



FORESTRY SCIENCE

Taxonomic study of Hymenochaetaceae species (Agaricomycetes, Basidiomycota) in the municipalities of Tomé-Açu and Bujaru, Pará, Brazil

RICHARD BRUNO M. FREIRE & ADRIENE MAYRA S. SOARES

Abstract: The family Hymenochaetaceae includes a diversity of 893 species described around the world. Its representatives are known by their usually rusty colored basidiomes with a poroid hymenial surface, hydroid or smooth, woody consistency, and wide morphological variation regarding the arrangement on the substrate. They behave as saprophytic, parasitic, ectomycorrhizal and play a fundamental role in the decomposition of wood in forest ecosystems. In the Brazilian Amazonia region, approximately 40 species of Hymenochaetaceae are currently recorded. The main goal of this study was to increase the knowledge on Hymenochaetaceae from the Brazilian Amazonia. Collections were carried out between October 2021 and April 2022 in the state of Pará, municipalities of Tomé-Açu and Bujaru, to expanding the knowledge of this fungal family to the Brazilian Amazonia. A total of 15 specimens were identified, distributed in seven genera and 12 species. Four species are new records for the state of Pará (*Fomitiporia apiahyna*, *Phellinus neocallimorphus*, *Phellinus sancti-georgii*, and *Sclerotus extensus*) and two of them are new records for the Brazilian Amazonia (*P. neocallimorphus* and *P. sancti-georgii*). Our findings contribute to taxonomic knowledge of this family in the Brazilian Amazonia and reduce the information gaps about the diversity of species.

Key words: Amazonia, Hymenochaetales, morphology, richness, taxonomy.

INTRODUCTION

The family Hymenochaetaceae was described by Donk (1948) and includes a diversity with 893 species described, and distributed in 42 genera (Wijayawardene et al. 2022). Its representatives have saprophytic, parasitic, and ectomycorrhizal lifestyle on a wide diversity of angiosperms and gymnosperms. They play a fundamental role in the decomposition of wood in forest ecosystems, causing white rot in the breakdown of lignin, cellulose and hemicellulose (Ryvarden 1991, 2004, Cannon & Kirk 2007, Tedersoo et al. 2007, 2010, Vasco-Palacios et al. 2018). Further, some species are good candidates in the control

of the long-term biological impact caused by exotic living tree species (Morera et al. 2017).

Hymenochaetaceae specimens are characterized by having basidiomes of ferruginous brown color due to the presence of styrylpyrones in the hyphae (rarely other colors), poroid hymenial surface, hydroid or smooth, woody consistency, and wide morphological variation regarding the arrangement on the substrate, which may be pileate, resupinate, effused-reflexed, or stipitate. The hyphae are generative with simple septa, clamp connections are absent in the septa, and most of the species have hymenial and/or tramal setae. These features are important in taxonomic studies of

the family. In addition to the microstructures, the xanthochroic reaction in the presence of potassium hydroxide —KOH— become the permanent blackening of the hyphae, is also important for the recognition specimens of this family (Parmasto & Parmasto 1979, Gill & Steglich 1987, Ryvarden 1991, 2004, Wagner & Fischer 2002, Larsson et al. 2006, Dai 2010, Campos-Santana et al. 2015).

The Amazonia region has an extensive and highly biodiverse humid hardwood forest, being the largest tropical forest in the world. It is characterized by a hot and humid climate, high rainfall rates, and abundant water resources (Aragão 2012).

The occurrence of Hymenochaetaceae in the Brazilian Amazonia region has been reported in taxonomic reviews (Gomes-Silva & Gibertoni 2009a b, Júnior et al. 2011, Soares et al. 2014, Silva et al. 2021), showing frequent new records and new taxa for science (Gomes-Silva et al. 2009, 2012a, 2013, Soares et al. 2018, Alves-Silva et al. 2020 Silva et al. 2021, Couceiro et al. 2022, Lima et al. 2022, Oliveira et al. 2022). According to Flora do Brasil (2020), approximately 40 species distributed in 13 genera of Hymenochaetaceae are currently known to occur in the region.

The municipality of Tomé-Açu in the state of Pará, Brazil, is characterized by having large areas of Ombrophilous Dense Forest, mostly corresponding to secondary vegetation due to the timber trade, agriculture and livestock farming, while primary vegetation remnants are restricted to small areas. The municipality of Bujaru, in turn, is characterized by presenting natural areas of dense lowland evergreen forest and dense alluvial evergreen forest with secondary vegetation at different successional stages called “capoeira”, resulting from successive logging for continuous use of the land for agricultural purposes over several decades (Pacheco & Bastos 2001, Rodrigues et

al. 2003, Bolfe & Batistella 2011). Mycological studies in these two municipalities are scarce and in the case of Hymenochaetaceae, they are non-existent. Thus, the main goal of this work was to know the diversity of fungi of the Hymenochaetaceae family in forest areas in these two municipalities.

MATERIAL AND METHODS

Study areas

The study areas are located in the municipalities of Tomé-Açu and Bujaru, in the state of Pará. Tomé-Açu is located at the geographic coordinates 2°24'53" S, 48°8'60" W (IBGE 2020), and Bujaru at the geographic coordinates 1°31'15" S and 48°2'37" W (Brasil 2022) (Figure 1). Collections were carried out in a total of five forest areas located in legal reserves of rural properties in these municipalities, called Sítio Ribeiro (2°15'41.50" S 48°18'53.27" W), Sítio Kenichi (2°39'16.00" S 48°23'59.00" W), and Sítio São Francisco (02°31'06.76" S 48°28'30.13" W) in Tomé-Açu and Fazenda Bom Intento (1°32'35.790" S 48°3'16.108" W) and Sítio Corrêa (1°30'51.204" S 48°2'29.160" W) in Bujaru.

Specimen collections

Eight collections were carried out along trails in primary and secondary forests between October 2021 and April 2022. The specimens were collected with the aid of a penknife with a portion of the substrate (trunks, fallen branches of decaying plants and soil). After removing the substrate, the material was placed in paper bags containing the main traits of the basidiomata, according to the methods proposed by Fidalgo & Bononi (1989).

Analysis and taxonomic identification of spe-

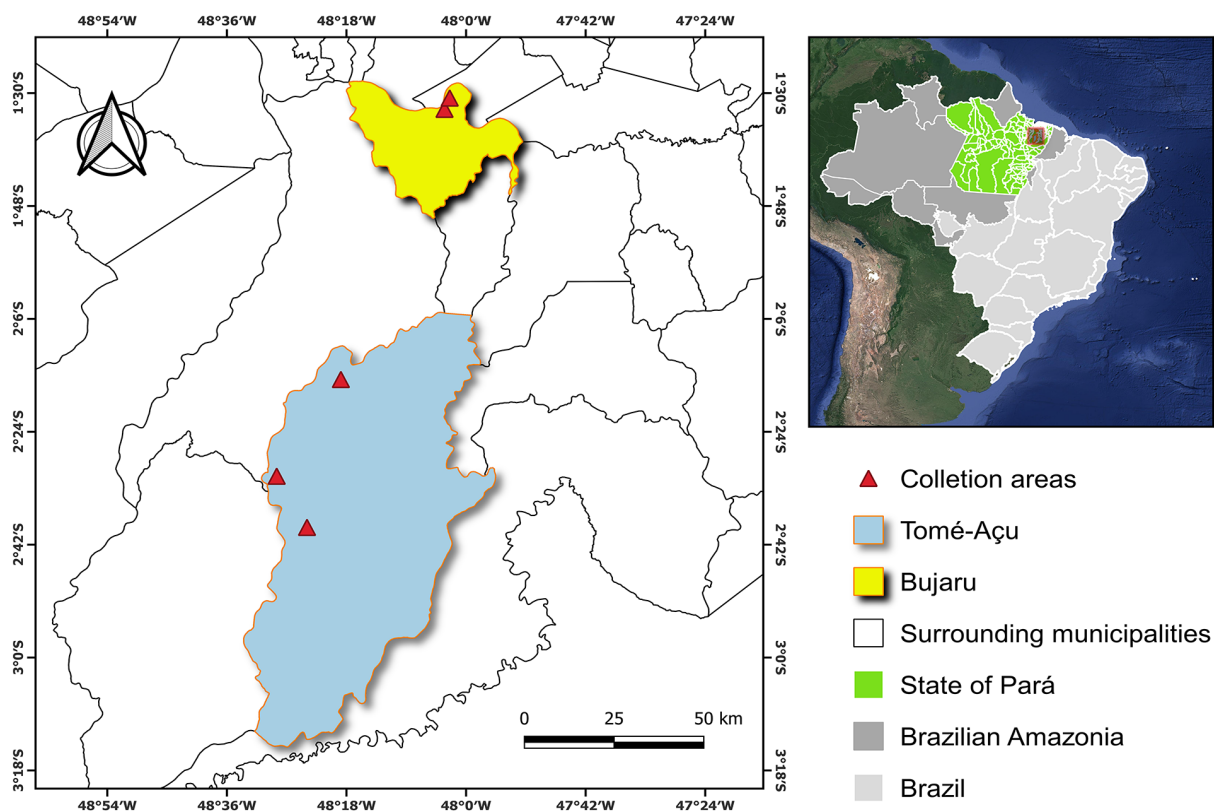


Figure 1. Studied areas in the state of Pará: in yellow the municipality of Bujaru and in blue, Tomé-Açu.

cimens

Macro- and micromorphological analyses of the samples were made. The former corresponds to the study of the characteristics of the context, tubes, margin and dimensions (width, length and thickness of caps and stipe and context, number of pores/mm on the hymenial surface). Micromorphological analyses were performed by hand-cutting thin fragments of the hymenial surface and the context of the specimens with the aid of steel blades. These sections were mounted between a slide and a coverslip in a 3% potassium hydroxide (KOH) plus 2% phloxine solution and observed under an optical microscope for identification of the following microstructures: basidia, basidiospores, hyphae, setae, and organization of the hyphal system (Teixeira 1995). Slides with samples were mounted in Melzer's reagent to determine the presence

of amyloid or dextrinoid reaction. In addition to the chemical reactions, the microstructures were analyzed in terms of shape, dimensions, type of ornamentation, and color (Ryvarden 2004).

The main identification keys used were Ryvarden (1991, 2004, 2005), Parmasto (2001), Baltazar et al. (2010), Gomes-Silva et al. (2012b, 2013), Groposo et al. (2007), Campos-Santana et al. (2013), Drechsler-Santos et al. (2016), Alves-Silva et al. (2020) Silva et al. (2021), and Lima et al. (2022).

The classification and nomenclature followed the databases Index Fungorum (<http://www.indexfungorum.org>) and Mycobank (<http://www.mycobank.org>). Data on basidiomata morphology, substrates, and geographic distribution in Brazil were checked on the Flora do Brasil (<http://floradobrasil.jbrj.gov>).

br), Specieslink (<http://www.splink.org.br>), and Global Biodiversity Information Facility (GBIF) (<https://www.gbif.org/>) databases. All specimens were deposited in the herbarium of the Museu Paraense Emílio Goeldi (MPEG).

RESULTS

Altogether, 15 specimens of Hymenochaetaceae were collected and identified (Table I). Based on the analyses, the specimens corresponded to 12 species represented in seven genera: *Coltricia* Gray, *Fomitiporia* Murrill, *Fulvifomes* Murrill, *Fuscoporia* Murrill, *Hymenochaete* Lév., *Phellinus* Quél., *Sclerotus* Xavier de Lima (Table I). Four species are new records for the state of Pará, namely, *Fomitiporia apiahyna* (Speg.) Robledo, Decock & Rajchenb, *Phellinus neocallimorphus* Gibertoni & Ryvarden, *Phellinus sancti-georgii* (Pat.) Ryvarden and *Sclerotus extensus* (Lév.) Xavier de Lima. Two among the latter are new records for the Brazilian Amazonia: *Phellinus neocallimorphus* and *P. sancti-georgii*.

Taxonomy

Coltricia cinnamomea (Jacq.) Murrill, Bulletin of the Torrey botanical Club 31(6): 343 (1904) (Fig. 2a-c and 5d)

Description: Ryvarden (2004).

Substrate: on soil.

Specimen examined: BRAZIL, state of Pará, municipality of Bujaru, Fazenda Bom Intento (1°32'35.790" S 48°3'16.108" W), October 2021, Silva EO, ES26 (MG202354).

Distribution in Brazil: Amazonas, Pará, Paraná, Pernambuco, Rondônia, Rio de Janeiro, Rio Grande do Sul, Sergipe (Flora do Brasil 2020).

Comments: The species has stipitate basidiomata, circular pileus, rigid consistency when dry, velvety reddish-brown abhymenial surface, cream hymenial surface, centralized stipe, thin context, large pores, 2–3 per mm, and

broadly ellipsoid basidiospores (9–10 × 6–6.5 μm). This species is characterized by stipitate, annual, circular basidiomata of brown to deep reddish-brown color with numerous concentric zones, cylindrical to flat stipe, brown hymenial surface, and oblong to broadly ellipsoid basidiospores (6.5–8 × 5–6 μm) (Ryvarden 2004). *Coltricia cinnamomea* is considered a morphologically variable species. The specimens from the Northern and Northeastern regions of Brazil have larger basidiospores than those described by Ryvarden (2004). The species showed is in the range of variation described by Ryvarden & Johansen (1980) (6–10 × 4.5–7 μm) and Corner (1991) (5–11 × 3.7–7.5 μm).

Coltricia hamata (Romell) Ryvarden, Svensk Botanisk Tidskrift 68: 276 (1974) (Fig. 3a-f)

Description: Ryvarden (2004).

Substrate: on soil.

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, KM 14 of Jamic, Sítio Kenichi (02°39'16.00" S 48°23'59.00" W), March 2022, Freire, RBM, RF74 (MG202355).

Distribution in Brazil: Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima (Gomes-Silva et al. 2009, 2012b, Soares et al. 2014, Flora do Brasil 2020).

Comments: The species has stipitate basidiomata leathery consistency when dry, brown abhymenial surface with black zones, brown centralized stipe, rusty brown hymenial surface, 4–5 pores per mm, hyphal setae, broadly ellipsoid basidiospores (5–5.7 × 5–5.5 μm). *Coltricia hamata* is characterized by a rusty to snuff-brown, finely tomentose to velvety, circular and infundibuliform pileus with a centralized stipe, snuff-brown pore surface, round to slightly angular pores, and hyphal setae present in the lower context and trama. This is the only Neotropical species of the genus that presents hyphal setae (Ryvarden 2004, Baltazar et al. 2010).

Table I. List of Hymenochaetaceae species collected and identified in the municipalities of Tomé-Açu and Bujaru. Legend: Sítio Ribeiro – SR, Sítio Kenichi – SK, Sítio São Francisco – SSF, Sítio Correa – SC, Fazenda Bom Intento – FBI.

Genera/species	Municipalities					Species voucher
	Tomé-Açu			Bujaru		
	SR	SK	SSF	SC	FBI	
Coltricia Gray						
<i>Coltricia cinnamomea</i> (Jacq.) Murrill					1	MG202354
<i>Coltricia hamata</i> (Romell) Ryvardeen		1				MG202355
Fomitiporia Murrill						
<i>Fomitiporia apiahyna</i> (Speg.) Robledo, Decock & Rajchenb.		1				MG202356
Fulvifomes Murrill						
<i>Fulvifomes fastuosus</i> (Lév.) Bondartseva & S.Herrera					1	MG202357
<i>Fulvifomes merrilli</i> (Murrill) Baltazar & Gibertoni					1	MG202358
Fuscoporia Murrill						
<i>Fuscoporia callimorpha</i> (Lév.) Groposo, Log.-Leite & Góes-Neto		2		1		MG202359 MG202360 MG202361
<i>Fuscoporia senex</i> (Nees & Mont.) Ghobad- Nejhad		1				MG202362
Hymenochaete Lév.						
<i>Hymenochaete damicornis</i> (Link) Lév.				2		MG202363 MG202364
Phellinus Quél.						
<i>Phellinus griseoporus</i> D.A.Reid	1					MG202365
<i>Phellinus neocallimorphus</i> Gibertoni & Ryvardeen			1			MG202366
<i>Phellinus sancti-georgii</i> (Pat.) Ryvardeen		1				MG202367
Sclerotus Xavier de Lima						
<i>Sclerotus extensus</i> (Lév.) Xavier de Lima			1			MG202368
Total of specimens	1	6	2	3	3	

Fomitiporia apiahyna (Speg.) Robledo, Decock & Rajchenb., Mycologia 102(6): 1315 (2010) (Fig. 5a)

Description: Ryvardeen (2004) as *Phellinus apiahynus* (Speg.) Rajchenb. & J.E. Wright

Substrate: on decayed wood.

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, KM 14 of Jamic, Sítio Kenichi (02°39'16.00"S 48°23'59.00"W), March 2022, Freire, RBM, RF85 (MG202356).

Distribution in Brazil: Amazonas, Bahia, Paraná, Pernambuco, Rio Grande do Sul, Santa

Catarina, São Paulo (Flora do Brasil 2020, Silva et al. 2021). First record for the state of Pará.

Comments: The species has pileate, perennial basidiomata with woody consistency, grooved and black abhymenial surface, rusty brown hymenial surface, yellow context, 7–9 pores per mm, and subglobose to globose, dextrinoid basidiospores. *Fomitiporia apiahyna* is characterized by the pileate, perennial basidiomata with a densely sulcate, brown glabrous upper surface and concentric zones of dark brown to black color, shining yellowish-brown context (up to 11 cm), grayish-brown hymenial surface, round pores, 6–9 per mm, absence of hymenial setae, subglobose basidiospores, and dextrinoid reaction in

Melzer's reagent (Ryvarden 2004, Alves-Silva et al. 2020).

Fulvifomes fastuosus (Lév.) Bondartseva & S.Herrera, Mikol. Fitopatol. 26(1): 13 (1992)

Description: Ryvarden (2004) as *Phellinus fastuosus* (Lév.) S. Ahmad

Substrate: on decayed wood.

Specimen examined: BRAZIL, state of Pará, municipality of Bujaru, Fazenda Bom Intento (01°32' 35.790" S 48°3'16.108" W), October 2021, Silva EO, ES31 (MG202357).

Distribution in Brazil: Alagoas, Amazonas, Bahia, Maranhão, Mato Grosso, Pará, Paraíba, Paraná, Pernambuco, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina (Flora do Brasil 2020).

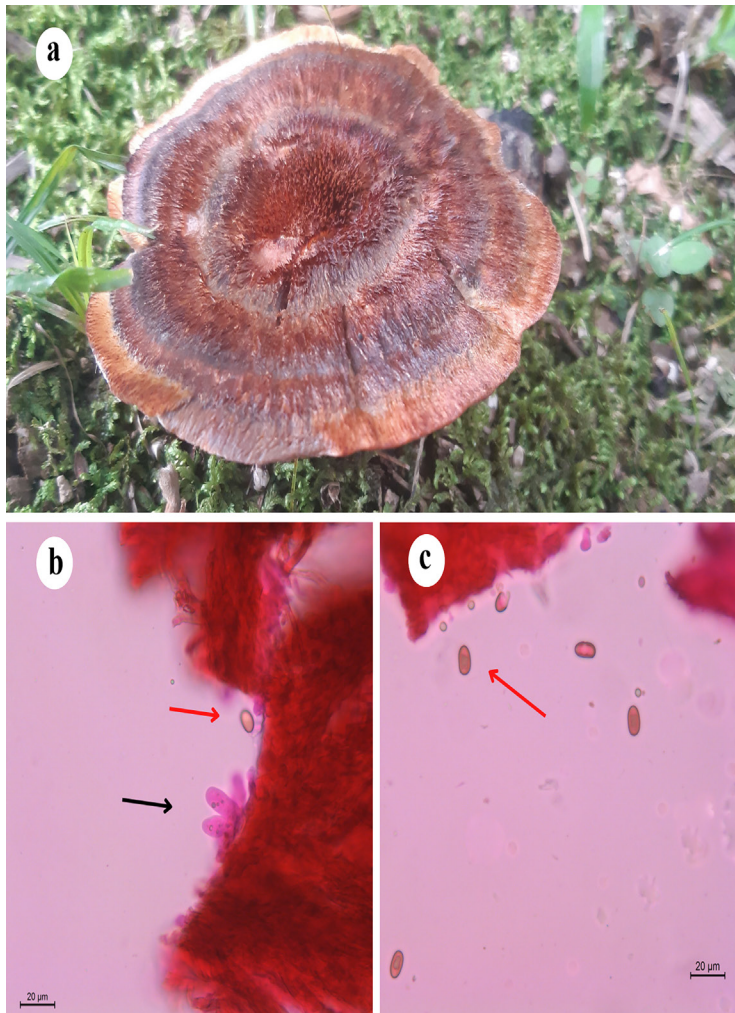


Figure 2. *Coltricia cinnamomea*. a. basidiomata; b. basidia (black setae) and basidiospores (red setae); c. basidiospores (red setae). Scale Bar: 20µm (b-c).

Comments: The specimen was identified by Ryvarden (2004) as *Fulvifomes fastuosus* based on the following characters: pileate basidiomata, woody consistency when dry, rusty brown abhymenial surface, golden yellow hymenial surface, 7–10 pores per mm; absence of hyphal and hymenial setae; subglobose basidiospores ($4.5\text{--}6(-6.5) \times 4\text{--}5.5 \mu\text{m}$).

Fulvifomes merrillii (Murrill) Baltazar & Gibertoni, Mycotaxon 111: 206 (2010) (Fig. 5b)

Description: Ryvarden (2004) as *Phellinus merrillii* (Murrill) Ryvarden

Substrate: on decayed wood.

Specimen examined: BRAZIL, state of Pará, municipality of Bujaru, Fazenda Bom Intento ($1^{\circ}32' 35.790''\text{S } 48^{\circ}3'16.108''\text{W}$), February 2022, Silva EO, ES130 (MG202358).

Distribution in Brazil: Bahia, Pará, Paraná, Pernambuco, Rondônia, Tocantins (Gomes-Silva et al. 2009, Soares et al. 2014, Flora do Brasil 2020).

Comments: The species analyzed has a pileate basidiomata, woody consistency when dry, yellowish brown abhymenial surface, golden yellow brown margin, brown hymenial surface, ferruginous brown trama, round pores, 7–9 pores

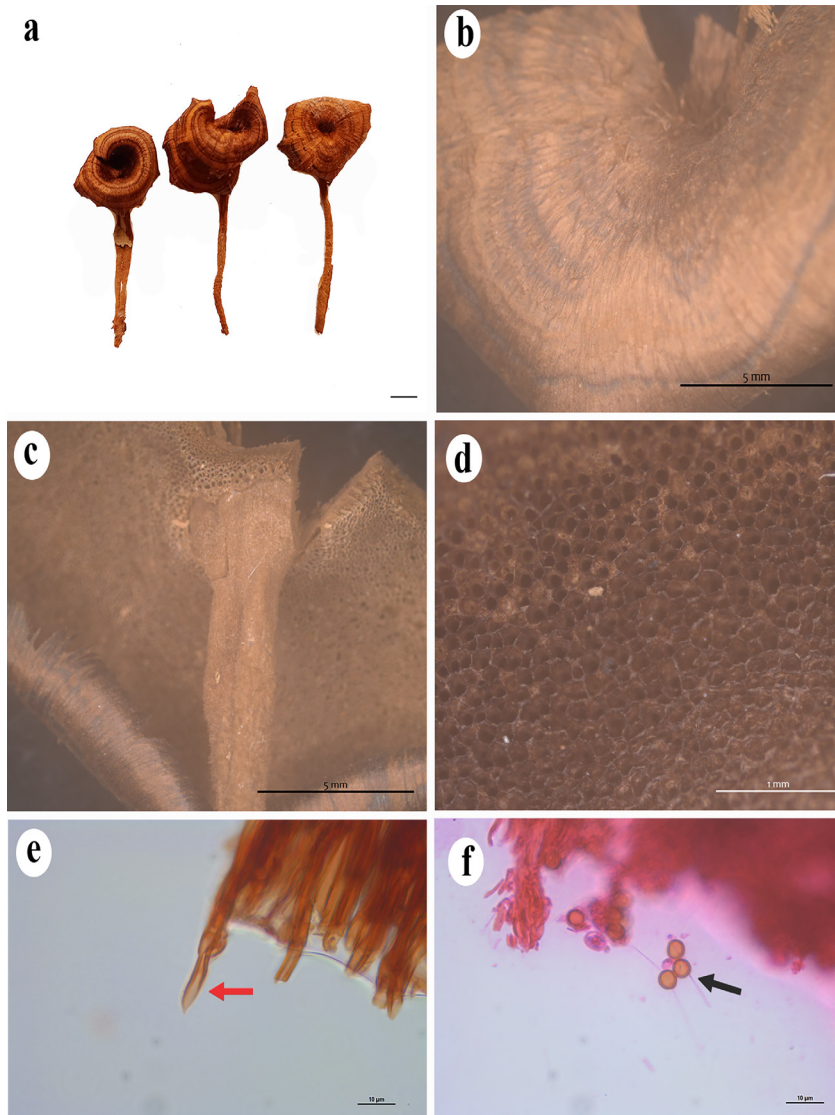


Figure 3. *Coltricia hamata*.
a. stipitate basidiomata;
b. abhymenial surface;
c-d. hymenial surface; **e.**
 hyphal setae (red setae); **f.**
 basidiospores (black setae).
 Scale Bar: 1cm (a); 5mm (b-
 c); 1mm (d); 10µm (e-f).

per mm, non-dextrinoid globose basidiopores, hymenial setae absent. *Fulvifomes merrillii* is characterized by perennial, sessile, dimidiate to unguulate basidiomata with a matted tomentose to coarsely scurpuse, rugose and shallowly concentric sulcate upper surface of reddish brown color; small round pores, 7–10 per mm, hymenial setae or other hymenial elements absent, and subglobose to globose basidiospores (5–6 × 4–5 µm) (Ryvarden 2004). Few differences were found in this specimen when compared with the ones described in Ryvarden (2004), but these differences are in the range of variation. Also, the globose, yellow to brown basidiospores are a remarkable character to recognize this species (Gomes-Silva et al. 2009).

Fuscoporia callimorpha (Lév.) Groposo, Log.-Leite & Góes-Neto, Mycotaxon 101: 57 (2007)

Description: Ryvarden & Johansen (1980) as *Phellinus callimorphus* (Lév.) Ryvarden

Substrate: on unknown angiosperm wood.

Specimens examined: BRAZIL, state of Pará, municipality of Bujaru, Sítio Corrêa (01°30'51.204" S 48°2'29.160" W), December 2021, Silva EO, ES83 (MG202359); municipality of Tomé-Açu, KM 14 of Jamic, Sítio Kenichi (02°39'16.00" S 48°23'59.00" W), March 2022, Freire RBM, RF76/RF94 (MG202360, MG202361).

Distribution in Brazil: Amapá, Mato Grosso, Pará, Paraíba, Pernambuco, Rondônia, Santa Catarina, São Paulo (CRIA 2021).

Comments: The species has pileate basidiomata, woody consistency when dry, brown abhymenial surface, cream hymenial surface, round pores, 8 per mm, and small tramal setae. *Fuscoporia callimorpha* is characterized by the pileate, flattened, dimidiate to cupped, widely inserted, semicircular to elongated basidiomata, round pores, 7–10 per mm, and presence of hymenial and hyphal setae (Ryvarden & Johansen 1980).

Fuscoporia senex (Nees & Mont.) Ghobad-Nejhad, Mycotaxon 101: 208 (2007)

Description: Nuñez & Ryvarden (2000) as *Phellinus senex* (Nees & Mont.) Imazeki

Substrate: on decayed wood.

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, KM 14 of Jamic, Sítio Kenichi (02°39'16.00" S 48°23'59.00" W), March 2022, Freire RBM, RF98 (MG202362).

Distribution in Brazil: Amazonas, Bahia, Maranhão, Mato Grosso do Sul, Pará, Paraná, Pernambuco, Santa Catarina, São Paulo (Flora do Brasil 2020).

Comments: Our specimen was identified by the following characters: pileate basidiomata broadly attached to the substrate, woody consistency, presenting mosses on the upper surface, rusty brown context, trama and hymenial surface, lacking a black line at the base, and presence of hymenial setae. *Fuscoporia senex* is characterized by the perennial, solitary to imbricate basidiomata, eventual presence of a darker line in context, seen below the tomentum, round and small pores, 7–11 per mm, straight or hook-shaped, thick-walled hymenial setae, and broadly ellipsoid basidiospores (4.5–6 × 3.5–5 µm) (Ryvarden 2004, Groposo et al. 2007).

Hymenochaete damicornis (Link) Lév., Annales des Sciences Naturelles Botanique 5: 151 (1846) (Fig. 5e)

Description: Parmasto (2001).

Substrate: on soil.

Specimens examined: BRAZIL, state of Pará, municipality of Bujaru, Sítio Corrêa (01°30'51.204" S 48°2'29.160" W), March 2022, Silva EO, ES152/ES153 (MG202363, MG202364).

Distribution in Brazil: Acre, Alagoas, Amazonas, Mato Grosso, Pará, Pernambuco, Piauí, Rio Grande do Sul, Rondônia, Roraima, Sergipe, Santa Catarina, São Paulo (Flora do Brasil 2020).

Comments: This species presents stipitate basidiomata, leathery consistency when dry, brown, densely zonate abhymenial surface with a cream border, smooth and brown hymenial surface, thick context, brown stipe, and hymenial setae. Parmasto (2001) distinguished *Hymenochaete damicornis* by its stipitate, infundibuliform, flabelliform to spatulate basidiomes, smooth cinnamon to brown hymenial surface, stipe composed of densely interwoven hyphae, and absence of hyphal setae, rare scattered or numerous hymenial setae, and broadly ellipsoidal basidiospores. *Hymenochaete damicornis* can be found individually, as well as in cauliflower form.

Phellinus griseoporus D.A.Reid, *Memoirs of the New York Botanical Garden* 28: 192 (1976)

Description: Ryvar den (2004).

Substrate: on decayed wood.

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, Vila Socorro, Sítio Ribeiro (02°15'41.50" S 48°18'53.27" W), October 2021, Freire RBM, RF23 (MG202365).

Distribution in Brazil: Amapá, Pará, Rondônia (Gomes-Silva et al. 2009; Soares et al. 2014, *Flora do Brasil* 2020).

Comments: This species presents perennial, pileate basidiomata, woody consistency, dark brown abhymenial surface, brownish hymenial surface, round pores, 8 per mm, globose basidiospores, and hymenial and trama setae are absent. *Phellinus griseoporus* is characterized by perennial, solitary, pileate, dimidiate to semicircular basidiomata, gray upper surface, generally brownish hymenial surface, round and regular pores, 6–7 per mm, absence of hymenial setae, and globose, hyaline basidiospores (4.0–5.5 µm in diam) (Ryvar den 2004, Gomes-Silva et al. 2009).

Phellinus neocallimorphus Gibertoni & Ryvar den, *Synopsis Fungorum* 18: 53 (2004) (Fig. 4a-b and 5a)

Description: Ryvar den (2004).

Substrate: on living angiosperm tree (*Inga* sp.).

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, Vila forquilha, Sítio São Francisco (02°31'06,76" S 48°28'30,13" W), April 2022, Castro TC, TC145 (MG202366).

Distribution in Brazil: Alagoas, Pernambuco (*Flora do Brasil* 2020). First record for the state of Pará.

Comments: The species analyzed has perennial, pileate basidiomata, woody consistency when dry, rounded margins, brown abhymenial surface with presence of mosses (fig. 4b), brown hymenial surface, 7–9 pores per mm, oblong ellipsoid to subglobose basidiospores (4–4.5 × 4–5 µm) and lacks hyphal and trama setae. According to Ryvar den (2004), *Phellinus neocallimorphus* is characterized by perennial, flattened, dimidiate to broadly attached, semicircular to elongated basidiomata with rounded margin, dark reddish-brown to black abhymenial surface, cinnamon to deep dark brown hymenial surface, 7–9 pores per mm, no hymenial setae, ellipsoid oblong to subcylindrical, hyaline to pale yellow basidiospores (3.5–4.5 × 2–2.5 µm).

Phellinus sancti-georgii (Pat.) Ryvar den, *Norwegian Journal of Botany* 19: 235 (1972)

Description: Ryvar den (2004).

Substrate: on hard wood.

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, KM 14 of Jamic, Sítio Kenichi (02°39'16.00" S 48°23'59.00" W), March 2022, Freire RBM, RF86 (MG202367).

Distribution in Brazil: Bahia, Parará (*Flora do Brasil* 2020). First record for the state of Pará.

Comments: The specimen analyzed in this study is pileate to dimidiate, woody consistency when dry, rusty brown abhymenial surface, cinnamon context, golden-yellow hymenial

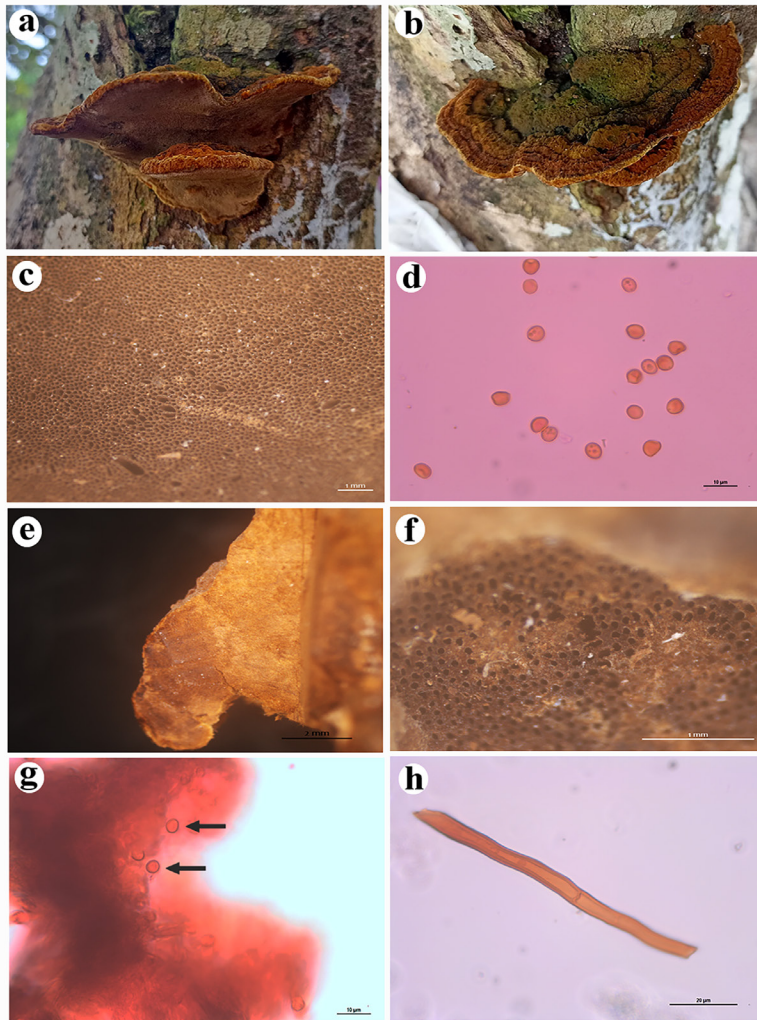


Figure 4. *Phellinus neocallimorphus*. a-b. basidiomata; c. hymenial surface; d. basidiospores. *Phellinus sancti-georgii*. e. details of context; f. hymenial surface; g. basidiospores (black setae); h. generative hyphae. Scale Bar: 1mm (c,f); 10 μ m (d,g); 2mm (e); 20 μ m (h).

surface, black line below the tomentum, round pores, 5–7 per mm, hymenial setae absent, oblong ellipsoid, reddish-brown basidiospores (3.8–4 \times 4.1 μ m). *Phellinus sancti-georgii* is known by its perennial, pileate, semicircular, unguulate to slightly dimidiate basidiomata, rusty brown pileus with narrow sulcate zones, rusty brown hymenial surface, round pores, 6–8 per mm, absence of hymenial setae, and the globose to broadly ellipsoid, reddish-brown basidiospores (4–5 (6) \times 3.5–4 μ m) (Ryvarden 2004).

Sclerotus extensus (Lév.) Xavier de Lima, *Cryptogamie, Mycologie* 43(1): 10 (2022) (Fig. 5f)

Description: Lima et al. (2022).

Substrate: on angiosperm tree.

Specimen examined: BRAZIL, state of Pará, municipality of Tomé-Açu, KM 14 of Jamic, Sítio Kenichi (02°39'16.00"S 48°23'59.00"W), March 2022, Freire RBM, RF83 (MG202368).

Distribution in Brazil: Amapá (Lima et al. 2022). First record for the state of Pará.

Comments: The species presents pileate basidiomata, black zones in the pileus, woody consistency when dry, yellowish-brown abhymenial surface, golden-yellow hymenial surface, 10 pores per mm, hymenial setae, and small and subglobose basidiospores. According to Lima et al. (2022), *Sclerotus extensus* is characterized by perennial, pileate basidiomata, presence of strongly ventricose and dark

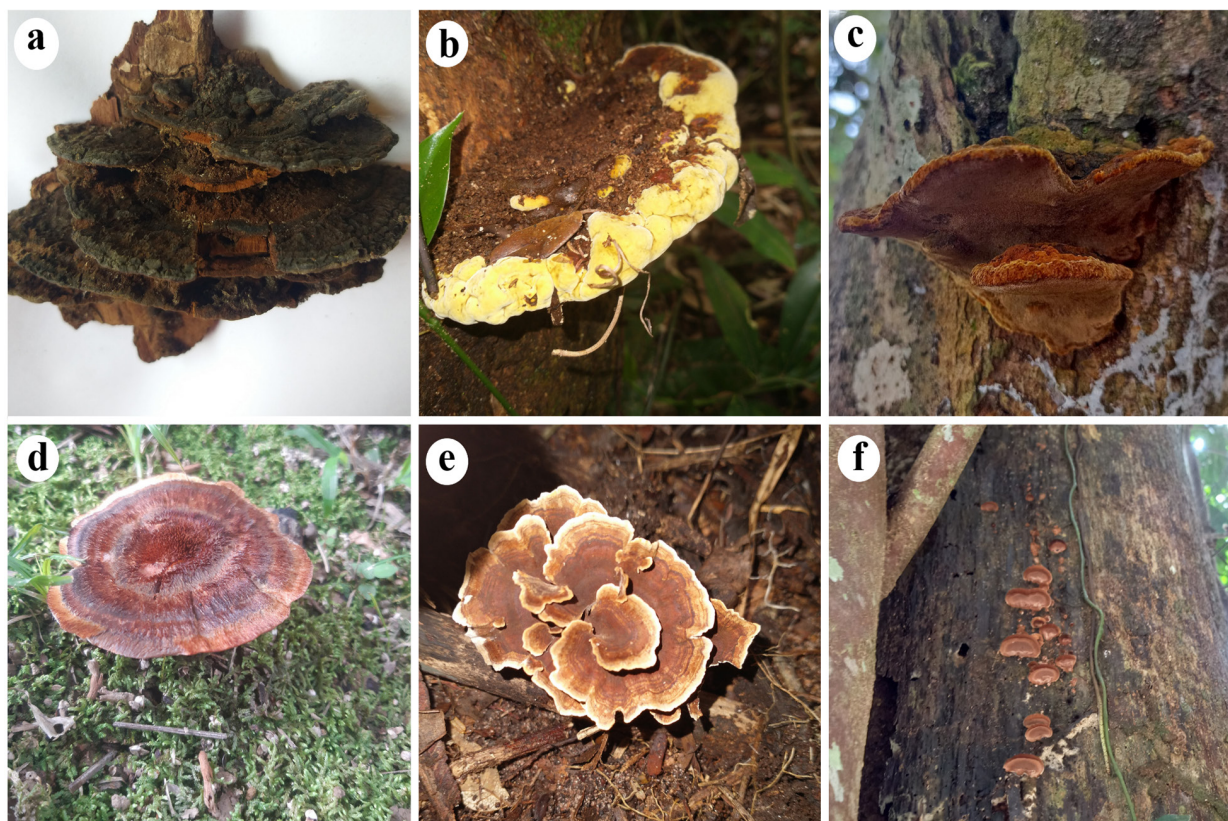


Figure 5. a. *Fomitiporia apiahyna*; b. *Fulvifomes merrillii*; c. *Phellinus neocallimorphus*; d. *Coltricia cinnamomea*; e. *Hymenochaete damicornis*; f. *Sclerotus extensus*.

hymenial setae, and a thick black line that is exposed after the tomentum wears away, and ellipsoid to globose basidiospores. The black line and globose basidiospores were found in the specimen analyzed.

DISCUSSION

In this study, all species are registered for the first time in the municipalities of Bujaru and Tomé-Açu; four species are new records for the state of Pará, and two of them are new records for the Brazilian Amazonia. The Flora do Brasil database (2020) presented 43 species of Hymenochaetaceae registered for the Brazilian Amazonia and recent taxonomical studies, including this family, also expanded the knowledge of the distribution of the

species (Soares et al. 2014, Silva et al. 2021, Couceiro et al. 2022). However, the new records found demonstrated the importance of fungal inventories in different areas of the Amazonia, to understand the true diversity.

Fuscoporia was the most representative genera in this study, with four specimens and two species identified, *Fuscoporia callimorpha* and *Fuscoporia senex*. *Fuscoporia callimorpha* showed the largest number of specimens (3) and the only one collected in more than one study area, sítio Kenichi (2 occurrences) and sítio Corrêa (1 occurrence), but no host preference was found. Studies on *Fuscoporia callimorpha* demonstrated that species could be classified as rare or occasional (Xavier et al. 2018, Couceiro et al. 2022).

The great representation of *Fuscoporia* species in forest areas is cited by Pires & Gugliotta (2016). These authors found 24 species of Hymenochaetaceae, among them seven of *Fuscoporia*. The genus also stood out as the third richest genus (7 species), behind only *Phellinus* and *Hymenochaete*, in the study by Lira et al. (2015), who compiled species of Hymenochaetaceae occurring in Northeast Brazil based on a review of the literature and herbarium samples.

In the present survey, *Phellinus neocallimorphus* and *P. sancti-georgii* had a geographic distribution that did not include the Brazilian Amazonia and are, therefore, being reported for the first time from this region. *Phellinus neocallimorphus* was registered in the states of Alagoas and Pernambuco, while *P. sancti-georgii* in the states of Bahia and Paraná (Flora do Brasil 2020). *Phellinus sancti-georgii* was known to occur in the Amazonian phytogeographic domain only in Venezuela (Ryvarden 2004, GBIF 2021).

Fomitiporia apiahyna and *Sclerotus extensus* are new records for the state of Pará. *Fomitiporia apiahyna* was formerly registered only in the state of Amazonas and *Sclerotus extensus* in Amapá (Silva et al. 2021, Lima et al. 2022).

In a study on polyporoid fungi conducted in the Amapá National Forest, Soares et al. (2014) identified 16 species belonging to Hymenochaetaceae. Four of these species were also found in the present work (*Coltricia hamata*, *Fulvifomes fastuosus*, *F. merrillii*, *Phellinus griseoporus*). Hymenochaetaceae was the second most representative family, with 17 species, in the study by Xavier et al. (2018) with poroid Agaricomycetes from the municipality of Serra do Navio, in the state of Amapá.

Alves-Silva et al. (2020) highlighted that species of the Hymenochaetales group show a low level of variation in their morphological features

and this prevents the accurate identification at the species level by taxonomists, which is known as the species complex hypothesis. In fact, some species identified in the present study, such as *Fuscoporia callimorpha*, showed low variation of features, exhibiting similar morphological characters as other *Fuscoporia* species (Chen et al. 2020). Therefore, ecological data and molecular tools are needed for a better delimitation of the species.

CONCLUSIONS

This study contributes to the taxonomic knowledge of Hymenochaetaceae from the state of Pará, being the first conducted on this family in the municipalities of Tomé-Açu and Bujaru. The study also contributed with two new records for the Amazonia region. It was not possible to carry out molecular analyses, but this tool is necessary to delimitate the species found here in further studies. Thus, it is important that new taxonomic studies be carried out in order to deepen the knowledge on the fungal biodiversity of the Brazilian Amazonia region.

Acknowledgments

The authors thank the Universidade Federal Rural da Amazônia and Museu Paraense Emílio Goeldi for support during the fieldtrips and provide the materials to identify the specimens analyzed in this study.

REFERENCES

- ALVES-SILVA G, RECK MA, SILVEIRA RMB, BITTENCOURT F, ROBLEDO GL, GÓES-NETO A & DRECHSLER-SANTOS ER. 2020. The Neotropical *Fomitiporia* (Hymenochaetales, Basidiomycota): the redefinition of *F. apiahyna* s.s. allows revealing a high hidden species diversity. *Mycol Progress* 19: 769-790.
- ARAGÃO L. 2012. The rainforest's water pump. *Nature* 489 (1): 217-225.

- BALTAZAR JM, RYVARDEN L & GIBERTONI TB. 2010. The genus *Coltricia* in Brazil: new records and two new species. *Mycologia* 102(6): 1253-1262.
- BOLFE EL & BATISTELLA M. 2011. Análise florística e estrutural de sistemas silviagrícolas em Tomé-Açu, Pará. *Pesq Agropec Bras* 46(10): 1139-1147.
- BRASIL. 2022. Município de Bujaru. Available in: <https://www.cidade-brasil.com.br/municipio-bujaru.html>. Access: 16 apr. 2022.
- CAMPOS-SANTANA M, AMALFI M, ROBLEDO G, SILVEIRA RMB & DECOCK C. 2013. *Fomitiporia neotropica*, a new species from South America evidenced by multilocus phylogenetic analyses. *Mycol Progress* 13(3): 601-615.
- CAMPOS-SANTANA M, ROBLEDO G, DECOCK C & SILVEIRA RMB. 2015. Diversity of the Poroid Hymenochaetaceae (Basidiomycota) from the Atlantic Forest and Pampa in Southern Brazil. *Cryptogam Mycol* 36(1): 43-78.
- CANNON PF & KIRK PM. 2007. Fungal families of the world. CABI 1-456.
- CHEN Q, DU P, VLASÁK J, WU F & DAI YC. 2020. Global diversity and phylogeny of *Fuscoporia* (Hymenochaetales, Basidiomycota). *Mycosphere* 11(1): 1477-1513.
- CORNER EJH. 1991. Ad Polyporaceas VII: The Xanthochroic Polypores. *Beih Nova Hedwig* 101: 1-175.
- COUCEIRO DM, SOARES AMS & COUCEIRO SRM. 2022. Contribution to the knowledge of Polypores (Agaricomycetes) in the Amazonian Forest, with 16 new records for the state of Pará, Brazil. *Res Soc Dev* 11: 1-15.
- CRIA - CENTRO DE REFERÊNCIA E INFORMAÇÃO AMBIENTAL. 2022. [s. d.]. SpeciesLink. Available in: <https://specieslink.net/>. Access: 28 may 2022.
- DAI YC. 2010. Hymenochaetaceae (Basidiomycota) in China. *Fungal Divers* 45:131-343.
- DONK MA. 1948. Notes on Malesian fungi. *Bull Bot Gard Buitenz III* 17: 473-482.
- DRECHSLER-SANTOS ER, ROBLEDO G, LIMA-JÚNIOR NC, MALOSSO E, RECK MA, GIBERTONI TB, CAVALCANTI MAQ & RAJCHENBERG. 2016. *Phellinotus*, a new neotropical genus in the Hymenochaetaceae (Basidiomycota, Hymenochaetales). *Phytotaxa* 261: 218-239.
- FIDALGO O & BONONI VL. 1989. Guia de coleta, preservação e herborização de material botânico. Instituto de Botânica, São Paulo.
- FLORA DO BRASIL. 2020. Jardim Botânico do Rio de Janeiro. Available in: <http://floradobrasil.jbrj.gov.br/>. Access: 25 apr. 2022.
- GILL M & STEGLICH W. 1987. Pigments of Fungi (Macromycetes). In: Fortschritte Der Chemie Organischer Naturstoffe. Progress in the Chemistry of Organic Natural Products, vol. 51. Springer, Vienna, 1-297.
- GBIF - GLOBAL BIODIVERSITY INFORMATION FACILITY. 2021. Backbone Taxonomy. Checklist dataset. Available in: <https://doi.org/10.15468/39omei>. Access: 30 may 2022.
- GOMES-SILVA AL & GIBERTONI TB. 2009a. Revisão do Herbário URM. Novas ocorrências de Aphyllophorales para a Amazônia brasileira. *Rev Bras Bot* 32(3): 587-596.
- GOMES-SILVA AC, BALTAZAR JM & GIBERTONI TB. 2012b. *Coltricia* and *Hymenochaete* (Hymenochaetaceae) from the Amazonia and the Atlantic Forest, Brazil: One new combination and new records. *J Torrey Bot Soc* 139(4): 428-436.
- GOMES-SILVA AL & GIBERTONI TB. 2009b. Checklist of the aphyllophoraceous fungi (Agaricomycetes) of the Brazilian Amazonia. *Mycotaxon* 108: 319-322.
- GOMES-SILVA AC, RYVARDEN L & GIBERTONI TB. 2009. New and interesting species of Hymenochaetaceae from the Brazilian Amazonia. *Mycol Progress* 8: 273-279.
- GOMES-SILVA AC, RYVARDEN L & GIBERTONI TB. 2012a. Two new species of *Phellinus* s.l. from the Brazilian Amazonia. *Phytotaxa* 67: 55-60.
- GOMES-SILVA AC, RYVARDEN L & GIBERTONI TB. 2013. *Inonotus amazonicus* sp. nov., *I. calcitratus* comb. nov. and notes on *Phylloporia* (Hymenochaetaceae, Agaricomycetes) from the Brazilian Amazonia. *Mycoscience* 54: 116-121.
- GROPOSO C, LOGUERCIO-LEITE C, GÓES-NETO A. 2007. *Fuscoporia* (Basidiomycota, Hymenochaetales) in southern Brazil. *Mycotaxon* 101: 55-63.
- IBGE - INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. 2020. Censo Demográfico. Available in: <https://www.ibge.gov.br/estatisticas/downloads-estatisticas.html>. Access: 10 set. 2020.
- JÚNIOR ASM, GIBERTONI TB & SOTÃO HMP. 2011. Espécies de *Ganoderma* P. Karst (Ganodermataceae) e *Phellinus* Quél. (Hymenochaetaceae) na Estação Científica Ferreira Penna, Pará, Brasil. *Acta Bot Bras* 25: 531-533.
- LARSSON KH, PARMASO E, FISCHER M, LANGER E, NAKASONE KK & REDHEAD SA. 2006. Hymenochaetales: a molecular phylogeny for the hymenochaetoid clade. *Mycologia* 98(6): 926-936.
- LIMA VX DE, OLIVEIRA VRT DE, LIMA-JUNIOR NC DE, OLIVEIRA-FILHO JRC, SANTOS C, LIMA N & GIBERTONI TB. 2022. Taxonomy and phylogenetic analysis reveal one new genus and

three new species in *Inonotus* s.l. (Hymenochaetaceae) from Brazil. *Cryptogam Mycol* 43(1): 1-21.

LIRA CRS, NOGUEIRA-MELO G, RYVARDEN L & GIBERTONI TB. 2015. Checklist of Hymenochaetaceae from Northeast Brazil. *Mycotaxon* 130: 1213.

MORERA G, ROBLEDO G, FERREIRA-LOPES V & URCELAY C. 2017. South American *Fomitiporia* (Hymenochaetaceae, Basidiomycota) 'jump on' exotic living trees revealed by multi-gene phylogenetic analysis. *Phytotaxa* 321: 277-286.

NÚÑEZ M & RYVARDEN L. 2000. East Asian polypores. *Syn Fungorum* 13: 1-168.

OLIVEIRA VRT, LIMA VX, OLIVEIRA-FILHO JRC & GIBERTONI TB. 2022. Three new species of *Fulvifomes* (Hymenochaetales, Basidiomycota) from Brazil. *Sydowia* 75: 1-12.

PACHECO NA & BASTOS TX. 2001. Caracterização climática do município de Tomé-Açu, PA. *Embra Amaz Oriental* 1-18.

PARMASTO E. 2001. Hymenochaetoid fungi (Basidiomycota) of North America. *Mycotaxon* 79: 107-176.

PARMASTO E & PARMASTO I. 1979. The xanthocroic reaction in Aphyllophorales. *Mycotaxon* 8(1), 201-232.

PIRES RM & GUGLIOTTA AM. 2016. Poroid Hymenochaetaceae (Basidiomycota) from Parque Estadual da Serra do Mar, Núcleo Santa Virgínia, São Paulo, Brazil. *Rodriguésia* 67(3): 667-676.

RODRIGUES TE, SANTOS PL, SILVA JML, VALENTE MA, SANTOS E & ROLIM PAM. 2003. Caracterização e classificação dos solos do município de Bujaru. *Embrapa* 165: 1-44.

RYVARDEN L. 1991. Genera of Polypores-Nomenclature and Taxonomy. *Syn Fungorum* 5: Fungiflora, Oslo. 1-363.

RYVARDEN L. 2004. Neotropical polypores Part 1: Introduction, Ganodermataceae & Hymenochaetaceae *Syn Fungorum* 19: 1-229.

RYVARDEN L. 2005. The genus *Inonotus* a synopsis. *Syn Fungorum* 21: 24-143.

RYVARDEN L & JOHANSEN GJ. 1980. A preliminary polypore flora of East Africa. *Fungiflora*: 1-636.

SILVA MA, JESUS MA, PERES RS & SALES-CAMPOS C. 2021. Notes on *Fomitiporia* Murrill in Amazon region: a list of species and new records. *Check List* 17(2): 323-331.

SOARES AMS, SOTÃO HMP, MEDEIROS PS & GIBERTONI T. 2014. Riqueza de fungos poliporoides (Agaricomycetes, Basidiomycota) em uma floresta ombrófila densa no Amapá, Amazônia brasileira. *Bol Mus Biol Mello Leitão* 35: 5-18.

SOARES AMS, OLIVEIRA-FILHO JRC, GOMES-SILVA AC, RYVARDEN L & GIBERTONI TB. 2018. Notes on some poroid

Hymenochaetaceae from Brazil: one new species, two new combinations and one synonymy. *Syn Fungorum* 38: 56-61.

TEDERSOO L, SUVI T, BEAVER K & SAAR I. 2007. Ectomycorrhizas of *Coltricia* and *Coltriciella* (Hymenochaetales, Basidiomycota) on Caesalpiniaceae, Dipterocarpaceae and Myrtaceae in Seychelles. *Mycol Progress* 6(2): 101-107.

TEDERSOO L, MAY TW & SMITH ME. 2010. Ectomycorrhizal lifestyle in fungi: global diversity, distribution, and evolution of phylogenetic lineages. *Mycorrhiza* 20(4): 217-263.

TEIXEIRA AR. 1995. Método para estudo das hifas do basidiocarpo de fungos poliporáceos. *Inst Bot*: 1-20.

VASCO-PALACIOS AM, HERNANDEZ J, PEÑUELA-MORA MC, FRANCO-MOLANO AE & BOEKHOUT T. 2018. Ectomycorrhizal fungi diversity in a white sand forest in western Amazonia. *Fungal Ecology* 31: 9-18.

WAGNER T & FISCHER M. 2002. Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetic relationships of allied genera. *Mycologia* 94(6): 998-1016.

WIJAYAWARDENE NN ET AL. 2022. Outline of Fungi and fungus-like taxa – 2021. *Mycosphere* 13(1): 53-453.

XAVIER WKS, SOTÃO HMP, SOARES AMS, GIBERTONI TB, RODRIGUES FJ & RYVARDEN L. 2018. Riqueza de Agaricomycetes poroides da Serra do Navio, Amazônia oriental, com novo registro de *Oxyporus lacera* para o Brasil. *Bol Mus Para Emílio Goeldi Cienc Nat* 13(3): 303-315.

How to cite

FREIRE RBM & SOARES AMS. 2024. Taxonomic study of Hymenochaetaceae species (Agaricomycetes, Basidiomycota) in the municipalities of Tomé-Açu and Bujaru, Pará, Brazil. *An Acad Bras Cienc* 96: e20230338. DOI 10.1590/0001-3765202420230338.

*Manuscript received on March 29, 2023;
accepted for publication on October 20, 2023*

RICHARD BRUNO M. FREIRE¹

<https://orcid.org/0000-0002-9527-0833>

ADRIENE MAYRA S. SOARES^{1,2}

<https://orcid.org/0000-0002-1143-0706>

¹Universidade Federal Rural da Amazônia, Laboratório de Botânica/Micologia, Centro de Ciências Biológicas, Campus Tomé-Açu, Rodovia PA-451 Km 03, 68680-000 Tomé-Açu, PA, Brazil

²Museu Paraense Emílio Goeldi, Coordenação de Botânica, Laboratório de Micologia, Avenida Perimetral, 1901, Terra Firme, 66077-530 Belém, PA, Brazil

Correspondence to: **Richard Bruno Mendes Freire**

E-mail: richard.b.m.freire@gmail.com

Author contributions

Richard Bruno Mendes Freire and Adriene Mayra da Silva Soares collected, analyzed and identified the samples. Richard Bruno Mendes Freire was responsible for taking the photographs and preparing the plates. Both authors wrote the manuscript.

