest, located in the municipality of Juquitiba, São Paulo state, Brazil. We provide full descriptions, photoplates, illustrations, remarks on geographic distribution, and additional comments for the newly recorded polypores.

Palavras-chave:
- Hymenochaetales
- Mycologia
- Polyporales
- Taxonomia
- America Tropical

Resumo

Este trabalho tem por objetivo apresentar seis novos registros de políporos do sudeste brasileiro (Floresta Atlântica): *Fibroporia gossypium*, *Fomitiporia subtilissima*, *Fuscoporia marquesiana*, *Microporellus terrestris*, *Neodictyopus atlanticae* e *Perenniporia brasiliensis*, assim como discutir perspectivas da pesquisa micológica básica através da análise contextual de metadados primários e secundários de inventários, monografias e coleções físicas existentes. Políporos são macrofungos lignícolas com himenóforos tubulares. Eles desempenham funções cruciais na decomposição dos ecossistemas terrestres e possuem uma importância significativa para os humanos. A Floresta Atlântica, hotspot da biodiversidade com níveis elevados de diversidade e endemismo, é uma fonte ideal para descobertas de fungos desconhecidos. Sendo assim, o inventário dos fungos foi elaborado a partir de coletas em remanescentes naturais da Reserva da Biosfera do Cinturão Verde de São Paulo, que são locais estratégicos da Floresta Atlântica brasileira, situados no município de Juquitiba, estado de São Paulo, Brasil. Além do mais, este artigo provê descrições completas, pranchas fotográficas, ilustrações, informações sobre distribuições geográficas e comentários adicionais para os seis novos registros de políporos.

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Introduction

Polypores are wood-inhabiting macrofungi with tubular hymenophores (Rajchenberg 2011). They play a major role in decomposition within forests (Dighton 2003), and hold significant biological, cultural, and economic importance for humans (Willis *et al.* 2018; Antonelli *et al.* 2020).

Global fungal diversity is estimated in millions of species but only less than 10% of them are scientifically known, *i.e.*, ca. 148,000 spp. (Hawksworth & Lücking 2017; Willis *et al.* 2018). Unknown fungi are emerging primarily from: (1) tropical regions and biodiversity hotspots; (2) little-explored sites and habitats; (3) morphologically and ecologically cryptic species; (4) existing reference collections (Hawksworth & Lücking 2017).

Brazil is one of the richest countries in fungal diversity in Tropical America - ca. 6,320 known spp./ - 200,000 estimated spp. (Lewinsohn & Prado 2002; Maia *et al.* 2015; BFG 2021). Therefore, the number of undetected species shows that Brazilian fungal studies are still far from reaching its census (Maia *et al.* 2015; BFG 2021; Hawksworth & Lücking 2017).

The Atlantic Forest, a biodiversity hotspot with high levels of diversity and endemism, retains about 28% of its original cover (Myers *et al.* 2000; Rezende *et al.* 2018) and is the richest and most well-known biome harboring fungal species in Brazil (BFG 2021). Nevertheless, considering the estimated number of species above, it still has enormous potential for new discoveries (Maia *et al.* 2015; Pires *et al.* 2016; Palacio *et al.* 2017; Motato-Vasquez *et al.* 2020; Pagin-Cláudio *et al.* 2022; Westphalen *et al.* 2022).

The state of São Paulo (Southeast Brazil) has 32.6% of its area within Atlantic Forest conservation units (IF 2020), and is well-known for hosting the greatest known fungal diversity in the country - ca. 1,900 known spp. (BFG 2021). Still, new taxa have been described by means of inventories, monographs and revisions of existing reference collections in basic mycological research.

The present study aims to present six newly recorded polypore species from Southeast Brazil: *Fibroporia gossypium* (Speg.) Parmasto, *Fomitiporia subtilissima* Alves-Silva, Reck & Drechsler-Santos, *Fuscoporia marquesiana* Gibertoni & C.R.S. de Lira, *Microporellus terrestris* (Gibertoni & Ryvarden) Decock, *Neodictyopus atlanticae* Palacio, Robledo & Drechsler-Santos, and *Perenniporia brasiliensis* C.R.S. de Lira, A.M.S. Soares, Ryvarden & Gibertoni. It will also synthesize perspectives in basic mycological research using contextual analysis of primary and secondary metadata from inventories, monographs, and revisions of existing reference collections. We provide full descriptions, photoplates, illustrations, remarks on geographic distribution, and additional comments for the newly recorded polypores.

Materials and Methods

Fieldwork and inventory zone

Fieldwork was carried out in remnants (24°01’20.9”S, 47°04’06.7”W) of Dense Ombrophilous Montane Forest within the Atlantic Forest province (IBGE 2012), located in the municipality of Juquitiba, São Paulo state, Brazil (Fig. 1). Those natural remnants are managed by Instituto Terra Luminous (ITL 2023) and are strategic for conservation due to their circumscription in UNESCO-designated sites, such as Mata Atlântica Biosphere Reserve and São Paulo Green Belt Biosphere Reserve (RBRB 2023). In addition, they are in the environmental preservation area of Serra do Mar, the buffer zones of Parque Estadual da Serra do Mar and Parque Estadual do Jurupará, as well as in spring protection and recovery areas (ITL 2023).

The inventory zone covers an area of approximately 270 ha., with a maximum altitude of nearly 760 m.a.s.l., mean temperatures of 18 °C, and the highest rainfall depth occurring in summer (PMGIRS Juquitiba 2009; ITL 2023).

Sample collection and preservation

Our fungal inventory was built from collections made through active sampling on trails and in forest interiors, conducted bimonthly from October 2021 to November 2022; the first author collected all specimens. Samples were collected and preserved using the traditional methods applied in the taxonomy of polypores (Fidalgo & Fidalgo 1989; Lodge *et al.* 2004). During the survey, basidiomata where photographed, collected with a knife and individually packed in paper bags. Samples were preserved by dehydration in an oven with air ventilation at room temperature and then frozen at -20 °C. Subsequently, vouchers were deposited as heritage in the SP-FUNGI collection (Maria Eneyda Pacheco Kauffmann Fidalgo), at Instituto de Pesquisas Ambientais da Secretaria de Meio Ambiente, Infraestrutura e Logística do Estado de São Paulo (IPA/SEMIL).

Morphologic analysis of basidiomata

Basidiomata were described using concepts and measurements applied in the taxonomy of polypores (Fidalgo & Fidalgo 1967; Vellinga 1988; Ryvarden 2004). Microscopic analysis was performed using freehand longitudinal and transversal cuts of the basidiomata. In order to hydrate the sections, a KOH solution was used (3–5%). Phloxine solution (1%) was used to stain the protoplasm, and Melzer's reagent was adopted to verify for chemical reactions in microstructures (Lodge *et al.* 2004). A minimum of thirty measurements were taken of microstructures, when founded. The following abbreviations and codes were used for measurements: Lm × Wm = mean length and width, Q = range of length/width ratio, Qm = length/width mean, and n = x/y [x = number of measurements from a given number (y) of specimens].

Species taxonomy and their geographic distribution

Species taxonomy - current names, classifications, authors and synonyms - as well as geographic distribution were verified using metadata from specialized databases and relevant literature [Ryvarden & Gilbertson 1993; Ryvarden 2004, 2015, 2016; Maia *et al.* 2015; Li *et al.* 2016; Crous *et al.* 2017; Palacio *et al.* 2017; Rajchenberg *et al.* 2022, Flora do Brasil 2020 (continuously updated), Index Fungorum electronic database 2023 (continuously updated), among others].

Results

Species taxonomy and remarks

1. *Fibroporia gossypium* (Speg.) Parmasto, Conspectus Systematis Corticiacearum (Tartu): 207 (1968). Figs. 2a-c; 9a

Basidiomata resupinate, seasonal, white to cream, in age or drying becoming sordid cream, adnate to effuse, soft when young turning wax-resinous and brittle when old, growing as radial meshes, up to 1 mm thick. Margin white, rhizomorphic to fimbriate, sterile, up to 1 mm of extension. Subiculum cottony, white, less than 1 mm thick. Tubes sordid cream to whitish cream, less than 1 mm deep. Hymenial surface poroid. Pores easily to hardly seen to the naked eye, circular to angular, decurrent in some parts, (3–)5–7 per mm. Dissepiments dentate to lacerated, pubescent. Hyphal system dimitic. Generative hyphae frequent in the trama of young parts and scarce in old parts, with unilateral clamps, thin-walled, hyaline, 2–3.5(–4) µm diam. Skeletal hyphae abundant in the subiculum, thick-walled to almost solid, sparingly branching, 3–4 µm diam. Cystidia absent. Cystidioles scarce to frequent,

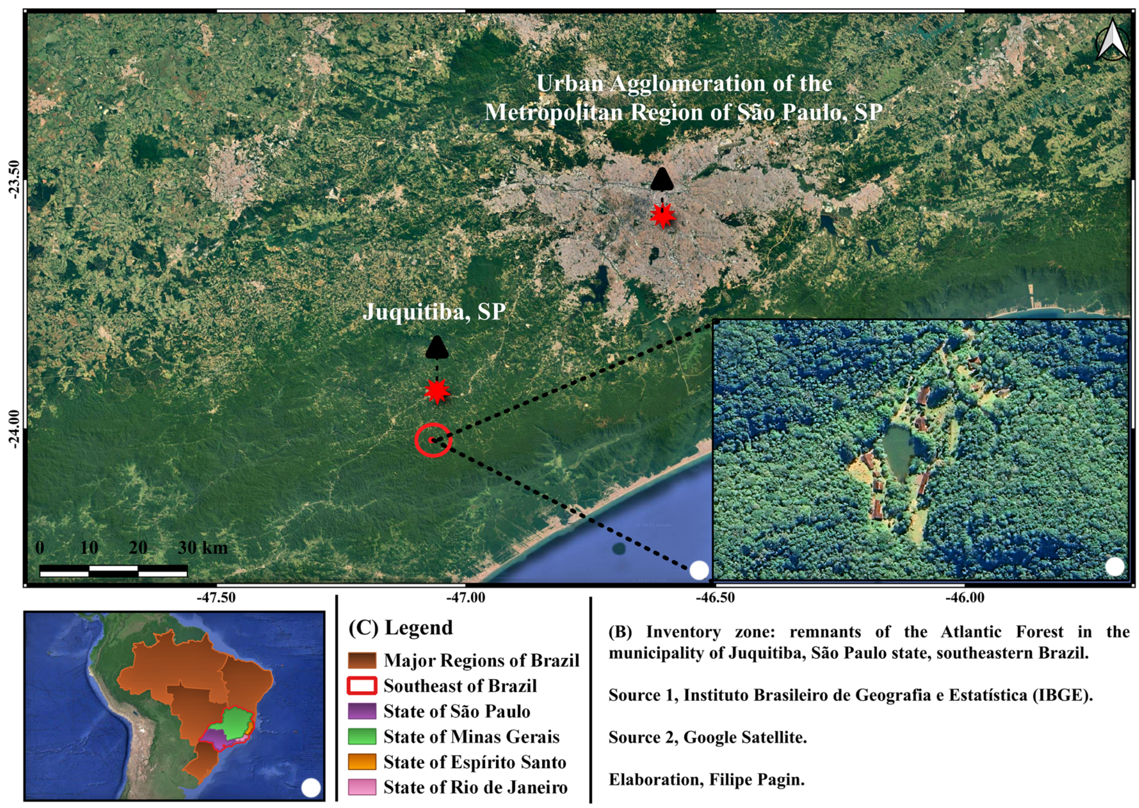

Figure 1 – a-c. Research area – a. geographical disposition of the inventory zone in relation to the municipality of Juquitiba and the urban agglomeration of the São Paulo metropolitan region; b. an overview of the inventory zone in the municipality of Juquitiba, located in the state of São Paulo; c. an overview of the Southeast region of Brazil, situated in South America.

fusiform, hyaline, thin-walled. Basidia not found. Basidiospores frequent, slightly thick-walled, hyaline, cylindrical to oblong-ellipsoid in frontal view and allantoid to slightly obovoid in lateral view, (4.3–)4.5–5.7(–5.9) × 2–2.4(–2.5) µm, Lm × Wm = 5 × 2.3 µm; Q = 2–2.5(–2.6); Qm = 2.2 (n = 32/1).

Material examined: Juquitiba, São Paulo Green Belt Biosphere Reserve, Trilha da Onça Parda, 13.VII.2022, *F. Pagin et al. FP 528*, (SP 528856).

Xylophagous on gymnosperm wood and rarely on angiosperm wood, the species causes brown rot (Ryvarden & Gilbertson 1993; Ryvarden 2016).

This species has a circumpolar distribution into the coniferous forests of Europe, warm parts of temperate zone, Argentina, Brazil, North America and Asia (Rick 1960; Lombard 1990; Ryvarden & Gilbertson 1993; Spirin 2007; Yuan & Dai 2008). Previously recorded from the Brazilian Atlantic Forest of the state of Rio Grande do Sul (Rick 1960). This is the second record from Brazil and the first record from the Southeast of Brazil.

The type locality of *F. gossypium* is La Plata, Buenos Aires, Argentina (Spegazzini 1899, as *Poria gossypium* Speg.).

Fibroporia gossypium can be recognized in the field by its resupinate, seasonal, soft to wax-resinous, white to sordid cream basidiomata, rhizomorphic to fimbriate margin, cottony subiculum, as well as by its circular to angular pores. In addition, the dimitic hyphal system composed of clamped generative hyphae and of skeletal hyphae plus the cylindrical to broadly-ellipsoid, slightly thick-walled, (4.3–)4.5–5.7(–5.9) × 2–2.4(–2.5) µm, basidiospores are diagnostic.

Fibroporia vaillantii (DC.) Parmasto is a morphologically similar species, but differs by a softer, not wax-resinous to brittle basidiomata, as well as by larger, 5–7 × 3–4 µm, basidiospores (Ryvarden & Gilbertson 1993). *Antrodia porothelioides* (Cke) Ryvarden, another morphologically similar species, differs by host preference (angiosperms wood), has slightly smaller pores and slightly longer basidiospores (Ryvarden & Gilbertson 1993; Ryvarden 2015).

Fibroporia gossypium was first described from La Plata (Argentina, South Hemisphere) and later identified from countries of the Northern Hemisphere (Spegazzini 1899; Ryvarden & Gilbertson 1993); molecular metadata show conspecificity between specimens from both Hemispheres (Rajchenberg *et al.* 2006). *Fibroporia gossypium* presents an antitropical distribution with conifers being its main hosts in the Northern Hemisphere and with *Nothofagus* spp. being its main hosts in Patagonia (Argentina, South Hemisphere), where *Fibroporia vaillantii* colonizes conifers (Rajchenberg 2022).

Our record is the second for *Fibroporia gossypium* in Brazil, the first one was made by Rick (1960) from an unidentified host at Rio Grande do Sul, and this species was classified as native (Rick 1960; Maia & Carvalho 2010), agreeing with its antitropical distribution. In our fungal inventory, *F. gossypium* was recorded in a site near to the Tropic of Capricorn, deviating from its typical distribution. This suggests that *F. gossypium* is an opportunistic and rare species in this region where it is associated with coniferous hosts; in this case sampled from a dead stump of *Pinus* sp. The morphologically similar *Fibroporia vaillantii* had never been recorded in Brazil, and *Antrodia porothelioides* was recorded only once by Rick (1960) in Rio Grande do Sul, though with differences in morphology and substrate preference when compared to *Fibroporia gossypium*.

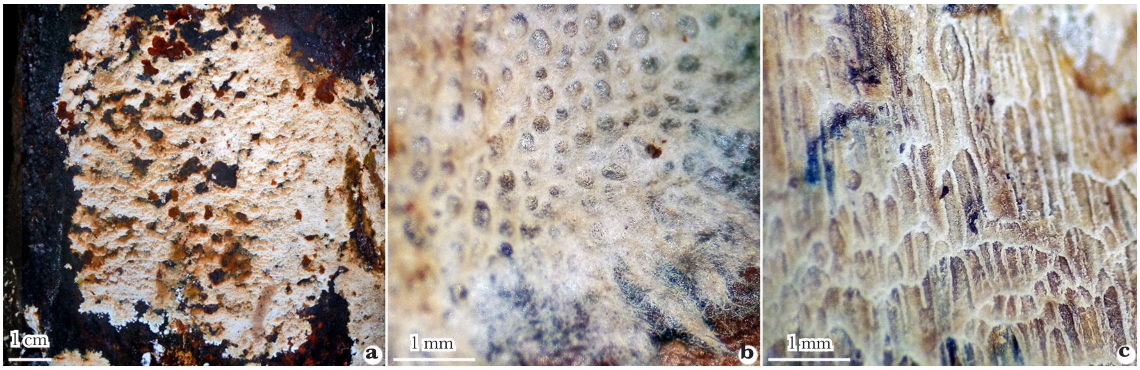

Figure 2 – a-c. *Fibroporia gossypium*. Macromorphology of the basidiomata – a. general view of the basidioma; b. margin showing rhizomorphs and pores in the regular portion of the hymenial surface; c. pores in the irregular portion of the hymenial surface. (a-c. *Pagin et al. 528*). Scale bars: a = 1 cm; b-c = 1 mm.

2. *Fomitiporia subtilissima* Alves-Silva, Reck & Drechsler-Santos, *in* Li *et al*., Fungal Diversity 78 (2016). Figs. 3a-c; 9b

Basidiomata perennial, pileate, woody, sessile to pseudostipitate due to concrescence of layers, aplanate, flabelliform, dimidiate, convex to elongate, single or laterally connate and thus horizontally imbricate, gregarious, growing at the base and roots of trees, 4–22 × 4.5–15.5 cm, up to 1.5 cm thick. Abhymenial surface zonate, concentric zones slightly to strongly sulcate and narrow, crustose, dark brown to reddish-brown, glabrous, rimose, often with moss growing on. Margin obtuse, copper-brown, glabrous. Context homogeneous to slightly zonate, fibrous, with a resinous dark line near the abhymenial surface, golden-brown to slightly reddish-brown, up to 7 mm. Tubes unistratified to pluristratified, concolorous, up to 6 mm thick, old ones filled with white mycelium. Hymenial surface poroid, brownish-gray to copper gold. Pores invisible to the naked eye, round to slightly angular, (7–)8–9(–10) per mm. Dissepiments thick, tomentose, entire. Hyphal system dimitic. Generative hyphae more easily observed at the dissepiment, simple septate, hyaline, thin-walled, rarely with refringent content, 3–5(–6) μm diam. Skeletal hyphae dominant, moderately to strongly dextrinoid, thick-walled to solid, sulfurous-yellow to reddish-yellow, often aseptate to occasionally septate, sparingly branched, with or without refringent content, 3–5(–7) μm diam. Setae absent. Basidia not found. Basidiospores rare to frequent, subglobose to globose, slightly to moderately dextrinoid, hyaline, thick-walled, without content, (4.4–)4.5–5.2(–5.5) × (4.1–)4.2–5(–5.2) μm, Lm × Wm = 4.8 × 4.3 μm; Q = 1–1.18(–1.2), Qm = 1.1 (n = 24/2).

Material examined: Juquitiba, São Paulo Green Belt Biosphere Reserve, Trilha da Chama Violeta, 9.II.2022, *F. Pagin et al. FP 504* (SP 528834); 14.VII.2022, *F. Pagin et al. FP 548* (SP 527875).

Growing on angiosperm wood (Li *et al.* 2016).

The species was found in Brazil (Li *et al.* 2016). Previously recorded from the Brazilian Atlantic Forest in the state of Santa Catarina (Li *et al.* 2016). This is the first record from the Southeast of Brazil.

The type locality of *Fomitiporia subtilissima* is Blumenau, Santa Catarina, Brazil (Li *et al.* 2016).

Fomitiporia subtilissima can be recognized in the field by its perennial, gregarious, aplanate, sessile to pseudostipitate basidiomata, narrowly sulcate abhymenial surface, dark resinous line in the context, obtuse margin, brownish-gray to copper-gold hymenial surface, and by pores which are invisible to the naked eye as well. In addition other diagnostic features are its globose and dextrinoid basidiospores with 4–6 μm in diam. and not surpassing 6 μm in diam. (Alves-Silva *et al.* 2020). This set of morphological features used to identify *F. subtilissima* is quite unique within the genus.

In our fungal inventory, as well as in Li *et al.* (2016), basidiomata were collected from the base and roots of trees, both dead or alive, suggesting that this species may oscillate between being a parasite and a saprotroph.

3. *Fuscoporia marquesiana* Gibertoni & C.R.S. de Lira, *in* Yuan *et al*., Fungal Diversity (2020). Figs. 4a-c; 9c-d

Basidiomata seasonal to perennial, pileate, aplanate to slightly reflexed on the base, coriaceous to sub-woody, flabelliform, semicircular, elongate to convex, gregarious, up to 1 cm deep, 1–7(–8) × 1–4 cm. Abhymenial surface zonate, zones slightly to moderately sulcate and numerous, glabrous to pubescent or tomentose, sometimes radially striate and rugose, brownish-yellow, yellowish-orange to faintly purplish-dark. Margin acute to

Figure 3 – a-c. *Fomitiporia subtilissima*. Macromorphology of the basidiomata – a. young basidiomata covered with mosses; b. an aged basidioma, partially covered with dead plant material; c. hymenial surface. (a. *Pagin et al. 504*; b-c. *Pagin et al. 548*). Scale bars: a-c = 1 cm.

subobtuse. Context zonate, fibrous-velutinate, gold-yellowish to yellowish-brown, 1–5 mm thick. Tubes unistratified to pluristratified, distinctly stratified, up to 8 mm deep. Hymenial surface poroid, brownish-purple, often with a grayish tint. Pores invisible to the naked eye, round, 7–9 per mm. Dissepiments entire, thick, pubescent. Hyphal system dimitic. Generative hyphae frequent, simple septate, hyaline to yellow, thin- to slightly thick-walled, straight, branches proximal, 2–3 μm diam. Skeletal hyphae dominant, thick-walled to solid, often aseptate, yellowish-red to reddish-brown, 3–4 μm diam. Setae hymenial, frequent, covering about 3/4 of the pores, apex acute to slight- or even moderately hook, lanceolate to subulate, brown, thick-walled, aseptate to simple septate close to the apex, (14–)15–23.8(–25) × (3.4)4.1–5.7(–6.7) μm, Lm × Wm = 20 × 4.8 μm, Q = (2.6–)3–5.4(–6.3), Qm = 4.2 (n = 26/1). Basidia not found. Basidiospores few, widely ellipsoid, hyaline, thin-walled, smooth, often with refringent content, 4–6.9(–7) × 2.5–4.5(–4.6) μm, Lm × Wm = 5.1 × 3.6 μm; Q = 1.2–1.6; Qm = 1.4 (n = 16/1).

Material examined: Juquitiba, São Paulo Green Belt Biosphere Reserve, Tenda Tipi, 9.II.2022, *F. Pagin et al. FP 508* (SP 528838).

Xylophagous on angiosperm wood, where it may cause white rot like other species in the genus.

The species was found in Brazil (Yuan *et al*. 2020). Previously recorded from the Brazilian Atlantic Forest of the state of Bahia (Yuan *et al.* 2020). This is the second record for the species since its description and the first record from the Southeast of Brazil.

The type locality of *Fuscoporia marquesiana* is Santa Teresinha, Bahia, Brazil (Yuan *et al.* 2020).

Fuscoporia marquesiana can be recognized in the field by its aplanate, seasonal to perennial basidiomata, narrowly to densely sulcate abhymenial surface, often acute margin, brown to purple-brown hymenial surface, as well as by pores which are invisible to the naked eye. In addition, it's both hooked and acute hymenial setae plus broadly ellipsoid basidiospores are diagnostic.

The material examined (SP 528838), has slightly larger basidiospores compared to the original description, but only few were found and the original description for *F. marquesiana* was based on a single specimen (URM 83094), which is insufficient to verify intraspecific variations (Yuan *et al.* 2020; present study). *Fuscoporia wahlbergii* (Fr.) T. Wagner & M. Fisch. is a morphologically similar species, but differs by the strongly hooked setae (*vs.* slightly to moderately hooked in *F. marquesiana*), besides the type of insertion, margin thickness, and coloration of the basidiomata (Yuan *et al.* 2020; present study).

4. *Microporellus terrestris* (Gibertoni & Ryvarden) Decock, Czech Mycol. 59(2): 161 (2007).
Figs. 5a-c; 9e

Basidiomata pileate, laterally to eccentrically stipitate, circular, coriaceous, up to 1 cm high, up to 1 cm in diameter, up to 2 mm thick. Abhymenial surface radially striate, faintly zonate, up to 2 zones, infundibuliform at the center, dark reddish-brown, glabrous. Margin obtuse to sub-truncate. Stipe darkish-brown, up to 0.5 mm high, up to 0.3 mm in diam., rugose, glabrous to pubescent in some parts. Context fibrous, pale brown, up to 1 mm thick. Tubes concolorous, up to 2 mm deep. Hymenial surface poroid, grayish-brown to pale brown. Pores visible to the naked eye, irregular, 2–3 per mm. Dissepiments entire, glabrous, moderately thick. Hyphal system dimitic. Generative hyphae with unilateral clamps, hyaline, simple septate, thin-walled, with refringent content, 3–4 μm diam. Skeletal-binding hyphae aseptate, thick-walled to

Figure 4 – a-c. *Fuscoporia marquesiana*. Macromorphology of the basidiomata – a. close view of the basidiomata; b. basidiomata; c. hymenial surface. (a-c. *Pagin et al. 508*). Scale bars: a-c = 1 cm.

solid, hyaline to brownish, variably dextrinoid, 1–3 µm diam. Cystidia absent. Basidia not found. Basidiospores frequent to abundant, hyaline, cylindrical to navicular, thin-walled to slightly thick-walled, often with ferruginous content, (7–)7.1–10(–11.5) × 3–4(–4.4) µm, Lm × Wm = 8.4 × 3.5 µm; Q = 1.9–2.9(–3.6), Qm = 2.4, (n = 77/1).

Material examined: Juquitiba, São Paulo Green Belt Biosphere Reserve, Zé da Paz, 3.X.2021, *F. Pagin et al. FP 494* (SP 528825).

Xylophagous on angiosperm wood, the species causes white rot.

The species was found in Brazil (Gibertoni *et al.* 2004; Drechsler-Santos *et al.* 2007). Previously recorded from the Brazilian Atlantic Forest of the state of Rio Grande do Norte (Gibertoni *et al.* 2004); Caatinga, from the state of Bahia (Drechsler-Santos *et al.* 2007). This is the first record from the Southeast of Brazil.

The type locality of *Microporellus terrestris* is Baía Formosa, Rio Grande do Norte, Brazil (Gibertoni *et al.* 2004, as *Navisporus terrestris* Gibertoni & Ryvarden).

Microporellus terrestris can be recognized in the field by its circular, laterally to eccentrically stipitate, coriaceous basidiomata, black and rugose stipe, faintly zonated, reddish-brown abhymenial surface, cream to beige hymenial surface, as well as by the 2–3 pores per mm, which are visible to the naked eye. In addition, its dimitic hyphal system composed by clamped generative hyphae and of skeletal-binding hyphae plus the navicular to cylindrical, (7–)7.1–10(–11.5) × 3–4(–4.4) µm, basidiospores are diagnostic.

With the exception of *Microporellus ellipsosporus* Decock & Ryvarden, all species in the genus differ from *M. terrestris* by their tiny pores, presence of cystidia, and globose to lacrimoid basidiospores (Motato-Vásquez & Gugliotta 2016). *Microporellus ellipsosporus* is the closest species to *M. terrestris* in morphology, but the first differs by its narrower basidiospores, 1.7–2.3 µm width, and presence of hymenial cystidia (Decock & Ryvarden 2007).

5. *Neodictyopus atlanticae* Palacio, Robledo & Drechsler-Santos, *in* Palacio, Robledo, Reck, Grassi, Góes-Neto & Drechsler-Santos, PLoS ONE 12(10): e0186183, 15 (2017).
Figs. 6a-c; 7a-f; 9f

Basidiomata pileate, seasonal to perennial, laterally to eccentrically stipitate, widely flabelliform, reniform, discoid to circular, coriaceous, gregarious in small groups, sometimes cespitose, 1.5–5.5 × 1.8–3 cm, up to 2.5 mm thick. Abhymenial surface azonate, glabrous, radially striate to occasionally radially rugose when dehydrated, orange-brown, reddish-brown, dark red to purple, often darker in the central region, usually with a depression. Stipe covered by a dark cuticle, insertion at 90° to 180°, up to 2.3 cm high, up to 0.8 mm in diam. - but rarely surpassing 0.5 mm, reticulate, glabrous to slightly pubescent, base radially extended in the substrate. Margin acute to subobtuse, frequently marked by a dark line, deflexed when dehydrated. Context fibrous to occasionally pubescent, cream to grayish-cream, eventually with resinous bands, 1–3 mm thick. Tubes with up to two layers, but often one, cream, grayish-cream to brownish, up to 1 mm each layer. Hymenial surface poroid, grayish-cream, puff gray, dark gray to dark brown. Pores hardly seen to the naked eye, round to angular, 5–9(–10) per mm. Dissepiments entire, granulose to pubescent, slightly to moderately thick. Hyphal system dimitic. Trama frequently impregnated by resinous yellowish-green substance. Generative hyphae frequent, with unilateral clamps, thin-walled, tortuous, densely branched, (1.5–)2–3(–6) µm diam. Skeletal-binding hyphae dominant, aseptate, hyaline, thick-walled to solid, very tortuous, densely branched, 1–4(–5) µm diam. Cystidioles

Figure 5 – a-c. *Microporellus terrestris*. Macromorphology of the basidiomata – a. basidiomata; b. inferior view of the basidiomata; c. pores. (a-c. *Pagin et al. 494*). Scale bars: a-b = 1 cm; c = 1 mm.

frequent, widely fusiform to narrowly utriform, with basal clamp, (8.5–)12–16 × (3–)4.7–6.5(–8) µm. Cystidia absent. Basidia clavate, 4-sterigma, hyaline, 5 µm wide. Basidiospores rare to frequent, abundant only in pores, subcylindrical, hyaline, often with refringent and ferruginous content, 5–6.9(–7.5) × (1.8–)2–3(–4) µm, Lm × Wm 6.1 × 2.3 µm, Q = (2.1–)2.2-3(–3.1), Qm = 2.6, (n = 334/6).

Material examined: Juquitiba, São Paulo Green Belt Biosphere Reserve, Zé da Paz (Parcela ESALQ), 3.X.2021, *F. Pagin*, *FP 461*, SP 528795, *F. Pagin 463*, SP 528796; Chama Violeta, *F. Pagin*, *FP 507*, SP 528837; Chama Violeta, 13.VII.2022, *F. Pagin et al. FP 520*, SP 528849; Trilha da Jaguatirica, 13.IV.2022, *F. Pagin et al. FP 543*, SP 528871; Chama Violeta, 13.VII.2022, *F. Pagin et al. FP 550*, SP 528877; Trilha da Onça Parda, 22.IX.2022, *F. Pagin et al. FP 579*, SP 528905; Trilha da Jaguatirica, 24.XI.2022, *F. Pagin et al. FP 598*, SP 528924.

Xylophagous on angiosperm wood, the species causes white rot.

The species was found in Brazil (Palacio *et al.* 2017). Previously recorded from the Brazilian Atlantic Forest in the state of Santa Catarina (Palacio *et al.* 2017). This is the first record from the Southeast of Brazil.

The type locality of *Neodictyopus atlanticae* is Santo Amaro de Imperatriz, Santa Catarina, Brazil (Palacio *et al.* 2017).

Neodictyopus atlanticae can be recognized in the field by its pileate, laterally to eccentrically stipitate, leathery basidiomata, black cuticle covering the stipe, often reddish-orange to purple, radially striate abhymenial surface, grayish-cream to brown hymenial surface, as well as by pores which are hardly seen to the naked eye.

The potential geographic distribution presented in Palacio *et al.* (2017) shows that *Picipes dictyopus* (Mont.) B.K. Cui, Xing Ji & J.L. Zhou, a morphologically similar species, is distributed in the Cerrado province, as well as in Juan Fernandez Islands, where *N. atlanticae* is distributed in the Atlantic province.

We observed a case of polymorphism (see paragraph 4 of the discussion) in *N. atlanticae* (Figs. 6-7) through morphological analysis of basidiomata. The morphological features - stipe, pileus and margin configuration as well as basidiospores size (value o Q) - used to distinguish between *N. atlanticae* (Atlantic province) and *P. dictyopus* (Cerrado province) (Palacio *et al.* 2017) overlapped. We observed that phenotypic traits used to distinguish these taxa had low taxonomic value when more specimens were sampled. Firstly, the unknown specimens were morphologically chimeric, exhibiting mixed features used to distinguish *N. atlanticae* and *P. dictyopus*. Thus, for the identification of *N. atlanticae* we used the Q value of basidiospores by means of measurements from all sampled specimens (334 basidiospores/- 6 specimens). Accounting for one subpopulation, they had higher taxonomical value, which were equal to Q = 2–3.5 matching the original description of *N. atlanticae* (*vs.* Q = 2.5–3.3 in *P. dictyopus*) (Palacio *et al.* 2017; present study). Although, we lack molecular metadata for the material examined, morphological evidence supports the hypothesis that *N. atlanticae* occurs in the Atlantic province,while *P. dictyopus* is found in the Cerrado province in Brazil (Palacio *et al.* 2017; present study).

6. *Perenniporia brasiliensis* C.R.S. de Lira, A.M.S. Soares, Ryvarden & Gibertoni, *in* Crous *et al.*, Persoonia 38: 355 (2017). Figs. 8a-c; 9g

Basidiomata resupinate, seasonal to perennial, adnate to effused, coriaceous to woody, white to cream, often with orange-brown macules, difficult to separate from the substrate, often formed by fusion of smaller basidiomata, 1–6.5 × 1–5.5 cm, up to 5 mm thick. Margin sterile, thick, black to reddish-brown,

Figure 6 – a-c. *Neodictyopus atlanticae*. Macromorphology of the basidiomata – a. basidiomata; b. inferior view of the basidioma; c. pores. (a-c. *Pagin et al. 530*). Scale bars: a-b = 1 cm; c = 1 mm.

glabrous, crustose, slightly zonated. Subiculum cream, less than 1 mm thick. Tubes unistratified to pluriestratified, 1–4 mm deep, eventually filled with white mycelium. Hymenial surface poroid. Pores invisible to the naked eye, round, 9–10(–11) per mm. Dissepiments slightly to moderately thick, slightly granulous, entire to slightly dentate. Hyphal system dimitic. Generative hyphae rare, with unilateral clamps, hyaline, thin- to thick-walled, 2 μm diam. Skeletal hyphae dominant, arachnoid, slightly

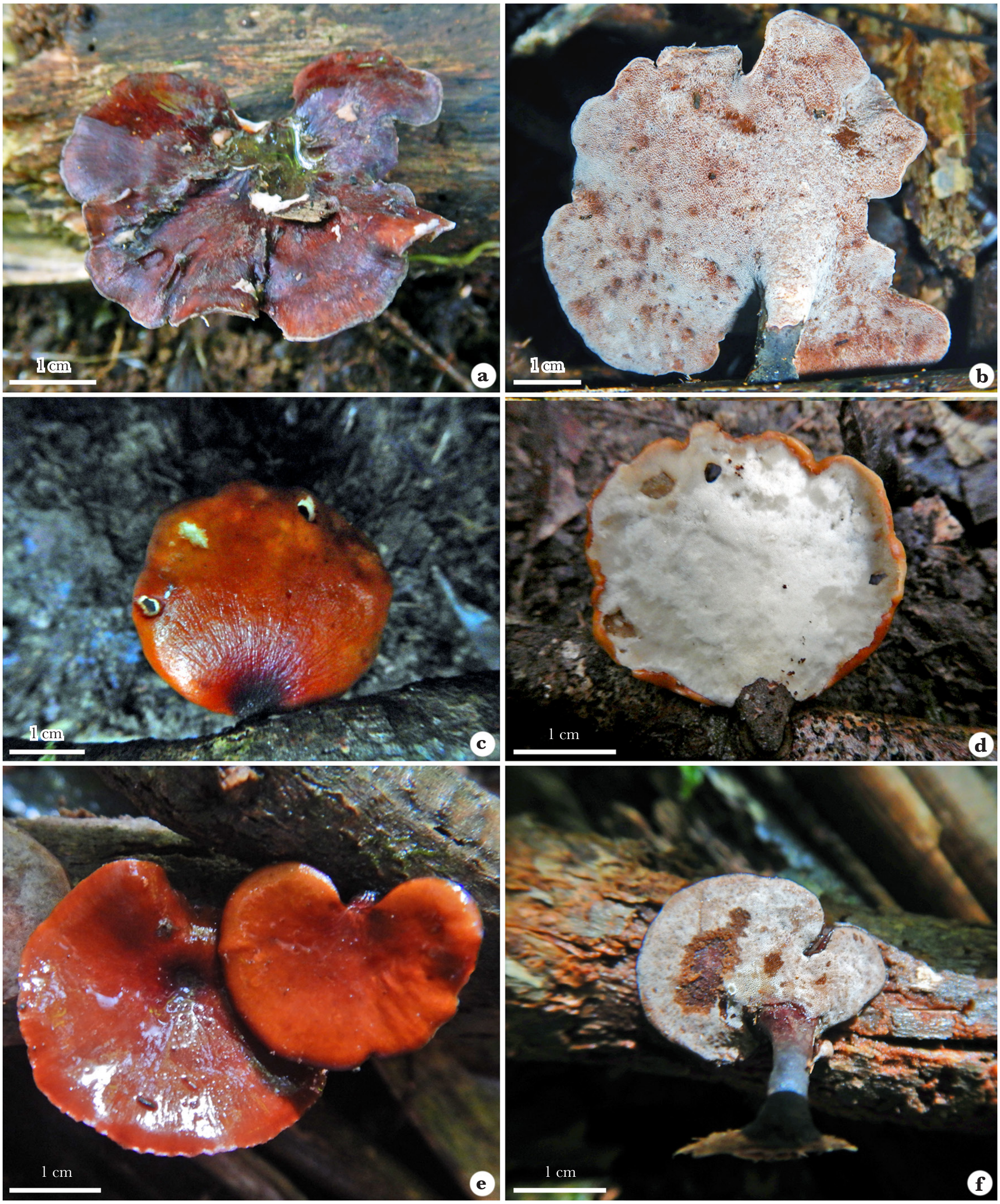

Figure 7 – a-f. Polymorphism of *Neodictyopus atlanticae*. Superior and inferior views of the basidiomata. (a-b. *Pagin et al. 507*; c-d. *Pagin et al. 543*; e-f. *Pagin et al. 550*). Scale bars: a-f = 1 cm.

to moderately dextrinoid, strongly dextrinoid in mass, densely branched, very tortuous, aseptate to occasionally septate, sometimes with refringent content, 1–2.5 μm diam. in lateral branches, 2–3 μm diam. in axial branches. Crystals occasional to frequent, hyaline, diamond-shaped, tiny to large. Cystidia absent. Basidia not found. Basidioles widely clavate, thin-walled, hyaline. Basidiospores frequent to abundant, subglobose to widely ellipsoid, apex truncate, thick-walled, slightly to strongly dextrinoid, hyaline, 3–4.2(–4.6) × 3–3.7(–4) μm, Lm × Wm = 3.8 × 3.3 μm; Q = 1–1.3(–1.5), Qm = 1.2 (n = 86/3).

Material examined: Juquitiba, São Paulo Green Belt Biosphere Reserve, Chama Violeta, 14.VI.2022, *F. Pagin et al. FP 546*, SP 528874; *F. Pagin et al. FP 552*, SP 528879; Trilha da Jaguatirica, 24.XI.2022, *F. Pagin et al. FP 594*, SP 528920.

Xylophagous on angiosperm wood, the species causes white rot.

The species was found in Brazil and Cameroon (Crous *et al.* 2017). Previously recorded from the Brazilian Atlantic Forest in the states of Bahia, Ceará, and Pernambuco (Crous *et al.* 2017); Amazon, from the state of Amapá (Crous *et al.* 2017). This is the first record from the Southeast of Brazil.

The type locality of *Perenniporia brasiliensis* is Porto Grande, Amapá, Brazil (Crous *et al.* 2017).

Perenniporia brasiliensis can be recognized in the field by its resupinate, white to cream, with orange-brown macules, coriaceous basidiomata, besides its pores which are hardly seen to the naked eye. In addition, other diagnostic features are its dimitic hyphal system composed by clamped generative hyphae and of dextrinoid skeletal hyphae plus the small subglobose to globose basidiospores are diagnostic. Crystals in the trama were observed for the first time in this species, although they have been reported in morphologically similar species that differ by their larger basidiospores. In *Perenniporia guyanensis* Decock & Ryvarden, the basidiospores measure 5.0–5.5(–6.0) μm in diameter, while in *Perenniporia paraguyanensis* Lira & Gibertoni, they measure 4.5–5.2 μm (Ryvarden 2016; Crous *et al*. 2017). *Perenniporia brasiliensis* is unique, presenting the smallest basidiospores in the genus.

Discussion

Perspectives in basic mycological research

In this section, we discuss perspectives in basic mycological research through contextual analysis of primary and secondary metadata from inventories, monographs, and revisions of existing reference collections. We highlight the intersection between these branches in basic mycological research, which are foundational for scientific inquiries on fungal diversity, conservation and prospecting.

Our results, in consonance with metadata from inventories, monographs and revisions of existing reference collections (Drechsler-Santos *et al.* 2008; Wartchow *et al.* 2011; Abrahão *et al.* 2012; Baltazar *et al.* 2012; Pires *et al.* 2016; Palacio *et al.* 2017; Motato-Vasquez *et al.* 2020; Pagin-Cláudio *et al.* 2022; Westphalen *et al.* 2022; Fraga-Júnior *et al.* 2023, among others, some of which are compiled in Maia *et al.* 2015), demonstrate that the major sources from which unknown fungi emerge overlap in Brazil - (1) tropical regions and biodiversity hotspots; (2) little-explored sites and habitats; (3) morphologically and ecologically cryptic species; (4) existing reference collections (Hawksworth & Lücking 2017). For this reason, the discovery of new fungal taxa has been growing exponentially as basic mycological research advances across the country, mainly in little-explored sites, many of which still show great potential for novel discoveries compared to more studied locations

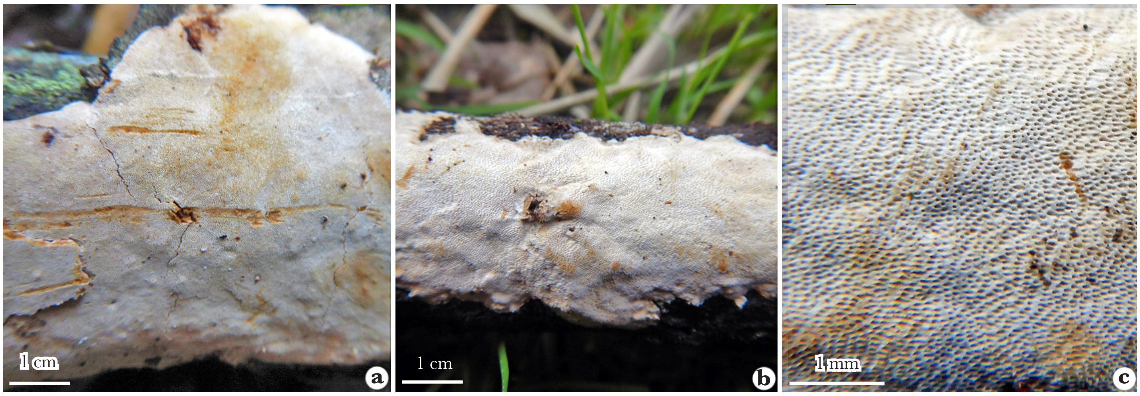

Figure 8 – a-c. *Perenniporia brasiliensis*. Macromorphology of the basidiomata – a. close view of the basidioma; b. basidioma; c. hymenial surface. (a. *Pagin et al. 546*; b-c. *Pagin et al. 552*). Scale bars: a-b = 1 cm; c = 1 mm.

(Baltazar *et al*. 2012; Maia *et al*. 2015; BFG 2021). Considering the conservation principles of vulnerability and irreplaceability at global and local scales (Grace *et al*. 2021), tropical regions, particularly biodiversity hotspots, are crucial for socio-environmental development. These regions are highly heterogeneous, largely unexplored, and home to endemic, cryptic, and novel taxa. They also provide all four types of ecosystem services (*i.e.,* provisioning, regulating, cultural, and supporting), essential for the biosphere's welfare, which is increasingly threatened by anthropogenic activities (Myers *et al*. 2000; Millennium Ecosystem Assessment 2005). The biodiversity crisis highlights the importance of biodiversity assessments in developing sustainable conservation plans and strategies for future biological resource use. This is notably relevant in Brazil, a developing country with biological megadiversity in Tropical America, the richest region in species on the planet (Myers *et al.* 2000; Mace 2004; Millennium Ecosystem Assessment 2005; Antonelli *et al.* 2018).

In our fungal inventory, the newly recorded *Fomitiporia subtilissima*, *Fuscoporia marquesiana*, *Neodictyopus atlanticae*, and *Perenniporia brasiliensis*, were originally described in Brazil and have an underestimated geographic distribution as they were decrypted from species complexes less than 10 years ago (Li *et al.* 2016; Crous *et al.* 2017; Palacio *et al.* 2017; Yuan *et al.* 2020). The fact that decryption detects unknown taxa, including endangered ones, needs to be acknowledge as a predictable pattern in the intersection of inventories, monographs and revisions of existing reference collections (*e.g.*, Gómez-Montoya *et al.* (2017) for *Trametopsis brasiliensis* (Ryvarden & de Meijer) Gómez-Mont. & Robledo - vulnerable, VU, Salvador-Montoya *et al.* (2018) for *Tropicoporus drechsleri* Salvador-Montoya & Popoff - vulnerable, VU, Westphalen *et al.* (2018) for *Steccherinum neonitidum* Westphalen & Tomšovský, Alves-Silva *et al.* (2020) for *Fomitiporia nubicola* Alves-Silva, Bittencourt & Drechsler-Santos - vulnerable, VU, and Lira *et al.* (2021) for *Megasporoporia neosetulosa* C.R.S. Lira & Gibertoni). This predictable pattern also highlights that existing reference collections, particularly those from little-explored sites in biodiversity hotspots, harbor a significant number of unknown fungal species (*e.g.*, Drechsler-Santos *et al.* 2008; Fraga-Júnior *et al.* 2023), sampled decades ago or even a century ago, in the form of vouchers requiring analytical update (BFG 2021). Goodwin *et al.* (2015) estimated that half of the tropical plants preserved in existing reference collections requires nomenclatural updating. From a pragmatic standpoint, plants are less diverse, less neglected, and more extensively researched than fungi. For instance, about 20% of the Earth's flora is still unknown, whereas above 90% of the Earth's funga remains to be known (Dawson *et al.* 2017; Hawksworth & Lücking 2017; Willis *et al.* 2018). It has also been estimated that half of the unknown plant species are already represented in existing reference collections (Bebber *et al.* 2010), which is at least partially true for fungal species. Consequently, revisions of existing reference collections are as important as inventories and monographs, due to their significant potential for metadata integration, as well as their availability, which positively impacts institutions, researchers and individuals worldwide (Andrew *et al.* 2018).

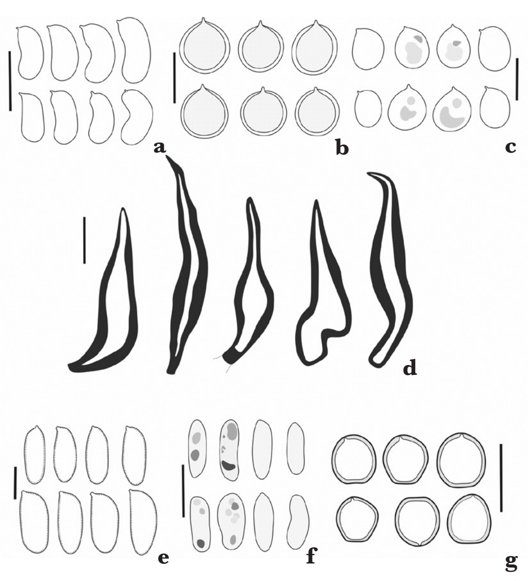

Figure 9 – a-g. Microscopic structures of six newly recorded polypores – a. basidiospores of *Fibroporia gossypium*; b. basidiospores of *Fomitiporia subtilissima*; c. basidiospores of *Fuscoporia marquesiana*; d. hymenial setae of *Fuscoporia marquesiana*; e. basidiospores of *Microporellus terrestris*; f. basidiospores of *Neodictyopus atlanticae*; g. basidiospores of *Perenniporia brasiliensis*. (a. *Pagin et al. 528*; b. *Pagin et al. 504, 548*; c-d. *Pagin et al. 508*; e. *Pagin et al. 494*; f. *Pagin et al. 507, 530, 543, 598*; g. *Pagin et al. 546, 552, 594*). Scale bars: a-g = 5 µm. Drawings by Cristiano Coelho-Nascimento.

Polymorphism is a universal phenomenon in biodiversity, often neglected both epistemologically and methodologically (Wiens 1999). Here, we define it as intraspecific variation in qualitative or quantitative traits of an individual´s phenotype. The phenotypic polymorphism observed for *N. atlanticae* (see remarks; Fig. 6-7), may be relevant to other cryptic species; *e.g.*, *Trullella duracina* complex (Pat.) Zmitr. The case for polymorphism affirms that: (1) the current set of morphological features or traits used to distinguish between cryptic species has low taxonomic value and is relative, not absolute; (2) population/subpopulation samples displays higher taxonomic value compared to individuals; (3) population/subpopulation samples from different geographic regions display higher taxonomical value than just specimens from the type locality; (4) species-level systematics are essential for distinguishing between intraspecific and interspecific variability, as closely related species share some heritable features, and may exhibit mutations (Bicudo 1988; Wiens 1999; present study). Polymorphism needs to be epistemologically and methodologically acknowledged, with the aim advancing intraspecific systematics in basic mycological research, where the current focus is on interspecific systematics. Additionally, we need to be cautious because numerous new taxa, when collections are scarce, have been described based on a single or a few specimens (*e.g.*, Palacio *et al.* (2017) for *N. atlanticae* and Yuan *et al.* (2020) for *Fuscoporia marquesiana*), and thus may not reflect the full diversity within species.

Microporellus terrestris is known in Brazil, where it was sampled from three sites (two in the Brazilian Atlantic Forest and one in the Caatinga) (Gibertoni *et al.* 2004; Drechsler *et al.* 2007; present study). We hypothesize that *M. terrestris* is a rare and potentially endangered species due to its low population. We need to consider that inventories and revisions of existing reference collections can widen its population size by discovering new records. Since its original description in Gibertoni *et al.* (2004), *M. terrestris* was not sampled again until several years (Dreschsler *et al.* 2007; present study), which can be due to its low population, small basidiomata, and limited sampling effort. In this regard, the detection of new records positively impacts knowledge about the species population size, also increasing the availability of metadata to support education, conservation, and future planning regarding inventories, monographs and existing reference collections in basic mycological research.

Although this discussion extends beyond the primary results of the present study by incorporating secondary metadata, it highlights several key perspectives in basic mycological research. These include: (1) emphasizing the need to integrate knowledge from monographs, inventories, and existing reference collections, as these resources mutually inform each other; (2) demonstrating that major sources of unknown fungi overlap in Brazil; (3) showing that the discovery of new records can improve our understanding of species distribution and conservation status; (4) highlighting the relevance of intraspecific systematics, particularly in cases of cryptic species polymorphism; and (5) reinforcing the importance of advancing basic mycological research in a megadiverse and developing country like Brazil.

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Data Availability Statement

In accordance with Open Science communication practices, the authors inform that all data are available within the manuscript.

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