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LUCAS LEONARDO DA SILVA

Desvendando as orelhas-de-pau do Cerrado: um estudo taxonômico, ecológico e biotecnológico de fungos corticioides e poroides

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Lucas Leonardo da Silva

Desvendando as orelhas-de-pau do Cerrado: um estudo taxonômico, ecológico e biotecnológico de fungos corticioides e poroides

Tese apresentada ao Programa de Pós-Graduação *Stricto Sensu* em Recursos Naturais do Cerrado, da Universidade Estadual de Goiás para obtenção do título de Doutor em Recursos Naturais do Cerrado.
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ESTADO
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PROGRAMA DE PÓS-GRADUAÇÃO *STRICTO SENSU* EM RECURSOS NATURAIS DO CERRADO

ATA DE DEFESA PÚBLICA DE TESE Nº 125/2022

Ao primeiro dia do mês de Novembro do ano de 2022, às 13h30min, reuniu-se no auditório do Centro de Pesquisa e Ensino de Ciências do Câmpus Central da UEG, a banca Examinadora composta pelos: Dra. Solange Xavier dos Santos (Universidade Estadual de Goiás), Dr. Vagner Gularte Cortez (Universidade Federal do Paraná), Dr. Renato Lúcio Mendes Alvarenga(Universidade Federal de Pernambuco), Dr. Jadson Diogo Pereira Bezerra (Universidade Federal de Goiás), Dra. Hélida Ferreira da Cunha (Universidade Estadual de Goiás) para sob a presidência do primeiro, procederem à “defesa de doutorado” intitulada: Desvendando as orelhas-de-pau do Cerrado: um estudo taxonômico, ecológico e biotecnológico de fungos corticioides e poroides, de Lucas Leonardo da Silva, discente do PPG Recursos Naturais do Cerrado, nível doutorado. Foi realizada a avaliação oral no sistema de apresentação e defesa de tese de autoria do discente. Terminada a avaliação oral, a Banca Examinadora reuniu-se emitindo os seguintes pareceres mediante as justificativas e sugestões abaixo:

Membro da Banca	Aprovado	Reprovado
Dra. Solange Xavier dos Santos	X	
Dr. Vagner Gularte Cortez	X	
Dr. Renato Lúcio Mendes Alvarenga	X	
Dr. Jadson Diogo Pereira Bezerra	X	
Dra. Hélida Ferreira da Cunha	X	

Após avaliação foi aprovado na defesa. Às 18:00 horas, a Prof. Dra. Solange Xavier dos Santos, presidente da Banca Examinadora deu por encerrada a sessão e, para constar, lavrou a presente Ata:

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Prof. Dr. Vagner Gularte Cortez

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Prof. Dra. Solange Xavier dos Santo

DEDICO

À minha família, que sonhou esse momento junto comigo, especialmente minha mãe, Irene Pereira e ao meu fiel companheiro de vida, Simba, que em sua inocência de “doguinho” me proporciona apenas momentos de conforto e alegria.

Agradecimentos

Car@ leitor,

Neste espaço eu gostaria de expressar meus sinceros agradecimentos às pessoas e instituições que colaboraram comigo para a conclusão deste trabalho. Reitero, que sem elas as publicações e outros produtos científicos oriundos desta pesquisa não seriam possíveis.

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Agradeço à minha família, pelo amor, carinho e apoio, especialmente minha mãe, Irene Pereira, pela preocupação diária, compreensão e incentivo sem fim. À minha segunda família, Carlos Filipe, Izabel Cristina, Geovane Pereira, e os quatro “doguinhos”, Simba, Jon, Teo e Billy, pela bagunça diária na nossa casa de estudantes cientistas que compartilhamos há anos, pelas risadas, discussões, contribuições em inúmeras etapas de desenvolvimento do meu trabalho e por comerem as refeições que eu sirvo diariamente sem reclamar.

À profa. Dra. Tatiana Baptista Gibertoni, por sua ajuda na identificação taxonômica de algumas espécies listadas neste trabalho. Ao Dr. Renato Lúcio Mendes Alvarenga, por ter me ensinado a filogenia de fungos e a entender, mesmo que um pouco, esse lado obscuro da micologia. Ao. Prof. Dr. Ahmed M. Abdel-Azeem, por contribuir na revisão de alguns manuscritos. Ao prof. Dr. Patrick Brandon Matheny, pelas informações disponibilizadas de exsicatas de interesse para estudo. Ao Dr. Paul Kirk, por sua ajuda com normas de nomenclatura taxonômica. À profa. Dra. Rosiane Andrade da Costa, pela infraestrutura na realização de algumas etapas do processo de análise molecular, incluindo o sequenciamento.

Aos seguintes professores e alunos que colaboraram para os ensaios biotecnológicos fornecendo infraestrutura, reagentes e técnicas: Me. Abel Vieira de Melo Bisneto, Me. Ana Beatriz Lobo Moreira, Me. Anielly Monteiro de Melo, Me. Camila da Silva Castro, Me. Carlos

Filipe Camilo Cotrim, Me. Ester Vieira Gonçalves, Me. Igor Romeiro dos Santos, Dr. Leonardo Luiz Borges, Dra. Thâmara Machado e Silva, Dra. Joelma Abadia Marciano de Paula, Dra. Lee Chen Chen, Dra. Luciana Damacena Silva, Dra. Luciane Madureira de Almeida e Dra. Samantha Salomão Caramori.

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À curadoria dos herbários BPI, ICN, NY, SP, TENN e URM pelo empréstimo de importantes exsicatas, especialmente de holótipos. Agradeço também à Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável (SEMAD), à administração do Parque Estadual da Serra de Caldas Novas (PESCAN) e da Floresta Nacional (FLONA) de Silvânia pela autorização de coleta e apoio logístico nos trabalhos de campo. À Universidade Estadual de Goiás, onde estou desde a graduação pela infraestrutura e logística oferecida, e a todo corpo docente do curso de Ciências Biológicas e do PPG-RENAC por me proporcionar experiências fantásticas e enriquecedoras a minha formação profissional.

“*Em algum lugar, alguma coisa incrível está esperando para ser descoberta*”

Carl Sagan

Sumário

Apresentação e mapa da tese

Car@ leitor,

Este trabalho consiste em um amplo estudo sobre fungos corticioides e poroides que ocorrem no Cerrado brasileiro, incluindo aspectos taxonômico, filogenético e ecológico. Os exemplares estudados são oriundos de coletas realizadas em importantes Unidades de Conservação do bioma no estado de Goiás durante os anos de desenvolvimento da tese, além de revisão do acervo de fungos do fungário HUEG, que abriga a maior coleção de fungos macroscópicos do Cerrado e de alguns exemplares dos fungários BPI, ICN, NY, URM e SP.

A tese está organizada em forma de capítulos. Cada capítulo conta com artigos publicados e/ou submetidos e seguem parcialmente o estilo de formatação de cada periódico, no idioma inglês. Além disso, um breve comentário sobre cada capítulo é apresentado a seguir:

Capítulo
I

O estado da arte dos fungos corticioides e poroides do Cerrado

Neste capítulo, apresentamos um panorama geral, incluindo aspectos históricos sobre a pesquisa e o conhecimento acerca dos fungos corticioides e poroides do Cerrado, que originou o artigo inicial da tese, a saber:

- **Artigo 1.** “Corticioid and poroid fungi from Brazilian Cerrado: a history of research and a checklist of species”. O manuscrito deste trabalho foi submetido e aceito no periódico Anais da Academia Brasileira de Ciências.

Capítulo
II

Inventariando a micobiota corticioide e poroide de Unidades de Conservação representativas do bioma Cerrado

Para o desenvolvimento deste capítulo, foram realizas coletas em campo e revisado material do fungário da Universidade Estadual de Goiás (HUEG-Fungos), totalizando aproximadamente 1000 amostras de fungos corticioides e poroides analisadas, o que resultou em 3 artigos, listados a seguir e no capítulo III.

- **Artigo 2.** “Poroid fungi (Agaricomycetes, Basidiomycota) from Floresta Nacional de Silvânia - a conservation unit of Brazilian Savanna”. Publicado no periódico Microbial Biosystems.

- **Artigo 3.** “ Corticioid and poroid fungi (Basidiomycota) from Parque Estadual da Serra de Caldas Novas (PESCAN), Brazilian Savanna, Goiás, Brazil”. O manuscrito deste trabalho foi submetido no periódico Mycotaxon.

- **Artigo 4. “**Wood-inhabiting corticioid and poroid fungi (Basidiomycota) from Reserva Ecológica da Universidade Estadual de Goiás, a remnant of the Brazilian Cerrado”. Publicado no periódico Biota Neotrópica.

Capítulo III

Ampliando a diversidade de fungos corticioides e poroides, com a descrição de uma nova espécie e novos registros de ocorrência

Nesse capítulo estudamos espécies de fungos corticioides e poroides, principalmente das famílias Ganodermataceae e Hymenochaetaceae, conhecidas por possuírem diversos complexos de espécies. Assim, buscamos ampliar o conhecimento da diversidade dessas famílias e o entendimento de alguns complexos de espécies utilizando uma abordagem morfológica clássica e filogenética. Os artigos deste capítulo são listados abaixo:

- **Artigo 5.** “*Furtadomyces* gen. nom. nov. (Ganodermataceae, Basidiomycota) with description of *F. sumptuosus*, a new species of ganodermatoid fungi from Brazil”. Publicado no periódico Mycological Progress.

- **Artigo 6.** “*Inonotus rickii* (Agaricomycetes, Hymenochaetaceae) in Brazilian Cerrado: Expanding its geographic distribution and host list”. Publicado no periódico Frontiers in Microbiology.

- **Artigo 7.** “ A new occurrence of *Gyrodontium sacchari* (Spreng.) Hjortstam Pat. (Boletales, Coniophoraceae) expands the geographic distribution of the genus to the Cerrado biome and of the family to the Midwest Region of Brazil”. Publicado no periódico Check List.

- **Artigo 8.** “Additions to the knowledge of Ganodermataceae in brazilian Cerrado”. Publicado no periódico Hoehnea.

Capítulo IV

Divulgação científica

Neste capítulo são apresentados trabalhos focados na divulgação científica de alguns resultados da tese, visando à popularização da micologia.

- **Capítulo de livro 1**. De orelha em pé.: In Nas trilhas do PESCAN – Descobrindo o Parque Estadual da Serra de Caldas Novas.

- **Capítulo de livro 2**. As orelhas-de-pau do Parque Estadual da Serra de Caldas Novas: uma biodiversidade ameaçada pela fragmentação do Cerrado. Publicado como capítulo de livro no 5º prêmio SBPC/GO de popularização da Ciência em 1º lugar da área de Ciências Biológicas.

- **Livro**. Guia de fungos macroscópicos do Parque Estadual da Serra de Caldas Novas, Goiás, Brasil, volume II − Fungos poroides.

Resumo

Na classe Agaricomycetes, Basidiomycota, encontra-se um grande grupo de fungos lignícolas conhecidos tradicionalmente como afiloforoides. Esse grupo reúne espécies de macrofungos geralmente não lamelares onde se encontram subgrupos classificados como poroides, corticioides, hidnoides, estereoides, entre outros, os quais são agrupados pelo hábito e morfologia do basidioma. Os fungos corticioides e poroides são amplamente conhecidos por sua eficiência no processo de decomposição da madeira, na ciclagem de nutrientes, bem como por suas propriedades para aplicações biotecnológicas. Apesar de serem um dos grupos de fungos mais estudados no mundo, dados sobre diversidade e padrões de ocorrência geográfica no Brasil são insuficientes, principalmente em áreas pouco estudadas, incluindo o Cerrado. Desse modo, buscamos ampliar o conhecimento sobre a diversidade, filogenia, distribuição geográfica e padrões ecológicos de fungos corticioides e poroides do Cerrado a partir de uma extensa revisão na literatura, excursões a campo e revisão de amostras de fungários. A revisão da literatura nos permitiu identificar o estado da arte, as tendências e lacunas no conhecimento e a história da pesquisa sobre esses fungos do Cerrado, bem como elaborar uma checklist das espécies conhecidas no bioma. A partir dessa análise, encontramos 387 registros de ocorrência e 223 espécies. Destas, 94 espécies são novas adições às listas de espécies publicadas na última década. Seis das espécies listadas são endêmicas do Cerrado e 29, embora ocorram em outras regiões do mundo, no Brasil existem apenas registros no bioma. Além disso, observamos que o baixo número de micologistas treinados na região, a falta de investimento, dados insuficientes de áreas inexploradas e os poucos estudos, a longo prazo, no bioma são obstáculos que dificultam o entendimento da riqueza de espécies do Cerrado e seus aspectos biológicos, ecológicos e evolutivos. Assim, partindo dessa problemática, direcionamos o foco dos nossos estudos taxonômicos para áreas pouco estudadas no estado de Goiás, onde expedições de campo em importantes unidades de conservação do bioma foram realizadas, bem como a revisão taxonômica do fungário da Universidade Estadual de Goiás (HUEG-Fungos) que abriga uma das mais importantes coleções de fungos do Cerrado. Entre coletas e revisões do acervo HUEG-Fungos foram analisados aproximadamente 1000 espécimes. Dessas, *Furtadomyces sumptuosos* é descrita como nova para a Ciência, 20 como novas ocorrências para o Cerrado, 20 para a região Centro-Oeste e 24 para o estado de Goiás. O material coletado permitiu, ainda, criar um banco de DNA desses grupos de fungos com aproximadamente 100 amostras. Essas novas contribuições aumentam o conhecimento sobre estes organismos no país e contribuem para o entendimento das relações filogenéticas de grupos específicos. Além disso, a descoberta dessa diversidade, até então, desconhecida, estimula novos estudos no Cerrado e novas abordagens de pesquisa, como a biotecnológica e ecológica.

Palavras-chave: Agaricomycetes, Basidiomycota, filogenia, fungos lignícolas, macrofungos, savana Brasileira, taxonomia.

Abstract

In the class Agaricomycetes, Basidiomycota, there is a large group of lignicolous fungi traditionally known as aphyllophoroid. This group includes species of macrofungi, usually not-lamellate, where there are subgroups classified as poroids, corticioids, hydnoids, and stereoids, grouped from the morphology of the basidiomata and growth habits. Corticioid and poroid fungi are widely known for their efficiency in wood decomposition, nutrient cycling, and biotechnological applications. Despite being one of the most studied groups of fungi in the world, data on diversity and geographical occurrence patterns in Brazil are insufficient, especially in understudied areas, including the Cerrado. Thus, we aimed to increase the knowledge about diversity, phylogeny, geographic distribution, and ecological patterns of corticioid and poroid fungi from Cerrado through an extensive literature review, field expeditions, and exsiccate review. The literature review allowed us to identify the state of the art, the trends and gaps in knowledge, and the history of research on these fungi from the Cerrado, along with a list of species found in the biome so far. We found 387 records and 223 species, while 94 species are new additions to the checklists published in the last decade. Six of the listed species are endemic to Cerrado and 29, although they occur in other regions of the world, in Brazil there are only records in the biome. The low number of trained mycologists, lack of investment, deficient data from unexplored areas of the biome, and few long-term studies are obstacles to understanding the species richness of the biome and its biological, ecological, and evolutionary aspects. Thus, based on this problem, we focused our taxonomic studies on areas poorly studied in the Goiás state, where field expeditions in important conservation units of the biome were carried out, as well as the taxonomic revision of the fungarium of the State University of Goiás (HUEG-Fungi) which has one of the most important collections of Cerrado fungi. Between collections and revisions of the HUEG-Fungi collection, approximately 1000 specimens were analyzed. Of these, *Furtadomyces sumptuosos* is described as new to science, 20 as new occurrences from Cerrado, 20 from the Midwest region, and 24 from Goiás. A DNA database with about 100 samples of this material was also created. These new contributions increase the knowledge about these organisms in the country and the understanding of phylogenetic relationships of specific groups. Furthermore, the discovery of an unknown diversity may encourage new study approaches, such as biotechnology and ecology.

Keywords: Agaricomycetes, Basidiomycota, Brazilian Savanna, lignicolous fungi, phylogeny, macrofungi, taxonomy.

Introdução

Os fungos constituem um grupo diverso de organismos eucariontes, encontrados em praticamente todos os ecossistemas, ocupando diferentes substratos, onde podem viver como saprobiontes, parasitas ou simbiontes (HAWKSWORTH; LÜCKING, 2017; MOORE; ROBSON; TRINCI, 2011; MUELLER *et al.*, 2007). Com base em dados de distribuição geográfica, materiais de coleções e comparações moleculares, Hawksworth e Lücking (2017) estimaram a diversidade de fungos em cerca de 3,8 milhões de espécies. Atualmente, são conhecidas cerca de 120.000 (HAWKSWORTH; LÜCKING, 2017); a maioria pertencentes aos filos Ascomycota (≈ 64 mil espécies) e Basidiomycota (≈ 32 mil espécies) (KIRK *et al.*, 2008; MOORE; ROBSON; TRINCI, 2011).

Entre os Basidiomycota encontram-se os fungos afiloforoides (antiga ordem Aphyllophorales), que constituem um grande grupo tradicional, sem relações filogenéticas, de modo que os representantes desse grupo estão, atualmente, distribuídos em diversas ordens e famílias. Esse grupo reúne espécies de macrofungos lignícolas geralmente não lamelares, mas que possuem himênio exposto. Dentre os fungos afiloforoides, observam-se subgrupos classificados como poroides, corticioides, hidnoides, estereoides, entre outros, os quais são agrupados pelo hábito do basidioma e pela semelhança morfológica do himênio (STALPERS, 1978; BUCHANAN, 2001).

Entre os fungos afiloforoides, aqueles conhecidos como corticioides e poroides são amplamente estudados e diversas espécies possuem distribuição mundial (MUELLER *et al.*, 2007; HE *et al.*, 2019). Devido à forma e ao hábito do basidioma esses fungos são popularmente conhecidos como orelha-de-pau, orelha-de-coco, casinha-de-sapo, chapéu-de-cobra, no caso dos fungos poroides (CUNHA, 2019), e crosta e tinta de madeira para algumas espécies de fungos corticioides.

Os fungos corticioides e poroides são homobasidiomicetos, caracterizados por apresentar basidioma ressupinado (totalmente aderido ao substrato), efuso-reflexo (parte aderida ao substrato e outra projetada na borda, formando um píleo) ou pileado (provido de píleo, também conhecido como “chapéu”), séssil (aderido central ou lateralmente ao substrato) ou estipitado (aderido ao substrato por um estipe) (Figura 1). O basidioma possui tempo de vida anual ou perene, que varia quanto à coloração, forma e morfologia do himênio, onde se observa formas tubulares (poroides), circulares, angulares, irregulares, hexagonais, radialmente alongados, sinuosos, dedaloides, denteadas, lamelares ou lisas (Figura 2). No himênio ainda são produzidas estruturas férteis (os basídios e basidiósporos), e estéreis (cistídios, setas e medas) (RYVARDEN, 2004; LARSSON, 2007).

Figura 1. Tipo de basidioma dos fungos corticioides e poroides em relação à aderência ao substrato. **A.** Ressupinado. **B.** Efuso-reflexo. **C.** Pileado. **D.** Estipitado. A–D: Leonardo-Silva, L.

Baseado nessas características morfológicas, o termo corticioides é direcionado às espécies de hábito geralmente ressupinado e com o himênio liso a denteado, enquanto espécies que possuem o himênio em formato tubular e suas variações são caracterizadas como poroide (RYVARDEN, 2004; LARSSON, 2007). Embora essa seja uma classificação tradicional e comumente utilizada, exceções são observadas em ambos os agrupamentos, bem como sobreposições de espécies em cada grupo.

Tradicionalmente, a identificação desses fungos é baseada nas características macro e micromorfológicas do basidioma (TEIXEIRA, 1995; RYVARDEN, 2004). Entretanto, devido ao grande número de caracteres morfológicos sujeitos a convergências evolutivas, de espécies crípticas e dos complexos taxonômicos do grupo, novas abordagens na determinação taxonômica têm sido necessárias (LÜCKING *et al.*, 2020). Atualmente, essa abordagem é realizada por características polifásicas em que são utilizados, além dos caracteres morfológicos, informações relacionadas à ecologia (distribuição geográfica e especificidade por substrato) e análises moleculares (COSTA-REZENDE *et al.*, 2020; ELIAS *et al.*, 2020; LÜCKING *et al.*, 2020). Dentre essas, o desenvolvimento e a adaptação de técnicas da biologia molecular, principalmente as baseadas na reação em cadeia da polimerase (PCR) utilizando genes marcadores como o RNA ribossomal, tornaram-se ferramentas utilizadas para a determinação de novos táxons e estudos de relações filogenéticas (WHITE *et al.*, 1990; HE *et al.*, 2019).

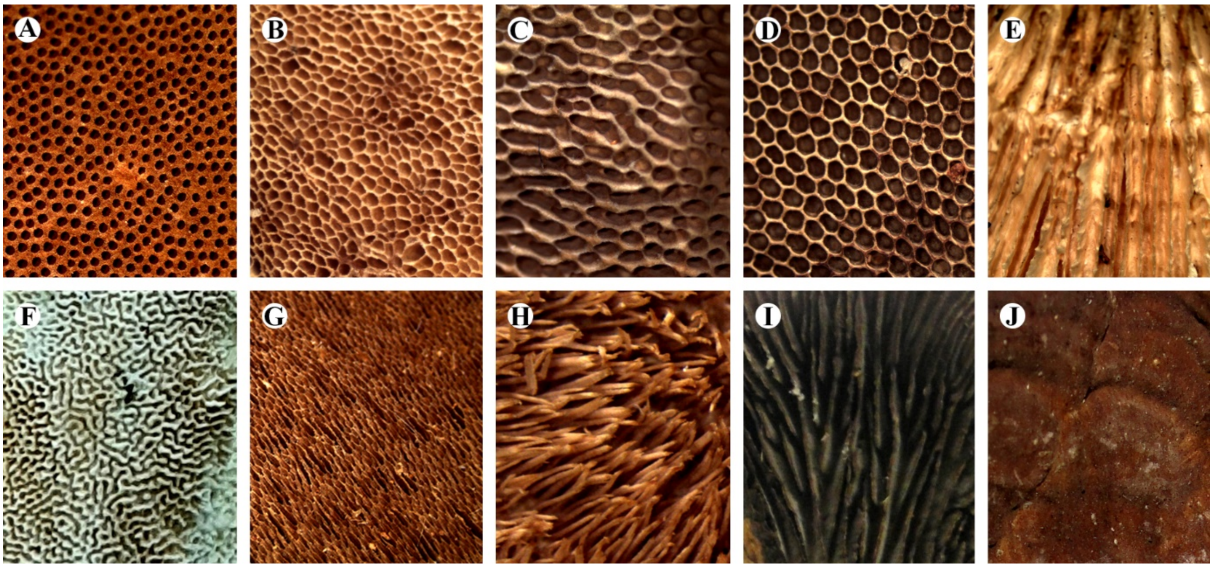


Figura 2. Variação morfológica da superfície himenial dos fungos corticioides e poroides. **A.** Circular. **B.** Angular. **C.** Irregular. **D.** Hexagonal. **E.** Radialmente alongado. **F.** Dedaloide. **G.** Sinuosa. **H.** Denteada. **I.** Lamelar. **J.** Lisa. A–J: Leonardo-Silva, L.

Os genes ribossomais são alvos particularmente atraentes para essa análise devido a sua composição estrutural formada por regiões altamente conservadas (18S, 5,8S e 28S) e outras variáveis (ITS1 e ITS2) e pela presença em grande número de cópias no genoma (FUNGARO, 2000). A região ITS (*Internal Transcribed Spacer*) tem sido usada por muitos anos para estimativas de diversidade e identificação taxonômica de fungos. Além disso, ela é conhecida pelo elevado polimorfismo em relação ao número e tamanho dos fragmentos e pode ser utilizada na distinção de espécies relacionadas ou, até mesmo, variedades de uma mesma espécie (WHITE *et al.*, 1990; FUNGARO, 2000; BEGEROW *et al.*, 2010; SCHOCH *et al.*, 2012). A subunidade ribossomal maior (LSU), localizada à jusante da região ITS, também é amplamente utilizada para atribuição filogenética (LIU *et al.*,2012).

A eficácia na análise das regiões ITS+LSU para estabelecer relações filogenéticas e descrição de novos táxons do complexo de espécies da família Ganodermataeae (COSTA-REZENDE *et al.*, 2016; COSTA-REZENDE; GÓES-NETO; DRECHSLER-SANTOS, 2020) e Hymenochaetaceae (DRECHSLER-SANTOS *et al.*, 2016; LIMA *et al.*, 2022) já foi previamente relatada. Entretanto, estudos recentes apontam os limites dos dados de sequências ITS+LSU e recomendam, em algumas ocasiões, uma abordagem multigênica utilizando marcadores complementares, como a subunidade da RNA polimerase II (RBP1 e RBP2) e o Fator de elongação 1-α (EF1-α) (COSTA-REZENDE *et al.*, 2020; LÜCKING *et al.*, 2020; SUN *et al.*, 2020). Assim, com base em dados moleculares, ecológicos e morfológicos, as pesquisas com delimitação de espécies fúngicas vêm evoluindo.

Concomitante aos estudos taxonômicos e filogenéticos desses fungos, observa-se expressiva produção científica que destacam sua importância econômica e ambiental, devido, principalmente, a sua capacidade de produzir enzimas (OLICÓN-HERNÁNDEZ; GONZÁLEZ-LÓPEZ; ARANDA, 2017; EL-GENDI *et al.*, 2021; SANTOS-VARJÃO *et al.*, 2022). Eles são importantes na ciclagem de nutrientes, no processo de decomposição da madeira e de substâncias tóxicas no solo (ZMITROVICH; WASSER; TURA, 2015; ALI *et al.*, 2017). Em processos biotecnológicos, algumas espécies estão sendo testadas na obtenção de novas fontes de oxidantes (HWANG; LEE; YUN, 2016), enzimas (GRASSI; ROBLEDO; LEVIN, 2018; EL-GENDI *et al.*, 2021) e em procedimentos de biorremediação (CRUZ-MORATÓ *et al.*, 2013; ALI *et al.*, 2017; SANTOS-VARJÃO *et al.*, 2022).

Na biorremediação, os fungos corticioides e poroides têm sido utilizados, principalmente, no tratamento de efluentes industriais que são potenciais poluentes ambientais (SALVACHÚA *et al.*, 2013; WEHAIDY *et al.*, 2018). Esses processos visam à obtenção e aplicação de enzimas, em sua maioria as oxidorredutases, dentre as quais encontram-se as peroxidases, que desempenham função importante devido a sua capacidade de degradar substâncias tóxicas (GRASSI; ROBLEDO; LEVIN, 2018; WEHAIDY *et al.*, 2018; EL-GENDI *et al.*, 2021).

Apesar de sua grande diversidade biológica e grande potencial para melhorar a vida humana, lacunas nesse conhecimento, em várias regiões do mundo, representam um desafio. Especificamente no Brasil, estudos sobre os fungos corticioides e poroides são irregulares, concentrando-se em regiões onde existem Universidades e Institutos com focos de pesquisas voltados à Micologia (BONONI *et al.*, 2017). Assim, grande parte do território nacional permanece inexplorada, como é o caso da região central do país que abrange grandes extensões do bioma Cerrado.

Hawksworth e Lücking (2017) destacam que existe uma grande probabilidade das novidades científicas em relação à descrição de novos táxons e entendimento das suas relações filogenéticas serem respondidas em habitats pouco estudados, sobretudo, em regiões tropicais e em *hotspots* de biodiversidade. Considerando que o Cerrado é classificado como um dos 25 *hotspots* de biodiversidade do mundo (MYERS *et al.*, 2000), e o pouco conhecimento dos fungos corticioides e poroides no bioma, estudos com esses grupos taxonômicos devem ser incentivados nesse hábitat.

Atualmente, alguns complexos de espécies desses fungos têm sido revisados, principalmente em representantes das famílias Ganodermataceae, Hymenochaetaceae e Polyporaceae. Essas revisões, embasadas em dados moleculares, possibilitam a descrição de novos táxons, a inclusão e reposicionamento de novas espécies. Por isso, faz-se necessária a exploração desse grupo de organismos em habitats tropicais, principalmente em áreas pouco estudadas, buscando explanar o conhecimento acerca das suas relações filogenéticas. Em decorrência da caracterização polifásica detalhada dos fungos corticioides e poroides, é possível, ainda, elucidar os aspectos ecológicos e bioquímicos que vêm despertando mais interesse da comunidade científica na última década.

Objetivo geral

Ampliar o conhecimento sobre a diversidade, filogenia, ecologia e distribuição geográfica de fungos corticioides e poroides provenientes do bioma Cerrado.

Objetivos específicos

- Apresentar os aspectos históricos e cienciométricos de fungos corticioides e poroides do Cerrado;
- Revisar o acervo de fungos corticioides e poroides do fungário da Universidade Estadual de Goiás (HUEG-Fungos);
- Caracterizar macro e micromorfologicamente espécimes de fungos corticioides e poroides provenientes de diferentes localidades do Cerrado, tanto de material depositado em fungários quanto de novas coletas;

- Elaborar um banco de DNA das amostras de exsicatas e de novas coletas;
- Ampliar o conhecimento da diversidade e da distribuição geográfica desses fungos no bioma;
- Entender as relações filogenéticas das espécies estudadas por análise molecular;
- Promover a divulgação científica dos resultados encontrados para a comunidade em geral.

Referências

ALI, A. *et al.* Mycoremediation of Potentially Toxic Trace Elements—a Biological Tool for Soil Cleanup: A Review. **Pedosphere**, v. 27, n. 2, p. 205–222, 2017. Disponível em: http://dx.doi.org/10.1016/S1002-0160(17)60311-4.

BEGEROW, D. *et al.* Current state and perspectives of fungal DNA barcoding and rapid identification procedures. **Applied Microbiology and Biotechnology**, v. 87, n. 1, p. 99–108, 2010. Disponível em: http://link.springer.com/10.1007/s00253-010-2585-4.

BONONI, V. L. R. *et al.* Agaricomycetes (Basidiomycota, Fungi) diversity in a protected area in the Maracaju Mountains, in the Brazilian central region. **Hoehnea**, v. 44, n. 3, p. 361–377, 2017. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2236-89062017000300361&lng=en&tlng=en.

BUCHANAN, P. K. Aphyllophorales in Australasia. **Australian Systematic Botany**, v. 14, n. 3, p. 417–437, 2001. Disponível em: http://www.publish.csiro.au/?paper=SB99033.

COSTA-REZENDE, D. H. *et al. Amauroderma calcitum* sp. nov. and notes on taxonomy and distribution of *Amauroderma* species (Ganodermataceae). **Phytotaxa**, v. 244, n. 2, p. 101, 2016. Disponível em: https://biotaxa.org/Phytotaxa/article/view/phytotaxa.244.2.1.

COSTA-REZENDE, D. H. *et al.* Taxonomy and phylogeny of polypores with ganodermatoid basidiospores (Ganodermataceae). **Mycological Progress**, v. 19, n. 8, p. 725–741, 2020. Disponível em: http://link.springer.com/10.1007/s11557-020-01589-1.

COSTA-REZENDE, D. H.; GÓES-NETO, A.; DRECHSLER-SANTOS, E. R. Studies on Brazilian *Amauroderma* s.str. reveal a new species from the Atlantic Forest, *Amauroderma robledoi* sp. nov. (Polyporales, Ganodermataceae). **The Journal of the Torrey Botanical Society**, v. 147, n. 2, p. 199, 2020. Disponível em: https://bioone.org/journals/the-journal-of-the-torrey-botanical-society/volume-147/issue-2/1095-5674-147.2.199/Studies-on-Brazilian-Amauroderma-sstr-reveal-a-new-species-from/10.3159/1095-5674-147.2.199.full.

CRUZ-MORATÓ, C. *et al.* Degradation of pharmaceuticals in non-sterile urban wastewater by *Trametes versicolor* in a fluidized bed bioreactor. **Water Research**, v. 47, n. 14, p. 5200–5210, 2013. Disponível em: https://linkinghub.elsevier.com/retrieve/pii/S0043135413004983.

CUNHA, E. L. **Etnomicologia: A produção científica global e o conhecimento etnomicológico em uma comunidade quilombola do Cerrado**. 2019. 1–60 f. 2019.

DRECHSLER-SANTOS, E. R. *et al. Phellinotus*, a new neotropical genus in the Hymenochaetaceae (Basidiomycota, Hymenochaetales). **Phytotaxa**, v. 261, n. 3, p. 218, 2016. Disponível em: https://biotaxa.org/Phytotaxa/article/view/phytotaxa.261.3.2.

EL-GENDI, H. *et al.* A comprehensive insight into fungal enzymes: structure, classification, and their role in mankind's challenges. **Journal of Fungi**, v. 8, n. 1, p. 23, 2021. Disponível em: https://www.mdpi.com/2309-608X/8/1/23.

ELIAS, S. G. *et al.* Studies on the biogeography of *Phellinotus piptadeniae* (Hymenochaetales, Basidiomycota): Expanding the knowledge on its distribution and clarifying hosts relationships. **Fungal Ecology**, v. 45, p. 100912, 2020. Disponível em: https://linkinghub.elsevier.com/retrieve/pii/S1754504819301655.

FUNGARO, M. PCR na micologia. **Biotecnologia: Ciência & Desenvolvimento**, v. 3, p. 12–16, 2000.

GRASSI, E.; ROBLEDO, G.; LEVIN, L. Influence of light on lignin-degrading activities of fungal genus *Polyporus* s. str. **Journal of Basic Microbiology**, v. 58, n. 11, p. 947–956, 2018. Disponível em: https://onlinelibrary.wiley.com/doi/10.1002/jobm.201800183.

HAWKSWORTH, D. L.; LÜCKING, R. Fungal diversity revisited: 2.2 to 38 million species. **Microbiology spectrum**, v. 5, n. 4, p. 1–17, 2017.

HE, M. Q. *et al.* Notes, outline and divergence times of Basidiomycota. **Fungal Diversity**, v. 99, n. 1, p. 105–367.

HWANG, B. S.; LEE, I. K.; YUN, B. S. Phenolic compounds from the fungus *Inonotus obliquus* and their antioxidant properties. **Journal of Antibiotics**, v. 69, n. 2, p. 108–110, 2016.

KIRK, P. M. *et al.* **Dictionary of the Fungi**. 10. ed. Wallingford, UK: CABI, 2008.

LARSSON, K.-H. Re-thinking the classification of corticioid fungi. **Mycological Research**, v. 111, n. 9, p. 1040–1063, 2007. Disponível em: https://linkinghub.elsevier.com/retrieve/pii/S095375620700175X.

LIMA, V. X. *et al.* Taxonomy and phylogenetic analysis reveal one new genus and three new species in *Inonotus* s.l. (Hymenochaetaceae) from Brazil. **Cryptogamie, Mycologie**, v. 43, n. 1, 2022. Disponível em: https://bioone.org/journals/cryptogamie-mycologie/volume-43/issue-1/cryptogamie-mycologie2022v43a1/Taxonomy-and-Phylogenetic-Analysis-Reveal-One-New-Genus-and-Three/10.5252/cryptogamie-mycologie2022v43a1.full.

LIU, K. L.; PORRAS-ALFARO, A.; KUSKE, C. R.; EICHORST, S. A.; XIE, G. Accurate, rapid taxonomic classification of fungal large-subunit rRNA genes. **Applied and Environmental Microbiology**, v. 78, n. 5, p. 1523-33. Disponível em: https://journals.asm.org/doi/10.1128/AEM.06826-11.

LÜCKING, R. *et al.* Unambiguous identification of fungi: where do we stand and how accurate and precise is fungal DNA barcoding?. **IMA Fungus**, v. 11, n. 1, p. 14, 2020. Disponível em: https://imafungus.biomedcentral.com/articles/10.1186/s43008-020-00033-z.

MOORE, D.; ROBSON, G. D.; TRINCI, A. P. J. **21st Century Guidebook to Fungi**. Cambridge University Press, 2011.

MUELLER, G. M. *et al.* Global diversity and distribution of macrofungi. **Biodiversity and Conservation**, v. 16, n. 1, p. 37–48, 2007. Disponível em: http://link.springer.com/10.1007/s10531-006-9108-8.

MYERS, N.; MITTERMEIER, R. A.; MITTERMEIER, C. G.; FONSECA, G. A. B.; KENT, J. Biodiversity hotspots for conservation priorities. **Nature**, v. 403, n. 6772, p 853–858, 2000.

OLICÓN-HERNÁNDEZ, D. R.; GONZÁLEZ-LÓPEZ, J.; ARANDA, E. Overview on the biochemical potential of filamentous fungi to degrade pharmaceutical compounds. **Frontiers in Microbiology**, v. 8, n. SEP, p. 1–17, 2017. Disponível em: http://journal.frontiersin.org/article/10.3389/fmicb.2017.01792/full.

RYVARDEN, L. **Neotropical polypores Part 1**. Oslo, Norway: Fungiflora, 2004. v. 19

SALVACHÚA, D. *et al.* Characterization of a novel dye-decolorizing peroxidase (dyp)-type enzyme from *Irpex lacteus* and its application in enzymatic hydrolysis of wheat straw. **Applied and Environmental Microbiology**, v. 79, n. 14, p. 4316–4324, 2013. Disponível em: https://journals.asm.org/doi/10.1128/AEM.00699-13.

SANTOS-VARJÃO, M. T. *et al.* Leishmanicidal activity of fungal bioproducts: A systematic review. **Fungal Biology Reviews**, 2022. Disponível em: https://linkinghub.elsevier.com/retrieve/pii/S174946132200001X.

SCHOCH, C. L. *et al.* Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. **Proceedings of the National Academy of Sciences**, v. 109, n. 16, p. 6241–6246, 2012. Disponível em: http://www.pnas.org/cgi/doi/10.1073/pnas.1117018109.

STALPERS, J. A. **Identification of wood-inhabiting Aphyllophorales in pure culture**. Studies in Mycology No. 16, 1978.

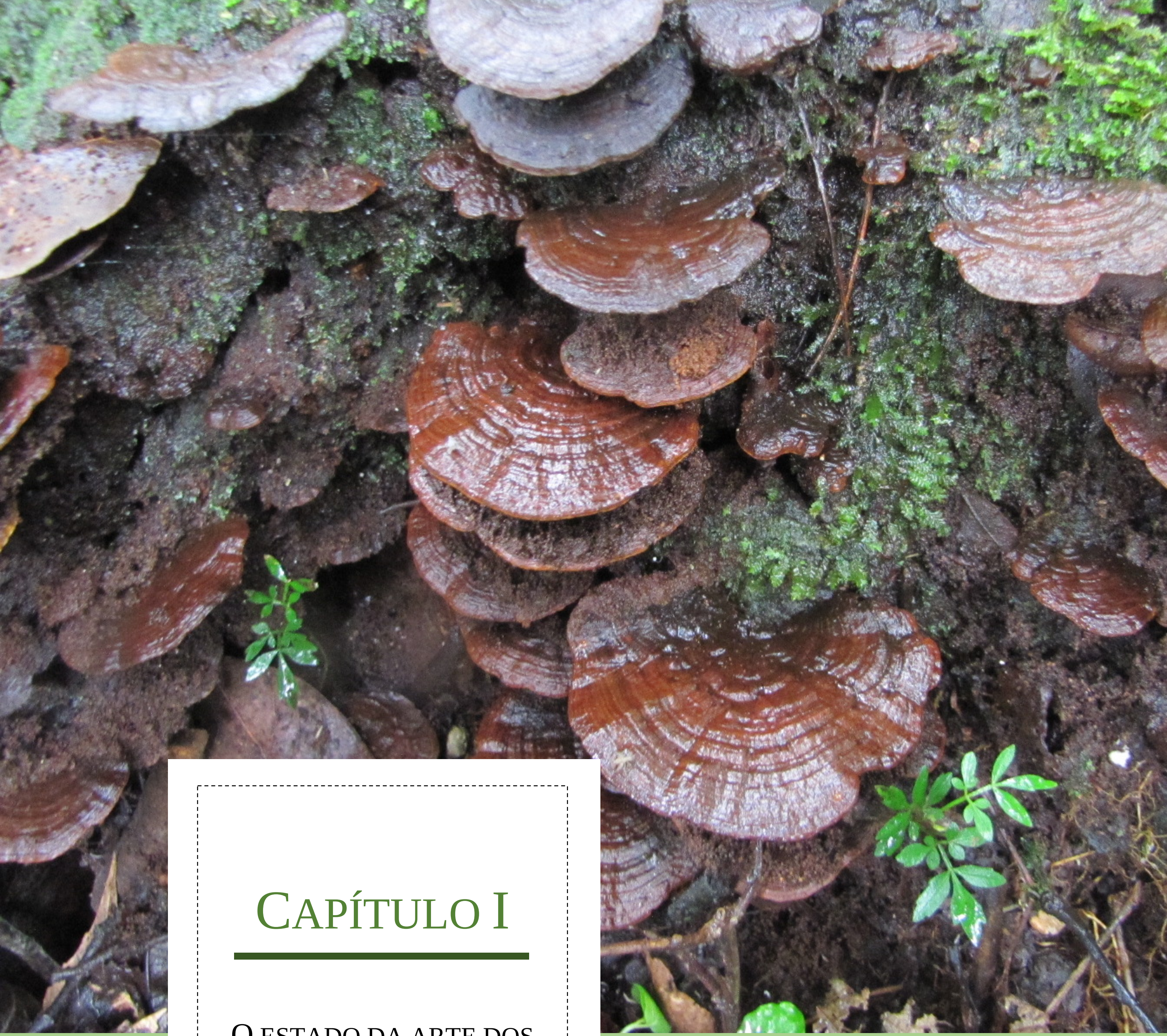
SUN, Y.-F. *et al.* Multi-gene phylogeny and taxonomy of *Amauroderma* s. lat. (Ganodermataceae). **Persoonia - Molecular Phylogeny and Evolution of Fungi**, v. 44, n. 1, p. 206–239, 2020. Disponível em: https://www.ingentaconnect.com/content/10.3767/persoonia.2020.44.08.

TEIXEIRA, A. R. **Métodos para estudo das hifas do basidiocarpo de fungos poliporáceos**. São Paulo: Instituto de Botânica, 1995.

WEHAIDY, H. *et al.* Comparative study on crude and partially purified laccase from *Polyporus durus* ATCC 26726 in the decolorization of textile dyes and wastewater treatment. **Egyptian Pharmaceutical Journal**, v. 17, n. 2, p. 94, 2018. Disponível em: http://www.epj.eg.net/text.asp?2018/17/2/94/240667.

WHITE, T. J. *et al.* Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *In*: PCR PROTOCOLS. Elsevier, 1990. p. 315–322. *E-book*. Disponível em: https://linkinghub.elsevier.com/retrieve/pii/B9780123721808500421.

ZMITROVICH, I. V.; WASSER, S. P.; TURA, D. Wood-inhabiting fungi. *In*: MISRA, J. K. *et al.* (org.). **Fungi from different substrates**. CRC press, 2015. p. 17–74.



CAPÍTULO I

O ESTADO DA ARTE DOS FUNGOS CORTICIOIDES E POROIDES DO CERRADO

ARTIGO 1

CORTICIOID AND POROID FUNGI FROM BRAZILIAN CERRADO: A HISTORY OF RESEARCH AND A CHECKLIST OF SPECIES

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Corticioid and poroid fungi from Brazilian Cerrado: a history of research and a checklist of species

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Abstract − Corticioid and poroid fungi are widely known for wood decomposition which confers an important ecological role and biotechnological properties upon these species. Although being one of the most studied groups of fungi worldwide, data on diversity and geographic occurrence patterns in Brazil are insufficient, especially in poorly studied areas, including the Cerrado biome. Here we present an overview of the scientific literature concerning the corticioid and poroid fungi from Cerrado, along with a list of species found in the biome so far. The historic research at Cerrado comprised 47 articles published between 1876 and 2021, of which 55% were published in the last decade. We found 387 records and 223 species, while 94 species are new additions to the checklists published in the last decade. Six of the listed species are endemic to Cerrado. Furthermore, 29 species are only known from Cerrado in Brazil, although they occur in other regions of the world. The main research groups focused on these fungi in Brazil have already published at least one article with samples from Cerrado. Therefore, intensifying studies throughout Cerrado could help in a better understanding of its Funga, its evolutionary relationship, and its threatens status.

Keywords − Basidiomycota, biogeography, Brazilian Savanna, gaps, research trends, wood-decaying fungi.

Introduction

The history of Brazilian mycology began in the 18th century with the exploration of native Funga by foreign researchers (Fidalgo 1968). The first contributions to the knowledge of Brazilian fungi were made at the beginning of the 19th century, mainly by European researchers, who visited several regions of the country. At that time, important mycological collections were created and deposited in European herbaria (Fidalgo 1968, Capelari 1998). Starting in the 20th century, Brazilian researchers began studies in mycology focused on the taxonomy of the group, especially diversity inventories, new records of species occurrence, taxonomic revisions, and description of new taxa (Fidalgo 1965, Fidalgo et al. 1965, Bononi 1984, Gugliotta 1997, Xavier-Santos et al. 2004, Abrahão et al. 2012, Maia et al. 2015, Costa-Rezende et al. 2016). Currently, the significant increase in the number of occurrence records of fungi for Brazil and the establishment of important *ex-situ* collections in national herbaria reflect the efforts of Brazilian mycologists in the knowledge of regional Funga.

In 2015 a list of Brazilian fungi was published showing that the country has a great diversity of species, distributed in several vegetation-landscapes along six biomes. Although fungi diversity knowledge has increased, many regions of Brazil remain understudied while efforts focused on specific biomes are restricted to a limited number of locations. On the other hand, Cerrado, Pampa, and Pantanal remain poorly studied (Maia et al. 2015).

The Cerrado is the second largest biome in South America and spreads across Central Brazil, covering 11 Brazilian states and isolated patches within other biomes: Goiás, Tocantins, Mato Grosso, Mato Grosso do Sul, Rondônia, Minas Gerais, São Paulo, Bahia, Ceará, Maranhão, Piauí, and Distrito Federal. The Cerrado is known as one of the Brazilian savannas consisting of a mixture of undergrowth, shrubland, forest vegetation, and has a well-defined rainfall regime (Ribeiro & Walter 2008).

Due to the agriculture expansion and livestock, about 50% of the Cerrado has already been devastated (Lahsen et al. 2016, Colli et al. 2020). Thus, it is necessary to establish protective measures to preserve its natural diversity which remains poorly understood. Nevertheless, the knowledge of Cerrado’s Funga has increased exponentially in recent years, especially about corticioid and poroid fungi (Gibertoni & Drechsler-Santos 2010, Abrahão et al. 2012, Costa-Rezende et al. 2016, 2017, Leonardo-Silva et al. 2020a, 2020b).

Corticioid and poroid fungi (previously grouped in the order Aphyllophorales) are traditional groups of Agaricomycetes (Basidiomycota) species that produce visible and exposed fruiting bodies, usually with non-lamellate hymenium (Stalpers 1978, Kunttu 2018). Both groups are initially delimited from the morphology of the basidiomata and growth habits (Gafforov et al. 2020). The term corticioid is used for species with a usually resupinated basidioma and smooth to hydnoid hymenium, while species with a tubular (pores) hymenophore and its variations are characterized as poroid (or polypores) (Ryvarden 2004, Larsson 2007). Although this classification is widely used, exceptions are observed in both groups, as well as overlapping species in each group. They comprise a diverse group in terms of species richness and habits, being widely known for wood decomposition which confers an important ecological role and biotechnological potential (Lundell et al. 2010, Grienke et al. 2014). Furthermore, molecular data have shown that corticioid and poroid fungi are phylogenetically diverse, distributed among all major clades within Agaricomycetes (Larsson 2007, Justo et al. 2017, He et al. 2019).

Although these are one of the most studied fungi groups worldwide, there are no reviews that provide an up-to-date and critical view of historical, biological, and ecological studies about these fungi in Brazilian Cerrado. Thus, we present an overview of the scientific literature concerning the corticioid and poroid fungi from Cerrado, along with a species checklist.

Materials and Methods

We performed an extensive literature review concerning the corticioid and poroid fungi from Cerrado available on Google Scholar (scholar.google.com.br), SciELO (www.scielo.org), and Clarivate Analytics Web of Science (www.webofknowledge.com). The search was performed in all indexed fields using the following terms and boolean operators: (Agaricomycetes OR Basidiomycota) AND ("Brazilian Savanna" OR Cerrado). No language restrictions and time period of the publication were used to refine the results. Data was recorded in December 2021. The Web of Science was used due to the scope and quality of the indexed scientific journals and for being recognized as the most authoritative scientific literature indexing tool available (Li et al. 2018). Google Scholar and SciELO were used to search for articles published in Brazilian regional journals and older articles not indexed on the Web of Science database.

In total, we found 2835 articles (Google Scholar: n = 2810, SciELO: n = 6 and Web of Science: n = 19). The exclusion criteria were: (*i*) articles that did not study corticioid and poroid fungi species; (*ii*) academic theses and dissertations, conference proceedings; and (*iii*) duplicate articles. Then, we selected 47 articles (including the book Mycological writings of C.G. Lloyd) (Supplementary Material, Table I) to analyze the following parameters: (*i*) publication year; (*ii*) taxa recorded; (*iii*) localities sampled; (*iv*) journal; (*v*) author and affiliation; and (*vi*) study approach (taxonomic, biotechnological, and ecological) (Figure 1). Additionally, we checked the articles' references to assess if they were in our dataset.

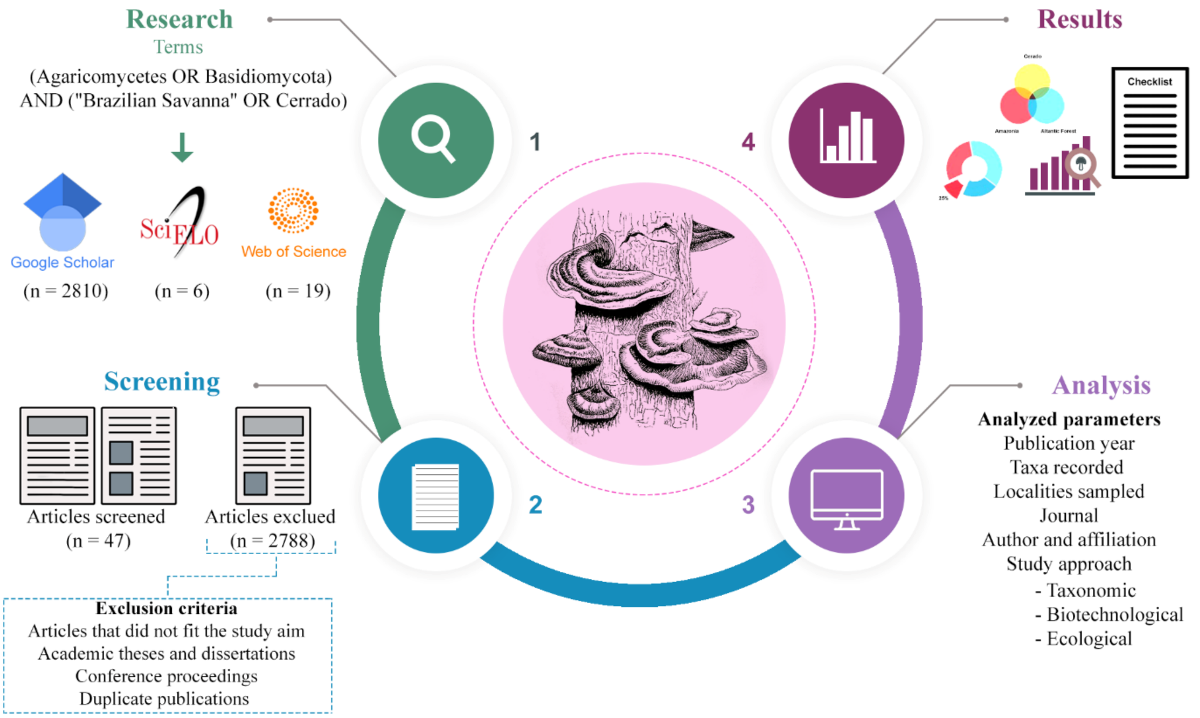

Figure 1. Methodology for a systematic search and analysis of the scientific production on corticioid and poroid fungi from Cerrado

Publication trends through years were tested using Spearman's correlation (r_s, 5% significance) and Pettitt's test was used to determine the point of change in the dataset, which we classify between explanatory and developmental periods. Author's collaboration network was carried out using the IGRAPH (Csárdi & Nepusz 2006) and CIRCLIZE (Gu et al. 2014) packages. These analyses were performed in R software version 3.6.1 (R Core Team, 2017) and RStudio environment version 1.2.1335 (RStudio Team 2019).

Species distribution inside Cerrado's area was created according to vegetation map of Brazil (IBGE 2019). In this analysis for articles with non-available collection locations, we consider the reported municipality. The species distribution map was made using QGIS (QGIS Development Team 2020) and the Veen diagram for the species occurrence dataset by Brazilian biomes was performed in InteractiVenn (Heberle et al. 2015). Descriptive statistics were carried out in Microsoft Excel, while GraphPad Prism version 9 was used to create graphs.

For species checklist, articles that mentioned the species voucher, regardless of the study approach and identified at the species level were considered. All recorded taxa had their names updated according to the Index Fungorum (http://www.indexfungorum.org) and Mycobank (https://www.mycobank.org/) databases and were classified as a traditional morphological group according to Hjortstam & Ryvarden (2007), Gibertoni et al. (2016), Baltazar et al. (2017), Chikowski et al. (2020), Gafforov et al. (2020), and Gorjón (2020).

Results and Discussion

The first mycological investigation on corticioid and poroid fungi from Cerrado was carried out in the late 19th century by the British researcher's Miles Joseph Berkeley and Mordecai Cubitt Cooke (Berkeley & Cooke 1876) (Figure 2). They presented a list of 437 species, including corticioid and poroid fungi, previously collected by naturalists in some states of the country. From their list, we considered species reported from the state of Goiás, extensively covered by the Cerrado vegetation. Other species were excluded once the data provided was not sufficient to make sure that they were collected in a Cerrado area.

Until the 1960s few articles were published about corticioid and poroid fungi, but it marks the first studies by mycologists from the Instituto de Botânica de São Paulo (IBot) (currently Instituto de Pesquisas Ambientais do Estado de São Paulo), such as João Salvador Furtado, Maria Eneyda Pacheco Kauffmann Fidalgo, Oswaldo Fidalgo, and Vera Lucia Ramos Bononi (Fidalgo 1965, Fidalgo et al. 1965, Bononi 1984). Since the 1990s onwards, Adriana de Mello Gugliotta studies have risen to prominence (Gugliotta 1997). These researchers presented the first inventories of corticioid and poroid fungi from Cerrado in important Conservation Units of the state of São Paulo and are considered a starting point for diversity research of this group in the biome. The first decade of the 20th century was marked by the publication of a study focusing on biotechnological properties and the first checklist of lignocellulolytic Agaricomycetes (Xavier-Santos et al. 2004, Gibertoni & Drechsler-Santos 2010). Thus, from the aforementioned data, an exploratory period was observed until 2011 (change-point; Pettitt test, $p = 0.009$) (Figure 2).

In 2012, an extensive list of xylophilous Agaricomycetes of the Brazilian Cerrado was published (Abrahão et al. 2012). This article compiled and reviewed the results of previous researchers and provided a list of more than 100 species of fungi. The temporal distribution of the articles showed an increase in publications ($r_s = 0.62$; $p = 0.0003$) over the years, especially within the last decade (2011 to 2021). From 2012 there was a rapid research development time and when 55% of articles were published. Furthermore, the diversity knowledge of these fungi from the Cerrado increased exponentially during this period (Figure 2). This growing trend is related to the interest of new research groups, especially from Universidade Estadual de Goiás (UEG), Universidade Federal de Pernambuco (UFPE), and Universidade Federal de Santa Catarina (UFSC), besides training of new human resources through undergraduate research and graduate programs by these institutions.

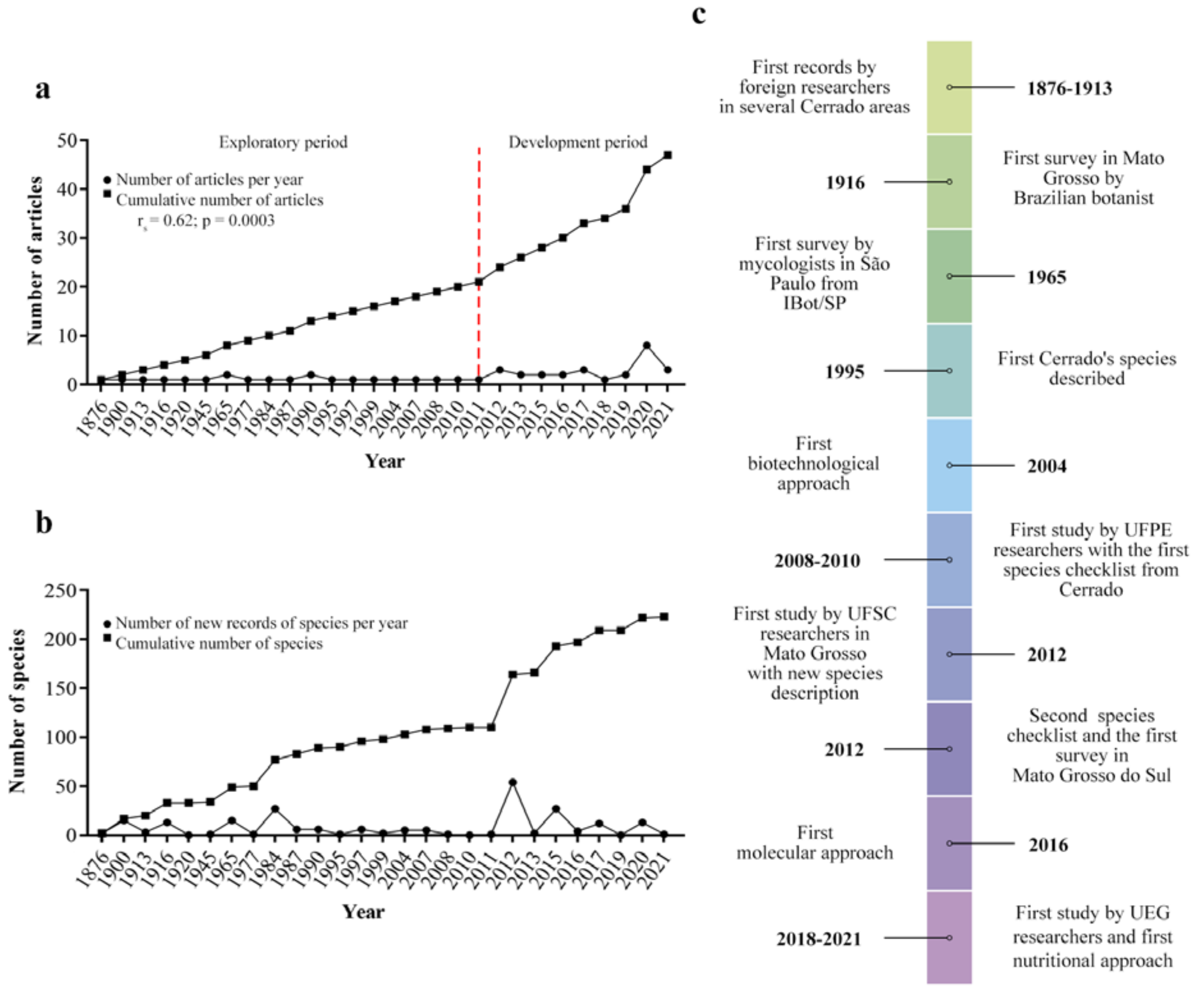

Figure 2. a. Absolute and cumulative number of articles on corticioid and poroid fungi from Cerrado. The red dotted line represents the change point by the Pettitt test (p = 0.009). **b.** Absolute and cumulative number of species added per year, from 1876 to 2021. **c.** Timeline of scientific production on the topic.

The articles published in the period studied were distributed in 27 journals, 67% (n = 18) of which are international and 33% (n = 9) are Brazilian (Figure 3). We observed that 22% (n = 6) have a scope focused exclusively on Mycology and 78% (n = 21) on Botany, Microbiology, and Multidisciplinary. The most prolific journals were: Mycotaxon (17%, n = 8) and Hoehnea (9%, n = 4). Both have publications mainly focused on taxonomy. In this sense, 85% (n = 40) of studies had a taxonomic focus, 11% (n = 5) biotechnological and 4% (n = 2) ecological. Interestingly, 17% (n = 7) of taxonomic studies used a phylogenetic approach, and of those, only Costa-Rezende et al. (2016) focused on a large number of species within the Cerrado biome. There is a growing trend of studies with a taxonomic focus, which justifies the higher frequency of articles published in journals regarding this scope. Despite this, the preference for few Brazilian journals for these publications may be related to the scope of national journals, the difficulty in publishing species lists, and the lack of Brazilian journals focused on Mycology.

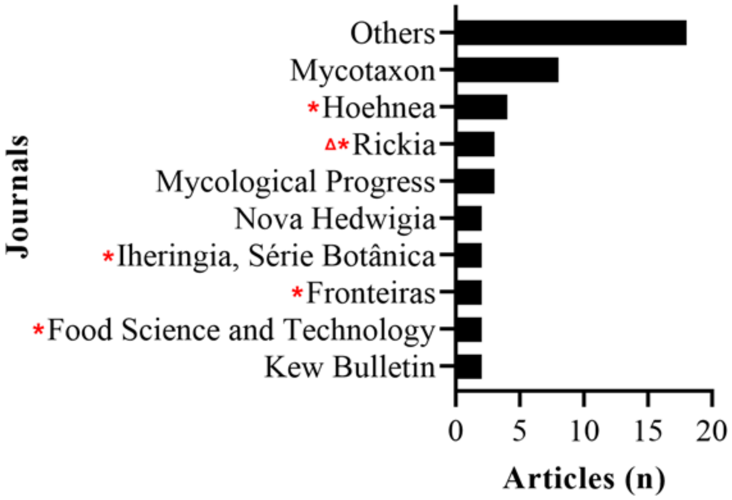

Figure 3. Journals with the highest number of publications on corticioid and poroid fungi from Cerrado between 1876 and 2021. (*) Brazilian journals; ($^{\Delta}$) Inactive journal. Others (one published article): $^{\Delta}$*Arquivos do Museu Nacional, Botanical Journal of the Linnean Society, *Bragantia, $^{\Delta}$Brotéria: Série Botanica, Check List, Folia Microbiologica, Frontiers in Microbiology, Fungal Ecology, Hedwigia, Kurtziana, Microbial Biosystems, Persoonia, Phytotaxa, PloS One, $^{\Delta}$*Revista Brasileira de Biociências, *Rodriguesia, Sydowia, and Synopsis Fungorum (publisher).

Despite the increase in the scientific production of this fungi group from Cerrado, there is still no data on this biodiversity in several regions of the biome. São Paulo is the state with the largest number of species occurrence records (52.5%), followed by Mato Grosso (16.5%), Goiás (15.2%), Mato Grosso do Sul (13.2%), Tocantins (2.1%), and the Distrito Federal (0.5%). Currently, there are 285 protected areas in the biome (Lahsen et al. 2016), and among these, 15 (5%) have species records, whereas the most studied are the Reserva Biológica de Mogi Guaçu

(124 records), Floresta Nacional de Silvânia (29 records) and Serra de Maracaju (26 records). Thus, further research concerning the unstudied regions would be highly relevant (Figure 4).

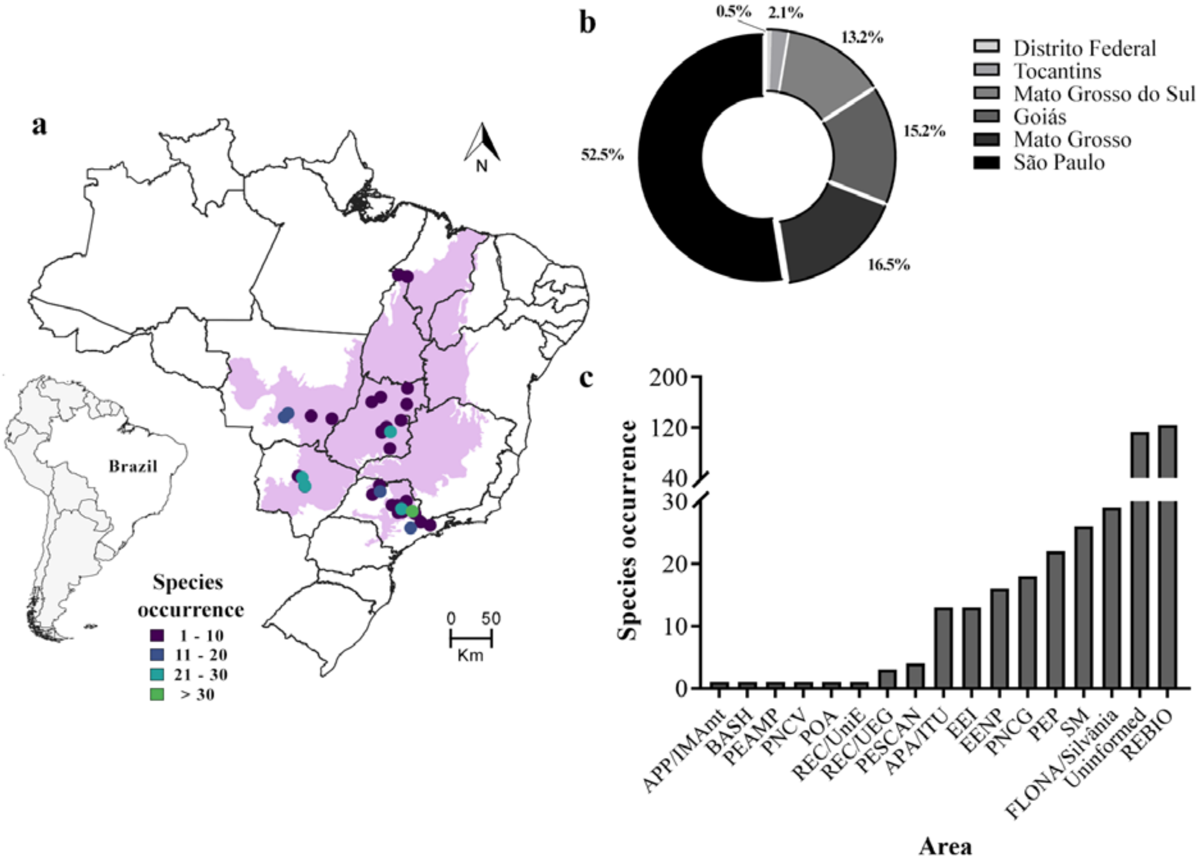

Figure 4. Occurrence of corticioid and poroid fungi in the Cerrado. **(a)** Occurrence records in the biome coverage, **(b)** number of records in Brazilian states, and **(c)** in protected area. APP/IMAmt: Área de Proteção Permanente, IMAmt; BASH: Bosque Auguste Saint-Hilaire; PEAM: Parque Estadual Altamiro de Moura Pacheco; PNCV: Parque da Nacional Chapada dos Veadeiros; POA: Parque Olhos D'Água; REC/UniE: Reserva Ecológica da UniEvangélica; REC/UEG: Reserva Ecológica da Universidade Estadual de Goiás; PESCAN: Parque Estadual da Serra de Caldas Novas; APA/ITU: Area de proteção ambiental/Itu; EEI: Estação Ecológica de Itirapina; EENP: Estação Ecológica do Noroeste Paulista; PNCG: Parque Nacional da Chapada dos Guimarães; PEP: Parque Estadual do Prosa; SM: Serra de Maracaju; FLONA/Silvânia: Floresta Nacional de Silvânia; REBIO: Reserva Biológica de Mogi Guaçu.

An amount of 387 occurrences and 223 species were listed in the present study, while 94 species are new additions to the checklists published by Gibertoni & Drechsler-Santos (2010) and Abrãao et al. (2012). From these, 63% are poroid species and 37% corticioid. The most species-rich genera are *Hymenochaete* (10 species), *Ganoderma* (9 species), *Amauroderma* (8 species), *Polyporus* (8 species), *Trametes* (8 species), and *Fuscoporia* (7 species). Cosmopolitan species such as *Hexagonia hydnoides*, *Fuscoporia gilva*, *Pycnoporus sanguineus*, and *Gloeophyllum striatum* were the most frequent.

Among the Brazilian biomes, the Atlantic Forest and Amazonia show greater species similarity to the Cerrado, while Pampa, Pantanal, and Caatinga present few species in common (Figure 5). *Trametes villosa* is the only species found in all the biomes. *Favolus brasiliensis*, *Hexagonia hydnoides*, *H. variegata*, *Lentinus crinitus*, *L. velutinus*, *Fuscoporia gilva*, and *Pycnoporus sanguineus* occurred in five biomes (Supplementary Material, Table II).

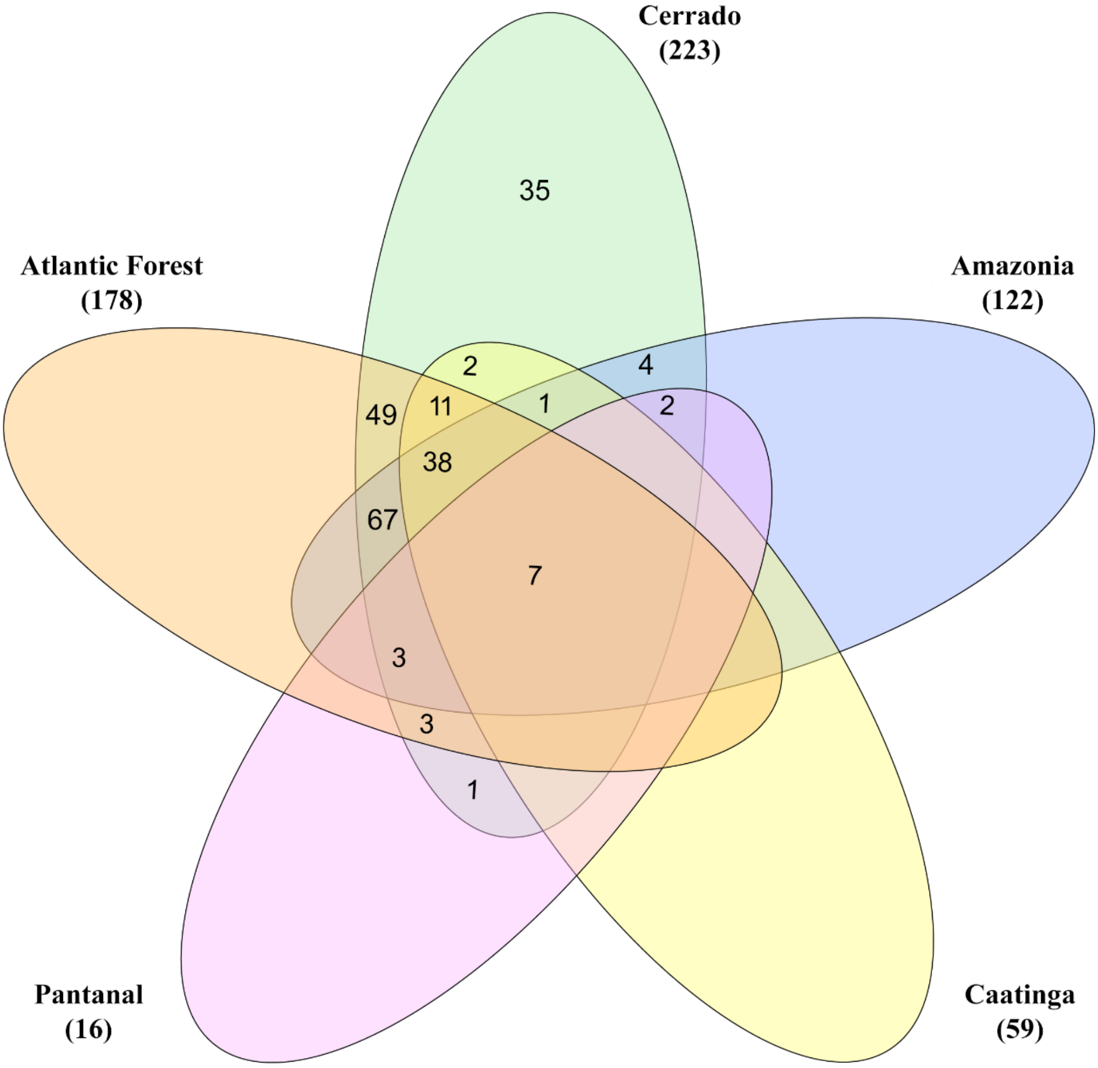

Figure 5. Occurrence records of species of corticioid and poroid fungi from the Cerrado and which also have records in other Brazilian biomes. The Pampa data is not presented as it has only three occurrence records (See Supplementary Material, Table II). In parentheses, the total number of species cited for each biome.

Studies regarding these fungi are focused on Amazonia and Atlantic forests (Maia et al. 2015). But our data highlight the importance of investigating the Cerrado region, once 35 (68% corticioid, 32% poroid) of the listed species are endemic of this biome (6 species) or in Brazil, occur only in the Cerrado (29 species), despite being reported in other regions of the world [these are indicated by symbols (• and *) on species checklist; (Supplementary Material, Table II)]. This result is potentially useful to the development of protective measures for Cerrado and to raise concerns about rare, endemic, and possibly threatened species, once the biome is constantly degraded by anthropic actions. Additionally, for low-occurrence species, these data support the implementation of conservation measures according to the International Union for Conservation of Nature (IUCN). Interestingly, only *Perenniporia medulla-panis* of the listed species is presented on IUCN Red List as near threatened (Iršėnaitė 2019).

Up to now, 88 authors from 29 institutions contributed to the knowledge of corticioid and poroid fungi from Cerrado, 52% Brazilian and 48% foreign. The IBot [23% of publications (n = 11); 10.2% linked authors (n = 9)] UFSC [17% of publications (n = 8); 12.5% linked authors (n = 11)], UEG [17% of publications (n = 8); 19.3% linked authors (n = 9)] and UFPE [15% of publications (n = 7); 10.2% linked authors (n = 9)] were the institutions showing the largest number of publications and authors who were affiliated at some point during their academic training.

We observed that 64% of authors published only one article, 24% two to three, and 13% four or more. Furthermore, 74% of the articles were published in collaboration and intra-institutional collaboration dominated the publication network. Figure 6 represents the interaction between the authors through the chord diagram. Each author is represented by a fragment on the outside of the circular layout and their collaboration is represented by lines (line's width is proportional to the importance of the flow). The main research groups focused on corticioid and poroid fungi in Brazil have already published at least one article with samples from the Cerrado (Figure 6).

We emphasize that 60% of the scientific production about these fungi groups in the Cerrado present species based on sporadic collections, as well as reviews of isolated exsiccates in fungaria. These studies are not focused on the diversity of the biome explaining the large number of authors presented in the collaboration network (Figure 6). Thus, we evaluated the scientific production focused on the Cerrado through the study objective, studied area, and the number of species recorded. These articles summed 40% of the scientific production and most of them came from research conducted by four different institutions' research groups. Teams associated with Adriana de Melo Gugliotta and Solange Xavier dos Santos were the ones who contributed the most to the knowledge of current diversity of corticioid and poroid fungi. Both researchers are dedicated to studies of Cerrado's Funga and are linked to the SP and HUEG fungaria, corresponding to the most significant *ex-situ* collection of this fungi groups in the biome (CRIA 2021).

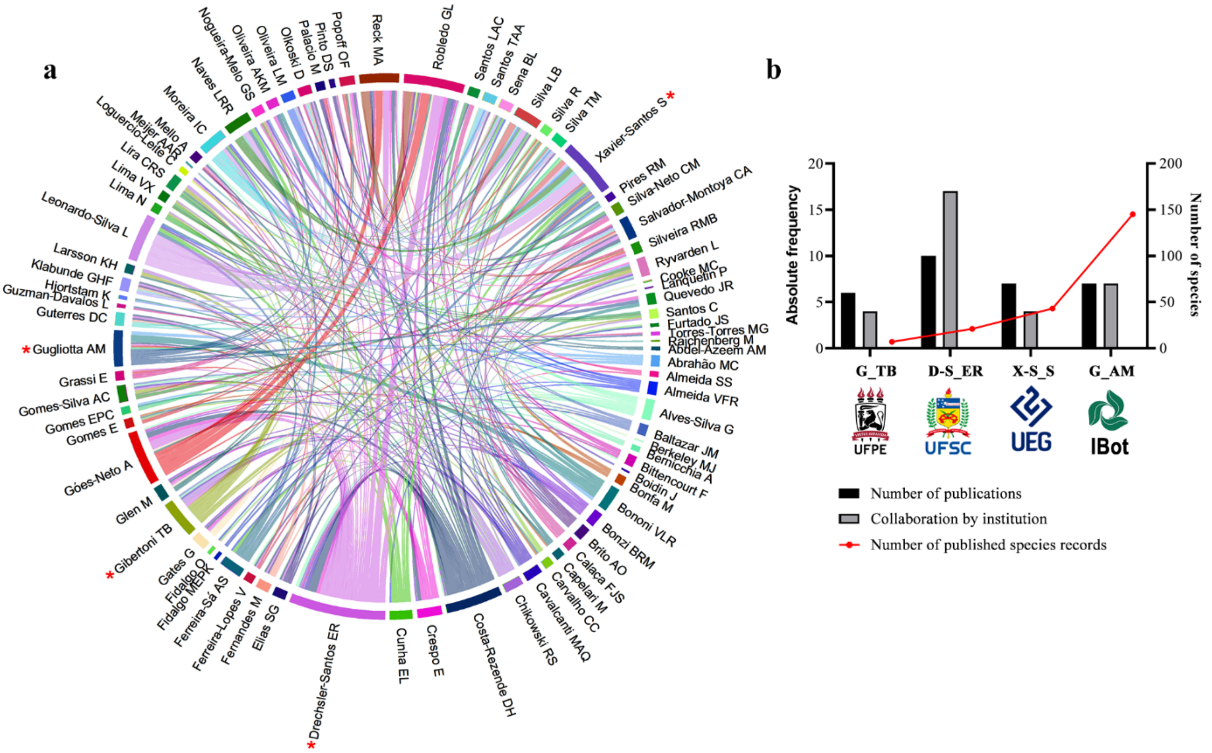

Figure 6. a. Collaboration network among authors with articles on corticioid and poroid from Cerrado. The asterisk (*) shows the most collaborative authors among the institutions. We chose not to select authors who are part of the same research group. **b.** Main research groups and institutions that contributed to the current knowledge on the topic and the research groups are represented by their coordinators. For this analysis we did not consider the article by Maia et al. (2015), because it is a collaboration among several mycologists, many from distinct taxonomic groups, to survey the diversity of fungi in Brazil.

Corticioid and poroid fungi diversity from Cerrado reported here is lower than in other biomes where the diversity is better explored (Flora do Brasil, 2021). The low number of trained mycologists, lack of investment, deficient data from unexplored areas of the biome, and few long-term studies are obstacles to understanding the species richness of the biome and its biological, ecological, and evolutionary aspects. In this context, intensive fieldwork explorations could help in upgrading the species diversity, contributing to the understanding of species phylogenetic relationships, and their threat status, especially those with restricted distribution in the biome. The discovery of an unknown diversity may encourage new study approaches, such as biotechnology, ecology, and others still incipient. On the other hand, the exponential growth in knowledge observed in the last decade, especially by the new research groups involved in studies within the Cerrado, brings a perspective of improvement to this situation.

Facing the gaps and trends presented, we believe that to overcome the knowledge limitations of Cerrado corticioid and poroid fungi the following actions are required: (1) increase the support for training new taxonomists; (2) maximize the inter-institutional integration to understand the biodiversity in the Cerrado; (3) expanding inventories to the unexplored region, mainly in protected areas, once only 5% have been studied; (4) investments on data collection over long periods; (5) intensify phylogenetic studies of native species to clarify the relationship and taxonomic position of the species in the group; and (6) the implementation of programs which assess threatened species, especially those with restricted distribution in the Cerrado.

Updating Cerrado corticioid and poroid fungi checklist after a decade of studies

We present below the checklist of corticioid and poroid fungi from Cerrado. Endemic species are marked by a circle (•), species that occur in other regions of the world, but in Brazil, there are only records in the Cerrado are marked by an asterisk (*), and new additions to the checklists published by Gibertoni & Drechsler-Santos (2010) and Abrahão et al. (2012) are marked by a triangle (∆). The checklist was organized alphabetically by species, followed by the traditional morphological group, occurrence in Brazil's Cerrado states, and occurrence in other Brazilian biomes. Species mentioned by Berkeley & Cooke (1876), Hennings (1900), Lloyd (1913), and Sampaio (1916) were included in the list, although revision of the exsiccates is necessary to confirm identification.

Fungi
Basidiomycota
Agaricomycetes
Aleurodiscus botryosus Burt
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Caatinga (Chikowski et al. 2020).

Aleurodiscus cerussatus (Bres.) Höhn. & Litsch.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Bononi 1984, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia (Neves et al. 2015) and Caatinga (Chikowski et al. 2020).

Aleurodiscus exasperatus Hjortstam & Ryvarden
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest (Neves et al. 2015).

$^{\Delta}$***Amauroderma aurantiacum*** (Torrend) Gibertoni & Bernicchia
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Gibertoni et al. 2008, Leonardo-Silva et al. 2020a) and Mato Grosso (Costa-Rezende et al. 2016).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Maia et al. 2015).

Amauroderma calcigenum (Berk.) Torrend
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás [Berkeley & Cooke (1876) as *Polyporus calcigenus* Berk., Torrend (1920), Leonardo-Silva et al. (2020b)] and Mato Grosso [Sampaio (1916) as *Leucoporus partitus* (Berk.) Pat.].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

•$^{\Delta}$***Amauroderma calcitum*** D.H. Costa & Drechsler-Santos
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2016).
Occurrence in other Brazilian biomes: Endemic species from Cerrado.

$^{\Delta}$***Amauroderma camerarium*** (Berk.) J.S. Furtado
Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

△***Amauroderma exile*** (Berk.) Torrend

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020a).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Amauroderma omphalodes (Berk.) Torrend

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Hennings (1900), Sampaio (1916) both as *Fomes omphalodes* (Berk.) Sacc., Costa-Rezende et al. (2016)] and Mato Grosso do Sul (Bononi et al. 2017).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Amauroderma praetervisum (Pat.) Torrend

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2016) and São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

△***Amauroderma schomburgkii*** (Mont. & Berk.) Torrend

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2016), Mato Grosso do Sul (Bononi et al. 2017), and São Paulo (Rajchenberg & Meijer 1990).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

△***Amaurodermellus ovisporum*** (Gomes-Silva, Ryvarden & Gibertoni) Costa-Rezende, Drechsler-Santos & Góes-Neto

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2020).

Occurrence in other Brazilian biomes: Amazonia (Gomes-Silva et al. 2015).

$^{\Delta}$***Antrodia malicola*** (Berk. & M.A. Curtis) Donk
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Rajchenberg & Meijer 1990).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Antrodiella versicutis*** (Berk. & M.A. Curtis) Gilb. & Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Aquascypha hydrophora*** (Berk.) D.A. Reid
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Xavier-Santos et al. 2004).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Athelia arachnoidea (Berk.) Jülich
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Atlantic Forest (Silveira 2015).

*$^{\Delta}$***Athelopsis galzinii*** (Bres.) Hjortstam
Morphological group: Corticioid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Not known from other biomes.

*$^{\Delta}$***Australicium singulare*** (G. Cunn.) Hjortstam & Ryvarden
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Hjortstam & Ryvarden 2007).
Occurrence in other Brazilian biomes: Not known from other biomes.

*$^{\Delta}$***Botryohypochnus isabellinus*** (Fr.) J. Erikss.

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Lloyd (1913) as *Pellicularia isabellina* (Fr.) D.P. Rogers].

Occurrence in other Brazilian biomes: Not known from other biomes.

***Bulbillomyces farinosus** (Bres.) Jülich

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Peniophora candida* Lyman, Abrahão et al. (2012)].

Occurrence in other Brazilian biomes: Not known from other biomes.

***Butyrea luteoalba** (P. Karst.) Miettinen

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012) as *Junghuhnia luteoalba* (P. Karst.) Ryvarden].

Occurrence in other Brazilian biomes: Not known from other biomes.

Byssomerulius corium (Pers.) Parmasto

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Merulius confluens* Schwein., Bononi (1984) as *Merulius sordidus* Berk. & M.A. Curtis ex Cooke, Abrahão et al. (2012)].

Occurrence in other Brazilian biomes: Amazonia (Gorjón & Jesus 2012), Atlantic Forest (Gugliotta et al. 2015), and Caatinga (Chikowski et al. 2020).

•△***Candelabrochaete adnata*** Hjortstam

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Hjortstam 1995).

Occurrence in other Brazilian biomes: Endemic species from Cerrado.

Ceriporia spissa (Schwein. ex Fr.) Rajchenb.

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia (Gugliotta et al. 2015).

$^{\Delta}$***Ceriporia viridans*** (Berk. & Broome) Donk

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Gugliotta et al. 2015).

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Ceriporia xylostromatoides (Berk.) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Poria xylostromatoides* (Berk.) Cooke, Abrahão et al. (2012)].

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Cerocorticium molle*** (Berk. & M.A. Curtis) Jülich

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Hjortstam & Bononi 1987).

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

*Chondrostereum purpureum (Pers.) Pouzar

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012) as *Thelephora lilacina* (Batsch) Pers.].

Occurrence in other Brazilian biomes: Not known from other biomes.

Coltricia hamata (Romell) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Pelloporus hamatus* Romell].

Occurrence in other Brazilian biomes: Amazonia (Gibertoni et al. 2015).

Coriolopsis byrsina (Mont.) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Polyporus byrsinus* Mont.] and São Paulo (Xavier-Santos et al. 2004).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Coriolopsis floccosa (Jungh.) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás [Leonardo-Silva et al. (2020b) as *Funalia floccosa* (Jungh.) Zmitr. & Malysheva] and São Paulo [Bononi (1984) as *Trametes rigida* Berk. & Mont., Rajchenberg & Meijer (1990), Gugliotta (1997) both as *Coriolopsis rigida* (Berk. & Mont.) Murrill, Abrahão et al. (2012, 2019)].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

$^{\Delta}$***Cotylidia aurantiaca*** (Pat.) A.L. Welden

Morphological group: Corticioid.

Distribution in Cerrado areas: Goiás [Lloyd (1913), Teixeira (1945) both as *Stereum aurantiacum* (Pat.) Lloyd].

Occurrence in other Brazilian biomes: Amazonia (Capelari et al. 2015) and Atlantic Forest (Baltazar et al. 2022).

Cotylidia undulata (Fr.) P. Karst.

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Not known from other biomes.

$^{\Delta}$***Crustodontia chrysocreas*** (Berk. & M.A. Curtis) Hjortstam & Ryvarden

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Gugliotta et al. 2015).

Occurrence in other Brazilian biomes: Amazonia (Gorjón & Jesus 2012) and Atlantic Forest (Hjortstam & Bononi 1987).

Cymatoderma caperatum (Berk. & Mont.) D.A. Reid

Morphological group: Corticioid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

△**_Cymatoderma dendriticum_** (Pers.) D.A. Reid
Morphological group: Corticioid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

*△**_Cymatoderma elegans_** Jungh.
Morphological group: Corticioid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Not known from other biomes.

Daedalea aethalodes (Mont.) Rajchenb.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012) and São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

△**_Daedalea ryvardeniana_** Drechsler-Santos & Robledo
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and Mato Grosso (Drechsler-Santos et al. 2012).
Occurrence in other Brazilian biomes: Caatinga (Santos et al. 2018).

Datronia mollis (Sommerf.) Donk
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

•△**_Dendrothele moquiniarum_** (Viégas) P.A. Lemke
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Viégas (1939) as *Aleurodiscus moquiniarum* Viégas, Chikowski et al. (2020)].
Occurrence in other Brazilian biomes: Endemic species from Cerrado.

Dichostereum sordulentum (Cooke & Massee) Boidin & Lanq.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012, 2019) as *Dichostereum* cf. *sordulentum*].
Occurrence in other Brazilian biomes: Atlantic Forest (Chikowski et al. 2020).

$^{\Delta}$***Earliella scabrosa*** (Pers.) Gilb. & Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Tocantins (Gugliotta et al. 2015).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Echinochaete brachypora (Mont.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Echinoporia aculeifera (Berk. & M.A. Curtis) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest and Pantanal (Gibertoni et al. 2015).

Efibula corymbata (G. Cunn.) Zmitr. & Spirin
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012) as *Ceraceomyces corymbatus* (G. Cunn.) Stalpers, Abrahão et al. (2019) as *Phanerochaete corymbata* (G. Cunn.) Burds.].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Epithele alba*** (Viégas) Boidin, Lanq. & Duhem
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Nakasone 2013).
Occurrence in other Brazilian biomes: Amazonia (Chikowski et al. 2020) and Atlantic Forest (Gugliotta et al. 2015).

△***Epithele subfusispora*** (Burds. & Nakasone) Hjortstam & Ryvarden
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Gugliotta et al. 2015).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Epithelopsis fulva (G. Cunn.) Jülich
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Epithele fulva* G. Cunn., Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Pantanal (Gugliotta et al. 2015).

Favolus brasiliensis (Fr.) Fr.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás [Leonardo-Silva et al. (2020b) as *Favolus tenuiculus* P. Beauv., Silva-Neto et al. (2021)] and São Paulo [Gugliotta (1997), Abrahão et al. (2012, 2019) all as *Polyporus tenuiculus* (P. Beauv.) Fr.].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, Pampa, and Pantanal (Gugliotta et al. 2015).

△***Fibrodontia brevidens*** (Pat.) Hjortstam & Ryvarden
Morphological group: Corticioid.
Distribution in Cerrado areas: Mato Grosso do Sul (Chikowski et al. 2020).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest (Gugliotta et al. 2015), and Caatinga (Chikowski et al. 2020).

Fomes fasciatus (Sw.) Cooke
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo (Gugliotta 1997, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest and Caatinga (Gugliotta et al. 2015).

Fomitella supina (Sw.) Murrill
Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Fomes subolivaceus* (Berk. & M.A. Curtis) Cooke, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\triangle}$***Fomitiporia apiahyna*** (Speg.) Robledo, Decock & Rajchenb.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b).
Occurrence in other Brazilian biomes: Atlantic Forest and Caatinga (Gibertoni et al. 2015).

$^{\triangle}$***Fomitiporia conyana*** Alves-Silva & Drechsler-Santos
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso (Alves-Silva et al. 2020).
Occurrence in other Brazilian biomes: Atlantic Forest (Alves-Silva et al. 2020).

Fomitiporia maxonii Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Phellinus punctatus* (P. Karst.) Pilát and *Phellinus robustus* (P. Karst.) Bourdot & Galzin, Abrahão et al. (2012, 2019)].
Occurrence in other Brazilian biomes: Atlantic Forest and Caatinga (Gibertoni et al. 2015).

$^{\triangle}$***Fomitiporia robusta*** (P. Karst.) Fiasson & Niemelä
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Atlantic Forest (Baltazar & Gibertoni 2009).

$^{\triangle}$***Fomitopsis rosea*** (Alb. & Schwein.) P. Karst.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\triangle}$***Foraminispora rugosa*** (Berk.) Costa-Rezende, Drechsler-Santos & Robledo
Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020a) and Mato Grosso [Costa-Rezende et al. (2016) as *Amauroderma sprucei* (Pat.) Torrend].
Occurrence in other Brazilian biomes: Amazonia (Costa-Rezende et al. 2017), Atlantic Forest (Campacci & Gugliotta 2009), and Caatinga (Drechsler-Santos et al. 2013).

$^{\Delta}$***Fulvifomes fastuosus*** (Lév.) Bondartseva & S. Herrera
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Gibertoni et al. (2015) as *Phellinus fastuosus* (Lév.) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

Fulvifomes luteoumbrinus (Romell) Y.C. Dai & Vlasák
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Phaeoporus luteoumbrinus* Romell] and Tocantins [Gibertoni et al. (2015) as *Inonotus luteoumbrinus* (Romell) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gibertoni et al. 2015).

$^{\Delta}$***Fulvifomes merrillii*** (Murrill) Baltazar & Gibertoni
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017) and Tocantins (Gibertoni et al. 2015).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest and Caatinga (Gibertoni et al. 2015).

$^{\Delta}$***Fulvifomes nilgheriensis*** (Mont.) Bondartseva & S. Herrera
Morphological group: Poroid.
Distribution in Cerrado areas: Tocantins (Gibertoni et al. 2015).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

$^{\Delta}$***Fulvifomes rimosus*** (Berk.) Fiasson & Niemelä
Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul [Bononi et al. (2017) as *Phellinus rimosus* (Berk.) Pilát] and São Paulo [Xavier-Santos et al. (2004) as *P. rimosus*).

Occurrence in other Brazilian biomes: Atlantic Forest and Caatinga (Gibertoni et al. 2015).

Funalia caperata (Berk.) Zmitr. & Malysheva

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b), Mato Grosso [Sampaio (1916) as *Polyporus caperatus* Berk.], Mato Grosso do Sul [Quevedo et al. (2012) as *Datronia caperata* (Berk.) Ryvarden], São Paulo [Gugliotta (1997) as *D. caperata*, Abrahão et al. (2012, 2019)], and Tocantins (Gugliotta et al. 2015).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

•$^{\Delta}$***Furtadomyces biseptatus*** (Costa-Rezende, Drechsler-Santos & Reck) Leonardo-Silva, Cotrim & Xavier-Santos

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Costa-Rezende et al. (2017) as *Furtadoa biseptata* Costa-Rezende, Drechsler-Santos & Reck).

Occurrence in other Brazilian biomes: Endemic species from Cerrado.

$^{\Delta}$***Furtadomyces brasiliensis*** (Singer) L. Leonardo-Silva, C.F.C Cotrim & S. Xavier-Santos

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Costa-Rezende et al. (2016) as *Amauroderma brasiliense* (Singer) Ryvarden].

Occurrence in other Brazilian biomes: Amazonia (Costa-Rezende et al. 2015) and Atlantic Forest (Campacci & Gugliotta 2009).

$^{\Delta}$***Fuscoporia callimorpha*** (Lév.) Groposo, Log.-Leite & Góes-Neto

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b).

Occurrence in other Brazilian biomes: Amazonia (Xavier et al. 2018) and Atlantic Forest (Gibertoni et al. 2015).

Fuscoporia chrysea (Lév.) Baltazar & Gibertoni

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012, 2019) both as *Phellinus chryseus* (Lév.) Ryvarden].

Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

Fuscoporia contigua (Pers.) G. Cunn.

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Amazonia (Xavier et al. 2018) and Atlantic Forest (Gibertoni et al. 2015).

Fuscoporia gilva (Schwein.) T. Wagner & M. Fisch.

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás [Leonardo-Silva et al. (2020b) as *Phellinus gilvus* (Schwein.) Pat.], Mato Grosso [Hennings (1900) as *Polyporus gilvus* (Schwein.) Fr., Sampaio (1916) as *Chaetoporus gilvus* Schwein., *C. licnoides* Mont., *C. scruposus* Fr., *Polyporus aggrediens* Berk., *P. gilvus* and *Polystictus licnoides* (Mont.) Fr.], Mato Grosso do Sul [Quevedo et al. (2012) as *P. gilvus*, Bononi et al. (2017)], and São Paulo [Fidalgo et al. (1965), Bononi (1984), Xavier-Santos et al. (2004) all as *P. gilvus*, Abrahão et al. (2012, 2019)].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, and Pantanal (Gibertoni et al. 2015).

Fuscoporia punctatiformis (Murrill) Zmitr., Malysheva & Spirin

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Phellinus punctatus* (P. Karst.) Pilát, Abrahão et al. (2012, 2019) both as *Phellinus punctatiformis* (Murrill) Ryvarden].

Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

Fuscoporia rhabarbarina (Berk.) Groposo, Log.-Leite & Góes-Neto

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

$^{\Delta}$***Fuscoporia wahlbergii*** (Fr.) T. Wagner & M. Fisch.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b).
Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

Ganoderma australe (Fr.) Pat.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012) and São Paulo [Bononi (1984) as *Ganoderma applanatum* (Pers.) Pat., Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

$^{\Delta}$***Ganoderma lucidum*** (Curtis) P. Karst.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Hennings (1900), Sampaio (1916) both as *Fomes lucidus* (Curtis) Sacc.].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Ganoderma multiplicatum (Mont.) Pat.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020a), Mato Grosso do Sul (Quevedo et al. 2012), and São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Ganoderma orbiforme*** (Fr.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Ganoderma stipitatum*** (Murrill) Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: Distrito Federal, Goiás (Leonardo-Silva et al. 2020a), and Mato Grosso do Sul [Bononi et al. (2017) as *Ganoderma parvulum* Murrill].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

***$^{\Delta}$Ganoderma testaceum** (Cooke) Pat.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b).
Occurrence in other Brazilian biomes: Not known from other biomes.

***Ganoderma tuberculosum** Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Ganoderma resinaceum* Boud., Abrahão et al. 2012].
Occurrence in other Brazilian biomes: Not known from other biomes.

***$^{\Delta}$Ganoderma weberianum** (Bres. & Henn. ex Sacc.) Steyaert
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Torres-Torres et al. 2013).
Occurrence in other Brazilian biomes: Not known from other biomes.

Ganoderma zonatum Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Gloeocystidiopsis salmonea (Burt) Boidin, Lanq. & Gilles
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Amazonia (Chikowski et al. 2020).

Gloeodontia discolor (Berk. & M.A. Curtis) Boidin
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest (Neves et al. 2015), and Caatinga (Chikowski et al. 2020).

Gloeophyllum striatum (Fr.) Murrill

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Fidalgo et al. 1965, Abrahão et al. 2012), Mato Grosso [Hennings (1900), Sampaio (1916) both as *Lenzites striatus* (Fr.) Fr.], Mato Grosso do Sul (Quevedo et al. 2012), and São Paulo (Fidalgo et al. 1965, Rajchenberg & Meijer 1990, Xavier-Santos et al. 2004, Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Drechsler-Santos et al. 2015).

****Gloeoporus purpurascens*** Hjortstam

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Not known from other biomes.

Gloeoporus thelephoroides (Hook.) G. Cunn.

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017) and São Paulo (Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Pantanal (Gugliotta et al. 2015).

Grammothele subargentea (Speg.) Rajchenb.

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Rajchenberg & Meijer 1990, Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Hapalopilus phlebiiformis (Berk. ex Cooke) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Poria phlebiiformis* Berk. ex Cooke, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Hexagonia hirta*** (P. Beauv.) Fr.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Xavier-Santos et al. 2004).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Hexagonia hydnoides (Sw.) M. Fidalgo
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás [Leonardo-Silva et al. (2020b) as *Cerrena hydnoides* (Sw.) Zmitr.], Mato Grosso [Sampaio (1916) as *Trametes fibrosa* Fr. and *Trametes hydnoides* (Sw.) Fr.], Mato Grosso do Sul (Quevedo et al. 2012, Bononi et al. 2017), and São Paulo [Fidalgo et al. (1965) as *Pogonomyces hydnoides* (Sw.) Murrill, Bononi (1984), Rajchenberg & Meijer (1990), Gugliotta (1997), Xavier-Santos et al. (2004), Abrahão et al. (2012, 2019)].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, and Pantanal (Gugliotta et al. 2015).

Hexagonia scutigera (Fr.) Sacc.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Fidalgo et al. 1965, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Atlantic Forest (Torrend 1935).

$^{\Delta}$***Hexagonia tenuis*** (Fr.) Fr.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Gugliotta et al. 2015).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Hexagonia variegata Berk.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás [Leonardo-Silva et al. (2020b) as *Trametes variegata* (Berk.) Zmitr., Wasser & Ezhov], Mato Grosso do Sul [Quevedo et al. (2012) as *Hexagonia*

papyracea Berk., Bononi et al. (2017)], and São Paulo [Bononi (1984), Rajchenberg & Meijer (1990), Gugliotta (1997), Abrahão et al. (2012) as *H. papyracea*, Abrahão et al. (2019)].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, and Pantanal (Drechsler-Santos et al. 2013, Gugliotta et al. 2015).

Hydnopolyporus palmatus (Hook.) O. Fidalgo
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Naves et al. 2021), Mato Grosso [Hennings (1900) as *Polystictus warmingii* (Berk.) Sacc. & D. Sacc.], and São Paulo (Fidalgo et al. 1965, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Hydnoporia corrugata (Fr.) K.H. Larss. & Spirin
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Hymenochaete unicolor* Berk. & M.A. Curtis, Abrahão et al. (2012, 2019) as *Hymenochaete corrugata* (Fr.) Lév.].
Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

Hymenochaete berkeleyana (Mont.) Cooke
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Hymenochaete cacao* (Berk.) Berk. & M.A. Curtis, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni a et al. 2015).

Hymenochaete damicornis (Link) Lév.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Fidalgo et al. 1965, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

****Hymenochaete digitata*** Burt
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Not known from other biomes.

Hymenochaete iodina (Mont.) Baltazar & Gibertoni
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Chaetoporus iodinus* (Mont.) Rom.] and São Paulo [Abrahão et al. (2012, 2019) as *Cyclomyces iodinus* (Mont.) Pat.].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

△***Hymenochaete luteobadia*** (Fr.) Höhn. & Litsch.
Morphological group: Corticioid.
Distribution in Cerrado areas: Tocantins (Gibertoni et al. 2015).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

****Hymenochaete opaca*** Burt
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Not known from other biomes.

△***Hymenochaete peroxydata*** (Berk. ex Cooke) Baltazar, Gorjón & Rajchenb.
Morphological group: Corticioid.
Distribution in Cerrado areas: Mato Grosso do Sul [Bononi et al. (2017) as *Hydnochaete badia* Bres.].
Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

Hymenochaete pinnatifida Burt
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

Hymenochaete rheicolor (Mont.) Lév.
Morphological group: Corticioid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo [Bononi (1984) as *Hymenochaete berkeleyana* (Mont.) Cooke, Hennings (1900) as *Hymenochaete tenuissima* Berk, Abrahão et al. (2012, 2019)].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gibertoni et al. 2015).

Hymenochaete tenuis Peck
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Hymenochaete multisetae* Burt, Abrahão et al. (2012, 2019)].
Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

****Hyphoderma amoenum*** (Burt) Donk
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Corticium pilosum* Burt, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Not known from other biomes.

Hyphoderma heterocystidiatum (Burt) Donk
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012) as *Mutatoderma heterocystidium* (Burt) C.E. Gómez]
Occurrence in other Brazilian biomes: Atlantic Forest (Bononi et al. 1981).

$^{\Delta}$*Hyphodontia alutaria (Burt) J. Erikss.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Maia et al. 2015).
Occurrence in other Brazilian biomes: Not known from other biomes.

$^{\Delta}$***Hyphodontiastra virgicola*** Hjortstam & Melo
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Hjortstam 1999).
Occurrence in other Brazilian biomes: Atlantic Forest (Hjortstam 1999).

$^{\Delta}$***Inocutis jamaicensis*** (Murrill) A.M. Gottlieb, J.E. Wright & Moncalvo
Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso (Gibertoni et al. 2015).

Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015).

$^{\Delta}$***Inonotus rickii*** (Pat.) D.A. Reid

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás and São Paulo (Leonardo-Silva et al. 2021).

Occurrence in other Brazilian biomes: Atlantic Forest, Caatinga (Gibertoni et al. 2015), and Pampa (Leonardo-Silva et al. 2021).

*****$^{\Delta}$***Inonotus xanthoporus*** Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Gibertoni et al. 2015).

Occurrence in other Brazilian biomes: Not known from other biomes.

Irpex lacteus (Fr.) Fr.

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017) and São Paulo [Fidalgo et al. (1965) as *Polyporus tulipiferae* (Schwein.) Overh., Bononi (1984), Rajchenberg & Meijer (1990), Abrahão et al. (2012, 2019)].

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Irpex rosettiformis C.C. Chen & Sheng H. Wu

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Polyporus fimbriatus* Fr.], Mato Grosso do Sul [Bononi et al. (2017) as *Hydnopolyporus fimbriatus* (Cooke) D.A. Reid], and São Paulo [Abrahão et al. (2012, 2019) as *H. fimbriatus*].

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

*****$^{\Delta}$***Kneiffiella lanata*** (Burds. & Nakasone) Riebesehl & Langer

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Hjortstam & Bononi (1987) as *Hyphodontia lanata* Burds. & Nakasone].

Occurrence in other Brazilian biomes: Not known from other biomes.

△***Lentinus berteroi*** (Fr.) Fr.

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo [Gugliotta et al. 2015 as *Lentinus bertieri* (Fr.) Fr.].

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Lentinus crinitus (L.) Fr.

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Silva-Neto et al. 2020), Mato Grosso do Sul (Quevedo et al. 2012, Bononi et al. 2017), and São Paulo [Fidalgo et al. (1965), Bononi (1984), Abrahão et al. (2012) as *Panus crinitus* (L.) Singer, Abrahão et al. (2019)].

Occurrence in other Brazilian biomes: Amazonia (Gomes-Silva & Gibertoni 2009), Atlantic Forest, Caatinga, and Pantanal (Gugliotta et al. 2015).

△***Lentinus velutinus*** (Fr.)

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás [Gugliotta et al. (2015) as *Panus velutinus* (Fr.) Sacc.].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, and Pampa (Gugliotta et al. 2015).

Lenzites elegans (Spreng.) Pat.

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Hennings (1900) as *Lenzites repanda* (Pers.) Fr., Sampaio (1916) as *L. repanda* and *Trametes ambigua* (Berk.) Fr.] and São Paulo [Rajchenberg & Meijer (1990) as *Trametes elegans* (Spreng.) Fr., Abrahão et al. (2012)].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Lenzites stereoides (Fr.) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Dadedalea stereoides* Fr.].

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Lyomyces crustosus*** (Pers.) P. Karst.

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Hjortstam & Bononi (1987) as *Hyphodontia crustosa* (Pers.) J. Erikss.].

Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015) and Caatinga (Chikowski et al. 2020).

$^{\Delta}$***Lyomyces sambuci*** (Pers.) P. Karst.

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Gibertoni et al. (2015) as *Hyphodontia sambuci* (Pers.) J. Erikss.].

Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015) and Caatinga (Chikowski et al. 2020).

Megasporia cavernulosa (Berk.) C.R.S. Lira & T.B. Gibertoni

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012, 2019) both as *Dichomitus cavernulosus* (Berk.) Masuka & Ryvarden].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Megasporoporia setulosa (Henn.) Rajchenb.

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012, 2019) both as *Dichomitus setulosus* (Henn.) Masuka & Ryvarden].

Occurrence in other Brazilian biomes: Atlantic Forest, Amazonia, and Caatinga (Gugliotta et al. 2015).

Metuloidea reniformis (Berk. & M.A. Curtis) Westphalen & Motato-Vásq.

Morphological group: Corticioid.

Distribution in Cerrado areas: Goiás [Neves et al. (2015) as *Steccherinum reniforme* (Berk. & M.A. Curtis) Banker], Mato Grosso do Sul [Bononi et al. (2017) as *S. reniforme*], and São Paulo [Bononi (1984), Abrahão et al. (2012, 2019) all as *S. reniforme*].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Neves et al. 2015).

$^{\triangle}$***Microporellus dealbatus*** (Berk. & M.A. Curtis) Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\triangle}$***Microporellus obovatus*** (Jungh.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Gugliotta et al. 2015).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Mycobonia flava (Sw.) Pat.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Hjortstam & Bononi 1987, Xavier-Santos et al. 2004, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Neodictyopus dictyopus (Mont.) Palacio, Robledo & Drechsler-Santos
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás [Leonardo-Silva et al. (2020b) as *Polyporus dictyopus* Mont.], Mato Grosso (Palacio et al. 2017), and São Paulo [Fidalgo et al. (1965) as *Polyporus infernalis* Berk., Abrahão et al. (2012, 2019) both as *P. dictyopus*].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Nigrofomes melanoporus (Mont.) Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Fomes melanoporus* (Mont.) Sacc., Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

△***Nigroporus macroporus*** Ryvarden & Iturr.

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012).

Occurrence in other Brazilian biomes: Atlantic Forest and Pantanal (Gugliotta et al. 2015).

Nigroporus vinosus (Berk.) Murrill

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Polyporus vinosus* Berk.].

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Oxyporus pellicula (Jungh.) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Gugliotta 1997, Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Atlantic Forest (Borba-Silva et al. 2015).

Pachykytospora alabamae (Berk. & Cooke) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Pachykytospora papyracea (Cooke) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

△***Panus neostrigosus*** Drechsler-Santos & Wartchow

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Gugliotta et al. 2015).

Occurrence in other Brazilian biomes: Amazonia and Pantanal (Gugliotta et al. 2015).

Panus strigellus (Berk.) Overh.

Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo [Xavier-Santos et al. (2004) as *Lentinus strigellus* Berk., Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Peniophorella rude (Bres.) K.H. Larss.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Hjortstam & Bononi (1987) as *Hyphoderma rude* (Bres.) Hjortstam & Ryvarden, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015) and Caatinga (Chikowski et al. 2020).

$^{\Delta}$***Perenniporia aurantiaca*** (A. David & Rajchenb.) Decock & Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2015).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

$^{\Delta}$***Perenniporia martia*** (Berk.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Costa-Rezende et al. (2015) as *Hornodermoporus martius* (Berk.) Teixeira].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Pantanal (Gugliotta et al. 2015).

Perenniporia medulla-panis (Jacq.) Donk
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Fomes unitus* (Pers.) J. Lowe, Bononi (1984) as *Poria albostygia* (Berk. & M.A. Curtis) Lloyd, Rajchenberg & Meijer (1990), Xavier-Santos et al. (2004), Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Perenniporia parvispora*** Decock & Ryvarden
Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Gugliotta et al. 2015).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

△***Perenniporiella neofulva*** (Lloyd) Decock & Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Phaeodaedalea incerta (Curr.) Ţura, Zmitr., Wasser & Spirin

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Lenzites distantifolia* Romell] and São Paulo [Fidalgo et al. (1965), Abrahão et al. (2012) as *Trametes incerta* (Curr.) Cooke].

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

△***Phanerochaete australis*** Jülich

Morphological group: Corticioid.

Distribution in Cerrado areas: Mato Grosso do Sul (Chikowski et al. 2020).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest (Gugliotta et al. 2015), and Caatinga (Chikowski et al. 2020).

Phanerochaete sordida (P. Karst.) J. Erikss. & Ryvarden

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Phellinotus piptadeniae (Teixeira) Drechsler-Santos & Robledo

Morphological group: Poroid.

Distribution in Cerrado areas: Distrito Federal (Elias et al. 2020).

Occurrence in other Brazilian biomes: Atlantic Forest and Caatinga (Drechsler-santos et al. 2016, Elias et al. 2020).

•△***Phlebia faviformis*** W.B. Cooke

Morphological group: Corticioid.

Distribution in Cerrado areas: Goiás (Hjortstam & Ryvarden 2007).

Occurrence in other Brazilian biomes: Endemic species from Cerrado.

$^{\triangle}$***Phlebiopsis amethystea*** (Hjortstam & Ryvarden) R.S. Chikowski & C.R.S. Lira

Morphological group: Corticioid.

Distribution in Cerrado areas: Mato Grosso do Sul (Xavier-Lima et al. 2020).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest (Gugliotta et al. 2015), and Caatinga (Xavier-Lima et al. 2020).

Phlebiopsis flavidoalba (Cooke) Hjortstam

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Peniophora vernicosa* Ellis & Everh. ex Burt, Abrahão et al. (2012)].

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015) and Caatinga (Chikowski et al. 2020).

Phlebiopsis papyrina (Mont.) Miettinen & Spirin

Morphological group: Corticioid.

Distribution in Cerrado areas: Goiás [Teixeira (1945) as *Stereum papyrinum* Mont.], Mato Grosso [Gugliotta et al. (2015) as *Lopharia papyrina* (Mont.) Boidin], Mato Grosso do Sul [Quevedo et al. (2012) as *L. papyrina*), and São Paulo [Fidalgo et al. (1965) as *S. papyrinum*, Abrahão et al. (2012) as *L. papyrina*).

Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Phylloporia chrysites (Berk.) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gibertoni et al. 2015).

Phylloporia pectinata (Klotzsch) Ryvarden

Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso [Hennings (1900) as *Fomes pectinatus* (Klotzsch) Gillet, Sampaio (1916) as *F. pectinatus* and *Phaeoporus ferrugineus* Romell].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

Phylloporia spathulata (Hook.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Fidalgo et al. 1965, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

Physisporinus lineatus (Pers.) F. Wu, Jia J. Chen & Y.C. Dai
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012, 2019) both as *Rigidoporus lineatus* (Pers.) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Podoscypha aculeata (Berk. & M.A. Curtis) Boidin
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Podoscypha nitidula*** (Berk.) Pat.
Morphological group: Corticioid.
Distribution in Cerrado areas: Goiás [Berkeley & Cooke (1876) as *Stereum nitidulum* Berk.].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Podoscypha ravenelii (Berk. & M.A. Curtis) Pat.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Polyporus arcularius (Batsch) Fr.
Morphological group: Poroid.

Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017) and São Paulo (Rajchenberg & Meijer 1990, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Polyporus ciliatus Fr.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Polyporus grammocephalus*** Berk.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Amazonia (Soares et al. 2014), Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Polyporus guianensis Mont.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Polyporus lentinoides (Henn.) Lloyd
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Fidalgo 1965, Fidalgo et al. 1965, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Polyporus leprieurii Mont.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

___Polyporus philippinensis___ Berk.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

___Polyporus tricholoma___ Mont.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás [Naves et al. (2021) as *Lentinus tricholoma* (Mont.) Zmitr.], Mato Grosso (Hennings 1900, Sampaio 1916), and São Paulo (Xavier-Santos et al. 2004, Abrahão et al. 2019).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

___Pycnoporus sanguineus___ (L.) Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b), Mato Grosso [Hennings (1900) as *Polystictus sanguineus* (L.) G. Mey., Sampaio (1916) as *Polyporus sanguineus* (L.) Fr.], Mato Grosso do Sul (Quevedo et al. 2012), and São Paulo (Fidalgo et al. 1965, Bononi 1984, Gugliotta 1997, Xavier-Santos et al. 2004, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, and Pantanal (Gugliotta et al. 2015).

△___Pyrofomes lateritius___ (Cooke) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2015).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

*△___Radulomyces rickii___ (Bres.) M.P. Christ.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Hjortstam & Ryvarden 2007).
Occurrence in other Brazilian biomes: Not known from other biomes.

*___Resinicium granulare___ (Burt) Sheng H. Wu
Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Corticium granulare* Burt, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Not known from other biomes.

$^{\Delta}$***Rhizochaete flava*** (Burt) Nakasone, K. Draeger & B. Ortiz
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Gugliotta et al. (2015) as *Phanerochaete flava* (Burt) Nakasone, Burds. & Lodge].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Rhizochaete sulphurosa*** (Bres.) Chikowski, K.H. Larss. & Gibertoni
Morphological group: Corticioid.
Distribution in Cerrado areas: Mato Grosso do Sul (Chikowski et al. 2016).
Occurrence in other Brazilian biomes: Atlantic Forest (Chikowski et al. 2016).

Rhodofomitopsis cupreorosea (Berk.) B.K. Cui, M.L. Han & Y.C. Dai
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Polyporus roseofuscus* Romell] and Mato Grosso do Sul [Quevedo et al. (2012) as *Fomitopsis cupreorosea* (Berk.) J. Carranza & Gilb.].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Rhodofomitopsis feei*** (Fr.) B.K. Cui, M.L. Han & Y.C. Dai
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul [Quevedo et al. (2012) as *Fomitopsis feei* (Fr.) Kreisel].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

Rigidoporus microporus (Sw.) Overeem
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Gugliotta 1997, Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Sanguinoderma rude (Berk.) Y.F. Sun, D.H. Costa & B.K. Cui
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012) as *Amauroderma rude* (Berk.) Torrend].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Schizophyllum commune Fr.
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b), Mato Grosso [Hennings (1900), Sampaio (1916) both as *Schizophyllum alneum* (L.) J. Schröt.], Mato Grosso do Sul (Bononi et al. 2017), and São Paulo [Fidalgo et al. (1965) as *S. alneum*, Bononi (1984), Xavier-Santos et al. (2004), Abrahão et al. (2012, 2019)].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest and Caatinga (Capelari et al. 2015).

Schizophyllum umbrinum Berk.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest (Abrahão et al. 2009).

Scopuloides rimosa (Cooke) Jülich
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Not known from other biomes.

Scytinostroma albocinctum (Berk. & Broome) Boidin & Lanq.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Coniophora atrocinerea* Karst. and *C. byssoidea* (Pers.) Fr., Hjortstam & Bononi (1987), Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Neves et al. 2015).

Scytinostroma duriusculum (Berk. & Broome) Donk
Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest (Neves et al. 2015), and Caatinga (Chikowski et al. 2020).

Sidera lenis (P. Karst.) Miettinen

Morphological group: Poroid.

Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Skvortzovia furfurella*** (Bres.) Bononi & Hjortstam

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Hjortstam & Bononi 1987).

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Hjortstam & Bononi 1987, Chikowski et al. 2020).

$^{\Delta}$***Steccherícium seriatum*** (Lloyd) Maas Geest.

Morphological group: Corticioid.

Distribution in Cerrado areas: Tocantins (Neves et al. 2015).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Neves et al. 2015).

Steccherinum hydneum Rick ex Maas Geest.

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Bononi 1984, Abrahão et al. 2012).

Occurrence in other Brazilian biomes: Atlantic Forest (Neves et al. 2015).

Steccherinum rawakense (Pers.) Banker

Morphological group: Corticioid.

Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Hydnum rawakense* Pers.].

Occurrence in other Brazilian biomes: Atlantic Forest (Bresadola 1896).

*****$^{\Delta}$***Steccherinum setulosum*** (Berk. & M.A. Curtis) L.W. Mill.

Morphological group: Corticioid.

Distribution in Cerrado areas: São Paulo (Hjortstam 1999).

Occurrence in other Brazilian biomes: Not known from other biomes.

Steccherinum undigerum (Berk. & M.A. Curtis) Westphalen & Tomšovský
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Gugliotta (1997), Abrahão et al. (2019) both as *Junghuhnia undigera* (Berk. & M.A. Curtis) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Neves et al. 2015).

△***Stereum hirsutum*** (Willd.) Pers.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Xavier-Santos et al. 2004).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Neves et al. 2015).

Stereum ostrea (Blume & T. Nees) Fr.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Stereum australe* Lloyd, Abrahão et al. (2012, 2019)].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Neves et al. 2015).

***Thelephora atrocitrina** Quél.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Not known from other biomes.

Thelephora dentosa Berk. & Curt.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Thelephora perplexa* Burt, Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Silveira et al. 2015).

△***Thelephora paraguayensis*** Corner
Morphological group: Corticioid.

Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Silveira et al. 2015).

Tomentella ferruginea (Pers.) Pat.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Bononi 1984, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Not known from other biomes.

Tomentella galzinii Bourdot
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Bononi 1984, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Not known from other biomes.

Tomentella subclavigera Litsch.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Bononi 1984, Abrahão et al. 2012).
Occurrence in other Brazilian biomes: Not known from other biomes.

$^{\Delta}$***Trametes cingulata*** Berk.
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Gugliotta et al. 2015).
Occurrence in other Brazilian biomes: Atlantic Forest (Figueiredo et al. 2019).

*****$^{\Delta}$***Trametes ellipsospora*** Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Not known from other biomes.

Trametes modesta (Kunze ex Fr.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Hennings (1900) as *Polystictus albocervinus* (Berk.) Cooke, Sampaio (1916) as *Polyporus modestus* Kunze ex Fr. and *P. albocervinus*] and São Paulo (Gugliotta et al. 2015).

Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Trametes ochracea (Pers.) Gilb. & Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Bononi (1984) as *Trametes hispida* Bagl., Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

$^{\Delta}$***Trametes pavonia*** (Hook.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and Tocantins (Gugliotta et al. 2015).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Trametes polyzona (Pers.) Justo
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Sampaio (1916) as *Polyporus occidentalis* Klotzsch and *Polystictus occidentalis* (Klotzsch) Sacc.] and São Paulo [Bononi (1984) as *Coriolus occidentalis* (Klotzsch) G. Cunn., Abrahão et al. (2012) as *Coriolopsis polyzona* (Pers.) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Pantanal (Gugliotta et al. 2015).

$^{\Delta}$***Trametes versicolor*** (L.) Lloyd
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Bononi et al. 2017).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Trametes villosa (Sw.) Kreisel
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo [Fidalgo et al. (1965) as *Trametes pinsita* (Fr.) O. Fidalgo & M. Fidalgo, Gugliotta (1997), Abrahão et al. (2012, 2019)].

Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, Caatinga, Pampa, and Pantanal (Gugliotta et al. 2015).

***$^{\Delta}$Trechispora subsphaerospora** (Litsch.) Liberta
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Hjortstam & Ryvarden 2007).
Occurrence in other Brazilian biomes: Not known from other biomes.

$^{\Delta}$***Trichaptum biforme*** (Fr.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Rajchenberg & Meijer 1990).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

Trichaptum byssogenum (Jungh.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Hennings (1900) as *Polystictus versatilis* (Berk.) Cooke, Sampaio (1916) as *Polyporus versatilis* (Berk.) Romell and *Polystictus versatilis*].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Trichaptum perrottetii (Lév.) Ryvarden
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Gibertoni et al. 2011, Leonardo-Silva et al. 2020b), Mato Grosso [Hennings (1900) as *Polystictus trichomallus* (Berk. & Mont.) Fr., Sampaio (1916) as *Polyporus trichomallus* Berk. & Mont. and *P. trichomallus*], and São Paulo [Fidalgo et al. (1965) as *P. trichomallus*, Bononi (1984) as *Poria nigra* (Berk.) Cooke and *Trichaptum trichomallum* (Berk. & Mont.] Murrill, Gibertoni et al. (2011), Abrahão et al. (2012)].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Pantanal (Gugliotta et al. 2015).

Trichaptum sector (Ehrenb.) Kreisel
Morphological group: Poroid.

Distribution in Cerrado areas: Goiás (Leonardo-Silva et al. 2020b) and São Paulo [Bononi (1984) as *Polyporus sector* (Ehrenb.) Fr., Abrahão et al. (2012, 2019)].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

•△***Trichaptum strigosum*** Corner
Morphological group: Poroid.
Distribution in Cerrado areas: Goiás (Gibertoni et al. 2011).
Occurrence in other Brazilian biomes: Endemic species from Cerrado.

△***Trullella duracina*** (Pat.) Zmitr.
Morphological group: Poroid.
Distribution in Cerrado areas: [Gugliotta (1997), Abrahão et al. (2019) both as *Tyromyces duracinus* (Pat.) Murrill].
Occurrence in other Brazilian biomes: Atlantic Forest (Gugliotta et al. 2015).

△***Truncospora detrita*** (Berk.) Decock
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso (Costa-Rezende et al. 2015).
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest and Caatinga (Gugliotta et al. 2015).

Truncospora ochroleuca (Berk.) Pilát
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso (Gugliotta et al. 2015) and São Paulo [Abrahão et al. (2012), Abrahão et al. (2019) as *Perenniporia ochroleuca* (Berk.) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia, Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

△***Truncospora tephropora*** (Mont.) Zmitr.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso [Costa-Rezende et al. (2015) as *Perenniporia tephropora* (Mont.) Ryvarden].

Occurrence in other Brazilian biomes: Amazonia (Medeiros et al. 2012), Atlantic Forest, and Caatinga (Gugliotta et al. 2015).

$^{\Delta}$***Tyromyces fumidiceps*** G.F. Atk.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul (Quevedo et al. 2012).
Occurrence in other Brazilian biomes: Atlantic Forest and Pantanal (Gugliotta et al. 2015).

Tyromyces leucomallus (Berk. & M.A. Curtis) Murrill
Morphological group: Poroid.
Distribution in Cerrado areas: São Paulo (Abrahão et al. 2012, 2019).
Occurrence in other Brazilian biomes: Atlantic Forest and Caatinga (Gugliotta et al. 2015).

$^{\Delta}$***Vararia splendida*** (Viégas) Boidin & Lanq.
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo (Boidin & Lanquetin 1977)
Occurrence in other Brazilian biomes: Atlantic Forest (Boidin & Lanquetin 1977).

Vitreoporus dichrous (Fr.) Zmitr.
Morphological group: Poroid.
Distribution in Cerrado areas: Mato Grosso do Sul [Quevedo et al. (2012) as *Gloeoporus dichrous* (Fr.) Bres.] and São Paulo [Rajchenberg & Meijer (1990), Abrahão et al. (2012, 2019) all as *G. dichrous*).
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gugliotta et al. 2015).

Xylodon flaviporus (Berk. & M.A. Curtis ex Cooke) Riebesehl & Langer
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Abrahão et al. (2012, 2019) both as *Schizopora flavipora* (Berk. & M.A. Curtis ex Cooke) Ryvarden].
Occurrence in other Brazilian biomes: Amazonia and Atlantic Forest (Gibertoni et al. 2015).

Xylodon paradoxus (Schrad.) Chevall.
Morphological group: Corticioid.

Distribution in Cerrado areas: Mato Grosso do Sul [Bononi et al. (2017) as *Schizopora paradoxa* (Schrad.) Donk] and São Paulo [Bononi (1984) as *Poria papyracea* Cooke, Abrahão et al. (2012, 2019) both as *S. paradoxa*).
Occurrence in other Brazilian biomes: Atlantic Forest (Gibertoni et al. 2015) and Caatinga (Chikowski et al. 2020).

△Xylodon tenuicystidius (Hjortstam & Ryvarden) Hjortstam & Ryvarden
Morphological group: Corticioid.
Distribution in Cerrado areas: São Paulo [Hjortstam & Ryvarden (2007) as *Hyphodontia tenuicystidia* Hjortstam & Ryvarden].
Occurrence in other Brazilian biomes: Not known from other biomes.

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Author contributions

Lucas Leonardo-Silva: conceptualization, design of the study, investigation, data collection, analysis, writing – original draft. Solange Xavier-Santos: conceptualization, design of the study, critical revision, adding intellectual content.

References

ABRAHÃO MC, GUGLIOTTA AM & BONONI VLR. 2012. Xylophilous Agaricomycetes (Basidiomycota) of the Brazilian Cerrado. Check List 8(5):1102–1116.

ABRAHÃO MC, PIRES RM, GUGLIOTTA AM, GOMES EPC & BONONI VLR. 2019. Wood-decay fungi (Agaricomycetes, Basidiomycota) in three physiognomies in the Savannah region in Brazil. Hoehnea 46(1):1–11.

ALVES-SILVA G, RECK M, 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 Prog 19(8):769–790.

BALTAZAR JM, TRIERVEILER-PEREIRA L, SILVEIRA RMB & LOGUERCIO-LEITE C. 2017. Santa Catarina Island mangroves 5: Corticioid fungi and an updated checklist of xylophilous fungi and pseudofungi. J Torrey Bot Soc 144(2):230–238.

BERKELEY MJ & COOKE MC. 1876. The Fungi of Brazil, including those collected by J. W. H. Trail, Esq., M.A., in 1874. J Linn Soc London, Bot 15(86):363–398.

BOIDIN J & LANQUETIN P. 1977. Les genres *Dichostereum* et Vararia en Guadeloupe (Basidiomycetes, Lachnocladiaceae). Mycotaxon 6(2):277–336.

BONONI VL. 1984. Basidiomicetos do Cerrado da Reserva Biológica de Moji-Guaçu, SP. Rickia1 (11):1–25.

BONONI VLR, OLIVEIRA AKM, GUGLIOTTA AM & QUEVEDO JR. 2017. Agaricomycetes (Basidiomycota, Fungi) diversity in a protected area in the Maracaju Mountains, in the Brazilian central region. Hoehnea 44(3):361–377.

BONONI VLR, TRUFEM S & GRANDI R. 1981. Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga, São Paulo, Brasil, depositados no herbário do Instituto de Botânica. Rickia 9:37–53.

BORBA-SILVA MA, DRECHSLER-SANTOS RE & ROBLEDO GL. 2015. Community structure and functional diversity of polypores (Basidiomycota) in the Atlantic Forest of Santa Catarina State, Brazil. Biotemas 28(1):1–11.

BRESADOLA J. 1896. Fungi Brasilienses lecti a cl. Dr. Alfredo Möller. Hedwigia 35: 277–302.

BUCHANAN PK. 2001. Aphyllophorales in Australasia. Aust Syst Bot 14(3):417–437.

CAMPACCI TVS & GUGLIOTTA AM. 2009. A review of *Amauroderma* in Brazil, with *A.*

oblongisporum newly recorded from the neotropics. Am J Comp Law 110: 423–436.

CAPELARI M, CORTEZ VG, NEVES MA, BASEIA IG, WARTCHOW F, MENOLLI-JÚNIOR N, KARSTEDT F, OLIVEIRA JJS, URREA-VALENCIA S. 2015. Agaricales in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available in <http://floradobrasil.jbrj.gov.br/>. Access on: 22 Sep. 2022.

CAPELARI M, GUGLIOTTA AM & FIGUEIREDO MB. 1998. O estudo de fungos macroscópicos no estado de São Paulo. In: JOLY CA, BICUDO CEM (Eds), Biodiversidade do estado de São Paulo, Brasil: síntese do conhecimento ao final do século XX. 2: Fungos macroscópicos e plantas, São Paulo: FAPESP, p. 9–23.

CHIKOWSKI RS, LIRA CRS, LARSSON KH & GIBERTONI TB. 2020. A checklist of corticioid fungi (Agaricomycetes, Basidiomycota) from Brazil. Mycotaxon 35(2):276–302.

COLLI GR, VIEIRA CR & DIANESE JC. 2020. Biodiversity and conservation of the Cerrado: recent advances and old challenges. Biodivers Conserv 29(5):1465–1475.

COSTA-REZENDE DH, FERREIRA-LOPES V, SALVADOR-MONTOYA CA, ALVES-SILVA G, MELLO A & DRECHSLER-SANTOS ER. 2015. New records of *Perenniporia* sensu lato and *Pyrofomes* for the Brazilian Cerrado. Iheringia - Ser Bot 70(1):157–166.

COSTA-REZENDE DH, GUGLIOTTA AM, GÓES-NETO A, RECK MA, ROBLEDO GL & DRECHSLER-SANTOS ER. 2016. *Amauroderma calcitum* sp. nov. and notes on taxonomy and distribution of *Amauroderma* species (Ganodermataceae). Phytotaxa 244(2):101–124.

COSTA-REZENDE DH, ROBLEDO GL, DRECHSLER-SANTOS ER, GLEN M, GATES G, MADRIGNAC-BONZI BR, POPOFF OF, CRESPO E & GÓES-NETO A. 2020. Taxonomy and phylogeny of polypores with ganodermatoid basidiospores (Ganodermataceae). Mycol Prog 19(8):725–741.

COSTA-REZENDE DH, ROBLEDO GL, GÓES-NETO A, RECK MA, CRESPO E & DRECHSLER-SANTOS ER. 2017. Morphological reassessment and molecular phylogenetic analyses of *Amauroderma* s.lat. raised new perspectives in the generic classification of the Ganodermataceae family. Persoonia - Mol Phylogeny Evol Fungi 39(1):254–269.

CRIA. Centro de referência e informação ambiental. Specieslink. Available in: https://specieslink.net/search/. Accessed on December 17, 2021.

CSÁRDI G & NEPUSZ T. 2006. The igraph software package for complex network research. Inter J Complex Syst 1695: 1–9.

DRECHSLER-SANTOS ER, CAVALVANTI MAQ, LOGUERCIO-LEITE C & ROBLEDO GL. 2012. On Neotropical *Daedalea* species: *Daedalea ryvardenica* sp. nov. Kurtziana 37(1):65–72.

DRECHSLER-SANTOS ER, MELO GSN, PALACIO M, GOMES-SILVA AC. 2015. Gloeophyllales in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available in: http://floradobrasil.jbrj.gov.br/. Accessed on December 22, 2021.

DRECHSLER-SANTOS ER, ROBLEDO GL, LIMA-JUNIOR NC, MALOSSO E, RECK MA, GIBERTONI TB, CAVALCANTI MAQ & CALVACANTI MAQ. 2016. *Phellinotus*, a new neotropical genus in the Hymenochaetaceae (Basidiomycota, Hymenochaetales). Phytotaxa 261(3): 218–239.

DRECHSLER-SANTOS ER, RYVARDEN L, BEZERRA JL, GIBERTONI TB, SALVADOR-MONTOYA CA & CALVACANTI MAQ. 2013. New records of Auriculariales, Hymenochaetales and Polyporales (Fungi: Agaricomycetes) for the Caatinga Biome. Check List 9(4): 800–805.

ELIAS SG, SALVADOR-MONTOYA CA, COSTA-REZENDE DH, GUTERRES DC, FERNANDES M, OLKOSKI D, KLABUNDE GHF & DRECHSLER-SANTOS ER. 2020. Studies on the biogeography of *Phellinotus piptadeniae* (Hymenochaetales, Basidiomycota): Expanding the knowledge on its distribution and clarifying hosts relationships. Fungal Ecol 45: 100912.

FIDALGO MEPK. 1965. Two Brazilian polypores described by Hennings. Rickia 2: 107–120.

FIDALGO O. 1968. Introdução à história da micologia brasileira. Rickia 3: 1–44.

FIDALGO O, FIDALGO MEPK & FURTADO JS. 1965. Fungi of the “Cerrado” region of São Paulo. Rickia 2: 55–71.

FLORA DO BRASIL. 2021. Fungos in Flora do Brasil 2020. Jardim Botânico do Rio Janeiro. Available in: http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB128473. Accessed on December 17, 2021.

GAFFOROV Y, ORDYNETS A, LANGER E, YARASHEVA M, GUGLIOTTA AM, SCHIGEL D, PECORARO L, ZHOU Y, CAI L & ZHOU LW. 2020. Species Diversity With Comprehensive Annotations of Wood-Inhabiting Poroid and Corticioid Fungi in Uzbekistan. Front Microbiol 11:598321.

GIBERTON TB, BERNICCHIA A, RYVARDEN L & GOMES-SILVA AC. 2008. Bresadola’s polypore collection at the Natural History Museum of Trento, Italy 2. Mycotaxon 104:321–323.

GIBERTONI TB & DRECHSLER-SANTOS ER. 2010. Lignocellulolytic *Agaricomycetes* from the Brazilian Cerrado biome. Mycotaxon 111(1):87–90.

GIBERTONI TB, DRECHSLER-SANTOS ER, BALTAZAR JM, GOMES-SILVA AC, NOGUEIRA-MELO GS, RYVARDEN L & CAVALCANTI MAQ. 2011. The genus *Trichaptum* (Agaricomycetes, Basidiomycota) in Brazil. Nov Hedwigia 93(1–2):85–96.

GIBERTONI TB ET AL. 2015. Hymenochaetales in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available in: http://floradobrasil.jbrj.gov.br/. Accessed on December 22, 2021.

GIBERTONI TB, MEDEIROS PS, SOARES AMS, GOMES-SILVA AC, SANTOS PJP, SOTÃO HMP, FERREIRA LV & SAVINO E. 2016. The distribution of polypore fungi in endemism centres in Brazilian Amazonia. Fungal Ecol 20:1–6.

GOMES-SILVA AC & GIBERTONI TB. 2009. Checklist of the aphyllophoraceous fungi (Agaricomycetes) of the Brazilian Amazonia. Mycotaxon 108(1):319–322.

GOMES-SILVA AC, LIMA-JUNIOR N, MALOSSO E, RYVARDEN L & GIBERTONI T. 2015. Delimitation of taxa in *Amauroderma* (Ganodermataceae, Polyporales) based in morphology and molecular phylogeny of Brazilian specimens. Phytotaxa 227(3):1–28.

GORJÓN SP. 2020. Genera of corticioid fungi: keys, nomenclature, and taxonomy. Studies in Fungi 5(1): 125–309.

GORJÓN SP & JESUS MA. 2012. Some new species and new records of corticioid fungi (Basidiomycota) from the Brazilian Amazon. Phytotaxa 67(1):38–54.

GRIENKE U, ZÖLL M, PEINTNER U & ROLLINGER JM. 2014. European medicinal polypores – A modern view on traditional uses. J Ethnopharmacol 154(3):564–583.

GU Z, GU L, EILS R, SCHLESNER M & BRORS B. 2014. Circlize implements and enhances circular visualization in R. Bioinformatics 30(19):2811–2812.

GUGLIOTTA AM. 1997. Polyporaceae de Mata Ciliar da Estação Experimental e Reserva Biológica de Moji-Guaçu, SP, Brasil. Hochnea 24(2):89–106.

GUGLIOTTA AM, GIBERTONI TB, DRECHSLER-SANTOS ER, SILVEIRA RMB, CHIKOWSKI RS, PIRES RM, MONTOYA CAS, SOUZA JF, PALACIO M & REZENDE DHC. 2015. Polyporales in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available in: http://floradobrasil.jbrj.gov.br/. Accessed on December 22, 2021.

HEBERLE H, MEIRELLES GV, SILVA FR, TELLES GP & MINGHIM R. 2015. InteractiVenn: a web-based tool for the analysis of sets through Venn diagrams. BMC Bioinformatics 16(1):169.

HENNINGS VP. 1900. Fungi mattogrossenses a Dr. R. Pilger collecti 1899. 134–139.

HJORTSTAM K. 1995. Two new species of Candelabrochaete (Basidiomycotina, Aphylophorales). Mycotaxon 56:451–453.

HJORTSTAM K. 1999. New corticioid taxa from Brazil , with a brief discussion on *Hydnum setulosum* (Basidiomycotina). Kew Bull 54(3):755–761.

HJORTSTAM K & BONONI VLR. 1987. A contribution to the knowledge of Corticiaceae s.l. (Aphyllophorales) in Brazil. Mycotaxon 28(1):1–15.

HJORTSTAM K & RYVARDEN L. 2007. Checklist of corticioid fungi (Basidiomycotina) from the tropics, subtropics and the southern hemisphere. Synopsis Fungorum 22:27–146.

Instituto Brasileiro de Geografia e Estatistica (IBGE). 2019. Biomas e Sistema Costeiro-Marinho do Brasil. Compatível com a escala 1:250000. Coordenação de Recursos Naturais e Estudos Ambientais, Rio de Janeiro, 168 p.

IRŠĖNAITĖ R. 2019. *Perenniporia medulla-panis.* The IUCN Red List of Threatened Species. 8235.

KUNTTU P. 2018. Updates to Finnish aphyllophoroid funga (Basidiomycota): new species and range extensions. Mycosphere 9(3):519–564.

LAHSEN M, BUSTAMANTE MMC & DALLA-NORA EL. 2016. Undervaluing and overexploiting the brazilian Cerrado at our peril. Environ Sci Policy Sustain Dev 58(6):4–15.

LARSSON KH. 2007. Re-thinking the classification of corticioid fungi. Mycol Res 111(9):1040–1063.

LEONARDO-SILVA L, ABDEL-AZEEM AM & XAVIER-SANTOS S. 2021. *Inonotus rickii* (Agaricomycetes, Hymenochaetaceae) in Brazilian Cerrado: Expanding its geographic distribution and host list. Front Microbiol 12: 647920.

LEONARDO-SILVA L, SILVA LB, SÁ ASF, NAVES LRR, CUNHA EL & XAVIER-SANTOS S. 2020a. Additions to the knowledge of Ganodermataceae in brazilian Cerrado. Hoehnea 47: e852019.

LEONARDO-SILVA L, SILVA LB & XAVIER-SANTOS S. 2020b. Poroid fungi (Agaricomycetes, Basidiomycota) from Floresta Nacional de Silvânia – a conservation unit of Brazilian Savanna. Microb Biosyst 5(1):100–107.

LI K, ROLLINS J & YAN E. 2018. Web of Science use in published research and review papers 1997–2017: a selective, dynamic, cross-domain, content-based analysis. Scientometrics 115(1):1–20.

LLOYD CG. 1913. Mycological writings of C. G. Lloyd volume IV. Ohio, USA, 580 p.

LUNDELL TK, MÄKELÄ MR & HILDÉN K. 2010. Lignin-modifying enzymes in filamentous basidiomycetes - ecological, functional and phylogenetic review. J Basic Microbiol 50(1):5–20.

MAIA LC ET AL. 2015. Diversity of Brazilian fungi. Rodriguesia 66(4):1033–1045.

MATHENY PB, WANG Z, BINDER M, CURTIS JM, LIM Y, HENRIK-NILSSON R, HUGHES KW, HOFSTETTER V. AMMIRATI JF & SCHOCH CL. 2007. Contributions of rpb2 and tef1 to the phylogeny of mushrooms and allies (Basidiomycota, Fungi). Mol Phylogenet Evol 43(2):430–451.

MCLAUGHLIN DJ & SPATAFORA JW. 2014. Systematics and Evolution. Berlin: Springer, 461 p.

MEDEIROS PS, GOMES-SILVA AC, SOTÃO HMP, RYVARDEN L & GIBERTONI TB. 2012. Notes on *Perenniporia* Murrill (Basidiomycota) from the Brazilian Amazonia. Nov Hedwigia 94(3–4):507–519.

NAKASONE KK. 2013. Taxonomy of *Epithele* (Polyporales, Basidiomycota). Sydowia

65(1):59–112.

NEVES MA, GIBERTONI TB, JAEGER MCW, MELO GSN, GOMES-SILVA AC, ARAÚJO-NETA L, WARTCHOW F, CHIKOWSKI RS & SILVEIRA RMB. 2015. Russulales in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available in http://floradobrasil.jbrj.gov.br/. Accessed on December 22, 2021.

PALACIO M, ROBLEDO GL, RECK MA, GRASSI E, GÓES-NETO A & DRECHSLER-SANTOS ER. 2017. Decrypting the *Polyporus dictyopus* complex: Recovery of *Atroporus* Ryvarden and segregation of *Neodictyopus* gen. nov. (Polyporales, Basidiomyocta). PLoS One 12(10):1–26.

QGIS DEVELOPMENT TEAM. 2020. QGIS Geographic Information System, version 3.14. Open source geospatial foundation project.

QUEVEDO JR, BONONI VLR, OLIVEIRA AKM & GUGLIOTTA AM. 2012. Agaricomycetes (Basidiomycota) em um fragmento florestal urbano na cidade de Campo Grande, Mato Grosso do Sul, Brasil. Rev Bras. Biociências 10(4):430–438.

R CORE TEAM. 2017. A language and environment for statistical computing, Version 3.6.1. R Foundation for Statistical Computing.

RAJCHENBERG M & MEIJER AAR. 1990. New and Noteworthy Polypores from Paraná and São Paulo States, Brazil. Mycotaxon 38:173–185.

RIBEIRO JF & WALTER BMT. 2008. As principais fitofisionomias do bioma Cerrado. In: SANO SM, ALMEIDA SP & RIBEIRO JF (Eds), Cerrado: Ecologia e flora, Embrapa, Planaltina p. 152–212.

RSTUDIO TEAM. 2019. RStudio: Integrated Development for R, Version 1.2.1335. RStudio, PBC.

RYVARDEN L. 2004. Neotropical polypores Part 1. Introduction, Ganodermataceae &

Hymenochaetaceae. Synopsis Fungorum 19:1–238.

SAMPAIO AJ. 1916. A flora de Matto Grosso. Arq do Mus Nac 191–127.

SANTOS CD, SILVA RO, SOARES ACF, DRECHSLER-SANTOS ER & BEZERRA JL. 2018. First record of *Daedalea ryvardeniana* Drechsler-Santos & Robledo (Agaricomycetes, Polyporales, Fomitopsidaceae) in the Caatinga area of Bahia, Brazil. Check List 14(1):173–176.

SILVA-NETO CM, PINTO DS, SANTOS LAC & CALAÇA FJS. 2020. Bromatological aspects of *Lentinus crinitus* mushroom (Basidiomycota: Polyporaceae) in agroforestry in the Cerrado. Food Sci Technol 40(3):659–664.

SILVA-NETO CM, PINTO DS, SANTOS LAC, CALAÇA FJS & ALMEIDA SS. 2021. Food production potential of *Favolus brasiliensis* (Basidiomycota: Polyporaceae), an indigenous food. Food Sci Technol 41:183–188.

SILVEIRA RMB. 2015. Atheliales in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available in: http://floradobrasil.jbrj.gov.br/. Accessed on December 22, 2021.

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

STALPERS JA. 1978. Identification of wood-inhabiting Aphyllophorales in pure culture. Studies in Mycology No. 16.

TEIXEIRA AR. 1945. Himenomicetos Brasileiros Hymeniales - Thelephoraceae. Bragantia 5(7):397–434.

TORRES-TORRES MG, GUZMÁN-DÁVALOS L & GUGLIOTTA AM. 2013. *Ganoderma* in Brazil: known species and new records. Mycotaxon 121(1):93–132.

VIÉGAS AP. 1939. Uma nova espécie de *Aleurodiscus*: *A. Moquiniarum*. Rev Agric 14(7–8): 311–314.

XAVIER-LIMA V, LIRA CS, CHIKOWSKI RS, SANTOS C, LIMA N & GIBERTONI TB. 2020. Additions to neotropical stereoid fungi (Polyporales, Basidiomycota): one new species of *Lopharia* and one new combination in *Phlebiopsis*. Mycol Prog 19(1):31–40.

XAVIER-SANTOS S, CARVALHO CC, BONFÁ M, SILVA R, CAPELARI M & GOMES E. 2004. Screening for pectinolytic activity of wood-rotting basidiomycetes and characterization of the enzymes. Folia Microbiol (Praha) 49(1):46–52.

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 Do Mus Para Emílio Goeldi - Ciências Nat 13(3):303–315.

Supplementary material

Corticioid and poroid fungi from Brazilian Cerrado: a history of research and a checklist of species

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Table I. Articles found in the systematic search of the scientific production on corticioid and poroid fungi from Cerrado.

Title	**Year**
The Fungi of Brazil, including those collected by J. W. H. Trail, Esq., M.A., in 1874	1876
Fungi mattogrossenses a Dr. R. Pilger collecti 1899	1900
Mycological writings of C. G. Lloyd volume IV	1913
A flora de Matto Grosso	1916
Les Polyporacées du Brésil	1920
Himenomicetos brasileiros - Hymeniales - Thelephoraceae	1945
Two Brazilian polypores described by Hennings	1965
Fungi of the "Cerrado" region of São Paulo	1965
Les genres *Dichostereum* et Vararia en Guadeloupe (Basidiomycetes, Lachnocladiaceae)	1977
Basidiomicetos do Cerrado da Reserva Biológica de Moji-Guaçu, SP	1984
A contribution to the knowledge of Corticiaceae s.l. (Aphyllophorales) in Brazil	1987
New and Noteworthy polypores from Paraná and São Paulo States, Brazil	1990
Agaricales of Brazil described by J. P. F. C. Montague	1990
Two new species of Candelabrochaete (Basidiomycotina, Aphylophorales)	1995
Polyporaceae de Mata Ciliar da Estação Experimental e Reserva Biológica de Moji-Guaçu, SP, Brasil	1997
New corticioid taxa from Brazil, with a brief discussion on *Hydnum setulosum* (Basidiomycotina)	1999
Screening for pectinolytic activity of wood-rotting Basidiomycetes and characterization of the enzymes	2004
Checklist of corticioid fungi (Basidiomycotina) from the tropics, subtropics and the southern hemisphere	2007
Bresadola’s polypore collection at the Natural History Museum of Trento, Italy 2	2008
Lignocellulolytic Agaricomycetes from the Brazilian Cerrado biome	2010
The genus *Trichaptum* (Agaricomycetes, Basidiomycota) in Brazil	2011
On Neotropical *Daedalea* species: *Daedalea ryvardenica* sp. nov.	2012
Agaricomycetes (Basidiomycota) em um fragmento florestal urbano na cidade de Campo Grande, Mato Grosso do Sul, Brasil	2012

Table I (continued)

Title	Year
Xylophilous Agaricomycetes (Basidiomycota) of the Brazilian Cerrado	2012
Ganoderma in Brazil: known species and new records	2013
Taxonomy of *Epithele* (Polyporales, Basidiomycota)	2013
New records of *Perenniporia* sensu lato and *Pyrofomes* for the Brazilian Cerrado	2015
Diversity of Brazilian Fungi	2015
Amauroderma calcitum sp. nov. and notes on taxonomy and distribution of *Amauroderma* species (Ganodermataceae)	2016
Three new combinations in Rhizochaete (Agaricomycetes, Fungi) and a new record to the Brazilian Amazonia	2016
Agaricomycetes (Basidiomycota, Fungi) diversity in a protected area in the Maracaju Mountains, in the Brazilian central region	2017
Morphological reassessment and molecular phylogenetic analyses of *Amauroderma* s.lat. raised new perspectives in the generic classification of the Ganodermataceae family	2017
Decrypting the *Polyporus dictyopus* complex: Recovery of *Atroporus* Ryvarden and segregation of *Neodictyopus* gen. nov. (Polyporales, Basidiomyocta)	2017
Bioprospecção de Fungos de um Fragmento de Cerrado no Brasil Central para Aplicações Biotecnológicas	2018
Filamentous fungi as promising agents for the biodegradation of biosolids compounds	2019
Wood-decay fungi (Agaricomycetes, Basidiomycota) in three physiognomies in the Savannah region in Brazil	2019
Additions to the knowledge of Ganodermataceae in brazilian Cerrado	2020
Poroid fungi (Agaricomycetes, Basidiomycota) from Floresta Nacional de Silvânia – a conservation unit of Brazilian Savanna	2020
Bromatological aspects of *Lentinus crinitus* mushroom (Basidiomycota: Polyporaceae) in agroforestry in the Cerrado	2020
Additions to neotropical stereoid fungi (Polyporales, Basidiomycota): one new species of *Lopharia* and one new combination in *Phlebiopsis*	2020
A checklist of corticioid fungi (Agaricomycetes, Basidiomycota) from Brazil	2020
Taxonomy and phylogeny of polypores with ganodermatoid basidiospores (Ganodermataceae)	2020
The Neotropical *Fomitiporia* (Hymenochaetales, Basidiomycota): the redefinition of *F. apiahyna* s.s. allows revealing a high hidden species diversity	2020
Studies on the biogeography of *Phellinotus piptadeniae* (Hymenochaetales, Basidiomycota): Expanding the knowledge on its distribution and clarifying hosts relationships	2020
Inonotus rickii (Agaricomycetes, Hymenochaetaceae) in Brazilian Cerrado: Expanding its geographic distribution and host list	2021
Food production potential of *Favolus brasiliensis* (Basidiomycota: Polyporaceae), an indigenous food	2021
Expanding the knowledge of poroid fungi (Agaricomycetes: Basidiomycota) in Brazilian Cerrado: new reports of *Hydnopolyporus palmatus* and *Lentinus tricholoma*	2021

Table II. Species richness, frequency, traditional group, and occurrence by Brazilian biomes of corticioid and poroid fungi from Cerrado. •Endemic species from Cerrado; *Species that occur in other regions of the world, but in Brazil, there are only records in the Cerrado; AM = Amazonia; AF = Atlantic Forest; CA = Caatinga; CE = Cerrado; PA = Pampa; and PN = Pantanal.

Species	**Frequency**	**Traditional group**	**Records by Brazilian biome**					
			AM	**AF**	**CA**	**CE**	**PA**	**PN**
Aleurodiscus botryosus	1	Corticioid			x	x		
Aleurodiscus cerussatus	2	Corticioid	x		x	x		
Aleurodiscus exasperatus	1	Corticioid		x		x		
Amauroderma aurantiacum	5	Poroid	x	x		x		
Amauroderma calcigenum	3	Poroid	x	x		x		
•*Amauroderma calcitum*	1	Poroid				x		
Amauroderma camerarium	1	Poroid	x	x	x	x		
Amauroderma exile	1	Poroid	x	x		x		
Amauroderma omphalodes	4	Poroid	x	x		x		
Amauroderma praetervisum	2	Poroid	x	x	x	x		
Amauroderma schomburgkii	3	Poroid	x	x		x		
Amaurodermellus ovisporum	1	Poroid	x			x		
Antrodia malicola	1	Poroid		x		x		
Antrodiella versicutis	1	Poroid	x	x		x		
Aquascypha hydrophora	1	Corticioid	x	x		x		
Athelia arachnoidea	1	Corticioid		x		x		
**Athelopsis galzinii*	1	Corticioid				x		
**Australicium singulare*	1	Corticioid				x		
**Botryohypochnus isabellinus*	1	Corticioid				x		
**Bulbillomyces farinosus*	1	Corticioid				x		
**Butyrea luteoalba*	1	Poroid				x		
Byssomerulius corium	2	Corticioid	x	x	x	x		
•*Candelabrochaete adnata*	1	Corticioid				x		
Ceriporia spissa	1	Poroid	x			x		
Ceriporia viridans	1	Poroid		x		x		
Ceriporia xylostromatoides	1	Poroid		x		x		
Cerocorticium molle	1	Corticioid		x		x		
**Chondrostereum purpureum*	1	Corticioid				x		
Coltricia hamata	1	Poroid	x			x		
Coriolopsis byrsina	2	Poroid	x	x		x		
Coriolopsis floccosa	3	Poroid	x	x	x	x		
Cotylidia aurantiaca	2	Corticioid	x	x		x		
**Cotylidia undulata*	1	Corticioid				x		
Crustodontia chrysocreas	1	Corticioid	x	x		x		
Cymatoderma caperatum	2	Corticioid	x	x	x	x		
Cymatoderma dendriticum	1	Corticioid	x	x		x		
**Cymatoderma elegans*	1	Corticioid				x		
Daedalea aethalodes	2	Poroid	x	x		x		
Daedalea ryvardeniana	2	Poroid			x	x		
Datronia mollis	1	Poroid	x	x		x		
•*Dendrothele moquiniarum*	1	Corticioid				x		
Dichostereum sordulentum	1	Corticioid		x		x		
Earliella scabrosa	1	Poroid	x	x	x	x		
Echinochaete brachypora	1	Poroid	x	x		x		
Echinoporia aculeifera	1	Poroid		x		x		x
Efibula corymbata	1	Corticioid	x	x		x		
Epithele alba	1	Corticioid	x	x		x		
Epithele subfusispora	1	Corticioid		x		x		

Table II (continued)

Species	Frequency	Traditional group	Records by Brazilian biome					
			AM	AF	CA	CE	PA	PN
Epithelopsis fulva	1	Corticioid				x		x
Favolus brasiliensis	3	Poroid	x	x	x	x		x
Fibrodontia brevidens	1	Corticioid	x	x	x	x		
Fomes fasciatus	2	Poroid		x	x	x		
Fomitella supina	1	Poroid	x	x		x		
Fomitiporia apiahyna	1	Poroid		x	x	x		
Fomitiporia conyana	2	Poroid		x		x		
Fomitiporia maxonii	1	Poroid		x	x	x		
Fomitiporia robusta	1	Poroid		x		x		
Fomitopsis rosea	1	Poroid		x		x		
Foraminispora rugosa	2	Poroid	x	x	x	x		
Fulvifomes fastuosus	1	Poroid	x	x		x		
Fulvifomes luteoumbrinus	2	Poroid	x	x	x	x		
Fulvifomes merrillii	2	Poroid	x	x	x	x		
Fulvifomes nilgheriensis	1	Poroid	x	x		x		
Fulvifomes rimosus	2	Poroid		x	x	x		
Funalia caperata	5	Poroid	x	x	x	x		
•*Furtadomyces biseptatus*	1	Poroid				x		
Furtadomyces brasiliensis	1	Poroid	x	x		x		
Fuscoporia callimorpha	1	Poroid	x	x		x		
Fuscoporia chrysea	1	Poroid		x		x		
Fuscoporia contigua	1	Poroid	x	x		x		
Fuscoporia gilva	10	Poroid	x	x	x	x		x
Fuscoporia punctatiformis	1	Poroid		x		x		
Fuscoporia rhabarbarina	1	Poroid		x		x		
Fuscoporia wahlbergii	1	Poroid		x		x		
Ganoderma australe	2	Poroid	x	x	x	x		
Ganoderma lucidum	2	Poroid		x		x		
Ganoderma multiplicatum	3	Poroid	x	x		x		
Ganoderma orbiforme	1	Poroid	x	x		x		
Ganoderma stipitatum	4	Poroid	x	x	x	x		
**Ganoderma testaceum*	1	Poroid				x		
**Ganoderma tuberculosum*	1	Poroid				x		
**Ganoderma weberianum*	1	Poroid				x		
Ganoderma zonatum	1	Poroid	x	x		x		
Gloeocystidiopsis salmonea	1	Corticioid	x			x		
Gloeodontia discolor	1	Corticioid	x	x	x	x		
Gloeophyllum striatum	8	Poroid	x	x	x	x		
**Gloeoporus purpurascens*	1	Poroid				x		
Gloeoporus thelephoroides	4	Poroid	x	x		x		x
Grammothele subargentea	2	Poroid	x	x		x		
Hapalopilus phlebiiformis	1	Poroid		x		x		
Hexagonia hirta	1	Poroid		x		x		
Hexagonia hydnoides	11	Poroid	x	x	x	x		x
Hexagonia scutigera	1	Poroid		x		x		
Hexagonia tenuis	1	Poroid	x	x		x		
Hexagonia variegata	6	Poroid	x	x	x	x		x
Hydnopolyporus palmatus	5	Poroid		x		x		
Hydnoporia corrugata	1	Corticioid		x		x		
Hymenochaete berkeleyana	1	Corticioid		x		x		
Hymenochaete damicornis	1	Corticioid	x	x		x		
**Hymenochaete digitata*	1	Corticioid				x		
Hymenochaete iodina	2	Poroid	x	x		x		
Hymenochaete luteobadia	1	Corticioid	x	x		x		
**Hymenochaete opaca*	1	Corticioid				x		

Table II (continued)

Species	Frequency	Traditional group	Records by Brazilian biome					
			AM	AF	CA	CE	PA	PN
Hymenochaete peroxydata	1	Corticioid		x		x		
Hymenochaete pinnatifida	1	Corticioid	x	x		x		
Hymenochaete rheicolor	3	Corticioid	x	x	x	x		
Hymenochaete tenuis	2	Corticioid		x		x		
**Hyphoderma amoenum*	1	Corticioid				x		
Hyphoderma heterocystidiatum	1	Corticioid		x		x		
**Hyphodontia alutaria*	1	Corticioid				x		
Hyphodontiastra virgicola	1	Corticioid		x		x		
Inocutis jamaicensis	1	Poroid		x		x		
Inonotus rickii	4	Poroid		x		x	x	
**Inonotus xanthoporus*	1	Poroid				x		
Irpex lacteus	3	Poroid	x	x		x		
Irpex rosettiformis	3	Poroid	x	x		x		
**Kneiffiella lanata*	1	Corticioid				x		
Lentinus berteroi	2	Poroid		x		x		
Lentinus crinitus	6	Poroid	x	x	x	x		x
Lentinus velutinus	1	Poroid	x	x	x	x	x	
Lenzites elegans	4	Poroid	x	x	x	x		
Lenzites stereoides	1	Poroid	x	x		x		
Lyomyces crustosus	1	Corticioid		x	x	x		
Lyomyces sambuci	1	Corticioid		x	x	x		
Megasporia cavernulosa	1	Poroid	x	x	x	x		
Megasporoporia setulosa	1	Poroid	x	x	x	x		
Metuloidea reniformis	3	Corticioid	x	x	x	x		
Microporellus dealbatus	1	Poroid	x	x		x		
Microporellus obovatus	1	Poroid	x	x		x		
Mycobonia flava	3	Poroid	x	x		x		
Neodictyopus dictyopus	4	Poroid	x	x	x	x		
Nigrofomes melanoporus	1	Poroid	x	x		x		
Nigroporus macroporus	1	Poroid		x		x		x
Nigroporus vinosus	1	Poroid	x	x		x		
Oxyporus pellicula	1	Poroid		x		x		
Pachykytospora alabamae	1	Poroid	x	x		x		
Pachykytospora papyracea	1	Poroid		x		x		
Panus neostrigosus	1	Poroid	x			x		x
Panus strigellus	3	Poroid		x		x		
Peniophorella rude	2	Corticioid		x	x	x		
Perenniporia aurantiaca	1	Poroid	x	x	x	x		
Perenniporia martia	1	Poroid	x	x		x		x
Perenniporia medulla-panis	4	Poroid	x	x		x		
Perenniporia parvispora	1	Poroid	x	x		x		
Perenniporiella neofulva	1	Poroid	x	x		x		
Phaeodaedalea incerta	2	Poroid	x	x		x		
Phanerochaete australis	1	Corticioid	x	x	x	x		
Phanerochaete sordida	1	Corticioid	x	x		x		
Phellinotus piptadeniae	1	Poroid		x	x	x		
•*Phlebia faviformis*	1	Corticioid				x		
Phlebiopsis amethystea	1	Corticioid	x	x	x	x		
Phlebiopsis flavidoalba	1	Corticioid		x	x	x		
Phlebiopsis papyrina	4	Corticioid		x		x		
Phylloporia chrysites	1	Poroid	x	x	x	x		
Phylloporia pectinata	2	Poroid	x	x		x		
Phylloporia spathulata	2	Poroid	x	x	x	x		
Physisporinus lineatus	1	Poroid	x	x		x		
Podoscypha aculeata	1	Corticioid		x		x		

Table II (continued)

Species	Frequency	Traditional group	Records by Brazilian biome					
			AM	AF	CA	CE	PA	PN
Podoscypha nitidula	1	Corticioid	x	x		x		
Podoscypha ravenelii	1	Corticioid		x		x		
Polyporus arcularius	3	Poroid	x	x		x		
Polyporus ciliatus	1	Poroid		x		x		
Polyporus grammocephalus	1	Poroid	x	x	x	x		
Polyporus guianensis	2	Poroid	x	x		x		
Polyporus lentinoides	1	Poroid		x		x		
Polyporus leprieurii	1	Poroid	x	x		x		
Polyporus philippinensis	1	Poroid	x	x		x		
Polyporus tricholoma	7	Poroid	x	x		x		
Pycnoporus sanguineus	8	Poroid	x	x	x	x		x
Pyrofomes lateritius	1	Poroid	x	x		x		
**Radulomyces rickii*	1	Corticioid				x		
**Resinicium granulare*	1	Corticioid				x		
Rhizochaete flava	1	Corticioid		x		x		
Rhizochaete sulphurosa	1	Corticioid		x		x		
Rhodofomitopsis cupreorosea	2	Poroid	x	x		x		
Rhodofomitopsis feei	1	Poroid		x		x		
Rigidoporus microporus	1	Poroid	x	x	x	x		
Sanguinoderma rude	1	Poroid	x	x		x		
Schizophyllum commune	7	Poroid	x	x	x	x		
Schizophyllum umbrinum	1	Poroid		x		x		
**Scopuloides rimosa*	1	Corticioid				x		
Scytinostroma albocinctum	2	Corticioid		x		x		
Scytinostroma duriusculum	1	Corticioid	x	x	x	x		
Sidera lenis	1	Poroid	x	x		x		
Skvortzovia furfurella	1	Corticioid	x	x	x	x		
Stecchericium seriatum	1	Corticioid	x	x		x		
Steccherinum hydneum	1	Corticioid		x		x		
Steccherinum rawakense	1	Corticioid		x		x		
**Steccherinum setulosum*	1	Corticioid				x		
Steccherinum undigerum	1	Corticioid	x	x		x		
Stereum hirsutum	1	Corticioid	x	x		x		
Stereum ostrea	2	Corticioid	x	x	x	x		
**Thelephora atrocitrina*	1	Corticioid				x		
Thelephora dentosa	1	Corticioid		x		x		
Thelephora paraguayensis	1	Corticioid	x	x		x		
**Tomentella ferruginea*	1	Corticioid				x		
**Tomentella galzinii*	1	Corticioid				x		
**Tomentella subclavigera*	1	Corticioid				x		
Trametes cingulata	1	Poroid		x		x		
**Trametes ellipsospora*	1	Poroid				x		
Trametes modesta	3	Poroid	x	x		x		
Trametes ochracea	1	Poroid		x		x		
Trametes pavonia	2	Poroid	x	x		x		
Trametes polyzona	3	Poroid	x			x		x
Trametes versicolor	1	Poroid	x	x	x	x		
Trametes villosa	4	Poroid	x	x	x	x	x	x
**Trechispora subsphaerospora*	1	Corticioid				x		
Trichaptum biforme	1	Poroid	x	x	x	x		
Trichaptum byssogenum	2	Poroid	x	x		x		
Trichaptum perrottetii	7	Poroid	x	x		x		x
Trichaptum sector	2	Poroid	x	x		x		
•*Trichaptum strigosum*	1	Poroid				x		
Trullella duracina	1	Poroid		x		x		

Species	Frequency	Traditional group	Records by Brazilian biome					
			AM	AF	CA	CE	PA	PN
Truncospora detrita	1	Poroid	x	x	x	x		
Truncospora ochroleuca	3	Poroid	x	x	x	x		
Truncospora tephropora	1	Poroid	x	x	x	x		
Tyromyces fumidiceps	1	Poroid		x		x		x
Tyromyces leucomallus	1	Poroid		x	x	x		
Vararia splendida	1	Corticioid		x		x		
Vitreoporus dichrous	3	Poroid	x	x		x		
Xylodon flaviporus	1	Corticioid	x	x		x		
Xylodon paradoxus	2	Corticioid		x	x	x		
**Xylodon tennuicystidius*	1	Corticioid				x		
Total	**387**		**122**	**178**	**59**	**223**	**3**	**16**

Capítulo II

Inventariando a micobiota corticioide e poroide de Unidades de Conservação representativas do bioma Cerrado

ARTIGO 2

POROID FUNGI (AGARICOMYCETES, BASIDIOMYCOTA) FROM FLORESTA NACIONAL DE SILVÂNIA – A CONSERVATION UNIT OF BRAZILIAN SAVANNA

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Poroid fungi (Agaricomycetes, Basidiomycota) from Floresta Nacional de Silvânia – a conservation unit of Brazilian Savanna

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Abstract − We present a taxonomic inventory, including ecological aspects, of poroid fungi from the Floresta Nacional de Silvânia, a conservation unit representative of the Brazilian Savanna (Cerrado) biome. Basidioma collection was sampled randomly (active search), between 2005 to 2012, considering the conservation unit area, and occurred along or outside preexisting trails, mainly within forest formations. Totally we found 27 species, distributed into 22 genera, 9 families and 3 order. The α diversity (H') was 2.86; the maximum diversity estimated (H max) was 3.29 and the Pielou equability (J') was 0.87. These data, added to species accumulation curve, indicate that the number of species of poroid fungi found has not yet exhausted the real diversity of the area and it may increase with the increase in collections (sampling effort). About 37% of the species were found in both living and decaying wood; 33% exclusively in dead and 22% exclusively in alive wood. Among these, 44% were classified as rare in the area, 33% occasional, 15% common and 7% abundant. The most frequent species were those that occurred in both living and decaying wood, while the rare ones occurred exclusively in one type of wood (living or dead). The present work is one of the pioneers in the study of poroid fungi in Central Brazil, increasing the knowledge of this biodiversity in the Brazilian Savanna, which can be used as support to update the management plan of the conservation unit.

Keywords – Biodiversity, Cerrado, Hymenochaetales, Mycobiota, Polyporales.

Introduction

The Floresta Nacional (FLONA) de Silvânia was created by Law 612 on January 13, 1949, as Horto Florestal de Silvânia, Goiás, Brazil. In 2001, the Horto was elevated to the National Forest category, by IBAMA Ordinance 247 of July 18, 2001. Today, the Conservation Unit (CU) is managed by the Chico Mendes Institute for Biodiversity Conservation (ICMBio), a federal agency created by Law 11516, on August 28, 2007 (Marques et al. 2009; ICMBio 2015). Among the federal conservation units of the Brazilian Savanna (Cerrado biome) managed by ICMBio, the Silvânia's FLONA is considered the oldest (ICMBio 2020).

Silvânia's FLONA aims to promote the proper management of natural resources, guarantee the protection of water and scenic beauty, in addition to configuring an important source for the development of basic and applied scientific research, as well as new technologies, environmental education, recreation, leisure and tourism activities (Marques et al. 2009; Morais et al. 2012; ICMBio 2015). It is a CU whose protected area has representative typical vegetation types of Cerrado, such as campo sujo, cerrado *sensu stricto*, vereda, cerradão, mata seca and mata de galeria (ICMBio 2015).

The Brazilian Savanna, known as the Cerrado, is formed by a mosaic of ecologically related communities and has an area that covers the states of Central Brazil and part of the Northern, Northeastern, Southern and Southeastern regions (Fig. 1), constituting one of the largest Brazilian biomes by area, second only to the Amazon Forest (Ribeiro and Walter 2008). Its climate is characterized by two well-defined seasons, the rainy season, which lasts from October to March and the dry season, from April to September. This biome is composed of several types of landscapes, resulting in a vegetation mosaic, with phytophysiognomies that vary between savanna and forest formations (Klink and Machado 2005; Ribeiro and Walter 2008). The Cerrado has approximately 30% of the known species of biodiversity in Brazil, however, due to human activities, more than 50% of the biome has already been deforested and fragmented, and only 3% are in conservation units (Françoso et al. 2015; WWF 2020).

Included in this Cerrado biodiversity are poroid fungi, which play an important role in nutrient cycling within ecosystems, in addition to being the main decomposers of wood. These fungi represent a large artificial group within the Agaricomycetes class. They are so named because the hymenophore is made up of fused vertical tubes, called pores (Kirk et al. 2008). There are about 175 species of poroid fungi listed for the Brazilian Savanna (Gibertoni and Drechsler-Santos 2010; Abrahão et al. 2012; Costa-Rezende et al. 2015; Maia et al. 2015; Costa-Rezende et al. 2016; Bononi et al. 2017; Leonardo-Silva et al. 2020); of these, only nine have been recorded occurring in the state of Goiás. This present study presents the first taxonomic inventory of poroid fungi from Silvania's FLONA and includes ecological aspects of the group.

Materials & Methods

The Silvânia's FLONA is located in the municipality of Silvânia, in the eastern portion of the state of Goiás, 88 km from Goiânia (the state capital) and 177 km from Brasília (the capital of the country), between 16º 38' 30.0'' S and 48º 39' 02.5'' W, and has an area of 486.37 ha (Figure 1). The average altitude is 900 m, and its average temperature is 26 °C. The CU administrative headquarters has accommodation, a research support house, and a library with more than 500 titles on fauna, flora and ecology for research and reading. Along its length, there are internal roads, for the observation of local fauna, flora and mycobiota and trails, among which is one with about 1 km, composed of gallery forest in transition with the cerradão, and one with 2.5 km extension, through the densest forest (ICMBio 2015).

The sampling took place between 2005 to 2012. Basidioma collection was sampled randomly (active search), considering the CU area, and occurred along or outside pre-existing trails, mainly within forest formations. Taxonomic identification was performed based on the macro and micromorphological characteristics of the collected material, using specialized literature as a reference (Teixeira 1995; Ryvarden 2004). The classification and nomenclature of the cited taxa is in accordance with the Index Fungorum (2020). Voucher of the studied specimens were deposited in the Herbarium of the Universidade Estadual de Goiás (HUEG).

For ecological analyses, the absolute frequency (AF) was determined for each species, that is the absolute number of occurrences of the species and the relative frequency (RF) that presents the ratio between the AF of a species and the sum of the AFs of all species inventoried, given as a percentage (Mungai et al. 2011). The frequency classes of each species were designated using the same criteria established by Lindblad (2000), Hattori (2005) and Soares et al. (2014): $0.5 < RF \leq 1.5\%$ are considered as rare (R); $1.5 < RF \leq 5\%$, are occasional (O); $5 < RF \leq 10\%$ are given as common (C); $RF > 10\%$ are considered abundant (A).

To verify α diversity, the Shannon-Wiener diversity index (H') was used, which takes into account the uniformity of species abundances by measuring the number of equally common species (Shannon 1948). The maximum diversity index (H max) was also calculated. Through the ratio between H' and H max, the Equity Index (J') was obtained, which represents a measure of uniformity constrained between 0 and 1.0 (Rebêlo and Garófalo 1997; Magurran 1988).

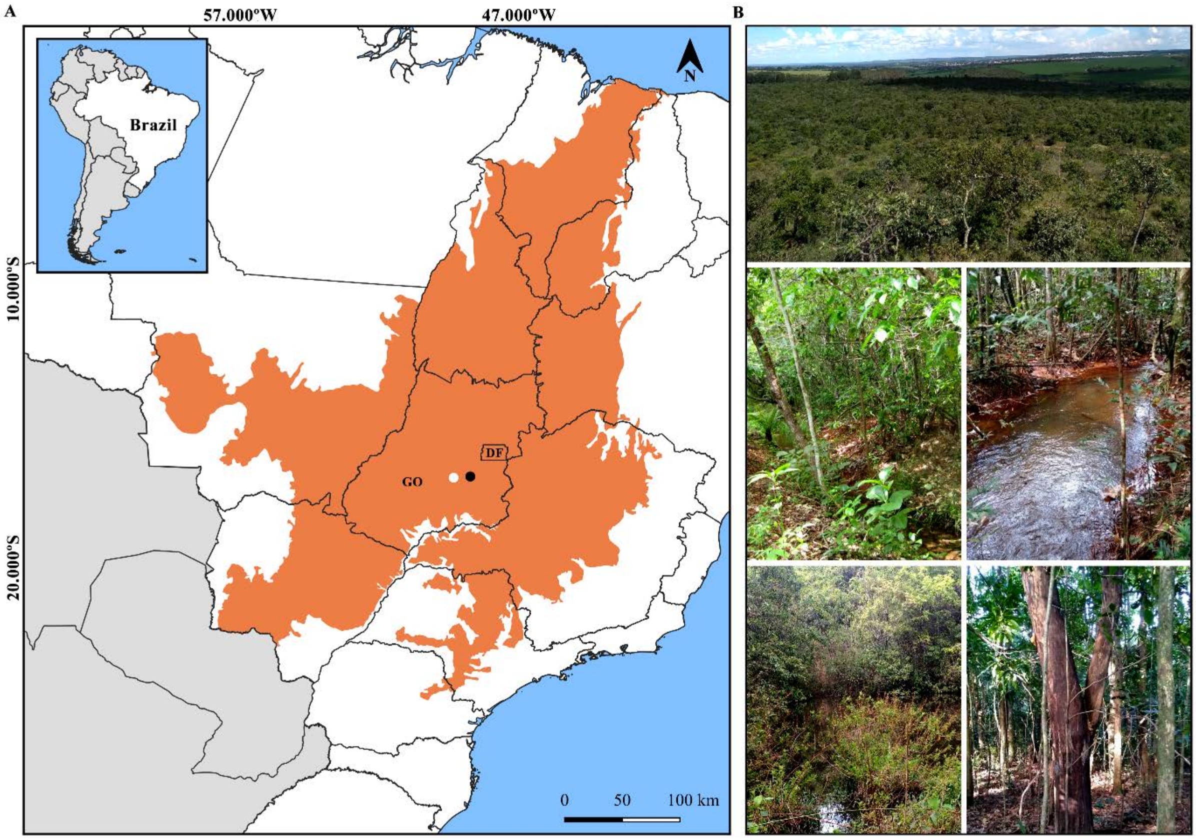

Figure 1. Studied area. **A.** Location: In orange the distribution area of Brazilian Savanna; black dot indicates the location of the Floresta Nacional (FLONA) de Silvânia in the state of Goiás; white dot represents Goiânia (capital of the state of Goiás) and DF represents the Distrito Federal, where the country's capital Brasília is located. **B.** Some phytophysiognomies of the Brazilian Savanna in Silvânia's FLONA.

Results and Discussion

We documented 27 species of poroid fungi in the area, which are distributed into 22 genera, 9 families and 3 orders (Figure 2 and 3). Polyporaceae was most represented family, with 49 occurrences, 8 genera, 11 species, followed by Hymenochaeteaceae, represented by 7 occurences, 4 genera and 5 species (Table 1). The representation of these families is in accordance with expectations, as they account for the largest and most diverse group of poroid fungi, with a wide variety of shapes and structures (Kirk et al. 2008). Similar results were observed in inventories carried out in areas of the Amazon rainforest in Brazil (Soares et al. 2014; Xavier et al. 2018).

The relative frequency (RF) of each species showing that 44.4% are rare in the area, 33.3% occasional, 15% common and 7.4% abundant (Table 1). Studies carried out in the Amazon biome show that 83.3% of the species of fungi found in the FLONA in Amapá and

61.5% of the species of the FLONA in Caxiuanã are rare (Soares et al. 2014 and Medeiros et al. 2015, respectively). Gibertoni et al. (2007) and Gibertoni (2008) also report a high rate of rare species in tropical regions, showing the importance of maintaining CUs, which maintain the natural resources of these habitats and a wide variety of species.

Figure 2. Recorded taxa. Basidiomata of *Schizophyllum commune* **(A)**, *Fomitiporia apiahyna* **(B)**, *Fuscoporia wahlbergii* **(C)**, *Hymenochaete rheicolor* **(D)**, *Phellinus gilvus* **(E)**, *Trichaptum perrottetii* **(F)**, *Trichaptum sector* **(G)**, *Cerrena hydnoides* **(H)**, *Daedalea ryvardeniana* **(I)**, *Amauroderma calcigenum* **(J)**, *Ganoderma testaceum* **(K)**, *Cymatoderma caperatum* **(L)**, *Panus strigellus* **(M)**, *Gloeoporus thelephoroides* **(N)** and *Antrodiella versicutis* **(O)**. Bars A–C, E–O = 1 cm; D = 2 mm.

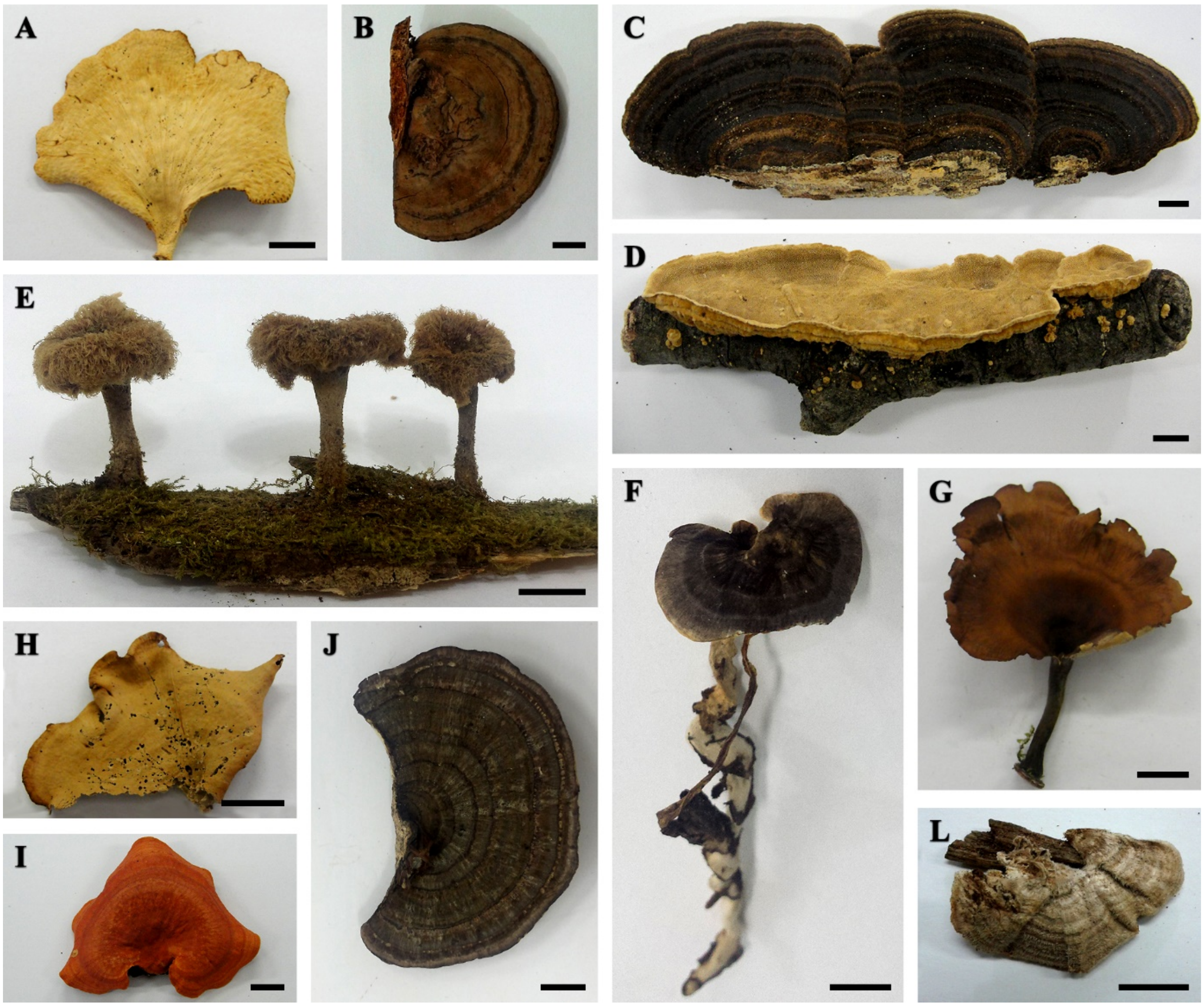

Figure 3. Recorded taxa. Basidiomata of *Favolus tenuiculus* **(A)**, *Fomes fasciatus* **(B)**, *Funalia caperata* **(C)**, *Funalia floccosa* **(D)**, *Lentinus berteroi* **(E)**, *Microporellus dealbatus* **(F)**, *Polyporus dictyopus* **(G)**, *Polyporus guianensis* **(H)**, *Pycnoporus sanguineus* **(I)**, *Trametes pavonia* **(J)** and *Trametes variegata* **(L)**. Bars = 1 cm.

All specimens were found on wood (dead or alive); 37% of the species were found on both live and dead wood; 33.3% exclusively in dead wood and 22.2% exclusively in live wood (resulting in 55.5% of species with specificity for live or dead wood). For 7.4% of them it was not possible to identify the state of the substrate (Table 1).

Table 1. Poroid fungi sampled in the Floresta Nacional (FLONA) de Silvânia according to taxonomy, substrate, absolute frequency, relative frequency, frequency class and voucher registration at HUEG herbaria.

Order/Family/Species	Substrate	FA	FR (%)	CF	Voucher (HUEG)
AGARICALES					
Schizophyllaceae Quél.					
Schizophyllum commune Fr.	DLW	6	7.06	C	9957-9962
HYMENOCHAETALES					
Hymenochaetaceae Donk					
Fomitiporia apiahyna (Speg.) Robledo, Decock & Rajchenb.	LW	1	1.17	R	9968
Fuscoporia callimorpha (Lév.) Groposo, Log.-Leite & Góes-Neto	DW	2	2.35	O	9963, 9965
Fuscoporia wahlbergii (Fr.) T. Wagner & M. Fisch.	LW	1	1.17	R	9966
Hymenochaete rheicolor (Mont.) Lév.	W	1	1.17	R	9967
Phellinus gilvus (Schwein.) Pat.	LW	2	2.35	O	9964, 9969
Incertae Sedis					
Trichaptum perrottetii (Lév.) Ryvarden	DLW	5	5.88	C	10035-10039
Trichaptum sector (Ehrenb.) Kreisel	DLW	2	2.35	O	10040, 10041
POLYPORALES					
Cerrenaceae Miettinen, Justo & Hibbett					
Cerrena hydnoides (Sw.) Zmitr.	DW	1	1.17	R	10001
Fomitopsidaceae Jülich					
Daedalea ryvardeniana Drechsler-Santos & Robledo	DW	2	2.35	O	9970, 9971
Ganodermataceae Donk					
Amauroderma calcigenum (Berk.) Torrend	DW	1	1.17	R	9972
Ganoderma testaceum (Cooke) Pat.	LW	3	3.53	O	9973-9975
Panaceae Miettinen, Justo & Hibbett					
Cymatoderma caperatum (Berk. & Mont.) D.A. Reid	DLW	5	5.88	C	9976-9980
Panus strigellus (Berk.) Overh.	DW	1	1.17	R	10020
Irpicaceae Spirin & Zmitr.					
Gloeoporus thelephoroides (Hook.) G. Cunn.	W	1	1.17	R	9981
Steccherinaceae Parmasto					
Antrodiella versicutis (Berk. & M.A. Curtis) Gilb. & Ryvarden	DW	2	2.35	O	9982, 9983
Polyporaceae Fr. ex Corda					
Favolus tenuiculus P. Beauv.	DLW	4	4.70	O	9984-9987
Fomes fasciatus (Sw.) Cooke	LW	1	1.17	R	9988
Funalia caperata (Berk.) Zmitr. & Malysheva	DLW	4	4.70	O	9989-9992
Funalia floccosa (Jungh.) Zmitr. & Malysheva	DLW	8	9.41	C	9993-10000
Lentinus berteroi (Fr.) Fr.	DLW	17	20	A	10002-10018
Microporellus dealbatus (Berk. & M.A. Curtis) Murrill	DW	1	1.17	R	10019
Polyporus dictyopus Mont.	DW	1	1.17	R	10021
Polyporus guianensis Mont.	LW	1	1.17	R	10022
Pycnoporus sanguineus (L.) Murrill	DLW	9	10.6	A	10023-10031
Trametes pavonia (Hook.) Ryvarden	DLW	2	2.35	O	10032, 10033
Trametes variegata (Berk.) Zmitr., Wasser & Ezhov	DW	1	1.17	R	10034

Abbreviation: Absolute frequency (AF); Relative frequency (RF); Frequency class (FC): abundant (A), common (C), occasional (O), rare (R); Dead wood (DW); Living wood (LW); Dead and living wood (DLW) and Wood (W).

The great availability of woody resources in tropical forests is one of the main factors that favor the presence of poroid fungi in these environments since these fungi are predominantly ligninocellulolitic. Although the relationship between the distribution of these fungi and the substrate is not satisfactorily clarified, varying according to the region (Ferrer and Gilbert 2003; Medeiros et al. 2015). Yamashita and Hijii (2006) point out that the diversity of fungi in an area can be affected by the specificity of substrates, including stages of decomposition, age and availability of these substrates. We found that the most frequent species of poroid fungi in the Silvânia's FLONA were those that occurred in both living and decaying wood, while the rare ones were those that occurred exclusively in one type of wood (live or dead) (Table 1). These data agree with the claims of Gilbert and Sousa (2002), that the specificity by the substrate is a factor that increases the number of rare species.

The species accumulation curve generated according to species collected per year, did not reach asymptote, thus indicating that the richness of poroid fungi in the area may increase with the increase in collections (sampling effort). This result is similar to those found by Soares et al. (2014), Medeiros et al. (2015) and Xavier et al. (2019), who despite having found great richness in the studied areas, also obtained non-asymptotic accumulation curves.

The α diversity, estimated through the Shannon- Wiener index (H'), was 2.86. The maximum diversity index (H max) was 3.29. The H' value lower than the H max reaffirms the data of the species accumulation curve, indicating that the number of species found has not yet exhausted the real diversity of the area. Pielou's equability (J') was 0.87, which indicates that the number of records is uniform among the sampled species.

Inventories of fungi help to document a local diversity and to understand ecological and biogeographic relationship of these species in ecosystems, highlighting their richness, abundance, frequency, substrate, and others. These studies help in the elaboration of measures to conserve the biodiversity of the local mycobiota, in status of habitat (environmental quality) and know potential species of economic interest, besides being an important tool in the promotion of mycophilia (Soares et al. 2014; Mouchacca 2016; Karun et al. 2018; Xavier et al. 2018; Kotowski 2019).

The present work is one of the pioneers in the study of poroid fungi within areas of the Cerrado of Central Brazil and the diversity inventoried evidences the need to intensify researches in both taxonomy and ecology, which allows for representation of the richness of fungal species and their exosystemic role.

Moreover, further research will make it possible to expand the knowledge of the economic potential of the local mycobiota. In addition, the diversity of poroid fungi from the Silvânia's FLONA showed great richness and a high number of species considered rare, which adds value to biotic factors and can be used in appliance to update the management plan of the conservation unit.

Conflict of Interest

The authors do not have any conflicts of interest.

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References

Abrahão MC, Gugliotta AM, Bononi VLR. 2012. Xylophilous Agaricomycetes (Basidiomycota) of Brazilian Cerrado. CheckList 8: 1102–1116.

Bononi VLR, Oliveira AKM, Gugliotta AM, Quevedo JR. 2017. Agaricomycetes (Basidiomycota, Fungi) diversity in a protected area in the Maracaju Mountains, in the Brazilian central region. Hoehnea 44: 361–377.

Costa-Rezende DH, Ferreira-Lopes V, Salvador-Montoya CA, Alves-Silva G, Mello A, Drechsler-Santos ER. 2015 – Novos registros de *Perenniporia* s. l. e *Pyrofomes* para o Cerrado Brasileiro. Iheringia 70: 157–166.

Costa-Rezende DH, Gugliotta AM, Góes-Neto A, Reck MA, Robledo GL, Drechsler-Santos ER. 2016. *Amauroderma calcitum* sp. nov. and notes on taxonomy and distribution of *Amauroderma* species (Ganodermataceae). Phytotaxa 244: 101–124.

Ferrer A, Gilbert GS. 2003. Effect of tree host species on fungal community composition in a tropical rain forest in Panama. Diversity and Distributions 9: 455–468.

Françoso RD, Brandão R, Nogueira CC, Salmona YB, Machado RB, Colli GR. 2015. Habitat loss and the effectiveness of protected areas in the Cerrado biodiversity hotspot. Natureza & Conservação 13: 35–40.

Gibertoni TB, Drechsler-Santos ER. 2010. Lignocellulolytic Agaricomycetes from the Brazilian Savannah biome. Mycotaxon 111: 87–90.

Gibertoni TB, Santos PJP, Cavalcanti MAQ. 2007. Ecological aspects of Aphyllophorales in the Atlantic Rain Forest in Northeast Brazil. Fungal Diversity 25: 49–67.

Gibertoni TB. 2008. Polyporoid fungi (Agaricomycetes, Basidiomycota) in the Estação Científica Ferreira Penna (State of Pará, Brazilian Amazonia): diversity and ecological aspects. Scientifica Acta 2: 70–74.

Gilbert GS, Sousa WP. 2002. Host specialization among wood-decay polypore fungi in a Caribbean mangrove forest. Biotropica 34: 396–404.

Hattori T. 2005. Diversity of wood-inhabiting polypores in temperate forest with different vegetation types in Japan. Fungal Diversity 18: 73–88.

ICMBio – O Instituto Chico Mendes de Conservação da Biodiversidade. 2015. Plano de Manejo da Floresta Nacional de Silvânia. Volume I – Diagnóstico. 297 p.

ICMBio – O Instituto Chico Mendes de Conservação da Biodiversidade. 2020. Unidades de Conservação – Cerrado. Accessed May 31, 2020. Available from: https://www.icmbio.gov.br/portal/unidadesdeconservacao/biomas-brasileiros/cerrado/unidades-de-conservacao-cerrado.

Index Fungorum. 2020. Available from: http://www.indexfungorum.org/. Accessed 31 may 2020.

Karun NC, Bhagya BS, Sridhar KR. 2018. Biodiversity of macrofungi in Yenepoya campus, Southwest India. Microbial Biosystems 3:1–11.

Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Ainsworth & Bisby‘s Dictionary of the Fungi. 10rd edition, CAB International, United Kingdom. 784 p.

Klink CA, Machado RB. 2005. A conservação do Cerrado Brasileiro. Megadiversidade 1: 147–155.

Kotowski MA. 2019. History of mushroom consumption and its impact on traditional view on mycobiota–an example from Poland. Microbial Biosytems 4:1–13.

Leonardo-Silva L, Silva LB, Sá ASF, Naves LRR, Cunha EL, Xavier-Santos S. 2020. Additions to the knowledge of Ganodermataceae in brazilian Cerrado. Hoehnea 47: 1–7.

Lindblad I. 2000. Host Specificity of Some Wood-Inhabiting Fungi in a Tropical Forest. Mycologia 92: 399–405.

Magurran AE. 1988. Ecological diversity and its measurement. New Jersey: Princeton University Press. 179 p.

Maia LC, Carvalho AA, Júnior Cavalcanti LH, Gugliotta AM, Drechsler Santos ER, Santiago ALMA et al. 2015. Diversity of Brazilian fungi. Rodriguésia 66: 1033–1045.

Marques BF, Marques CRS, Roriz GFS. 2009. A concessão de florestas públicas. Revista da Faculdade de Direito - Universidade Federal de Goiás 33: 89–111.

Medeiros OS, Cattanio JH, Sotão HMP. 2015. Riqueza e relação dos fungos poroides lignolíticos (Agaricomycetes) com o substrato em floresta da Amazônia. Boletim do Museu Paraense Emílio Goeldi - Ciências Naturais 10: 423 – 436.

Morais AR, Bastos RP, Vieira R, Signorelli L. 2012. Herpetofauna of the Floresta Nacional de Silvânia, a Cerrado remnant in Central Brazil. Neotropical Biology and Conservation 7: 114–121.

Mouchacca J. 2016. Mycological discoveries in the Middle East region in the second part of the last century. Microbial Biosystems 1:1–39.

Mungai P, Hyde KD, Njogu J, Chukeatirote E. 2011. Coprophilous ascomycetes of northern Thailand. Current Research in Environmental and Applied Mycology 1: 135–159.

Rebêlo JMM, Garófalo CA. 1997. Comunidades de machos de *Euglossini* (Hymenoptera: Apidae) em Matas Semidecíduas do nordeste do estado de São Paulo. Anais da Sociedade Entomológica do Brasil 26: 243-255.

Ribeiro JF, Walter BMT. 2008. As principais fitofisionomias do bioma Cerrado. In: Sano SM, Almeida SP, Ribeiro JF. Cerrado: Ecologia e Flora, Brasília: Embrapa Cerrados: Embrapa informação tecnológica. 1279 p.

Ryvarden L. 2004. Neotropical polypores: Part 1. Introduction, Ganodermataceae & Hymenochaetaceae. Oslo, Fungiflora. 227 p.

Shannon CE. 1948. A mathematical theory of communication. Bell System Technical Journal, 27: 379–423.

Soares MAS, Sotão HMP, Medeiros OS, Gibertoni TB. 2014. Riqueza de fungos Poliporoides (Agaricomycetes, Basidiomycota) em uma floresta ombrófila densa no Amapá, Amazônia Brasileira. Boletim do Museu de Biologia Mello Leitão 35: 5–18.

Teixeira AR. 1995. Métodos para estudo das hifas do basidiocarpo de fungos poliporáceos. Instituto de Botânica. 20 p.

WWF – World Wide Fund for Nature. 2020. The “Big Five” of the Cerrado. WWF Brasil. 10 Sep 2015. Available from: https://www.wwf.org.br/informacoes/english/?50242/The-Big-Five-of-the-Cerrado. Accessed 31 may 2020.

Xavier WKS, Sotão HMP, Soares MAS, 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. Boletim do Museu Paraense Emílio Goeldi - Ciências Naturais 13: 303–315.

Yamashita S, Hijii N. 2006. Spatial distribution of the fruiting bodies of Agaricales in a Japanese red pine (*Pinus densiflora*) forest. Journal of Forest Research 11: 181–189.

ARTIGO 3

CORTICIOID AND POROID FUNGI (BASIDIOMYCOTA) FROM PARQUE ESTADUAL DA SERRA DE CALDAS NOVAS (PESCAN), BRAZILIAN SAVANNA, GOIÁS, BRAZIL

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Corticioid and poroid fungi (Basidiomycota) from Parque Estadual da Serra de Caldas Novas (PESCAN), Brazilian Savanna, Goiás, Brazil

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Abstract − This study was based on specimens collected on 15 field expeditions between 2007 and 2013 in the Parque Estadual da Serra de Caldas Novas (PESCAN), the first conservation unit decreed by the government of the State of Goiás and one of the most representative protected areas of the Brazilian Savanna (Cerrado biome). A list of 51 species composes this inventory, six of them reported for the first time from Cerrado Biome (*Flabellophora parva*, *Hymenochaete microcycla*, *Navisporus sulcatus*, *Stiptophyllum erubescens*, *Trechispora mellina*, and *Truncospora ohiensis*), five from the Midwest region of Brazil and two from Goiás. These results increase sampling efforts and knowledge about these fungi in this little-studied region of Brazil.

Keywords − Agaricomycetes, Cerrado Biome, geographic distribution, polypores, resupinate fungi.

Introduction

The Parque Estadual da Serra de Caldas Novas (PESCAN) was created by the government of Goiás, Brazil, in 1970, being the first conservation unit decreed in the State. PESCAN aims to conserve the fauna, flora, springs, and their surroundings, natural sites of ecological and tourist relevance (SEMAD 2021). The park is located in one of the regions with the largest occurrence of thermal waters in Brazil and is one of the most relevant recharge areas of the hydrothermal aquifers in the municipalities of Caldas Novas and Rio Quente. Furthermore, the area constitutes a representative remnant of the Cerrado (Brazilian Savanna), with diverse typical vegetation of the biome (Klink & Machado 2005, SEMAD 2021).

The known biodiversity of PESCAN comprises more than 800 species, including plants, vertebrate animals, insects, amoeboid protists (Myxomycetes), and fungi (Alvarenga & Xavier-Santos 2017, Moreira & al. 2019, SEMAD 2021). Among these groups of organisms, the fungi are one of the poorer known with only 10 species of macrofungi (Alvarenga & al. 2015, Calaça & al. 2015, Calaça & Xavier-Santos 2016, Alvarenga & Xavier-Santos 2017, Leonardo-Silva & al. 2020), which supports the need for more sampling efforts in the region.

Corticioid and poroid fungi are some of the common and important wood-inhabiting fungi in forest environments. These macrofungi are traditionally grouped by the morphology of the basidioma and do not represent taxa in any rank. Species with smooth to hydnoid hymenium usually organized in the form of a sheet on the substrate (resupinate) are known as corticioid fungi, and those with the hymenium composed of tubes (pores), poroid fungi or polypores (Ryvarden 2004, Larsson 2007, Ghobad-Nejhad 2011). These groups of fungi are essential components of forest ecosystems by the ecological interactions associated with wood decay, nutrient cycling, soil formation, and symbiosis with plants (Ryvarden 2004, Moore & al. 2011).

Despite the importance of corticoid and poroid fungi, data on their diversity are scarce in the Cerrado, one of the richest biomes in Brazil and most threatened by human activities. We undertook a survey into the diversity of these fungi in the PESCAN and its surroundings and presented an annotated checklist of the species.

Materials & methods

Study area

The PESCAN is located in South America, Central Brazil, in the State of Goiás, between the municipalities of Caldas Novas and Rio Quente (17°47′34″S to 17°50′55″S and

48°40′00″W to 48°42′14″W) (Figure 1). The area comprises about 125 km2, in an elliptical shape (plateau), with side slopes that form natural walls (enclaves). The base of the mountain is bordered by farms and urban settlements (Carvalho & al. 2015, SEMAD 2021).

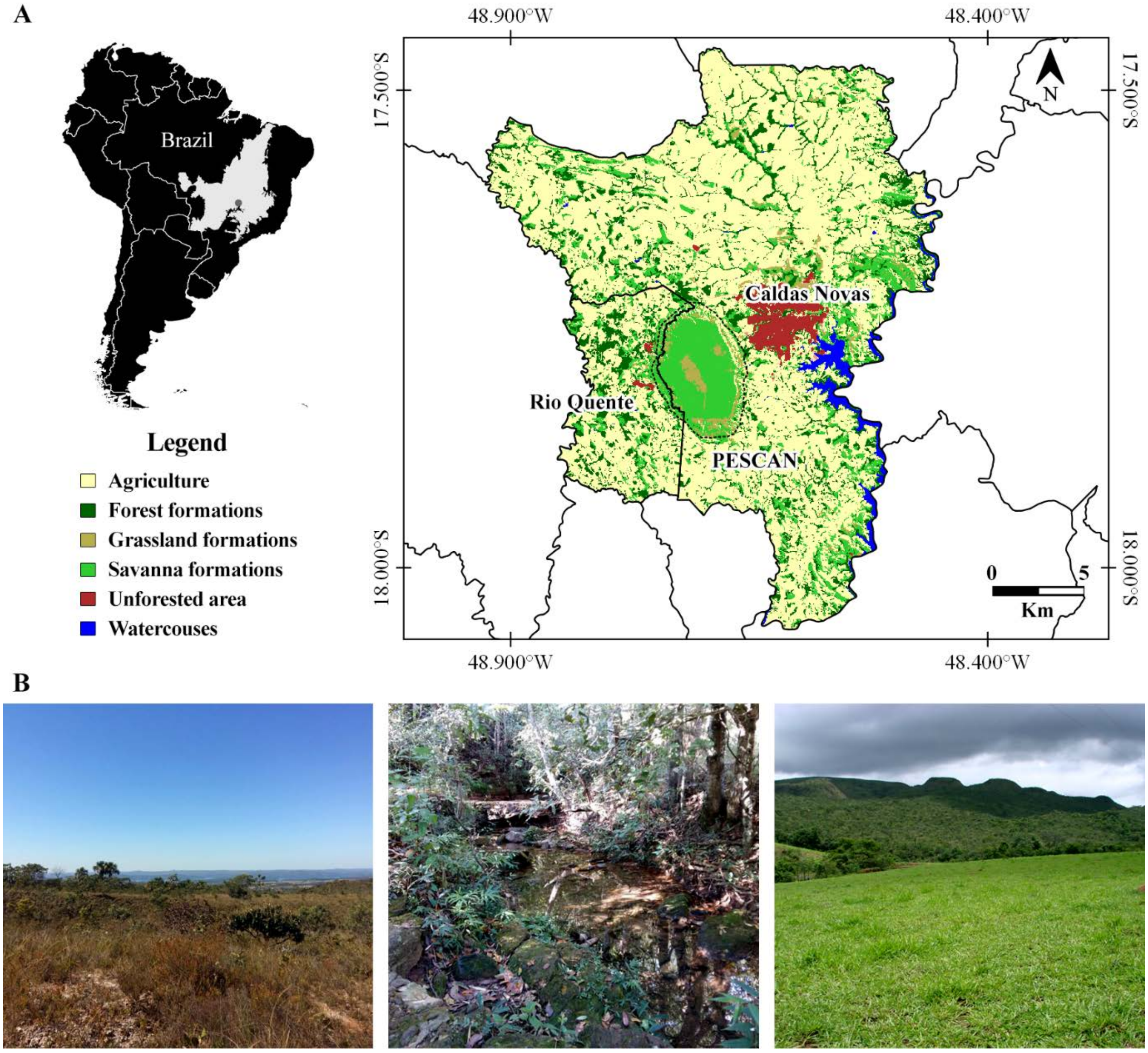

Figure 1. A. Location of the Parque Estadual da Serra de Caldas Novas (dark grey dot) in the Brazilian Cerrado (light grey area), highlighting the use and land cover of the region. **B.** Some landscapes (savanna, forest, and grassland formations) from the sampling area. Use and land cover according to Souza & al. (2020).

The mean altitude of the region is 1043 m a.s.l. and the climate is tropical (Aw) with dry winters and rainy summers according to Köppen-Geiger climate classification (Peel & al. 2007). Rains are concentrated from October to March, and the dry season is between April and September. The average annual temperature of the region is around 23 °C, with a correspondence between the minimum average values (20 °C) in the dry months and the maximum average values (25 °C) in the rainy months (Carvalho & al. 2015). The PESCAN is inserted in the Cerrado biome, which is characterized by the following landscapes: campo limpo, campo sujo, cerrado rupestre, enclaves of deciduous forest, veredas, gallery forest, mesophilic forest, trails, and savannas. Despite this rich vegetation landscape, most of the area is represented by savanna and grassland formations (Carvalho & al. 2015, SEMAD 2021).

Collection and identification of the material

To collect the material, we undertook 15 field expeditions over four years, within the limits of the PESCAN and its surroundings. The method of collection, preservation, and herborization followed the standard techniques for fungi (Gadelha-Neto & al. 2013). The taxonomic identification was performed by macro and microscopic analysis of the dried material and according to relevant identification keys (Hjortstam & Ryvarden 1980, Núñez & Ryvarden 2001, Ryvarden 2004, 2015, 2016, Groposo & al. 2007, Ţura & al. 2008, Abrahão & al. 2009, Chikowski & al. 2020, Gorjón 2020). Vouchers were deposited in the fungarium of the Universidade Estadual de Goiás (HUEG-Fungi) (Thiers 2022 [continuously updated]). All recorded taxa had their names were updated according to Index Fungorum (http://www.indexfungorum.org) and Mycobank (https://www.mycobank.org/) databases.

Results

We analyzed 192 samples that resulted in the identification of 51 species, six of which are new records from the Cerrado (Figure 2), five from the Midwest region, and two for the State of Goiás. Considering the distribution in Brazil of the new occurrences for Cerrado, *Navisporus sulcatus* and *Trechispora mellina* were only known for the Atlantic Forest, *Flabellophora parva* for Atlantic Forest and Caatinga, while *Hymenochaete microcycla*, *Stiptophyllum erubescens,* and *Truncospora ohiensis* have a distribution known, so far, for the Amazonia and Atlantic Forest biomes.

Species names are listed alphabetically in the checklist, including information on fungarium vouchers. An asterisk (*) indicates that the taxon is reported for the first time for Cerrado, two asterisks (**) new record for the Midwest region, and three asterisks (***) new record for the State of Goiás.

Figure 2. Species recorded for the first time from the Cerrado Biome. **A–B.** *Flabellophora parva*. **C–D.** *Hymenochaete microcycla*. **E–F.** *Navisporus sulcatus*. **G–H.** *Truncospora ohiensis*. **I–J.** *Stiptophyllum erubescens*. **K.** *Trechispora mellina.* Scale bars = 1 cm.

Checklist of species

Amauroderma aurantiacum (Torrend) Gibertoni & Bernicchia

Basionym: *Ganoderma aurantiacum* Torrend

Description: Ryvarden (2004) as *A. macrosporum* J.S. Furtado.

Material examined HUEG: 9927, 9928, 9929, 9930, 9931, 9932, 9933, 9934, 10552, 10555, 10560, 10597, 10634, 10650, 14523, 14524, 14544.

Amauroderma exile (Berk.) Torrend

Basionym: *Polyporus exilis* Berk.

Description: Ryvarden (2004).

Material examined HUEG: 9935.

Coriolopsis floccosa (Jungh.) Ryvarden

Basionym: *Polyporus floccosus* Jungh.

Description: Ryvarden & Johansen (1980).

Material examined HUEG: 9909, 9910, 9911, 10783, 14526, 14551, 14558, 10566, 10567.

Cymatoderma caperatum (Berk. & Mont.) D.A. Reid

Basionym: *Polyporus caperatus* Berk.

Description: Welden (1960).

Material examined HUEG: 9921, 9922, 9923, 9924, 9925, 10579, 14510.

Daedalea ryvardeniana Drechsler-Santos & Robledo

Description: Drechsler-Santos & al. (2012).

Material examined HUEG: 10557, 10582, 10588, 10590, 10596, 14543, 14561.

Earliella scabrosa (Pers.) Gilb. & Ryvarden

Basionym: *Polyporus scabrosus* Pers.

Description: Ryvarden (2015).

Material examined HUEG: 9895, 10545.

Favolus brasiliensis (Fr.) Fr.

Basionym: *Daedalea brasiliensis* Fr.

Description: Ryvarden (2016) as *Polyporus tenuiculus* (Beauv.) Fr.

Material examined HUEG: 9895, 9886, 9887, 10598, 14507, 14520, 14522, 14527.

Flabellophora parva Corner (Fig. 2).

Description: Ryvarden (2015).

Material examined HUEG: 10712, 14879.

Funalia caperata (Berk.) Zmitr. & Malysheva

Basionym: *Polyporus caperatus* Berk.

Description: Ryvarden & Johansen (1980).

Material examined HUEG: 9912, 9913, 9914, 14552, 10550, 10580.

Fuscoporia callimorpha (Lév.) Groposo, Log.-Leite & Góes-Neto

Basionym: *Polyporus callimorphus* Lév.

Description: Groposo & al. (2007).

Material examined HUEG: 9247, 9940, 10564, 10572.

Fuscoporia gilva (Schwein.) T. Wagner & M. Fisch.

Basionym: *Boletus gilvus* Schwein.

Description: Ryvarden (2004).

Material examined HUEG: 9942, 14540.

Gloeophyllum striatum (Fr.) Murrill

Basionym: *Daedalea striata* Fr.

Description: Núñez & Ryvarden (2001).

Material examined HUEG: 9955, 10546, 10578.

Gloeoporus thelephoroides (Hook.) G. Cunn.

Basionym: *Boletus thelephoroides* Hook.

Description: Ryvarden (2015).

Material examined HUEG: 9917, 9918, 9919, 9920.

Hexagonia hydnoides (Sw.) M. Fidalgo

Basionym: *Boletus hydnoides* Sw.

Description: Ryvarden (2015).

Material examined HUEG: 9906, 9907, 9908, 10554, 10593, 10586, 10601, 10790, 14542.

Hexagonia variegata Berk.

Description: Ryvarden (2015) as *H. papyracea* Berk.

Material examined HUEG: 9901, 9902, 9903, 9904, 10548, 10570, 10584, 10600, 10776, 14509, 14517, 14533, 14537, 14546, 14549, 14555.

Hymenochaete damicornis (Link) Lév.

Basionym: *Stereum damicorne* Link.

Description: Parmasto (2001).

Material examined HUEG: 9944, 9945, 9946, 9947, 9948, 9949, 9950.

****Hymenochaete microcycla*** (Zipp. ex Lév.) Spirin & Miettinen (Fig. 2).

Basionym: *Polyporus microcyclus* Zipp. ex Lév.

Description: Ryvarden & Johansen (1980).

Material examined HUEG: 14513, 14529.

Hymenochaete rheicolor (Mont.) Lév.

Basionym: *Stereum rheicolor* Mont.

Description: Parmasto (2001).

Material examined HUEG: 9951.

Lentinus berteroi (Fr.) Fr.

Basionym: *Agaricus berteroi* Fr.

Description: Ryvarden (2015).

Material examined HUEG: 10575, 10577, 14518.

Lentinus crinitus (L.) Fr.

Basionym: *Agaricus crinitus* L.

Description: Ryvarden (2015).

Material examined HUEG: 14456, 14514, 14521.

Lenzites elegans (Spreng.) Pat.

Basionym: *Daedalea elegans* Spreng.

Description: Núñez & Ryvarden (2001).

Material examined HUEG: 9896, 9897, 14545.

*****Megasporia cavernulosa*** (Berk.) C.R.S. Lira & T.B. Gibertoni

Basionym: *Polyporus cavernulosus* Berk.

Description: Núñez & Ryvarden (2001) as *Dichomitus cavernulosus* (Berk.) Masuka & Ryvarden.

Material examined HUEG: 10589.

Metuloidea reniformis (Berk. & M.A. Curtis) Westphalen & Motato-Vásq.

Basionym: *Hydnum reniforme* Berk. & M.A. Curtis.

Description: Maas Geesteranus (1974).

Material examined HUEG: 9926.

****Navisporus sulcatus*** (Lloyd) Ryvarden (Fig. 2).

Basionym: *Trametes sulcata* Lloyd.

Description: Ryvarden (2015).

Material examined HUEG: 9905.

Neodictyopus dictyopus (Mont.) Palacio, Robledo & Drechsler-Santos

Basionym: *Polyporus dictyopus* Mont.

Description: Ryvarden (2016).

Material examined HUEG: 9894, 14511, 14519, 14525, 14550, 14565.

*****Pachykytospora alabamae*** (Berk. & Cooke) Ryvarden

Basionym: *Polyporus alabamae* Berk. & Cooke.

Description: Núñez & Ryvarden (2001).

Material examined HUEG: 14560.

Panus strigellus (Berk.) Overh.

Basionym: *Lentinus strigellus* Berk.

Description: Ryvarden (2015).

Material examined HUEG: 10573, 14541.

******Perenniporia aurantiaca*** (A. David & Rajchenb.) Decock & Ryvarden

Basionym: *Pyrofomes aurantiacus* A. David & Rajchenb.

Description: Ryvarden (2016).

Material examined HUEG: 9916, 10738, 14880.

******Phaeodaedalea incerta*** (Curr.) Ţura, Zmitr., Wasser & Spirin

Basionym: *Polyporus incertus* Curr.

Description: Ryvarden (2016) as *Trichaptum sprucei* (Berk.) Rajchenb. & Bianchin.

Material examined HUEG: 9954, 14515, 14562.

Phlebiopsis amethystea (Hjortstam & Ryvarden) R.S. Chikowski & C.R.S. Lira

Basionym: *Porostereum amethysteum* Hjortstam & Ryvarden.

Description: Hjortstam & Ryvarden (1990).

Material examined HUEG: 9915, 10587, 14557.

*****Phylloporia chrysites*** (Berk.) Ryvarden

Basionym: *Polyporus chrysites* Berk.

Description: Ryvarden (2004).

Material examined HUEG: 14559.

Phylloporia* cf. *pectinata (Klotzsch) Ryvarden

Description: Ryvarden (2004).

Material examined HUEG: 10603.

*****Phylloporia spathulata*** (Hook.) Ryvarden

Basionym: *Boletus spathulatus* Hook.

Description: Ryvarden (2004).

Material examined HUEG: 14532.

Polyporus guianensis Mont.

Description: Ryvarden (2016).

Material examined HUEG: 9889, 9890, 9891, 9892, 10602, 14535, 14548, 14553, 14594.

Polyporus leprieurii Mont.

Description: Ryvarden (2016).

Material examined HUEG: 9893, 14547, 10565, 10574.

Polyporus tricholoma Mont.

Description: Ryvarden (2016).

Material examined HUEG: 9489, 9888, 10780, 14534.

Pycnoporus sanguineus (L.) Murrill

Basionym: *Boletus sanguineus* L.

Description: Ryvarden (2016).

Material examined HUEG: 14508, 14536, 14538, 14539, 14554.

Schizophyllum commune Fr.

Description: Cooke (1961).

Material examined HUEG: 10562, 10592.

Schizophyllum umbrinum Berk.

Description: Cooke (1961).

Material examined HUEG: 10559, 10568, 14516.

Stereum hirsutum (Willd.) Pers.

Basionym: *Thelephora hirsuta* Willd.

Description: Ţura & al. (2008).

Material examined HUEG: 10583, 10591.

Stereum ostrea (Blume & T. Nees) Fr.

Basionym: *Thelephora ostrea* Blume & T. Nees.

Description: Chamuris (1988).

Material examined HUEG: 10553.

Stiptophyllum erubescens (Berk.) Ryvarden (Fig. 2).

Basionym: *Daedalea erubescens* Berk.

Description: Ryvarden (2015) as *Gloeophyllum erubescens* (Berk.) Popoff.

Material examined HUEG: 14528.

Trametes pavonia (Hook.) Ryvarden

Basionym: *Boletus pavonius* Hook.

Description: Ryvarden (2016).

Material examined HUEG: 9898, 9899, 9900, 10571.

Trametes psila (Lloyd) Ryvarden

Basionym: *Fomes psila* Lloyd.

Description: Nogueira-Melo & al. (2012) as *Coriolopsis psila* (Lloyd) Ryvarden.

Material examined HUEG: 10778.

Trametes supermodesta Ryvarden & Iturr.

Description: Ryvarden (2016).

Material examined HUEG: 9884, 10563, 10605.

****Trechispora mellina*** (Bres.) K.H. Larss. (Fig. 2).

Basionym: *Corticium mellinum* Bres.

Description: Hjortstam & Ryvarden (1980).

Material examined HUEG: 14857.

*****Trichaptum biforme*** (Fr.) Ryvarden

Basionym: *Polyporus biformis* Fr.

Description: Ryvarden (2016).

Material examined HUEG: 9952.

Trichaptum perrottetii (Lév.) Ryvarden

Basionym: *Trametes perrottetii* Lév.

Description: Ryvarden (2016).

Material examined HUEG: 10779.

Trichaptum sector (Ehrenb.) Kreisel

Basionym: *Boletus sector* Ehrenb.

Description: Ryvarden (2016).

Material examined HUEG: 9953.

Trullella duracina (Pat.) Zmitr.

Basionym: *Leptoporus duracinus* Pat.

Description: Ryvarden (2015).

Material examined HUEG: 9936, 9937, 9938, 9939, 10547, 10556, 10671, 14531.

Truncospora ohiensis (Berk.) Pilát (Fig. 2).

Basionym: *Trametes ohiensis* Berk.

Description: Núñez & Ryvarden (2001).

Material examined HUEG: 10549.

Conclusion

The PESCAN is a representative area of the Cerrado biome and has one of the richest landscapes in the region. The knowledge of the park biodiversity is currently focused on fauna and flora, while the Funga is little known by the local and scientific community. Thus, we expect that the data on the diversity of corticioid and poroid fungi provided in this inventory will be relevant to mitigate the lack of local knowledge and raise awareness of the need to increase sampling efforts in the region and its importance as a significant reservoir of fungal biodiversity for the State of Goiás and Midwest Brazil.

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Literature cited

Abrahão MC, Gugliotta AM, Gomes E. 2009. Poliporóides (*Basidiomycota*) em fragmentos de mata no perímetro urbano de São José do Rio Preto, São Paulo, Brasil. Revista Brasileira de Botânica 32(3): 427–440. https://doi.org/10.1590/S0100-84042009000300004.

Alvarenga RLM, Xavier-Santos S. 2017. New records of *Dacrymycetes* (Fungi: *Basidiomycota*) from the Cerrado Biome (Brazilian Savanna) and Midwest Region, Brazil. Check List 13(4): 335–342. https://doi.org/10.15560/13.4.335.

Alvarenga RLM, Naves LRR, Xavier-Santos S. 2015. The Genus *Auricularia* Bull. ex Juss. (*Basidiomycota*) in Cerrado (Brazilian Savanna) areas of Goiás State and the Federal District, Brazil. Mycosphere 6(5): 532–541. https://doi.org/10.5943/mycosphere/6/5/3.

Calaça FJS, Delpont M, Xavier-Santos S. 2015. *Delitschia gigaspora* var. *pescanii*: a new variety of coprophilous fungus from Brazil. Mycosphere 6(1): 122–126. https://doi.org/10.5943/mycosphere/6/1/12.

Calaça FJS, Xavier-Santos S. 2016. New records of coprophilous ascomycetes (Fungi: *Ascomycota*) from Brazil and Neotropical Region. Check List 12(6): 1–9. https://doi.org/10.15560/12.6.2009.

Carvalho MAS, Xavier-Santos S, Guilherme FAG. 2015. Edge effects on epiphytic moss (Bryophyta) communities in a savanna area in Central Brazil. Brazilian Journal of Ecology: 17–28.

Chamuris GP. 1988. The non-stipitate steroid fungi in the Northeastern United States and adjacent Canada. Mycologia Memoir 14: 1–247.

Chikowski RS, Larsson KH, Gibertoni TB. 2020. Taxonomic novelties in *Trechispora* (*Trechisporales, Basidiomycota*) from Brazil. Mycological Progress 19(12): 1403–1414. https://doi.org/10.1007/s11557-020-01635-y.

Cooke WB. 1961. The Genus *Schizophyllum*. Mycologia 53(6): 575–599. https://doi.org/doi:10.2307/3756459.

Drechsler-Santos ER, Cavalvanti MAQ, Loguercio-Leite C, Robledo GL. 2012. On Neotropical *Daedalea* species: *Daedalea ryvardenica* sp. nov. Kurtziana 37(1): 65–72.

Gadelha-Neto PC, Barbosa MRV, Menezes M, Wartchow F, Lima JR, Barbosa MA, Pôrto KC, Gibertoni TB, Peixoto AL, Maia LC. 2013. Manual de procedimentos para herbários. Editora UFPE. 95pp.

Ghobad-Nejhad M. 2011. Updated checklist of corticioid and poroid basidiomycetes of the Caucasus region. Mycotaxon 117(1). https://doi.org/10.5248/117.508.

Gorjón SP. 2020. Genera of corticioid fungi: keys, nomenclature, and taxonomy. Studies in Fungi 5(1): 125–309. https://doi.org/10.5943/sif/5/1/12.

Groposo C, Loguercio-Leite C, Góes-Neto A. 2007. *Fuscoporia* (*Basidiomycota*, *Hymenochaetales*) in Southern Brazil. Mycotaxon 101: 55–63.

Hjortstam K, Ryvarden L. 1980. Studies in tropical *Corticiaceae* (*Basidiomycetes*) II. Mycotaxon 12(1): 168–184.

Hjortstam K, Ryvarden L. 1990. *Lopharia* and *Porostereum* (Corticiaceae). Oslo, Norway: Fungiflora. 68pp.

Klink CA, Machado RB. 2005. A conservação do Cerrado brasileiro. Megadiversidade 1(1): 147–155. https://doi.org/10.1590/S0100-69912009000400001.

Larsson KH. 2007. Re-thinking the classification of corticioid fungi. Mycological Research 111(9):1040–1063. https:// 10.1016/j.mycres.2007.08.001.

Leonardo-Silva L, Silva LB, Sá ASF, Naves LRR, Cunha EL, Xavier-Santos S. 2020. Additions to the knowledge of *Ganodermataceae* in brazilian Cerrado. Hoehnea 47: 1–7. https://doi.org/10.1590/2236-8906-85/2019.

Maas Geesteranus RA. 1974. Studies in the genera *Irpex* and *Steccherinum*. Persoonia 7: 443–581.

Moore D, Robson GD, Trinci APJ. 2011. 21st Century Guidebook to Fungi. Cambridge University Press. 627pp.

Moreira I, Leonardo-Silva L, Xavier-Santos S. 2019. The myxobiota of the Serra de Caldas Novas State Park (PESCAN), Goiás, Brazil, with new records for the Central-West region and the Cerrado biome (Brazilian Savanna). Current Research in Environmental & Applied Mycology 9(1): 313–320. https://doi.org/10.5943/cream/9/1/26.

Nogueira-Melo GS, Medeiros PS, Gomes-Silva AC, Ryvarden L, Sotão HMP, Gibertoni TB. 2012. *Coriolopsis psila* comb. nov. (*Agaricomycetes*) and two new *Coriolopsis* records for Brazil. Mycotaxon 120: 223–230. https://doi.org/10.5248/120.223.

Núñez M, Ryvarden L. 2001. East Asian Polypores 2. *Polyporaceae* s. lato. Oslo, Norway: Fungiflora. 280pp.

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

Peel MC, Finlayson BL, McMahon TA. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth System Sciences 11: 1633–1644. https://doi.org/10.5194/hess-11-1633-2007.

Ryvarden L. 2004. Neotropical polypores Part 1. Introduction, *Ganodermataceae* & *Hymenochaetaceae*. Synopsis Fungorum 19:1–238.

Ryvarden L. 2015. Neotropical polypores Part 2. *Polyporaceae*. *Abortiporus-Nigroporus*. Synopsis Fungorum 34: 232–443.

Ryvarden L. 2016. Neotropical polypores Part 3. *Polyporaceae*. *Obba-Wrightoporia*. Synopsis Fungorum 36: 447–613.

Ryvarden L, Johansen I. 1980. A preliminary Polypore flora of East Africa. Oslo: Fungiflora. 636pp.

SEMAD. 2021. Plano de Manejo do Parque Estadual da Serra de Caldas Novas. Goiânia - GO: Secretaria de Estado de Meio Ambiente e Desenvolvimento, Sustentável do Estado de Goiás (SEMAD). 96pp.

Souza CM, Shimbo JZ, Rosa MR, Parente LL, Alencar AA, Rudorff BFT, Hasenack H, Matsumoto M, Ferreira LG, Souza-Filho PWM, Oliveira SW, Rocha WF, Fonseca AV, Marques CB, Diniz CG, Costa D, Monteiro D, Rosa ER, Vélez-Martin E, Weber EJ, Lenti FEB, Paternost FF, Pareyn FGC, Siqueira JV, Viera JL, Neto LCF, Saraiva MM, Sales MH, Salgado MPG, Vasconcelos R, Galano S, Mesquita VV, Azevedo T. 2020. Reconstructing three decades of land use and land cover changes in Brazilian Biomes with landsat archive and earth engine. Remote Sensing 12(17): 2735. https://doi.org/10.3390/rs12172735.

Thiers B. (2022. Continuously updated). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. http://sweetgum.nybg.org/science/ih/ [Accessed 23 January 2022].

Ţura D, Zmitrovich IV, Wasser SP, Nevo E. 2008. The genus *Stereum* in Israel. Mycotaxon 106: 109–126.

Welden AL. 1960. The Genus *Cymatoderma* (*Thelephoraceae*) in the Americas. Mycologia 52(6): 856–876. https://doi.org/10.2307/3755848.

ARTIGO 4

WOOD-INHABITING CORTICIOID AND POROID FUNGI (BASIDIOMYCOTA) FROM RESERVA ECOLÓGICA DA UNIVERSIDADE ESTADUAL DE GOIÁS, A REMNANT OF THE BRAZILIAN CERRADO

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Wood-inhabiting corticioid and poroid fungi (Basidiomycota) from Reserva Ecológica da Universidade Estadual de Goiás, a remnant of the Brazilian Cerrado

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Abstract – Corticioid and poroid fungi are traditional morphological groups composed of ligninolytic species. Due to their efficiency in wood decomposition process, many species have great ecological importance, especially in nutrient cycling, as well as for their biotechnological properties. Nevertheless, the knowledge of these fungi is scarce in many phytogeographic regions of Brazil, as is the case of the Cerrado, since mycodiversity studies in this biome are mainly focused on areas of the São Paulo state. Here we present the taxonomic inventory of corticioid and poroid fungi from the Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), a Cerrado remnant in Anápolis, Goiás, Brazil. The area is covered by three typical Cerrado landscapes (cerrado *stricto sensu*, mesophilic forest, and gallery forest), widely explored for scientific and educational purposes by the academic and regional community which seeks to learn about and preserve its biodiversity. Exsiccates deposited in the fungarium of the Universidade Estadual de Goiás (HUEG-Fungi) were analyzed. They are the result of collections made over 20 years, in approximately 103 ha of the reserve. Samples were characterized macro and microscopically and identified based on specialized literature. 51 species were recognized, which are distributed in 33 genera, 15 families, and five orders. Species were most frequent in forested areas and among them, six are new occurrence records for the Cerrado, nine for the Midwest region, and nine for the Goiás state. These results contribute to increase the knowledge of these fungi in the Cerrado, as well as geographic distribution, and show the relevance of preserving the reserve for the regional Funga representativity.

Keywords – Hymenochaetaceae, inventory, macrofungi, Polyporaceae, wood decayers.

Fungos corticioides e poroides (Basidiomycota) que habitam madeira da Reserva Ecológica da Universidade Estadual de Goiás, um remanescente do Cerrado Brasileiro

Resumo – Fungos corticioides e poroides são assim agrupados com base em aspectos morfológicos e compostos por espécies essencialmente lignícolas. Por sua eficiência no processo de decomposição da madeira, muitas espécies desses grupos apresentam grande importância ecológica, especialmente na ciclagem de nutrientes, além de propriedades para aplicações biotecnológicas. Entretanto, o conhecimento sobre esses fungos é escasso em algumas regiões fitogeográficas do Brasil, como é o caso do Cerrado, uma vez que os estudos da micodiversidade no bioma estão focados principalmente em áreas do estado de São Paulo. Portanto, aqui apresentamos o inventário taxonômico de fungos corticioides e poroides da Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), um remanescente de Cerrado no município de Anápolis, Goiás, Brasil. A área é formada por três fitofisionomias típicas do Cerrado (cerrado *stricto sensu*, mata mesófila e mata de galeria) e é amplamente explorada para fins científicos e educacionais pela comunidade acadêmica regional, que buscam conhecer e preservar sua biodiversidade. Foram analisadas exsicatas depositadas no fungário da Universidade Estadual de Goiás (HUEG-Fungos), cujo acervo é fruto de coletas realizadas ao longo de 20 anos nos cerca de 103 hectares da reserva. As amostras foram caracterizadas macro e microscopicamente e identificadas com base na literatura especializada. Foram reconhecidas 51 espécies, distribuídas em 33 gêneros, 15 famílias e cinco ordens. As espécies são mais frequentes em áreas de mata na reserva e entre elas seis configuram novos registros de ocorrência para o Cerrado, nove para região Centro-Oeste e nove para o estado de Goiás. Desse modo, esses resultados contribuem para ampliar o conhecimento desses fungos no Cerrado, assim como da distribuição geográfica das espécies, além de mostrar a importância da preservação da reserva para a representatividade da Funga regional.

Palavras-chave – Decompositores de madeira, Hymenochaetaceae, inventário, macrofungos, Polyporaceae.

Introduction

Brazil is a forest country, with approximately 58% of its territory covered by natural and planted forests (SNIF 2016). It is known that the large availability of woody resources in tropical forests promotes the presence of several species of macrofungi, as they are predominantly lignocellulolytic organisms (Zmitrovich et al. 2015, Medeiros et al. 2015).

Fungi that are associated with this substrate at some stage in their life cycle are named "wood-inhabiting fungi". The main diversity of wood-inhabiting fungi is represented by some groups of Basidiomycota (Zmitrovich et al. 2015). The decomposition of woody substrates by these fungi is possible due to enzyme production that degrades the constituents of wood (Lundell et al. 2010). For this reason, some species have been used in biotechnological processes to obtain new sources of bioproducts and in bioremediation activity (Salvachúa et al. 2013, Olicón-Hernández et al. 2017, Grassi et al. 2018, Wehaidy et al. 2018).

Within the phylum Basidiomycota, several groups are traditionally defined according to morphological criteria and life habits (Ghobad-Nejhad 2011). Among these are the corticioid and poroid fungi, which are characterized by annual or perennial, resupinate to stipitate basidiomata and exposed hymenium. The resupinated habit (usually) is characteristic of corticioid fungi, while the presence of pores (and variants) on the hymenium is found in poroid fungi (Ryvarden 2004, Larsson 2007). They have worldwide distribution (He et al. 2019) and in Brazil, they occur in all six biomes (Maia et al. 2015). Most of these occurrence records come from long-term surveys, inventories, research made in important remnants of these biomes, or environmental protection areas (conservation units) (Bononi et al. 2008, Drechsler-Santos et al. 2013, Motato-Vásquez et al. 2015, Bononi et al. 2017, Xavier et al. 2018).

In the Cerrado (Brazilian savanna), one of the richest and most threatened biomes in the world (Myers et al. 2000, Lahsen et al. 2016, Colli et al. 2020), inventories of corticioid and poroid fungi started in the 1960s, mainly focused on areas in the state of São Paulo (Fidalgo et al. 1965). Since that, research was conducted in other regions of the biome within the States of Goiás (Leonardo-Silva et al. 2020), Mato Grosso (Bononi et al. 2017) and Mato Grosso do Sul (Quevedo et al. 2012). However, the lack of species inventories in large areas leads to a significant gap in knowledge about the presence and distribution of the taxa.

Over two decades, collections have been made frequently in the Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), a remnant of Cerrado, located in Central Brazil. These samples are the result of academic-scientific activities carried out by both undergraduate and graduate students, also educational and recreational activities focused on environmental education for elementary school students. The collected species are presented in this study and compose the inventory of corticioid and poroid fungi from the REC-UEG, contributing to increase the knowledge about these fungi groups around the Cerrado and Midwest regions of Brazil.

Material and Methods

1. *Study area*

The REC-UEG is located in the Campus Central da Universidade Estadual de Goiás, Anápolis, Goiás, Brazil (Figure 1). It comprises 134 ha while 103 ha is covered by the reserve. The REC-UEG is limited by the University Campus (north), the agro-industrial district of Anápolis (south), rural properties and cargo airport (east), and clothing industries (west).

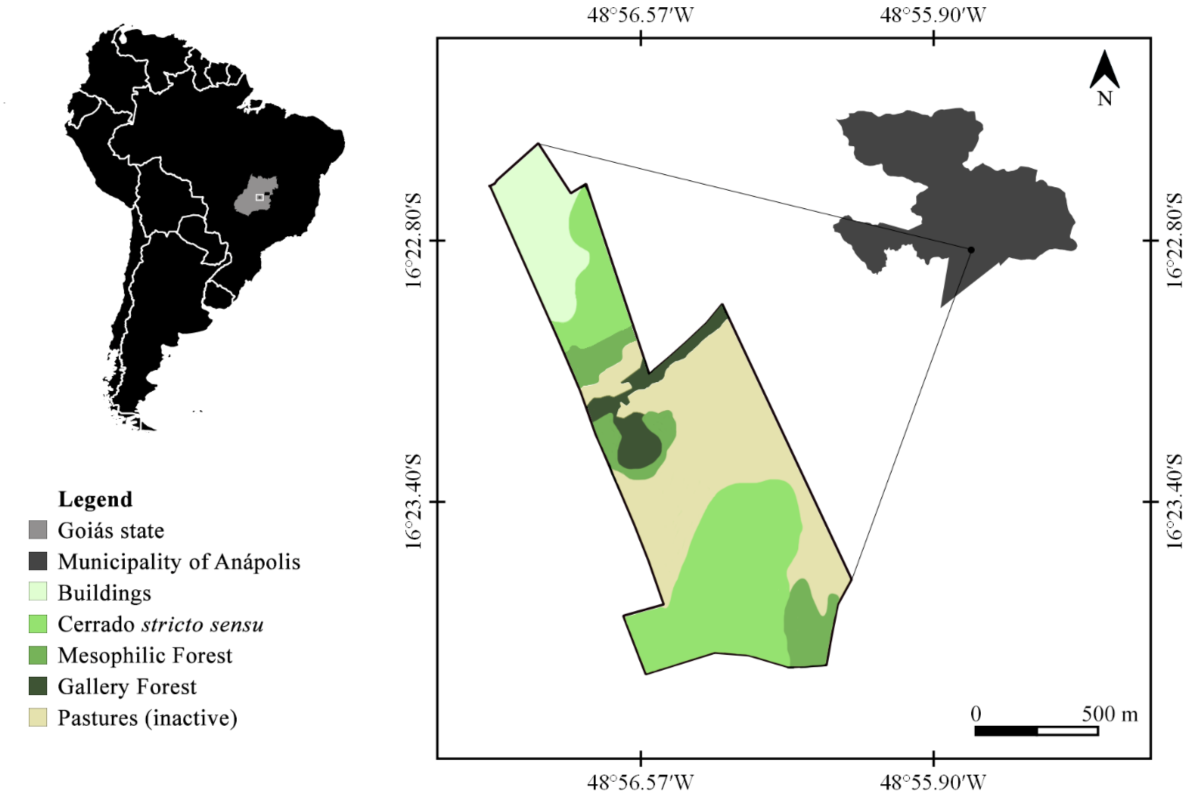

Figure 1. Location of the study area showing typical Cerrado vegetation where the samples were collected in the Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), Goiás, Brazil.

The region's weather is classified as tropical Cwb type according to Köppen-Geiger climate classification, with a dry cold season (April to September) and a rainy warm season (October to March). The average annual temperature is 25 °C, altitude between 1000 and 1200 m (Cardoso et al. 2014). The area is composed almost entirely of savanna native vegetation (cerrado *stricto sensu*) and forest type (mesophilic forest or semideciduous dry forest and gallery forest) (Figure 2), which Myrtaceae, Rubiaceae, Leguminosae, and Asteraceae are the most dominant families. The cerrado *stricto sensu* has a shrub-arboreal vegetation characteristic of the phytophysiognomy. The mesophilic forest is observed as denser vegetation, where plant species are predominant with various levels of deciduousness in the dry season and is not associated with watercourses. The gallery forest is also composed of dense vegetation and evergreen following small rivers and stream courses (Ribeiro & Walter 2008). Lastly, a vegetation corridor is formed over the Barreiro stream inside the reserve.

Due to the strong environmental impact and reduction of native biodiversity caused by anthropic actions, in 2016, an area management plan was proposed by UEG. Thus, the reserve represents a means to preserve and conserve local biodiversity, native vegetation, springs, and waterways in the area-encouraging academic-scientific activities; restoration of degraded areas, recompose native vegetation, and promote environmental education activities including both university community and the regional population.

2. *Data collection and analysis*

Collections were carried out randomly between 2001 and 2021, in and around REC-UEG. All basidiomata found in wood and leaf litter were photographed and we took information, such as substrate type (living or dead wood) and environment (phytophysiognomy). Preservation and herborization of collected material followed the standard techniques for fungi (Gadelha-Neto et al. 2013) and were deposited at the fungarium of the Universidade Estadual de Goiás (HUEG-Fungi) (Thiers 2021 [continuously updated]).

The dried material was identified taxonomically by macro and microscopic analysis using relevant taxonomic identification keys (Ryvarden 2001, Núñez & Ryvarden 2001, Ryvarden 2004, 2015, 2016, Ţura et al. 2008, Abrahão et al. 2009, Gomes-Silva et al. 2010, Nogueira-Melo et al. 2012, Zmitrovich et al. 2012, Gorjón 2020). For macroscopic characters, we considered the shape, consistency, texture, color, dimension, hymenophore morphology, and the number of pores per mm of basidiomata. For observations and measurements of microscopic characters, freehand sections were made from dried basidiomata and mounted in 2% potassium hydroxide (KOH) and 1% phloxine (Teixeira 1995). The hyphal system, basidia, basidiospores, and cystidia were observed in Olympus CX31 optical microscope while measurements were performed using the Piximètre software version 5.10 R 1541 (Henriot &

Cheype 2017). Melzer's reagent and cotton blue were used to test the amyloid or dextrinoid and cyanophilic reactions of the microscopic structures, respectively. The color classification was based on Kornerup & Wansher (1978). Nomenclature and classification system followed Index Fungorum (http://www.indexfungorum.org) and Mycobank (https://www.mycobank.org/) databases. Global Geographical distribution was based on recent literature, and, in Brazil, we used the List of Brazilian Algae, fungi, and plants (http://floradobrasil.jbrj.gov.br).

We performed the interpolation and extrapolation curve for the data for the area. The curve was based on specimen's abundance (Hill number q = 0; 95% confidence interval), and the extrapolation estimated for double sample size (Chao et al. 2014). The analysis was performed using the iNEXT package (Hsieh et al. 2016) in R software version 3.6.1 (R Core Team 2017) and RStudio environment version 1.2.1335 (RStudio Team, 2019).

Results

We found 253 specimens, 51 species, distributed in 33 genera, 15 families, and five orders (Figure 3). Polyporales (39 species) and Hymenochaetales (6 species) were the most representative orders, comprising 88% of the total. Polyporaceae was the most frequent family (47% of occurrences; 24 species), followed by Hymenochaetaceae (10%; 5 species), Ganodermataceae (8%; 4 species), and Panaceae (6%; 3 species). *Trametes* was the best-represented genus (12%; 6 species) and the most common species with 10 or more occurrences are *Funalia caperata*, *Lentinus berteroi* (both with 9.5%; 24 specimens), *Pycnoporus sanguineus* (8%; 20 specimens), *Coriolopsis floccosa*, *Favolus brasiliensis* (both with 6%; 15 specimens), *Hymenochaete rheicolor, Polyporus tricholoma* (both with 4.7%; 12 specimens), and *Hexagonia variegata* (4.3%; 11 specimens) (Figure 3). Six of the sampled species are new occurrences for the Cerrado, nine for the Midwest region, and nine for the State of Goiás. We observed that 98% of the species occurred in forest formations, and the rarefaction and extrapolation curve suggest that sampling in the area was satisfactory, although new collections indicate an increase in diversity (Figure 4).

Figure 2. Phytophysiognomies of the collection area in the rainy season of the Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), Goiás, Brazil. **A–C.** Cerrado *stricto sensu*. **D–F.** Mesophilic Forest. **G–I.** Gallery Forest.

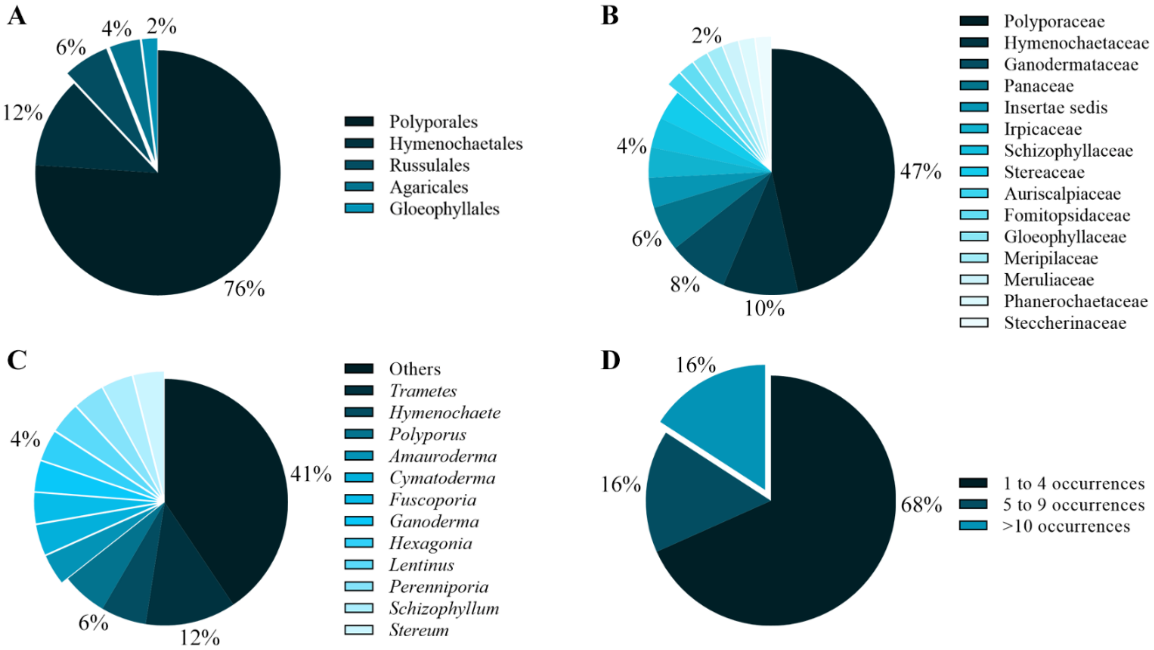

Figure 3. Distribution of corticoid and poroid fungi specimens recorded in the Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), Goiás, Brazil, according to order **(A)**, family **(B)**, genus **(C)** and occurrence **(D)**.

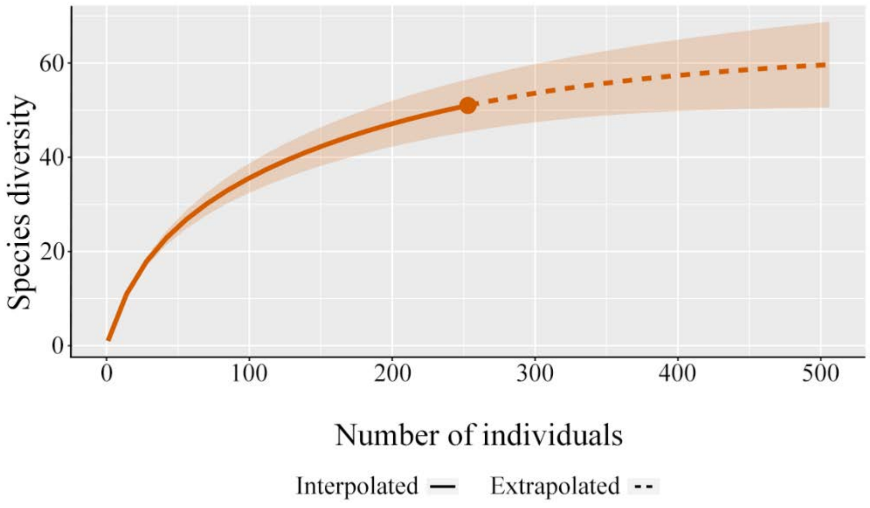

Figure 4. Accumulation curve and extrapolation with 95% confidence interval (shaded area) of corticoid and poroid fungi in the Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), Goiás, Brazil.

The list of corticioid and poroid fungi species occurring in the REC-UEG is described below. Following we provide data on substrates, occurring phytophysiognomy, and herbarium voucher of each species, as well as taxonomic remarks of those cited for the first time for the

Cerrado. A (*) before the name of the species indicates that the taxon is reported for the first time for the Cerrado, (**) Midwestern region, or Goiás state (***).

Agaricales
Schizophyllaceae

Schizophyllum commune Fr.
Description: Cooke (1961).
Substrate: dead wood.
Phytophysiognomy: gallery forest and mesophilic forest.
Material examined HUEG: 3989, 4721, 8126, 8133, 8606, 9615, 10646.

*****Schizophyllum umbrinum*** Berk.
Description: Cooke (1961).
Substrate: dead wood.
Phytophysiognomy: mesophilic forest.
Material examined HUEG: 8613.

Gloeophyllales
Gloeophyllaceae

Gloeophyllum striatum (Fr.) Murrill
Basionym: *Daedalea striata* Fr.
Description: Núñez & Ryvarden (2001).
Substrate: dead wood.
Phytophysiognomy: gallery forest.
Material examined HUEG: 159, 10799, 15108.

Hymenochaetales
Hymenochaetaceae

Fuscoporia callimorpha (Lév.) Groposo, Log.-Leite & Góes-Neto
Basionym: *Polyporus callimorphus* Lév.

Description: Groposo et al. (2007).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 8531, 8533, 8567, 10775.

Fuscoporia gilva (Schwein.) T. Wagner & M. Fisch.

Basionym: *Boletus gilvus* Schwein.

Description: Ryvarden (2004) as *Phellinus gilvus* (Schwein.) Pat.

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 4720, 8552.

*****Hymenochaete damicornis*** (Link) Lév.

Basionym: *Stereum damicorne* Link.

Description: Parmasto (2001).

Substrate: leaf litter.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 1573, 15109.

******Hymenochaete iodina*** (Mont.) Baltazar & Gibertoni

Basionym: *Polyporus iodinus* Mont.

Description: Ryvarden (2004) as *Cyclomyces iodinus* (Mont.) Pat.

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 4020, 10708.

Hymenochaete rheicolor (Mont.) Lév.

Basionym: *Stereum rheicolor* Mont.

Description: Parmasto (2001).

Substrate: living and dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4030, 9305, 10639, 14098, 14602, 14626, 14628, 14639, 14646, 14647, 15110, 15111.

Insertae sedis

Trichaptum perrottetii (Lév.) Ryvarden

Basionym: *Trametes perrottetii* Lév.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 10765.

Polyporales

Fomitopsidaceae

Daedalea ryvardeniana Drechsler-Santos & Robledo

Description: Drechsler-Santos et al. (2012).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4022, 4432, 4477, 4772, 4982, 10732.

Ganodermataceae

Amauroderma aurantiacum (Torrend) Gibertoni & Bernicchia

Basionym: *Ganoderma aurantiacum* Torrend.

Description: Ryvarden (2004).

Substrate: leaf litter.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 15126, 15127, 15128, 15129.

Amauroderma calcigenum (Berk.) Torrend

Basionym: *Polyporus calcigenus* Berk.

Description: Ryvarden (2004).

Substrate: leaf litter.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 10640, 15123, 15124, 15125.

Ganoderma multiplicatum (Mont.) Pat.

Basionym: *Polyporus multiplicatus* Mont.

Description: Ryvarden (2004).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 11881, 15134.

Ganoderma testaceum (Lév.) Pat.

Basionym: *Polyporus testaceus* Lév.

Description: Bhosle et al. (2010).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4367, 10659, 10685, 10781.

Insertae sedis

***Rickiopora latemarginata** (Rick) Westph., Tomšovský & Rajchenb. (Figure 5A).

Basionym: *Daedalea latemarginata* Rick

Description: Westphalen et al. (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 10643.

Remarks: The genus *Rickiopora* was described by Westphalen et al. (2016) to accommodate the species *Daedalea latemarginata* and *Antrodiella angulatopora*, previously considered synonymous (Rajchenberg 1987), in *R. latemarginata*. The species is characterized by pileate to effused-reflex basidiomata, rigid and curled when dried, poroid hymenophore with larger angular to irregular pores (2–4 per mm), sometimes forming daedaloid to hydnoid areas in old, dried specimens; monomitic to pseudo-dimitic hyphal system, and subglobose, hyaline, smooth, thin-walled basidiospores.

Our specimen was found only once in the collection area, even after years of sampling, growing on dead wood from an unidentified angiosperm. Currently, *R. latemarginata* is recorded in Argentina, Brazil, Costa Rica, and Venezuela (Rajchenberg 1987, Ryvarden 2015, Westphalen et al. 2016). Previously cited for Brazil in the Amazonia and Atlantic Forest biomes

(Maia et al. 2015, Motato-Vásquez et al. 2015), the occurrence in the present study is the first for the Cerrado.

Irpicaceae

Gloeoporus thelephoroides (Hook.) G. Cunn.

Basionym: *Boletus thelephoroides* Hook.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4010, 4717, 8524, 8525, 8560, 10730, 14631.

Vitreoporus dichrous (Fr.) Zmitr.

Basionym: *Polyporus dichrous* Fr.

Description: Ryvarden (2015) as *Gloeoporus dichrous* (Fr.) Bres.

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 4773, 10736.

Meripilaceae

Rigidoporus microporus (Sw.) Overeem

Basionym: *Boletus microporus* Sw.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 10798.

Meruliaceae

Climacodon pulcherrimus (Berk. & M.A. Curtis) Nikol. (Figure 5E, F).

Basionym: *Hydnum pulcherrimum* Berk. & M.A. Curtis

Description: Moreno et al. (2007).

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 10626.

Remarks: *Climacodon pulcherrimus* is characterized by the dimidate and flattened basidioma; pilear surface light orange (5A4), finely tomentose; hymenial surface light orange (5A4) becoming reddish orange (7A8) in some parts, hydnoid, spines up to 4 mm long, 2–5 per mm; basidiospores ellipsoid, hyaline, smooth, thin-walled (4) 4.6 – 5.6 (6.7) × (1.8) 2 – 3 (3.1) µm. We found our species strongly attached to decaying wood near the stream. Interestingly, after a long herborization period, some regions of the hymenial surface show darker regions (caramelized appearance). *Climacodon pulcherrimus* has a cosmopolitan distribution (Bononi 1979, Moreno et al. 2007) and, in Brazil, occurs in the Amazonia and Atlantic Forest biomes (Maia et al. 2015), and is now cited for the first time for the Cerrado.

Panaceae

Cymatoderma caperatum (Berk. & Mont.) D.A. Reid

Basionym: *Thelephora caperata* Berk. & Mont.

Description: Welden (1960).

Substrate: dead wood and leaf litter.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4003, 4099, 8582, 9307, 10619, 10766, 10767.

******Cymatoderma dendriticum*** (Pers.) D.A. Reid

Basionym: *Thelephora dendritica* Pers.

Description: Welden (1960).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 8568, 8576, 14634.

Panus strigellus (Berk.) Overh.

Basionym: *Lentinus strigellus* Berk.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 2245, 8614.

Phanerochaetaceae

******Phlebiopsis amethystea*** (Hjortstam & Ryvarden) Chikowski & C.R.S. Lira

Basionym: *Porostereum amethysteum* Hjortstam & Ryvarden

Description: Hjortstam & Ryvarden (1990).

Substrate: dead wood.

Material examined HUEG: 8138.

Polyporaceae

Coriolopsis floccosa (Jungh.) Ryvarden

Basionym: *Polyporus floccosus* Jungh.

Description: Ryvarden & Johansen (1980).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4034, 8129, 8130, 8523, 8538, 8547, 8550, 8556, 10707, 10718, 14567, 14576, 14580, 14582, 14601.

*****Earliella scabrosa*** (Pers.) Gilb. & Ryvarden

Basionym: *Polyporus scabrosus* Pers.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 1698, 3990, 3996.

*****Echinochaete brachypora*** (Mont.) Ryvarden

Basionym: *Polyporus brachyporus* Mont.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 10688.

Favolus brasiliensis (Fr.) Fr.

Basionym: *Daedalea brasiliensis* Fr.

Description: Palacio et al. (2021).

Substrate: living and dead wood.

Phytophysiognomy: cerrado *stricto sensu*, gallery forest, and mesophilic forest.

Material examined HUEG: 2230, 4775, 4974, 8124, 8520, 8534, 8569, 8580, 10630, 10652, 10743, 10768, 14094, 14622, 15112.

Fomes fasciatus (Sw.) Cooke

Basionym: *Boletus fasciatus* Sw.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 8546, 11435.

Funalia caperata (Berk.) Zmitr. & Malysheva

Basionym: *Polyporus caperatus* Berk.

Description: Ryvarden & Johansen (1980) as *Coriolopsis caperata* (Berk.) Murrill.

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 3994, 4031, 8526, 8528, 8548, 8551, 8558, 8559, 8563, 8573, 10616, 10723, 14569, 14572, 14574, 14575, 14588, 14591, 15115, 15116, 15117, 15118, 15119. 15120.

Hexagonia hydnoides (Sw.) M. Fidalgo

Basionym: *Boletus hydnoides* Sw.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 8147, 8154, 8156, 8157, 8541, 8555, 10627, 10722, 14624.

Hexagonia variegata Berk.

Description: Ryvarden (2015) as *H. papyracea* Berk.

Substrate: living and dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4774, 8127, 8536, 8544, 8564, 10699, 10734, 14155, 14640, 15113, 15114.

Lentinus berteroi (Fr.) Fr.

Basionym: *Agaricus berteroi* Fr.

Description: Ryvarden (2015).

Substrate: dead wood.

Phytophysiognomy: cerrado *stricto sensu*, gallery forest, and mesophilic forest.

Material examined HUEG: 4018, 4465, 4760, 4968, 8132, 8137, 8150, 8506, 8516, 8591, 8602, 10609, 10629, 10755, 10770, 10789, 11433, 14607, 14609, 14610, 14613, 14615, 14617, 14618.

Lentinus velutinus Fr.

Description: Ryvarden (2015).

Substrate: dead wood.

Material examined HUEG: 8530.

*****Microporellus obovatus*** (Jungh.) Ryvarden

Basionym: *Polyporus obovatus* Jungh.

Description: Ryvarden (2015) as *Flabellophora obovata* (Jungh.) Corner.

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 14632.

Neodictyopus dictyopus (Mont.) Palacio, Robledo & Drechsler-Santos

Basionym: *Polyporus dictyopus* Mont.

Description: Ryvarden (2016) as *Po. dictyopus.*

Substrate: living and dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 4724, 4747, 8532, 8578, 14092, 14592, 15122.

Remarks: *Polyporus dictyopus* was placed in *Neodictyopus* Palacio, Robledo, Reck & Drechsler-Santos based on morphological and phylogenetic analyses (Palacio et al. 2017), and recently transferred to *Picipes* Zmitr. & Kovalenko by Ji et al. (2022). Despite that, we will use *N. dictyopus* as the current name since Ji et al. (2022) did not include South American specimens of the specie in their analyses.

******Perenniporia martia*** (Berk.) Ryvarden

Basionym: *Polyporus martius* Berk.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 8549, 10645.

****Perenniporiella micropora*** (Ryvarden) Decock & Ryvarden (Figure 5G, H).

Basionym: *Perenniporia micropora* Ryvarden

Description: Decock & Ryvarden (2003).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 10641.

Remarks: The genus *Perenniporiella* was proposed in 2003 by Decock and Ryvarden segregated from *Perenniporia* Murrill (Decock & Ryvarden 2003). Currently, the genus has six species and *P. micropora* differs from the others by the thin, flexible, effused reflexed basidioma, smaller pores, circular to irregular, 8–10 per mm, and basidiospores globose, thick-walled (4.4) 4.5 – 5.6 (5.8) × (3) 3.1 – 4.4 (4.5) µm. The species has been recorded in Belize, Brazil, Costa Rica, Cuba, and Peru (Decock & Ryvarden 2003, Drechsler-Santos et al. 2015). In Brazil, it is cited for the Amazonia and Atlantic Forest biomes (Drechsler-Santos et al. 2015, Maia et al. 2015) and the occurrence reported here is the first for the Cerrado.

Polyporus guianensis Mont.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 8575, 8581, 9308, 14088, 14093, 15121.

****Polyporus leprieurii** Mont.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest and gallery forest.

Material examined HUEG: 2255, 4014.

Polyporus tricholoma Mont.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest

Material examined HUEG: 8565, 8566, 8570, 8579, 10642, 10667, 10716, 10759, 10795, 14099, 14598, 14599.

Pycnoporus sanguineus (L.) Murrill,

Basionym: *Boletus sanguineus* L.

Description: Ryvarden (2016).

Substrate: living and dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 8135, 8155, 8158, 8159, 8504, 8505, 8507, 8508, 8535, 8537, 8554, 10621, 10647, 10729, 10731, 10733, 10751, 10782, 10784, 14585.

******Trametes elegans*** (Spreng.) Fr.

Basionym: *Daedalea elegans* Spreng.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 8134, 8140, 8542, 10636, 14649.

****Trametes marianna*** (Pers.) Ryvarden (Figure 5K, L).

Basionym: *Polyporus mariannus* Pers.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: HUEG 10769.

Remarks: *Trametes marianna* is characterized by the pileate, flattened, semicircular to flabeliform basidioma; pilear surface light orange (5B4) to light brown (5D4), concentrically zoned with sulcate zones; hymenial surface greyish orange (5B3) to brownish orange (5C3), pores circular to irregular, 6–7 per mm; basidiospores cylindrical to ellipsoid, hyaline, smooth, thin-walled (6.5) 7.4 – 9.4 (10.2) × 4 – 5.1 (5.8) µm. A tropical species (Ryvarden 2016) and, in Brazil, occurs in Amazonia and Atlantic Forest biomes (Maia et al. 2015) and is now cited for the first time for the Cerrado.

Trametes pavonia (Hook.) Ryvarden

Basionym: *Boletus pavonius* Hook.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: gallery forest and mesophilic forest.

Material examined HUEG: 10735, 10739, 10791.

Remarks: *Trametes pavonia* (Hook.) Ryvarden is an illegitimate name because this binomial was already used since 1851: *T. pavonia* (Berk.) Fr [= *T. elegans* (Spreng.) Fr.]. Despite that, we have chosen to use the name since some authors have frequently used it as current. A new name should be proposed for the species after a review of the type material.

******Trametes polyzona*** (Pers.) Justo

Basionym: *Polyporus polyzonus* Pers.

Description: Núñez & Ryvarden (2001) as *Coriolopsis polyzona* (Pers.) Ryvarden.

Substrate: dead wood.

Material examined HUEG: 8128.

Trametes psila (Lloyd) Ryvarden (Figure 5I, J).

Basionym: *Fomes psila* Lloyd

Description: Nogueira-Melo et al. (2012) as *Coriolopsis psila* (Lloyd) Ryvarden.

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 4035, 10676.

Remarks: A dense layer of thick, matted, light orange (6A5) to reddish brown (8D4) tomentum covering the pileus and small pores (6–7 per mm) invisible to the naked eye on the hymenial surface are characteristic of the species. *Trametes psila* was described in 1915 by Lloyd as *Fomes psila* Lloyd from material collected in Brazil and, currently, it is also recorded in Mexico. In Brazil, its occurrence was known for the Amazon and Atlantic Forest biomes (Nogueira-Melo et al. 2012), and the record of the present study is the first for the Cerrado.

******Trametes versicolor*** (L.) Lloyd

Basionym: *Boletus versicolor* L.

Description: Ryvarden (2016).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 8131.

Steccherinaceae

Antrodiella versicutis (Berk. & M.A. Curtis) Gilb. & Ryvarden

Basionym: *Polyporus versicutis* Berk. & M.A. Curtis

Description: Ryvarden (2015).

Substrate: living wood.

Phytophysiognomy: gallery forest.

Material examined HUEG: 10625.

Russulales

Auriscalpiaceae

****Auriscalpium villipes*** (Lloyd) Snell & E.A. Dick (Figure 5B-D).

Basionym: *Hydnum villipes* Lloyd

Description: Ryvarden (2001).

Substrate: dead wood.

Phytophysiognomy: mesophilic forest.

Material examined HUEG: 14876.

Remarks: *Auriscalpium* is a genus described by Gray in 1821 based on *Hydnum auriscalpium* L. Currently, the genus comprises 10 widely distributed species, some of which are known to grow on pinecones (Ryvarden 2001, Wang & Yang 2019). Of these, *A. villipes* is characterized by the central or laterally stipitate basidioma, flabelliform to reniform pileus; pilear surface greyish orange (5B4) to light bown (5D5), velutine near the union with the stipe, becoming glabrous towards the margin; hymenial surface concolor to pilear surface, hydnoid, spines up to 80 mm long, stipe cylindrical, velutine to tomentose; dimitic hyphal system and basidiospores ellipsoid, hyaline and finely ornamented (3.8) 4.1 - 4.9 (5.1) × (3) 3.3 - 3.9 (4.3) µm. It is a species of neotropical distribution (Ryvarden 2001, Wang & Yang 2019) and the only one of the genus that occurs in Brazil. The records in the country come from studies carried out in the Atlantic Forest (Gibertoni et al. 2004), which is the first record for the Cerrado biome.

Stereaceae

*****Stereum hirsutum*** (Willd.) Pers.
Basionym: *Thelephora hirsuta* Willd.
Description: Ţura et al. (2008).
Substrate: dead wood.
Phytophysiognomy: mesophilic forest.
Material examined HUEG: 8522, 8561.

*****Stereum ostrea*** (Blume & T. Nees) Fr.
Basionym: *Thelephora ostrea* Blume & T. Nees
Description: Chamuris (1988).
Substrate: dead wood.
Material examined HUEG: 4098.

Discussion

The corticioid and poroid Funga of the Cerrado is historically recognized as one of the less studied in the country, a result of poor sampling efforts and few trained taxonomists in the region. According to our recent studies 223 species are known in the biome and the present inventory has about 19% of these species. Furthermore, these records add 24 new species known in Goiás and rank the State as the second richest in corticioid and poroid fungi in the Cerrado, just behind the State of São Paulo.

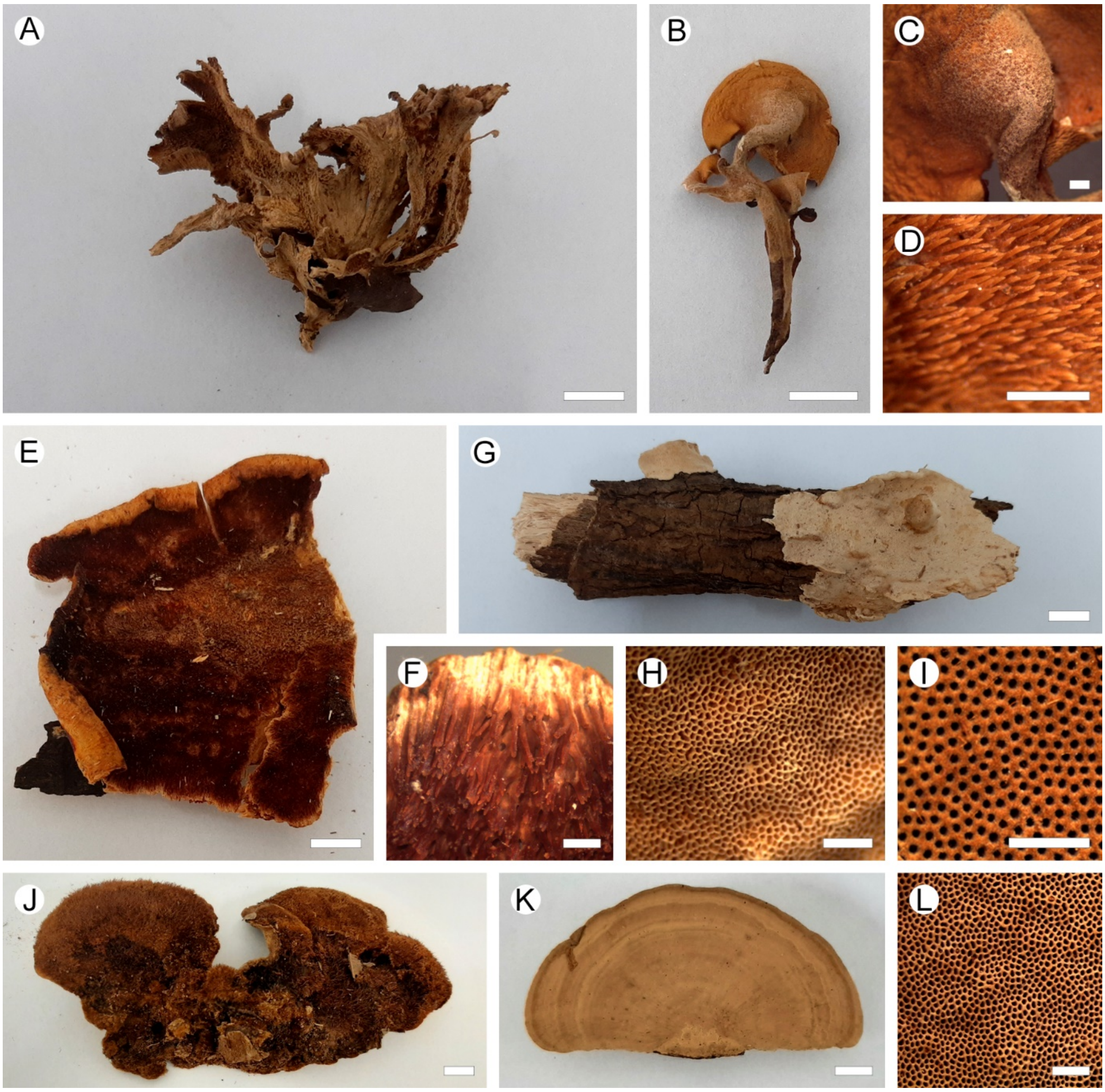

Figure 5. Species cited for the first time in the Cerrado. *Rickiopora latemarginata* **(A)**. *Auriscalpium villipes* **(B)** with velutine pilear surface near the union with the stipe **(C)** and hydnoid hymenial surface **(D)**. *Climacodon pulcherrimus* **(E)** and hydnoid hymenial surface **(F)**. *Perenniporiella micropora* **(G)** and poroid hymenial surface **(H)**. *Trametes psila* **(J)** and poroid hymenial surface **(I)**. *Trametes marianna* **(K)** and poroid hymenial surface **(L)**. Bar = 1 cm (A, B, E, G, J, K); 1 mm (C, D, F, H, I, L).

The diversity of these fungi groups in the REC-UEG is higher in the number of families, genera, and species than those recorded by other inventories of Cerrado macrofungi that included the same taxa (Quevedo et al. 2012, Bononi et al. 2017, Leonardo-Silva et al. 2020).

Although the area is formed by a fragment of the biome and part of it has been deforested by anthropic actions, its species richness may be influenced by the varied vegetation found in the Cerrado physiognomic forms, especially the forest formations, and the sampling period, showing the importance of long-term studies to evidence the regional diversity.

Although there is a wide variety of wood-inhabiting corticioid and poroid fungi species, most belong to the orders Hymenochaetales and Polyporales (Kirk et al. 2008). Both orders have species widely distributed worldwide and are known for their wood degrading ability (Lundell et al. 2010, He et al. 2019). These fungi obtain their energy demands by metabolizing the constituents of wood, living or dead, such as cellulose and lignin. This process is only possible due to the broad enzymatic profile of these species, evidencing the potential for biotechnological progression (Zmitrovich et al. 2015, El-Gendi et al. 2022). Currently, some genera and species found in the corticioid and poroid Funga of the REC-UEG are already considered as having potential for biotechnological processes. *Trametes* and *Polyporus* are largely used (or studied) for obtaining enzymes and degrading potential environmental pollutants (Cruz-Morató et al. 2013, Olicón-Hernández et al. 2017, Wehaidy et al. 2018). In addition, previous studies focusing on biotechnological aspects of some species from the reserve have shown potential results (Leonardo-Silva et al. 2018, Naves et al. 2019).

Species widely distributed in Brazil (Maia et al. 2015) also dominated the data recorded at the REC-UEG. On the other hand, 32% of the low-occurrence species in the area, including all the new records reported here, may be related to substrate specificity; production of inconspicuous basidiomata, especially the corticioid fungi; physiological and nutritional aspects of each species for basidioma development, which reduce their sampling on the field. The higher richness found in forest formations was expected since this vegetation presents ideal environmental conditions and varied substrate availability for fungi growth. Differently, the herbaceous vegetation of cerrado *stricto sensu* exposes the community to high temperatures, low humidity levels, and the entrance of winds, reducing the growth and colonization of species that are more sensitive to these climatic variations.

Although the REC-UEG suffers a strong environmental impact due to its location, it is still possible to observe expressive biodiversity that resists. Besides the richness of corticioid and poroid fungi that we reported, previous studies in the area also presented new occurrences for the Cerrado (Alvarenga & Xavier-Santos 2017, Camilo-Cotrim et al. 2020, Ferreira-Sá et al. 2023). Thus, the number of specimens collected over the years, as well as the species richness~~,~~ shows the importance of preservation for regional Funga representativeness. Ditto, it is necessary to establish measures to protect the area, which is also used as a didactic resource by graduate, undergraduate and elementary school students who carry out research activities and educational excursions. In addition, some species collected in the area have been identified, conserved *ex situ*, and represent part of the genetic and biotechnological heritage of the Cerrado.

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Data Availability

The data resulting from this research has been archived in the public data repository Biota Neotropica Dataverse: https://doi.org/10.48331/scielodata.ELHOOR.

Author Contributions

Lucas Leonardo-Silva: Substantial contribution in the concept and design of the study, to data collection, analysis, and interpretation; to manuscript preparation.

Geovane Pereira-Silva: Contribution to data collection, analysis, and interpretation.

Izabel Cristina Moreira: Contribution to data collection and manuscript preparation.

Robson Bernardo Silveira Silva: Contribution to data collection and manuscript preparation.

Solange Xavier-Santos: Substantial contribution in the concept and design of the study; Contribution to data collection and critical revision, adding intellectual content.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

References

ABRAHÃO, M.C., GUGLIOTTA, A.M. & GOMES, E. 2009. Poliporóides (Basidiomycota) em fragmentos de mata no perímetro urbano de São José do Rio Preto, São Paulo, Brasil. Revista Brasileira de Botânica 32(3):427–440.

ALVARENGA, R.L.M. & XAVIER-SANTOS, S. 2017. New records of Dacrymycetes (Fungi: Basidiomycota) from the Cerrado Biome (Brazilian Savanna) and Midwest Region, Brazil. Check List 13(4):335–342.

BHOSLE, S., RANADIVE, K., BAPAT, G., GARAD, S., DESHPANDE, G. & VAIDYA, J. 2010. Taxonomy and diversity of *Ganoderma* from the western parts of Maharashtra (India). Mycosphere 1(3):249–262.

BONONI, V.L. 1979. Basidiomicetos do Parque Estadual da Ilha do Cardoso: I. Espécies Hidnóides. Rickia 8:63–74.

BONONI, V.L. 1984. Basidiomicetos do Cerrado da Reserva Biológica de Moji-Guaçu, SP. Rickia1 11:1–25.

BONONI, V.L.R., OLIVEIRA, A.K.M., GUGLIOTTA, A.M. & QUEVEDO, J.R. 2017. Agaricomycetes (Basidiomycota, Fungi) diversity in a protected area in the Maracaju Mountains, in the Brazilian central region. Hoehnea 44(3):361–377.

BONONI, V.L.R., OLIVEIRA, A.K.M., QUEVEDO, J.R. & GUGLIOTTA, A.M. 2008. Fungos macroscópicos do Pantanal do Rio Negro, Mato Grosso do Sul, Brasil. Hoehnea 35(4):489–511.

CAMILO-COTRIM, C.F., LEONARDO-SILVA, L. & XAVIER-SANTOS, S. 2020. First records of *Myriostoma calongei* Baseia, Sousa & Martin (Geastraceae, Basidiomycota) in central Brazil. Check List 16(1):53–57.

CARDOSO, M.R.D., MARCUZZO, F.F.N. & BARROS, J.R. 2014. Climatic Classification of Köppen-Geiger for the State of Goias and Federal District. Acta Geográfica 8(16):40–55.

CHAMURIS, G.P. 1988. The non-stipitate steroid fungi in the Northeastern United States and adjacent Canada. Mycologia Memoir 141–247.

CHAO, A., GOTELLI, N.J., HSIEH, T.C., SANDER, E.L., MA, K.H., COLWELL, R.K. & ELLISON, A.M. 2014. Rarefaction and extrapolation with Hill numbers: a framework for sampling and estimation in species diversity studies. Ecological Monographs 84(1):45–67.

COLLI, G.R., VIEIRA, C.R. & DIANESE, J.C. 2020. Biodiversity and conservation of the Cerrado: recent advances and old challenges. Biodiversity and Conservation 29(5):1465–1475.

COOKE, W.M.B. 1961. The Genus *Schizophyllum*. Mycologia 53(6):575–599.

CRUZ-MORATÓ, C., FERRANDO-CLIMENT, L., RODRIGUEZ-MOZAZ, S., BARCELÓ, D., MARCO-URREA, E., VICENT, T. & SARRÀ, M. 2013. Degradation of pharmaceuticals in non-sterile urban wastewater by *Trametes versicolor* in a fluidized bed bioreactor. Water Research 47(14):5200–5210.

DECOCK, C. & RYVARDEN, L. 2003. *Perenniporiella* gen. nov. segregated from *Perenniporia*, including a key to neotropical *Perenniporia* species with pileate basidiomes. Mycological Research 107(1):93–103.

DRECHSLER-SANTOS, E.R., CAVALVANTI, M.A.Q., LOGUERCIO-LEITE, C. & ROBLEDO, G.L. 2012. On Neotropical *Daedalea* species: *Daedalea ryvardenica* sp. nov. Kurtziana 37(1):65–72.

DRECHSLER-SANTOS, E.R., RYVARDEN, L., BEZERRA, J.L., GIBERTONI, T.B., SALVADOR-MONTOYA, C.A. & CALVACANTI, M.A.Q. 2013. New records of Auriculariales, Hymenochaetales and Polyporales (Fungi: Agaricomycetes) for the Caatinga Biome. Check List 9(4):800–805.

DRECHSLER-SANTOS, R.E., SALVADOR-MONTOYA, C.A., ALVES-SILVA, G., FERNANDES, M., RECK, M., PALACIO, M., NUNES, P., ELIAS, S.G., BATISTELLA, D.A., SMIDERLE, E.C., MACHINER, M., KORPANBARBOSA, G.C. & BARBOSA, F.R. 2015. Macrofungos: aspectos preliminares sobre a diversidade de Basidiomycota. In Biodiversidade do Parque Estadual Cristalino Áttema, Sinop, Mato Grosso, p.54–67.

EL-GENDI, H., SALEH, A.K., BADIERAH, R., REDWAN, E.M., EL-MARADNY, Y.A. & EL-FAKHARANY, E.M. 2022. A Comprehensive Insight into Fungal Enzymes: Structure, Classification, and Their Role in Mankind’s Challenges. Journal of Fungi 8(1):23.

FERREIRA-SÁ, A.S., LEONARDO-SILVA, L., CORTEZ, V.G. & XAVIER-SANTOS, S. 2023. Second world record for two *Calvatia* species (Agaricaceae: Basidiomycota). Brazilian Journal of Biology 83:e247840.

FIDALGO, O., FIDALGO, M.E.P.K. & FURTADO, J.S. 1965. Fungi of the “Cerrado” region of São Paulo. Rickia 2:55–71.

GADELHA-NETO, P.C.G., BARBOSA, M.R.V., MENEZES, M., WARTCHOW, F., LIMA, J.R., BARBOSA, M.A., PÔRTO, K.C., GIBERTONI, T.B., PEIXOTO, A.L. & MAIA, L.C. 2013. Manual de procedimentos para herbários. Editora UFPE, Pernambuco, Recife.

GHOBAD-NEJHAD, M. 2011. Updated checklist of corticioid and poroid basidiomycetes of the Caucasus region. Mycotaxon 117(1): 508.

GIBERTONI, T.B., RYVARDEN, L. & CAVALCANTI, M.A.Q. 2004. New records of Aphyllophorales (Basidiomycota) in the Atlantic Rain Forest in Northeast Brazil. Acta Botanica Brasilica 18(4):975–979.

GOMES-SILVA, A.C., RYVARDEN, L. & GIBERTONI, T.B. 2010. Notes on *Trametes* from the Brazilian Amazonia. Mycotaxon 113(1):61–71.

GRASSI, E., ROBLEDO, G. & LEVIN, L. 2018. Influence of light on lignin-degrading activities of fungal genus *Polyporus* s. str. Journal of Basic Microbiology 58(11):947–956.

GROPOSO, C., LOGUERCIO-LEITE, C. & GÓES-NETO, A. 2007. *Fuscoporia* (Basidiomycota, Hymenochaetales) in Southern Brazil. Mycotaxon 101:55–63.

HE, M.Q. et al. 2019. Notes, outline and divergence times of Basidiomycota. Fungal Diversity 99(1):105–367.

HENRIOT, A. & CHEYPE, J.L. 2017. Piximètre, la measure des dimensions sur images. http://www.piximetre.fr. (last access in 25 may 2022).

HJORTSTAM, K. & RYVARDEN, L. 1990. *Lopharia* and *Porostereum* (Corticiaceae). Fungiflora, Oslo, Norway.

HSIEH, T.C., MA, K.H. & CHAO, A. 2016. iNEXT: an R package for rarefaction and extrapolation of species diversity (Hill numbers). Methods in Ecology and Evolution 7(12):1451–1456.

KIRK, P.M., CANNON, P.F., MINTER, D.W. & STALPERS, J.A. 2008. Dictionary of the Fungi. 10 ed. CABI, Wallingford, UK.

KORNERUP, A. & WANSHER, J.H. 1978. Handbook of colour. 3 ed. Eyre Methuen, London.

JI, X., ZHOU, J.L., SONG, C.G., XU, T.M., WU, D.M. & CUI, B.K. 2022. Taxonomy, phylogeny and divergence times of *Polyporus* (Basidiomycota) and related genera. Mycosphere 13(1): 1–52.

LAHSEN, M., BUSTAMANTE, M.M.C. & DALLA-NORA, E.L. 2016. Undervaluing and Overexploiting the Brazilian Cerrado at Our Peril. Environment: Science and Policy for Sustainable Development 58(6):4–15.

LARSSON, K.-H. 2007. Re-thinking the classification of corticioid fungi. Mycological Research 111(9):1040–1063.

LEONARDO-SILVA, L., MOREIRA, I.C., SILVA, T.M., SILVA, L.B., SANTOS, T.A.A., OLIVEIRA, L.M., SOUZA, D.F., BRITO, A.O. & XAVIER-SANTOS, S. 2018. Bioprospecção de Fungos de um Fragmento de Cerrado no Brasil Central para Aplicações Biotecnológicas. Fronteiras: Journal of Social, Technological and Environmental Science 7(1):288–305.

LEONARDO-SILVA, L., SILVA, L.B. & XAVIER-SANTOS, S. 2020. Poroid fungi (Agaricomycetes, Basidiomycota) from Floresta Nacional de Silvânia – a conservation unit of Brazilian Savanna. Microbial Biosystems 5(1):100–107.

LUNDELL, T.K., MÄKELÄ, M.R. & HILDÉN, K. 2010. Lignin-modifying enzymes in filamentous basidiomycetes - ecological, functional and phylogenetic review. Journal of Basic Microbiology 50(1):5–20.

MAIA, L.C. et al. 2015. Diversity of Brazilian fungi. Rodriguesia 66(4):1033–1045.

MEDEIROS, P.S., CATTANIO, J.H. & SOTÃO, M.P. 2015. Riqueza e relação dos fungos poroides lignolíticos (Agaricomycetes) com o substrato em floresta da Amazônia brasileira. Boletim do Museu Paraense Emílio Goeldi - Ciências Naturais 10(3):423–436.

MORENO, G., BLANCO, M.N., OLARIAGA, I. & CHECA, J. 2007. *Climacodon pulcherrimus* a badly known tropical species, present in Europe. Cryptogamie, Mycologie 28(1):3–11.

MOTATO-VÁSQUEZ, V., PIRES, R.M. & GUGLIOTTA, A.M. 2015. Polypores from an Atlantic rainforest area in southeast Brazil: pileate species. Brazilian Journal of Botany 38(1):149–164.

MYERS, N., MITTERMEIER, R.A., MITTERMEIER, C.G., FONSECA, G.A.B. & KENT, J. 2000. Biodiversity hotspots for conservation priorities. Nature 403(6772):853–858.

NAVES, L.R., LEONARDO-SILVA, L., CUNHA, E.L., ALMEIDA, V.F.R., SÁ, A.S.F., SENA, B.L., MOREIRA, I.C. & XAVIER-SANTOS, S. 2019. Filamentous fungi as promising agents for the biodegradation of biosolids compounds. Fronteiras: Journal of Social, Technological and Environmental Science 8(2):35–51.

NOGUEIRA-MELO, G.S., MEDEIROS, P.S., GOMES-SILVA, A.C., RYVARDEN, L., SOTÃO, H.M.P. & GIBERTONI, T.B. 2012. *Coriolopsis psila* comb. nov. (Agaricomycetes) and two new *Coriolopsis* records for Brazil. Mycotaxon 120(1):223–230.

NÚÑEZ, M. & RYVARDEN, L. 2001. East Asian Polypores 2. Polyporaceae s. lato. Synopsis Fungorum 14:166–574.

OLICÓN-HERNÁNDEZ, D.R., GONZÁLEZ-LÓPEZ, J. & ARANDA, E. 2017. Overview on the biochemical potential of filamentous fungi to degrade pharmaceutical compounds. Frontiers in Microbiology 8:1–17.

PALACIO, M., DRECHSLER-SANTOS E.R., MENOLLI JÚNIOR, N. & SILVEIRA, R.M.B. 2021. An overview of *Favolus* from the Neotropics, including four new species. Mycologia 113(4):759 –775.

PALACIO, M., ROBLEDO, G.L., RECK, M.A., GRASSI, E., GÓES-NETO, A., & DRECHSLER-SANTOS, E.R. 2017. Decrypting the *Polyporus dictyopus* complex: Recovery of *Atroporus* Ryvarden and segregation of *Neodictyopus* gen. nov. (Polyporales, Basidiomyocta). Plos one 12(10): e0186183.

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

QUEVEDO, J.R., BONONI, V.L.R., OLIVEIRA, A.K.M. & GUGLIOTTA, A.D.M. 2012. Agaricomycetes (Basidiomycota) em um fragmento florestal urbano na cidade de Campo Grande, Mato Grosso do Sul, Brasil. Revista Brasileira de Biociências 10(4):430–438.

R CORE TEAM. 2017. A language and environment for statistical computing, Version 3.6.1. R Foundation for Statistical Computing.

RAJCHENBERG, M. 1987. Type studies of Polyporaceae (Aphyllophorales) described by J. Rick. Nordic Journal of Botany 7(5):553–568.

RIBEIRO, J.F. & WALTER, B.M.T. 2008. As principais fitofisionomias do bioma Cerrado. In Cerrado: ecologia e flora (S.M. Sano, S.P. Almeida & J.F. Ribeiro, eds). Embrapa, Planaltina. p.151–212.

RSTUDIO TEAM. 2019. RStudio: Integrated Development for R, Version 1.2.1335. RStudio, PBC.

RYVARDEN, L. 2001. The genus *Auriscalpium*. Harvard Papers in Botany 6(1):193–198.

RYVARDEN, L. 2004. Neotropical polypores Part 1. Introduction, Ganodermataceae & Hymenochaetaceae. Synopsis Fungorum 19:1–238.

RYVARDEN, L. 2015. Neotropical Polypores Part 2. Polyporaceae. Abortiporus-Nigroporus. Synopsis Fungorum 34: 232–443.

RYVARDEN, L. 2016. Neotropical polypores Part 3. Polyporaceae. Obba-Wrightoporia. Synopsis Fungorum 36: 447–613.

RYVARDEN, L. & JOHANSEN, I. 1980. A preliminary Polypore flora of East Africa. Fungiflora, Oslo.

SALVACHÚA, D., PRIETO, A., MARTÍNEZ, Á.T. & MARTÍNEZ, M.J. 2013. Characterization of a novel dye-decolorizing peroxidase (DyP)-type enzyme from *Irpex lacteus* and its application in enzymatic hydrolysis of wheat straw. Applied and Environmental Microbiology 79(14):4316–4324.

SNIF. 2016. Sistema nacional de informações florestais. Serviço florestal brasileiro, Brasília.

TEIXEIRA, A.R. 1995. Métodos para estudo das hifas do basidiocarpo de fungos poliporáceos. São Paulo, Instituto de Botânica, p. 22.

THIERS, B. 2021. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. http://sweetgum.nybg.org/science/ih/.

ŢURA, D., ZMITROVICH, I.V., WASSER, S.P. & NEVO, E. 2008. The genus *Stereum* in Israel. Mycotaxon 106:109–126.

WANG, P.M. & YANG, Z.L. 2019. Two new taxa of the *Auriscalpium vulgare* species complex with substrate preferences. Mycological Progress 18(5):641–652.

WEHAIDY, H., EL-HENNAWI, H., AHMED, S. & ABDEL-NABY, M. 2018. Comparative study on crude and partially purified laccase from *Polyporus durus* ATCC 26726 in the decolorization of textile dyes and wastewater treatment. Egyptian Pharmaceutical Journal 17(2):94.

WELDEN, A.L. 1960. The Genus *Cymatoderma* (Thelephoraceae) in the Americas. Mycologia 52(6):856–876.

WESTPHALEN, M.C., RAJCHENBERG, M., TOMŠOVSKÝ, M. & GUGLIOTTA, A.M. 2016. Extensive characterization of the new genus *Rickiopora* (Polyporales). Fungal Biology 120(8):1002–1009.

XAVIER, W.K.S., SOTÃO, H.M.P., SOARES, A.M.S., GIBERTONI, T.B., RODRIGUES, F.J. & RYVARDEN, L. 2018. Riqueza de Agaricomycetes poroides da Serra do Navio, Amazônia oriental, com novo registro de *Oxyporus lacera* para o Brasil. Boletim Do Museu Paraense Emílio Goeldi - Ciências Naturais 13(3):303–315.

ZMITROVICH, I.V., EZHOV, O.N. & WASSER, S.P. 2012. A survey of species of genus *Trametes* Fr. (higher Basidiomycetes) with estimation of their medicinal source potential. International Journal of Medicinal Mushrooms 14(3):307–319.

ZMITROVICH, I.V., WASSER, S.P. & TURA, D. 2015. Wood-inhabiting fungi. In fungi from different substrates (J. K. Misra, J. P. Tewari, S. K. Deshmukh, C. V, & Ágvölgyi, eds) CRC press, p.17–74.

CAPÍTULO III

AMPLIANDO A DIVERSIDADE DE FUNGOS CORTICIOIDES E POROIDES, COM A DESCRIÇÃO DE UMA NOVA ESPÉCIE E NOVOS REGISTROS DE OCORRÊNCIA

ARTIGO 5

FURTADOMYCES NOM. NOV. (*GANODERMATACEAE*, *BASIDIOMYCOTA*) WITH DESCRIPTION OF *F. SUMPTUOSUS*, A NEW SPECIES OF GANODERMATOID FUNGI FROM BRAZIL

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***Furtadomyces* nom. nov. (*Ganodermataceae, Basidiomycota*) with description of *F. sumptuosus*, a new species of ganodermatoid fungi from Brazil**

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Abstract – Based on morphological and phylogenetic evidence, a new species of ganodermatoid fungi is recorded and described from the Brazilian Cerrado. After the species was placed in *Furtadoa*, this genus name was declared an illegitimate homonym by the Index Fungorum and MycoBank databases, according to Art. 53.1 of the International Code of Nomenclature for algae, fungi and plants, thus requiring the need to replace *Furtadoa*. Therefore, *Furtadomyces* is proposed as the new name for the genus. The new species *Furtadomyces sumptuosus* is characterized by the combination of large basidiomata, multiple pilei, presence of radial striae on the pilear surface, an involute margin exposing the pore surface, and large, subglobose to ellipsoid (7.2–) 9.1–11.2 (–13.3) × (6.6–) 7.1–8.8 (–10.4) µm, double-walled basidiospores. It is closely related to *Furtadoa biseptata*, evidenced morphologically by the presence of two different septa in the generative hyphae of the context. Phylogeny, morphological description, illustrations, and comments for *F. sumptuosus* are presented, as well as two new combinations in *Furtadomyces: F. biseptatus* and *F. brasiliensis.*

Keywords – *Agaricomycetes, Amauroderma* s. lat., ITS, partial LSU, Neotropics, phylogeny.

Introduction

Ganodermataceae (*Polyporales*, *Basidiomycota*) comprises a diverse group with ecologically variable species, mainly characterized by the presence of double-walled basidiospores with the inner layer ornamented (ganodermatoid basidiospores) (Ryvarden 2004; Costa-Rezende et al. 2017). Members of this family have a worldwide distribution and are essential components of biodiversity, playing a role in the decomposition of woody components (Ryvarden 2004; Hapuarachchi et al. 2019).

Since the first formal description of the *Ganodermataceae* by Donk in 1948, morphological and phylogenetic analyses provided more accurate identification and contributed to the definition of the taxonomic status of the genera in the family (Jülich 1981; Ryvarden 2004; Justo et al. 2017; Costa-Rezende et al. 2017, 2020; Sun et al. 2020). Thus, 12 genera are currently accepted within *Ganodermataceae*: *Amauroderma* Murrill, *Amaurodermellus* Costa-Rezende, Drechsler-Santos & Góes-Neto, *Cristataspora* Robledo & Costa-Rezende, *Foraminispora* Robledo, Costa-Rezende & Drechsler-Santos, *Furtadoa* Costa-Rezende, Robledo & Drechsler-Santos, *Ganoderma* P. Karst., *Haddowia* Steyaert, *Humphreya* Steyaert, *Magoderna* Steyaert, *Sanguinoderma* Y.F. Sun, D.H. Costa & B.K. Cui, *Tomophagus* Murrill and *Trachyderma* (Imazeki) Imazeki (Imazeki 1952; Steyaert 1972; Ryvarden 2004; Costa-Rezende et al. 2017, 2020; Sun et al. 2020).

Amauroderma accommodates tropical, neotropical, and subtropical species. They are usually characterized by annual and stipitate to sessile basidiomata, dimitic to trimitic hyphal system, globose to ellipsoid basidiospores that are not truncate and with rarely smooth, ornamented endospores (Ryvarden 2004; Costa-Rezende et al. 2017; Sun et al. 2020). The genus has been pointed to as polyphyletic (Gomes-Silva et al. 2015), but recent studies have shown that several species previously considered as *Amauroderma*, represent new genera: *Amaurodermellus*, *Foraminispora, Furtadoa,* and *Sanguinoderma* (Costa-Rezende et al. 2017, 2020; Sun et al. 2020).

Furtadoa was established by Costa-Rezende et al. (2017) to accommodate three species: *F. biseptata* Costa-Rezende, Drechsler-Santos & Reck (genus type), *F. brasiliensis* (Singer) Costa-Rezende, Robledo & Drechsler-Santos and *F. corneri* (Gulaid & Ryvarden) Robledo & Costa-Rezende. *Furtadoa* has a neotropical distribution and is distinguished from *Amauroderma* s. lat by presenting a monomitic context (Costa-Rezende et al. 2017). However, the name *Furtadoa* is illegitimate according to Art. 53.1 in the International Code of

Nomenclature for algae, fungi, and plants (Turland et al. 2018), since it is a plant genus described in 1963, thus demanding its replacement.

As part of the inventory of Brazilian poroid fungi, one new species of *Ganodermataceae* with conspicuous and sumptuous basidiomata was found in areas of the Cerrado phytogeographic region (Colli et al. 2020). Based on morphological and phylogenetic evidence, this species was established as a member of the genus *Furtadomyces*, a new name proposed to replace *Furtadoa*. Here, we provide a detailed description and illustrations of the new species as well as two new combinations*:* *F. biseptatus* and *F. brasiliensis.*

Materials and methods

Sampled area and morphological studies

The current study was based on a specimen collected in 2019 during a survey of poroid fungi diversity in the Brazilian Cerrado. The area is located in the Floresta Nacional de Silvânia, an important conservation unit of the Cerrado biome within the municipality of Silvânia, Goiás (16º 38' 30.0" S, 48º 39' 02.5" W; 900 m). At present, the area comprises approximately 486.37 ha, with an average temperature of 26 ºC and two well-defined seasons: the wet season from October to March and the dry season from April to September. The area is composed of typical Cerrado vegetation, which ranges from grassland, savanna, and forest formations (MMA 2015).

Macroscopic characteristics and measures of fresh specimens were recorded in the field and the sample was deposited in the fungarium of the Universidade Estadual de Goiás (HUEG) (Thiers 2021 [continuously updated]). Microscopic analyses were made from dried material with 3% KOH and 1% phloxine solution. Cotton blue was used to check cyanophily (CB+) or its absence (CB−). Melzer’s reagent was used to verify amyloidicity or dextrinoidicity (IKI+) or their absence (IKI−). Sections of the basidioma were incubated at 40 ºC in 3% NaOH solution and mounted on microscope slides with a drop of 3% NaOH solution for analyses of the hyphal system (Decock et al. 2013). The color indication for all evaluated characters was based on Kornerup and Wansher (1978) color cards. All microscopic structures were observed with an Olympus CX31 optical microscope (OM) (1000x) magnification and the measurements were performed using the Piximètre software version 5.10 R 1541 (Henriot and Cheype 2017). Abbreviations used for measurements are as follows: Q = quotient between length and width, Qm = medium value of Q, N = number of measured structures. Basidiospores were also observed using Scanning Electron Microscopy (SEM) JSM – 6610 (Jeol, Tokyo, Japan) at the

Laboratório Multiusuários de Microscopia de Alta Resolução (LabMic) of the Universidade Federal de Goiás to observe the ornamentation in detail.

DNA extraction, amplification, and sequencing

Total DNA was extracted from small pieces of dried basidioma according to Doyle and Doyle (1987) modified by Góes-Neto et al. (2005). In addition, NaAc 3M pH 5.4 was used before being washed with 70% EtOH for pigment removal. Amplification of the internal transcribed spacer regions (ITS) and large subunit of nuclear ribosomal RNA gene (nLSU) regions were performed using the ITS5/ITS4 (White et al. 1990) and LR0R/LR5 (Vilgalys and Hester 1990) primer pairs, respectively. The polymerase chain reaction (PCR) thermocycling protocol (for both ITS and nLSU) used the following parameters: an initial denaturation step at 95 °C for 5 min, followed by 35 cycles of denaturation at 95 °C for 30 s, annealing at 55 °C for 30 s, and extension at 72 °C for 1 min; the reaction ended with a final extension of 7 min at 72 °C and storage to 4 °C. The PCR products were purified and sequenced with the same primers used in the amplification performed in an Applied Biosystems 3730xl DNA Analyzer (MacroGen Ltd., South Korea).

Phylogenetic analyses

Sequence chromatograms were assembled and edited using Staden Package 2.0 software (Staden et al. 1998), and the consensus sequences were combined with sequences deposited in GenBank database using BLAST (http://blast.ncbi.nlm.nih.gov/). GenBank sequences with high similarity and others available in the literature were retrieved and aligned with those in the present study using the online version of MAFFT, under the G-INS-i criteria. *Perenniporiella chaquenia* Robledo & Decock and *P. pendula* Decock & Ryvarden were used as an outgroup in phylogenetic analyses following Costa-Rezende et al. (2017) and Sun et al. (2020). The sequences were manually inspected and adjusted using MEGA v. 6 (Tamura et al. 2013). Sequences generated in this study were deposited in the GenBank (ITS = MZ577572, nLSU = MZ577577) and all sequence used in the analysis are available in Table 1.

Phylogenetic trees were constructed using ITS and nLSU rDNA sequences. The phylogenetic analyses were inferred with Maximum Likelihood (ML) and Bayesian Inference (BI) methods under the GTR + GAMMA substitution model estimated based on the Akaike Information Criterion (AIC) using W-IQ-TREE (Kalyaanamoorthy et al. 2017). ML analysis was conducted in W-IQ-TREE (Trifinopoulos et al. 2016), with branch support (BS) determined by 1000 rapid bootstrap replicates and ultrafast bootstrap (UB) (Hoang et al. 2018). BI was performed in MrBayes 3.2 (Ronquist and Huelsenbeck 2003) with two independent runs, each one beginning from random trees with four simultaneous independent chains, performing 10 million generations, sampling one tree every 10000 generations until the average standard deviation of the split frequencies dropped below 0.01. The convergence of the runs was checked using TRACER v1.7.1 (Rambaut et al. 2018) and the first 25% of the resulting trees were discarded as burn-in, and Bayesian posterior probabilities (PP) were calculated from the remaining sampled trees. Statistical support for branches was considered strongly supported with BS and UB ≥70% and PP ≥ 0.95.

Table 1. Species, vouchers, origin and GenBank accession numbers of sequences used in phylogenetic analyses. The sequences obtained in this study are marked in bold.

Taxa	Voucher	Origin	GenBank accession no.		Reference
			ITS	nc LSU	
Amauroderma aurantiacum	FLOR 52205	Brazil	KR816510	KU315205	Costa-Rezende et al. (2016)
A. aurantiacum	DHCR 540 (HUEFS)	Brazil	MF409961	MF409953	Costa-Rezende et al. (2017)
A. calcigenum	URM 86847	Brazil	KT006601	-	Gomes-Silva et al. (2015)
A. calcigenum	URM 83864	Brazil	JX982565	-	Gomes-Silva et al. (2015)
A. calcitum	FLOR 50931	Brazil	KR816528	KU315207	Costa-Rezende et al. (2016)
A. calcitum	FLOR 52230	Brazil	KR816529	-	Costa-Rezende et al.(2016)
A. camerarium	FLOR 52216	Brazil	KR816509	-	Costa-Rezende et al.(2016)
A. camerarium	FLOR 52169	Brazil	KR816523	-	Costa-Rezende et al.(2016)
A. elegantissimum	URM83822	Brazil	MK119795	MK119873	Sun et al. (2020)
A. elegantissimum	URM 82789	Brazil	JX310844	KT006617	Gomes-Silva et al. (2015)
A. exile	URM 82794	Brazil	JX310845		Gomes-Silva et al. (2015)
A. exile	URM 89226	Brazil	MK119796	MK119874	Sun et al. (2020)
A. floriformum	URM 83250	Brazil	JX310846	-	Gomes-Silva et al. (2015)
A. laccatostiptatum	URM 83238	Brazil	JX310847	-	Gomes-Silva et al. (2015)
A. omphalodes	DHCR 499 (HUEFS)	Brazil	MF409956	MF409951	Costa-Rezende et al. (2017)
A. omphalodes	DHCR 500 (HUEFS)	Brazil	MF409957	MF409952	Costa-Rezende et al. (2017)
A. robledoi	FLOR 52249	Brazil	KR816511	-	Costa-Rezende et al. (2016)
A. robledoi	URM 84230	Brazil	KC348461	-	GenBank
A. schomburgkii	URM 89225	Brazil	MK119805	MK119883	Sun et al. (2020)
A. schomburgkii	URM 89273	Brazil	MK119804	MK119882	Sun et al. (2020)
A. subsessile	URM 89295	Brazil	MK119808	MK119887	Sun et al. (2020)
A. subsessile	URM 83239	Brazil	JX310860	-	Gomes-Silva et al. (2015)
Amaurodermellus ovisporum	DHCR 546 (HUEFS)	Brazil	MN077528	-	Costa-Rezende et al. (2020)
Am. ovisporum	DHCR 547 (HUEFS)	Brazil	MN077527	MN077553	Costa-Rezende et al. (2020)
Bresadolia craterella	CR 001	USA	MT196970	-	GenBank
Cristataspora coffeata	Robledo 3182 (FCOS)	Brazil	MN077525	MN077559	Costa-Rezende et al. (2020)
C. coffeata	Robledo 3183 (FCOS)	Brazil	MN077526	MN077560	Costa-Rezende et al. (2020)
C. flavipora	Robledo 3288 (FCOS)	Brazil	MN077521	MN077555	Costa-Rezende et al. (2020)
Foraminispora austrosinensis	Cui 14318	China	MK119810	MK119889	Sun et al. (2020)
F. austrosinensis	Cui 14319	China	MK119811	MK119890	Sun et al. (2020)
F. concentrica	Cui 12644	China	MK119812	MK119891	Sun et al. (2020)
F. concentrica	Cui 12646	China	MK119813	MK119892	Sun et al. (2020)
F. rugosa	DHCR 554 (HUEFS)	Brazil	MF409962	MF409954	Costa-Rezende et al. (2017)
F. rugosa	DHCR 560 (HUEFS)	Brazil	MF409963	MF409955	Costa-Rezende et al. (2017)
F. yinggelingensis	Cui 13618	China	MK119821	MK119900	Sun et al. (2020)
F. yinggelingensis	Cui 13630	China	MK119822	MK119901	Sun et al. (2020)

Table 1 (continued)

Taxa	Voucher	Origin	GenBank accession no.		Reference
			ITS	ITS	
F. yunnanense	Cui 7974	China	KJ531653	KU220013	Li and Yuan (2015)
F. yunnanense	Dai 13021	China	KJ531654	-	GenBank
Furtadomyces biseptatus	FLOR 50932	Brazil	KU315196	KU315206	Costa-Rezende et al. (2016)
Fu. brasiliensis	TBG 58	Brazil	JX982569	-	Gomes-Silva et al. (2015)
Fu. brasiliensis	URM 83578	Brazil	JX310841	-	Gomes-Silva et al. (2015)
Fu. sumptuosus	**HUEG 14416**	**Brazil**	**MZ577572**	**MZ577577**	**This study**
Ganoderma concinnum	Robledo 3192 (FCOS)	-	MN077522	MN077556	Costa-Rezende et al. (2020)
G. concinnum	Robledo 3235 (FCOS)	-	MN077523	MN077557	Costa-Rezende et al. (2020)
G. lucidum	Dai 2272	Sweden	JQ781851	-	Cao et al. (2012)
G. lucidum	Dai 11593	Finland	JQ781852	-	Cao et al. (2012)
G. multiplicatum	URM 83346	Brazil	JX310823	JX310837	Lima-Junior et al. (2014)
G. multiplicatum	ICN 200402	Brazil	MW541360	MW546321	GenBank
G. orbiforme	URM 83334	Brazil	JX310814	JX310828	Lima-Junior et al. (2014)
G. orbiforme	URM 83336	Brazil	JX310816	JX310830	Lima-Junior et al. (2014)
G. oregonense	CBS 265.88	USA	JQ781875	-	Cao et al. (2012)
G. oregonense	CBS 266.88	USA	JQ781876	-	Cao et al. (2012)
G. parvulum	URM 83339	Brazil	JX310817	JX310831	Lima-Junior et al. (2014)
G. parvulum	URM 83340	Brazil	JX310818	JX310832	Lima-Junior et al. (2014)
G. perzonatum	URM 89437	Brazil	MK119830	-	Sun et al. (2020)
G. perzonatum	SP 445987	Brazil	KJ792747	-	GenBank
Haddowia longipes	GACP 17072708	Laos	MK345423	MK346828	Hapuarachchi et al. (2019)
H. longipes	GACP 17072709	Laos	MK345424	MK346829	Hapuarachchi et al. (2019)
Magoderna subresinosum	Dai 18626	Malaysia	MK119823	MK119902	Sun et al. (2020)
M. subresinosum	Dai 18630	Malaysia	MK119824	MK119903	Sun et al. (2020)
Perenniporiella chaquenia	MUCL 49758	Argentina	NR111365	FJ393857	Robledo et al. (2009)
P. pendula	MUCL 47129	Cuba	FJ411082	FJ393854	Robledo et al. (2009)
Sanguinoderma elmerianum	HMAS 133187	China	MK119834	MK119913	Sun et al. (2020)
S. laceratum	Cui 8155	China	MK119851	MK119928	Sun et al. (2020)
S. microporum	Cui 13851	China	MK119854	MK119933	Sun et al. (2020)
S. reniforme	Cui 16511	Zambia	MK119850	MK119929	Sun et al. (2020)
S. rude	MEL 2150776	Australia	MK119838	MK119918	Sun et al. (2020)
S. rude	DHCR 448 (HUEFS)	Brazil	MN077515	MN077549	Costa-Rezende et al. (2020)
S. rugosum	Cui 9011	China	KJ531664	KU220010	Li and Yuan (2015)
S. rugosum	Cui 9012	China	KJ531665	KU220011	Li and Yuan (2015)
Tomophagus cattienensis	CT 99	Vietnam	JN184397	-	Le et al. (2012)
T. cattienensis	CT 119	Vietnam	JN184398	-	Le et al. (2012)
T. colossus	URM 80450	Brazil	JX310825	JX310839	Lima-Junior et al. (2014)
T. colossus	URM 83330	Brazil	JQ618247	JX310811	Lima-Junior et al. (2014)
Trachyderma tsunodae	GR 363	-	FJ154773	-	GenBank
Tr. tsunodae	WD 2034	Japan	AB588989	AB368069	Sotome et al. (2011)

Results

Phylogenetic analyses

The ITS + nLSU dataset included sequences from 77 fungal specimens that represent 44 taxa. The dataset had an aligned length of 1543 characters, including gaps (665 characters for ITS, 878 characters for nLSU). Of these, 1167 characters were constant, 375 were variable, and 290 were parsimony informative. BI analysis resulted in an average standard deviation of split frequencies = 0.003543. ML and BI phylogenetic reconstructions produced similar topologies and therefore, only the ML tree is shown here (Figure 1).

Figure 1. Phylogenetic tree reconstruction using ITS + nLSU. The tree topology is from ML analysis and the new species is indicated in bold. Numbers at branches indicate the values of bootstrap frequency (BS)/ultrafast bootstrap (UB)/bayesian posterior probability (PP).

The phylogenetic tree based on the combined ITS + nLSU sequences formed 11 supported clades. The clades obtained were as follows: *Amauroderma* s. str. (BS = 94%, UB = 99%, PP = 0.99), *Amaurodermellus* (BS = 100%, UB = 100%, PP = 1), *Furtadomyces* (BS = 99%, UB = 100%, PP = 1), *Foraminispora* (BS = 81%, UB = 94%, PP = 0.99), *Cristataspora* (BS = 97%, UB = 100%, PP = 1), *Ganoderma* (BS = 87%, UB 79%, PP = 0.82), *Sanguinoderma* (BS = 95%, UB = 99%, PP = 1), *Haddowia* (BS = 100%, UB = 100%, PP = 1), *Trachyderma* (BS = 99%, UB = 100%, PP = 1), *Tomophagus* (BS = 99%, UB = 100%, PP = 1) and *Magoderna* (BS = 100%, UB = 100%, PP = 1). The new species formed a strongly supported clade in *Furtadomyces* in a well-supported terminal branch with *Bresadolia craterellus* (Berk. & M.A. Curtis) Audet (BS = 91%, UB = 100%, PP = 0.99) and both with *F. biseptatus* (BS = 97%, UB = 100%, PP = 1) (Figure 1). *Furtadomyces* is proposed as a new name for the genus *Furtadoa*, *Furtadomyces sumptuosus* is introduced as new species, and *F. biseptatus* and *F. brasiliensis* are proposed as new combinations.

Taxonomy

Furtadomyces Leonardo-Silva, Cotrim, and Xavier-Santos, nom. nov.

MycoBank: MB841235

Typus: *Furtadoa biseptata* Costa-Rezende, Drechsler-Santos, and Reck, Persoonia 39: 265 (2017).

Etymology: Named in honor of Dr. João Salvador Furtado, in recognition of his contribution to the knowledge of *Ganodermataceae*.

Diagnosis and description: see Costa-Rezende et al. (2017).

Distribution: So far this genus has been found in the Neotropics in two ecoregions: Tropical and Subtropical Moist Broadleaf Forest and Tropical and Subtropical Grassland, Savannas and Shrublands in Brazil, Guyana, and Venezuela (Figure 2). In Brazil, these ecoregions comprise the Amazon Forest, Atlantic Forest, and Cerrado biomes.

Notes: *Furtadomyces* presents similar characteristics to the other genera of *Amauroderma* s. lat.; however, it can be distinguished by its dull, striated or wrinkled pilear surface and a monomitic context composed of clamped and simple-septate generative hyphae, variable in diameter and thickness. Both Index Fungorum and MycoBank pointed out that *Furtadoa* is an illegitimate homonym, according to Art. 53.1 of the International Code of Nomenclature for algae, fungi, and plants (Turland et al. 2018). Since the authors proposed the genus name in honor of Dr. João Salvador Furtado, we chose to keep it by making a simple change in the name. According to the phylogenetic analysis based on ITS + nLSU sequences for the genus, Costa-Rezende et al. (2017) grouped *F. biseptata*, *F. brasiliensis* and *F. corneri*. However, *F. corneri* is considered by some authors synonymous with *F. brasiliensis* due to its morphological similarity (Gomes-Silva et al. 2015). In this study, we consider these species as synonyms until further molecular studies are carried out.

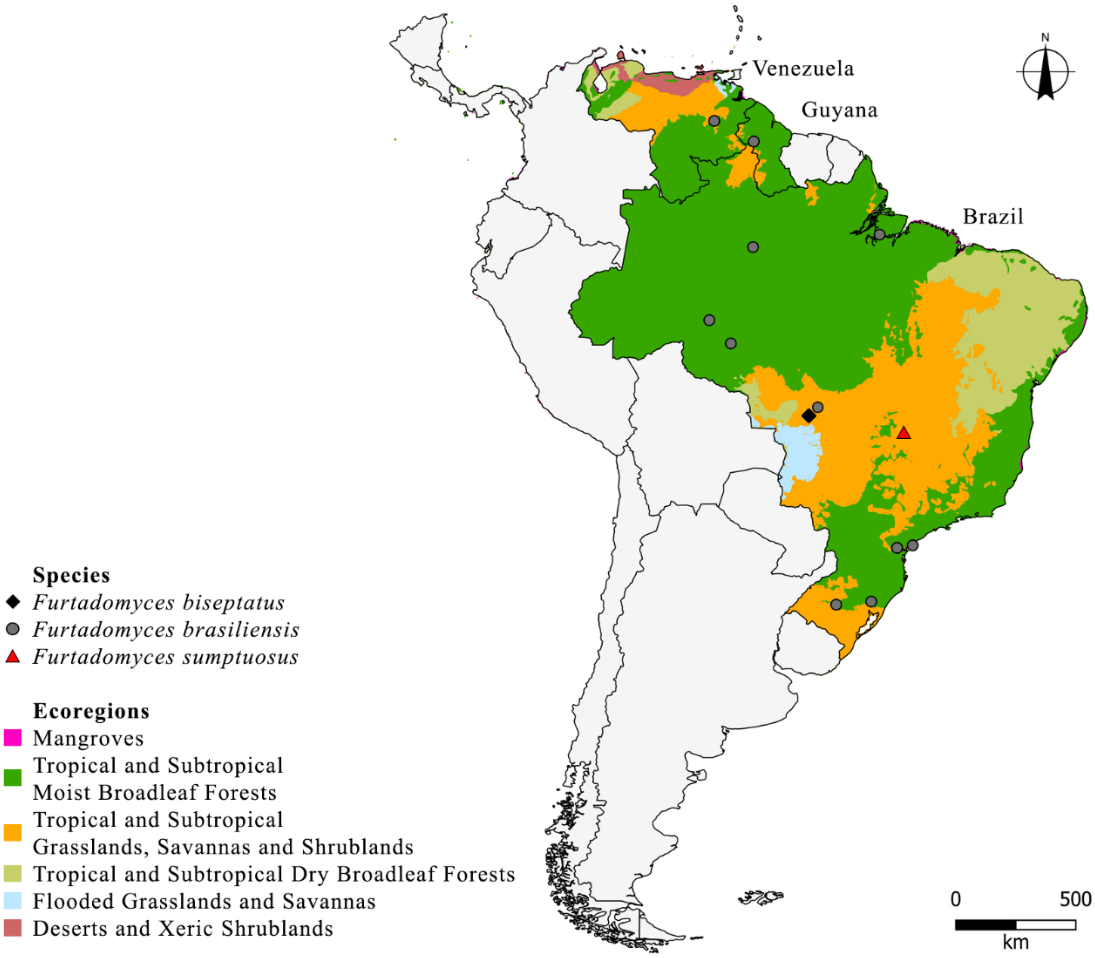

Figure 2. Distribution of the genus *Furtadomyces* in the main Ecoregions of the Neotropics. The orange area indicates the ecoregion covered by the Cerrado biome in Brazil Central. Ecoregions are according to Dinerstein et al. (2017).

Furtadomyces sumptuosus Leonardo-Silva, Cotrim, and Xavier-Santos sp. nov. Figure 3, 4

MycoBank: MB841236

Type: Brazil, Goiás, municipality of Silvânia, Floresta Nacional de Silvânia, 16º 38' 30.0" S, 48º 39' 02.5" W; 900 m a.s.l., in mesophilic forest, attached to the leaves on the soil surface and to the roots of an unidentified dead angiosperm, 21 Jan 2019, Leonardo-Silva, L. and Camilo-Cotrim, C.F. (SXS 6963), Holotype (HUEG 14416), Isotype (URM 83559).

Etymology: S*umptuosus* (Latin), referring to the conspicuous and large basidiomata.

Distribution: So far known only from the Cerrado biome, in Goiás state, Brazil (Fig. 2).

Diagnosis: *Furtadomyces sumptuosus* is characterized by multiple pilei and can be distinguished by large basidiomata (≥ 20×25 cm), pore size (1–4 mm diam.), the presence of radial striae on the pilear surface, an involute margin exposing the pore surface, numerous cystidia in the hymenium and large basidiospores (7.2–) 9.1–11.2 (–13.3) × (6.6–) 7.1–8.8 (–10.4) µm.

Description: *Basidioma* annual, centrally to laterally stipitate, coriaceous to corky, 23 cm long and 25 cm high when fresh and 16 cm long, and 15 cm high when dry. *Pilei* multiple (4), some fused, circular to semicircular, 6–25 cm in diam., up to 4 cm thick and soft when fresh, 6–14 cm in diam., up to 1 cm thick, and corky when dry. *Margin* entire, wavy to lacerate, involute exposing the pore surface. *Pilear surface* greyish brown (8E3), dull, azonate, finely strigose, radially striated with pale grey (1B1) striae, wrinkled at the center. *Context* pale grey (1B1), homogeneous, corky, up to 0.6 cm thick. *Pore surface* concolorous to context when fresh and greyish beige (4C2) when dry; pores angular, circular, irregular to elongate, 1–4 mm diam.; dissepiments thin, partially dilacerate upon drying, 70–150 µm thick; tubes concolorous to context when fresh, brown (7E4) when dry, up to 6 mm deep. *Stipe* yellowish brown (5D4) and greyish beige (4C2) next to pilei, solid, softly velutinous, conical, 15 cm long, branched, with tortuous, flattened to cylindrical branches, 5–11 cm long, up to 4 cm thick, sometimes thickening towards the pileus.

Hyphal system dimitic with generative and skeletal hyphae; all the hyphae IKI–, CB+; context monomitic composed of hyaline generative hyphae, mostly simple-septate but also clamped, straight to tortuous, branched, occasionally collapsing, thin to slightly thick-walled, sometimes very thick and resembling skeletal hyphae, parallelly arranged, 2–10 µm diam.; trama of tubes dimitic: hyaline, simple-septate generative hyphae, 3–5 µm diam., and arboriform hyphae skeletal, hyaline, abundant, with a thick-walled, wide to narrow lumen, few apical branches, 3–8 µm diam. Pilear surface composed of generative hyphae, hyaline to greyish yellow, occasionally clamped or simple-septated, thin to thick-walled, parallel to the context hyphae, apical cells clavate, occasionally tortuous, hyaline to greyish orange. *Gloeopleurous hyphae* present in the context and trama of tubes, simple-septate, rarely clamped, up to 390 µm long, straight, mostly sinuous, branched, thin to slightly thick-walled, grainy contents similar to oil droplets present, hyaline, or intensely staining in phloxine, 6–15 µm diam. *Cystidia* numerous in the hymenium, immersed or slightly projecting, with grainy contents similar to oil droplets ranging from grey to greyish yellow in KOH, thin- to thick-walled, of two types: fusiform to subcylindrical, sometimes widened at base, narrowing towards apex, 16–94 × 4.4–13.4 µm, and subglobose to clavate, shape similar to basidioles, scattered among the basidia and basidioles, 14–35 × 10–16 µm. *Cystidioles* hyaline, clavate to fusiform, thin-walled, 4–12 × 11–23 µm. *Basidia* hyaline, subglobose to clavate, four-sterigmate, 17–31 × 9.5–18 µm; sterigmata up to 9.5 µm long. *Basidioles* hyaline, similar to basidia in shape, thin-walled, 15–24 × 8–18 µm. *Basidiospores* hyaline, subglobose to ellipsoid, double-walled, exospore wall smooth to verrucose in OM and alveolate to verrucose under SEM, endospore projections column-like, IKI-, CB+, (7.2–) 9.1–11.2 (–13.3) × (6.6–) 7.1–8.8 (–10.4) µm [Q = (1–) 1.1–1.4 (–1.6); Qm = 1.3; N = 100].

Notes: *Furtadomyces sumptuosus* is macroscopically characterized by multiple pilei with a greyish brown pilear surface, radially striated with pale grey striae and an involute margin exposing the pore surface. Microscopically, it presents a dimitic hyphal system, with a monomitic context composed of generative hyphae with two different septa, and a dimitic trama with abundant skeletal hyphae, and large basidiospores. In context, the generative hyphae differ in diameter and wall thickness, being sometimes similar to skeletal hyphae and other times small and collapsed. Furthermore, the basidiospores show a prominent and conspicuous apiculus, mainly under SEM. The specimen was collected in a mesophilic forest, a typical Cerrado forest formation characterized by the deciduousness of some trees, mainly in the dry season. It was found on a dense leaf litter, and its stipe was attached to the leaves on the soil surface and the roots of an unidentified dead angiosperm.

New combinations

Furtadomyces biseptatus (Costa-Rezende, Drechsler-Santos, and Reck) Leonardo-Silva, Cotrim, and Xavier-Santos, comb. nov.

MycoBank: MB841238

Basionym: *Furtadoa biseptata* Costa-Rezende, Drechsler-Santos, and Reck, Persoonia 39: 265, 2017.

Description and illustration: see Costa-Rezende et al. (2017).

Furtadomyces brasiliensis (Singer) Leonardo-Silva, Cotrim, and Xavier-Santos, comb. nov.

MycoBank: MB841237

Basionym: *Scutiger brasiliensis* Singer, Nova Hedwigia, Beih. 77: 22, 1983.

Description and illustration: see Ryvarden (2004), Coelho et al. (2007) and Gomes-Silva et al. (2015) as *Amauroderma brasiliensis* (Singer) Ryvarden.

Figure 3. *Furtadomyces sumptuosus*. **a.** Fresh basidioma. **b.** General view of basidioma highlighting the multiple pilei. **c.** Pore surface. **d.** Pilear surface with radial striae and involute margin exposing the pore surface. Scale bar = 1 cm.

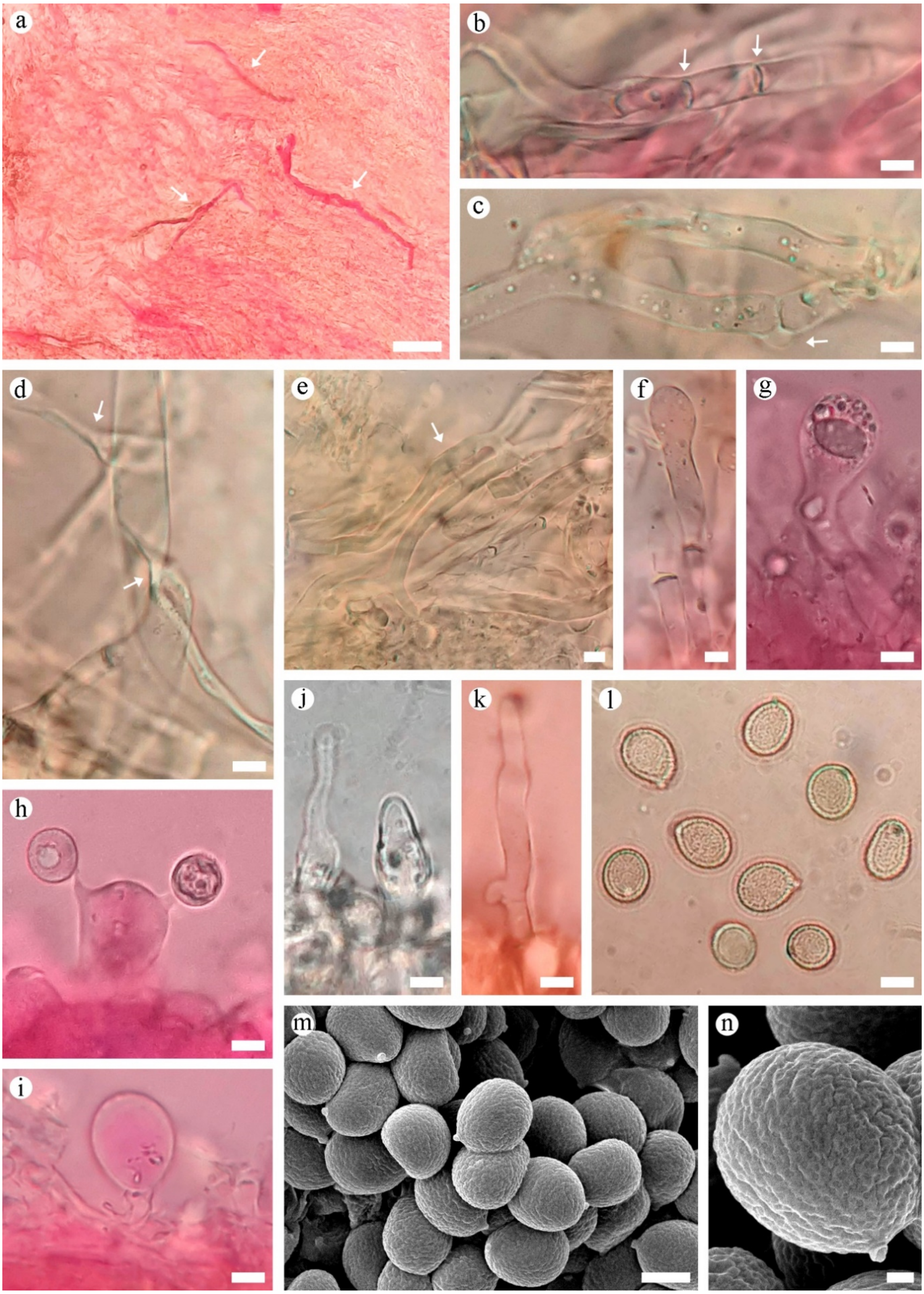

Figure 4. Microstructures of *Furtadomyces sumptuosus*. **a.** Gloeopleurous hyphae. **b–d.** Generative hyphae from context simple-septate (b), clamped (c) and collapsed (d), each hypha is pointed by the arrow. **e.** Skeletal hyphae from trama of tubes. **f, g.** Cystidia. **j, k.** Cystidioles.

h. Basidia. **i.** Basidioles. **l–n.** Basidiospores in Optical Microscopic (**l**) and in Scanning Electron Micrograph (**m, n**). Scale bar: a = 100 µm, b–m = 5 µm, n = 1 µm.

Discussion

Recently, several studies confirmed the polyphyletic status of *Amauroderma*, and species considered "deviating elements" were placed in new genera (Gomes-Silva et al. 2015; Costa-Rezende et al. 2016, 2017). In this context, *Furtadomyces* has been proposed to accommodate species with a monomitic context, a feature unique within the family and which may represent a synapomorphy for the genus (Costa-Rezende et al. 2017, under *Furtadoa*).

The final dataset from the ribosomal ITS + nLSU regions confirmed the placement of the new species in the *Furtadomyces* clade, forming a monophyletic lineage with strong support. The clade grouped the species with one retrieved lineage from GenBank deposited as *Bresadolia craterellus*. This specimen was collected on fallen hardwood, in a hardwood forest of *Quercus*, *Fagus*, and *Carya* in Tennessee, USA, and a brief field description note and images are available on MyCoPortal (Catalog: TENN-F-074997; GenBank: MT196970). We suggest that this specimen represents a new species of *Furtadomyces,* closely related to *F. sumptuosus,* being similar in the presence of multiple pilei. However, a new morphological and phylogenetic analysis using other molecular biomarkers for a better distinction and delimitation of the taxon is required.

Macroscopically, *F. sumptuosus* presents characteristics that differ from the other species of the genus, but it is microscopically related to *F. biseptatus* due to the presence of the two types of septa in the generative hyphae of the context; it differs, though, in the presence of cystidia and in the basidiospore size, being larger in *F. sumptuosus*, while *F. brasiliensis* has cystidia and simple-septate generative hyphae (Table 2). Thus, the presence of different septa in generative hyphae of the context is a simple method to separate species from the genus.

Interestingly, *F. biseptatus* (Costa-Rezende et al. 2017) and *F. sumptuosus* were collected only once in areas of typical Cerrado vegetation, despite several field expeditions. The area where *F. sumptuosus* was found has been widely explored since 2005 and showed high richness and a high number of species considered to be rare (Leonardo-Silva et al. 2020a), thus suggesting that the new species may be rare and therefore threatened, showing the importance of protecting these areas.

Although some areas of the Cerrado have been studied since the middle of the last century, many regions of the biome remain unexplored due to the lack of extensive inventories of the Funga. The Cerrado is a Brazilian biome intensely degraded by human activity, with a significant reduction in its coverage in central Brazil (Sano et al. 2010; Lahsen et al. 2016). It possesses a rich biological diversity, some of it known and much as yet unknown, including fungi. The Cerrado is among the Brazilian biomes with the lowest known species and currently, 22 ganodermatoid fungi are known from the Cerrado (Maia et al. 2015; Costa-Rezende et al. 2016, 2020; Leonardo-Silva et al. 2020b). Therefore, comprehensive studies on the species diversity, taxonomy, and phylogeny of the ganodermatoid fungi are needed, mainly in areas that remain poorly studied, to clarify the relationship and position of many species within the family.

Table 2. Morphological comparison of species of the genus *Furtadomyces*.

Criteria	***Species***		
	Furtadomyces biseptatus (Costa-Rezende et al. 2017)	***Furtadomyces brasiliensis*** (Ryvarden 2004; Coelho et al. 2007)	***Furtadomyces sumptuosus*** Present study
Basidiomata	Centrally to laterally stipitate	Centrally to laterally stipitate	Centrally to laterally stipitate
Pileus	Single, 25–45 mm diam., up to 10 mm thick, almost flattened to slightly convex	Single, up to about 95 × 80 × 16 mm, rounded to almost flabelliform, depressed	Multiple pilei, 6-25 cm in diam., up to 4 cm thick, circular to semicircular
Pilear surface	Greyish brown, azonate, radially finely strigose, wrinkled at the center, glabrous	Light yellowish brown to yellowish brown, azonate, dull, tomentose to hirsute in some parts, slightly striate near to the margin	Greyish brown, azonate, finely strigose, radially striated with pale grey striae, wrinkled at the center
Pore surface	Pores circular, 3–5 per mm	Pores angular to daedaloid, 1–2 per mm	Pores angular, circular, irregular to elongate, 1–4 mm diam.
Stipe	Pale brown, solid to hollow, straight to tortuous	Yellowish brown to dark yellowish brown, tomentose, expanded towards the pileus	Yellowish brown and greyish beige next to pileus, solid, softly velutinous, conical, branched, with tortuous, flattened to cylindrical branches, sometimes thicker towards the pileus
Hyphal system	Dimitic; monomitic context composed by generative hyphae with two different septa	Dimitic; monomitic context composed by generative hyphae with large conspicuous clamps	Dimitic; monomitic context composed by generative hyphae with two different septa
Gloeopleurous hyphae	Present	Present	Present
Cystidia	Absent	Present	Present
Basidiospores	Subglobose to ellipsoid, hyaline, verrucose, (6–)7–10 × (5.5–)6–8(–9) µm	Subglobose to broadly-ellipsoid, hyaline, verrucose (5.6–)6–9.2(–10) × (4.4–)5.2–7.2(–8) µm	Subglobose to ellipsoid, hyaline, verrucose, (7.2–)9.1–11.2 (–13.3) × (6.6–)7.1–8.8 (–10.4) µm

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Declarations

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection, and data analysis were performed by Lucas Leonardo-Silva. The first draft of the manuscript was written by Lucas Leonardo-Silva. All authors commented on previous versions of the manuscript and approved the final version. Solange Xavier-Santos provided funds and supervised this research.

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Availability of data and material

Voucher is deposited in Herbarium HUEG. The sequences generated in this study are deposited in NCBI GenBank (https://www.ncbi.nlm.nih.gov/genbank/).

Conflicts of interest/Competing interests

The authors declare that they have no competing interests.

Code availability

Not applicable.

Ethics approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

References

Cao Y, Wu S-H, Dai Y-C (2012) Species clarification of the prize medicinal *Ganoderma* mushroom "Lingzhi." Fungal Divers 56:49–62. https://doi.org/10.1007/s13225-012-0178-5

Coelho G, Cortez VG, Guerrero RT (2007) New morphological data on *Amauroderma brasiliense* (Polyporales, Basidiomycota). Mycotaxon 100:177–183

Colli GR, Vieira CR, Dianese JC (2020) Biodiversity and conservation of the Cerrado: recent advances and old challenges. Biodiversity and Conservation 29:1465–1475. https://doi.org/10.1007/s10531-020-01967-x

Costa-Rezende DH, Gugliotta AM, Góes-Neto A, Reck MA, Robledo GL, Drechsler-Santos ER (2016) *Amauroderma calcitum* sp. nov. and notes on taxonomy and distribution of *Amauroderma* species (*Ganodermataceae*). Phytotaxa 244:101. https://doi.org/10.11646/phytotaxa.244.2.1

Costa-Rezende DH, Robledo GL, Drechsler-Santos ER, Glen M, Gates G, Bonzi BRM, Popoff OF, Crespo E, Góes-Neto A (2020) Taxonomy and phylogeny of polypores with ganodermatoid basidiospores (*Ganodermataceae*). Mycol Prog 19:725–741. https://doi.org/10.1007/s11557-020-01589-1

Costa-Rezende DH, Robledo GL, Góes-Neto A, Reck MA, Crespo E, Drechsler-Santos ER (2017) Morphological reassessment and molecular phylogenetic analyses of *Amauroderma* s.lat. raised new perspectives in the generic classification of the *Ganodermataceae* family. Persoonia - Mol Phylogeny Evol Fungi 39:254–269. https://doi.org/10.3767/persoonia.2017.39.10

Decock C, Amalfi M, Robledo G, Castillo G (2013) *Phylloporia nouraguensis,* an undescribed species on Myrtaceae from French Guiana. Cryptogam Mycol 34:15–27. https://doi.org/10.7872/crym.v34.iss1.2013.15

Dinerstein E, Olson D, Joshi A, et al (2017) An ecoregion-based approach to protecting half the terrestrial realm. Bioscience 67:534–545. https://doi.org/10.1093/biosci/bix014

Doyle JJ, Doyle JL (1987) A rapid DNA isolation procedure for small quantities of fresh leaf tissue. Phytochem. Bull. 19:11–15

Góes-Neto A, Loguercio-leite C, Guerrero RT (2005) DNA extraction from frozen field-collected and dehydrated herbarium fungal basidiomata performance of SDS and CTAB-based methods. Biotemas 18:19–32

Gomes-Silva AC, Lima-Junior N, Malosso E, Ryvarden L, Gibertoni TB (2015) Delimitation of taxa in *Amauroderma* (*Ganodermataceae*, *Polyporales*) based in morphology and molecular phylogeny of Brazilian specimens. Phytotaxa 227:201. https://doi.org/10.11646/phytotaxa.227.3.1

Hapuarachchi KK, Karunarathna SC, Phengsintham P, Yang HD, Kakumyan P, Hyde KD, Wen TC (2019) *Ganodermataceae* (*Polyporales*): Diversity in Greater Mekong Subregion countries (China, Laos, Myanmar, Thailand and Vietnam). Mycosphere 10:221–309. https://doi.org/10.5943/mycosphere/10/1/6

Henriot A, Cheype JL (2017) Piximètre, la measure des dimensions sur images. http://www.piximetre.fr/. Accessed 13 Nov 2020

Hoang DT, Chernomor O, von Haeseler A, Minh BQ, Vinh LS (2018) UFBoot2: Improving the Ultrafast Bootstrap Approximation. Mol Biol Evol 35:518–522. https://doi.org/10.1093/molbev/msx281

Imazeki R (1952) A contribution to the fungous flora of Dutch New Guinea. Bull Gov For Exp Stn Meguro 87–128

Jülich W (1981) Higher taxa of Basidiomycetes. Vaduz: J. Cramer

Justo A, Miettinen O, Floudas D, Ortiz-Santana B, Sjokvist E, Lindner D, Nakasone K, Niemela T, Larsson KH, Ryvarden L, Hibbett DS (2017) A revised family-level classification of the *Polyporales* (*Basidiomycota*). Fungal Biol 121:798–824. https://doi.org/10.1016/j.funbio.2017.05.010

Kalyaanamoorthy S, Minh BQ, Wong TKF, Haeseler AV, Jermiin LS (2017) ModelFinder: fast model selection for accurate phylogenetic estimates. Nat Methods 14:587–589. https://doi.org/10.1038/nmeth.4285

Kornerup A, Wansher JH (1978) Handbook of colour, 3rd edn. Eyre Methuen, London.

Lahsen M, Bustamante MMC, Dalla-Nora EL (2016) Undervaluing and Overexploiting the Brazilian Cerrado at Our Peril. Environment: Science and Policy for Sustainable Development 58:4–15. https://doi.org/10.1080/00139157.2016.1229537

Le XT, Nguyen-Le QH, Pham ND, Duong VH, Dentinger BTM, Moncalvo JM (2012) *Tomophagus cattienensis* sp. nov., a new *Ganodermataceae* species from Vietnam: Evidence from morphology and ITS DNA barcodes. Mycol Prog 11:775–780. https://doi.org/10.1007/s11557-011-0789-3

Leonardo-Silva L, Silva LB, Sá ASF, Naves LRR, Cunha EL, Xavier-Santos S (2020b) Additions to the knowledge of *Ganodermataceae* in brazilian Cerrado. Hoehnea 47:1–7. https://doi.org/10.1590/2236-8906-85/2019

Leonardo-Silva L, Silva LB, Xavier-Santos S (2020a) Poroid fungi (*Agaricomycetes, Basidiomycota*) from Floresta Nacional de Silvânia – a conservation unit of Brazilian Savanna. Microb Biosyst 5:100–107. https://doi.org/10.21608/mb.2020.32419.1015

Li M-J, Yuan H-S (2015) Type studies on *Amauroderma* species described by J.D. Zhao et al. and the phylogeny of species in China. Mycotaxon 130:79–89. https://doi.org/10.5248/130.79

Lima-Junior NC, Gibertoni TB, Malosso E (2014) Delimitación de algunos *Ganoderma* (*Ganodermataceae*) lacados neotropicales: filogenia molecular y morfología. Rev Biol Trop 62:1197. https://doi.org/10.15517/rbt.v62i3.12380

Maia LC, Carvalho Júnior AA, Cavalcanti LDH, et al (2015) Diversity of Brazilian fungi. Rodriguesia 66:1033–1045. https://doi.org/10.1590/2175-7860201566407

MMA (2015) Plano de Manejo da Floresta Nacional de Silvânia, Goiás, Brasil. Volume I - Diagnóstico, Brasilia. ICMBio.

Rambaut A, Drummond AJ, Xie D, Baele G, Suchard MA (2018) Posterior summarization in bayesian phylogenetics using Tracer 1.7. Syst Biol 67:901–904. https://doi.org/10.1093/sysbio/syy032

Robledo GL, Amalfi M, Castillo G, Rajchenberg M, Decock C (2009) *Perenniporiella chaquenia* sp. nov. and further notes on *Perenniporiella* and its relationships with *Perenniporia* (*Poriales*, *Basidiomycota*). Mycologia 101:657–673. https://doi.org/10.3852/08-040

Ronquist F, Huelsenbeck JP (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19:1572–1574. https://doi.org/10.1093/bioinformatics/btg180

Ryvarden L (2004) Neotropical polypores Part 1. Fungiflora, Oslo, Norway

Sano EE, Rosa R, Brito JLS, Ferreira LG (2010) Land cover mapping of the tropical savanna region in Brazil. Environ Monit Assess 166:113–124. https://doi.org/10.1007/s10661-009-0988-4

Sotome K, Hattori T, Ota Y (2011) Taxonomic study on a threatened polypore, *Polyporus pseudobetulinus,* and a morphologically similar species, *P. subvarius*. Mycoscience 52:319–326. https://doi.org/10.1007/S10267-011-0111-X

Staden R, Beal KF, Bonfield JK (1998) The Staden package. Computer methods in Molecular Biology 132. In: S M, S A K (eds) Bioinformatics Methods and Protocols. The Humana Press, pp 115–130

Steyaert R (1972) Species of *Ganoderma* and related genera mainly of the. Persoonia 7:55–

118

Sun Y-F, Costa-Rezende DH, Xing J-H, Zhou J-L, Zhang B, Gibertoni TB, Gates G, Glen M, Dai Y-C, Cui B-K (2020) Multi-gene phylogeny and taxonomy of *Amauroderma* s.lat. (*Ganodermataceae*). Persoonia - Mol Phylogeny Evol Fungi 44:206–239. https://doi.org/10.3767/persoonia.2020.44.08

Tamura K, Stecher G, Peterson D, Filipski A, Kumar S (2013) MEGA6: Molecular evolutionary genetics analysis version 6.0. Mol Biol Evol 30:2725–2729. https://doi.org/10.1093/molbev/mst197

Thiers B (2021) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. In: http://sweetgum.nybg.org/science/ih/

Trifinopoulos J, Nguyen L-T, von Haeseler A, Minh BQ (2016) W-IQ-TREE: a fast online phylogenetic tool for maximum likelihood analysis. Nucleic Acids Res 44:W232–W235. https://doi.org/10.1093/nar/gkw256

Turland N, Wiersema J, Barrie F, et al (eds) (2018) International Code of Nomenclature for algae, fungi, and plants. Koeltz Botanical Books

Vilgalys R, Hester M (1990) Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. J Bacteriol 172:4238–4246. https://doi.org/10.1128/jb.172.8.4238-4246.1990

White TJ, Bruns T, Lee S, Taylor J (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: PCR Protocols. Elsevier, pp 315–322**.**

ARTIGO 6

INONOTUS RICKII (AGARICOMYCETES, HYMENOCHAETACEAE) IN BRAZILIAN CERRADO: EXPANDING ITS GEOGRAPHIC DISTRIBUTION AND HOST LIST

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Inonotus rickii (Agaricomycetes, Hymenochaetaceae) in Brazilian Cerrado: Expanding its geographic distribution and host list

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Abstract ‒ *Inonotus rickii* (Pat.) Reid (Agaricomycetes: Hymenochaetaceae) is a poroid fungus characterized by the expressive production of chlamydospores, *in vivo* and *in vitro*, especially during its anamorphic stage. The species plays important ecological roles, standing out as a phytopathogen, affecting several species of ornamental and wild trees, mainly in tropical and subtropical regions. The infected trees develop canker and white rot of the wood, showing symptoms of reduced vegetative vigor and decline of leaves and branches which causes death in some cases. The first record of *I. rickii* for the Cerrado biome (Brazilian Savanna) and the first record as causal agent of canker in *Schinus molle* L. in Brazil is reported here. In addition, we present a checklist of its worldwide geographical distribution and known hosts, from an extensive bibliographic search in Google Scholar, SciELO, Scopus and Web of Science databases. The species is widespread in tropical and subtropical zones; common in the American continent, especially in Central and South America and the Mediterranean region, and rare in temperate zones. We found specimens growing in both living and dead hosts, totalizing 70 species of hosts, distributed in 43 genera and 22 families. Of these, *Acer negundo* L. (10.5%), *Celtis australis* L. (6.5%) and *Platanus acerifoliax* (Aiton) Willd. (4.8%), and the Fabaceae (30%), Fagaceae (10%) and Sapindaceae (8.6%) families were the most frequent. We present morphological descriptions and illustrations, as well as the growth characteristics in culture medium. Our study expands the known geographical distribution of *I. rickii*, including the Cerrado biome, as well as its structural, physiological characteristics, and its hosts.

Keywords ‒ Brazilian Savanna, Canker, Decay, Phytopathogen, Poroid fungi.

Introduction

Inonotus rickii (Pat.) Reid is a poroid fungus that belongs to the family Hymenochaetaceae, class Agaricomycetes. It was described in South America in 1896 as *Ptychogaster cubensis* Pat., from a review of specimens from Cuba by Patouillard (1896). However, in 1908, the author observed that the species should be the anamorphic stage of a poroid fungus collected by Ricki in Brazil, recognized as *Xanthochrous rickii* Pat. (Patouillard, 1908); later the nomenclature was changed to *Polyporus rickii* (Pat.) Sacc. & Trotter (Saccardo and Trotter, 1912). In 1957, the species was recognized by Reid as *I. rickii* (Reid, 1957), currently accepted nomenclature, and its anamorphic stage as *P. cubensis*.

The relationship between the two life stages of the species has been confirmed by experimental studies carried by Davidson et al. (1942) and Stalpers (2000) and by molecular analysis of specimens collected from different geographical origins (Gottlieb et al., 2002; De Simone et al., 2011). *I. rickii* has a wide distribution in tropical, subtropical, and Mediterranean zones (Mazza et al., 2008; Ramos et al., 2008), where it is frequently found in trees in urban environments, mainly in its anamorphic stage (Mazza et al., 2008), which is considered a potential phytopathogen.

As a pathogen of woody plants, *I. rickii* infects branches and stems, causing canker and wood decay (Mazza et al., 2008; Annesi et al., 2010; De Simone et al., 2011). Adhesion and colonization of the substrate occurs due to the degradation of wood components, especially cellulose, hemicellulose and lignin, due to taxon enzymatic activity (Robles et al., 2014). When parasitizing the host, *I. rickii* can reach the heartwood, sapwood and cambium, as well as provoke deep lesions resulting from the death of the bark tissues, characterizing the canker (Ramos et al., 2008; Annesi et al., 2010). Infected trees may show reduced vegetative growth, crown and branches decline and sparse foliage, which leads, in some cases, to death (Mazza et al., 2008; Ramos et al., 2008; Annesi et al., 2010).

The knowledge of this species-host began with reports describing the presence of a powdery mass of abundant ferruginous chlamydospores, which characterizes the anamorphic stage of the taxon in different plant hosts, but without mentioning its pathogenicity (Davidson et al., 1942). However, in the beginning of 2000, the diseases symptoms and pathological aspects became more evident in Europe. In Italy, the species was recorded in public gardens and wooded boulevards on *Acer negundo* L. and *Albizia julibrissin* Durazz. (Mazza et al., 2008; Annesi et al., 2010), and in Portugal, on *Celtis australis* L. (Ramos et al., 2008) causing serious damage or death of tree. Other reports in Chile (Sepúlveda et al., 2016), China (Cui et al., 2014) and Egypt (Shehata and Abdel-Wahab, 2013) also presented a similar situation regarding *Schinus molle* L., *Acacia richii*, A. Gray, *Citrus* spp. and *Vitis* spp. respectively. Based on the morphology of the basidiome and species of the host plants, the fungus called by different popular names e.g. "mapúa chepa", which means "mascarilla de la mapúa", in the Wayuu indigenous community of Colombia (Villalobos et al., 2017), or "Florcita de espinillo","Florcita de molle","Florcita de palo","Hongo de espinillo","Hongo de molle" and "Hongo de palo", in La Paz, Córboda, Argentina (Flamini et al., 2015).

In Brazil, information on *I. rickii* is mystery or fragmented and restricted to the holotype with unknown localities (Patouillard, 1908) and to occurrence records in the Caatinga biomes, on *Spondias* sp. (Umbuzeiro) (Drechsler-Santos et al., 2013; Maia et al., 2015); Atlantic Forest and Pampa without host identification (Campos-Santana and Loguercio-Leite, 2010; Maia et al., 2015). Here we report for the first time *I. rickii* in the Cerrado biome, which constitutes the first record of this species causing canker disease in *S. molle*. In addition, we present detailed morphological descriptions of both anamorphic and teleomorphic stages supported with illustrations, and updated checklist of its worldwide geographical distribution and known hosts up till now.

Materials and Methods

Study area

Samples were collected during the period from 2001 to 2020 in three conservation units of the Cerrado biome: the Estação Ecológica do Noroeste Paulista (EENP) (20°50′55″ S, 49°26′53″ W), located between the municipalities of São José do Rio Preto and Mirassol, São Paulo; the Floresta Nacional (FLONA) de Silvânia (16°38′30″ S, 48°39′02″ W), located in the municipality of Silvânia, Goiás; the Parque Estadual Altamiro de Moura Pacheco (PEAMP) (16°33′12″ S, 49°8′50″ W), inserted in the municipalities of Goianápolis, Goiânia and Nerópolis, Goiás, and urban areas (16°19′38″ S, 48°57′11″ W) in the municipality of Anápolis, Goiás, which are surrounded by several Cerrado fragments (Figure 1).

The Brazilian Cerrado is considered the richest savanna in the world and is the dominant biome in the Central Plateau of Brazil which covers part of the North, Northeast, South and Southeast regions, representing approximately 25% of the country's territory. The Cerrado characterized by a rainy tropical climate, with high temperatures in summer and dry winter, this biome is known for its diverse landscapes represented by a vegetation mosaic, which includes forest, savanna, and grassland formations, where trees, shrubs, and undergrowth predominate, respectively (Klink and Machado, 2005; Ribeiro and Walter, 2008; WWF, 2015). Despite its great diversity, only 61% of the original Cerrado vegetation remains preserved (Sano et al., 2010). Sampling of our target species occurred in mesophilic forest (semideciduous dry forest) in which there is a predominance of tree species and canopy formation, occurring in interfluves and rich soil presented different levels of deciduous vegetation in the dry season (Ribeiro and Walter, 2008).

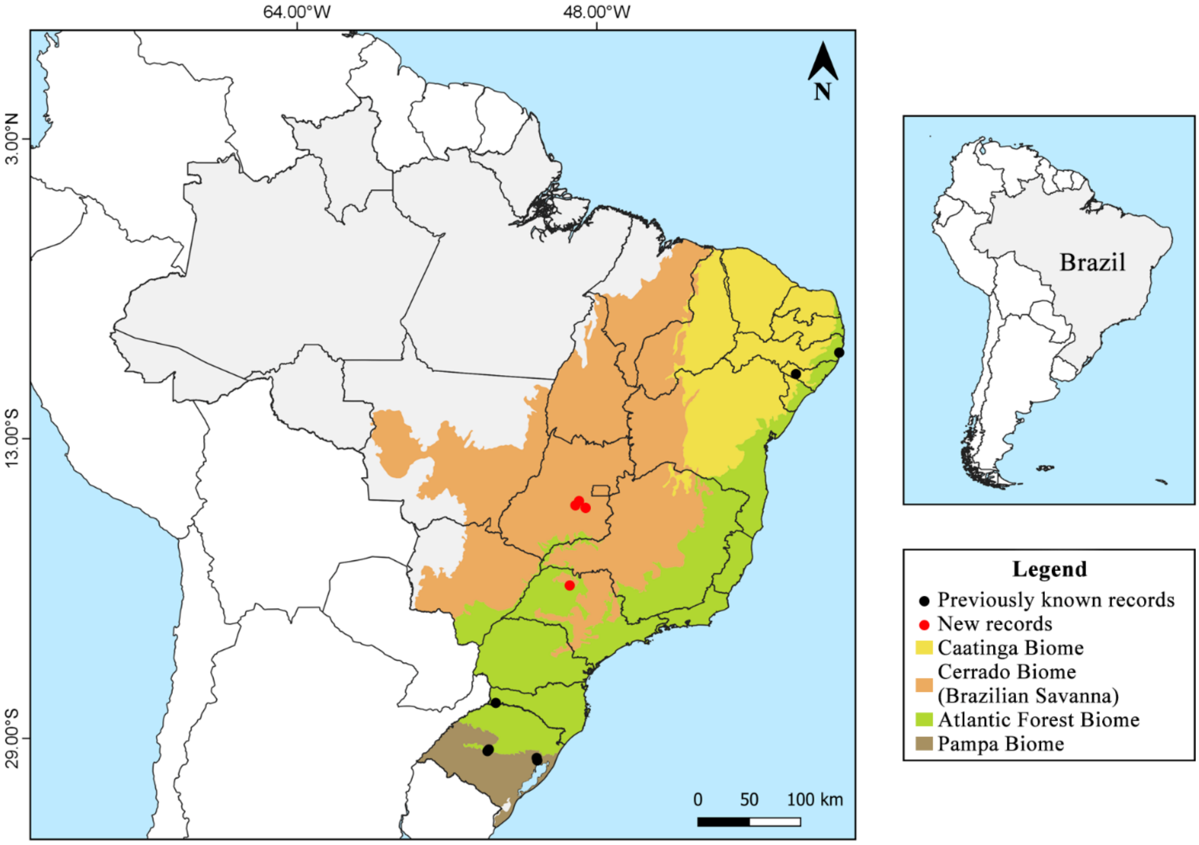

Figure 1. Study area and geographical distribution of *Inonotus rickii* in Brazil.

Morphological characterization

Collected samples were dried at 40 °C in oven and deposited in the Herbarium of the Universidade Estadual de Goiás (HUEG) and the Universidade Estadual Paulista (SJRP). Micro and macrophenotypic identification of basidiomata were carried out according to the relevant identification keys. For macroscopic characterization, the shape, consistency, color, dimension and number of pores per mm of basidiomata were considered. For the description of the microscopic criteria, cross sections through the basidiomata in distilled water and 3% KOH were microscopically examined. Hyphal structure, hymenial setae, setal hyphae, basidia, basidiospores, and chlamydospores and their ornaments were examined according to Ryvarden (2004, 2005) and Ramos et al. (2008). Melzer reagent was used to test the amyloid reaction of the microstructures (Kirk et al., 2008). All microscopic criteria were observed by Olympus CX31 optical microscope (1000x) magnification, and the measurements were performed using the Piximètre software version 5.10 R 1541 (Henriot and Cheype, 2017). Abbreviations used for measurements of basidiospores and chlamydospores are: Q = quotient between length and width, Qm = medium value of Q and, N = number of measured structures. All photographs and measurements were made using 3% KOH as mounting medium. The color indication for all evaluated characters was based on Kornerup and Wanscher colour cards (Kornerup and Wansher, 1978).

Fresh collected samples were plated out on potato dextrose agar (PDA) supplemented with 0.025 g/ml^{-1} of chloramphenicol as bactericidal and incubated in a BOD incubator at 25 °C. Recovered colonies were characterized based on macro (shape, color, texture and presence of exudates) and micromorphological criteria (hyphae, setal hyphae and chlamydospores) according to relevant identification keys. The cultures were preserved according to Castellani (1963) and deposited in the collection of fungal cultures of the Laboratório de Micologia Básica, Aplicada e Divulgação Científica (FungiLab) of the Universidade Estadual de Goiás, Brazil.

Checklist of geographical distribution and hosts

We collected the data from an extensive bibliographic search of Google Scholar (scholar.google.com.br), SciELO (www.scielo.org), Scopus (www.scopus.com) and Web of Science (www.webofknowledge.com) by using different keywords: "*Inonotus rickii*" OR "*Polyporus rickii*" OR "*Ptychogaster cubensis*" OR "*Xanthochrous rickii*". Our data included all published articles, books, chapters and abstracts available for access. For the worldwide geographical distribution of the species, we consider the specific location described by the authors and the geographic coordinates; when not available, they were obtained using the Latlong coordinate system (Latitude and Longitude Finder, 2020). The geographic distribution map was constructed using the Quantum GIS software (QGIS Development Team, 2020) and the climatic classification was determined between the North and South zones of both hemispheres as: tropical between 23°27′, subtropical 23°27′ and 46°54′, temperate 46°54′ and 66°33′, and polar 66°33′ and 90°, respectively (Peel et al., 2007; Eccles et al., 2019).

For the host checklist, we considered the absolute frequency the number of times the species was reported and relative frequency the quotient between the absolute frequency and the total of citations. The system of nomenclature, hierarchical classification and the name authority of the plant species followed The plant list (The Plant List, 2020).

Results

Taxonomic treatment

Inonotus rickii (Pat.) D. A. Reid, Kew Bull. [12](2): 141 (1957). (Figure 2, 3).

≡ *Xanthochrous rickii* Pat., Bull. Soc. Mycol. France 24(1): 6 (1908).

Description: Teleomorphic stage − basidiomata annual, 7.0−11 × 6.0−7.8 cm in size, solitary or aggregated in the form of semicircular shelves, sessile, pileate, and strongly attached to the substrate. Pileus applanate to ungulate, margin obtuse to undulate, soft and spongy consistency when fresh and firm and crumbly when dry. Pileal surface covered by a dense powdery layer formed by reddish brown chlamydospore (8D7). Pore surface also covered by chlamydospore, circular to angular pores, 2−4 pores per mm, thin and lacerated. Thick context and positive KOH reaction. Anamorphic stage − semicircular or cushion-shaped, soft and robust, velvety to the touch, reddish orange (8B8) when young and reddish brown (8E7) when mature, structured by a dense mass of chlamydospore attached to hyphae, forming a structure similar to capillitium, which facilitates dispersion by anemophilia.

Hyphal system monomitic, with generative hyphae, hyaline, septate, ranging from brownish yellow (5C7) to brownish orange (6C8), thin-walled to thick-walled, occasionally branched, 3.0-6.6 µm in diam. Setal hyphae abundant in context, lanceolate, yellowish brown (5D5), thick-walled with a large lumen, with pointed apex, occasionally parallel to the hymenium, 8−20 µm in diam. and 110−200 µm long. Hymenial setae abundant, ventricular to subulate, dark brown (6F8), 14.3-63 × 5.0-18.4 µm, with thick-walled. Basidia hyaline, clavate to cylindric, 10 × 6.5 µm, with projection of four sterigmatic structures. Basidiospores abundant, subglobose to ellipsoid, (5.4) 5.9−8.7 (9.5) × (3.6) 4.3−6.2 (6.5) µm (Q = (1) 1.2−1.6 (2.1), Qm = 1.4, N = 50), golden yellow (5B7) to yellowish brown (5D5), dark brown (6F3), inamyloid, smooth with thick-walled. Chlamydospores abundant in the context, inamyloid, irregular, globose to subglobose, (7.4) 9.1−13.7 (15.5) × (6.9) 8.0−11.6 (13.9) µm (Q = 1.0−1.3 (1.9), Qm = 1.1, N = 50), orange (6A8) to reddish orange (7A8), dark brown (6F3), smooth with thick-walled.

In culture presents velutinous to cottony mycelium, occupying the entire length of the petri dish (90 × 15 mm) in 2 weeks of cultivation, yellowish white (2A2) when young, becoming grayish yellow (4B4) to dark yellow (4C8) when mature, production of exudates in the form of reddish orange droplets (8A8). Abundant production of chlamydospores of various shapes, occasionally attached to setal hyphae, also abundant and parallel in the hyphalic trama. The color and size characteristics of the cultures' microstructures are in accordance with those observed in the basidiomata.

Worldwide geographical distribution: Widespread in tropical and subtropical zones, considered then pantropical; common on the American continent, especially in Central and South America and the Mediterranean region, rare in temperate zones. There are records of the species in Argentina, Bahamas, Bermuda Islands, Brazil, Chile, China, Colombia, Costa Rica, Cuba, Egypt, France, Greece, Guadeloupe, Guinea, Haiti, India, Iran, Israel, Italy, Jamaica, Martinique, Mexico, Montenegro, Morocco, Myanmar, Pakistan, Paraguay, Peru, Philippines, Portugal, South Africa, Spain, Taiwan, United States, and Uruguay (Figure 4) (Seaver and Waterston, 1946; Jaquenoud, 1985; Kotlaba and Pouzar, 1994; Chang and Fu, 1998; Stalpers, 2000; Melo et al., 2002; Ryvarden, 2005; Martínez, 2006; Mata et al., 2007; Ghobad-Nejhad and Kotiranta, 2008; Annesi et al., 2010; Campos-Santana and Loguercio-Leite, 2010; Ţura et al., 2010; De Simone et al., 2011; Ouabbou et al., 2012; Shehata and Abdel-Wahab, 2013; Valenzuela et al., 2013; Cui et al., 2014; García et al., 2014a; Robles et al., 2015a; Sepúlveda et al., 2016; Villalobos et al., 2017; Maubet, 2020; Tchoumi et al., 2020). Table 1 show detailed description of the species' worldwide geographic distribution, which contains the exact sampling location of each specimen described in the literature data found.

Geographical distribution in Brazil: There are records in the Atlantic Forest areas in Pernambuco, Rio Grande do Sul and Santa Catarina, Caatinga areas in Alagoas and Bahia (record not shown in Figure 1, as the specific location was not found), Pampa areas in Rio Grande do Sul, and Cerrado areas (present study) in Goiás and São Paulo (Figure 1) (Campos-Santana and Loguercio-Leite, 2010; Maia et al., 2015).

Habitat and substrate: We collect our specimens in the mesophilic forest in both stages of life, on dead wood and an unknown living host, and in urban areas in the anamorphic stage on living and dead *S. molle* trees. In the data set listed in the present review, we found 70 plant species distributed in 43 genera and 22 families (Table 2). Of these hosts, *A. negundo* (representing 10.5% of the total species), *C. australis* 6.5% and *Platanus acerifolia* 4.8%. On the family level Fabaceae came first by accounted 30% out of all host families followed by Fagaceae (10%) and Sapindaceae (8.6%). In the checklist, the host species referred as sp. or spp., were accounted for as a single species. Table 2 presents a complete list of *I. rickii* hosts.

Figure 2. *Inonotus rickii*. **A.** Basidiome (HUEG 12067). **B.** Anamorphic stage (HUEG 12062). **C.** Chlamydospores attached to setal hyphae. **D.** Generative hyphae, hyaline with simple septate (arrow). **E.** Hymenial setae. **F.** Setal hyphae and abundant chlamydospores. **G.** Basidia hyaline, with projection of four sterigmatic structures and attached basidiospores. **H.** Basidiospores. Bar = 1 cm **(A, B)**; 5 mm **(C)**; 5 mm **(D–H)**.

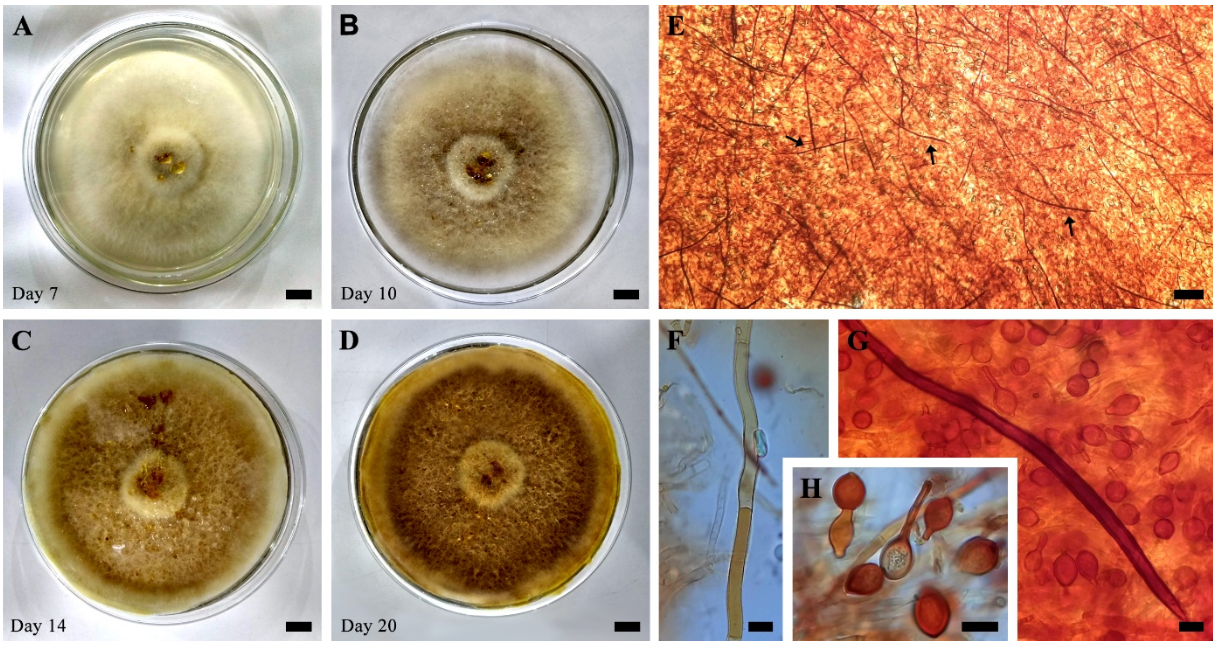

Figure 3. A–D. Evolution of growth in cultivation (SXS 37) in PDA at 25 °C for 20 days. **E.** Mycelial trama showing abundant setal hyphae (arrows). **F.** Generative hyphae. **G.** Setal hyphae and chlamydospores. **H.** Chlamydospores. Bar = 1 cm **(A–D)**; 100 mm **(E)**; 10 mm **(F–H)**.

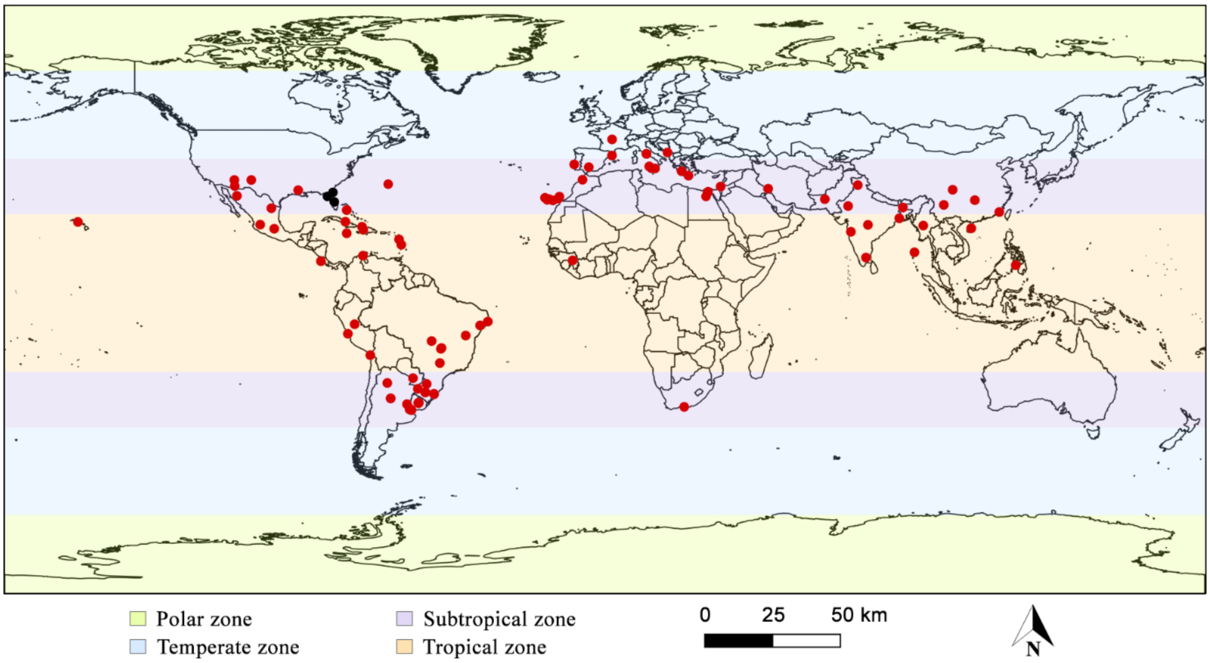

Figure 4. Global geographical distribution of *Inonotus rickii*. Black dots highlight samples that may belong to another species, according to De Simone et. al (2011) and Cui et. al (2014).

Table 1. Referenced literature for the global geographical distribution of *Inonotus rickii*. *Records of uncertain identification, according to De Simone et al. (2011) and Cui et. al (2014).

Country	Locality	Reference
Argentina	Acassuso, Buenos Aires Province	(Gottlieb et al., 2002)
	Argentina (location not specified)	(Intini, 1988)
	Buenos Aires City	(Gottlieb et al., 2002; Mielnichuk and Lopez, 2007; Robles et al., 2011, 2012, 2015a, 2015b)
	Buenos Aires Province	(Gottlieb et al., 2002)
	Córdoba, Córdoba Province	(Urcelay et al., 2012)
	Gualeguay, Entre Ríos Province	(Gottlieb et al., 2002)
	La Plata, Buenos Aires Province	(Gottlieb et al., 2002; Wright and Alberto, 2006; Murace et al., 2019)
	Llavallol, Buenos Aires Province	(Gottlieb et al., 2002)
	Lomas de Zamora, Buenos Aires Province	(Gottlieb et al., 2002)
	Martínez, Buenos Aires Province	(Gottlieb et al., 2002)
	Rosario del Tala, Entre Ríos Province	(Gottlieb et al., 2002)
	Santo Tomé, Corrientes Province	(Gottlieb et al., 2002)
	Tucumán Province	(Gottlieb et al., 2002)
	Valle de Traslasierra, Córdoba Province	(Flamini et al., 2015)
	Yacanto, Córdoba Province	(Gottlieb et al., 2002)
Bahamas	Bahamas (location not specified)	(Intini, 1988; Ryvarden, 2005)
	Nassau	(Davidson et al., 1942)
Bermuda Islands	Bermuda Islands (location not specified)	(Seaver and Waterston, 1946)
Brazil	Anápolis, Goiás	Present study
	Bahia	(Davidson et al., 1942; Stalpers, 2000)
	Brazil (location not specified)	(Davidson et al., 1942; Ryvarden, 1983; Intini, 1988)
	Goiânia, Goiás	Present study
	Ipojuca, Pernambuco	(Maia et al., 2015)
	Mondaí, Santa Catarina	(Campos-Santana and Loguercio-Leite, 2010)
	Porto Alegre, Rio Grande do Sul	(Campos-Santana and Loguercio-Leite, 2010)
	Santa Maria, Rio Grande do Sul	(Campos-Santana and Loguercio-Leite, 2010)
	São José da Tapera, Alagoas	(Drechsler-Santos et al., 2013)
	São José do Rio Preto-Mirassol, São Paulo	Present study
Chile	Arica, Arica Province	(Sepúlveda et al., 2016)
China	Hainan Province	(Cui et al., 2009; Dai et al., 2010; Yuan et al., 2015)
	Jianyang, Sichuan Province	(Zheng et al., 2011)
	Panzhihua, Sichuan Province	(Chen et al., 2014; Cui et al., 2014)
Colombia	Uribia, Guajira	(Villalobos et al., 2017)
Costa Rica	Puntarenas, Cóbano	(Mata et al., 2007)
Cuba	Cuba (location not specified)	(Murrill, 1919; Intini, 1988; Stalpers, 2000)
Egypt	Beni Suef Province	(Shehata and Abdel-Wahab, 2013)
	Giza Province	(Shehata and Abdel-Wahab, 2013)
	Qalubyia Province	(Shehata and Abdel-Wahab, 2013)
France	France (location not specified)	(Ryvarden, 2005)
Greece	Crete, Iráklion	(Kotlaba and Pouzar, 1994)
	Monemvasia, Laconia	(De Simone et al., 2011)
Guadeloupe	Guadeloupe (location not specified)	(Jaquenoud, 1985; Intini, 1988)
Guinea	Guinea (location not specified)	(Jaquenoud, 1985; Intini, 1988)

Table I (continued)

Country	Locality	Reference
Haiti	Haiti (location not specified)	(Davidson et al., 1942; Intini, 1988)
	Tortuga Island	(Davidson et al., 1942)
India	Andaman and Nicobar Islands, Manjari	(Sharma and Mishra, 2015)
	Calcutta, West Bengal	(Davidson et al., 1942)
	Dindigul, Tamil Nadu	(Mowna Sundari et al., 2018)
	India (location not specified)	(Intini, 1988; Ryvarden, 2005)
	Jodhpur, Rajasthan	(Singh et al., 2013)
	Pune, Maharashtra	(Jagtap et al., 2018)
	Western and Eastern Himalaya	(Sharma and Mishra, 2015)
Iran	Khuzestan Province	(Ghobad-Nejhad and Kotiranta, 2008)
Israel	Tel Aviv	(Ţura et al., 2010)
Italy	Catania, Sicily	(Intini, 1988; Annesi et al., 2005, 2010; De Simone et al., 2011)
	Palermo, Sicily	(Jaquenoud, 1985; Venturella and Raimondo, 2004; Annesi et al., 2005, 2010; Venturella et al., 2006; De Simone et al., 2011)
	Roma	(Annesi et al., 2003, 2010, 2015; Mazza et al., 2008; De Simone et al., 2011)
	Sicily	(Ryvarden, 2005)
Jamaica	Jamaica (location not specified)	(Jaquenoud, 1985; Intini, 1988)
Marocco	Forest of Mamora	(Ouabbou et al., 2012)
	Marocco (location not specified)	(Intini, 1988)
Martinique	Fort-de-France	(David and Rajchenberg, 1985; Jaquenoud, 1985; Intini, 1988)
Mexico	Jalisco	(Valenzuela et al., 2013)
	Mexico City	(Valenzuela et al., 2013)
	Nuevo León	(Valenzuela et al., 2013)
	Sonora	(Esqueda et al., 2010; Valenzuela et al., 2013)
	Sonoran Desert, Nacapule Canyon	(Raymundo et al., 2013)
Montenegro	Budva	(Kotlaba and Pouzar, 1994)
Myanmar	Myanmar (location not specified)	(Jaquenoud, 1985; Intini, 1988)
Pakistan	Pakistan (location not specified)	(Jaquenoud, 1985; Intini, 1988)
Paraguay	San Lorenzo	(Maubet, 2020)
Peru	Peru (location not specified)	(Intini, 1988; Ryvarden, 2005)
	Lima	(Davidson et al., 1942)
Philippines	Mindanao	(Gottlieb et al., 2002)
Portugal	Lisboa	(Melo et al., 2002; Ramos et al., 2008)
South Africa	Knysna, Western Cape Province	(Tchoumi et al., 2017, 2020)
Spain	Barcelona	(De Simone et al., 2011)
	Canary Islands, Rosa del Taro	(García et al., 2014a)
	Córdoba	(De Simone et al., 2011)
	Gran Canaria, Canary Islands	(Vergara et al., 2016)
	La Gomera, Canary Islands	(García et al., 2014b)
	La Palma, Canary Islands	(García et al., 2014b)
	Lanzarote, Canary Islands	(García et al., 2014b)
	Seville	(Intini, 2002a, 2002b; Intini and Tello, 2003)
	Spain (location not specified)	(Intini, 2002b)
	Tenerife, Canary Islands	(García et al., 2014b)
Taiwan	Kinmen County	(Chang and Fu, 1998)

Table I (continued)

Country	Locality	Reference
United States	Arizona	(Gilbertson et al., 1974; Ryvarden, 2004, 2005)
	Florida	(Davidson et al., 1942; Gilbertson and Ryvarden, 1986; Intini, 1988; Barnard, 1993; Ryvarden, 2004, 2005)
	Hawaii (location not specified)	(Intini, 1988)
	Hawthorne, Florida*	(De Simone et al., 2011)
	Jacksonville, Florida*	(De Simone et al., 2011)
	Levy County, Florida*	(De Simone et al., 2011)
	Louisiana	(Davidson et al., 1942; Gilbertson and Ryvarden, 1986; Intini, 1988; Ryvarden, 2004, 2005)
	New Mexico	(Sanogo and Lujan, 2018)
	Oahu, Hawaii	(Davidson et al., 1942)
	Tucson, Arizona	(Gilbertson and Ryvarden, 1986)
Uruguay	Uruguay (location not specified)	(Martínez, 2006)

Table 2. Checklist of hosts of *Inonotus rickii* reported in the literature. Absolute frequency (AF) = number of times that species was cited (n = 125); relative frequency (RF) = percentage of citations of the species in relation to the total of host species found. *Records of uncertain identification, according to De Simone et al. (2011) and Cui et. al (2014). **Articles that present the same data.

Family	Host species	AF	RF(%)
Adoxaceae	*Sambucus nigra* L. (Kotlaba and Pouzar, 1994; Annesi et al., 2003, 2005; De Simone et al., 2011)	4	3.2
Anacardiaceae	*Lithraea molleoides* (Vell.) Engl. (Flamini et al., 2015)	1	0.8
	Pistacia atlantica Desf. (Vergara et al., 2016)	1	0.8
	Schinus areira L. (Urcelay et al., 2012)	1	0.8
	Schinus molle L. (Intini, 1988, 2002b**; Annesi et al., 2003; Intini and Tello, 2003**; García et al., 2014a; Sepúlveda et al., 2016)	5	4.0
	Spondias sp. (Drechsler-Santos et al., 2013)	1	0.8
Altingiaceae	*Liquidambar styraciflua* L. (Nakasone, 1993)	1	0.8
Casuarinaceae	*Casuarina cunninghamiana* Miq. (Gottlieb et al., 2002)	1	0.8
	Casuarina equisetifolia L. (Valenzuela et al., 2013)	1	0.8
	Casuarina spp. (Gilbertson and Ryvarden, 1986; Wright and Alberto, 2006)	2	1.6
Cannabaceae	*Celtis australis* L. (Kotlaba and Pouzar, 1994; Gottlieb et al., 2002; Intini, 2002b**; Melo et al., 2002; Annesi et al., 2003, 2015; Intini and Tello, 2003**; Mazza et al., 2008; Ramos et al., 2008)	8	6.5
	Celtis iguanaea (Jacq.) Sarg. as *Celtis ehrenbergiana* (Klotzsch) Liebm. (Urcelay et al., 2012)	1	0.8
	Celtis spinosa Spreng. (Gottlieb et al., 2002)	1	0.8
	Celtis tala Gillies ex Planch. (Wright et al., 1988; Gottlieb et al., 2002)	2	1.6
	Celtis sp. (Wright and Alberto, 2006)	1	0.8
Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg. (Cui et al., 2009; Dai et al., 2010)	2	1.6
Fabaceae	*Acacia caven* (Molina) Molina (Flamini et al., 2015)	1	0.8
	Acacia koa A. Gray (Davidson et al., 1942)	1	0.8
	Acacia melanoxylon R. Br. (Gottlieb et al., 2002)	1	0.8

Table II (continued)

Family	Host species	AF	RF(%)
Fabaceae	*Acacia praecox* Griseb. (Urcelay et al., 2012)	1	0.8
	Acacia richii A. Gray (Cui et al., 2014)	1	0.8
	Acacia visco Griseb. (Urcelay et al., 2012)	1	0.8
	Albizia julibrissin Durazz. (Annesi et al., 2007; Mazza et al., 2008)	2	1.6
	Albizia lebbeck (L.) Benth. (Ghobad-Nejhad and Kotiranta, 2008)	1	0.8
	Albizia sp. (Pieri and Rivoire, 1996)	1	0.8
	Cercidium sp. (Gilbertson and Ryvarden, 1986)	1	0.8
	Delonix regia (Hook.) Raf. (Tura et al., 2009; Ţura et al., 2010; Jagtap et al., 2018; Maubet, 2020)	4	3.2
	Gleditsia sinensis Lam. (Zheng et al., 2011)	1	0.8
	Haematoxylon brasiletto H. Karst (Villalobos et al., 2017)	1	0.8
	Parkinsonia aculeata L. (Gilbertson et al., 1974; Jaquenoud, 1985)	2	1.6
	Parkinsonia praecox (Ruiz & Pav.) Hawkins (Villalobos et al., 2017)	1	0.8
	Parkinsonia spp. (Jaquenoud, 1985, 1987; Gilbertson and Ryvarden, 1986; Ryvarden and Gilbertson, 1993; Annesi et al., 2003)	5	4.0
	Prosopis cineraria (L.) Druce (Singh et al., 2013)	1	0.8
	Prosopis juliflora (Sw.) DC. (Singh et al., 2013; Villalobos et al., 2017)	2	1.6
	Robinia pseudoacacia L. (Mazza et al., 2008; De Simone et al., 2011; Annesi et al., 2015)	3	2.4
	Styphnolobium japonicum (L.) Schott (Urcelay et al., 2012)	1	0.8
	Tamarindus indica L. (Davidson et al., 1942; David and Rajchenberg, 1985**; Jaquenoud, 1987**)	2	1.6
Fagaceae	*Quercus laevis* Walter as *Quercus catesbaei* Michx. (Davidson et al., 1942)	1	0.8
	Quercus cerris L. (Annesi et al., 2005; Fodor and Hâruta, 2016)	2	1.6
	Quercus laurifolia Michx. (Gilbertson and Ryvarden, 1986)	1	0.8
	Quercus nigra L. (Davidson et al., 1942)	1	0.8
	Quercus phellos L. (Davidson et al., 1942)	1	0.8
	Quercus sp. (Gilbertson and Ryvarden, 1986)	1	0.8
	Quercus geminata Small as *Quercus virginiana* var. *geminata* (Small) Sarg. (Davidson et al., 1942)	1	0.8
Icacinaceae	*Apodytes dimidiata* E. Mey. ex Arn. as *Apodytes dimidiata* subsp. *dimidiata* (Tchoumi et al., 2017)	1	0.8
Juglandaceae	*Carya illinoinensis* (Wangenh.) K. Koch (Sanogo and Lujan, 2018)	1	0.8
Malvaceae	*Chorisia* spp. (Urcelay et al., 2012)	1	0.8
	Brachychiton sp. (Murace et al., 2019)	1	0.8
Moraceae	*Ficus carica* L. (Michailides, 2003)	1	0.8
	Morus spp. (Urcelay et al., 2012)	1	0.8
Myricaceae	*Morella cerifera* (L.) Small as *Myrica cerifera* L. (Davidson et al., 1942; Seaver and Waterston, 1946; Gilbertson and Ryvarden, 1986; De Simone et al., 2011*)	4	3.2
	Myrica sp. (Gilbertson and Ryvarden, 1986)	1	0.8
Oleaceae	*Fraxinus* sp. (Valenzuela et al., 2013)	1	0.8
	Olea capensis subsp. *macrocarpa* (C. H. Wright) I. Verd. (Tchoumi et al., 2017**, 2020**)	1	0.8
Platanaceae	*Platanus acerifolia* (Aiton) Willd. (Mazza et al., 2008; Robles et al., 2011, 2012, 2015a, 2015b; Annesi et al., 2015)	6	4.8
	Platanus × hispanica Mill. ex Münchh as *Platanus x hybrida* Brot. (Intini, 2002b; Intini and Tello, 2003)	1	0.8
	Platanus spp. (Gottlieb et al., 2002; Intini and Tello, 2003; Wright and Alberto, 2006)	3	2.4
Rhamnaceae	*Ziziphus spina-christi* (L.) Desf. (Ghobad-Nejhad and Kotiranta, 2008)	1	0.8
Rutaceae	*Citrus* spp. (Shehata and Abdel-Wahab, 2013)	1	0.8
Salicaceae	*Dovyalis caffra* (Hook.f. & Harv.) Sim as *Aberia caffra* Hook. f. & Harv. (Annesi et al., 2005)	1	0.8

Table II (continued)

Family	Host species	AF	RF(%)
Sapindaceae	*Acer negundo* L. (Pegler, 1967; Wright et al., 1988; Gottlieb et al., 2002; Intini, 2002a**, 2002b**; Annesi et al., 2003, 2010, 2015; Intini and Tello, 2003**; Venturella and Raimondo, 2004; Venturella et al., 2006; Wright and Alberto, 2006; Mazza et al., 2008; De Simone et al., 2011; Murace et al., 2019)	13	10.5
	Acer saccharinum L. (Gilbertson and Ryvarden, 1986)	1	0.8
	Acer sp. (Gottlieb et al., 2002)	1	0.8
	Koelreuteria paniculata Laxm. (Annesi et al., 2007; Mazza et al., 2008)	2	1.6
	Melicoccus bijugatus Jacq. (Pegler, 1967)	1	0.8
	Sapindus saponaria L. (Melo et al., 2002)	1	0.8
Ulmaceae	*Ulmus* sp. (Murace et al., 2019)	1	0.8
Verbenaceae	*Aloysia citriodora* Palau as *Lippia citriodora* (Palau) Kunth (Gottlieb et al., 2002)	1	0.8
	Lippia sp. (Wright and Alberto, 2006)	1	0.8
Vitaceae	*Vitis* spp. (Shehata and Abdel-Wahab, 2013)	1	0.8

Material examined: BRAZIL. São Paulo: São José do Rio Preto-Mirassol, Estação Ecológica do Noroeste Paulista, 13/XI/2001, *Xavier-Santos, S. (SJRP 28714)*, teleomorphic stage, found growing on fragment of dead wood, unknown host, isolated in culture with voucher number *SXS 37;* Goiás: Silvânia, Floresta Nacional de Silvânia, 26/VI/2009, *Xavier-Santos, S. (HUEG 13945)*, anamorphic stage, growing on living tree, unknown host; Goianápolis-Goiânia-Nerópolis, Parque Estadual Altamiro de Moura Pacheco, 08/VIII/2014, *Xavier-Santos, S. (HUEG 12067)*, teleomorphic stage, found growing on living tree, unknown host; Anápolis, urban area, 20/III/2011, *Xavier-Santos, S. (HUEG 13944)*, anamorphic stage, growing on living tree, unknown host; Parque Ipiranga, 19/IX/2018, *Leonardo-Silva, L. (HUEG 12062)*, anamorphic stage, growing on a dead ornamental tree of *S. molle*, isolated in culture with voucher number *SXS 641*; ibid, 05/XII/2018, *Leonardo-Silva, L. (HUEG 11993)*, anamorphic stage, growing on living *S. molle*; ibid, 27/V/2019, *Leonardo-Silva, L. (HUEG 12063)*, anamorphic stage, growing on dead *S. molle*; ibid, 09/V/2020, *Leonardo-Silva, L. (HUEG 12994)*, anamorphic stage, growing on living *S. molle*; ibid, 09/V/2020, *Leonardo-Silva, L. (HUEG 12996)*, anamorphic stage, growing on dead *S. molle*; ibid, 09/V/2020, *Leonardo-Silva, L. (HUEG 12997)*, anamorphic stage, growing on living *S. molle*; ibid, 10/XI/2020, *Leonardo-Silva, L. (HUEG 13946)*, anamorphic stage, growing on dead *S. molle*.

Examined reference material: BRAZIL. Rio Grande do Sul: Santa Maria, 11/I/1993, *Gilberto Coelho (24–9) (ICN 097679)*; Alagoas: São José da Tapera, 17/VI/2008, *Drechsler-Santos (6) (URM 80418)*, on living tree, unknown host; ibid, 17/VI/2008, *Drechsler-Santos (21) (URM 80460)*, growing on living tree of *Spondias* sp. (Umbuzeiro); ibid, 17/VI/2008, *Drechsler-Santos (18) (URM 80582)*, an unknown living tree.

Comments: The morphological characteristics observed in collected samples coincide with those described by many authors (Gottlieb et al., 2002; Melo et al., 2002; Ryvarden, 2005). Measurements of setal hyphae recorded by Ryvarden (2005) and Campos-Santana and Loguercio-Leite (2010) were up to 250 mm or more long. Although these measurements are similar to our samples, we recorded smaller hyphal setae ranged between 110 and 200 mm in the examined materials and pure cultures. *I. rickii* is similar to *Inonotus patouillardii* (Rick) Imazeki in the field but differentiating itself by the abundant presence of chlamydospores. Our specimens were collected during both rainy and drought periods which reflected the resistance to the climatic variations of the Cerrado.

Discussion

Our study expands and shed the light on the geographic distribution of the species with special reference to the Cerrado biome and updated list of plant hosts. *I. rickii* is easily described by the massive production of chlamydospores *in vitro* and *in vivo*, mainly in the anamorphic stage, and the presence of setal hyphae in the context (Pegler, 1964; Melo et al., 2002; Ramos et al., 2008; Tura et al., 2009; Maubet, 2020). In all of our specimens we observe these characteristics. Furthermore, the taxonomic criteria observed in pure cultures are compatible with those described by Ramos et al. (2008) and Tura et al. (2009).

Inonotus rickii is considered one of the most nocive basidiomycete in urban trees (Ramos et al., 2008), parasitizing a large number of hosts, thus being able to form an effective biological corridor in the dissemination of the pathogen in this environment (Annesi et al., 2010). The infection of these trees has a great impact in some regions of the world, as ornamental trees when parasitized and with symptoms of the disease, lose their ornamental value and represent a great danger to other members of the population (Ramos et al., 2008).

In Europe, especially in Italy (Annesi et al., 2010) and Portugal (Ramos et al., 2008), it has been reported that canker caused in plant tissues has reduced the number of ornamental tree species in urban environments. In addition, in the Wayuu indigenous community in Colombia, it has been reported that the fungus has had an impact on local native vegetation, also parasitizing species of daily use, such as *Parkinsonia praecox* and *Haematoxylon brasiletto*, used for resin and paint extraction, respectively (Villalobos et al., 2017).

The most frequent host species of *I. rickii* are widely known as ornamental trees. However, some of the reported hosts are used as a food source (Barolo et al., 2014; Viveros García et al., 2018) or for extracting compounds for different applications (Sharma et al., 2018;

Milena et al., 2019). This warns of the need to know the impact of *I. rickii* on species of local, regional and worldwide economics.

Our specimens were detected growing at the base of the stem and on main branches of living and dead trees, usually in the anamorphic stage. Only specimens SJRP 28714 and HUEG 12067 were sampled in their teleomorphic stage. Although the species produces reproductive structures in both stages of the life cycle, the teleomorphic phase occurs occasionally, with the anamorphic stage usually frequent (Mazza et al., 2008; Ramos et al., 2008).

The propagation of the species occurs mainly by the production and release of chlamydospores, which are more abundant in the anamorphic phase. At this stage, a structure sensitive to touch appears, which releases a large number of chlamydospores. On this occasion, in urban environments, dispersal is facilitated by tactile gardening activities in the maintenance of squares and parks, by anemophilia, by the contact of insects and other animals, including the flux of human traffic (Annesi et al., 2010). We observed that all specimens collected in an urban area (HUEG 11993, 12062, and 12063) were in the anamorphic stage and the dispersion of chlamydospores may have been facilitated by the activities mentioned before. Infection and development of the fungus occur when its spores (basidiospores or chlamydospores) are deposited on susceptible hosts, preferably due to the presence of dead wounds, scars, or fragments; these spores then germinate and promote the growth of the fungus within wood tissues (Phillips and Burdekin, 1989).

In the present study, we report for the first time occurrence of *I. rickii* on *S. molle* in Brazil. The fungus was found either as saprobic or as a pathogen, causing canker of the host plant. Belonging to the Anacardiaceae family, *S. molle* is an arboreal and perennial species, popularly known as pepper tree, pink pepper, American pepper, false pepper, aroeira salsa (Brazil) or aroeira mansa (Brazil). It is native to South America, but it was introduced and naturalized in several regions of the world, mainly as an ornamental in urban environments. Its great popularity as a cultivated plant is associated with its high tolerance to water and temperature availability, high growth rate and medicinal properties (Kramer, 1957; Goldstein and Coleman, 2004; Habte et al., 2020).

Anamorphic samples infected *S. molle* (HUEG 11993, 12062, and 12063) were developed over the trunk and main branches of the living and dead host. We observed that the individuals growing in the dead host (HUEG 12062 and 12063) occupied a large extension of the wood between the bark and bark, projecting over the crevices of the stem and reaching to the heart (Figure 5). On the other hand, samples that grew on a living host (HUEG 11993), initial canker development was observed, possibly due to the time of maturity of the fungus that was in the early stages of development (Figure 5). The presence of *I. rickii* in this plant has already been reported in Portugal (Melo et al., 2002), Chile, and Spain (Intini and Tello, 2003; Sepúlveda et al., 2016).

Figure 5. *Inonotus rickii* in its anamorphic stage on *Schinus molle*. **A–C.** Fruiting projecting between the bark and heartwood of dead tree. **D.** Initial projection of the fruiting body on living tree. **E.** Powdery, rust-colored coating on the wood, which was formed by the deposition of chlamydospores when removing fruiting; it is also possible to observe the lesions (arrows) caused by the infection along the trunk. Bar = 2 cm.

Parallel to studies of phytopathological interest, *I rickii* has also been the subject of studies to prospect for secondary metabolites and lignocellulolytic enzymes involved in attacking the host and degrading the constituents of wood (Xavier-Santos et al., 2004; Tura et al., 2009; Chen et al., 2014), aiming, above all, at an option sustainable in the bioremediation of recalcitrant compounds. The species is also associated with cultural events in the Wayuu indigenous community, Colombia, in which women apply a layer of chlamydospores to their face, previously treated with sheep tallow to protect themselves from solar radiation (Villalobos et al., 2017). Moreover, taxonomic and phylogenetic aspects are still performed, specially to understand its anamorphic stage.

Although molecular studies carried on different samples confirmed the relationship between anamorphic and teleomorphic phases of I. rickii. A preliminary phylogenetic analysis of samples (anamorphic and teleomorphic) collected from different geographical origins showed came from Florida, United States, were separated from those came from Asia, South America and Europe (De Simone et al., 2011; Cui et al., 2014). An interesting aspect to consider that all species from the Florida were collected in the anamorphic stage and the teleomorphic stage has never been recorded in North America. These results suggest the existence of two possible distinct species and are reinforced by morphophysiological, ecological data and climatic conditions (De Simone et al., 2011; Cui et al., 2014). However, studies that analyze isolates from North America and other regions, as well as the holotype of both stages of life, are necessary to confirm the distinction.

Conclusion

Our study expands the knowledge of geographical distribution of *I. rickii*, including the Cerrado biome, as well as of its structural, physiological characteristics, and its hosts. Although common in tropical and subtropical regions, the specimens described here constitute the first documented records of the species for the Brazilian Cerrado and for the Midwest and Southeast regions, in addition to the first report on *S. molle* within Brazil. The checklist of hosts provided may assist in the development of practices for the control of the pathogen in urban areas with a high incidence of infections. Therefore, it should be mentioned here that, although the present study adds new data to information concerning *I. rickii*, this updated checklist must be considered as a provisional one always waiting for continuous supplementation.

Author contributions

LLS and SXS designed this study, collected and analyzed the samples, and wrote the manuscript text. LLS prepared figures and tables. AMAA reviewed and edited the manuscript. All authors have read and approved to the published version of the manuscript.

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References

Annesi, T., Bressanin, D., Coppola, R., Mazza, G., and Motta, E. (2007). Osservazioni su *Inonotus rickii* in alberate cittadine. *Micol. Ital.* 36, 39–43.

Annesi, T., Calienno, L., Picchio, R., De Simone, D., and Lo Monaco, A. (2015). Degradation of some technological features in the wood of ornamental species caused by *Inonotus rickii* (Pat.) Reid. *Drewno* 58, 5–18. doi:10.12841/wood.1644-3985.136.01.

Annesi, T., Coppola, R., D'Amico, L., and Motta, E. (2005). First report of *Aberia caffra* and *Quercus cerris* as hosts of *Inonotus rickii*. *Plant Dis.* 89, 107–107. doi:10.1094/PD-89-0107C.

Annesi, T., Coppola, R., and Motta, E. (2003). Decay and canker caused by *Inonotus rickii* spreading on more urban tree species. *For. Pathol.* 33, 405–412. doi:10.1046/j.1437-4781.2003.00340.x.

Annesi, T., D'Amico, L., Bressanin, D., Motta, E., and Mazza, G. (2010). Characterization of Italian isolates of *Inonotus rickii*. *Phytopathol. Mediterr.* 49, 301–308. doi:10.14601/Phytopathol_Mediterr-8402.

Barnard, E. L. (1993). *Inonotus rickii* (Anamorph: *Ptychogaster cubensis*): A wood-decaying fungus of importance to Florida. *Plant Pathol. Circ.*, 10–12.

Barolo, M. I., Ruiz Mostacero, N., and López, S. N. (2014). *Ficus carica* L. (Moraceae): An ancient source of food and health. *Food Chem.* 164, 119–127. doi:10.1016/j.foodchem.2014.04.112.

Campos-Santana, M., and Loguercio-Leite, C. (2010). Austro-American lignocellulolytic basidiomycetes (Agaricomycotina): new records. *Mycotaxon* 114, 377–392. doi:10.5248/114.377.

Castellani, A. (1963). Further researches on the long viability and growth of many pathogenic fungi and some bacteria in sterile distilled water. *Mycopathol. Mycol. Appl.* 20, 1–6. doi:10.1007/BF02054872.

Chang, T., and Fu, C.-S. (1998). Studies on eight species of polypores from Taiwan. *Fungal Sci.* 13, 75–83.

Chen, H.-P., Dong, W.-B., Feng, T., Yin, X., Li, Z.-H., Dong, Z.-J., et al. (2014). Four new sesquiterpenoids from fruiting bodies of the fungus *Inonotus rickii*. *J. Asian Nat. Prod. Res.* 16, 581–586. doi:10.1080/10286020.2014.925451.

Cui, B. K., Yu, C. J., and Li, H. J. (2009). Two species of *Inonotus* (Hymenochaetaceae) new to China. *For. Res.* 22, 784–787.

Cui, B. K., Zhao, C. L., Vlasák, J., and Dai, Y. C. (2014). A preliminary report on decay and canker of *Acacia richii* caused by *Inonotus rickii* in China. *For. Pathol.* 44, 82–84. doi:10.1111/efp.12088.

Dai, Y. C., D'Amico, L., Motta, E., and Annesi, T. (2010). First report of *Inonotus rickii* causing canker and decay on *Hevea brasiliensis* in China. *Plant Pathol.* 59, 806–806. doi:10.1111/j.1365-3059.2009.02253.x.

David, A., and Rajchenberg, M. (1985). Pore fungi from French Antilles and Guiana. *Mycotaxon* 22, 285–325.

Davidson, R. W., Campbell, W. A., and Weber, G. F. (1942). *Ptychogaster cubensis*, a wood-decaying fungus of southern oaks and waxmyrtle. *Mycol. Soc. Am.* 34, 142–153.

De Simone, D., D'Amico, L., Bressanin, D., Motta, E., and Annesi, T. (2011). Molecular characterization of *Inonotus rickii*/*Ptychogaster cubensis* isolates from different geographic provenances. *Mycol. Prog.* 10, 301–306. doi:10.1007/s11557-010-0702-5.

Drechsler-Santos, E. R., Gibertoni, T. B., Calvacanti, M. A. de Q., Ryvarden, L., and Góes-Neto, A. (2013). "Basidiomycota Polypores - Orelhas de pau," in *Guide to the Common Fungi of the Semiarid Region of Brazil* (Florianópolis: Tecc Editora).

Eccles, R., Zhang, H., and Hamilton, D. (2019). A review of the effects of climate change on riverine flooding in subtropical and tropical regions. *J. Water Clim. Chang.* 10, 687–707. doi:10.2166/wcc.2019.175.

Esqueda, M., Coronado, M., Gutierrez, A., Valenzuela, R., Chacón, S., Gilbertson, R. L., et al. (2010). "Hongos," in *Diversidad biológica de Sonora*, eds. F. E. M. Freaner and T. R. Van

Devender (Mexico: BMC Public Health), 496.

Flamini, M., Robledo, G. L., and Suárez, M. E. (2015). Nombres y clasificaciones de los hongos según los campesinos de La Paz (Valle de Traslasierra, Córdoba, Argentina). *Boletín la Soc. Argentina Botánica* 50, 265–289.

Fodor, E., and Hâruta, O. (2016). *Quercus Robur*, *Q. Cerris* and *Q. Petraea* as hot spots of biodiversity. *J. Plant Dev.* 23, 187–210.

García, V. J. E., Inchaurtieta, E. B., Martín, L. C., López-Quintanilla, J. F., Rodríguez-Cabrera, C. C., and Vergara, J. I. V. (2014a). Dos nuevos hongos para la isla de Fuerteventura. *Majorensis* 10, 29–36.

García, V. J. E., Romero, D. B., Cabrera, C. C. R., and Godoy, S. J. (2014b). Revisión y actualización de la biota fúngica de la isla de Fuerteventura. in *XXI Coloquio de Histo- ria Canario-Americana (2014)*.

Ghobad-Nejhad, M., and Kotiranta, H. (2008). The genus *Inonotus* Sensu lato in Iran, with Keys to *Inocutis* and *Mensularia* worldwide. *Ann. Bot. Fenn.* 45, 465–476. doi:10.5735/085.045.0605.

Gilbertson, R. L., Martin, K. J., and Lindsey, J. P. (1974). *Annotated check list and host index for Arizona wood-rotting fungi*. Tucson, Arizona: College of Agriculture, University of Arizona.

Gilbertson, R. L., and Ryvarden, L. (1986). *North American polypores*. Oslo, Norway: Fungiflora.

Goldstein, D. J., and Coleman, R. C. (2004). *Schinus molle* L. (Anacardiaceae) Chicha production in the Central Andes. *Econ. Bot.* 58, 523–529. doi:10.1663/0013-0001(2004)058[0523:SMLACP]2.0.CO;2.

Gottlieb, A. M., Wright, J. E., and Moncalvo, J. M. (2002). *Inonotus* s. l. in Argentina – morphology, cultural characters and molecular analyses. *Mycol. Prog.* 1, 299–313.

Habte, G., Nedi, T., and Assefa, S. (2020). Antimalarial activity of aqueous and 80% methanol crude seed extracts and solvent fractions of *Schinus molle* Linnaeus (Anacardiaceae) in *Plasmodium berghei* -Infected mice. *J. Trop. Med.* 2020, 1–9. doi:10.1155/2020/9473250.

Henriot, A., and Cheype, J. L. (2017). Piximètre, la measure des dimensions sur images. Available at: http://www.piximetre.fr/ [Accessed November 13, 2020].

Intini, M. (1988). Contributo alla conoscenza dei funghi lignicoli italiani: *Inonotus rickii* (Pat.) Reid. *Micol. Ital.* 1, 49–53.

Intini, M. (2002a). First report of *Inonotus rickii* causing canker rot on boxelder in Europe.

Plant Dis. 86, 922–922. doi:10.1094/PDIS.2002.86.8.922C.

Intini, M. (2002b). *Inonotus rickii* found in Spain. *Micol. e Veg. Mediterr.* 17, 25–30.

Intini, M., and Tello, M. (2003). Comunicación, investigaciones sobre hongos xilófagos de arboles urbanos en Europa: primera cita de *Inonotus rickii* (Pat.) Reid en España. *Boletín Sanid. Veg. Plagas* 29, 277–279.

Jagtap, N., Ranadive, K., Jagtap, P., Chaudhari, N., Thopate, P., Jagtap, P., et al. (2018). Bioactive potentials of *Inonotus rickii* (Pat.) D. A. Reid from Pune. *Ajanta* 7, 184–193.

Jaquenoud, M. (1985). *Inonotus rickii,* un polypore nouveau pour la flore européenne. *Mycol. Helv.* 1, 371–391.

Jaquenoud, M. (1987). Les cellules hymèniales d' *Inonotus rickii* trouvé en Europe. *Mycol. Helv.* 2, 209–2015.

Kirk, P. M., Cannon, P. F., Minter, D. W., and Stalpers, J. A. (2008). *Dictionary of the Fungi*. 10th ed. Wallingford, UK: CABI.

Klink, C. a., and Machado, R. B. (2005). A conservação do Cerrado brasileiro. *Megadiversidade* 1, 147–155. doi:10.1590/S0100-69912009000400001.

Kornerup, A., and Wansher, J. H. (1978). *Handbook of colour*. 3rd ed. London: Eyre Methuen.

Kotlaba, F., and Pouzar, Z. (1994). Two new localities of *Inonotus rickii* in Europe. *Czech Mycol.* 47, 159–161. doi:10.33585/cmy.47205.

Kramer, F. L. (1957). The pepper tree, *Schinus molle* L. *Econ. Bot.* 11, 322–326. doi:10.1007/BF02903811.

Latitude and Longitude Finder (2020). Available at: https://www.latlong.net/ [Accessed March 3, 2020].

Maia, L. C., De Carvalho Júnior, A. A., Cavalcanti, L. D. H., Gugliotta, A. D. M., Drechsler-Santos, E. R., Santiago, A. L. M. D. A., et al. (2015). Diversity of brazilian fungi. *Rodriguesia* 66, 1033–1045. doi:10.1590/2175-7860201566407.

Martínez, S. (2006). The genera *Inocutis* and *Inonotus* (Hymenochaetales) in Uruguay. *Mycotaxon* 96, 1–8.

Mata, M., Ruiz-Boyer, A., Carranza, J., and Ryvarden, L. (2007). Nuevos registros de hongos poliporoides (Basidiomycetes) para Costa Rica. *Bol. Soc. Micol. Madr.* 31, 123–130.

Maubet, Y. (2020). Hymenochaetaceae from Paraguay: revision of the family and new records. *Curr. Res. Environ. Appl. Mycol.* 10, 242–261. doi:10.5943/cream/10/1/24.

Mazza, G., Moriondo, M., Motta, E., and Annesi, T. (2008). Monitoraggio fitopatologico di *Inonotus rickii* nella città di Roma e applicazioni GPS-GIS. *Forest@* 5, 160–170.

Melo, I., Ramos, P., and Caetano, M. F. F. (2002). First record of *Inonotus rickii* (Basidiomycetes, Hymenochaetaceae) in Portugal. *Port. Acta Biológica* 20, 265–269.

Michailides, themis J. (2003). “Diseases of Fig,” in *Diseases of Tropical Fruit Crops*, ed. R. C. Ploetz (Wallingford, UK: CABI), 527.

Mielnichuk, N., and Lopez, S. E. (2007). Interaction between *Epicoccum purpurascens* and xylophagous basidiomycetes on wood blocks. *For. Pathol.* 37, 236–242. doi:10.1111/j.1439-0329.2007.00496.x.

Milena, V., Tatjana, M., Gökhan, Z., Ivana, B., Aleksandra, C., Mohammad, M. F., et al. (2019). Advantages of contemporary extraction techniques for the extraction of bioactive constituents from black elderberry (*Sambucus nigra* L.) flowers. *Ind. Crops Prod.* 136, 93–101. doi:10.1016/j.indcrop.2019.04.058.

Mowna Sundari, T., Alwin Prem Anand, A., Jenifer, P., and Shenbagarathai, R. (2018). Bioprospection of Basidiomycetes and molecular phylogenetic analysis using internal transcribed spacer (ITS) and 5.8S rRNA gene sequence. *Sci. Rep.* 8, 10720. doi:10.1038/s41598-018-29046-w.

Murace, M., Luna, M. L., Robledo, G., and Perelló, A. (2019). “Pudrición del leño en los árboles urbanos,” in *Problemáticas sanitarias del arbolado. Enfermedades presentes en La Plata. Especial referencia a las de origen fúngico*, eds. A. M. Aprea and M. A. Murace (Buenos Aires, Argentina: Editorial de la Universidad de La Plata), 156.

Murrill, W. A. (1919). Cuban polypores and agarics. *Mycologia* 11, 22–32. doi:10.1080/00275514.1919.12016771.

Nakasone, K. K. (1993). “Diversity of lignicolous Basidiomycetes in coarse woody debris,” in *Biodiversity and Coarse Woody Debris in Southern Forests*, eds. J. W. McMim, D. A. J. Crossley, and G. A. Athens (Southern Research Station, Forestry Science Laboratory), 35–39.

Ouabbou, A., El-assfouri, A., Ouazzani-Touhami, A., Benkirane, R., and Douira, A. (2012). Bibliographic catalog of the forest of Mamora (Morocco) fungal flora. *J. Anim. &Plant Sci.* 15, 2200–2242.

Patouillard, N. (1896). Champignons nouveaux ou peu connus. *Bull. la Société Bot. Fr.* 12, 132–36.

Patouillard, N. (1908). Champignons nouveaux ou peu connus. *Bull. la Société Bot. Fr.* 24, 1–12.

Peel, M. C., Finlayson, B. L., and McMahon, T. A. (2007). Updated world map of the Köppen-

Geiger climate classification. *Hydrol. Earth Syst. Sci.* 11, 1633–1644. doi:10.5194/hess-11-1633-2007.

Pegler, D. N. (1964). A survey of the genus *Inonotus* (polyporaceae). *Trans. Br. Mycol. Soc.* 47, 175–195. doi:10.1016/S0007-1536(64)80051-6.

Pegler, D. N. (1967). Notes on Indian Hymenochaetoïdeae. *Kew Bull.* 21, 39–49.

Phillips, D. H., and Burdekin, D. A. (1989). *Diseases of forest and ornamental trees.* London: MACMILLAN.

Pieri, M., and Rivoire, B. (1996). À propos de quelques polypores (Aphyllophoromycetideae) rares ou critiques récoltes récemment. I. *Bull. la Société Mycol. Fr.* 112, 163–187.

QGIS Development Team (2020). QGIS Geographic Information System. Open source geospatial foundation project. Available at: https://qgis.org/en/site/.

Ramos, A. P., Caetano, M. F., and Melo, I. (2008). *Inonotus rickii* (Pat.) Reid: an important legnicolous Basidiomycete in urban trees. *Rev. Ciências Agrárias* 31, 159–167. doi:10.19084/rca.15616.

Raymundo, T., Valenzuela, R., Gutiérrez, A., Coronado, M. L., and Esqueda, M. (2013). Agaricomycetes xilófagos de la planicie central del desierto sonorense. *Rev. Mex. Biodivers.* 84, 417–424. doi:10.7550/rmb.30828.

Reid, D. A. (1957). New or interesting records of Australasian Basidiomycetes: III. *Kew Bull.* 12, 127–143.

Ribeiro, J. F., and Walter, B. M. T. (2008). "As principais fitofisionomias do bioma Cerrado," in *Cerrado: Ecologia e flora*, 152–212.

Robles, C. A., Carmarán, C. C., and Lopez, S. E. (2011). Screening of xylophagous fungi associated with *Platanus acerifolia* in urban landscapes: Biodiversity and potential biodeterioration. *Landsc. Urban Plan.* 100, 129–135. doi:10.1016/j.landurbplan.2010.12.003.

Robles, C. A., Castro, M. A., and Castro, M. A. (2014). Wood decay by *Inonotus rickii* and *Bjerkandera adusta*: A micro- and ultra-structural approach. *IAWA J.* 35, 51–60. doi:10.1163/22941932-00000047.

Robles, C. A., Lopez, S. E., and Carmarán, C. C. (2015a). Basidiomicetes endofíticos de madera en *Platanus acerifolia* (Platanaceae) de Argentina: notas y estudios de cultivo. *Boletín la Soc. Argentina Botánica* 50, 437–445. doi:10.31055/1851.2372.v50.n4.12907.

Robles, C. A., Lopez, S. E., McCargo, P. D., and Carmarán, C. C. (2015b). Relationships between fungal endophytes and wood-rot fungi in wood of *Platanus acerifolia* in urban environments. *Can. J. For. Res.* 45, 929–936. doi:10.1139/cjfr-2014-0560.

Robles, C., Carmarán, C., and Lopez, S. (2012). Molecular techniques based on ITS analysis: useful tools for the identification of wood-decay Basidiomycetes in urban trees? *Kurtziana* 37, 91–108.

Ryvarden, L. (1983). Type studies in the Polyporaceae 14. Species described by N. Patouillard, either alone or with other mycologists. *Occas. Pap. Farlow Herb. Cryptogam. Bot.* 18, 1–39.

Ryvarden, L. (2004). *Neotropical polypores Part 1*. Oslo, Norway: Fungiflora.

Ryvarden, L. (2005). *The genus Inonotus a synopsis*. Oslo, Norway: Fungiflora.

Ryvarden, L., and Gilbertson, R. L. (1993). *European Polypores*. Oslo: Fungiflora.

Saccardo, P. A. (1912). Sylloge fungorum omnium hucusque cognitorum. *Bull. la Société Bot. Fr.*, 928.

Sano, E. E., Rosa, R., Brito, J. L. S., and Ferreira, L. G. (2010). Land cover mapping of the tropical savanna region in Brazil. *Environ. Monit. Assess.* 166, 113–124. doi:10.1007/s10661-009-0988-4.

Sanogo, S., and Lujan, P. (2018). Rarity of a fungal pathogen and a parasitic flowering plant versus the commonness of a mycorrhizal fungus in *Pecan Orchards* in New Mexico. *Plant Heal. Prog.* 19, 207–211. doi:10.1094/PHP-05-18-0024-S.

Seaver, F. J., and Waterston, J. M. (1946). Contributions to the Mycoflora of Bermuda—IV. *Mycologia* 38, 180–201. doi:10.1080/00275514.1946.12024051.

Sepúlveda, G., Huanca, W., Cárdenas, S., Belmonte, E., Torres, T., and Latorre, B. A. (2016). First report of *Inonotus rickii* causing decay and death in *Schinus molle* in Chile. *Plant Dis.* 100, 2320. doi:10.1094/PDIS-01-16-0010-PDN.

Sharma, J. R., and Mishra, D. (2015). A Synoptic mycoflora of wood-rotting fungi of Andaman. *Nelumbo* 57, 135–164. doi:10.20324/nelumbo/v57/2015/87118.

Sharma, S., Sharma, S., and Vig, A. P. (2018). Antigenotoxic potential of plant leaf extracts of *Parkinsonia aculeata* L. using Allium cepa assay. *Plant Physiol. Biochem.* 130, 314–323. doi:10.1016/j.plaphy.2018.07.017.

Shehata, A. S. F., and Abdel-Wahab, F. M. (2013). First record of *Ptychogaster cubensis* causing canker and decay on Citrus and Grape trees in Egypt. *Egypt. J. Phytopathol.* 41, 215–216.

Singh, S. K., Doshi, A., Pancholy, A., and Pathak, R. (2013). Biodiversity in wood-decay macro-fungi associated with declining arid zone trees of India as revealed by nuclear rDNA analysis. *Eur. J. Plant Pathol.* 136, 373–382. doi:10.1007/s10658-013-0172-0.

Stalpers, J. A. (2000). The genus *Ptychogaster*. *Karstenia* 40, 167–180.

Tchoumi, J. M. T., Coetzee, M. P. A., Rajchenberg, M., and Roux, J. (2020). Poroid Hymenochaetaceae associated with trees showing wood-rot symptoms in the Garden Route National Park of South Africa. *Mycologia* 112, 722–741. doi:10.1080/00275514.2020.1753160.

Tchoumi, J. M. T., Coetzee, M. P. A., Vivas, M., Rajchenberg, M., and Roux, J. (2017). Wood-rotting basidiomycetes associated with declining native trees in timber-harvesting compartments of the Garden Route National Park of South Africa. *Austral Ecol.* 42, 947–963. doi:10.1111/aec.12524.

The Plant List (2020). A working list of all plant species. Available at: http://www.theplantlist.org/ [Accessed November 13, 2020].

Tura, D., Zmitrovich, I. V., Wasser, S. P., and Nevo, E. (2009). Medicinal species from genera *Inonotus* and *Phellinus* (Aphyllophoromycetideae): Cultural-morphological peculiarities, growth characteristics, and qualitative enzymatic activity tests. *Int. J. Med. Mushrooms* 11, 309–328. doi:10.1615/IntJMedMushr.v11.i3.100.

Ţura, D., Zmitrovich, I. V., Wasser, S. P., and Nevo, E. (2010). Checklist of Hymenomycetes (Aphyllophorales s.l.) and Heterobasidiomycetes in Israel. *Mycobiology* 38, 256. doi:10.4489/MYCO.2010.38.4.256.

Urcelay, C., Robledo, G., Heredia, F., Morera, G., and Montaño, F. G. (2012). *Hongos de la madera en el arbolado urbano de Córdoba*. 1st ed. Córdoba.

Valenzuela, R., Raymundo, T., and Cifuentes, J. (2013). El género *Inonotus* s.l. (Hymenochaetales: Agaricomycetes) en México. *Rev. Mex. Biodivers.* 84, S70–S90. doi:10.7550/rmb.31605.

Venturella, G., Bernicchia, A., and Saitta, A. (2006). Three rare lignicolous fungi from Sicily (S Italy). *Acta Mycol.* 41, 95–98. doi:10.5586/am.2006.013.

Venturella, G., and Raimondo, F. M. (2004). I funghi cariogeni delle alberature di parchi, giardini e strade 1-18. *Quad. di Bot. Ambient. e Appl.* 15, 181–201.

Vergara, J. I. V., Quintanilla, J. F. L., Inchaurtieta, E. B., Víboras, M. L., Pérez, J. D. R., and García, V. J. E. (2016). Contribución al conocimiento de los hongos del jardín botánico canario “viera y clavijo” (Gran Canaria, Islas Canarias). (II). *Botánica Macaronésica* 29, 15–24.

Villalobos, S., Mengual, M., and Henao-Mejía, L. G. (2017). Uso de los hongos, *Podaxis* *pistillaris*, *Inonotus rickii* y *Phellorinia herculeana* (Basidiomycetes), por la Etnia Wayuu en la Alta Guajira Colombiana. *Etnobiología* 15, 64–73.

Viveros García, J. C., Figueroa Rodríguez, K. A., Gallardo López, F., García Pérez, E., Ruiz Rosado, O., and Hernández Rosas, F. (2018). Sistemas de manejo y comercialización de tamarindo (*Tamarindus indica* L.) en tres municipios de Veracruz. *Rev. Mex. Ciencias Agrícolas* 3, 1217–1230. doi:10.29312/remexca.v3i6.1373.

Wright, J. E., and Alberto, E. (2006). *Guia de la region pampeana. II. Hongos sin laminillas*. Buenos Aires: LOLA.

Wright, J. E., Deschamps, J. R., and Blumenfeld, S. (1988). Basidiomycetos xilófilos de la región mesopotámica IV: Especies poroides de la familia Hymenochaetaceae (Inédito).

WWF (2015). The “Big Five” of the Cerrado. Available at: https://www.wwf.org.br/informacoes/english/?50242/The [Accessed November 13, 2020].

Xavier-Santos, S., Carvalho, C. C., Bonfá, M., Silva, R., Capelari, M., and Gomes, E. (2004). Screening for pectinolytic activity of wood-rotting Basidiomycetes and characterization of the enzymes. *Folia Microbiol. (Praha).* 49, 46–52. doi:10.1007/BF02931645.

Yuan, Y., Bian, L., Wu, F., and Si, J. (2015). Floral composition and ecology of polypores in Hainan Province. *Chinese J. Ecol.* 34, 1689–1698.

Zheng, J. J., Lin, Q., Liu, W., and He, X. S. (2011). First discovery of *Inonotus rickii* on *Gleditsia sinensis*. *Mycosystema* 30, 128–132.

ARTIGO 7

A NEW OCCURRENCE OF *GYRODONTIUM SACCHARI* (SPRENG.) HJORTSTAM PAT. (BOLETALES, CONIOPHORACEAE) EXPANDS THE GEOGRAPHIC DISTRIBUTION OF THE GENUS IN BRAZIL

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A new occurrence of *Gyrodontium sacchari* (Spreng.) Hjortstam Pat. (Boletales, Coniophoraceae) expands the geographic distribution of the genus in Brazil

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Abstract − We report the first occurrence of the genus *Gyrodontium* Pat. from the Brazilian Cerrado based on our finding of *G. sacchari* (Spreng.) Hjortstam. This also represents the first record of the family Coniophoraceae from the Midwest Region of central Brazil. We identified the sample by morphological and phylogenetic analyses (ITS gene), and a voucher was deposited in the fungarium of the Universidade Estadual de Goiás (HUEG-Fungi). This record adds to the knowledge of the Cerrado's funga by providing new phylogenetic and biogeographic data for *G. sacchari* from a Neotropical region.

Keywords − Basidiomycota, Brazilian savanna, corticioid fungi, taxonomy, phylogeny.

Introduction

Gyrodontium Pat. is a small genus in Coniophoraceae (Boletales, Basidiomycota) with a worldwide distribution and only three currently accepted species: *G. arizonicum* (Ginns) Zmitr., Kalinovskaya & Myasnikov, *G. eberhardtii* Pat., and *G. sacchari* (Spreng.) Hjortstam (He et al. 2019). *Gyrodontium* was proposed by Patouillard (1900) to accommodate *Hydnum henningsii* Bres. (Hydnaceae) from Cameroon in Central Africa. Linnaeus (1753) proposed the genus *Hydnum* L. for *H. repandum* L. (the type species), which has a spinose hymenophore. *Hydnum* is, currently, a nomen conservandum which was also sanctioned by Elias Magnus Fries. Species of *Hydnum* have their spores produced in structures resembling teeth or spines (spinose hymenophores) rather than in the most common lamellate hymenium of Agaricomycetes. Probably due to this characteristic, when Sprengel described *Hydnum sacchari* Spreng., he included *Odontia* Pers. as a subgenus of *Hydnum*, which led to numerous synonyms and misidentifications involving *Hydnum*, *Odontia* and, consequently, *Tomentella* Pers. ex Pat. (Sprengel 1820). Hundreds of names in *Hydnum* have been allocated to other genera in recent years due to advances in molecular phylogenetics that have clarified cryptic species with spinose hymenophores and misclassified in this genus (MycoBank 2022).

Hydnum sacchari Spreng. was described from material collected on the decaying plant debris of *Saccharum officinarum* L. (Poaceae) from Guadeloupe in the Caribbean (Sprengel 1820). Later, based on morphological characteristics, Hjortstam (1995) synonymized *H. henningsii*, *H. sacchari*, and other names in *Hydnum* with *Gyrodontium sacchari* (Spreng.) Hjortstam, now typified as the type species. *Gyrodontium sacchari* is a cosmopolitan species, with hotspots of occurrence mainly in pantropical areas of the world; it has been reported from all continents except Antarctica (Carlier et al. 2004; Bernicchia and Gorjón 2010; Robledo et al. 2014; He and Zhao 2022).

Although present in some regions of Asia (Bao et al. 2006; Park et al. 2015; Karun and Sridhar 2016), *G. sacchari* occurs mainly in tropical regions (Carlier et al. 2004) and shows a broad distribution in the Americas, where is it known from Argentina, Belize, Brazil, Costa Rica, Cuba, Ecuador, French Guiana, Guadeloupe, Mexico, Panama, and the USA (Hjortstam 1995; Carlier et al. 2004; Wright and Wright 2005; Læssøe and Petersen 2008; Valenzuela et al. 2012; Robledo et al. 2014; He et al. 2019).

In Brazil, the genus *Gyrodontium* is known only from records of *G. sacchari* in the Atlantic Forest, in the states of São Paulo (Southeast Region) and Sergipe (Northeast Region) (Hjortstam 1995; Robledo et al. 2014). In the Brazilian Cerrado, the second largest biome in

Brazil and an important hotspot for biodiversity conservation, the family Coniophoraceae is represented by only two species in the genus *Coniophora* DC—*Coniophora arida* (Fr.) P. Karst., and *C. olivacea* (Fr.) P. Karst—from grassland and cerrado forest in Mogi Guaçu, São Paulo state (Gibertoni and Drechsler-Santos 2010; Strassburg et al. 2017). Here, we report the first occurrence of *G. sacchari* in the Brazilian Cerrado, which is also the first record of family Coniophoraceae in the Midwest Region of Brazil, the core area of the Cerrado biome.

Methods

The studied specimen was collected in the municipality of Goiânia, Goiás state, Brazil, in a domestic agroforestry yard. There was a guapuruvu, *Schizolobium parahyba* (Vell.) Blake (Fabaceae), a tree native to the Atlantic Forest. This tree had been planted about 11 years ago but had rotted due to termite attack and had to be cut down. The cut trunk was left exposed in this yard for about three years, when *G. sacchari* specimens first appeared.

The species identification followed both morphological and phylogenetic analyses. Microscopic characterization and measurements were performed from freehand cuts of dried material. The sections were rehydrated in 3% KOH and dyed with floxine, when necessary. Cotton blue and Melzer's reagent was used to check cyanophily and amyloidicity or dextrinoidicity, respectively. Slides were photographed by using an Olympus CX31 optical microscope and a digital camera. Color classification of basidiomata morphology were based on the Kornerup and Wanscher (1978) color chart. Microscopic structures were measured by using Piximètre v. 5.10 R 1541, where Q refers to the quotient between the length and width, Qm is the medium value of Q, and N is the number of measured spores (Henriot and Cheype 2017). Scanning electron microscopy was performed at the Center of Analysis, Innovation, and Technology (CAiTec, Universidade Estadual de Goiás), by using a Hitachi TM3030Plus scanning electron microscope (SEM) at 15.0 kV, with previously dehydrated material. The morphological species description was based on comparison with specific literature (Hjortstam 1995; Carlier et al. 2004). A voucher specimen was preserved and deposited in the fungarium of the Universidade Estadual de Goiás (HUEG-Fungi; Thiers 2022).

Total DNA was extracted from fragments of dried and cleaned basidioma macerated in liquid nitrogen, according to CTAB method (Goés-Neto et al. 2005; Hosaka et al. 2006). The extracted DNA was quantified by a spectrophotometer using Qubit (Invitrogen), and then the nuclear rDNA internal transcribed spacers (ITS) region of the DNA was amplified with the ITS5/ITS4 primer pairs (White et al. 1990). The amplification products were purified and sequenced with the same primers used in the amplification performed in an Applied Biosystems 3730xl DNA Analyzer (MacroGen Ltd., South Korea).

The DNA sequence obtained in this study were assembled and edited using Staden Package v. 2.0 (Staden et al. 1998). The consensus sequence was aligned with sequences of Coniophoraceae based on studies of Binder et al. (2010) and Zhao et al. (2018), and through a BLAST (http://blast.ncbi.nlm.nih.gov/) search database (Table 1) using MAFFT (Katoh and Standley 2013); these data were manually inspected using MEGA v.6 (Tamura et al. 2013). *Athelia arachnoidea* (Berk.) Jülich and *A. epiphylla* Pers. were used as outgroups in our phylogenetic analyses following Zhao et al. (2018). Maximum likelihood (ML) and Bayesian inference (BI) phylogenetic analyses were performed in W-IQ-TREE (Kalayaanamoorthy et al. 2017) and MrBayes v. 3.2 (Ronquist and Huelsenbeck 2003), respectively, under the TIM2+F+I+G4 substitution model estimated based on the Akaike Information Criterion (AIC). ML was determined with branch support (BS) inferred by 1000 bootstrap replications and Ultrafast bootstrap (UB). BI was performed with 10 million generations, with convergence verified in TRACER v. 1.7.1 (Rambaut et al. 2018), and the first 25% of the resulting trees were discarded as burn-in; Bayesian posterior probabilities (PP) were calculated from the remaining sampled trees. Statistical support for branches was considered strong with BS and UB ≥70% and PP ≥ 0.95.

Table 1. Specimens along with GenBank accession numbers used in the phylogenetic analysis. The sequences obtained in this study are marked in bold.

Taxa	Voucher	Origin	ITS	Reference
Athelia arachnoidea	CBS: 41872	Netherlands	GU187504	Binder et al. (2010)
A. epiphylla	CFMR: FP-100564	USA	GU187501	Binder et al. (2010)
Coniophora arida	CFMR: FP-104367	USA	GU187510	Binder et al. (2010)
C. cerebella	HK‘8’	USA	GU187513	Binder et al. (2010)
C. hanoiensis	He 5197	Vietnam	MG763873	Zhao et al. (2018)
C. hanoiensis	He 5202	Vietnam	MG763874	Zhao et al. (2018)
C. marmorata	MUCL: 31667	Belgium	GU187515	Binder et al. (2010)
C. olivacea	CFMR: FP-104386	USA	GU187516	Binder et al. (2010)
C. prasinoides	CFMR: FP-105969	USA	GU187519	Binder et al. (2010)
C. puteana	MUCL: 1000	Germany	GU187521	Binder et al. (2010)
C. puteana	He 2909	China	MG763876	Zhao et al. (2018)
C. sp.	Braz-6	Brazil	GU187517	Binder et al. (2010)
Coniophoropsis bambusicola	He 5208	Vietnam	MG763877	Zhao et al. (2018)
C. bambusicola	He 5210	Vietnam	MG763878	Zhao et al. (2018)
Gyrodontium sacchari	**HUEG14877**	**Brazil**	**ON819574**	**This study**
G. sacchari	MEL: 2382749	Australia	KP012932	GenBank
G. sacchari	He 4157	Thailand	MG763879	Zhao et al. (2018)
G. sacchari	CLZhao 4800	China	MK343540	GenBank
G. sacchari	UOC MINNP MK05	Sri Lanka	KR867661	GenBank
G. sacchari	CLZhao 4804	China	MK343541	GenBank

Table I (continued)

Taxa	Voucher	Origin	ITS	Reference
G. sacchari	MUCL: 42789	French Guiana	GU187522	Binder et al. (2010)
Leucogyrophana olivascens	UC 2022939	USA	KP814170	GenBank
L. olivascens	CFMR: HHB-11134	USA	GU187532	Binder et al. (2010)
L. romellii	CFMR: T-547	Canada	GU187529	Binder et al. (2010)

Results

Phylogenetic analyses

Based on the BLAST search of the GenBank nucleotide database, the highest matches were all sequences of Coniophoraceae. The ITS sequence had up to 98% identity with sequences from *Gyrodontium sacchari* in GenBank, while for other species of Boletales was below 92%.

In the phylogenetic analysis, sequence alignment had a length of 772 characters with gaps and included 25 Coniophoraceae specimens. Of these, 351 characters were constant, 403 were variable, and 348 were parsimony informative. BI analysis resulted in an average standard deviation of split frequencies of 0.004012. The tree topology generated by ML was identical to that generated by BI analyses and was therefore used as the basal tree (Fig. 1). Based on phylogenetic analysis four supported clades were formed and *Gyrodontium* species recovered in this study were grouped into a clade with strong support values (BS = 100%, UB = 100%, PP = 1).

Gyrodontium sacchari (Spreng.) Hjortstam, Mycotaxon 54: 186 (1995) (Figure 2)

≡ *Hydnum sacchari* Spreng., K. svenska Vetensk-Akad. Handl., ser. 3 41: 51 (1820)

New record. BRAZIL – **Goiás** • Goiânia, in a domestic agroforestry yard; 16°35'15.9"S, 49°17'33.2"W; 749 m a.s.l.; 11.III.2021; C. M. Silva-Neto (FJSC107); on *Schizolobium parahyba* (Vell.) Blake (Fabaceae) dead trunks; GenBank: ON819574; HUEG14877.

Identification. Basidiomata annual, resupinate, effused-reflexed to pileate, imbricate, fleshy to spongy, up to 6 x 10 cm. Pileus applanate, ressupinate in some parts and others forming conchate that coalesce to form complex basidiomata (effused-reflexed). Pilear surface white (1A1), pale grey (1B1) to greyish yellow (1B4), slightly zonate, velvety. Margin white (1A1) to pale grey (1B1) when freshly, sterile, entire, obtuse to irregular, thick, spongy to cottony. Context concolorous to pilear surface, homogeneous, up to 6 mm thick, soft to spongy. Hymenial surface yellowish white (1A2) to pale yellow (1A3), smooth to tuberculate when young, light yellow (3A5) to olive yellow (3C6), aculeolate to hydnoid with maturity, gradually paler towards the margin. Spines 2–4 mm long, elongate to cylindric, with tip subulate, flattened to angular. Rhizomorphs white (1A1) and cottony.

Hyphal system monomitic; generative hyphae simple septate, hyaline to yellowish in KOH, inamyloid, thin to thick-walled, in the context 3–7 µm diam., often branched and mostly thin-walled, in the hymenium 2.2–7 µm diam. simple to slightly branched, parallel arranged and thin to thick-walled. Cystidia not seen. Basidia clavate, hyaline in KOH, four-sterigmate, 10.8–16.2 × 3.5–5 µm; sterigmata up to 5.6 µm long. Basidiospores ellipsoid to elongate, smooth, yellowish brown in KOH, cyanophilic, dextrinoid, thick-walled, (4) 4.2 – 5.3 (5.6) × (2.2) 2.5 – 3 (3.2) µm [Q = (1.5) 1.6 - 1.9 (2.1); Qm = 1.8; N = 50].

Distribution in Brazil. Known occurrence for the states of São Paulo and Sergipe in Atlantic Forest area (Hjortstam 1995; Robledo et al. 2014), Bahia and Rio Grande do Sul (ecosystem data not available) (Maas Gesteranus 1966; Bononi 1988) and Goiás (present study) in Cerrado area (Figure 3).

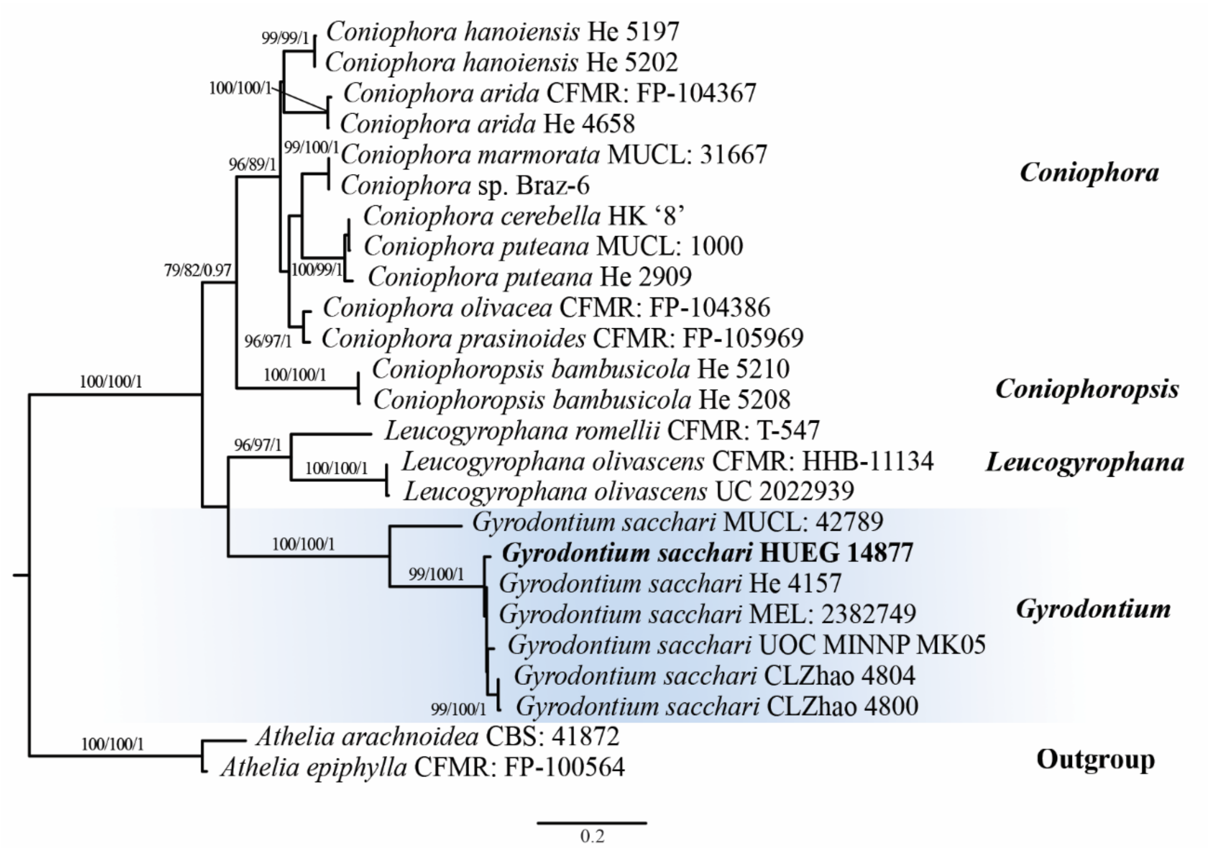

Figure 1. Phylogenetic tree obtained using ITS (gene). The tree topology is from ML analysis and the species of *Gyrodontium sacchari* recorded in this study is indicated in bold. Numbers at branches indicate the values of bootstrap frequency (BS)/ultrafast bootstrap (UB)/bayesian posterior probability (PP).

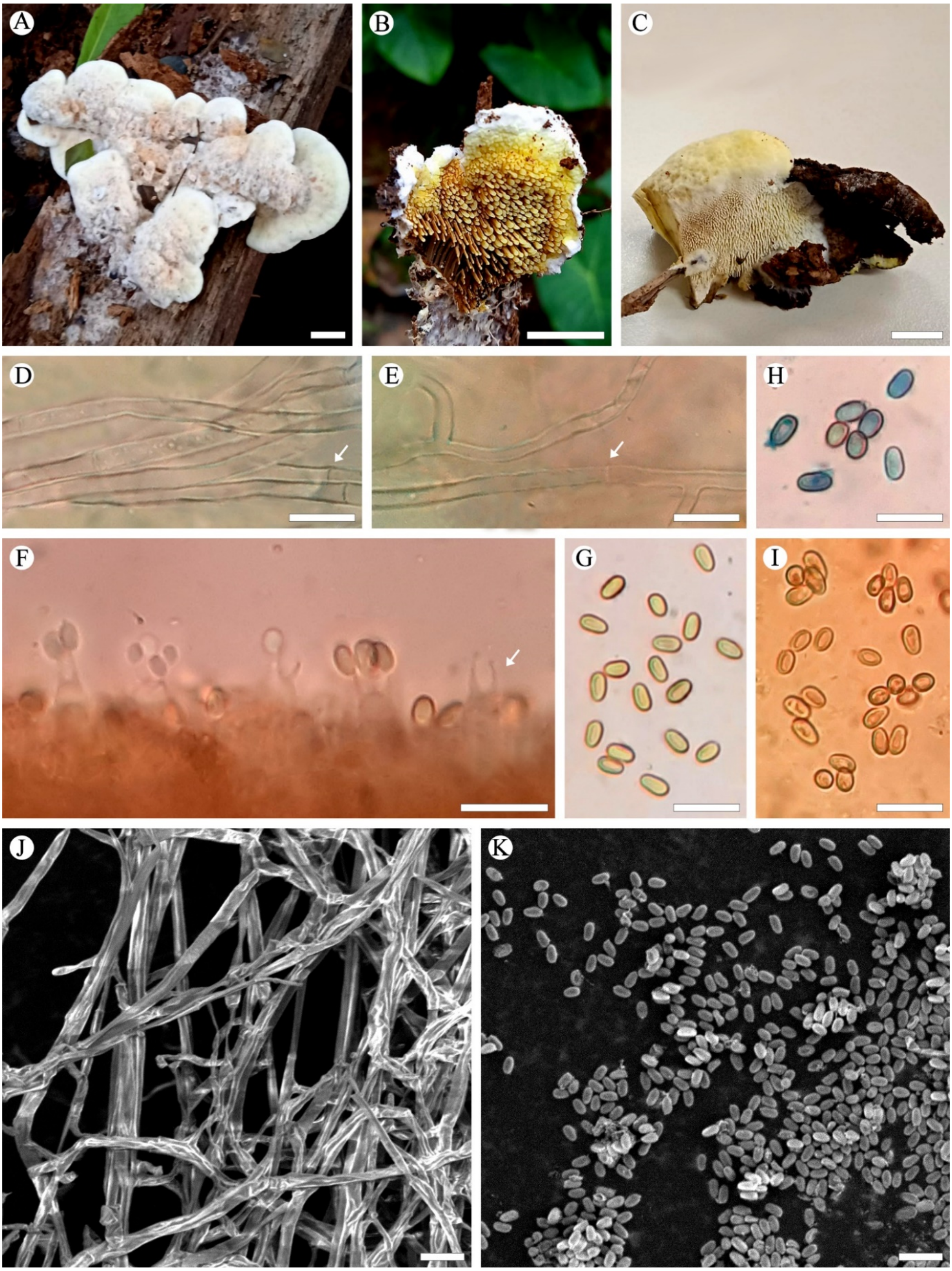

Figure 2. *Gyrodontium sacchari*. **A.** Pilear surface of mature basidioma on guapuruvu trunk. **B, C.** Details of the mature and young hydnoid hymenial surface. **D, E.** Generative hyphae simple septate (arrow) in context and hymenium. **F.** Basidia with immature basidiospores and evident sterigma (arrow). **F**–**I**. Basidiospores in KOH 3% and dyed with cotton blue and Melzer’s reagent. **J.** Generative hyphae viewed in Scanning Electron Micrograph (SEM). **K.** Basidiospores viewed in SEM. Scale bars: A–C = 1 cm; D–I = 5 µm; J, K = 10 µm.

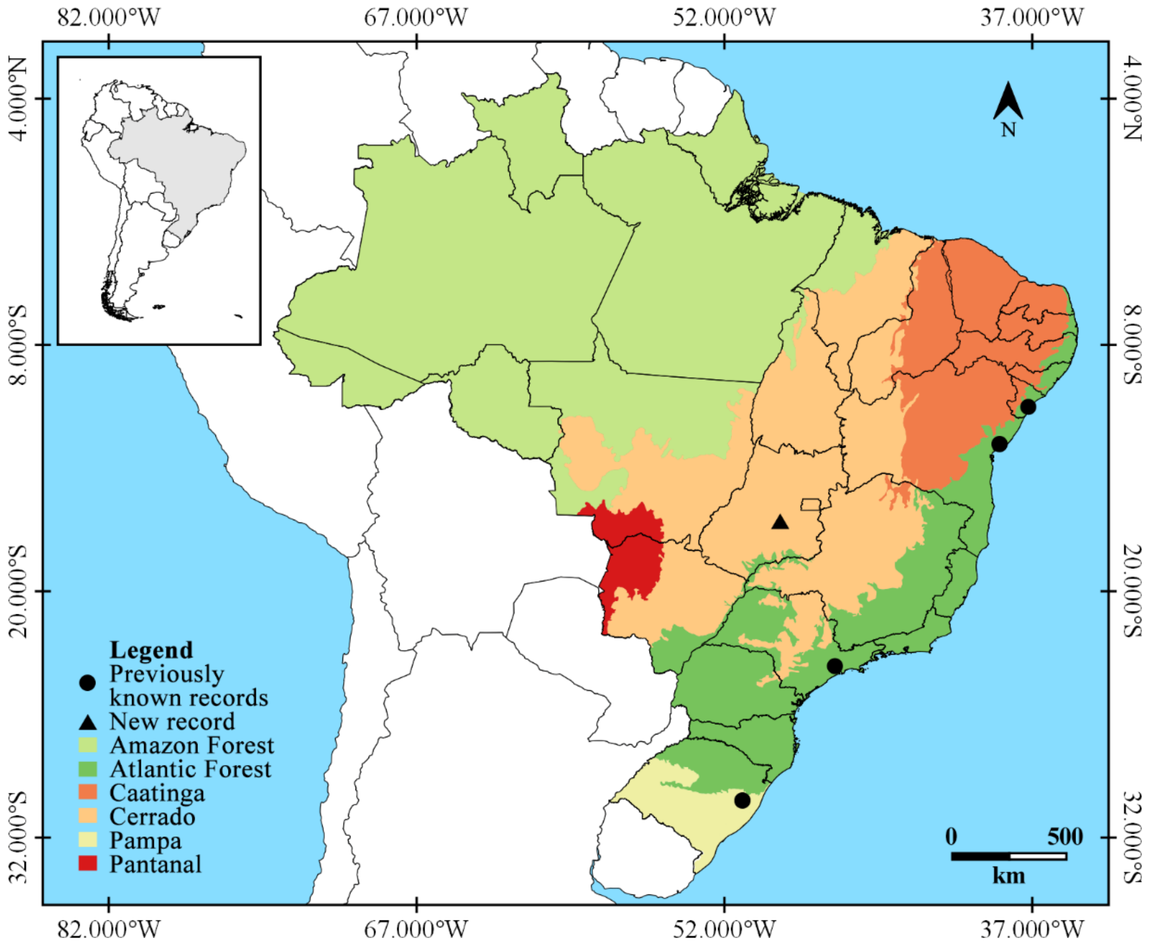

Figure 3. Sampled area and geographic distribution of *Gyrodontium sacchari* in Brazil.

Discussion

Gyrodontium sacchari is a peculiar species and is easily identified in the field due to the resupinate to effuse-reflexed basidiomata and yellow to olive-yellow hydnoid hymenial surface. Microscopically, the monomitic hyphal system with its simple septate generative hyphae and thick-walled smooth yellowish basidiospores is distinctive in the identification of the species. These features differ from other Coniophoraceae, such as *Coniophora*, *Coniophoropsis* Hjortstam & Ryvarden and *Penttilamyces* Zmitr., Kalinovskaya & Myasnikov, which are characterized by smooth to merulioid hymenophores and resupinate basidiomata (Zmitrovich et al. 2019). *Gyrodontium sacchari* is a saprotrophic fungal species, and in many cases, it has been reported as a brown-rot-causing agent in tropical rainforests, as observed in some other members of Coniophoraceae; its occurrence in the rotting hollow of woody plant species is common (Carlier et al. 2004; Dai et al. 2007; Robledo et al. 2014; Joshi et al. 2021).

Unlike *Hydnum* species, which are described as ectomycorrhizal, *G. sacchari* has a saprophytic habit, as we and others have observed (Feng et al. 2016; Swenie et al. 2018; Chen et al. 2019; this study). In studies of hydnoid species, this habit should be considered, together with the phylogenetic data to avoid misidentifications and unnecessary synonymization. In addition to our present study, only two other studies on this species' distribution have present phylogenetic data (Carlier et al. 2004; Zhao et al. 2018). We recommend that studies based on both morphological and multigene phylogeny must be carried out, including on type material and sequences from Neotropical species, to best clarify the taxonomic status of species with spinose hymenophores, such as *Hydnum* and *Hydnum*-like fungi.

Fidalgo et al. (1965) presented the first survey of macroscopic fungal diversity in the Brazilian Cerrado, and since then, some areas of this ecosystem have been explored further (Gibertoni and Drechsler-Santos 2010; Alvarenga et al. 2015, 2017; Calaça et al. 2018, 2020; Leonardo-Silva et al. 2020, 2021). Here, with our discovery of *G. sacchari*, we report the first occurrence of the genus *Gyrodontium* in the Brazilian Cerrado, as well as the first record of the family Coniophoraceae in the Midwest Region of the country. This new record adds to our knowledge of the Cerrado's funga and provides new phylogenetic and biogeographic data for this species from a tropical region. Considering that the Cerrado is a biodiversity hotspot and that there is the lack of records of the family Coniophoraceae from this biome, it is supposed that this species is threatened by habitat loss in the Cerrado (Dahlberg and Mueller 2011; Strassburg et al. 2017). We recommend that public policies give attention to the conservation of fungi of the Cerrado, especially due to the important function that fungi have in terrestrial ecosystems. We highlight the need for additional studies on the taxonomic diversity of the Cerrado's funga.

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Author Contributions

Conceptualization: LLS, FJSC, SXS, CMSN. Data curation: LLS, FJSC, GPS. Formal analysis: LLS, FJSC. Funding acquisition: SXS, CMSN. Methodology: LLS, FJSC, CMSN, GPS.

Supervision: SXS. Writing – original draft: LLS, FJSC. Writing – review and editing: CMSN, SXS.

References

Alvarenga RLM, Naves LRR, Xavier-Santos S (2015) The genus *Auricularia* Bull. ex Juss. (Basidiomycota) in Cerrado (Brazilian Savanna) areas of Goiás state and the Federal District, Brazil. Mycosphere 6: 532–542. https://doi.org/10.5943/mycosphere/6/5/3

Alvarenga RLM, Xavier-Santos S (2017) New records of Dacrymycetes (Fungi: Basidiomycota) from the Cerrado biome (Brazilian Savanna) and Midwest Region, Brazil. Check List 13 (4): 335–342. https://doi.org/10.15560/13.4.335

Bao QZ, Wei YL, Yuan HS, Li YR (2006) A new butt-rot disease in tropical area from Yunnan Province. Forest Research 19 (2): 246–247.

Bernicchia A, Gorjon SP (2010) Corticiaceae s.l. Fungi Europaei 12. Candusso Edizioni, Italy, 1008 pp.

Binder M, Larsson KH, Matheny PB, Hibbett DS (2010) Amylocorticiales ord. nov. and Jaapiales ord. nov.: early diverging clades of Agaricomycetidae dominated by corticioid forms. Mycologia 102 (4): 865–880.

Bononi VL (1988) Hydnoid fungi from Tropical America. In: F. Wolkinger. Aphyllophorales-Symposium, Eisenstadt 1982. Austrian Academy of Sciences, Graz, Austria, 73–88.

Calaça FJS, Magnago AC, Alvarenga RLM, Xavier-Santos S (2018) *Phlebopus beniensis* (Boletinellaceae, Boletales) in the Brazilian Cerrado biome. Rodriguésia 69 (2): 939–944. https://doi.org/10.1590/2175-786020186924x6

Calaça FJS, Cortez VG, Xavier-Santos S (2020) Dung fungi from Brazil: *Agrocybe pediades* (Fr.) Fayod (Basidiomycota) in Cerrado. Scientia Plena 16 (6) https://doi.org/10.14808/sci.plena.2020.066201

Carlier FX, Bitew A, Castillo G, Decock C (2004) Some Coniophoraceae (Basidiomycetes, Boletales) from the Ethiopian highlands: *Coniophora bimacrospora*, sp. nov. and a note on the phylogenetic relationships of *Serpula similis* and *Gyrodontium*. Cryptogamie Mycologie 25 (3): 261–275.

Chen J, Heikkinen J, Hobbie EA, Rinne-Garmston KT, Penttilä R, Mäkipää R (2019) Strategies of carbon and nitrogen acquisition by saprotrophic and ectomycorrhizal fungi in Finnish boreal *Picea abies*-dominated forests. Fungal Biology 123 (6): 456–464. https://doi.org/10.1016/j.funbio.2019.03.005

Dahlberg A, Mueller GM (2011) Applying IUCN Red-Listing criteria for assessing and reporting on the conservation status of fungal species. Fungal Ecology 4 (2): 147–162. https://doi.org/10.1016/j.funeco.2010.11.001

Dai YC, Cui BK, Yuan HS, Li BD (2007) Pathogenic wood-decaying fungi in China. Forest Pathology 37 (2): 105–120. https://doi.org/10.1111/j.1439-0329.2007.00485.x

Feng B, Wang XH, Ratkowsky D, Gates G, Lee SS, Grebenc T, Yang ZL (2016) Multilocus phylogenetic analyses reveal unexpected abundant diversity and significant disjunct distribution pattern of the hedgehog mushrooms (*Hydnum* L.). Scientific Reports 6: 25586. https://doi.org/10.1038/srep25586

Fidalgo O, Fidalgo M, Furtado JS (1965) Fungi of the “Cerrado” region of São Paulo. Rickia 2: 55–71.

Gibertoni TB, Drechsler-Santos ER (2010) Lignocellulolytic Agaricomycetes from the Brazilian Cerrado biome. Mycotaxon 111: 87–90.

Goés-Neto A, Logueiro-Leite C, Guerrero RT (2005) DNA extraction from frozen field-collected and dehydrated herbarium fungal basidiomata: performance of SDS and CTAB-based methods. Biotemas 18 (2): 19–32.

He MQ, Zhao RL, Hyde KD, Begerow D, Kemler M, Yurkov A, McKenzie EHC, Raspé O, Kakishima M, Sánchez-Ramírez S, Vellinga EC, Halling R, Papp V, Zmitrovich IV, Buyck B, Ertz D, Wijayawardene NN, Cui B-K, Schoutteten N, Liu X-Z, Li T-H, Yao Y-J, Zhu X-Y, Liu A-Q, Li G-J, Zhang M-Z, Ling Z-L, Cao B, Antonín V, Boekhout T, da Silva BDB, Crop ED, Decock C, Dima B, Dutta AK, Fell JW, Geml J, Ghobad-Nejhad M, Giachini AJ, Gibertoni

TB, Gorjón SP, Haelewaters D, He SH, Hodkinson BP, Horak E, Hoshino T, Justo A, Lim YW, Menolli-Jr. N, Mešić A, Moncalvo J-M, Mueller GM, Nagy LG, Nilsson RH, Noordeloos M, Nuytinck J, Orihara T, Ratchadawan C, Rajchenberg M, Silva-Filho AGS, Sulzbacher MA, Tkalčec Z, Valenzuela R, Verbeken A, Vizzini A, Wartchow F, Wei T-Z, Weiß M, Zhao CL, Kirk PM (2019) Notes, outline and divergence times of Basidiomycota. Fungal Diversity 99: 105–367. https://doi.org/10.1007/s13225-019-00435-4

He X, Zhao CL (2022) Diversity of wood-decaying fungi in Wuliangshan Area, Yunnan Province, P.R. China. Diversity 14 (2): 1–29. https://doi.org/10.3390/d14020131

Henriot A, Cheype JL (2017) Piximètre, la measure des dimensions sur images. http://www.piximetre.fr/. Accessed on: 11 Jul 2022.

Hjortstam K (1995) Two new genera and some new combinations of corticioid fungi (Basidiomycotina, Aphyllophorales) from tropical and subtropical areas. Mycotaxon 54: 183–193.

Hosaka K, Bates ST, Beever RE, Castellano MA, Colgan W, Domínguez LS, Nouhra ER, Geml J, Giachini AJ, Kenney SR, Simpson NB, Spatafora JW, Trappe JM (2006) Molecular phylogenetics of the gomphoid-phalloid fungi with an establishment of the new subclass Phallomycetidae and two new orders. Mycologia 98(6): 949–959. https://doi/org/10.3852/mycologia.98.6.949

Joshi M, Bhargava P, Bhatt M, Kadri S, Shri M, Joshi CG (2021) Coniophoraceae. In: Joshi M, Bhargava P, Bhatt M, Kadri S, Shri M, Joshi CG (Eds.) Mushrooms of Gujarat. Fungal Diversity Research Series, Springer, Singapore, 21–22. https://doi.org/10.1007/978-981-16-4999-8_6

Kalayaanamoorthy S, Minh BQ, Wong TKF, Haeseler AV, Jermiin LS (2017) ModelFinder: fast model selection for accurate phylogenetic estimates. Nature Methods 41 (6): 587–589. https://doi.org/10.1038/nmeth.4285

Karun NC, Sridhar KR (2016) Two new records of hydnoid fungi from the Western Ghats of India. Studies in Fungi 1 (1): 135–141. https://doi.org/10.5943/sif/1/1/14

Katoh K, Standley DM (2013) MAFFT Multiple Sequence Alignment Software Version 7: Improvements in Performance and Usability. Molecular Biology and Evolution 30(4): 772–780. https://doi.org/10.1093/molbev/mst010

Kornerup A, Wanscher JH (1978) Methuen handbook of colours. Eyre Methuen, London, 252 pp.

Læssøe T, Petersen JH (2008). Svampe livet pâ ækvator. Svampe 58: 1–52.

Leonardo-Silva L, Abdel-Azeem AM and Xavier-Santos S (2021) *Inonotus rickii* (Agaricomycetes, Hymenochaetaceae) in Brazilian Cerrado: Expanding Its Geographic Distribution and Host List. Frontiers in Microbiology 12:647920. https://doi.org/10.3389/fmicb.2021.647920

Leonardo-Silva L, Silva LB, Xavier-Santos S (2020) Poroid fungi (Agaricomycetes, Basidiomycota) from Floresta Nacional de Silvânia—a conservation unit of Brazilian Savanna. Microbial Biosystem 5:100–107.

Linnaeus C (1753) Species Plantarum. Holmiae, Impensis Laurentii Salvii, Stockholm, Sweden, 2: 561–1200. https://doi.org/10.5962/bhl.title.669

Maas Gesteranus RA (1966). Notes on hydnums III. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, Series A 69 (1): 24–36.

Park IC, Seok SJ, Kim JS, Yoo JH, Ahn JH (2015) Analysis of mycological characteristics and lignocellulose degradation of *Gyrodontium sacchari*. The Korean Journal of Mycology 43 (4): 239–246.

Patouillard NT (1900) Essai taxonomique sur les familles et les genres des Hyménomycètes. Imprimerie et lithographie L. Declume, Paris, France,184 pp.

Rambaut A, Drummond AJ, Xie D, Baele G, Suchar MA (2018) Posterior summarization in Bayesian phylogenetics using Tracer 1.7. Systematic Biology 67(5): 901–904. https://doi.org/10.1093/sysbio/syy032

Robledo GL, Giorgio EM, Franco CR, Popoff O, Decock C (2014) *Gyrodontium sacchari* (Spreng.: Fr.) Hjortstam (Boletales, Basidiomycota) in America: new records and its geographic distribution. Check List 10 (6): 1514–1519. https://doi.org/10.15560/10.6.1514

Ronquist F, Huelsenbeck JP (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19 (12): 1572–1574. https://doi.org/10.1093/bioinformatics/btg180

Sprengel CPJ (1820) Plantarum cryptogamicarum tropicarum pugillus. Kongliga Svenska Vetenskapsakademiens Handlinger 3 (8): 46–53.

Staden R, Beal KF, Bonfield JK (1998) The Staden package. Computer methods in Molecular Biology 132. In: Misener S, Krawetz SA (Eds.) Bioinformatics methods and protocols. The Humana Press, Totowa, USA, 115–130.

Strassburg B, Brooks T, Feltran-Barbieri R, Iribarrem A, Crouzeilles R, Loyola R, Latawiec AE, Oliveira-Filho FJB, Scaramuzza CAM, Scarano FR, Soares-Filho B, Balmford A (2017) Moment of truth for the Cerrado hotspot. Nature Ecology & Evolution 1: 0099. https://doi.org/10.1038/s41559-017-0099

Swenie RA, Baroni TJ, Matheny PB (2018) Six new species and reports of *Hydnum* (Cantharellales) from eastern North America. MycoKeys 42: 35–72. https://doi.org/10.3897/mycokeys.42.27369

Tamura K, Stecher G, Peterson D, Filipski A, Kumar S (2013) MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. Molecular Biology and Evolution 30 (12): 2725–2729. https://doi.org/10.1093/molbev/mst197

Thiers B (2022) Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. http://sweetgum.nybg.org/science/ih/. Accessed on: 2022-12-22.

Valenzuela R, Raymundo T, Decock C, Esqueda M (2012) Aphyllophoroid fungi from Sonora, México 2. New records from Sierra de Álamos–Río Cuchujaqui Biosphere Reserve. Mycotaxon 122 (1): 51–59.

White TJ, Bruns T, Lee S, Taylor J (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (Eds.) PCR protocols: a guide to methods and applications. Academic Press, London, UK, 315–322.

Wright JE, Wright AM (2005) Checklist of the mycobiota of Iguazú national park (Misiones, Argentina). Boletín de la Sociedad Argentina de Botánica 40 (1–2): 23–44.

Zhao YN, Liu SL, Nakasone KK, He SH (2018) *Coniophoropsis bambusicola* sp. nov. (Coniophoraceae, Basidiomycota) from southern Vietnam. Phytotaxa 360 (2): 153–160. https://doi.org/10.11646/phytotaxa.360.2.7

Zmitrovich IV, Kalinovskaya NI, Myasnikov AG (2019) Funga photographica. Boletales I: Coniophoraceae, Hygrophoropsidaceae, Paxillaceae, Serpulaceae, Tapinellaceae boreales. Folia Cryptogamica Petropolitana 7: 1–58.

ARTIGO 8

ADDITIONS TO THE KNOWLEDGE OF GANODERMATACEAE IN BRAZILIAN CERRADO

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Additions to the knowledge of Ganodermataceae in brazilian Cerrado

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Abstract − (Additions to the knowledge of Ganodermataceae in brazilian Cerrado). As a cosmopolitan family, Ganodermataceae has as distinctive characteristic the presence of double-walled basidiospore: the inner wall thick and ornamented, and the outer wall smooth. Even with the increasing interest in this family, the species are still poorly known in different regions of the brazilian territory, such as in the central Brazil. This study presents new distribution remarks of Ganodermataceae species in different sites of the biome Cerrado, in the Midwest region. We found 23 specimens from five species which are distributed into three genera, *Amauroderma*, *Foraminispora* and *Ganoderma*. From those species, one is a new record for the Cerrado (*A. exile*), four are new for the State of Goiás *A. exile*, *F. rugosa*, *G. multiplicatum* and *G. stipitatum* and one for the Distrito Federal (*G. stipitatum*). *Amauroderma aurantiacum* is rediscovered in Goiás after 88 years. This study contributes to improving the knowledge regarding the geographic distribution of these taxa in Brazil.

Keywords − *Amauroderma,* Brazilian savanna, *Foraminispora, Ganoderma,* geographic distribution.

Resumo − (Adições ao conhecimento de Ganodermataceae no Cerrado brasileiro). Cosmopolita, a família Ganodermataceae tem como característica distintiva a presença de basidiósporos de parede dupla, sendo a interna espessa e ornamentada e a externa lisa. Mesmo com o crescente interesse pela família, as espécies ainda permanecem muito pouco conhecidas em diferentes localidades do território brasileiro, como é o caso do Brasil central. Este trabalho relata novas ocorrências de espécies de Ganodermataceae em diferentes localidades do bioma Cerrado, na região Centro-Oeste. Os espécimes estudados somam 23 exemplares de cinco espécies, distribuídas em três gêneros, *Amauroderma*, *Foraminispora* e *Ganoderma*. Dessas, uma é novo registro para o Cerrado (*A. exile*), quatro são novas para o estado de Goiás *A. exile*, *F. rugosa*, *G. multiplicatum* e *G. stipitatum* e uma para o Distrito Federal (*G. stipitatum*). *Amauroderma aurantiacum* é novamente registrada para o estado de Goiás após 88 anos. Este trabalho contribui para ampliar o conhecimento da distribuição geográfica das espécies no Brasil.

Palavras-chave – *Amauroderma,* distribuição geográfica, *Foraminispora*, *Ganoderma,* savana brasileira.

Introduction

Proposed in 1948, the family Ganodermataceae (Donk) Donk has approximately 220 species described, distributed into seven genera (*Amauroderma* Murrill, *Foraminispora* Robledo, Costa-Rezende & Drechsler- Santos, *Furtadoa* Costa-Rezende, Robledo & Drechsler-Santos, *Ganoderma* P. Karst., *Haddowia* Steyaert, *Humphreya* Steyaert and *Tomophagus* Murrill) (Ryvarden 2004, Kirk *et al.* 2008, Costa-Rezende *et al.* 2017). Considered cosmopolitan, the family has as a distinct characteristic the presence of double-walled basidiospores, with the inner wall thick and ornamented and the outer smooth, distinguishing it from other polyporoid groups. The basidiospore can be found in globular and ellipsoid shapes with pigmentation (Gilbertson & Ryvarden 1986, Ryvarden 2004, Cannon & Kirk 2007). Thus, these characteristics, as well as the hardness of the pileus, are essential for the identification of Ganodermataceae species (Ryvarden 2004, Gugliotta *et al*. 2011).

Group of crucial importance in maintaining the trophic balance, Ganodermataceae species play a key role in nutrient cycling of ecosystems, causing white rot in woody tissues (Ryvarden 2004). The family comprises species of recognized economic and medicinal value, and some sources of bioactive compounds are widely studied for biotechnological purposes (Zjawiony 2004, Tseng *et al.* 2008, Wang *et al.* 2016).

Species of this family, except the genus *Haddowia*, are widely distributed in the tropics with records in several brazilian ecosystems (Gibertoni & Cavalcanti 2003, Ryvarden 2004, Silveira *et al*. 2008, Baltazar & Gibertoni 2009, Campacci & Gugliotta 2009, Drechsler-Santos et al. 2009, Gomes-Silva & Gibertoni 2009, Gibertoni & Drechsler-Santos 2010, Gugliotta *et al*. 2010, Gomes-Silva *et al*. 2011, Costa-Rezende *et al*. 2016, Bononi *et al*. 2017). However, knowledge about this family in the Cerrado biome is restricted to records of 17 species, with a predominance of the genera *Amauroderma* and *Ganoderma* (Gibertoni & Drechsler-Santos 2010, Abrahão *et al*. 2012, Maia *et al*. 2015, Costa-Rezende *et al*. 2016, Bononi *et al*. 2017). The present study presents new species occurrences of the family Ganodermataceae for the brazilian Cerrado and Midwest region.

Material and methods

The specimens studied were collected in Cerrado areas between 2005 and 2018, usually located in conservation units (UC) in the State of Goiás: municipality of Caldas Novas: Parque Estadual da Serra de Caldas Novas (PESCAN) (17°43'56"S to 17°50'55,7"S; 48°40'0"W to 48°42'57,6"W); municipality of Rio Quente (17°47'35"S and 48°47'36"W); municipality of

Silvânia: Floresta Nacional de Silvânia (FLONA) (16°38'30.46"S and 48°39'3.11"W); municipality of Goiânia: Bosque Auguste Saint-Hilaire (BASH) (16º36'26.74"S and 49º15'51.69"W); municipality of Anápolis: Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG) (16º23'40"S and 48º57'32"W); urban area (16º20'12"S and 48º56'42"W; 16º19'14"S and 48º55'39"W); municipality of Anápolis (14º11'44"S and 49º20'19"W); municipality of Cavalcante, Kalunga community, Engenho II (13º34'56"S and 47º28'16"W) and Distrito Federal: municipality of Brasília (15º46'48"S and 47º55'45"W) (Figure 1).

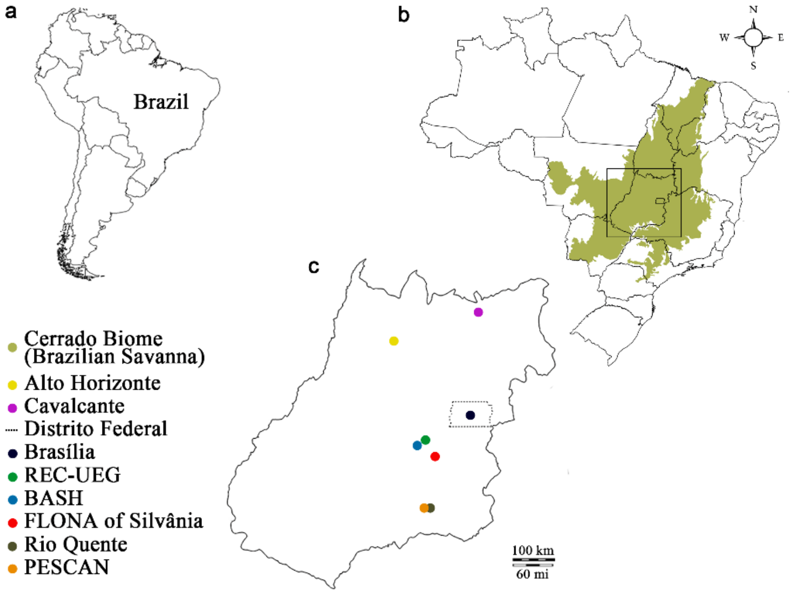

Figure 1. Location of the study area. **a.** location of Brazil in South America. **b.** In green, the distribution area of the Cerrado biome in the Brazilian territory. **c.** Detail of the States of Goiás and the Distrito Federal, with the location of the municipalities and the conservation units where the collections were made.

The Cerrado is considered the second largest biome in South America and is located in the Central Plateau of Brazil. Its area covers the States of Goiás, Tocantins, Bahia, Mato Grosso, Mato Grosso do Sul, Maranhão, Piauí, São Paulo, Minas Gerais, Distrito Federal, Rondônia and Paraná. This biome is characterized by physiognomies that encompass savanna and grassland forest formations, with a mixed presence of trees, shrubs and undergrowth vegetation, with a rainy tropical climate with hot summer and dry winter (Ribeiro & Walter 1998, Klink & Machado 2005).

The taxonomic identification of the collected specimens was based on macro and micromorphological characters, considering the methodologies adopted by Teixeira (1995) and Ryvarden (2004). The specimens were deposited in the Herbarium of the Universidade Estadual de Goiás (HUEG).

Results and Discussion

We found 25 specimens, which are distributed into three genera and five species. From those, one is a new record for the Cerrado (*Amauroderma exile* (Berk.) Torrend 1920), are new for the State of Goiás *Foraminispora rugosa* (Berk.) Costa-Rezende, Drechsler-Santos & Robledo 2017, *Ganoderma multiplicatum* (Mont.) Pat. 1889 and *G. stipitatum* (Murrill) Murrill 1908], one for the Distrito Federal (*G. stipitatum*) and *A. aurantiacum* (Torrend) Gibertoni & Bernicchia 2008 is recorded again for the State of Goiás (type locality) 88 years after its publication.

Taxonomy

Amauroderma aurantiacum (Torrend) Gibertoni & Bernicchia, Mycotaxon 104: 322 (2008).

= *Amauroderma macrosporum* J.S. Furtado, Revis. Revision of the genus *Amauroderma* (Polyporaceae); Studies based on microstructures of the basidiocarp: 203 (1968). Figure 2.

Description: see Gibertoni *et al.* (2008), Gomes-Silva *et al.* (2015).

Substrate: leaf litter.

Distribution: Brazil and Venezuela (Ryvarden 2004). In Brazil there are records in the States of Goiás, Mato Grosso, Rondônia, and São Paulo (Bononi *et al.* 1981, Gibertoni *et al.* 2004, 2007, 2008, Gugliotta *et al.* 2011, Gomes-Silva *et al.* 2015, Costa-Rezende *et al.* 2016).

Material examined: BRAZIL. Goiás: Caldas Novas, Parque Estadual da Serra de Caldas Novas (PESCAN), 17-III-2007, Xavier-Santos, S. (2117) (HUEG9927); ibid, 23-I-2008, Xavier-Santos, S. (2387) (HUEG9928); ibid, 24-I-2008, Xavier-Santos, S. (2481) (HUEG9929); ibid, 1-V-2008, Xavier-Santos, S. (2579) (HUEG9932); ibid, 24-I-2008, Xavier-Santos, S. (2418) (HUEG9933); ibid, 17-XII-2013, Xavier-Santos, S. (5803) (HUEG10552); ibid, 17-XII- 2013, Xavier-Santos, S. (6099) (HUEG10555); ibid, 1-V-2008, Xavier-Santos, S. (2540) (HUEG9934); Rio Quente: 28-III-2009, Xavier-Santos, S. (3733) (HUEG9930); ibid, 23-I-2008, Xavier- Santos, S. (2324) (HUEG9931); ibid, 29-III-2009, Xavier-Santos, S. (3707) (HUEG10650); ibid, collected in 28-III-2009, Xavier-Santos, S. (3580) (HUEG10560); ibid, 24-I-2008, Xavier-Santos, S. (2484) (HUEG10634); ibid, 28-III-2009, Xavier- Santos, S. (3593) (HUEG10597); Cavalcante, Kalunga community, Engenho II: 20-III-2018, Xavier-Santos, S (6353) (HUEG11877); ibid, 20-III-2018, Xavier- Santos, S (6354) (HUEG11878).

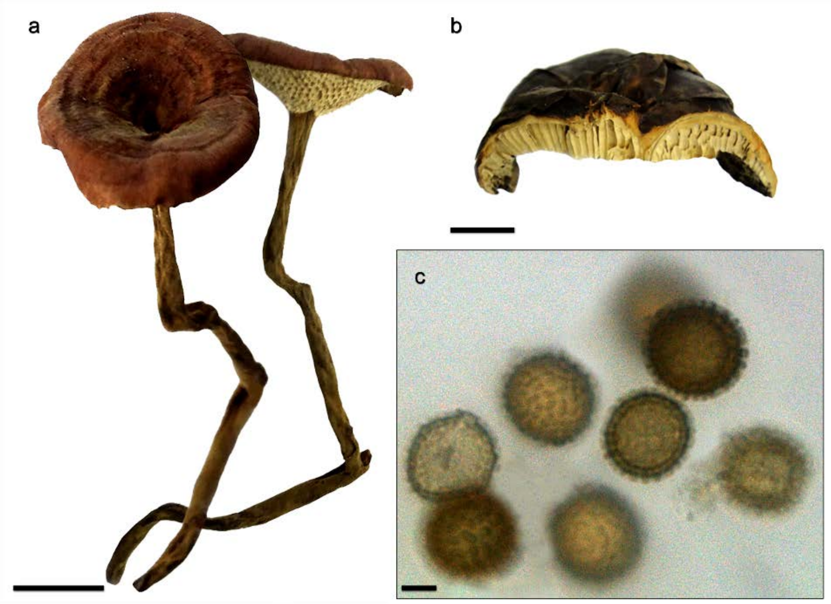

Figure 2. *Amauroderma aurantiacum*. **a.** Basidiome with an emphasis in the reddish color, long stipe with poroid hymenial surface, scale = 1 cm. **b.** Pileus and hymenial surface in detail, scale = 1 cm. **c.** Basidiospores, scale = 5 µm.

Notes: species representative in terms of sampling and showing resistance to changes in seasonality with sampling in dry and rainy seasons in the studied areas. The holotype is reported for the State of Goiás in 1932 (Gibertoni *et al*. 2008). In this case, the species is recorded again for the State of Goiás after 88 years. Among the available descriptions for the species hyphal system, Furtado (1968) and Ryvarden (2004), expose arguments. The first considers the system as a trimitic, composed of generative hyphae with clamp connections; branched thick-walled connective hyphae and arboriform skeletal hyphae. The second considers the system as dimitic, composed of generative hyphae with clamp connections and arboriform skeletal hyphae. In the present study, trimitic hyphal system was adopted. In the field, the species is very similar to *A. calcigenum* (Berk.) Torrend, distinguished by the presence of ellipsoid basidiospores. Among the distinctive characters, the reddish color of basidiome and globose basidiospores, yellowish with dense reticles-shaped ornamentation is highlighted.

Amauroderma exile (Berk.) Torrend, Brotéria, ser. bot. 18: 142 (1920).

≡ *Polyporus exilis* Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 173 (1856). Figure 3.

Description: see Ryvarden (2004).

Substrate: leaf litter.

Distribution: Brazil, Colombia, Honduras and Venezuela (Furtado 1981, Ryvarden 2004). In Brazil there are records for the species in the States of Amapá, Amazonas, Bahia, Mato Grosso, Pará, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Rondônia and São Paulo (Gomes-Silva *et al.* 2015, Maia *et al.* 2015).

Material examined: BRAZIL. GOIÁS: Caldas Novas, 23-XI-2008, Xavier-Santos, S. (3317) (HUEG9935).

Figure 3. *Amauroderma exile*. **a** and **b.** Basidiome with long stipe and hymenial (a) and abhymenial surfaces (b), scale = 1 cm. **c.** Hymenial surface in detail, scale = 1 mm. **d.** basidiospores, scale = 5 µm.

Notes: The species when fresh, has a typical bright reddish-brown color that characterizes it. According to Gomes-Silva *et al.* (2015) the species resembles *A. elegantissimum* Ryvarden & Iturr. differing in the morphology of the basidiospore, since *A. elegantissimum* has globose, not ornamented basidiospores, whith 7–10 µm. This is a new record for the Cerrado and for the State of Goiás.

Foraminispora rugosa (Berk.) Costa-Rezende, Drechsler-Santos & Robledo, in Costa-Rezende, Robledo, Góes-Neto, Reck, Crespo & Drechsler- Santos, Persoonia 39: 262 (2017).

≡ *Ganoderma sprucei* Pat., Bull. Soc. mycol. Fr. 10(2): 75 (1894). Figure 4.

Description: see Decock & Herrera-Figueroa (2006).

Substrate: dead wood.

Distribution: Brazil, Belize, Brazil, Colombia, Costa Rica, Cuba, French Guiana, Jamaica, Puerto Rico and Venezuela (Ryvarden 2004, Decock & Herrera-Figueroa 2006, Campacci & Gugliotta 2009). In Brazil there are records for the species in the States of Amazonas, Bahia, Mato Grosso, Minas Gerais, Pará, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo and Sergipe (Ryvarden 2004, Gibertoni *et al*. 2004, 2007, Gugliotta *et al*. 2011, Drechsler-Santos *et al.* 2013, Maia *et al.* 2015, Costa-Rezende *et al.* 2016).

Material examined: Brazil. GOIÁS: Goiânia, Bosque Auguste Saint-Hilaire, 20-I-2014, Naves L. R. 93 (HUEG9716).

Figure 4. *Foraminispora rugosa*. **a.** Basidiome, scale = 1 cm. **b.** Hymenial surface in detail, scale = 0.5 mm. **c.** Basidiospores, scale = 5 μm.

Notes: the species is characterized for its central to the lateral stipe, context cream to light brown and 5–6 pores per mm. Still, it can be distinguished from the other species of the genus by a slightly tomentous abhymenial surface. It is easily confused with *A. schomburgkii* (Mont. & Berk.) Torrend, differing because of the lack of blackened pileal surface (Gugliotta et al. 2011, Campos-Santana & Loguercio- Leite 2013). This is a new record for the State of Goiás.

Ganoderma multiplicatum (Mont.) Pat., Bull. Soc. mycol. Fr. 5 (2,3): 74 (1889).

≡ *Polyporus multiplicatus* Mont., Annls Sci. Nat., Bot., ser. 41: 128 (1854). Figure 5.

Description: see Ryvarden (2004).

Substrate: dead wood.

Distribution: Angola, Argentina, Brazil, China, Colombia, Egypt, French Guiana, India, Indonesia, Ivory Coast, New Guinea, Seychelles, Sierra Leone, Venezuela, Zaire and Zambia (Steyaert 1980, Gottlieb & Wright 1999, Ryvarden 2000, Baltazar & Gibertoni 2009, Gomes-Silva & Gibertoni 2009, Bhosle *et al*. 2010, Gomes-Silva et al. 2011, Bolaños *et al*. 2016). In Brazil there are records for the species in the States of Alagoas, Amazonas, Mato Grosso do Sul, Pará, Rio de Janeiro, Rondônia, Roraima, Santa Catarina, São Paulo and Sergipe (Steyaert 1980, Capelari & Maziero 1988, Loguercio-Leite *et al*. 2005, Drechsler-Santos *et al*. 2008, Martins-Júnior *et al*. 2011, Gomes-Silva *et al*. 2011, Gugliotta *et al.* 2011, Quevedo *et al*. 2012, Torres-Torres *et al.* 2012, Maia *et al.* 2015).

Material examined: BRAZIL. GOIÁS: Anápolis, Universidade Estadual de Goiás, Reserva Ecológica da Universidade Estadual de Goiás (REC-UEG), 22-V-2009, Xavier-Santos, S. (3772) (HUEG11881).

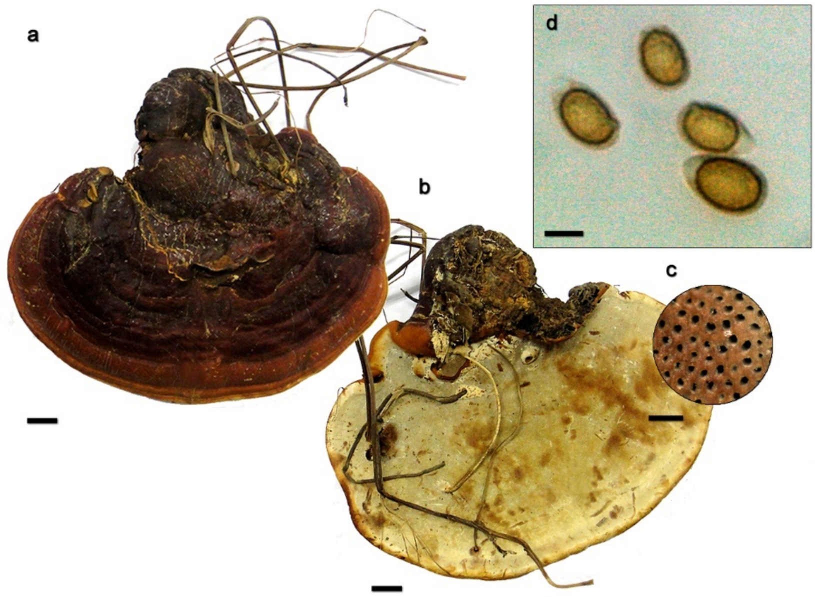

Figure 5. *Ganoderma multiplicatum*. **a** and **b.** Basidiome, hymenial (a) and abhymenial surfaces (b), scale = 1 cm. **c.** Hymenial surface in detail, scale = 0.5 mm. **d.** Basidiospores, scale = 5 µm.

Notes: The species is characterized by the sessile basidiome, lacquer layer, reddish color and pores 6–8/mm. *A. multiplicatum* is morphologically similar to *G. orbiforme* (Fr.) Ryvarden, however, differences can be observed through analysis of microscopic characters, and *G. orbiforme* has larger basidiospores (8.8–10.4 × 6.4–7.2 µm) and cuticle cells with more developed protuberances (Gugliotta *et al.* 2011). This is a new record for the State of Goiás.

Ganoderma stipitatum (Murrill) Murrill, N. Amer. Fl. (New York) 9 (2): 122 (1908).

≡ *Fomes stipitatus* Murrill, Bull. Torrey bot. Club 30 (4): 229 (1903). Figure 6.

Description: see Ryvarden (2004).

Substrate: living trees.

Distribution: Bolivia, Brazil, Costa Rica, Nicaragua, Peru, Suriname and Venezuela (Ryvarden 2004, Torres-Torres *et al.* 2012). In Brazil there are records in the States of Acre, Amazonas, Alagoas, Bahia, Mato Grosso do Sul, Pará, Paraná, Paraíba, Pernambuco, Rio de Janeiro, Rio Grande do Sul and Rondônia (Steyaert 1980, Capelari & Maziero 1988, Gibertoni *et al.* 2004, 2007, Gomes-Silva *et al.* 2011, Martins-Júnior *et al.* 2011, Torres-Torres *et al.* 2012, Maia *et al.* 2015).

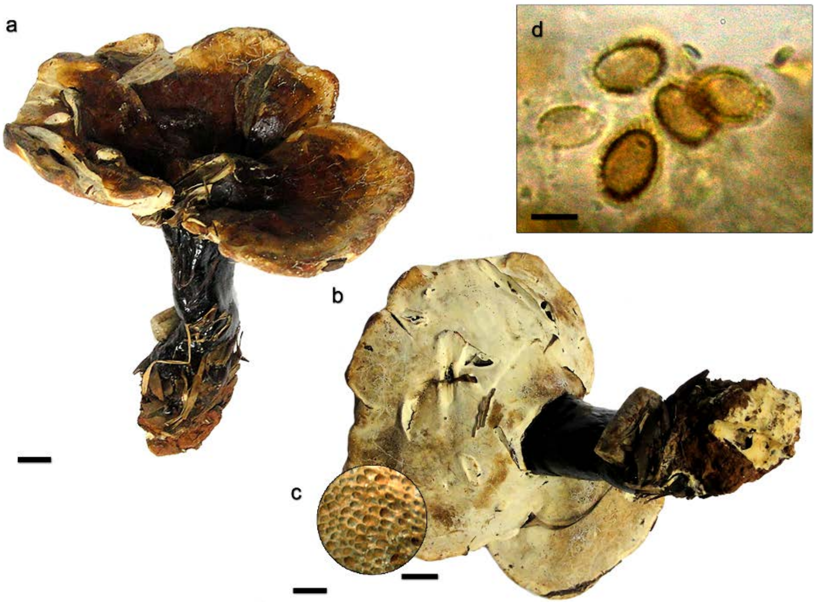

Figure 6. *Ganoderma stipitatum*. **a** and **b.** Basidiome, hymenial (a) e abhymenial surfaces (b), scale = 1 cm. **c.** Hymenial surface in detail, scale = 1 mm. **d.** Basidiospores, scale = 5 µm.

Material examined: BRAZIL. Distrito Federal: Brasília, next to the Universidade de Brasília (UNB), 1-XII-2010, Xavier-Santos, S. (4699) (HUEG10726). Goiás: Alto Horizonte, 15-I-2005, Faria-Junior, J. E.Q. (31) (HUEG10771); Anápolis: School São Francisco de Assis, 15-II-2018, Xavier-Santos, S. (6348) (HUEG11875); ibid 4-XII-2018, Xavier-Santos, S. (6380) (HUEG11991); Anápolis city, 29-V-2018, Xavier- Santos, S. (6355) (HUEG11876); Avenida São Francisco, 20-XI-2018, Xavier-Santos, S. (6381) (HUEG11992).

Notes: according to Ryvarden (2004), this species has dark resinous bands in the context as a distinguishing characteristic. It is easily confused with *G. lucidum* (Curtis) P. Karst., because they are macroscopically similar (Martins-Júnior et al. 2011), but they differ microscopically by the hyphal system, dimitic in *G. stipitatum* and trimitic in *G. lucidum* and by the basidiospores, ellipsoid to oblong, truncate at apex in *G. stipitatum* and ellipsoid to obovate in G. lucidum (Groposo & Loguercio-Leite 2002, Singh *et al.* 2014). This is a new record for the Distrito Federal and for the State of Goiás.

Key to species studied in this work

1. Basidiomata stipitate, with stipe zoned...***F. rugosa***

1. Stipitate basidiome, with stipe or substipe without zones……………………….......................**2**

2. Pilear surface glabrous to laccate; basidiospores with truncate apex.…………….………….**3**

2. Pilear surface glabrous to tomentous; basidiospores with globose to subglobose apex.…...…**4**

3. Pileus circular to dimidiate, long and irregular stipe, with hymenial surface showing pore angular to circular (6–8 per mm)………………………………………………..***G. stipitatum***

3. Pileus flabelliform to applanate, substipitate, with hymenial surface showing pore angular to circular (5–6 per mm)...***G. multiplicatum***

4. Globose basidiospores (10.2–13.3 × 10.1–13.4 μm), with dense reticles-shaped ornamentation..***A. aurantiacum***

4. Globose to subglobose basidiospores (5–7.6 × 5.3–7.4 μm), finely ornamented..........***A. exile***

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References

Abrahão, M.C., Gugliotta, A.M. & Bononi, V.L.R. 2012. Xylophilous Agaricomycetes (Basidiomycota) of Brazilian Cerrado. Check List 8: 1102-1116.

Baltazar, J.M. & Gibertoni T.B. 2009. A checklist of the aphyllophoroid fungi (Basidiomycota) recorded from the Brazilian Atlantic Forest. Mycotaxon 109: 439-442.

Bhosle, S., Ranadive, K., Bapat, G., Garad, S., Deshpande, G. & Vaidya J. 2010. Taxonomy and diversity of *Ganoderma* from the Western parts of Maharashtra (India). Mycosphere 1: 249-262.

Bolaños, A.C., Bononi, V.L.R., Gugliotta, A.M. & Muñoz J.E. 2016. New records of *Ganoderma multiplicatum* (Mont.) Pat. (Polyporales, Basidiomycota) from Colombia and its geographic distribution in South America. Check List 12: 1948.

Bononi, V.L.R., Oliveira, A.K.M., Gugliotta, A.M. & Quevedo J.R. 2017. Agaricomycetes (Basidiomycota, Fungi) diversity in a protected area in the Maracaju Mountains, in the Brazilian central region. Hoehnea 44: 361-377.

Bononi, V.L.R., Trufem, S.F.B. & Grandi R.A.P. 1981. Fungos macroscópicos do Parque Estadual das Fontes de Ipiranga, São Paulo, Brasil, depositados no herbário do Instituto de Botânica. Rickia 9: 37-53.

Campacci, T.V.S. & Gugliotta, A.M. 2009. A review of *Amauroderma* in Brazil, with *A. oblongisporum* newly recorded from the neotropics. Mycotaxon 110: 423-436.

Campos-Santana, M. & Loguercio-Leite, C. 2013. Species of *Amauroderma* (Ganodermataceae) in Santa Catarina State, Southern Brazil. Biotemas, 26: 1-5.

Cannon, P.F. & Kirk, P.M. 2007. Fungal Families of the world. CAB Internacional.

Capelari, M. & Maziero, R. 1988. Fungos macroscópicos do estado de Rondônia, região dos rios Jaru e Ji-Paraná. Hoehnea 15: 28–36.

Costa-Rezende, D.H., Gugliotta, A.M., Góes-Neto, A., Reck, M.A., Robledo, G.L. & Drechsler-Santos, E.R. 2016. *Amauroderma calcitum sp. nov.* and notes on taxonomy and distribution of *Amauroderma* species (Ganodermataceae). Phytotaxa 244: 101–124.

Costa-Rezende, D.H., Robledo, G.L., Góes-Neto, A., Reck, M.A., Crespo, E. & Drechsler-Santos E.R. 2017. Morphological reassessment and molecular phylogenetic analyses of *Amauroderma* s. lat. raised new perspectives in the generic classification of the Ganodermataceae family. Persoonia: Molecular Phylogeny and Evolution of Fungi, 39: 254.

Decock, C. & Herrera-Figueroa, S. 2006. Neotropical Ganodermataceae (Basidiomycota): *Amauroderma sprucei* and *A. dubiopansum*. Cryptogamie Mycologie 27: 3–10.

Drechsler-Santos E.R., Groposo, C. & Loguercio-Leite, C. 2008. Additions to the knowledge of lignocellulolytic Basidiomycetes (Fungi) in forests from Santa Catarina State, Brazil. Mycotaxon 103: 197–200.

Drechsler-Santos, E.R., Gibertoni, T.B., Góes-Neto, A. & Cavalcanti, M.A.Q. 2009. A re-evalutation of the lignocellulolytic *Agaricomycetes* from the Brazilian semi-arid region. Mycotaxon 108: 241–244.

Drechsler-Santos, E.R., Ryvarden, L., Bezerra, J.L., Gibertoni, T.B., Salvador-Montoya, C.A. & Calvacanti, M.A.Q. 2013. New records of Auriculariales, Hymenochaetales and Polyporales (Fungi: Agaricomycetes) for the Caatinga Biome. Check List 9: 800–805.

Furtado, J.S. 1968. Revisão do Gênero *Amauroderma* (Polyporaceae). Estudos baseados nas microestruturas do basidiocarpo. PhD Thesis, Universidade de São Paulo.

Furtado, J.S. 1981. Taxonomy of *Amauroderma* (Basidiomycetes, Polyporaceae). Memoirs of the New York Botanical Garden 34: 1–109.

Gibertoni, T.B. & Cavalcanti, M.A.Q. 2003. A mycological survey of the Aphyllophorales (Basidiomycotina) of the Atlantic Rain Forest in the State of Pernambuco, Brazil. Mycotaxon 87: 203-211.

Gibertoni, T.B., Ryvarden, L. & Cavalcanti, M.A.Q. 2004. Poroid fungi (Basidiomycota) of the Atlantic Rain Forest in Northeast Brazil. Synopsis Fungorum 18: 33–43.

Gibertoni, T.B., Santos, P.J.P. & Cavalcanti, M.A.Q. 2007. Ecological aspects of Aphyllophoralesin the Atlantic rain forest in northeast Brazil. Fungal Diversity 25: 49–67.

Gibertoni, T.B., Bernicchia, A., Ryvarden, L. & Gomes-Silva, A.C. 2008. Bresadola's polypore collection at the Natural History Museum of Trento, Italy 2. Mycotaxon 104: 321–323.

Gibertoni, T.B. & Drechsler-Santos, E.R. 2010. Lignocellulolytic *Agaricomycetes* from the Brazilian Cerrado biome. Mycotaxon 111: 87-90.

Gilbertson, R.L. & Ryvarden, L. 1896. North American Polypores. Fungiflora, Oslo.

Gomes-Silva, A.C. & Gibertoni, T.B. 2009. Revisão do Herbário URM. Novas ocorrências de Aphyllophorales para a Amazônia brasileira. Revista Brasileira de Botânica 32: 587-596.

Gomes-Silva, A.C., Ryvarden, L. & Gibertoni, T.B. 2011. New records of *Ganodermataceae* (Basidiomycota) from Brazil. Nova Hedwigia 92: 83-94.

Gomes-Silva, A.C., Lima-Júnior, N.C., Malosso, E., Ryvarden, L. & Gibertoni, T.B. 2015. Delimitation of taxa in *Amauroderma* (Ganodermataceae, Polyporales) based in morphology and molecular phylogeny of Brazilian specimens. Phytotaxa 227: 201–228.

Gottlieb, A.M. & Wright, J.E. 1999. Taxonomy of *Ganoderma* from southern South America: subgenus *Elfvingia*. Mycological Research, 103:1289-1298.

Groposo, C. & Loguercio-Leite, C. 2002. Fungos poliporóides xilófilos (Basidiomycetes) da Reserva Biológica Tancredo Neves, Cachoeirinha, Rio Grande do Sul, Brasil. Iheringia, Série Botânica, 57: 39-59.

Gugliotta, A.M., Fonsêca, M.P. & Bononi, V.L.R. 2010. Additions to the knowledge of aphyllophoroid fungi (Basidiomycota) of Atlantic Rain Forest in São Paulo State, Brazil. Mycotaxon 112: 335–338.

Gugliotta, A.M., Poscolere, G.D. & Campacci, T.V.S. 2011. Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, Sp, Brasil. Fungos, 10: Ganodermataceae. Hoehnea 38: 687-695.

Kirk, P.M., Cannon, P.F., Minter, D.W. & Stalpers, J.A. 2008. Ainsworth & Bisby‘s Dictionary of the Fungi. 10rd edition, CAB International, United Kingdom.

Klink, C.A. & Machado, R.B. 2005. A conservação do Cerrado Brasileiro. Megadiversidade. 1(1): 147-155.

Loguercio-Leite, C., Groposo, C. & Halmenschlager, M.A. 2005. Species of *Ganoderma* Karsten in a subtropical area (Santa Catarina State, Southern Brazil). Iheringia, Bot. 60(2): 135–139.

Maia, L. C. et al. 2015. Diversity of Brazilian fungi. Rodriguésia, 66(4): 1033-1045.

Martins-Júnior, A.S., Gibertoni, T.B. & Sótão, H.M.P. 2011. Espécies de *Ganoderma* P. Karst (Ganodermataceae) e *Phellinus* Quél. (Hymenochaetaceae) na Estação Científica Ferreira Penna, Pará, Brasil. Acta Botanica Brasílica 25: 531-533.

Quevedo, J.R., Bononi, V.L.R., Oliveira, A.K.M. & Gugliotta, A.M. 2012. Agaricomycetes (Basidiomycota) em um fragmento florestal urbano na cidade de Campo Grande, Mato Grosso do Sul, Brasil. Revista Brasileira de Biociências 10:430-438.

Ribeiro, J.F. & Walter, B.M.T. 1998. Fitofisionomias do Bioma Cerrado. *In:* Sano, S.M. & Almeida, S.P. (Org) Cerrado: Ambiente e flora. Brasília, DF: Embrapa Cerrados, pp 87-166.

Ryvarden, L. 2000. Studies in Neotropical polypores 2: a preliminary key to Neotropical species of *Ganoderma* with a laccate pileus. Mycologia 92: 180–191.

Ryvarden, L. 2004. Neotropical polypores: Part 1. Introduction, Ganodermataceae & Hymenochaetaceae. Oslo, Fungiflora. 227 pp.

Silveira, R.M.B., Reck, M.A., Graf, L.V. & SÁ, F.N. 2008. Polypores from a Brazilian pine Forest in Southern Brazil: pileate species. Hoehnea 35: 619-631.

Singh, R., Dhingra, G.S. & Shri, R. 2014. A comparative study of taxonomy, physicochemical parameters, and chemical constituents of *Ganoderma lucidum* and *G. philippii* from Uttarakhand, India. Turkish Journal of Botany, 38: 186-196.

Steyaert, R.L. 1980. Study of some *Ganoderma* species. Bulletin du Jardin Botanique de L'etat Bruxelles 50: 135–186.

Teixeira, A.R.1995. Método para estudo das hifas do basidiocarpo de fungos poliporáceos. Manual n. 6. Instituto de Botânica, São Paulo.

Torres-Torres, M.G., Guzman-Davalos, L., Gugliotta, A.M. 2012. *Ganoderma* in Brazil: known species and new records. Mycotaxon, 121: 93-132.

Tseng, Y.H., Yang, J.H. & Mau, J.L. 2008. Antioxidant properties of polysaccharides from *Ganoderma tsugae*. Food 18 Chemistry 107: 732–738.

Wang, Q., Wang, Y.G., Ma, Q.Y., Huang, S.Z., Kong, F.D., Zhou, L.M., Dai, H.F. & Zhao, Y.X. 2016. Chemical constituents from the fruiting bodies of *Amauroderma subresinosum.* Journal of Asian Natural Products Research*:* 11, 1030-1035.

Zjawiony, J.K. 2004. Biologically active compounds from Aphyllophorales (polypore) fungi. Journal of natural products 67: 300-310

CAPÍTULO IV

DIVULGAÇÃO CIENTÍFICA

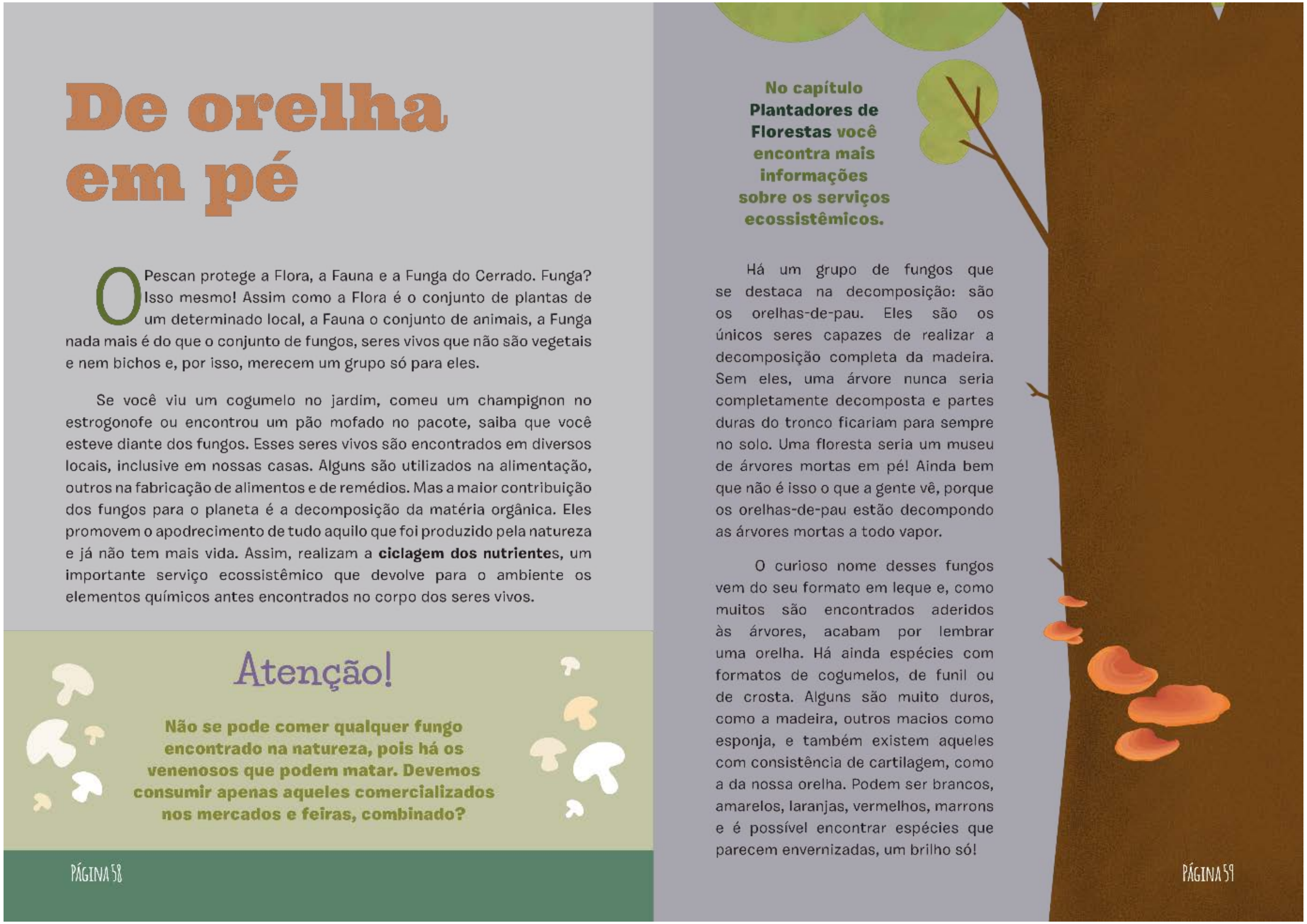
Capítulo de livro 1

DE ORELHA EM PÉ

Lucas Leonardo da Silva, Flávia Pereira Lima & Solange Xavier-Santos

Capítulo publicado no livro "Nas trilhas do PESCAN – Descobrindo o Parque Estadual da Serra de Caldas Novas" (ISBN: 978-85-68236-04-8).

De orelha em pé.: In Nas trilhas do PESCAN – Descobrindo o Parque Estadual da Serra de Caldas Novas



De orelha em pé

O Pescan protege a Flora, a Fauna e a Funga do Cerrado. Funga? Isso mesmo! Assim como a Flora é o conjunto de plantas de um determinado local, a Fauna o conjunto de animais, a Funga nada mais é do que o conjunto de fungos, seres vivos que não são vegetais e nem bichos e, por isso, merecem um grupo só para eles.

Se você viu um cogumelo no jardim, comeu um champignon no estrogonofe ou encontrou um pão mofado no pacote, saiba que você esteve diante dos fungos. Esses seres vivos são encontrados em diversos locais, inclusive em nossas casas. Alguns são utilizados na alimentação, outros na fabricação de alimentos e de remédios. Mas a maior contribuição dos fungos para o planeta é a decomposição da matéria orgânica. Eles promovem o apodrecimento de tudo aquilo que foi produzido pela natureza e já não tem mais vida. Assim, realizam a **ciclagem dos nutrientes**, um importante serviço ecossistêmico que devolve para o ambiente os elementos químicos antes encontrados no corpo dos seres vivos.

Atenção!

Não se pode comer qualquer fungo encontrado na natureza, pois há os venenosos que podem matar. Devemos consumir apenas aqueles comercializados nos mercados e feiras, combinado?

No capítulo Plantadores de Florestas você encontra mais informações sobre os serviços ecossistêmicos.

Há um grupo de fungos que se destaca na decomposição: são os orelhas-de-pau. Eles são os únicos seres capazes de realizar a decomposição completa da madeira. Sem eles, uma árvore nunca seria completamente decomposta e partes duras do tronco ficariam para sempre no solo. Uma floresta seria um museu de árvores mortas em pé! Ainda bem que não é isso o que a gente vê, porque os orelhas-de-pau estão decompondo as árvores mortas a todo vapor.

O curioso nome desses fungos vem do seu formato em leque e, como muitos são encontrados aderidos às árvores, acabam por lembrar uma orelha. Há ainda espécies com formatos de cogumelos, de funil ou de crosta. Alguns são muito duros, como a madeira, outros macios como esponja, e também existem aqueles com consistência de cartilagem, como a da nossa orelha. Podem ser brancos, amarelos, laranjas, vermelhos, marrons e é possível encontrar espécies que parecem envernizadas, um brilho só!

Orelhas-de-pau do Pescan

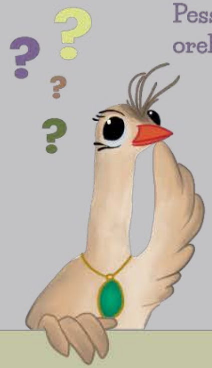
Trametes variegata sobre madeira morta.

Favolus tenuiculus sobre madeira viva.

Cymatoderma caperatum sobre madeira morta.

Fungo do grupo *Ganoderma* sobre madeira morta.

Pycnoporus sanguineus sobre madeira viva.



Pessoal, estou com uma dúvida: será que as orelhas-de-pau escutam a destruição do Cerrado?

Que pergunta espetacular, Jurema! Cientistas da Universidade Estadual de Goiás pesquisaram justamente como o desmatamento afeta as orelhas-de-pau no Pescan.Para compreendermos o que descobriram, é preciso dar uma olhada no efeito de borda:

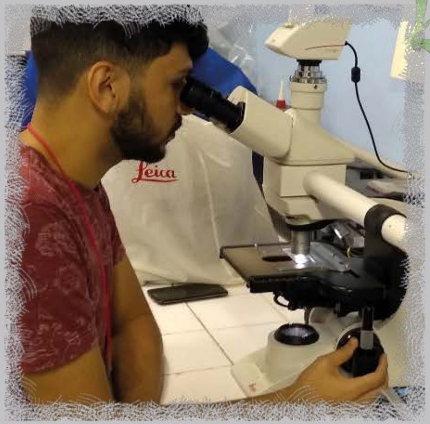
Me diga onde a sopa está mais quente: na borda ou no meio do prato? Se você começar a comer pela borda, a chance de queimar a língua é menor. Essa região tem maior contato com o ar e esfria mais rápido.

Volte ao primeiro capítulo e confira a foto de satélite do Pescan. Nela é possível ver a forma do parque, delimitada por suas bordas.

Assim como no prato de sopa, as condições são diferentes nas áreas no interior do parque daquelas mais afastadas. Nas bordas a temperatura e a iluminação são maiores e a umidade é menor. Logo, é esperado encontrar seres vivos diferentes em cada local, porque as condições ambientais são distintas.

O desmatamento fragmenta as áreas naturais que diminuem cada vez mais de tamanho. Quanto menor uma área, mais o seu interior sofrerá com o efeito de borda, ou seja, com as diferentes condições ambientais dessa região. Assim, as espécies adaptadas às condições de interior, como maior umidade, terão mais dificuldade de sobreviver. Portanto, quanto maior o efeito de borda, mais o interior se parecerá com as áreas externas, menor será a variabilidade ambiental e menor será a variedade de espécies.

Trabalho de campo: coletando orelhas-de-pau nas matas do PESCAN.



Trabalho de laboratório: identificando as espécies das amostras coletadas.

Pronto! Agora vamos entender os resultados da pesquisa. A primeira descoberta foi que nas matas do interior do Pescan há mais espécies de fungos orelhas-de-pau do que nas matas da borda do parque. Além disso, a maior parte das espécies encontradas consegue viver apenas nas áreas de mata do interior. Tudo isso porque o interior apresenta condições, como temperatura e umidade, mais favoráveis para o crescimento de diferentes espécies orelhas-de-pau.

Será que, por causa disso, a decomposição de madeira nas bordas é menor do que no interior do parque?

O Pescan e as outras áreas naturais preservadas no Cerrado são fundamentais para a preservação da Funga, Fauna e Flora e uma garantia de que os serviços ecossistêmicos, tão necessários para a nossa saúde e bem-estar, sejam mantidos.

Respondendo a nossa guia Jurema: os fungos orelhas-de-pau não são capazes de escutar, mas são excelentes indicadores das mudanças ambientais. Cabe a nós ficarmos de orelhas em pé para entender os recados da natureza e cobrar pela sua preservação.

Olha aí, minha gente!
Mais uma interessante pesquisa
a ser realizada no Pescan.

Capítulo de livro 2

AS ORELHAS-DE-PAU DO PARQUE ESTADUAL DA SERRA DE CALDAS NOVAS: UMA BIODIVERSIDADE AMEAÇADA PELA FRAGMENTAÇÃO DO CERRADO

Lucas Leonardo-Silva & Solange Xavier-Santos

Capítulo vencedor do 5º prêmio SBPC/GO de popularização da Ciência (ISBN: 978-85-495-0299-5).

As orelhas-de-pau do Parque Estadual da Serra de Caldas Novas: uma biodiversidade ameaçada pela fragmentação do Cerrado

Autor: Lucas Leonardo da Silva
Orientadora: Solange Xavier dos Santos

Introdução

Os fungos conhecidos popularmente como orelhas-de-pau representam um grande grupo artificial de espécies dentro da classe Agaricomycetes, filo Basidiomycota (KIRK et al., 2008). Esses fungos desempenham importantes papeis no meio ambiente, sobretudo na ciclagem de nutrientes, onde se destacam como os únicos agentes responsáveis pela decomposição completa da madeira. Por essa razão, muitas espécies vêm sendo estudadas em processos de biorremediação (remoção de substâncias toxicas do ambiente), além de outros processos biotecnológicos, seja na obtenção de enzimas de interesse industrial, gomas, oxidantes, sem falar nas espécies comestíveis ou de importância medicinal (LIU et al., 2012; ABREU et al., 2015).

Apesar da grande riqueza e importância das orelhas-de-pau, ainda há muitas lacunas no conhecimento da diversidade desse grupo no Brasil, especialmente na região Centro-Oeste, onde predomina o bioma Cerrado (BONONI et al., 2008). Esse bioma é um dos mais diversos do país, apresentando grande heterogeneidade de paisagens e de recursos naturais. No entanto, ele vem sofrendo uma grande perda de área em decorrência da intensa exploração agropecuária e de produtos nativos, contribuindo para sua fragmentação e consequentemente para a expansão dos ambientes de borda. Os ambientes de borda são considerados uma interrupção abrupta na vegetação, que expõe a comunidade a condições externas anteriormente inexistentes, como a redução de alimento, da disponibilidade de água e aumento da temperatura e radiação solar, o que resulta numa baixa na diversidade biológica ao longo do tempo (TERBORGH et al., 1997; KLINK e MACHADO, 2005).

Além da pouca informação sobre a diversidade fúngica no Cerrado, não há estudos relacionados à ecologia do grupo nesse ecossistema. Nessa perspectiva, esse trabalho objetivou inventariar as espécies de orelhas-de-pau, bem como investigar parâmetros ecológicos que afetam essa comunidade no Parque Estadual da Serra de Caldas Novas (PESCAN)/Goiás e seu entorno.

Materiais e Métodos

Área de estudo: A área de estudo está localizada no Parque Estadual da Serra de Caldas Novas (PESCAN) e seu entorno, compreendendo os municípios de Caldas Novas e Rio Quente, estado de Goiás (Figura 1). Situado no domínio do bioma Cerrado, o PESCAN possui uma extensão de 125 km² e constitui uma das mais importantes áreas de recargas dos aquíferos hidrotermais da região. O parque tem por objetivo principal preservar a Fauna, a Flora, os mananciais e seu entorno, protegendo sítios naturais de relevância ecológica e reconhecida importância turística, assegurando e proporcionando oportunidades controladas para uso pelo público, educação e pesquisa científica (ALMEIDA e SARMENTO, 1998).

Figura 1. Paisagens típicas do bioma Cerrado no Parque Estadual da Serra de Caldas Novas.

Abordagem taxonômica: Para os estudos taxonômicos, foram consideradas coletas aleatórias, em modelo de busca ativa, abrangendo áreas no interior do PESCAN e no seu entorno. Todos os basidiomas (corpo do fungo) de orelhas-de-pau visualizados em campo foram recolhidos e depositados em sacos de papel devidamente rotulados.

Abordagem ecológica: Para avaliar o efeito de borda sobre a comunidade fúngica, foram selecionados quatro fragmentos de floresta estacional semidecidual, localizados no PESCAN e em áreas circunvizinhas. Para cada fragmento florestal foram considerados dois tipos de ambientes: Interior de fragmentos (IF) e borda do fragmento (BF). A faixa de 0-10 m da margem para dentro de cada fragmento foi considerada borda (BF). Como interior (IF), foi determinada uma distância de 100 m a partir da borda. Para esses tratamentos, foram definidas quatro parcelas com extensão de 100 m² (10x10 m) estabelecidas aleatoriamente ao longo de 2000 m² (10x200 m) para cada tratamento nas réplicas. No interior das parcelas foram coletadas amostras de todos os basidiomas de orelhas-de-pau visualizados.

Caracterização e identificação: A identificação taxonômica dos espécimes coletados foi realizada com base nos caracteres macro e micromorfológicos dos exemplares, que foram depositados no Herbário da Universidade Estadual de Goiás (HUEG).

Resultados e Discussão

Foram identificadas 31 espécies, distribuídas em 20 gêneros, seis famílias e três ordens (Figura 2). Dentre essas espécies, 24 estão foram registradas pela primeira no estado de Goiás e 11 são novos registros para região Centro-Oeste. Polyporaceae foi a família mais representativa (52% das espécies). A maioria das espécies (49%) ocorreu exclusivamente sobre madeira morta, 23% ocorreu sobre madeira viva e morta, 16% em madeira viva, 6% em solo e folhedo. Isso reforça a predileção desses fungos por substratos compostos por lignina, celulose e hemicelulose, que são os principais constituintes da parede celular da madeira, cuja degradação completa depende de um complexo enzimático produzido exclusivamente por esses fungos, que realizam a chamada decomposição branca (ABREU et al., 2007).

Considerando o material coletado nos quatro fragmentos florestais amostrados, foi obtido um total de 48 exemplares, sendo 71% amostrados no interior e 29% em borda dos fragmentos. Cerca de 56% das espécies foi encontrada exclusivamente no interior; 20% foi exclusiva de borda e 24% foi comum a ambas as áreas. A composição de espécies também foi distinta entre as áreas. Em ambientes de borda foi detectado predomínio de espécies com características que lhes conferem resistência a alguns fatores físicos adversos, tais como a presença de pelos na superfície abhimenial, que auxiliam no armazenamento de água e na redução da incidência direta de raios solares, o que se torna vantajoso em ambientes áridos, pouco sombreados e de temperatura elevada. Por outro lado, a prevalência das espécies mais sensíveis às modificações do ambiente foi registrada em maior frequência em áreas de interior. Diante desses resultados, é possível inferir que o interior apresente condições mais favoráveis à comunidade fúngica e que a sobrevivência em áreas de borda seja limitada às espécies mais resistentes a condições ambientais adversas, como maior entrada de luz solar, ventos, entre outros fatores, que promovem diferenças nos parâmetros estruturais da vegetação (GASCON et al., 2000), assim afetando a comunidade fúngica e, contribuindo para o aumento do efeito de borda.

Figura 2. Alguns representantes de orelhas-de-pau do Parque Estadual da Serra de Caldas Novas.

Considerações Finais

O presente estudo resultou no inventário da micobiota de orelhas-de-pau do PESCAN e de seu entorno, além promover a expansão da distribuição geográfica das espécies, com um o acréscimo de 24 novos registros para o estado de Goiás e 11 para o Centro-Oeste. A investigação dos parâmetros ecológicos, como abundância, riqueza e composição de espécies, permitiu constatar efeito de borda nessa comunidade, sendo o interior dos fragmentos um ambiente mais propício às orelhas-de-pau do que as áreas de borda. Esses dados revelam que a biodiversidade do parque está sendo ameaçada pela fragmentação do Cerrado, e que medidas mitigatórias desses impactos poderão contribuir para a conservação dessa comunidade fúngica. Esse estudo culminou na elaboração de um livro bilíngue, intitulado: **“Guia de Fungos Macroscópicos do Parque Estadual da Serra de Caldas Novas, Goiás, Brasil, volume II - Fungos poroides”**, que constitui o primeiro guia de campo para os fungos poroides do Cerrado. Escrito em linguagem clara e ricamente ilustrado, o guia traz uma caracterização do parque, uma introdução sobre os fungos poroides e instruções de como coletar, preservar e preparar o material para estudo, chaves de identificação, descrição e ilustração das espécies, e ainda um glossário dos termos técnicos. Assim, atendendo desde estudantes da Educação Básica e Superior, à comunidade local ou ao grande público interessado na biodiversidade do Cerrado.

Referências

ABREU, J. A. S.; ROVIDA, A. F. S.; PAMPHILE, J. A. Fungos de interesse: aplicações biotecnológicas. **Uningá Review**, v.21, p. 55-59, 2015.

ABREU, L. D.; MARINO, R. H.; MESQUITA, J. B.; RIBEIRO, G. T. Degradação da madeira de *Eucalyptus* sp. por basidiomicetos de podridão branca. **Arquivos do Instituto Biológico**, v.74, n.4, p.321-328, 2007.

ALMEIDA, A. F.; SARMENTO, F. N. M. Parque Estadual da Serra de Caldas: Plano de manejo. CTE (Centro Tecnológico de Engenharia Ltda), Famego, Goiânia, 1998.

BONONI, V. L. R.; OLIVEIRA, A. K. M. QUEVEDO, J. R.; GUGLIOTTA, A. M. Fungos macroscópicos do Pantanal do Rio Negro, Mato Grosso do Sul, Brasil. **Hoehnea**, v.35, n.4, p. 489-511, 2008.

GASCON, C., G.B. WILLIAMSON.; G.A.B. FONSECA. Receding forest edges and vanishing reserves. **Science** n. 288, p.1356-1358, 2000.

KIRK, P. M.; CANNON, P. F.; DAVID, J. C.; STALPERS, J. A. **Dictionary of the Fungi**. 10th ed. Wallingford: CABI International, p. 485, 2008.

KLINK, C.A. E MACHADO, R.B. Conservation of the Brazilian Cerrado. **Conservation Biology,** n. 19, v. 3, p. 707-713, 2005.

LIU, J.; CAI, Y.; LIAO, X.; HUANG, Q.; HAO, Z.; HU, M.; ZHANG, D. Simultaneous laccase production and color removal by culturing fungus *Pycnoporus* sp. SYBC-L3 in a textile wastewater effluent supplemented with a lignocellulosic waste *Phragmites australis.* **Bulletin of environmental contamination and toxicology**, v.89, p. 269-273, 2012.

TERBORGH, J.; LOPES, L.; TELLO, J.; YU, D.; BRUNI, A. R. Transitory states in relaxing ecosystems of land bridge islands. In**: LAURANCE, W. F.; BIERREGAARD R. O. (eds.). Tropical Forest Remnants: Ecology, Management, and Conservation of Fragmented Landscape**. University of Chicago Press, Chicago, p. 256-274, 1997.

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Livro

GUIA DE FUNGOS MACROSCÓPICOS DO PARQUE ESTADUAL DA SERRA DE CALDAS NOVAS, GOIÁS, BRASIL, VOLUME II - FUNGOS POROIDES

Lucas Leonardo-Silva & Solange Xavier-Santos

O livro será publicado pela editora Kelps, Goiânia.

Guia de Fungos Macroscópicos do Parque Estadual da Serra de Caldas Novas, Goiás, Brasil, volume II - Fungos poroides

O guia de campo de fungos poroides do Parque Estadual da Serra de Caldas Novas (PESCAN) foi elaborado em linguagem clara e bilíngue. O guia é acessível ao grande público, que abrange desde estudantes da educação básica e superior à comunidade local, e estrangeiros interessados nessa biodiversidade. Além de documentar a Funga poroide do PESCAN, o guia apresenta uma descrição detalhada do Parque e fornece subsídios para o reconhecimento de espécies e para outros estudos sobre esses fungos do Cerrado, por meio da descrição, ilustração, de um glossário para os termos mais comumente empregados e de uma chave de identificação para 32 espécies de fungos poroides comuns na área estudada; servindo, assim, de apoio tanto para fins científicos quanto pedagógicos.

Considerações finais

i. Estudos sobre fungos corticioides e poroides no Cerrado tiveram início no final do século XIX e, mesmo após mais de 200 anos de estudo, ainda há pouca produção científica sobre essa temática;

ii. Observamos um crescimento exponencial desse conhecimento na última década devido ao interesse de novos grupos de pesquisa de Goiás e de outros estados brasileiros. Entretanto, ainda existe pouca colaboração interinstitucional;

iii. Estudos envolvendo aspectos filogenéticos e biotecnológicos desses grupos de fungos no Cerrado ainda são incipientes;

iv. Em linhas gerais, a diversidade de fungos corticioides e poroides do Cerrado é menos conhecida que a de outros biomas, como a Mata Atlântica e a Floresta Amazônica. Resultado da fata de recursos humanos, investimentos e estudos em áreas ainda não explorada do Cerrado;

v. O quantitativo de espécies raras (29 espécies) e endêmicas (6 espécies) encontradas neste trabalho alertam para importância de implementar programas que avaliam o grau de ameaça dessas espécies;

vi. Os novos registros de ocorrência ampliam de 223 para 244 as espécies de fungos corticioides e poroides para o Cerrado, de modo que a descoberta dessa diversidade, até então, desconhecida, pode estimular novos estudos no Cerrado e novas abordagens de pesquisa, como biotecnológica, ecológica, filogenética, entre outras;

vii. O estudo do material coletado permitiu criar um banco de DNA desses grupos de fungos com aproximadamente 100 amostras;

viii. A investigação filogenética de espécies ganodermatoides estabeleceu um novo nome para o gênero *Furtadoa*: *Furtadomyces*, uma nova espécie para a Ciência e perspectivas futuras para realização de novos estudos;

ix. A divulgação dos resultados para a comunidade não científica ainda é uma prática pouco adotada e ao mesmo tempo extremamente necessária, principalmente quando o negacionismo científico está tão presente em nossa sociedade. Assim, os produtos de divulgação científica produzidos são uma estratégia que contribuirá para formação cidadã e compreensão pública da ciência, sobretudo de crianças e jovens em formação.

Perspectivas futuras e outras reflexões

A execução desse trabalho promoveu, de forma significativa, a ampliação do conhecimento da Funga corticioide e poroide do Cerrado, contribuindo para o preenchimento de importantes lacunas acerca da composição de espécies e sua distribuição geográfica, levando à identificação de pontos quentes de ocorrência e grau de endemismo de determinados grupos, além de subsidiar ações de recuperação, regeneração, utilização sustentável e conservação das localidades estudadas. Assim, os resultados e conclusões alcançados abrem novas perspectivas para estudos futuros sobre fungos corticioides e poroides do Cerrado como:

i. Realização de novos inventários em outras importantes unidades de conservação do bioma, considerando também aspectos ecológicos quanto à especificidade pelo substrato e à influência da degradação do habitat (efeito de borda, redução de áreas florestais, queimadas, entre outros);
ii. Identificação molecular das espécies não identificadas do fungário HUEG, bem como de amostras disponíveis no banco de DNA do FungiLab, incluindo também análises filogenéticas;
iii. Realizar a circunscrição do gênero *Furtadomyces*, considerando espécies dentro de *Amauroderma* com posição incerta dentro do gênero;
iv. Conhecer a relação entre os estágios anamorfo e teleomorfo de *Inonotus rickii*, bem como sua circunscrição;
v. Ensaios de domesticação e de aplicações biotecnológicas desses grupos de fungos, visando à obtenção de fontes sustentáveis para a biorremediação de poluentes tóxicos ambientais, de modo a contribuir com o desenvolvimento de novas tecnologias para o país.

Aproveito para apresentar, nessa seção, uma parte do trabalho que não foi inserida nos capítulos apresentados. Esses resultados compõem dois artigos intitulados provisoriamente de: I) “Taxonomy and multi-gene phylogeny reveal one new anamorphic species in *Inonotus* s.s. (Hymenochaetaceae) from Brazil” e II) “New insights on *Inonotus rickii* (Hymenochaetaceae): bromatological aspects, biotechnological applications, toxic and mutagenic effects”, que devido às restrições impostas pela pandemia de Covid-19, não foi possível inserir na tese. Mencioná-los, mesmo que brevemente, expressa parte da nossa (minha e da Solange) aspiração de cientistas, idealizada em 2019 durante a concepção da tese.

Para o primeiro artigo mencionado acima, nós coletamos e analisamos diversos materiais de herbário, incluindo o exemplar tipo de *Inonotus rickii*. Esses exemplares somam 14 amostras que tiveram seu DNA extraído, e sete foram amplificados e sequenciados para três marcadores genéticos: ITS - Nuclear rDNA internal transcribed spacers, nLSU - Nuclear rDNA large subunit e TEF - Translation elongation factor 1α. Com esses resultados, nós objetivamos descrever uma nova espécie anamórfica para o gênero *Inonotus*, apresentando uma descrição detalhada da morfologia, cultivo em diferentes meios de cultura, prospecção enzimática, filogenia e micofagia, bem como a circunscrição da espécie *I. rickii*.

Para o segundo artigo, nós realizamos diferentes ensaios de domesticação e bioprospecção de isolados de *I. rickii,* que demonstraram potenciais propriedades biorremediativas de compostos fenólicos, efluentes industrial e têxtil, corantes sintéticos, pesticidas e plástico, removendo, em escala laboratorial, mais de 90% de alguns desses compostos. Além disso, a inocuidade dessas linhagens foi comprovada em testes de toxicidade em *Allium cepa*, *Biomphalaria glabrata* e *Salmonella typhimurium*, gerando perspectivas para o uso seguro, livre de riscos à saúde humana e ambientais, assim suscitando futuros estudos aplicados.

Apesar de não apresentarmos esses dados aqui, esperamos vê-los pulicados em breve, os quais, juntamente com os demais resultados da tese, consolidam uma importante linha de pesquisa do FungiLab/UEG, bem como ressalta a importância dos fungos, especialmente os corticioides e poroides, como fonte de recursos naturais do Cerrado. Assim, compartilho momentos de importantes etapas e conquistas deste trabalho, alcançadas ao longo de quatro anos como registro e agradecimento a todos que contribuíram neste período:


Atenção!!


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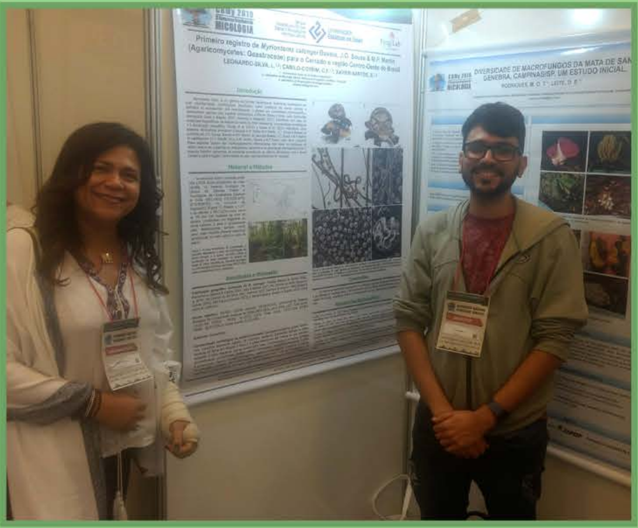
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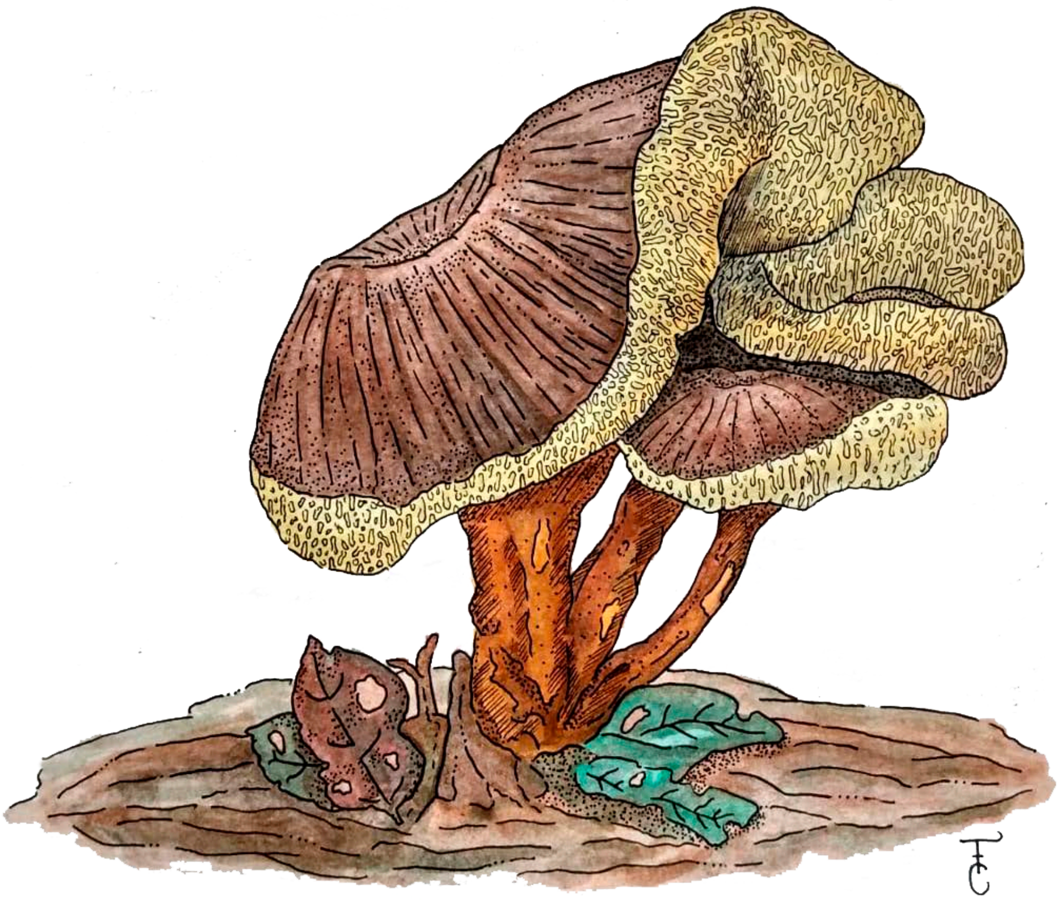
Fung Lab
Desvendando as orelhas-de-pau do Cerrado: um estudo taxonômico, ecológico e biotecnológico de fungos corticioides e poroides
Leonardo da Silva
Solange Xavier dos Santos
Fung Lab
END



Furtadomyces sumptuosus