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RENATO LÚCIO MENDES ALVARENGA

FUNGOS GELATINOSOS: ASPECTOS TAXONÔMICOS E BIOGEOGRÁFICOS

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Sumário

Resumo

Os fungos tradicionalmente conhecidos como gelatinosos constituem um grupo polifilético, assim denominados devido à consistência cartilaginosa ou gelatinosa do basidioma, classificados nas ordens Auriculariales, Dacrymycetales, Sebacinales e Tremellales, e nas classes Agaricomycetes, Dacrymycetes e Tremellomycetes. Microscopicamente, são caracterizados pela presença de basídios fragmentados ou bifurcados e esporos sem ornamentação. Este trabalho teve por objetivo estudar aspectos taxonômicos e biogeográficos de fungos gelatinosos, incluindo diagnosticar o conhecimento do grupo no país e promover a expansão desse conhecimento, através da revisão da literatura e dos acervos dos herbários, do inventário taxonômico em áreas do Cerrado, bem como da modelagem da distribuição geográfica potencial (passado, presente e futuro) de espécies do gênero *Auricularia* no mundo. A checklist da literatura publicada até o ano de 2014 listou 88 espécies de fungos gelatinosos com ocorrência para o Brasil, distribuídas em quatro ordens (Auriculariales, Dacrymycetales, Sebacinales e Tremellales), com maior número de representes nos estados do Rio Grande do Sul, São Paulo e Paraná, sendo as regiões Centro-Oeste e Nordeste as que apresentavam menos registros de ocorrências, seis e oito, respectivamente. O inventário taxômico em áreas de Cerrado possibilitou a expansão do conhecimento da distribuição geográfica das espécies: *Dacrymyces chrysospermus, Dacryopinax elegans, D. maxidorii, D. spathularia*, *Ductifera sucina*, *Exidia glandulosa Tremella foliacea* e *T. fuciformis* para o Cerrado e para a região Centro-Oeste, de *Auricularia delicata*, *A. fuscosuccinea*, *A. mesenterica* e *Calocera cornea* para o estado de Goiás e *A. delicata* para o Distrito Federal. A revisão das coleções de fungos gelatinosos depositados nos herbários FLOR, INPA e MPUC adicionou três novas ocorrências de espécies para o Brasil: *Calocera coralloide* coletada em Roraima, *Dacrymyces microsporus* no Pará e Rondônia e *D. lacrymalis* no Amazonas, e expandiu o conhecimento da distribuição geográfica de *Auricularia delicata* para os estados do Acre e Roraima; *A. mesenterica* e *A. nigricans* para a Paraíba; *Calocera arborea* para Roraima e Rondônia; *Dacryopinax elegans* para Roraima e Santa Catarina; *D. spathularia* para o Pará e Santa Catarina*; Tremella compacta T. foliacea,* e *T. fuciformis* para o Amazonas; e *Tremella basiliensis*, *T. dysentrica* e *T. mesenterica* para Santa Catarina. Os mapas de distribuição geográfica potencial evidenciaram a espécie *Auricularia auricula-judae* como predominantemente de regiões temperadas, enquanto as demais com ampla distribuição em regiões tropicais. Nos modelos de nicho ecológico, foi observado o direcionamento das espécies do gênero para as áreas de regiões temperadas e áreas litorâneas tropicais. Utilizando ainda as variáveis ambientais foram observadas relações

de co-ocorrência de um grupo de espécies filogeneticamente próximas. As áreas climaticamente estáveis reconhecidas para *A. auricula-judae* estão localizadas em regiões temperadas no norte da América do Norte, sul da América do Sul, sul Europeu e sudeste Asiático e para as demais espécies, regiões tropicais e/ou temperadas no hemisfério Sul. O trabalho apresenta ainda ilustrações, chave de identificação, ficha de identificação, descrições, mapas de distribuição geográfica e modelos de nicho ecológico, que constituem importantes subsídios e incentivos para o reconhecimento de espécies e novos estudos abordando os fungos gelatinosos.

Palavras-chaves: Brasil Central, Basidiomycota, Cerrado, Novas Ocorrências, Revisão de Herbário, Modelagem de nicho.

Abstract

The fungi traditionally known as jelly form a polyphyletic group, so named because of the cartilaginous or gelatinous consistency of basidioma, are classified in orders Auriculariales, Dacrymycetales, Sebacinales and Tremellales, in the classes Agaricomycetes, Dacrymycetes and Tremellomycetes. Microscopically, they are characterized by the presence of fragmented or forked basidia and spores without ornamentation. This work aimed to study taxonomic and biogeographic aspects of jelly fungi, including diagnose the knowledge of the group in the country and promote the expansion of this knowledge by reviewing the literature and collections of herbaria, the taxonomic survey on the Brazilian Savannah areas as well as modeling of potential geographic distribution (past, present and future) of the species the genus *Auricularia* in the world. A checklist of published literature by the year 2014 listed 88 species of jelly fungi occurring in Brazil, distributed in four orders (Auriculariales, Dacrymycetales, Sebacinales and Tremellales), with the highest number of representatives in the states of Rio Grande do Sul, São Paulo and Paraná, and the Midwest and Northeast those had less occurrences records, six and eight, respectively. The taxonomic survey on the Brazilian Savannah areas has enabled the expansion of the geographic distribution of species: *Dacrymyces chrysospermus*, *Dacryopinax elegans*, *D. maxidorii*, *D. spathularia*, *Ductifera sucin*a, *Exidia glandulosa*, *Tremella foliacea* and *T. fuciformis* for the Cerrado and the Midwest region, *Auricularia delicata*, *A. fuscosuccinea*, *A. mesenterica* and *Calocera cornea* to the state of Goias, and *A. delicata* for the Federal District. The review of jelly fungi collections deposited in herbaria FLOR, INPA and MPUC added three new occurrences of species for Brazil: *Calocera coralloide* collected in Roraima, *Dacrymyces microsporus* in Pará and Rondônia and *D. lacrymalis* in Amazonas, and expanded geographical distribution *Auricularia delicata* for the states of Acre and Roraima; *A. mesenterica* and *A. nigricans* for Paraíba; *Calocera arborea* to Roraima and Rondônia; *Dacryopinax elegans* to Roraima and Santa Catarina; *D. spathularia* to Pará and Santa Catarina; *Tremella compacta*, *T. foliacea*, and *T. fuciformis* to the Amazonas; and *Tremella basiliensis*, *T. dysenterica* and *T. mesenterica* to Santa Catarina. The potential geographic distribution maps show the specie *Auricularia auricula-judae* as predominantly the temperate regions, while other widely distributed in tropical regions. In the ecological niche models was observed the targeting of the species the genus for the areas of temperate regions and tropical coastal areas. Still using the environmental variables of the co-occurrence relationships was observed for a group of phylogenetically related species. The climatically stable areas known to *A. auricula-judae* are

located in temperate regions in northern North America, southern South America, southern Europe and Southeast Asia and for the other species, tropical and/or temperate regions in the Southern Hemisphere. The work also presents illustrations, identification key, identification card, descriptions, geographical distribution maps and ecological niche models, which are major subsidies and incentives for the recognition of species and further studies addressing the jelly fungi.

Keywords: Central Brazil, Basidiomycota, Cerrado, New Occurrences, Herbarium review, Tremellales, Niche Modeling

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Introdução

Os fungos gelatinosos constituem um grupo artificial, assim denominados devido à consistência gelatinosa ou cartilaginosa do basidioma, embora quanto secos sua textura possa apresentar-se dura, murcha ou quebradiça, podendo retomar a consistência original quando expostos à água. A textura gelatinosa peculiar, contudo, não é um indicador de relações ancestrais, podendo refletir apenas uma adaptação a certas pressões ambientais, de modo que ela pode ser encontrada em alguns Ascomycota e em Basidiomycota, incluindo desde espécies macroscópicas ou mesmo entre alguns Pucciniomycotina pequenos e inconspícuos (Moore 1965; Lowy 1971; Wells 1994; Hibbett 2006; Hibbett *et al*. 2007).

Os fungos tradicionalmente reconhecidos como gelatinosos estão classificados em 4 ordens do filo Basidiomycota: Auriculariales, Dacrymycetales, Sebacinales e Tremellales, que, além de apresentarem basidiomas quase exclusivamente gelatinosos, são microscopicamente caracterizados por apresentarem heterobasídios, ou seja, basídios fragmentados (Auriculariales, Sebacinales e Tremellales) ou bifurcados (Dacrymycetales) (Hibbett *et al.* 2007). Os basidiomas podem apresentar formas variadas, desde folhoso, irregularmente ramificado, côncavo, estipitado, cerebriforme ou coraloide, com coloração variando de branco, alaranjado, róseo, marrom, vináceo, acastanhado ou negro e os esporos não possuem ornamentação (Lowy 1951, 1952, 1971; Wells 1994; Musngi *et al*. 2005; Sierra *et al*. 2012; Looney *et al*. 2013).

São encontrados em galhos e sobre tocos de árvores. Alguns crescem em plantas, musgos e, ainda, em outros tipos de fungos. A utilização medicinal e alimentícia em diferentes comunidades tradicionais neotropicais já foi relatada no Brasil, destacando-se a espécie *Auricularia fuscosuccinea*, utilizada pelos povos Txição e Tucarramãe (Fidalgo & Hirata 1979). As comunidades Uitoto, Muinane e Andoke, na Colômbia, utilizam *A. delicata* (Vasco-Palacios *et al*. 2008), e no Peru, a população rural comumente utiliza *A. nigricans* na alimentação (Bardales 1997). O gênero *Auricularia* é utilizado na medicina chinesa há muitos anos para melhorar a circulação sanguínea e mais recentemente foi registrada a produção polissacarídeo β-glucano em *A. nigricans*, que apresenta atividade anti-tumoral (Chang 1999; Kho *et al*. 2009; Song & Du 2011; Yu *et al*. 2014).

Considerada literatura de referência para o grupo, Lowy (1971) apresenta uma extensa amostragem de fungos gelatinosos para o Neotrópico, que inclui espécies coletadas no Brasil, em diferentes regiões, e identificação de amostras depositadas nos principais herbários brasileiros até o início da década de 70. Este trabalho divide os fungos gelatinosos

em Eutremellales (Heterobasidiomycetidae), assim caracterizados pelos basídios septados, e Metatremellales (Metabasidiomycetidae) com basídios sub-clavados ou bifurcados.

Analisando a morfologia do poro septal, Wells (1994) redistribuiu o grupo em 5 ordens: Ceratobasidiales, Tulasnellales, Dacrymycetales, Auriculariales e Tremellales. Ao final do século XX, com o desenvolvimento das técnicas de biologia molecular, principalmente o estabelecimento da técnica de PCR (Polymerase Chain Reaction), Hibbett *et al.* (2007) organizaram a classificação filogenética do grupo, utilizando genes do rRNA, assim estabeleceram 4 ordens no clado Agaricomycotina: Tremellales, Dacrymycetales, Auriculariales e Sebacinales, sendo as antigas ordens Ceratobasidiales e Tulasnellales incluídas na ordem Cantharellales. Este foi o sistema de classificação considerado no presente trabalho.

Dentre os estudos deste grupo no Brasil, destaca-se o de Viégas (1945), com relatos de ocorrência de uma espécie de Dacrymycetaceae, uma de Sebacinaceae e seis de Auriculariaceae, o de Teixeira (1945), que registra ocorrências de seis espécies de Auriculariales e dois de Dacrymycetales e o de Lowy (1971), apresentando 62 espécies distribuídas nas ordens Auriculariales, Dacrymycetales, Sebacinales e Tremellales. Desde então, os trabalhos mencionando os fungos gelatinosos no país têm registrado ocorrências de espécies coletadas esporadicamente junto com outros grupos de macromicetos, referindo-se principalmente às espécies mais facilmente reconhecíveis (e.g. Roberts & Meijer 1997; Meijer 2006; Drechsler-Santos *et al*. 2008a-b; Trierveiler-Pereira *et al*. 2009; Gibertoni & Drechsler-Santos 2010; Dreschsler-Santos *et al*. 2013).

Desta forma, a proposta inicial desta dissertação consistiu em listar todas as ocorrências de fungos gelatinosos registradas no Brasil, a partir de uma ampla revisão da literatura, possibilitando reconhecer a distribuição geográfica das espécies, até então, conhecidas no país (Artigo 1). Os dados mostraram que as regiões Centro-Oeste e Nordeste eram as que menos apresentavam registros de ocorrências, seis e oito, respectivamente.

Diante disso, o estudo focou em promover o conhecimento dessa micobiota no Cerrado, a partir de novas coletas e da análise de amostras coletadas ao longo dos últimos 14 anos em localidades representativas do bioma no estado de Goiás e no Distrito Federal. Além de promover o inventário em unidades de conservação de relevância no Cerrado, os dados ampliaram o conhecimento da riqueza de fungos gelatinosos do Centro-Oeste, aumentando de seis para 13 espécies, apresentando oito primeiros registros para o Cerrado, quatro para Goiás e dois para o Distrito Federal (Artigos 2,3 e 5).

É sabido que muitos herbários abrigam amostras de fungos ainda não referidos na literatura, muitas vezes advindas de coletas esporádicas com foco em outros grupos taxonômicos, e que se encontram sem identificação ou erroneamente identificadas. Com o objetivo de conhecer a representatividade dos fungos gelatinosos nos herbários brasileiros, um levantamento na base de dados Specis Link mostrou que os maiores acervos estão nos herbários SP-Fungi (468 excicatas), INPA (253), URM (186), HUEG (137), FLOR (117) e MPUC (41). O contato com os respectivos curadores para o empréstimo do material permitiu o estudo de amostras provenientes dos herábrios INPA, FLOR, MPUC e HUEG, cujo trabalho de revisão possibilitou ampliar o número de ocorrências de fungos gelatinosos no Brasil e a distribuição das espécies dentro do território brasileiro (Artigos 4 e 5) .

A fim de reconhecer o padrão da distribuição de espécie de fungos gelatinos e sua potencial área de ocorrência, foram construídos modelos de nicho ecológico (ENM) das principais espécies cosmopolitas de importância econômica. A partir do levantamento dos pontos de ocorrências disponíveis na literatura, plataformas virtuais e herbários com coleções representativas de macromicetos, foi possível verificar a amplitude de nicho potencial, possíveis áreas de ocorrência e áreas climaticamente estáveis ao longo de grandes escalas temporais 21 milhões de anos atrás (MA) – 2080. O mapeamento para a espécie *Auricularia auricula-judae* distingui-se das demais espécies analisadas, por apresentar o maior número de áreas estáveis em regiões temperadas, ao contrário dos demais (*A. cornea*, *A. delicata*, *A. fuscosuccinea*, *A. mesenterica* e *A. nigricans*) que evidenciaram áreas estáveis na região tropical e pequenas áreas em regiões temperadas (Artigo 6).

Objetivos

Este trabalho teve por objetivo estudar aspectos taxonômicos e ecológicos de fungos gelatinosos, incluindo diagnosticar o conhecimento do grupo no país e promover a expansão desse conhecimento, através da revisão da literatura e dos acervos dos herbários, do levantamento taxonômico em áreas do Cerrado, bem como da modelagem da distribuição geográfica potencial (passada, presente e futura) das espécies do gênero *Auricularia* no mundo.

Para tanto, foram propostas as seguintes metas:

i- Elaborar uma *checklist* das espécies de fungos gelatinosos conhecidas e sua distribuição geográfica no Brasil;

ii- Promover, através de coletas e estudo de material herborizado, o levantamento taxonômico de espécies de fungos gelatinosos em diferentes localidades do bioma Cerrado;

iii- Realizar uma revisão das amostras de fungos gelatinosos depositados nos principais herbários brasileiros;

v- Construir mapas de distribuição e de modelagens de nicho para espécies do gênero *Auricularia*..

Artigo 1 – Alvarenga, RLM; Xavier-Santos, S. 2015. A *checklist* of Jelly Fungi (Agaricomycotina: Basidiomycota) recorded in Brazil. *Mycotaxon*, 130:926. http://dx.doi.org/10.5248/130.92

A checklist of Jelly Fungi (*Agaricomycotina*: *Basidiomycota*) recorded in Brazil

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ABSTRACT — Based on an intensive search of literature records on jelly fungi (*Agaricomycotina*: *Basidiomycota*) in Brazil, a list of 88 species was compiled. These are distributed into four orders (*Auriculariales*, *Dacrymycetales*, *Sebacinales*, and *Tremellales*) and seven families (*Auriculariaceae*, *Dacrymycetaceae*, *Hyaloriaceae*, *Phragmoxenidiaceae*, *Sebacinaceae*, *Sirobasidiaceae*, and *Tremellaceae*), with the most frequent taxa being *Auricularia nigricans*, *A. fuscosuccinea*, and *A. delicata* sensu lato. Among the 16 Brazilian states with occurrence records, the most frequent are Rio Grande do Sul, São Paulo and Paraná. The fact that in 40% of the states there is no occurrence and that most species are represented by a single record reinforce the need for taxonomic studies about the group.

KEY WORDS — biodiversity, neotropical, macrofungi, geographic distribution

Introduction

Jelly fungi are a paraphyletic group of fungi, so named because of the gelatinous or cartilaginous consistency of their basidioma. However, when dry their texture is hard, wilted or brittle, returning to their original consistency when exposed to water. The particular gelatinous texture is a product of convergent evolution as an adaptation to certain environmental pressures and is therefore found in a number of *Ascomycota* and *Basidiomycota*, including large, striking species and even some small, inconspicuous members of *Pucciniomycotina* (Moore 1965; Lowy 1971; Wells 1994; Hibbett 2006; Hibbett et al. 2007).

Jelly fungi, however, are traditionally classified as gelatinous members of 4 orders of macroscopic *Basidiomycetes*: *Auriculariales*, *Dacrymycetales*, *Sebacinales* and *Tremellales*, which, in addition to exhibiting almost exclusively gelatinous basidiomata, are microscopically characterized by their heterobasidia, that are either septate [*Auriculariales* J. Schröt., *Sebacinales* M. Weiss, Selosse, Rexer, A. Urb. & Oberw. and *Tremellales* Fr.] or

forked holobasidia [*Dacrymycetales* Henn.] (Hibbett et al. 2007). Basidiomata morphology can be quite varied, from foliose to irregularly branched, shapeless or shaped like cups, railroad spikes or branched like coral, with color ranging from white, orange, pink, rose, brown to black. The spores have no ornamentation and, in general, are cylindrical to allantoid or ovoid to subglobose (Lowy 1952; Lowy 1971; Alexopoulos et al. 1996; Wells 1994; Kendrick 2001; Musngi et al. 2005; Sierra et al. 2012; Looney et al. 2013).

Jelly fungi can be found on logs, twigs and tree stumps. Some grow on certain plants, moss, and even on other types of fungi. Some species are edible, while others have an unpalatable texture or taste, some are medicinal. Medicinal and dietary use has been reported in different traditional neotropical communities in Brazil, including *Auricularia fuscosuccinea* (Mont.) Henn. used by the Txição and Tucarramãe tribes (Fidalgo & Hirata 1979). The Uitoto, Muinane and Andoke communities in Colombia use *A. delicata* (Mont.) Henn. (Vasco-Palacios et al. 2008), and in Peru the rural population commonly uses *A. nigricans* (Fr.) Birkebak, Looney & Sánchez-García (Bardales 1997). The genus *Auricularia* Mont. has been used in Chinese medicine for many years to improve blood circulation and more recently the production of β-glucan polysaccharide has been reported in *A. nigricans*, which displays antitumor activity (Chang 1999; Kho et al. 2009; Song & Du 2011; Yu et al. 2014).

Lowy (1971) presented an extensive study of jelly fungi of the Neotropics, including species collected in different regions of Brazil, where he identified collections and deposited them in the most important herbaria up through the 1970s. This study circumscribed jelly fungi into two new subclasses of *Tremellales*: *Heterobasidiomycetidae* Alexop., characterized by septate basidia and *Metatremellales Metabasidiomycetidae* (Lowy) with subclavate or forked basidia. Analyzing septal pore morphology, Wells (1994) redistributed the group into 5 orders: *Ceratobasidiales* Jülich, *Tulasnellales* Rea, *Dacrymycetales*, *Auriculariales*, and *Tremellales*. At the end of the 20th century, with the development of molecular biology techniques Hibbett et al. (2007) organized the phylogenetic classification of the group using rRNA genes, thereby establishing 4 orders in the *Agaricomycotina* clade: *Tremellales*, *Dacrymycetales*, *Auriculariales* and *Sebacinales*. This the system adopted for the present checklist.

Among the studies on this group in Brazil is that conducted by Viégas (1945), with reports of one species of the family *Dacrymycetaceae*, one of *Sebacinaceae* and six species of *Auriculariaceae*, Teixeira (1945), who registered the occurrence of six species of *Auriculariales* and two of *Dacrymycetales*, and Lowy (1971), presenting 62 species distributed in the orders *Auriculariales*, *Dacrymycetales*, *Sebacinales* and *Tremellales*. Since

then, the studies describing jelly fungi in the country have registered the occurrence of species collected sporadically with other groups of macrofungi, mainly the most easily recognized species (e.g. Roberts & Meijer 1997; Meijer 2006; Drechsler-Santos et al. 2008a-b; Trierveiler-Pereira et al. 2009; Gibertoni & Drechsler-Santos 2010, Dreschsler-Santos et al. 2013). This study is aimed at organizing the occurrence records and presenting a checklist of the diversity and distribution of jelly fungi in Brazil.

Materials & Methods

The occurrences of jelly fungi in Brazil were listed after an extensive literature review, considering only records found in published articles and/or books, and the nomenclature updated (when necessary) using the Index Fungorum Partnership (http://www.indexfungorum.org) and MycoBank (http://www.mycobank.org/) as reference.

Species occurrence is distributed by Brazilian states, which are represented by acronyms: Acre (AC); Alagoas (AL); Amazonas (AM); Amapá (AP); Bahia (BA); Ceará (CE); Federal District (DF); Espirito Santo (ES); Goiás (GO); Maranhão (MA); Minas Gerais (MG); Mato Grosso (MT); Mato Grosso do Sul (MS); Pará (PA); Paraíba (PB); Pernambuco (PE); Piauí (PI); Paraná (PR); Rio de Janeio (RJ); Rio Grande do Norte (RN); Rondonia (RO); Rio Grande do Sul (RS); Roraima (RR); Santa Catarina (SC); Sergipe (SE); São Paulo (SP) and Tocantins (TO).

The records are organized in alphabetical order by family, genus and species. When a taxon is not clearly established in terms of its taxonomic position, it is identified as *Incertae sedis*.

The georeference points (longitude and latitude) of each record were obtained from the publications; when not available, the georeferences of the municipality were considered and plotted using DIVA-Gis software (Hijmans et al. 2001).

Results and Discussion

Records of 88 species were found distributed into four orders (*Auriculariales*, *Dacrymycetales*, *Sebacinales* and *Tremellales*) and seven families (*Auriculariaceae*, *Dacrymycetaceae*, *Hyaloriaceae*, *Phragmoxenidiaceae*, *Sebacinaceae*, *Sirobasidiaceae* and *Tremellaceae*). The highest number of species was found in Rio Grande do Sul state (50), followed by São Paulo and Paraná (30 and 27 respectively), with São Paulo containing the largest number of records and the most sites sampled; 40% of the states showed no occurrence records (Figure 1).

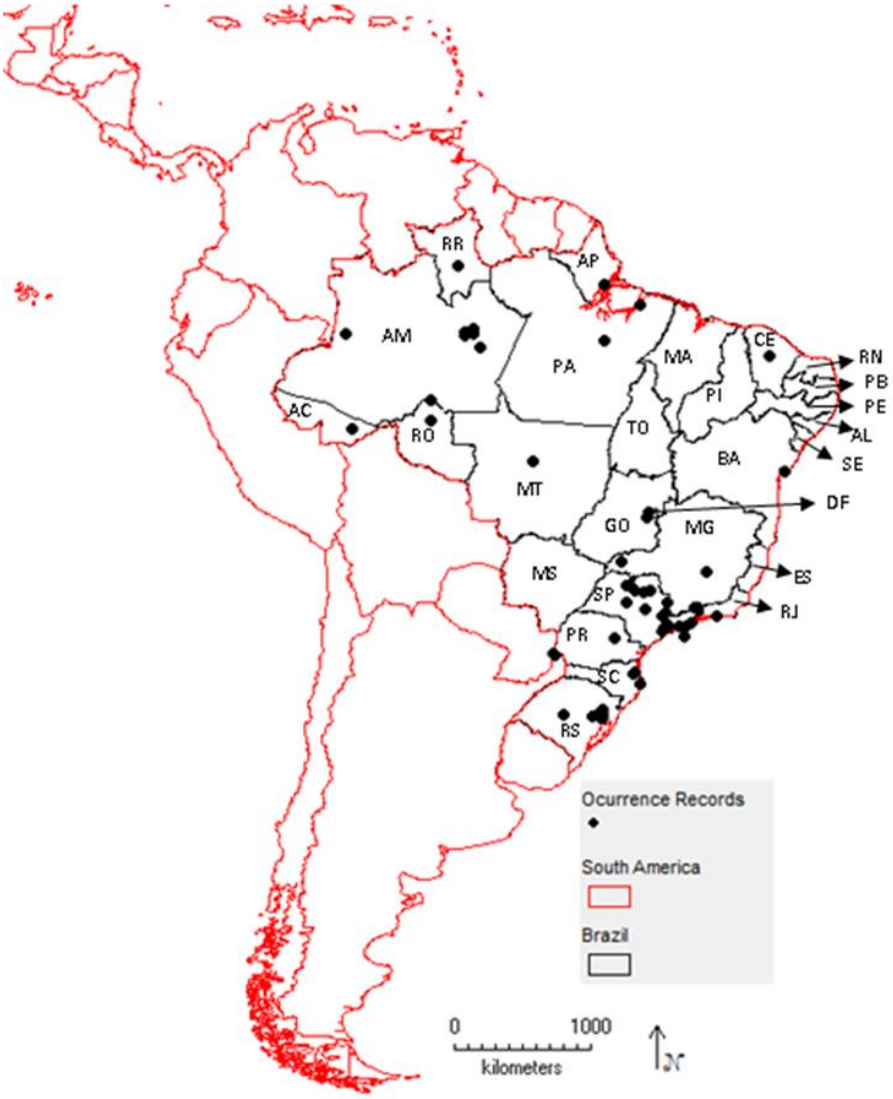

Figure 1. Distribution of the records of jelly fungi in Brazil.

Auricularia nigricans, *A. fuscosuccinea* and *A. delicata sensu lato* were the most abundantly represented taxa, occurring in 56%, 33%, and 30% of Brazilian states, respectively. This may be due to their more easily recognizable morphology. Around 60% of the species exhibited only one occurrence record. The data obtained reflect the lack of specialists in this fungal group in the country, limiting not only knowledge on taxonomic diversity, but also on the ecology and distribution of this economically important group.

Following is the list of species recorded in Brazil according to locality, accompanied by references in parentheses.

Jelly fungi cited for Brazil – a checklist

Fungi

Basidiomycota

Auriculariales

***Auriculariaceae* Fr.**

Auricularia auricula-judae (Bull.) Quél.

Basionym: *Tremella auricula-judae* Bull.

Locality: MT, PA, RJ, SP [Hennings 1902, 1908; Sampaio 1916; Teixeira 1945; Batista et al. 1966; Sotão et al. 2003; Campos et al. 2005 (all as *Auricularia auricularis* (Gray) G.W. Martin)].

Auricularia cornea Ehrenb.

Locality: RS (Sobestiansky 2005; Meijer 2006).

Auricularia delicata (Mont.) Henn. *sensu lato*

Basionym: *Laschia delicata* Fr.

Locality: AM, BA, MT, PA, PR RO, SC, SP (Hennings 1900; Batista et al. 1966; Fidalgo 1968; Lowy 1971; Capelari & Maziero 1988; Góes-Neto 1996; Drechsler-Santos et al. 2008a).

Auricularia fuscosuccinea (Mont.) Henn.

Basionym: *Exidia fuscosuccinea* Mont.

Locality: AM, MT, PA, PR, RJ, RO, RS, SC, SP (Teixeira 1945 as *Auricularia rosea* Burt. and *Auricularia fusco-succinea*; Lowy 1952, 1971; Dennis 1970; Fidalgo & Hirata 1979; Bononi 1984; Capelari & Maziero 1988; Sotão et al. 2003; Campos et al. 2005; Sobestiansky 2005; Meijer 2006; Drechsler-Santos et al. 2008b; Abrahão et al. 2012).

Auricularia mesenterica (Dicks.) Pers.

Basionym: *Helvella mesenterica* Dicks.

Locality: AM, MT, PA, RS, SP (Rick 1903; Hennings 1904; Rada & Stevenson 1942; Teixeira 1945; Batista et al. 1966; Lowy 1971).

Auricularia nigricans (Fr.) Birkebak, Looney & Sánchez-García

Basionym: *Peziza nigricans* Fr.

Locality: AM, AP, BA, CE, DF, GO, MG, MT, PA, RJ, RO, RR, RS, SC, SP (Hennings 1902, 1904; Lloyd 1920; Teixeira 1945; Fidalgo 1968; Lowy 1971; Bononi 1984; Capelari & Maziero 1988; Jesus 1996; Sotão et al. 1991, 2002, 2003; Drechsler-Santos et al. 2008a; Gibertoni & Drechsler-Santos 2010; Abrahão et al. 2012; Drechsler-Santos et al. 2013) as *Auricularia polytricha* (Mont.) Sacc.; (Teixeira 1945) as *Auricularia porphyrea* (Lév.) Ribeiro Teixeira

Bourdotia galzinii (Bres.) Trotter

Basionym*: Sebacina galzinii* Bres.

Locality: RS, SC (Lowy 1971) as *Bourdotia galzinii* and *Sebacina petiolata* D.P. Rogers

Eichleriella alliciens (Berk. & Cooke) Burt

Basionym: *Stereum alliciens* Berk. & Cooke

Locality: PR, RS, SP (Viégas 1945; Lowy 1971) all as *Hirneolina ubatubensis* Viégas

Eichleriella leveilleana (Berk. & M.A. Curtis) Burt

Basionym: *Corticium leveilleanum* Berk. & M.A. Curtis

Locality: PR, RS, SP (Lowy 1971).

Exidia glandulosa (Bull.) Fr.

Basionym: *Tremella glandulosa* Bull.

Locality: SP (Lowy 1971).

Exidiopsis mucedinea (Pat.) K. Wells

Basionym: *Sebacina mucedin*ea Pat.

Locality: SP (Lowy 1971).

Exidiopsis manihoticola Viégas

Locality: SP (Lowy 1971).

Exidiopsis opalea (Bourdot & Galzin) D.A. Reid

Basionym: *Sebacina opalea* Bourdot & Galzin

Locality: SP (Lowy 1971).

Exidiopsis sublivida (Pat.) K. Wells

Basionym: *Heterochaete sublivida* Pat.

Locality: RS (Lowy 1971).

Heterochaete albida Pat.

Locality: RS (Lowy 1971).

Heterochaete brasiliensis Bodman

Locality: RS (Lowy 1971).

Heterochaete crassa Bodman

Locality: RS (Lowy 1971).

Heterochaete cystidiophora (Lowy) Oberw., Kisim.-Hor. & L.D. Gómez

Basionym: *Heterochaetella cystidiophora* Lowy

Locality: RJ, SC (Lowy 1971) as *Heterochaetella cystidiophora*.

Heterochaete gelatinosa (Berk. & M.A. Curtis) Pat.

Basionym: *Kneiffia gelatinosa* Berk. & M.A. Curtis

Locality: RS (Lowy 1971).

Heterochaete hirneoloides (Pat.) K. Wells

Basionym: *Sebacina hirneoloides* Pat.

Locality: RS (Lowy 1971).

Heterochaete livida Pat.

Locality: RS (Lowy 1971).

Heterochaete lividofusca Pat.

Locality: RS (Lowy 1971).

Heterochaete nigerrima Viégas

Locality: SP (Viégas 1945).

Heterochaete ochracea Pat.

Locality: RS (Lowy 1971).

Heterochaete sanctae-catharinae Möller

Locality: RS, SC (Lowy 1971).

Heterochaete shearii (Burt) Burt

Basionym: *Sebacina shearii* Burt

Locality: RS (Lowy 1971).

***Hyaloriaceae* Lindau**

Hyaloria pilacre Möller

Locality: RS, SP (Lowy 1971).

Hyaloria traillii (Berk. & Cooke) G.W. Martin

Basionym: *Typhula traillii* Berk. & Cooke

Locality: AM (Lowy 1971).

Myxarium hyalinum (Pers.) Donk

Basionym: *Tremella hyalina* Pers.

Locality: AM, RS, SP (Lowy 1971) as *Exidia nucleata* (Schwein.) Burt.

Incertae Sedis

Aporpium dimidiatum A. David

Locality: PR, SC (Gerber & Loguercio-Leite 2000; Meijer 2006).

Basidiodendron burtii (Bres.) Wojewoda

Basionym: *Heterochaete burtii* Bres.

Locality: RS (Lowy 1971) as *Bourdotia burtii* (Bres.) K. Wells.

Basidiodendron cinereum (Bres.) Luck-Allen

Basionym: *Sebacina cinerea* Bres.

Locality: BA, RS, SP (Lowy 1971) as *Bourdotia cinerea* Bourdot & Galzin.

Basidiodendron eyrei (Wakef.) Luck-Allen

Basionym: *Sebacina eyrei* Wakef.

Locality: RS (Lowy 1971) as *Bourdotia eyrei* (Wakef.) Bourdot & Galzin.

Exidia richenii (Rick) Lloyd

Basionym: *Protomerulius richenii* Rick

Locality: RS (Lowy 1971).

Ductifera sucina (Möller) K. Wells

Basionym: *Exidia sucina* Möller

Locality: RS (Lowy 1971).

Guepinia dacrymycetospora (Speg.) Bres.

Basionym: *Hirneola dacrymycetospora* Speg.

Locality: RS (Bresadola 1920).

Heterochaetella chorisae Viégas

Locality: SP (Viégas 1945).

Heterochaetella ochracea Viégas

Locality: SP (Viégas 1945).

Patouillardina cinerea Bres.

Locality: PR, RS (Lowy 1971).

Protomerulius caryae (Schwein.) Ryvarden

Basionym: *Polyporus caryae* Schwein.

Locality: SC (Loguercio-Leite & Gerber 1997).

Protomerulius brasiliensis Möller

Locality: RS (Lowy 1971).

Protomerulius substuppeus (Berk. & Cooke) Ryvarden

Basionym: *Polyporus substuppeus* Berk. & Cooke

Locality: SC (Gerber & Loguercio-Leite 2000).

Pseudohydnum gelatinosum (Scop.) P. Karst.

Basionym: *Hydnum gelatinosum* Scop.

Locality: PA (Bononi 1981).

Stypella dubia (Bourdot & Galzin) P. Roberts

Basionym: *Heterochaete dubia* Bourdot & Galzin

Locality: SC, SP (Lowy 1971) as *Heterochaetella dubia*.

Stypella minor Möller

Locality: RS (Lowy 1971)

Stypella vermiformis (Berk. & Broome) D.A. Reid

Basionym: *Dacrymyces vermiform*is Berk. & Broome

Locality: SC (Lowy 1971) as *Stypella papillata* Möller.

Tremellodon cartilagineus (Möller) Rick

Basionym: *Protohydnum cartilagineum* Möller

Locality: RS (Lowy 1971).

Tremiscus helvelloides (DC.) Donk.

Basionym: *Tremella helvelloides* DC.

Locality: SP (Lowy 1971) as *Phlogiotis helvelloides* (DC.) G.W. Martin.

Dacrymycetales

***Dacrymycetaceae* J. Schröt.**

Arrhytidia involuta (Schwein.) Coker.

Basionym: *Dacrymyces involutus* Schwein.

Locality: RS (Lowy 1971).

Calocera arborea Shirouzu

Locality: AM (Shirouzu et al. 2013).

Calocera cornea (Batsch) Fr.

Basionym*: Clavaria cornea* Batsch

Locality: AM, DF, PA, PR, RS, SC, SP (Lowy 1971; Sotão et al. 2003; Campos et al. 2005; Sobestiansky 2005; Trierveiler-Pereira et al. 2009).

Cerinomyces lagerheimii (Pat.) McNabb

Basionym: *Ceracea lagerheimii* Pat.

Locality: PR, RS (Lowy 1971; Meijer 2006).

Dacrymyces chrysospermus Berk. & M.A. Curtis

Locality: PR (Meijer 2006)

Dacrymyces deliquescens var. *ellisii* (Coker) L.L. Kenn.

Basionym: *Dacrymyces ellisii* Coker

Locality: AM, RS (Lowy 1971)

Dacrymyces enatus var. *macrosporus* L.L. Kenn.

Locality: PR, RS (Sobestiansky 2005; Meijer 2006)

Dacrymyces stillatus Nees

Locality: PR (Meijer 2006)

Dacryopinax elegans (Berk. & M.A. Curtis) G.W. Martin

Basionym*: Guepinia elegans* Berk. & M.A. Curtis

Locality: AM, PR, RJ, RS, SP (Lowy 1971; Sobestiansky 2005; Meijer 2006).

Dacryopinax indacocheae Lowy

Locality: AM (Lowy 1971).

Dacryopinax martinii Lowy

Locality: PR (Meijer 2006).

Dacryopinax maxidorii Lowy

Locality: AM, PA (Lowy 1981; Sotão et al. 2003; Campos et al. 2005).

Dacryopinax spathularia (Schwein.) G.W. Martin

Basionym*: Merulius spathularius* Schwein.

Locality: AM, PR, RJ, RS, SP (Teixeira 1945; Viégas 1945; Lowy 1971; Sobestiansky 2005; Meijer 2006).

Ditiola radicata (Alb. & Schwein.) Fr.

Basionym: *Helotium radicatum* Alb. & Schwein.

Locality: SC (Lowy 1971).

Guepiniopsis buccina (Pers.) L.L. Kenn.

Basionym: *Peziza buccina* Pers.

Locality: PR (Meijer 2006).

Sebacinales

***Sebacinaceae* K. Wells & Oberw.**

Helvellosebacina concrescens (Schwein.) Oberw., Garnica & K. Riess

Basionym: *Peziza concrescens* Schwein.

Locality: SP (Lowy 1971) as *Tremella concrescens* (Schwein.) Burt.

Basidiodendron grandinioides (Bourdot & Galzin) Luck-Allen

Basionym: *Bourdotia grandinioides* Bourdot & Galzin

Locality: AM (Lowy 1971) as *Bourdotia grandinioides*.

Ductifera pululahuana (Pat.) Donk

Basionym: *Tremella pululahuana* Pat.

Locality: RS (Lowy 1971).

Sebacina fuliginea (Rick) L.S. Olive

Basionym: *Exidiopsis fuliginea* Rick

Locality: RS, SC (Lowy 1971; Sobestiansky 2005) as *Exidiopsis fuliginea*.

Sebacina stratosa (Viégas) L.S. Olive

Basionym: *Seismosarca stratosa* Viégas

Locality: SP (Viégas 1945) as *Seismosarca stratosa*.

Tremellodendron schweinitzii (Peck) G.F. Atk.

Basionym: *Thelephora schweinitzii* Peck

Locality: AM (Lowy 1971).

Tremellales

***Phragmoxenidiaceae* Oberw. & R. Bauer**

Phyllogloea tremelloidea Lowy

Locality: RS (Lowy 1971).

***Sirobasidiaceae* Lindau**

Sirobasidium brefeldianum Möller

Locality: RS, SP (Lowy 1971).

Sirobasidium rubrofuscum (Berk.) P. Roberts

Basionym: *Dacrymyces rubrofuscus* Berk.

Locality: BA, PR (Roberts & Meijer 1997; Meijer 2006).

Sirobasidium sanguineum Lagerh. & Pat.

Locality: BA, MG, RS (Lowy 1971).

***Tremellaceae* Fr.**

Holtermannia damicornis (Möller) Kobayasi

Basionym: *Tremella damicornis* Möller

Locality: RS (Lowy 1971).

Tremella aurantia Schwein.

Locality: PR, SP (Roberts & Meijer 1997).

Tremella auricularia Möller

Locality: PR (Roberts & Meijer 1997).

Tremella brasiliensis (Möller) Lloyd

Basionym: *Tremella lutescens* var. *brasiliensis* Möller.

Locality: RS, PR (Lowy 1971; Roberts & Meijer 1997)

Tremella compacta Möller

Locality: RS (Lowy 1971).

Tremella dysenterica Möller

Locality: PR (Roberts & Meijer 1997).

Tremella fibulifera Möller

Locality: BA, MG, PR, RS, SP (Lowy 1971; Roberts & Meijer 1997; Sobestiansky 2005).

Tremella foliacea Pers.

Locality: PR (Roberts & Meijer 1997).

Tremella fuciformis Berk.

Locality: BA, PR, RS, SP (Roberts & Meijer 1997; Sobestiansky 2005; Meijer 2006).

Tremella mesenterica (Schaeff.) Retz.

Basionym: *Helvella mesenterica* Schaeff.

Locality: RS, SP (Lowy 1971) as *Tremella lutescens* Pers.

Tremella moriformis Sowerby

Locality: RS (Lowy 1971).

Tremella philippinensis Lloyd

Locality: RS (Sobestiansky 2005).

Tremella riobrancensis Lowy

Locality: AC (Lowy 1981).

Tremella rubromaculata Lowy

Locality: SP (Lowy 1971).

Tremella wrightii Berk. & M.A. Curtis

Locality: PR, SC (Lowy 1971; Roberts & Meijer 1997; Meijer 2006).

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Artigo 2 – 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, Doi 10.5943/mycosphere/6/5/3

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The Genus *Auricularia* Bull. ex Juss. (Basidiomycota) in Cerrado (Brazilian Savanna) areas of Goiás state and the Federal District, Brazil

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Abstract

The present study reports species occurrence of the genus *Auricularia* found in areas of the Cerrado biome in Goiás state and in the Federal District, thereby expanding the occurrence records of this species in Brazil. A total of 101 samples were found, they are distributed into four species: *A. delicata*, *A. fuscosuccinea*, *A. mesenterica* and *A. nigricans*; the first three are being recorded for the first time for Goiás state and *A. delicata* are being registered for the first time for the Federal District.

Keywords – Auriculariales – Central Brazil – jelly fungi

Introduction

The genus *Auricularia*, belonging to the family Auriculariaceae, was established by Bulliard in 1787. The basidioma is gelatinous when fresh, pileate, auriform to orbiculate, substipitate or stipitate, resupinate, lobed, often upturned and color ranging from white to brownish (Bulliard 1787). It distinguishes itself macroscopically from other genera of the family by a basidioma with a zone of internal hyphae, hymenial surface ranging from smooth to reticulate, and microscopically by its dense hymenial surface with basidia ranging from cylindrical to clavate, with three septations and basidiospore white to ochraceous, able to produce conidia (Bulliard 1787, Lowy 1952, 1971).

Twenty-eight species are considered valid (Kirk 2015), often found in tropical, subtropical and temperate zones. Lowy (1951) developed a classification system based on identifying zones in the basidioma, which are observed after cross-sectioning, a technique still used as the primary taxonomic method for the genus, as observed in studies by Lowy (1952, 1971), Batista et al. (1966), Góes-Neto (1996), Sobestiansky (2005), and Looney et al. (2013).

The occurrence of species from the genus has been recorded in Brazil (Trierveiler-Pereira et al. 2009; Gibertoni & Drechsler-Santos 2010; Abrahão et al. 2012; Dreschsler-Santos et al. 2013; Alvarenga & Xavier-Santos, 2015), mainly those most easily recognizable, collected sporadically along with other groups of macromycetes. The present study reports the occurrence of *Auricularia* species collected in areas of the Cerrado biome in Goiás state and the Federal District, expanding the occurrence records of these species in Brazil.

Materials & Methods

The specimens studied were collected over the last 14 years (2001-2014) in different locations in Goiás state and in an area of the Federal District: Goiás, City of Anápolis, Campus of the Universidade Estadual de Goiás, Trilha do Tatu Ecological Reserve (16º23’40’’S and 48º57’32’’O) and Ciliar Forest of Ribeirão das Antas, AmBev, Cebrasa Branch (16°17’56.34”S and 48°48’43.68”O); City of Goiânia, Campus II of the Universidade Federal de Goiás, Auguste Saint-Hilaire Forest (BASH) (16º36’26.74’’S and 49º15’51.69’’O); City of Caldas Novas, Serra de Caldas Novas State Park (PESCAN) (17°43’56”S to 17°50’55,7”S; 48°40’0”O to 48°42’57,6”O); City of Jataí, Açude Forest (17°51’36.80”S and 51°43’33.69”O); City of Pirenópolis, Serra dos Pirineus State Park (48°50’49”O and 15°48'09"S); City of Rio Quente (17°47’35’’S and 48°47’36’’W); City of Silvânia, Silvânia Forest Park (FLONA) (16°38'30.46"S and 48°39’3.11”O) and the Federal District, City of Brasília: Botanical Garden of Brasília (15°52’21”S and 47°50’50”O) (Fig. 1).

All the locations are situated in the Central Plateau of Brazil and belonging to Cerrado biome, characterized by different phytophysiognomies, including mesophyll forest, semi deciduous, ciliary and gallery forest, that were sampled in this study.

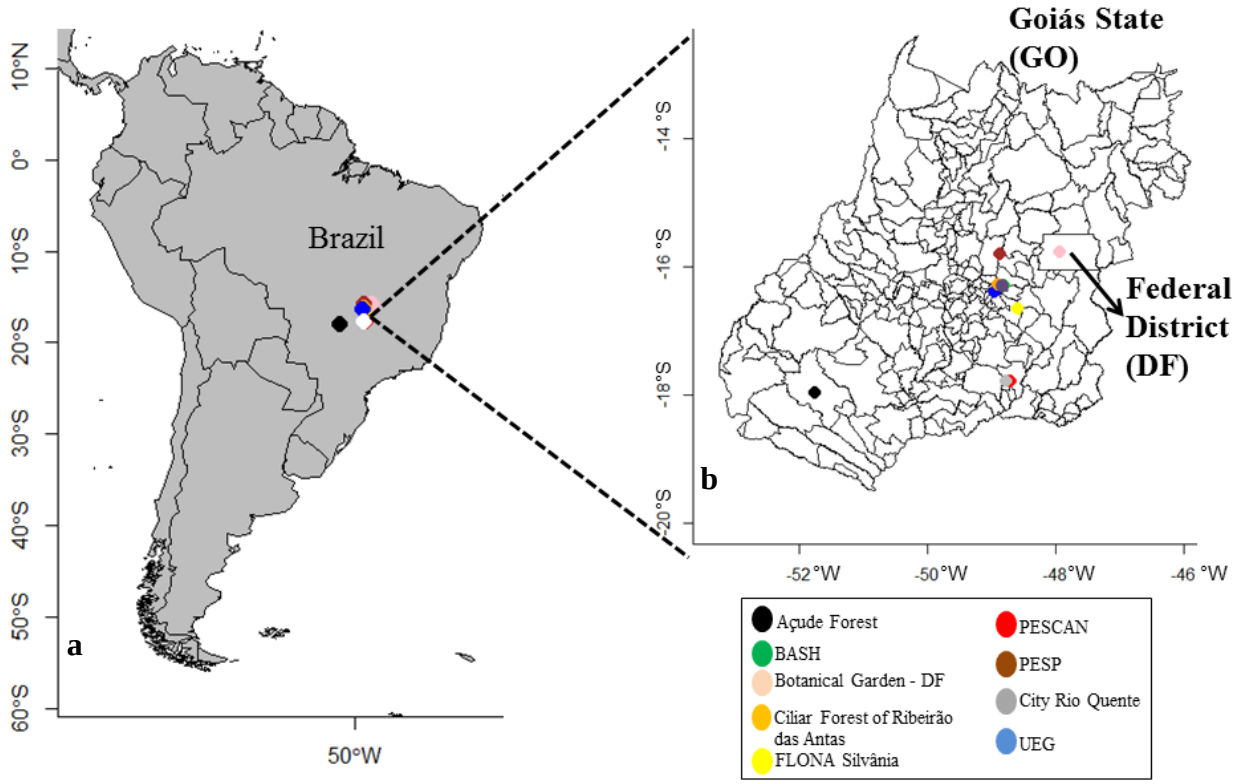

Fig. 1 – **a** Map of South America, showing collections areas in Brazil. **b** Location of collection areas in Goiás state and Federal District. Maps produced with R Software R (2015). (BASH - Auguste Saint-Hilaire Forest; FLONA Silvânia - National Forest of Silvânia; PESCAN - Serra de Caldas Novas State Park; PESP - Serra dos Pireneus State Park and UEG - Trilha do Tatu Ecological Reserve).

For the taxonomic study, macro and microscopical features were analyzed, including the general aspect of the basidioma, hymenial surface and zones of internal hyphae according to Lowy (1952, 1971) and Looney et al. (2013). The basidiomata underwent dry and wet preservation and were deposited at the Herbarium of Universidade Estadual de Goiás (HUEG).

Species occurrence is distributed by Brazilian states, which are represented by acronyms: Acre (AC); Alagoas (AL); Amazonas (AM); Amapá (AP); Bahia (BA); Ceará (CE); Federal District (DF); Espirito Santo (ES); Goiás (GO); Maranhão (MA); Minas Gerais

(MG); Mato Grosso (MT); Mato Grosso do Sul (MS); Pará (PA); Paraíba (PB); Pernambuco (PE); Piauí (PI); Paraná (PR); Rio de Janeio (RJ); Rio Grande do Norte (RN); Rondonia (RO); Rio Grande do Sul (RS); Roraima (RR); Santa Catarina (SC); Sergipe (SE); São Paulo (SP) and Tocantins (TO).

Results & Discussion

A total of 101 samples of the genus *Auricularia* were examined, they were distributed into four species: *A. nigricans* (the most frequent species, with 54% of occurrences), *A. fuscosuccinea* (20%), *A. mesenterica* (13%) and *A. delicata sensu lato* (12%). None of the species showed substrate specificity, occurring in both live wood or in decomposition. These are the first records of *A. fuscosuccinea*, *A. mesenterica* and *A. delicata* for Goiás state and of *A. delicata* for the Federal District.

Taxonomy

Auricularia delicata (Mont. ex Fr.) Henn. *lato sensu*

Fig 2

Description – Basidioma yellowish brown when mature and dry, pinkish when fresh or when preserved in wet way; 1.0–8.0 cm long and 1.5–5.0 cm wide. Abhymenium with yellowish hairs are gregarious but not dense, only on the small stipe, with sudden thickening at the base. Margin smooth, when young and undulated or lobad, when adult. Medulla absent, even in thick cuts, hyaline, branched and septates hyphae (2.5–5.0 µm). *Zona pilosa* 50–70 µm, *zona compacta superioris* 15–25 µm, *zona subcompacta superioris* is 36–48 µm, *zona laxa intermedia* 300–450 µm, *zona subcompacta inferioris* 120–140 µm, hymenium 76–90 µm with the same color as the abhymenial surface, reticulate, alveolate. Basidia cylindrical, spindle-shaped, 30–50 µm × 4–5 µm, basidiospores allantoid to curved-cylindrical, hyaline, generally with guttulate, (9)10–13(15) µm × (3.5)4–5(6) µm.

Distribution – Cosmopolitan, In Brazil: states of AM, BA, MT, RO, SC, SP, PA, PR.

Material examined – BRAZIL, Federal District, City of Brasília: Botanical Garden of Brasília, 01/12/2010. Alvarenga, R.L.M. (24)-HUEG 8387: The basidioma this sample was colonized by myxomycetes plasmodium the *Physarum polycephalum*; Goiás: City of Anápolis, *Campus* of the Universidade Estadual de Goiás, Trilha do Tatu Ecological Reserve, 04/10/2010, Alvarenga, R.L.M. (04)-HUEG 8469; 12/11/2007, idem Faria, J.E.Q. & Moreira, I.C. (229)-HUEG 8451; idem 28/09/2009 Xavier-Santos, S. (4306)-HUEG 8455; idem

10/12/2010 Xavier-Santos, S. (4500)-HUEG 8457; City of Caldas Novas, 02/11/2007, Xavier-Santos, S. (2137)-HUEG 8399; City of Goiânia, Campus II of the Universidade Federal de Goiás, Auguste Saint-Hilaire Forest (BASH), 07/10/2013, Naves, L.R. (11)-HUEG 10109, idem 16/01/2014, Naves, L.R. (92)-HUEG 10110 and idem, 22/02/2014, Naves, L.R. (158)-HUEG 10111; City of Silvânia, Silvânia Forest Park (FLONA), 22/10/2010, Alvarenga, R.L.M. (12)-HUEG 8475; idem (14)-HUEG 8479; idem (15)-HUEG 8483.

Notes – Specimens were collected from live trunks or in decomposition, mainly in wet areas. The species distinguishes itself from other species of the genus primarily by reticulate hymenial surface and from *Auricularia subglabra* Looney, Birkebak, & Matheny because it lack medulla and presence of gregarious hairs. In recent molecular analyses, Looney et al. (2013) observed the formation of two clades: *A. delicata* clado I, *A. delicata* clado II. Considering the impossibility of this molecular analysis in the present material, the species is being referred as *Auricularia delicata lato sensu*. One of the specimens examined was found to be a substrate for the myxomycetes plasmodium *Physarum polycephalum*. The species is used as food by the Uitoto, Muiana and Andoke indigenous communities in Colombia (Vasco-Palacios et al. 2008). These are the first records of species occurrence for Goiás state and the Federal District.

Auricularia fuscosuccinea (Mont.) Henn.

Fig 3

Description – Basidioma ranging between 3–10 cm long and 4–13 cm wide, pileate and cupulate, gelatinous, soft to the touch when fresh becoming very horny, rigid and brittle when dry. Abhymenial surface slightly pilous with gregarious hairs, color brown to reddish when fresh, becoming darker when dried. Margin commonly reflexed, medulla present. Hyaline hyphae, branched and septate (1.5–3.6 µm). *Zona pilosa* 40–100 µm, *zona compacta* 18–47 µm, *zona subcompacta superioris* 25–59 µm, *zona laxa superioris* 80–300 µm, medulla 50–230 µm, *zona laxa inferioris* 30–389µm, *zona subcompacta inferioris* 50–170 µm, hymenium 36–73 µm. Basidia elongated 48–65 × 5–7 µm, basidiospores (5)9–10.3(13) × (4)4.5–5(5.6) µm, curved-cylindrical. Basidia and basidiospores with guttulate.

Distribution – Pantropical, In Brazil: States of AM, MT, RJ, RO, RS, SC, SP, PA, PR.

Material examined – BRAZIL, Goiás State, City of Anápolis, *Campus* of the Universidade Estadual de Goiás, Trilha do Tatu Ecological Reserve, 28/09/2009 Xavier-Santos, S. (4307)-HUEG 8471; idem 10/12/2010 Xavier-Santos, S. (4507)-HUEG 8458; idem 04/10/2010 Alvarenga, R.L.M. (06)-HUEG 8477; idem 2001 Xavier-Santos, S. (3011)-HUEG

8388, idem (3027)-HUEG 8376, idem (3042)-HUEG 8392, idem 10/02/2009 Xavier-Santos, S. (4147)-HUEG 8473; City of Caldas Novas, Serra de Caldas Novas State Park (17°43'56"S and 17°50'55,7"S; 48°40'0"O to 48°42'57,6"O), 23/11/2008, Xavier-Santos, S. (3313)-HUEG 8468; City of Goiânia, *Campus* II of the Universidade Federal de Goiás, Auguste Saint-Hilaire Forest (BASH), 05/12/2013 Naves, L.R.R. (45)-HUEG 10116; idem 05/12/2013 Naves, L.R.R. (49)-HUEG 10117; idem 16/01/2014 Naves, L.R.R. (97)-HUEG 10115; idem 22/02/2014 Naves, L.R.R. (128)-HUEG 10112; idem 29/03/2014, Naves, L.R.R. (223)-HUEG 10113; idem 03/05/2014 Naves, L.R.R. (284)-HUEG 10114; City of Jataí, Açude Forest, 09/02/2011 Alvarenga, R.L.M. (63)-HUEG 8377; City of Rio Quente, (17°47'35''S e 48°47'36''W), 28/03/2009, Xavier-Santos, S. (3626)-HUEG 8437, idem (3629)-HUEG 8440; City of Silvânia, Silvânia Forest Park (FLONA), 22/10/2010 Alvarenga, R.L.M. (16)-HUEG 8478; idem 26/06/2009 Xavier-Santos, S.(3851)-HUEG 8467, idem (3961)-HUEG 8406.

Notes – Collected from live trunks or trunks in decomposition, with or without exposure to direct sunlight. *A. fuscosuccinea* differs from other species of the genus by having basidiomata vinaceous brown to rosy brown and clear medullary zone. Fidalgo & Hirata (1979) reported the use of this species as food by Txição and Tucarramãe indigenous people in Brazil. In some of the samples collected, it was observed that the basidioma serves as an egg-laying site and food during the larval development of flies from the genus *Drosophila* spp..These are the first reports of species occurrence for Goiás state**.**

Auricularia mesenterica (Dicks.) Pers.

Fig. 4

Description – Basidioma gelatinous when fresh, 8–13 cm long, resupinate with marginal ruptures. Abhymenial surface with greyish brown hairs in dense tufts, grey hymenium when young and dark purple when mature. Margin corrugated. Medulla absent. Hyaline hyphae, branched and septate (1.6–3 µm) in the *zona laxa intermedia*. *Zona pilosa* 390–800 µm, *zona compacta* 20–35 µm, *zona subcompacta superioris* 48–70 µm, *zona laxa intermedia* 423–600 µm, *zona subcompacta inferioris* 93–107 µm, hymenium 58–65 µm. Basidia 55–70 × 4.5–5 µm and basidiospore cylindrical to allantoid, rarely observed 15–18 × 4.5–7 µm.

Distribution – Cosmopolitan, In Brazil: states of AM, MT, PA, RS, SP.

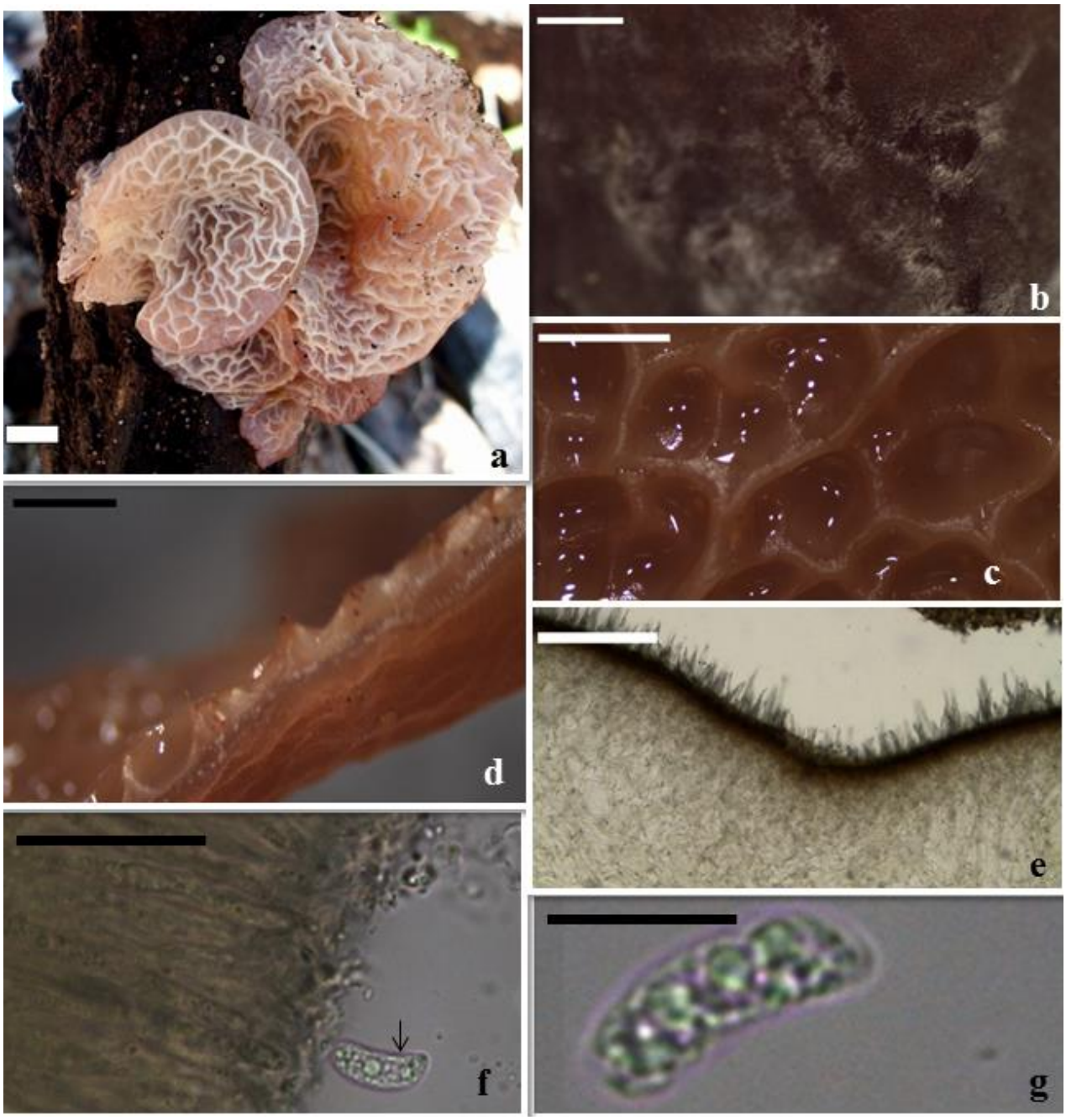

Fig. 2 – *Auricularia delicata*. a-Basidiomata on the substrate; b-Pilous abhymenial surface of the dehydrated basidioma; c-Hymenial surface of rehydrated basidioma; d-Cross-section of basidioma; e-Cross-section of the pilous region; f-Hymenial layer with basidiospore (arrow); g-Basidiospore with oil droplet inside. Scale bars- a: 2 cm; b-d: 2 mm; c-e: 0.5 mm; f-g: 20 µm

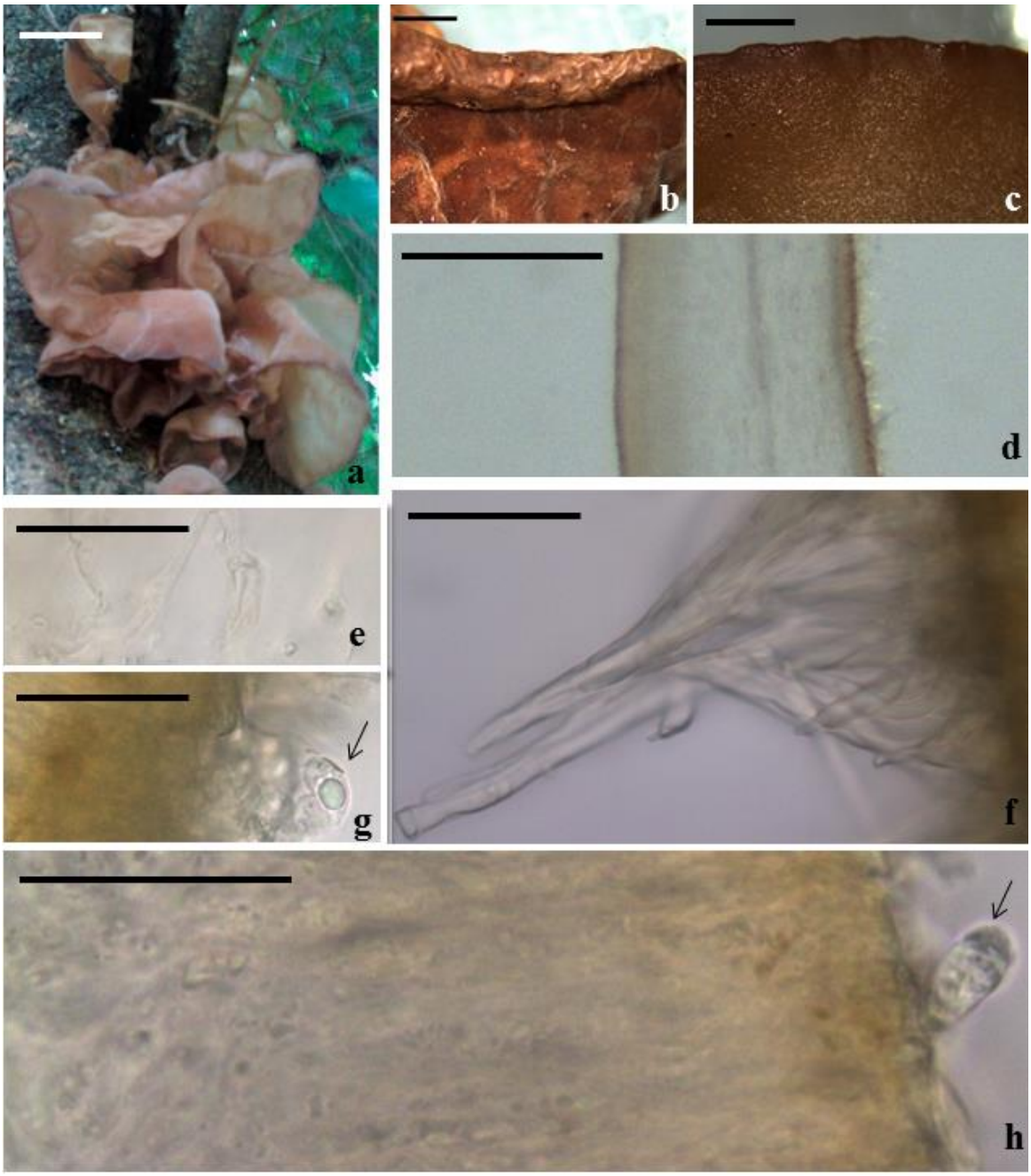

Fig. 3 – *Auricularia fuscosuccinea*. a-Basidiomata on the substrate; b-Revolute margin of the dehydrated basidioma; c-Margin of the abhymenial surface of the basidioma preserved by wet way; d-Cross-section; e-Hyphae of the medulla immersed in mucilage; f-Abhymenial hairs; g-Hymenial layer with basidiospore (arrow); h-Basidiospore with oil droplets inside (arrow). Scale bars-a: 1 cm; b-c: 2 mm; d: 0.5 mm; e-h: 20 µm.

Material examined – BRAZIL, Goiás State, City of Anápolis, *Campus* of the Universidade Estadual de Goiás, Trilha do Tatu Ecological Reserve, 28/09/2009 Xavier-Santos, S. (4313)-HUEG 8418; idem (4312)-HUEG 8423; idem 2001, Xavier-Santos, S.

(3035)-HUEG 8378; City of Caldas Novas, Serra de Caldas Novas State Park (17°43'56"S to 17°50'55,7"S; 48°40'0"O to 48°42'57,6"O)01/05/2008 Xavier-Santos, S. (2850)-HUEG 8401, idem (2861)-HUEG 8398; City of Jataí, Açude Forest, 09/02/2011 Alvarenga, R.L.M. (77)-HUEG 8389; City of Pirenópolis, Dona Júlia´s farm, 11/06/2009 Xavier-Santos, S. (3789)-HUEG 8452; City of Silvânia, Silvânia Forest Park (FLONA), 26/10/2007 Xavier-Santos, S. (807)-HUEG 8410; idem (838)-HUEG 8411; idem (888)-HUEG 8412; idem 26/06/2009 Xavier-Santos, S. (3874)-HUEG 8433; idem (3883)-HUEG 8413; idem (3855)-HUEG 8409; idem 22/10/2010 Alvarenga, R.L.M. (11)-HUEG 8481.

Notes – Collected from live trunks or trunks in decomposition, with or without direct exposure to sunlight. This species is distinguished from other species of the genus by exhibiting effused-reflexed basidioma with abhymenial surface in the substrate, in contrast to other species with lightly pedicellate concave basidioma. It can be easily confused with the species *Trametes versicolor* or *Stereum ostrea* (Looney et al. 2013), requiring analysis of microstructures as the presence of zone in cross-sectional and heterobasidia, for correct taxonomic determination. This is the first record of species occurrence for Goiás state.

Auricularia nigricans (Fr.) Birkebak, Looney & Sánchez-García

Fig. 5

Description – Basidioma concave, 0.4–5.0 cm, pedicellate to sessile, brittle when dry and cartillaginous when fresh. Abhymenial surface covered by wavy hairs, with narrow lumen. Hymenium vinous-black when dry. Margin generally more pilous, straight when young, becoming undulated when adult. Medulla present. Branched hyaline hyphae with slightly thick wall (1.5–2.5 µm), immersed in a large amount of mucilage. *Zona pilosa* 600–700 µm, *zona compacta* 20–39 µm, *zona subcompacta superioris* 35–90 µm, *zona laxa superioris* 73–200 µm, medulla 40–230 µm; *zona laxa inferioris* 36–340 µm, *zona subcompacta inferioris* 47–170 µm, hymenium 55–61 µm. Basidia cylindrical 51–60 × 3.5–4.8 µm, basidiospores hyaline, curved-cylindrical 11–15 × 4–6 µm.

Distribution – Cosmopolitan, in Brazil: states of AM, AP, BA, CE, DF, GO, MG, MT, PA, SC, SP, RJ, RO, RR, RS.

Material examined – BRAZIL, Federal District, Botanical Garden of Brasília, 01/12/2010. Alvarenga, R.L.M. (29)-HUEG 8395; Goiás, City of Anápolis, *Campus* of the Universidade Estadual de Goiás, Trilha do Tatu Ecological Reserve, 10/02/2009, Xavier-Santos, S. (3752)-HUEG 8434; idem 28/09/2009, (4309)-HUEG 8453; idem (4310)-HUEG 8428; idem 08/02/2010, Xavier-Santos, S. (4281)-HUEG 8447; idem 08/10/2008, Xavier-

Santos, S. (4043)-HUEG 8448; idem 2001, Xavier-Santos, S. (3072)-HUEG 8465; idem (3099)-HUEG 8393; idem (3053)-HUEG 8476; idem (3063)-HUEG 8386; idem (3046)-HUEG 8404; idem 10/11/2007, Faria, J.E.Q. & Moreira, I.C. (204)-HUEG 8407; idem (213)-HUEG 8446; Ciliar Forest of Ribeirão das Antas, AmBev, Cebrasa Branch (16°17'56.34"S and 48°48'43.68"O), 10/05/2011, Xavier-Santos, S (4819)-HUEG 10270; idem 29/05/2011, Xavier-Santos, S (4618)-HUEG 10271; idem 07/07/2011, Xavier-Santos, S (4847)-HUEG 10272; City of Caldas Novas, Serra de Caldas Novas State Park (17°42'53''S and 48°43'46''W), 01/05/2008, Xavier-Santos, S. (2806)-HUEG 8442; idem 02/11/2007, Xavier-Santos, S. (2138)-HUEG 8420; idem (17°46'21''S and 48°39'07''W), 01/05/2007, Xavier-Santos, S. (2518)-HUEG 8396; idem (17°42'53''S and 48°43'46''W), 01/05/2008, Xavier-Santos, S. (2771)-HUEG 8424; idem (2805)-HUEG 8445; idem (2882)-HUEG 8436; City of Goiânia, *Campus* II of the Universidade Federal de Goiás, Auguste Saint-Hilaire Forest (BASH), 22/02/2014 Naves, L.R.R. (144)-HUEG 10119; idem 30/05/2014 Naves, L.R.R. (333)-HUEG 10120; idem 27/06/2014 Naves, L.R.R. (364)-HUEG 10121; idem 27/06/2014 Naves, L.R.R. (366)-HUEG 10122; idem 27/06/2014 Naves, L.R.R. (369)-HUEG 10123; City of Jataí, Açude Forest, 09/02/2011, Alvarenga, R.L.M. (48)-HUEG 8380; idem (66)-HUEG 8390; idem (69)-HUEG 8391; idem (71)-HUEG 8379; idem (73)-HUEG 8489; idem (74)-HUEG 8490; idem (50)-HUEG 8375; City of Pirenópolis, Serra dos Pirineus State Park, 27/06/2008, Xavier-Santos, S. (1153)-HUEG 8432; idem (1162)-HUEG 8444; idem 11/06/2009, Xavier-Santos, S. (3803)-HUEG 8466; idem (3792)-HUEG 8405; City of Rio Quente, (17°47'35''S and 48°47'36''W), 28/03/2009, Xavier-Santos, S. (3627)-HUEG 8485; idem 29/03/2009, Xavier-Santos, S. (3658)-HUEG 8486; idem (3588)-HUEG 8431; idem (17°47'11''S e 48°45'25''W), 01/05/2008, Xavier-Santos, S. (2730)-HUEG 8439; idem (2685)-HUEG 8421; City of Silvânia, Silvânia Forest Park (FLONA), 26/10/2007, Xavier-Santos, S. (840)-HUEG 8430; idem (806)-HUEG 8417; idem (949)-HUEG 8443; idem (936)-HUEG 8422; idem 26/06/2009, Xavier-Santos, S. (3925)-HUEG 8449; idem (3864)-HUEG 8435; idem (3881)-HUEG 8397; idem (3859)-HUEG 8414; idem 22/10/2010, Xavier-Santos, S. (4465)-HUEG 8454; idem (4468)-HUEG 8456; idem Alvarenga, R.L.M. (13)-HUEG 8474; idem (19)-HUEG 8480.

Notes – Collected from live trunks or trunks in decomposition, mainly in wet areas. *A. nigricans* is distinguished from others species of the genus by presenting the abhimenial surface densely tomentose with hairs exceeding 450 µm. The specie is the most commonly collected, compared with other species of the genus. It is an edible species and widely used in

Chinese cuisine (Lowy 1971) and exhibiting medicinal value (Song & Du 2011, Yu et al. 2014).

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Key to *Auricularia* species

1. Pileate basidioma 2
1'.Effused-reflexed basidioma.....*A. mesenterica*
2. Basidioma with reticulate hymenial surface.....*A. delicata*
2'.Basidioma with smooth hymenial surface 3
3. Abhymenial surface densely pilous (hairs 600-700 µm long).....*A. nigricans*
3'.Abhymenial surface slightly pilous (hairs 40-100 µm long)…….*A. fuscosuccinea*

Acknowledgements

To the Research Support Foundation of Goiás State (FAPEG) for the Masters scholarship awarded to the first author and for financial support (Processes no. 201210267001098 and AUXPE 2036/2013)

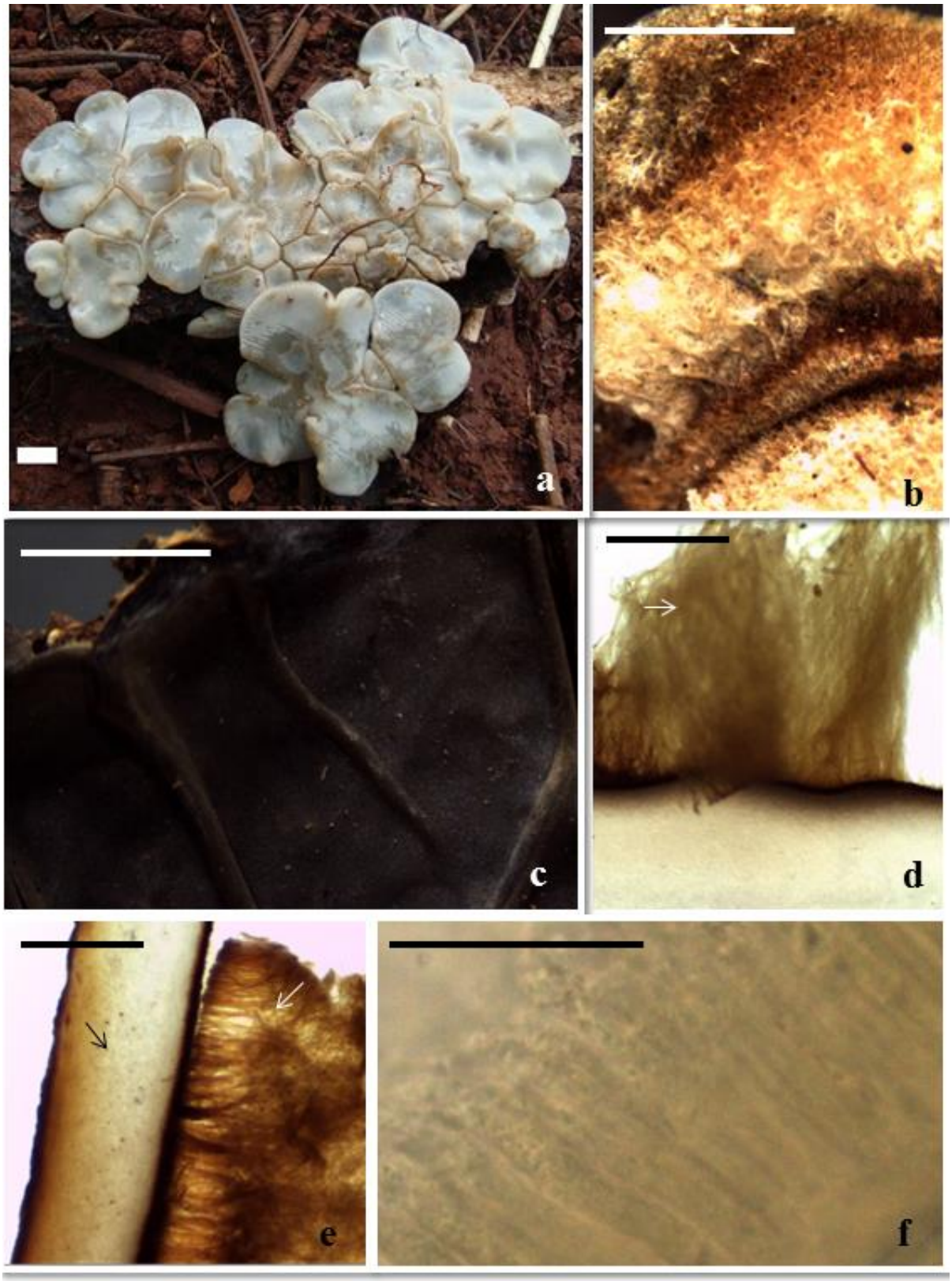

Fig. 4 – *Auricularia mesenterica*. a-Basidiomata on the substrate, hymenial surface; b-Pilous abhymenial surface of the dehydrated basidioma c-Hymenial surface of the dehydrated basidioma; d,e-Cross-section with context (black arrow) and abhymenial hairs (white arrow); f- Close-up of hymenial layer. Scale bars- a: 3 cm; b-c: 2 mm; d-e: 0.5 mm; f: 20 µm

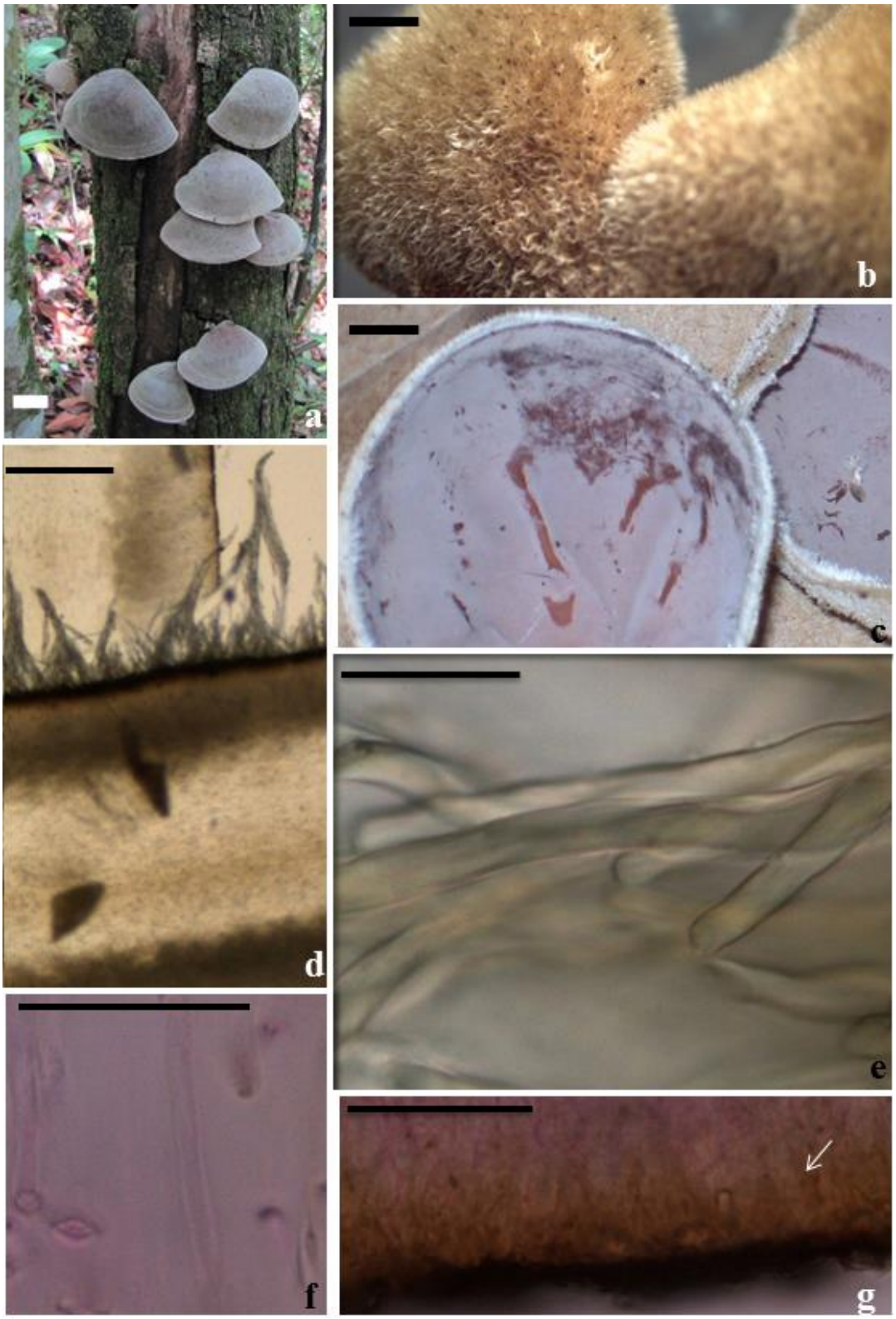

Fig. 5 – *Auricularia nigricans*. a-Basidiomata (abhymenial surface) on the substrate; b-Pilous abhymenial surface of the dehydrated basidioma; c-Hymenial surface of the fresh basidioma; d-Cross-section; e-Close-up of abhymenial hairs; f-hyphae of the medulla immersed in mucilage, stained with 2% Phloxine B, g-Hymenial layer, stained with 2% Phloxine B. Scale bars-a: 3 cm; b-c: 2 mm; d: 0.5 mm; e-g: 20 µm.

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Artigo 3- Alvarenga, RLM & Xavier-Santos, S. New Records of Dacrymycetes from the Cerrado Biome (Brazilian Savanna) and Midwest Region, Brazil. (Submetido à Revista Check List)

New Records of Dacrymycetes from the Cerrado Biome (Brazilian Savanna) and Midwest Region, Brazil

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Abstract: The distribution of five species of jelly-fungi from the Dacrymycetes class, recorded in different locations of the Cerrado biome, is updated and/or expanded. *Dacrymyces chrysospermus* Berk. & M.A. Curtis, *Dacryopinax elegans* (Berk. & M.A. Curtis) G.W. Martin, *D. maxidorii* Lowy and *D. spathularia* (Schwein.) G.W. Martin are the first records for the Cerrado and the Midwest region. *Calocera cornea* (Batsch) Fr. is being reported for the first time in Goias state and newly reported for the Federal District, after 40 years.

Key words: Jelly-Fungi, Distribution, Dacrymycetales, Dacrymycetaceae

<INTRODUCTION>

The Dacrymycetes class is a monophyletic clade belonging to the phylum Basidiomycota, with evolutionary origin estimated at 280-360 MYA (Dentinger et al. 2009). Dacrymycetes has only one order and one family (Dacrymycetales: Dacrymycetaceae), 13 genera and 156 species (Oberwinkler 2014; Kirk 2015), constituting a sister group of the Agaricomycetes class in the Agaricomycotina clade (Hibbett 2006; Hibbett et al. 2007).

Dacrymycetes is macroscopically characterized by gelatinous or cartilaginous basidioma, ranging from strictly corticoid to pustulate, cupulate, cyphelloid, stalked-capitate, or clavarioid, with color varying from yellowish to orangish and brownish. Microscopically it is characterized by frequent modified thick-walled hyphae on the abhymenial surface, denominated marginal hairs, forked (bifurcate) basidia (except in *Dacrymyces unisporus* (L.S. Olive) K. Wells), basidiospores with transverse septation in mature stages, and germination with microconidia or hyphae, but without secondary spores (McNabb 1964, 1965a, 1965b, 1965c, 1965d, 1965e,1966; Oberwinkler 1993, 2014, Shirouzu et al. 2009). Species that belong to this class are biochemically characterized as potent celulose degraders, classified as brown-rot fungi, with their enzymatic activity comparable to large hydrolase producers found in the old Order Aphyllophorales (Worrall et al. 1997).

In Brazil, the taxonomic knowledge of the group is limited to few studies, underscoring Lowy (1971), with occurrence records of eight species, Lowy (1981) describing *Dacryopinax maxidorii* Lowy, Meijer (2006) reporting the occurrence of eight species and, more recently, Shirouzu et al. (2013) with the description of *Calocera arborea* Shirouzu.

In addition to the scarcity of specialists on the group, the scant knowledge about the geographic distribution of species of this class results from the difficulty in conserving the basidioma for herborization. This is due to the high mucilage concentration that they produce, which becomes quite gelatinous and moist, accelerating their decomposition and/or provoking the collapse of microstructures during the dehydration process.

The present study aimed at reporting the occurrence of Dacrymycetes species sampled from 2008 to 2014 in Cerrado areas of Goiás state and Federal District, expanding the occurrence records of the class in Brazil.

<MATERIALS AND METHODS>

The specimens studied were collected over the last 7 years in different locations in Goiás state and in one area of the Federal District: Goiás, City of Anápolis, Campus of the Universidade Estadual de Goiás, Reserva Ecológica da Trilha do Tatu (16º23’40’’S and

48º57’32’’O), Parque Ambiental Antônio Marmo Canedo and Mata Ciliar do Ribeirão das Antas, AmBev, Cebrasa Branch (16°17’56.34”S and 48°48’43.68”O); City of Terezópolis de Goiás, Reserva Particular do Patrimônio Natural (RPPN) Fazenda Santa Branca; City of Goiânia, Campus II of the Universidade Federal de Goiás, Bosque Auguste Saint-Hilaire (BASH) (16º36’26.74’’S and 49º15’51.69’’O); City of Caldas Novas, Parque Estadual da Serra de Caldas Novas (PESCAN) (17°43’56”S to 17°50’55,7”S; 48°40’0”O to 48°42’57,6”O); City of Rio Quente (17°47’35’’S and 48°47’36’’W) and the Federal District, City of Brasília: Jardim Botânico de Brasília (15°52’21”S and 47°50’50”O) (Figure. 1-2).
All locations are located in the Central Plateau of Brazil, in the Cerrado biome domain. This biome is characterized by different phytophysiognomies, including mesophyll forest, semi-deciduous, ciliary and gallery forest, which were sampled in this study.

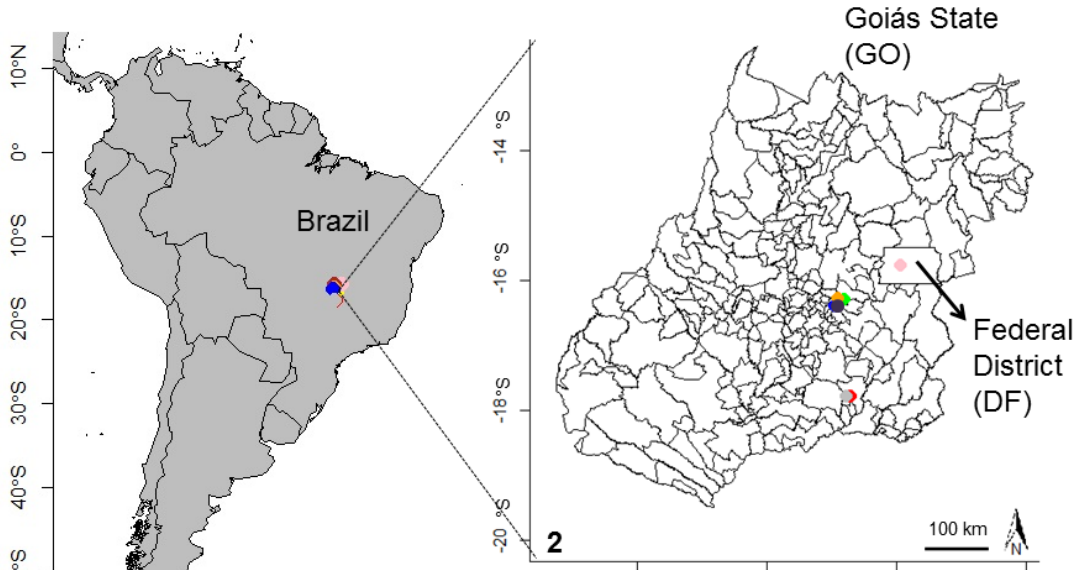


Figure 1–2. Distribution of the sites sampled in Goiás state and Federal District **1**: Map of South America, showing collection areas in Brazil. **2**: Location of collection areas in Goiás state and Federal District. Maps produced with R Software.

The basidioma underwent dry and wet preservation and were deposited at the Herbarium of Universidade Estadual de Goiás (HUEG). For the taxonomic study, macro and microscopic features were analyzed, including the general aspect of the basidioma, hymenial surface, basidia, and basidiopores, according to McNabb (1964, 1965a, 1965b, 1965c, 1965d, 1965e, 1973), Lowy (1971, 1981) and Shirouzu et al. (2009).

<IDENTIFICATION>

Calocera cornea (Batsch) Fr., Stirpes Agri Femsionensis 5: 67. 1827.

=*Clavaria cornea* Batsch, Elenchus fungorum: 139.1783.

Figures 3–7

Basidioma scattered, cylindrical, subulate, simple, slightly branched, dendroid, white to yellow, soft-cartilaginous, (1)5–15 × (0.5)1–2 mm. Structure showing in transverse section composed of a central core of compact parallel hyphae surrounded by a zone of loosely interwoven hyphae enclosed by the hymenium. Internal hyphae branched, thin- or thick-walled, septate, sub-hyaline, 2–4.5 µm diam, without clamp connections. Hymenium amphigenous. Probasidia cylindrical to clavate, pale yellow, 20–28 (35) × 2–4 µm, becoming bifurcate. Metabasidia cylindrical to clavate, becoming bifurcate 16–26 x 2–3 µm, basidiospores subglobose to reniform, with an apiculum at the base, thin-walled, sub-hyaline, 7–10 × 2–3 µm, 0–1 septate.

SPECIMENS EXAMINED: BRAZIL, Federal District: Jardim Botânico de Brasília, 01.XII.2010. Alvarenga, R.L.M. (32), HUEG 10503; Goiás: City of Rio Quente (17°47'35''S e 48°47' 36'' W), 01.V.2008, Xavier-Santos, S. (2501), HUEG 8438; City of Caldas Novas (17° 42' 53''S e 48° 43' 46''W), 23.I.2008, Xavier-Santos, S. (2293), HUEG 8402; City of Anápolis, Reserva Ecológica do Campus da Universidade Estadual de Goiás, 10.XII.2010, Xavier-Santos, S. (4501), HUEG 8459; 04.X.2010, Alvarenga, RLM. (42), HUEG 8482; Alvarenga, RLM. (105), HUEG 10504; Mata Ciliar of the Antas river, AmBev (Filial Cebrasa), 29.III.2011, Xavier-Santos, S. (4784), HUEG 10506 (associated to myxomycetes *Arcyria denudata* (L.) Wettst.).

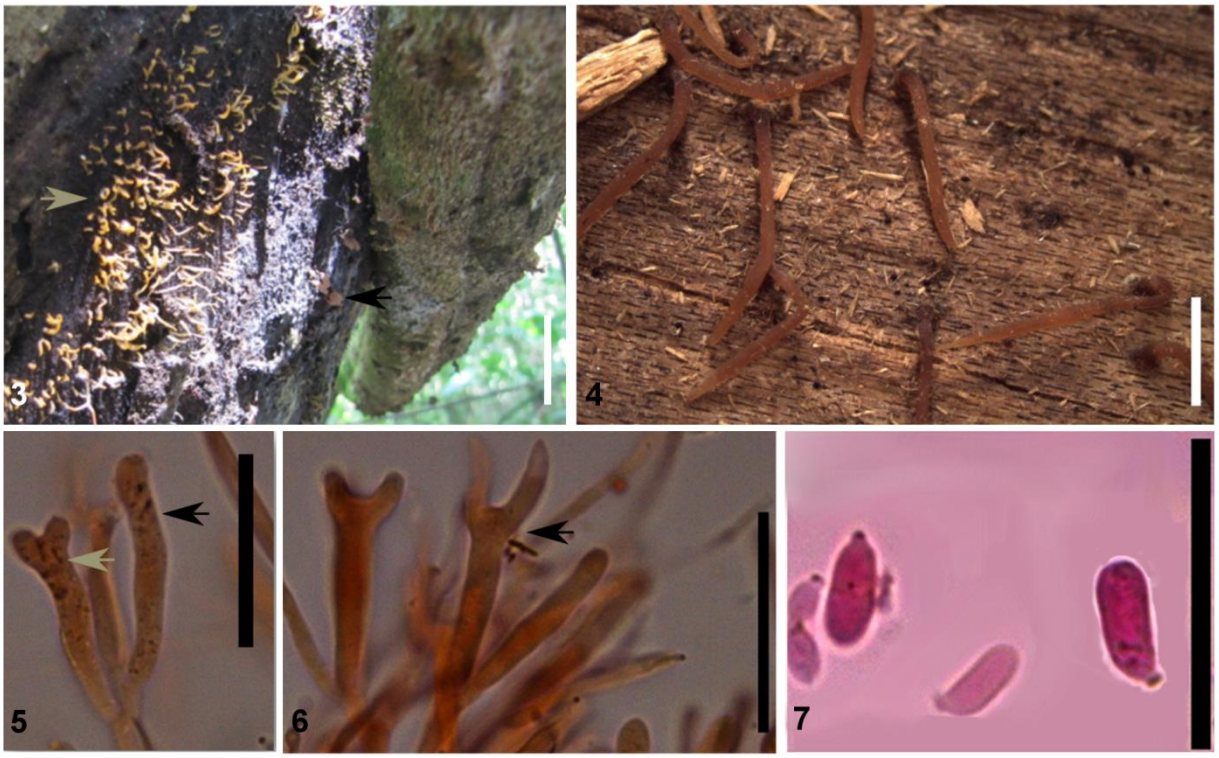


Figure 3–7. *Calocera cornea*. **3**: Basidiome of *Calocera cornea* when fresh (grey arrow) associated to sporacarp of myxomycetes *Arcyria denudata* (black arrow): HUEG 10506, scale bar = 1 cm; **4**: Basidiome when dried (HUEG 8438), scale bar = 2 mm. **5**: Probasidia (black arrow) and metabasidia (grey arrow), scale bar = 20 µm. **6**: Immature metabasidia (black arrow), scale bar = 20 µm. **7:** Basidiospores, scale bar = 20 µm.

NOTES ON DISTRIBUTION: Cosmopolitan. IN BRAZIL: It is recorded to the regions Midwest, North, Southeast and South, the Federal District, and in the Amazonas, Pará, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul states, in Amazon, Atlantic Forest and Cerrado biomes (Lowy 1971; Campos et al. 2005; Sobestiansky 2005; Trierveiler-Pereira et al. 2009). This record extends the geographic distribution of *Calocera cornea* for Goiás state and is the second of the species for the Cerrado biome and for the Federal District after more than 40 years.

Dacrymyces chrysospermus Berk. & M.A. Curtis, Grevillea 2 (14): 20. 1873.
Figures 8–9

Basidioma scattered or gregarious, flabellate or stoutly stipitate with a spathulate, yellow, firm-gelatinous, 4 cm high, 6–13 mm in height. Internal hyphae branched, thin-walled, gelatinous, septate, pale yellow, 2–3 µm diam., without clamp connections. Hymenium limited to upper surface of the pileus. Probasidia cylindrical to clavate, yellow to orange, 50–66 × 7–9 µm, becoming bifurcate. Basidiospores cylindrical to curved-cylindrical, with an apiculum at the base, thin-walled, yellow, 16–22 × 6–8 µm, 3–7 septate.

SPECIMENS EXAMINED: BRAZIL, Federal District: Jardim Botânico de Brasília, 01.XII.2010. Alvarenga, R.L.M. (25), HUEG 8382; Alvarenga, R.L.M. (27), HUEG 8383; Alvarenga, R.L.M. (28), HUEG 8394; Alvarenga, R.L.M. (33), HUEG 8385.

Figures 8–9. *Dacrymyces chrysospermus*. **8–9**: Basidiome when fresh (HUEG 8382 and HUEG 8394, respectively), scale bar = 1 cm.

NOTES ON DISTRIBUTION: Cosmopolitan. IN BRAZIL: Known only for Paraná state (Meijer 2006), in area of the Atlantic Forest biome. The species is newly recorded for Brazil, after nine years, and this is the first record for the Cerrado biome, for the Midwest region and for the Federal District.

ADDITIONAL NOTE: Due to compaction and dryness of the gelatinous matrix during the drying process of the samples, it was impossible to perform photo-documentation of microscopic characteristics.

Dacryopinax elegans (Berk. & M.A. Curtis) G.W. Martin, Lloydia 11 (2): 116. 1948.

≡*Guepinia elegans* Berk. & M.A. Curtis, Hooker's Journal of Botany and Kew Garden Miscellany 1: 239. 1849.

Figures 10–15

Basidioma scattered or gregarious, tough-gelatinous, pileus spreading-orbiculate, dark brownish when fresh, drying blackis, horny, stipe up to 6(10) ×5 mm, brownish-tomentose, hairs numerous, septate, thick-walled, hymenium unilateral, inferior, smooth, abhymenium coarsely brown-tomentose, hyphae without clamp connections. Probasidia cylindrical to clavate 35–41 × 3–5 μm, metabasidio cylindrical to clavate, aseptade, bifurcate with 23 × 3 μm. Basidiospores curved-cylindrical, 1–3 septate with 12–16 × 4–6 μm.

SPECIMENS EXAMINED: BRAZIL, Goiás: City of Anápolis, Parque Ambiental Antônio Marmo Canedo - Parque da Matinha, 13.XII.2014, Alvarenga, RLM (210), HUEG 10499; City of Goiânia, Campus II of the Universidade Federal de Goiás, Bosque Auguste Saint-Hilaire (BASH), 07.X.2013, Naves, L.R. (222), HUEG 10498.

NOTES ON DISTRIBUTION: Pantropical. IN BRAZIL: Reported for the North, Southeast and South regions of Amazonas, São Paulo, Rio de Janeiro, Paraná and Rio Grande do Sul states, in areas of the Amazon and Atlantic Forest biomes (Lowy 1971; Sobestiansky 2005; Meijer 2006). *Dacryopinax elegans* is now reported for the first time in the Cerrado biome, in the Midwest and in Goiás state.

Dacryopinax maxidorii Lowy. Mycotaxon 13 (2): 428. 1981.

Figures 16–20

Basidioma, when fresh, stipitate bearing sinuate flabellate, orange-yellow, at the sterile surface of basidiomas, soft-cartilaginous, 12–25 × 12–23 mm. Internal hyphae branched, thin-walled, septate, 1.8–3.4 μm diam., without clamp connections. Hymenium unilateral. Probasidia cylindrical to clavate, pale yellow, 31–37.2 × 4–5.3 μm, becoming bifurcate. Basidiospores curved-cylindrical, with an apiculum at the base, thin-walled, pale yellow, (8)9–10 × 4–5 μm, 0–1 septate.

SPECIMENS EXAMINED: BRASIL, Goiás: City of Rio Quente (17°47’35’’S e 48°47’ 36’’ W), Fazenda Particular, Mata Estacional Semidecidual. 28.III.2009, Xavier-Santos, S. (3541), HUEG 10505; City of Terezópolis de Goiás, Reserva Particular do Patrimônio Natural (RPPN) Fazenda Santa Branca. 03.V.2014, Xavier-Santos, S. (6081), HUEG 10507.

SPECIMENS CONSULTED: BRAZIL, Amazonas: km 405 Manaus-Porto Velho road. 16.IX.1980. Lowy, B & Coelho, D. (BR190) -INPA 101201. Det. Lowy. B [Holotype].

NOTES ON DISTRIBUTION: With distribution known only for the North of Brazil, in the states of Amazonas and Pará in the Amazon biome (Lowy 1981; Sotão et al. 2003; Campos et al. 2005), the species is being reported for the first time for the Cerrado biome, for the Midwest and for the Goiás state.

Dacryopinax spathularia (Schwein.) G.W. Martin, Lloydia 11 (2): 116. 1948.

≡*Guepinia spathularia* (Schwein.) Fr., Elenchus Fungorum 2: 32. 1828.

Figures 21–25

Basidioma scattered or gregarious, spathulate, stipitate bearing sinuate flabellate to petaloid pileus, orange, white-yellow at the sterile surface of basidiomas, soft-cartilaginous, 5–16 mm high, 0.6–2 mm diam. at stipe. Internal hyphae branched, thin-walled, septate, pale yellow, 1–2.5 μm diam, without clamp connections. Hymenium unilateral. Probasidia cylindrical to clavate, pale yellow, 20–38 × 2–4 μm, becoming bifurcate. Basidiospores subglobose to reniform, with an apiculum at the base, thin-walled, pale yellow, 9–10 × 3–4 μm, 0–1 septate.

SPECIMENS EXAMINED: BRAZIL, Goiás: City of Caldas Novas (17° 42’ 53’’S e 48° 43’ 46’’W), 01.V.2008, Xavier-Santos, S. (2500), HUEG 8400, (2800), HUEG 8403; City of Rio Quente (17° 47’35’’S e 48° 47’ 36’’ W), 22.I.2008, Xavier-Santos, S. (2207), HUEG 8419; City of Rio Quente (17° 47’35’’S e 48° 47’ 36’’ W), 24.I.2008, Xavier-Santos, S. (2483), HUEG 8426; (2232), HUEG 10501; (3281), HUEG 10502; (3283), HUEG 10500; City of Anápolis, Reserva Ecológica do Campus da Universidade Estadual de Goiás, 28.IX.2009, Xavier-Santos, S. (4295), HUEG 8461; 10.XII.2010, Xavier-Santos, S. (4508), HUEG 8441; Mata Ciliar do Ribeirão das Antas, AmBev (Filial Cebrasa), 26.X.2010, Xavier-Santos, S. (4564), HUEG 8416; (4553), HUEG 8415.

NOTES ON DISTRIBUTION: Pantropical, IN BRAZIL: It is recorded to North, Southeast and South regions, in Amazonas, Rio de Janeiro, São Paulo, Paraná and Rio Grande do Sul states, in Amazon and Atlantic Forest biomes [Teixeira 1945; Viégas 1945 (as *Guepinia spathularia*); Lowy 1971; Sobestiansky 2005; Meijer 2006]. This work presents the first Record of this species for the Cerrado biome, for the Midwest region and for the Goiás state.

<DISCUSSION>

The present study broadens the knowledge regarding the geographic distribution of Dacrymycetes in Brazil, reporting four new records of species for the Midwest region and for the Cerrado biome (*Dacrymyces chrysospermus*, *Dacryopinax elegans*, *D. maxidorii* and *D. spathularia*), and five new occurrences for Goiás state (including *Calocera cornea* among those aforementioned). Thus, the knowledge of jelly-fungi (Dacrymycetes) for the Midwest of Brazil is once again discussed in the literature, after 44 years, since it is the only record of Dacrymycetes in the region since 1971, for *Calocera cornea* in the Federal District.

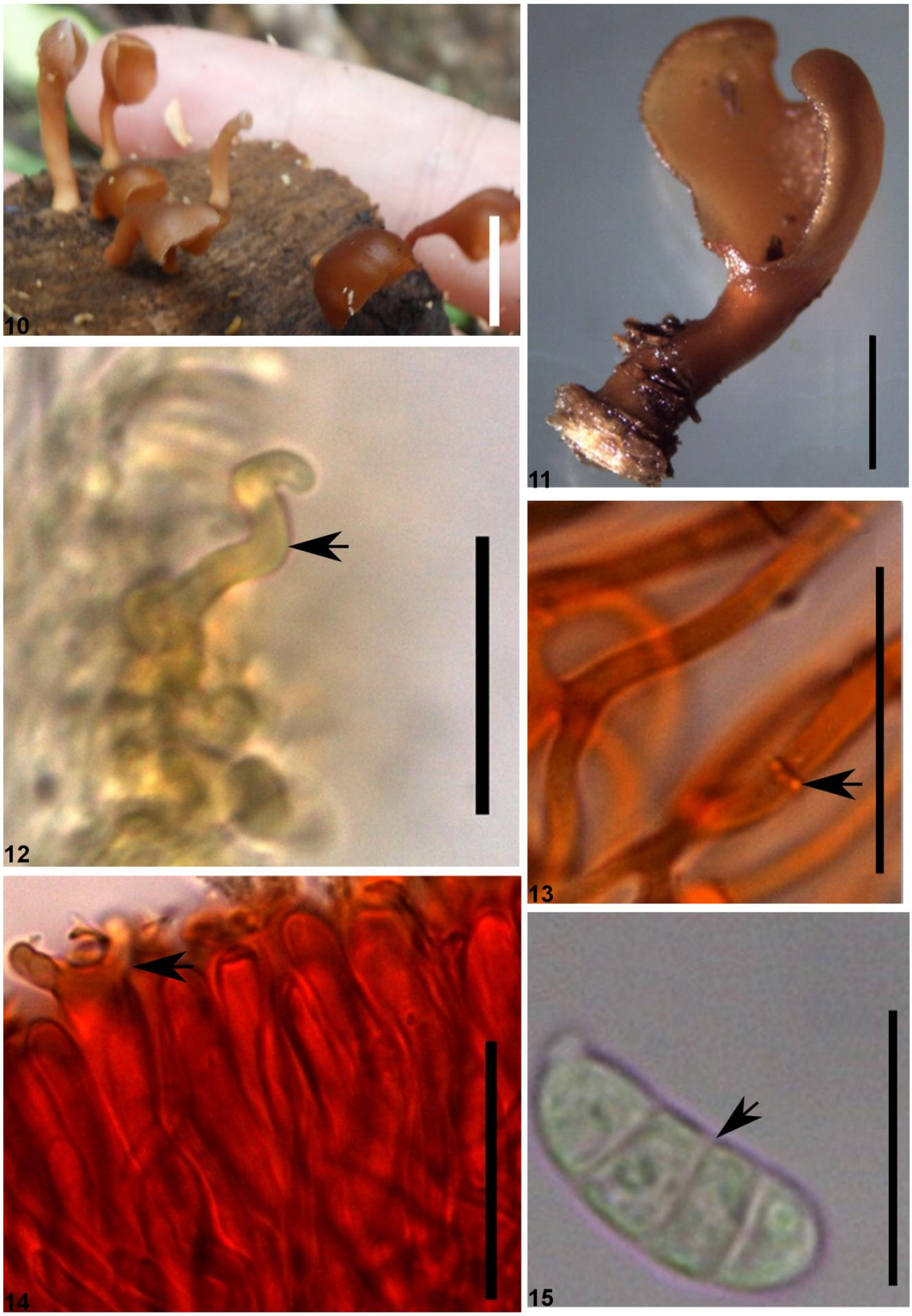
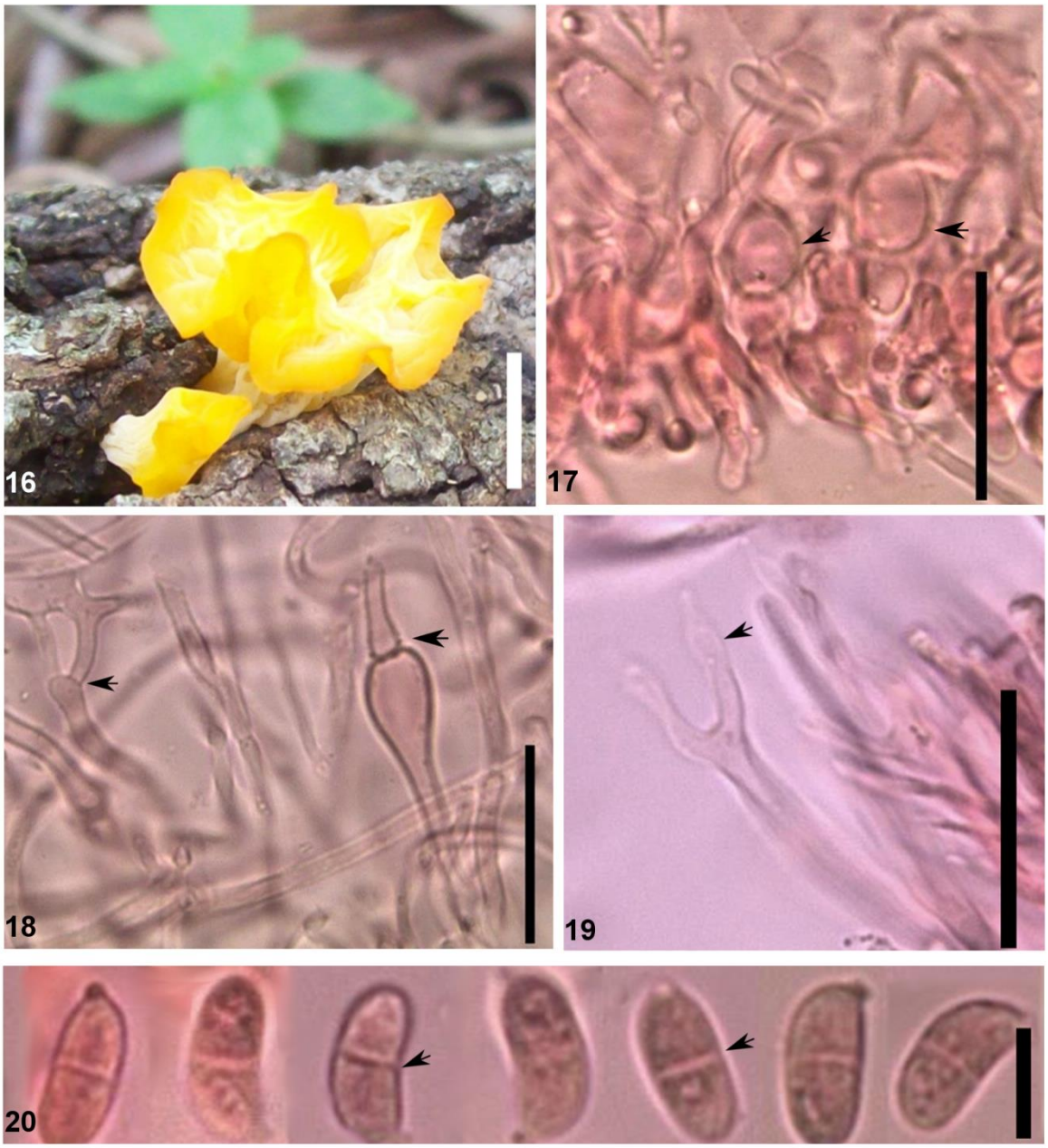
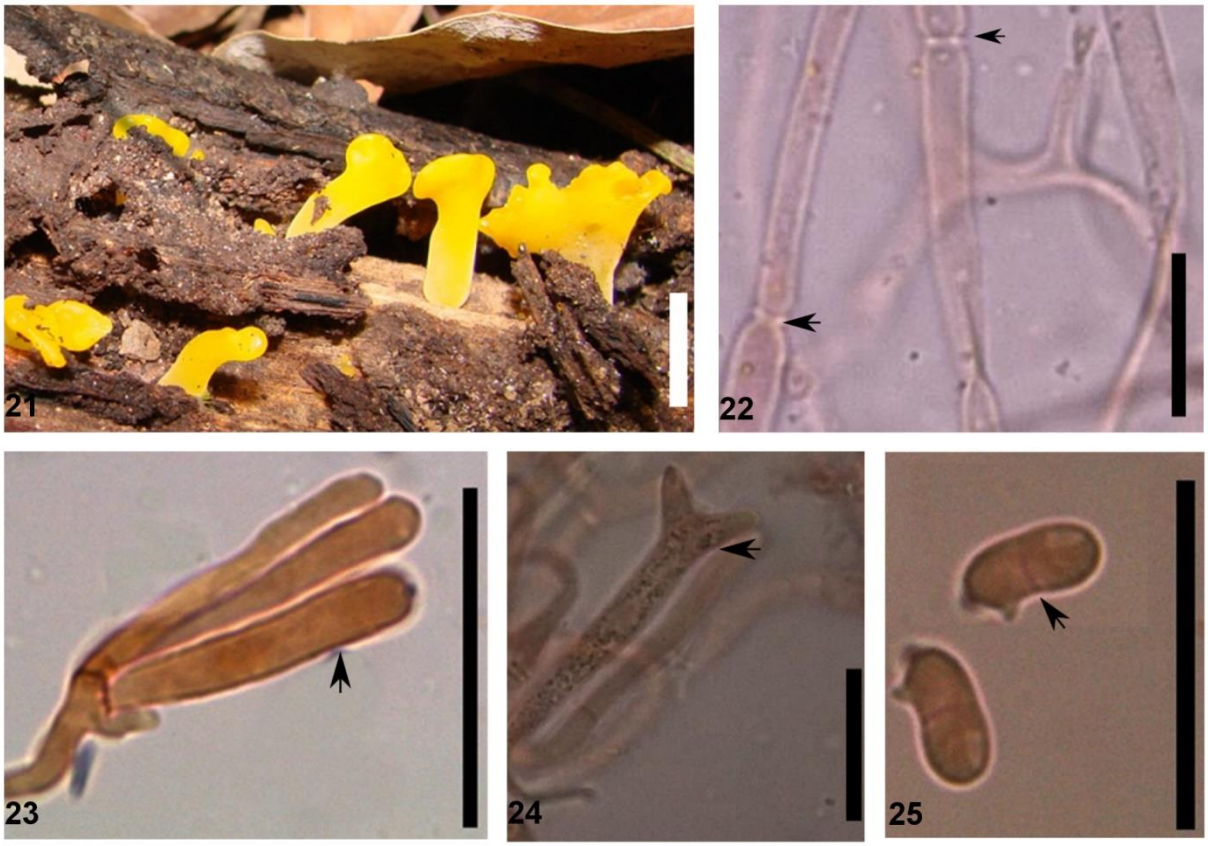


Figure 10–15. *Dacryopinax elegans*. **10–11**: Basidiome when fresh (HUEG 10499), scale bar = 1 mm and 2 mm respectively; **12**: Marginal hairs (black arrow), scale bar = 10 µm; **13**: Hyphae without clamp-connection (black arrow), scale bar = 10 µm; **14**: Hymenium with immature metabasidia (black arrow), scale bar = 10 µm. **15**: Basidiospore whith three septa (black arrow), scale = 10 µm.



Figures 16–20. *Dacryopinax maxidorii*. **16**: Basidiome when fresh (HUEG 10505), scale bar = 1 cm; **17**: Marginal hairs inflated (black arrow), scale bar = 20 µm; **18**: Hyphae without clamp connection (black arrow), scale bar = 20 µm; **19**: Metabasidia (black arrow), scale bar = 20 µm; **20**: Morphological variation among basidiospores with one septation, scale bar = 5 µm.



Figures 21–25. *Dacryopinax spathularia*. **21**: Basidiome (HUEG 8403), scale bar = 1 cm. **22**: Hyphae without clamp connection (black arrow), scale bar = 10 µm. **23**: Probasidia (black arrow), scale bar = 10 µm. **24**: Immature metabasidia (black arrow), scale bar = 10 µm. **25**: Basidiospore with septation (black arrow) scale bar = 10 µm.

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FIGURE CAPTIONS

Figure 1–2. Distribution of the sites sampled in Goiás state and Federal District **1**: Map of South America, showing collection areas in Brazil. **2**: Location of collection areas in Goiás state and Federal District. Maps produced with R Software.

Figure 3–7. *Calocera cornea*. **3**: Basidiome of *Calocera cornea* when fresh (grey arrow) associated to sporacarp of myxomycetes *Arcyria denudata* (black arrow): HUEG 10506, scale bar = 1 cm; **4**: Basidiome when dried (HUEG 8438), scale bar = 2 mm. **5**: Probasidia (grey arrow) and metabasidia (black arrow), scale bar = 20 µm. **6**: Immature metabasidia (black arrow), scale bar = 20 µm. **7:** Basidiospores, scale bar = 20 µm.

Figures 8–9. *Dacrymyces chrysospermus*. **8–9**: Basidiome when fresh (HUEG 8382 and HUEG 8394, respectively), scale bar = 1 cm.

Figure 10–15. *Dacryopinax elegans*. **10–11**: Basidiome when fresh (HUEG 10499), scale bar = 1 mm and 2 mm respectively; **12**: Marginal hairs (black arrow), scale bar = 10 µm; **13**: Hyphae without clamp-connection (black arrow), scale bar = 10 µm; **14**: Hymenium with immature metabasidia (black arrow), scale bar = 10 µm. **15**: Basidiospore whith three septa (black arrow), scale = 10 µm.

Figures 16–20. *Dacryopinax maxidorii*. **16**: Basidiome when fresh (HUEG 10505), scale bar = 1 cm; **17**: Marginal hairs inflated (black arrow), scale bar = 20 µm; **18**: Hyphae without clamp connection (black arrow), scale bar = 20 µm; **19**: Metabasidia (black arrow), scale bar = 20 µm; **20**: Morphological variation among basidiospores with one septation, scale bar = 5 µm.

Figures 21–25. *Dacryopinax spathularia*. **21**: Basidiome (HUEG 8403), scale bar = 1 cm. **22**: Hyphae without clamp connection (black arrow), scale bar = 10 µm. **23**: Probasidia (black arrow), scale bar = 10 µm. **24**: Immature metabasidia (black arrow), scale bar = 10 µm. **25**: Basidiospore with septation (black arrow) scale bar = 10 µm.

Artigo 4 – Alvarenga, RLM & Xavier-Santos, S. 2015. Review of the jelly fungi (Agaricomycotina: Basidiomycota) collection of the Herbarium of the National Institute for Amazonian Research (INPA-Fungi), Brazil. (Submetido à Acta Amazonica)

Review of the jelly fungi (Agaricomycotina: Basidiomycota) collection of the Herbarium of the National Institute for Amazonian Research (INPA-Fungi), Brazil

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Review of the jelly fungi (Agaricomycotina: Basidiomycota) collection of the Herbarium of the National Institute for Amazonian Research (INPA-Fungi), Brazil

Abstract

The Herbarium of the National Institute of Amazonian Research (INPA) is one of the country's main herbarium housing a mycological collection. The INPA-Fungi collection comprises 16.174 exsiccate of different taxonomic groups of fungi, among which the jelly fungi (Basidiomycota: Agaricomycotina), distributed among the orders Auriculariales, Dacrymycetales, Sebacinales and Tremellales. The entire fungi collection was inventoried in this study, amounting to 244 samples. These samples were taxonomically (re)determined, confirmed or had their names updated. Seven samples were not jelly fungi and 16 were not properly preserved, hindering taxonomic reviews. Data regarding the precedence, collector, date, represented biomes and the state of preservation of the exsiccatae were also considered. A distribution map of the families was created, showing that the entire collection proceeds from the Amazonian biome. The collection consists of 17 species, comprising five genera and three families, highlighting the most frequent species *Auricularia delicata sensu lato* and *A. fuscosuccinea*. The collection houses two holotypes (*Dacryopinax maxidorii* Lowy and *Tremella riobrancensis* Lowy). The species *Dacrymyces microsporus* and *D. lacrymalis* are being reported in Brazil for the first time in the literature, *Tremella fuciformis, T. foliaceae* and *T. compacta* are reported for the first time for the North Region and for the Amazonian biome and *Calocera arborea* is the second world record of the species and first record for Rondônia. The data reinforce the need for new revisions in the herbaria, which may contribute to expand the geographical distribution of jelly fungi species.

Key-Words: Amazônia, Auriculariaceae, Tremellaceae,

Introduction

The jelly fungi (Basidiomycota: Agaricomycotina) constitute a polyphyletic group characterized by a basidiomata in a jelly consistency and by the presence of fragmented or bifurcated basidia (Lowy 1971; Wells 1994; Hibbett 2006; Hibbett et al. 2007). The jelly fungi are distributed among the classes Agaricomycetes (orders: Auriculariales, with 264 species and Sebacinales, with 91 species), Dacrymycetes (order Dacrymycetales, with 156 species) and Tremellomycetes (order Tremellales, with 482 species) (Kirk 2015).

The jelly fungi collection deposited in the Herbarium of the National Institute of Amazonian Research (Instituto Nacional de Pesquisas da Amazônia; INPA-Fungi), located at Manaus/Amazonas was examined in this study as part of a project that aims to contribute to the inventory and knowledge on the distribution of jelly fungi in Brazil. The collection from INPA-Fungi consists of 16.174 exsiccatae, representing different taxonomic groups of fungi (CRIA 2015) and houses one of the largest collections of jelly fungi in Brazil.

Material and Methods

The fungi samples were found in the collection of the INPA Herbarium searching the INCT – HVFF (Virtual Herbarium of Flora and Fungi; Herbário Virtual da Flora e Fungos) and Species link-CRIA (Reference Center for Environmental Information) using the jelly fungi families as the search term and were requested by loan to be studied.

The samples were evaluated taxonomically, confirming or (re)determining its identification, with the support of relevant literature (McNabb 1973; Lowy 1951,1952, 1971, 1981; Looney et al. 2013; Shirouzu et al. 2009, 2013). The nomenclature was updated (when necessary), with reference to the Index Fungorum Partnership (http://www.indexfungorum.org) and MycoBank (http://www.mycobank.org/). The place of origin of the samples, the collector, year of collection, represented biomes and the state of preservation of the exsiccatae were also analyzed. The geographical species distribution in Brazil was based on the checklist of Alvarenga & Xavier-Santos (2015).

Auricularia delicata (Mont.) Henn., was recently divided into three clades: *A. delicata* clade I, A. *delicata* clade II and *A. subglabra* (Looney et al. 2013), and is referred to as *Auricularia delicata sensu lato* in this study, once clades are distinguishable only at the molecular level.

The coordinates of species occurrences were used to create the geographical distribution map of the analyzed samples, using software R. The geographical coordinates of the municipality (or of the nearest municipality) were used when the coordinates of the sample location were not informed.

Results

A total of 244 jelly fungi exsiccatae packed in paper envelopes were analyzed. Most exsiccatae (93.4%) have basidiomata in a good preservation state. However, 6.6% of the samples (INPA 65372, 100383, 100145, 102176, 144830, 145007, 145008, 144922, 155040,

183780, 183835, 185294, 185419, 185918, 185920, 192743) had the basidiomata completely or partially degraded, therefore not being used in this study.

The oldest sample (*Auricularia nigricans*; INPA 23680), was collected by Prance and Ramos in 1968, in the state of Rondônia and the most recent sample (*Calocera cornea*; INPA 192840) was collected by M.A. Jesus in 1998, in the State of Amazonas. Most samples were collected in the years of 1980-1989, where 19% was collected solely in 1984 (Figure 1).

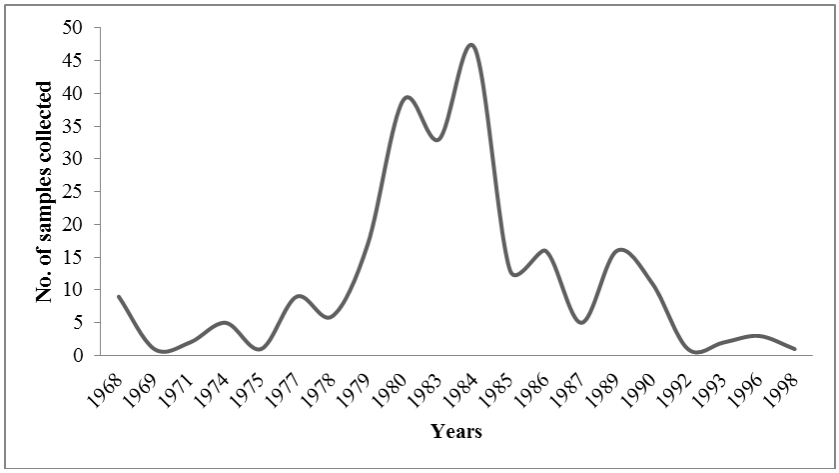

Figure 1 – Distribution of jelly fungi samples in the Herbarium of the National Institute of Amazonian Research, according to the year of collection.

After the macro and microscopic analyzes, 146 exsiccatae had their identification confirmed, 19 were redetermined, 27 had an update in nomenclature and 29 samples were identified to the species level. Seven samples were not recognized as belonging to the jelly fungi group. The species found are assigned to three orders, three families and 17 species (Table 1), where *A. delicata lato sensu* and *A. fuscosuccinea* were the most frequent species, representing, 28.50 and 23.52% of all exsiccatae, respectively.

The collection houses three holotypes (*Dacryopinax maxidorii* Lowy and *Tremella riobrancensis* Lowy, and *Calocera arborea* Shirouzu). Two species (*Dacrymyces microsporus* and *D. lacrymalis*) are being recorded in Brazil for the first time, three (*Tremella fuciformis, T. foliaceae* and *T. compacta*) are reported for the first time in the North region of Brazil and for the Amazon and one (*Calocera arborea*) is the second worldwide record of the species and first record for the state of Rondônia (Table 1).

Table 1. Distribution of the jelly fungi exsiccatae from the mycological collection of the Herbarium of the National Institute for Amazonian Research (INPA-Fungi) according to the taxonomic position and to all occurrences.

Order	**Family**	**Genus**	**Species**	**Exsiccatae number**
Auriculariales	Auriculariaceae	*Auricularia*	*A. delicata*	63
			A. fuscosuccinea	52
			A. mesenterica	5
			A. nigricans	30
Dacrymycetales	Dacrymycetaceae	*Calocera*	***C. arborea******	7
			C. cornea	23
		Dacrymyces	*Dacrymyces* sp.	1
			*D. microsporus***	1
			*D. lacrymalis **	1
		Dacryopinax	*D. spathularia*	23
			D. elegans	9
			D. indacocheae	2
			D. maxidorii	1
Tremellales	Tremellaceae	*Tremella*	*T. compacta**	1
			*T. foliaceae **	1
			*T. fuciformis**	1
			T. riobrancensi*s*	1
Discarded		-	-	16
Other groups		-	-	7
Total				**244**

* First records for the North region and for the Amazon biome, ** First records for Brazil. *** First record for Rondônia state and second world record. In bold the holotypes *Calocera arborea* (INPA 241458), *Dacryopinax maxidorii* Lowy (INPA 101201) and T*remella riobrancensis* Lowy (INPA 133573).

Nearly the entire collection derives from the Brazilian Amazon, except for a single voucher specimen (*Auricularia nigricans* INPA 22555), which is originally from the Bolivian Amazon. The highest percentage of samples comes from the states of Amazonas (65%) and

Acre (15%). The states with the highest number of sampled locations are Amazonas (nine) and Roraima (five) (Figure 2).

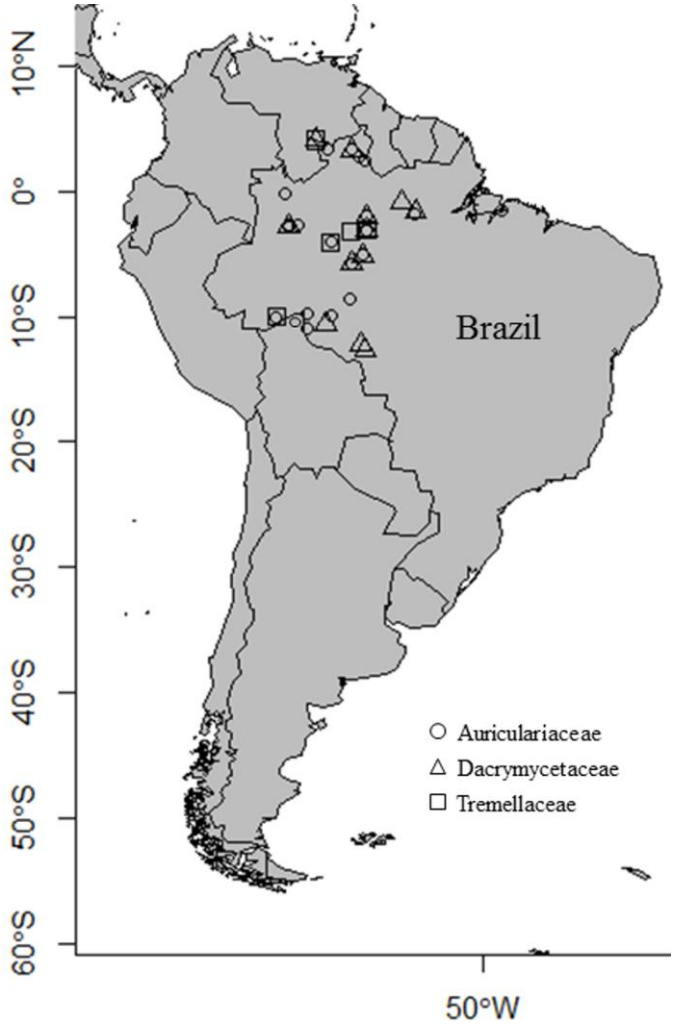

Figure 2 - Distribution of jelly fungi samples of herbarium of the National Institute of Amazonian Research (INPA-Fungi), according to the locality of origin.

The herbarium houses historical collections of great relevance for brazilian mycology, such as those of B. Lowy, R. Singer, R.H. Petersen, G.T. Prance, M.F. Cardias. The highest number of jelly fungi samples comes from the collections of M.A. Jesus (30%) and B. Lowy (13%).

Listed below are the materials examined, according to family, genus, species, locations of origin, record number, followed by a brief comment when required. Letters show whether the specimen is indicated for confirmed taxonomic determination ([c]), redetermination ([r]), nomenclature update ([u]) and for identification ([i]).

Species list

Auriculariaceae Fr.

Auricularia Bull.

Auricularia delicata (Mont. ex Fr.) Henn. *lato sensu*

BRAZIL, **Acre**: Municipality of Rio Branco: INPA 100460[c]; 100522[c]; 100580[c]; 100598[c]; 100653[c]; 100715[c]; 100893[c]; 100912[i]; 100920[c]; 100696[c]; 190494[c]; 190497[c]; 100459[c]; 190504[c]; 190505[c]; 190506[c]; 190507[c]; 190508[c]; **Amazonas**: Municipality of Coari: INPA 178521[i]; Municipality of Jutaí: INPA 154997[i]; 153826[r]; 155005[i]; Municipality of Presidente Figueiredo – Usina Hidrelétrica de Balbina: INPA 183779[c]; 192484[c]; 185330[c]; 183781[c]; 185274 [c]; 185262[c]; 185291[c]; 183782[c]; 185263[c]; 185322[c]; 183784[c]; 183834[c]; 185844[c]; 183855[c]; 183788[c]; 183292[c]; 183783[c]; 183785[c]; 185308[c]; 183786[c]; 185299[c]; 185830[c]; 185835[c]; 183839[c]; 183916[c]; Municipality of Manaus: 186273[c]; 186279[c]; 192866[c]; 192622[c]; 192666[c]; 192851[c]; 186352[c]; 192628[c]; 186343[c]; 186338[c]; 183643[c]; 192697[c]; 192497 [c]; 109161[c]; Municipality of São Gabriel da Cachoeira: INPA 102812; **Rondônia**: Municipality of Ariquemes: INPA 125157[c].

Remarks: The samples had basidiomata of varying sizes and maturity stage. It was not possible to observe spores in any of the samples analyzed, even selecting the samples with well-preserved macroscopic characteristics, such as shape, hair and color characteristic of the species.

Auricularia fuscosuccinea (Mont.) Henn.

BRAZIL, **Acre**: INPA 100665[c]; 100867[c]; Municipality of Rio Branco: 100622[c]; 100597[r]; 100612[c]; 100682[c]; **Amazonas**: Municipality of Jutaí: INPA 154990[i]; 153817[c]; Municipality of Manaus: INPA 216511[c]; 108362[i]; 183936[c]; 192852[c]; 192487[c]; 192848[c]; 192629[c]; Municipality of Presidente Figueiredo – Usina Hidrelétrica de Balbina: INPA 185900[c]; 183832[c]; 185917[c]; 183820[c]; 185297[c]; 185273[r]; 185875[c]; 185293[c]; 183843[c]; 185231[c]; 183790[c]; 183787[r]; 183845[c]; 185229[r]; 183946[r]; 185337[r]; 185923[r]; 185899[c]; 185891[c]; 183791[c]; 183824[c]; 185246[c]; 183838[c]; 185846[c]; 185289[c]; 185391[c]; 185807[c]; 183789[c]; 183846[r]; Municipality of São Gabriel da Cachoeira: INPA 102810[c]; **Mato Grosso**: Municipality of Novo Aripuanã: INPA 136953[c]; 140283[i]; **Pará**: Municipality of Belém, Parque do Museu Goeldi: INPA 102841[c]; Municipality of Oriximinã: INPA 103789[c]; **Rondônia:** INPA 125106[c]; 125229[c]; **Roraima:** Municipality of Alto Alegre: INPA 143417[c].

Remarks: The samples had young to mature basidiomata. Spores were seldom observed, even in well conserved samples. There were no spore print along the exsiccate.

Auricularia mesenterica (Dicks.) Pers.

BRAZIL, **Amazonas**: Municipality of Manaus: INPA 186324[c]; 192656[c]; **Roraima:** Road of Boa Vista Dormida: INPA 78534[r]; Municipality of Novo Paraíso: INPA 78392[r]; **Pará**: Municipality of Itaituba, Parque Nacional da Amazônia: INPA 74636[r].

Remarks: The basidioma analyzed had variable dimensions (2-15 cm in length), and were all considered mature due to the purplish color of the hymeneal surface. A large amount of quartz crystals originating from the sample collection site and partially damaged pilose surface were observed during the microscopic analysis. Spores were not observed. *A. mesenterica* closely resembles *A. ornata*, differing in regards to the internal zones (*Zona pilosa* and *Zona intermedia)*. The species *Auricularia mesenterica* has a *Zona pilosa* of about 500 µm and *Zona intermedia* of 576-600 µm, while *A. ornata* has a *Zona pilosa* of approximately 450µm and *Zona intermedia* of 360-375 µm.

Auricularia nigricans (Fr.) Birkebak, Looney & Sánchez-García

BOLÍVIA, **Pando**: W. bank of Rio madeira opposite Abunã: INPA 22555[u]; **BRAZIL**, **Amazonas**: 2 km. south of Maués, east of Maués River, surrounding Guaraná farm: INPA 46081[i]; Municipality of Manaus: 183738[u]; 183810 [u]; 51591[i]; 192660 [u]; 192677[u]; 192657[u]; 186274[u]; 192488[u]; 74647[u]; 137080[i]; Municipality of Manicoré: INPA 128959[u]; 103322[u]; Municipality of Presidente Figueiredo – Usina Hidrelétrica de Balbina: INPA 185892[u]; 183888[u]; 183833[u]; 183641[u]; 183792[u]; Rio Negro: INPA 78669[u]; Rio Purus: INPA 31843[u]; **Mato Grosso**: Municipality of Aripuanã: INPA 75599[u]; **Rondônia**: Municipality of Ouro Preto: INPA 76903[u]; Municipality of Porto Velho: INPA 23680[u]; 65148[u]; 65174[u]; **Roraima**: Between Maitá 3°20'N. 63°24'W: INPA 29016[u]; Municipality of Boa Vista: INPA 186258[u]; Municipality of Dormida: INPA 26434[u]; 78418[u].

Dacrymycetaceae J. Schröt.

Calocera (Fr.) Fr.

Calocera arborea Shirouzu

BRAZIL, **Amazonas**: Municipality of Manaus: INPA 137046[r]; Municipality of Manicoré: INPA 128917[r]; **Rondônia**: Municipality of Campo Novo: INPA 110647[i]; Municipality of Guaporé: INPA 110936[i]; Municipality of Vilhena: INPA 110719[i]; 110928[i].

Remarks: Probasidium, metabasidium and sterigmata were observed clearly using 2% congo red stain. This coloration enabled the observation of the contortion of the basidia that had

already released the spores, which commonly have 2 to 3 septations. This species was recently described by Shirouzu et al. (2013) from material from the Ducke Reserve (Manaus/AM), collected in 2011. However, this review of the herbarium shows samples of the same species collected in 1979, by R.H. Petersen, in different cities of Rondônia (Campo Novo, Guaporé and Vilhena) and in 1985 by K.F. Rodrigues in the state of Amazonas (municipalities of Manaus and Manicoré). Theses specimens were undetermined and were identified in this review.

Calocera cornea (Batsch) Fr

BRAZIL, **Acre**: Km 8 BR 317: INPA 100872[c]; Km 25 from Rio Branco to Porto Acre: INPA 100186[c]; Km 22 BR 317: INPA 100891[c]; **Amazonas**: Lago do Janauarí: INPA 82828[i]; Municipality of Manaus: INPA 192701[c]; 185945[c]; 185983[c]; 70032[c]; 69951[i]; 192840[c]; Municipality of Presidente Figueiredo – Usina Hidrelétrica de Balbina: INPA 185398[c]; 185388[c]; 183822[c]; 185311[c]; 185896[c]; 185392[c]; 192638[c]; 192500[c]; 216357[c]; **Rondônia**: Municipality of Vilhena: INPA 110968[i]; 110858[i]; 110682[c]; **Roraima**: Municipality of Ilha de Maracá: INPA 145264[c].

Remarks: The size of the basidioma ranged from 1 to 5 mm in length. The basidioma were well conserved despite the substrate (wood fragments) were very degraded, hindering the location of the basidioma. Therefore, separating the basidioma and disposing this substrate is recommended. Probasidium, metabasidium and sterigmata, inflated and twisted after spore release, were visualized clearly through the use of congo red stain 2%.

Dacrymyces Nees.

Dacrymyces sp.

BRAZIL, **Amazonas**: Municipality of Manaus: INPA 108363[i].

Remarks: It was not possible to determine the species due to the poor conservation condition of the sample, which caused the degradation of morphological characteristics relevant to the taxonomic identification. The determination to genus was based on the occurrence of basal hairs, bilateral hymenium, homogeneous context, absence of medullary region, cylindrical to sub-clavate probasidium (19.5-25.9 x 2.14-3.5 µm) with inconspicuous connection clamps and allantoid to subcylindrical spores, ranging from 7-9 x 2.14-3.3µm.

Dacrymyces microsporus P. Karst

BRAZIL, **Rondônia**: Municipality of Vilhena: 5-20 km on new road to colorado. Low mountain forest. Apricot orange, stipitate, flat on top. 3/11/1979, Petersen, R.H (381) (INPA 110869[i]).

Remarks: Basidioma varied from 1.1-3.33 x 0.5-1.0 mm, and were covered in sand. Microscopic structures were visualized after staining (2% Congo red), namely the cylindrical to clavate probasidium, subcylindrical metabasidium, and reniform spores with a septum.

Dacrymyces lacrymalis (Pers.) Nees

BRAZIL, **Amazonas**: Municipality of Manaus: Praia da Ponta Negra. 04/12/1977, Singer, R. (B10308) (INPA 82831[i]).

Remarks: The exsiccate has a single basidioma preserving characteristics typical of the species. The other basidioma are degraded or had their morphological characteristics modified during the drying process. Inflated and twisted probasidium, metabasidium and sterigmata after the release of spores, were clearly visualized with the 2% Congo red staining.

Dacryopinax G.W. Martin

Dacryopinax elegans (Berk. & M.A. Curtis) G.W. Martin

BRAZIL, Acre: Km13 BR-317: INPA 100926[c]; Km 29 BR-364NW: INPA 100658[c]; Km39 AC-010: INPA 100499; Km16 AC-040 SW: INPA 100676[c]; **Amazonas**: Road of Manaus-Caracarí, Km 60: INPA 192736[r]; Municipality of Coari: INPA 178482[i]; **Rondônia**: Municipality of Campo Novo: INPA 110504[i]; **Roraima**: Municipality of Ilha de Maracá: INPA 145196[c]; Municipality of Vicinity of Aurais: INPA 45482[c].

Dacryopinax indacocheae Lowy

BRAZIL, **Rondônia**: Municipality of Guaporé: INPA 110949[i]; Municipality of Vilhena: INPA 110912[i].

Dacryopinax maxidorii Lowy

BRAZIL, **Amazonas**: km 405 Manaus-Porto Velho road. 16/09/1980. Lowy, B & Coelho, D. (BR190) (INPA 101201). Det. Lowy. B [*Holotype*]

Remarks: The species, described by Lowy (1981), is represented only by the holotype, which remains in excellent condition, enabling a clear visualization of the macro and microscopic characteristics.

Dacryopinax spathularia (Schwein.) G.W. Martin

BRAZIL, **Acre**: Km 35 AC-40 SE: INPA 100615[c]; Km103 on Manaus-Itacoatiara Road.: INPA 65369[c]; **Amazonas**: Road of Manaus-Caracaraí, Km 45: INPA 76898; Road of Manaus-Itacoatiara, Km 30: INPA 77358[c]; Km 215: INPA 44762[c]; Município de Manaus: INPA 192623[c]; Municipality of Presidente Figueiredo – Usina Hidrelétrica de Balbina: INPA 185804[c]; 183637[c]; 185424[c]; 185417[c]; 185814[c]; Municipality of Jutaí: 154987[r]; 65352[c]; 183927[c]; 188007[c]; Reserva Florestal Walter Egler: INPA 65336[c]; 216358[r]; **Rondônia:** Along Madeira-Mamore Railroad up to 4 Km from Matumparana: INPA 64858[c]; Municipality of Vilhena: INPA 110919[i]; 110708[i]; **Roraima**: Ilha de Maracá: INPA 144998[c]; 144994[r]; Municipality of Vicinity of Auaris: INPA 45394[c].

Tremellaceae Fr.

Tremella Pers.

Tremella fuciformis Berk.

BRAZIL, **Amazonas**: Municipality of Manaus: INPA 183805[c].

Remarks: The species has a known distribution for the South, Southeast and Northeast regions, and in this study is recorded for the Northern and Amazonian regions.

Tremella foliacea Pers.

BRAZIL, **Amazonas**: Road of Caracaraí, Km 45: INPA 80490[i].

Remarks: The species has a known distribution only for the Southern region, and was recorded in this study for the Northern and Amazonian region.

Tremella compacta Möller

BRAZIL, **Roraima**: Municipality of Vicinity of Aurais: INPA 45390[i].

Remarks: This species is represented by only two small basidioma, that resemble stones both in stiffness and pigmentation. The fragments returned to gelatinous consistency after rehydration. This is possible due to the large amount of protein substances found in species of the family Tremellaceae. The species has a known distribution only for the Southern region, and is recorded in this study for the Northern and Amazonian regions.

Tremella riobrancensis Lowy

BRAZIL, **Acre**: Municipality of Porto Velho. Loc. Km 18 on road from Rio Branco to Porto Velho. 06/10/1980. Lowy, LB (485) (INPA 133573) [*Holotype*]

Remarks: This species was described by Lowy (1982) and is represented only by the holotype. An isotype was deposited in the New York Botanic Garden Herbarium (NY 00834157) (http://sweetgum.nybg.org/vh/specimen.php?irn=915569).

Discussion

The high number of samples collected in 1980 and 1984 is from collections carried out by B. Lowy and M.A. Jesus, in the state of Acre and Amazonas, respectively. These collectors were the main contributors to the increase of the jelly fungi samples recorded at INPA-Fungi.

Despite the species *Calocera arborea* having been described only recently (Shirouzu et al. 2013) from material collected in 2011 in Manaus/AM, we found in the INPA-Fungi collection samples of this species collected since 1979 in different municipalities of Amazonas and Rondônia, which were undetermined until now. These data reinforce the need for further revisions in the herbaria, which might contribute even to the discovery of new species, which were previously shelved.

It was not possible to identify to the species level the exsiccatae INPA 108263, due to the basidioma being partially degraded, preventing the viewing of macroscopic characteristics key to distinguish species of the genus, which is highlighted for having great morphological variation (e.g., basidioma discoid, pezizoid, frequently stipitate and spatulated, flabeliform, subglobose or with lobed to cerebriform pilei) (McNabb 1973).

Most of the degraded material, and recommended for disposal, belongs to Tremellaceae family (five exsiccatae). The difficulty in conserving samples of this family is common, because their basidioma are quite humid due to mucilage accumulation, which favors morphological changes and degradation by biotic agents, such as insects. In addition, samples may stick to the paper during the drying process, which hinders the determination at the species level. Therefore, obtaining photographic records of the fresh basidioma is recommended to prevent the loss of macroscopic characteristics during the drying process. Thus, we advise conditioning jelly fungi samples in vellum or parchment paper envelopes before storing in the brown paper bag, and to dehydrate the sample before the development of insects.

Conclusion

In general, the jelly fungi samples of INPA-Fungi are well conserved, except for samples of the Tremellaceae family, for which the greatest amount of degraded basidiomata was recorded.

The herbarium houses 17 species, whereas *Dacrymyces microsporus* and *D. lacrymalis* are new records for Brazil, *Dacryopinax indacocheae*, *D. maxidorii* and *Tremella riobrancensis* are known only to the Amazon and *Tremella compacta*, *T. foliacea* and *T. fuciformis* are new records for the Northern and Amazonian Region. *Calocera arborea* is the second world record of the species and first record for Rondônia. *Auricularia delicata lato sensu*, *A. fuscosuccinea*, *A. mesenterica*, *A. nigricans*, *Calocera cornea*, *Dacryopinax spathularia*, *Dacryopinax elegans*, are widely distributed among the different biomes and regions of Brazil, where *A. delicata lato sensu* and *A. fuscosuccinea* are the most frequent.

The data presented show the importance of reviewing the material deposited in the herbaria, expanding the knowledge of the diversity and geographic distribution of the jelly fungi and other macromycetes.

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Artigo 5 – Alvarenga, RLM & Xavier-Santos. 2016. Expansion of knowledge of the geographical distribution of jelly fungi (Auriculariales, Dacrymycetales, Tremellales) in Brazil. (Submetido à Revista Iheringia Ser. Botânica)

Abstract

This study expands the geographic distribution of gelatinous fungi species in Brazil, by reviewing samples deposited in different Brazilian herbaria (HUEG, FLOR, MPUC). The recognition of three orders, three families and 18 species was possible through the identification, redetermination, confirmation or taxonomic update of the studied material. The species *Calocera coralloide* and *Dacrymyces microsporus* are first records for Brazil; *Dacryopinax maxidorii* is first record for the Northeast region and the Semi-Arid of Brazil; *Ductifera sucina*, *Exidia glandulosa*, *Tremella foliacea* and *T. fuciformis* for the Midwest region and the Cerrado biome; *A. mesenterica* for the state of Paraíba and the Semi-Arid; *Auricularia delicata* for Acre and Roraima; *A. nigricans* for Paraíba; *Calocera arborea* for Roraima; *Dacryopinax elegans* for Roraima and Santa Catarina, *D. spathularia* for Pará and Santa Catarina; and *Tremella brasiliensis*, *T. dysenterica* and *T. mesenterica* for Santa Catarina.

Key Worlds: Amazônia, Basidiomycetes, Brazilian Savannah, Atlantic Forest, New Occurrences.

Expansion of knowledge of the geographical distribution of jelly fungi (Auriculariales, Dacrymycetales, Tremellales) in Brazil

Resumo

Este trabalho expande a distribuição geográfica de espécies de fungos gelatinosos no Brasil, através da revisão de amostras depositadas em diferentes herbários brasileiros, HUEG, FLOR, MPUC. Com a identificação, redeterminação, confirmação ou atualização taxonômica, foi possível o reconhecimento de três Ordens, três famílias e 18 espécies entre o material estudado. *Calocera coralloide* e *Dacrymyces microsporus* são primeiros registros para o Brasil; *Dacryopinax maxidorii* primeiro registro para a região Nordeste e para o Semiárido; *Ductifera sucina*, *Exidia glandulosa*, *Tremella foliacea* e *T. fuciformis* para a região Centro-Oeste e para o bioma Cerrado; *A. mesenterica* para o estado da Paraíba e para o Semiárido; *Auricularia delicata* para Acre e Roraima, *A. nigricans* para a Paraíba; *Calocera arborea* para Roraima; *Dacryopinax elegans* para Roraima e Santa Catarina, *D. spathularia* para o Pará e Santa Catarina; *Tremella brasiliensis*, *T. dysenterica* e *T. mesenterica* para Santa Catarina.

Palavras Chave: Amazônia, Basidiomycetes, Cerrado, Mata Atlântica, Novas Ocorrências.

Expansão do conhecimento da distribuição geográfica de fungos Gelatinosos (Auriculariales, Dacrymycetales, Tremellales) no Brasil

Introdution

The jelly fungi comprise a paraphyletic group of several fungi, so named due to the gelatinous or cartilaginous consistency of the fruiting body, although its texture when dry can become hard, shriveled or brittle, returning the original consistency when exposed to water. These fungi are found in the phyla Ascomycota and Basidiomycota, comprising microscopic species or even some small and inconspicuous Pucciniomycotina (Moore 1965, Lowy 1971, Wells 1994, Hibbett 2006, Hibbett *et al.* 2007).

However, the fungi traditionally recognized as gelatinous are classified into 4 orders of macroscopic Basidiomycetes: Auriculariales J. Schröt., Dacrymycetales Henn., Sebacinales M. Weiss, Selosse, Rexer, A. Urb. & Oberw. and Tremellales Fr.. The fungi classified into these orders, have basidioma almost exclusively gelatinous, in addition to being microscopically characterized by having heterobasidia, i.e., fragmented (Auriculariales, Sebacinales and Tremellales) or bifurcate basidia (Dacrymycetales) (Hibbett *et al*., 2007). The basidioma may have very diverse shapes (e.g., foliose, irregularly branched shapeless, shaped like cups, railroad, spikes or branched like, coral) and colors (with color ranging from white, orange, pink, rose, brown or black). Spores have no ornamentation and are, overall, lobed and/or segmented (Lowy 1952, 1971, Wells 1994, Musngi *et al.* 2005, Sierra *et al*. 2012, Looney *et al.* 2013).

Based on literature records, Alvarenga & Xavier-Santos (2015) listed 88 jelly fungi species occurring in Brazil. Many Brazilian herbaria keep samples of jelly fungi which are not yet reported in literature, many of which come from occasional sampling focused on other taxa, and that are unidentified or misidentified. Therefore, it is possible that the number of occurrences, along with the distribution of species within the Brazilian territory will undergo major changes with the review of this material. Therefore, this study aimed to review samples of jelly fungi deposited in Brazilian herbaria, contributing to the knowledge of the geographical distribution of species in the country.

Material and Methods

By contacting the curators of different herbaria in the country, it was requested a loan of the specimens in question which were available in the collection. The samples received came from the HUEG (Herbarium of the State University of Goiás; Universidade Estadual de Goiás), FLOR (Herbarium of the Botany Department of the Federal University of Santa

Catarina; Universidade Federal de Santa Catarina) and MPUC herbaria (Herbarium of the Museum of the Pontifical Catholic University of Rio Grande do Sul; Museu da Pontifícia Universidade Católica do Rio Grande do Sul).

The material was then screened and analyzed regarding the conservation status of the samples and taxonomic identification, confirming the identification, re-identifying or updating the nomenclature, when needed. Macro and microscopical features were analyzed in the taxonomic study, including the general aspect of the basidioma, hymenial surface, basidia, and basidiospores, according to McNabb (1964, 1965a, 1965b, 1965c, 1965d, 1965e, 1966, 1973), Lowy (1952, 1971, 1981, 1982), Shirouzu *et al* .(2009, 2013) and Looney *et al*. (2013). These characteristics were documented through photographic records.

The Index Fungorum Partnership (http://www.indexfungorum.org) and the MycoBank (http://www.mycobank.org) were followed to update the nomenclature. The geographical distribution of species in Brazil was based on Alvarenga & Xavier-Santos (2015). The states of the Federation were represented by acronyms: Acre (AC), Amazonas (AM), Amapá (AP), Bahia (BA), Ceará (CE), Federal District (DF), Goiás (GO), Minas Gerais (MG), Mato Grosso (MT), Pará (PA), Paraná (PR), Rio de Janeiro (RJ), Rondônia (RO), Rio Grande do Sul (RS), Roraima (RR), Santa Catarina (SC) and São Paulo (SP).

Results and Discussion

A total of 66 samples were examined, 40 from the FLOR herbarium, 16 from MPUC and 10 from HUEG. A total of 26 identifications were confirmed, 34 samples were identified to species level, 5 were re-determined and one had the nomenclature updated. All were well preserved. The material studied comprises three orders, (Auriculariales, Dacrymycetales and Tremellales), three families (Auriculariaceae, Dacrymycetaceae and Tremellaceae), and 18 species (*Auricularia delicata* (Mont. ex Fr.) Henn., *A. fuscosuccinea* (Mont.) Henn., *A. mesenterica* (Dicks.) Pers., *A. nigricans* (Sw.) Birkebak, Looney & Sánchez-García, *Calocera arborea* Shirouzu, *C. coralloide* Kobayasi, *C. cornea* (Batsch) Fr., *Dacrymyces microsporus* P. Karst., *Dacryopinax elegans* (Berk. & M.A. Curtis) G.W. Martin, *D. maxidorii* Lowy, *D. spathularia* (Schwein.) G.W. Martin, *Ductifera sucina* (Möller) K. Wells, *Exidia glandulosa* (Bull.) Fr., *Tremella brasiliensis* (Möller) Lloyd, *T. dysenterica* Möller, *T. foliacea* Pers., *T. fuciformis* Berk. and *T. mesenterica* Retz.).

. This work presents the first records *Calocera coralloide* and *Dacrymyces microsporus* for Brazil; *Dacryopinax maxidorii* is first record for the Northeast region and the Semi-Arid of Brazil; *Ductifera sucina*, *Exidia glandulosa*, *Tremella foliacea* and *T. fuciformis*

for the Midwest region and the Cerrado biome; *A. mesenterica* for the state of Paraíba and the Semi-Arid; *Auricularia delicata* for Acre and Roraima; *A. nigricans* for Paraíba; *Calocera arborea* for Roraima; *Dacryopinax elegans* for Roraima and Santa Catarina, *D. spathularia* for Pará and Santa Catarina; and *Tremella brasiliensis, T. dysenterica* and *T. mesenterica* for Santa Catarina.

Auricularia fuscosuccinea was the most frequent species (38% of the occurrences), followed by *A. delicata sensu lato* (8.9%) and *A. nigricans* (7.4%). The remaining 15 species account for 44.7% of the occurrences.

Below follows a brief description, known geographical distribution in Brazil, comments (when necessary) and illustration of the species that are new records.

AURICULARIALES

Incertae Sedis

Ductifera sucina (Möller) K. Wells, Mycologia 50(3): 413 (1958)

(Figs. 1-8)

Taxonomic aspects: Basidioma firm-gelatinous, originating as pustules, becoming smooth or convoluted, coalescing to form irregular areas to 100 mm, white or pallid ochraceous when fresh. Hymenium composed of dikaryophyses, gloeocystidia and basidia, dikaryophyses simple or irregularly branched apically, 1−3 µm diam., not or rarely arising from fertile hyphae, gloeocystidia clavate, subclavate or subfusiform, occasionally irregular, arising below probasidia, at first hyaline, contents becoming golden to brownish yellow, granular, 34−80×6−10(−13) µm, probasidia stalked, racket-shaped, with basal clamp connections, formed in groups on fertile hyphae, 16.5−29(−34) × 7−11.5(−13) µm, becoming 2−celled by longitudinal or oblique septa or longitudinally cruciate-septate. Basidiospores short-cylindrical to broadly elliptical, often slightly curved, hyaline, apiculate, 9−12(−14) × 5−9µm. Germination by repetition, or by germ tubes.

Remarks: The only previous record of the species in Brazil was made 40 years ago, in the Southern region of the country, in Atlantic Forest area; state of Rio Grande do Sul (Lowy 1971). Now it is referred to the Cerrado biome in the Midwest region, state of Goiás.

Distribution: State of RS and GO

Examined material: BRAZIL, GOIÁS, Silvânia, Floresta Nacional de Silvânia, 22.X.2010, R.L.M. Alvarenga 10 (HUEG 8472), Silvânia, Floresta Nacional de Silvânia, 22.X.2010, R.L.M. Alvarenga 20 (HUEG 8470), Silvânia, Floresta Nacional de Silvânia, 22.X.2010, R.L.M. Alvarenga 21 (HUEG 8484).

AURICULARIACEAE Fr.

Auricularia delicata *lato sensu* (Mont. ex Fr.) Henn., Bot. Jb. 17: 492 (1893)

Taxonomic aspects: Basidioma yellowish brown when mature and dry, pinkish when fresh or when preserved in wet way, 10−80 mm long and 15−50 mm wide. Abhymenium with yellowish hairs, only on the small stipe, with sudden thickening at the base. Margin smooth, when young and undulated or lobed, when adult. Context homogeneous (0.3−0.5 mm), with no medullary layer, even in thick cuts, hyaline, branched and septates hyphae (2.5−5.0 µm). *Zona pilosa* 50−70 µm, *zona compacta superioris* 15−25 µm, *zona subcompacta superioris* is 36−48 µm, *zona laxa intermedia* 300−450 µm, *zona subcompacta inferioris* 120−40 µm, *hymenium* 76−90 µm with the same color as the abhymenial surface, reticulate, alveolate (main feature that differentiates this species from the others). Basidia cylindrical, spindle-shaped, 30−50 µm × 4−5 µm, basidiospores allantoid to curved-cylindrical, hyaline, generally with with guttulate inside, ranging from (9−)10−15 × (3.5−)4−6 µm.

Remarks: Despite its wide distribution within Brazil, the species *A. delicata* is being recorded for the first time in the states of Acre and Roraima. See Alvarenga *et al.* (2015) for illustrations and discussion on the species. The species differs from other species of the genus, primarily for having a reticulated hymeneal surface. Looney *et al* (2013) recently observed the formation of three clades: *A. delicata* clade I, *A. delicata* clade II and *A. subglabra* Looney, Birkebak & Matheny. *Auricularia subglabra* differs from *A. delicata lato sensu* for having a medulla, while *A. delicata* clade I and *A. delicata* clade II can only be distinguished at the molecular level. Since molecular analyzes were not possible in this study, the samples studied were considered *Auricularia delicata lato sensu*.

Distribution: States of AM, BA, GO, MT, PA, PR, RO, SC, SP.

Examined material: BRAZIL, ACRE, Sena Madureira, Road to Bonsucesso, Right bank of Caeté river, 01.X.1980, C.A. Cid & B.W. Nelson 2675 (FLOR 46148, duplicata de INPA 97874), RIO GRANDE DO SUL, Porto Alegre, 13.II.1985, M.C.S. Mathias 249 (MPUC 15558), Triunfo, 16.I.2002, S.M. Nuves, C.S.A. Martins & F.R. Santos *s/nº* (MPUC 15555), RORAIMA, road Manaus-Caracaraí ca. km 328. 16.XI.1977, I. Araújo, M.A. Sousa, J. Bernardi, K.P. Dumont, D. Hosford & G. Samuels 490 (FLOR 45946, duplicate from INPA 77017), SANTA CATARINA, Florianópolis, Armação, 06.V.1984. H. Lobo *s/nº* (FLOR 10038), Florianópolis, Unidade de Conservação Ambiental Desterro, Santa Catarina island, 03.XI.2005, L. Trierveiler-Pereira & Marcon-Baltazar *s/nº* (FLOR 32188).

Auricularia mesenterica (Dicks.) Pers., Mycol. eur.(Erlanga) 1: 97 (1822)

Taxonomic aspects: Basidioma gelatinous when fresh, 80-130 mm long, resupinate with marginal ruptures. Abhymenial surface with greyish brown hairs in dense tufts, grey hymenium when young and dark purple when mature. *Zona pilosa* 390−800 µm, *zona compacta superioris* 20−35 µm, *zona subcompacta superioris* 48−70 µm, *zona laxa interna* 423−600 µm, *zona subcompacta inferioris* 93−107 µm, *hymenium* 58−65µm. Basidia 55-70 × 4.5-5 µm and basidiospores cylindrical to allantoid, rarely observed 15-18 × 4.5-7 µm.

Remarks: Despite its wide distribution in Brazil, *A. mesenterica* is being recorded for the first time in the state of Paraiba. See Looney *et al.* (2013), Alvarenga *et al.* (2015) and Wu *et al.* (2015) for illustrations and discussion on the species. This species differs from other species of the genus for having a effused-reflexed basidioma, with abhymenial surface adhered to the substrate, unlike the other species with slightly pedicellate concave basidiomata. The main difference between *A. mesenterica* and closely related species *A. brasiliana* Y.C. Dai & F. Wu and *A. orientalis* Y.C. Dai & F. Wu is the *A. mesenterica* has larger spores and basidia, and thinner hyphae an inflated in the presence of KOH (Wu et al. 2015).

Distribution: States of AM, GO, MT, PA, RS, SP.

Examined material: BRAZIL, PARAÍBA, João Pessoa, Jardim Botânico, Mata do Buraquinho. 15.XII.2008, M.A. Neves, N.P. Smith, A.C. Magnago, D. Cardoso, P. Gadelha 342 (FLOR 48823), RIO GRANDE DO SUL, Porto Alegre, 13.II.1985, M.C.S. Mathias 294 (MPUC 15559).

Auricularia nigricans (Sw.) Birkebak, Looney & Sánchez-García, in Looney, Birkebak& Matheny, N. Amer. Fung. 8(6): 12 (2013)

Taxonomic aspects: Basidioma concave, 3-50 mm, pedicellate to sessile, brittle when dry and cartillaginous when fresh. Abhymenial surface covered by wavy hairs, with narrow lumen. Hymenium vinous-black when dry. Margin generally more pilous, straight when young, becoming undulated when adult. Medulla present. Branched hyaline hyphae with slightly thick wall (1.5-2.5 µm), immersed in a large amount of mucilage. *Zona pilosa* 600−700 µm, *zona compacta superioris* 20−39 µm, *zona subcompacta superioris* 35−90 µm, *zona laxa superioris* 73−200 µm, *medula* 40−230 µm, *zona laxa inferioris* 36−340 µm, *zona subcompacta inferioris* 47−170 µm, *hymenium* 55−61 µm. Basidia cylindrical 51−63 × 3.5−4.4 µm, basidiospores hyaline, curved-cylindrical 11−14 × 5−6 µm.

Remarks: Despite its wide distribution in Brazil, *A. nigricans* is being recorded for the first time in the state of Paraiba. For illustrations and discussion on the species, see Looney *et al.* (2013) and Alvarenga *et al.* (2015).

Distribution: States of AM, AP, BA, CE, DF, GO, MG, MT, PA, SC, SP, RJ, RO, RR, RS.

Examined material: BRAZIL, MINAS GERAIS, Novo Cruzeiro, 01.II.2005, L.A. Navarro 11 (MPUC 17962), PARAÍBA, João Pessoa, Mata do Campus I, Universidade Federal da Paraíba, 11.XII.2008, M.A. Neves 335 (FLOR 49034), João Pessoa, Botanical Garden, 09.XII.2010, M.A. Neves, A.N.M. Furtado & A.C. Magnago 565 (FLOR 48935), João Pessoa, Chácara Paraíso, 18.X.2009, M.A. Neves 504 (FLOR 48164), João Pessoa, São José dos Cordeiros-Fazenda Almas, 24.I.2010, A.C. Magnago, M.A. Neves & A.N.M. Furtado 174 (FLOR 48793).

Exidia glandulosa (Bull.) Fr., Syst. mycol. (Lundae) 2(1): 224 (1822)

(Figs. 9-14)

Taxonomic aspects: Basidioma tough-gelatinous, hyaline when young, becoming blackish brown at maturity with 50 mm, drying dull black. Internal hyphae thin-walled, hyaline. 1.5−5 µm diam., clamp connections present. Hymenium composed of dikaryophyses and basidia, dikaryophyses extending beyond the basidia, probasidia subglobose, metabasidia becoming ovoid with 12−16(−18) × 8−10(−13) µm. Basidiospores allantoid, hyaline. apiculate, 11−15 × 4−5 µm.

Remarks: The only previous record of the species in Brazil was made 40 years ago, in the Southern region of Brazil, in Atlantic Forest area, state of São Paulo (Lowy 1971). Now it is referred to the Midwest region, and to Cerrado biome.

Distribution: State of SP.

Examined material: BRASIL, GOIÁS, Anápolis, Reserva Ecológica do Campus da Universidade Estadual de Goiás, 25.XI.2010, R.L.M. Alvarenga 34 (HUEG 8384).

DACRYMYCETALES

Dacrymycetaceae

Calocera arborea Shirouzu, in Shirouzu, Ishikawa, Hirose & Maekawa, Mycoscience 54: 253 (2013)

(Figs. 15-20)

Taxonomic aspects: Basidioma scattered, cylindrical, simple or branched, dendroid, stipitate, pileate, bearing a subglobose to hemispherical. Yellow to brown, soft-cartilaginous to firm-

gelatinous, 7−10 mm high, 1−2 mm in diam., in transverse section, the pileus is organization into three zones: a central core of compact parallel hyphae surrounded, zone of loosely interwoven hyphae enclosed and the hymenium. Marginal hyphae on sterile surfaces of basidioma cylindrical, simple or branched, straight or flexuous, septate, thin-walled hyaline. Internal hyphae branched, septate, thin- or thick-walled, hyaline, 2−3 µm in diam., without clamp connections. Hymenium limited to the surfaces of the heads, usually amphigenous, rarely unilateral. Metabasidia cylindrical to clavate, pale yellow, 11−31× 2−4 µm, without basal clamp connections. Basidiospores cylindrical to navicular, straight or curved, with an apiculum at the base, thin-walled, hyaline, (7−)10−14× 2.5−4 µm with 1−3 septate.

Remarks: *Calocera arborea* was recently described by Shirouzu *et al.* (2013) in the state of Amazonas, Amazonian Biome. The species distribution has now been expanded to the state of Roraima. *Calocera arborea* differs from other species of the genus for having branched, dendroid basidioma with subglobose to hemispheric apex.

Distribution: State of AM.

Examined material: BRAZIL, RORAIMA, Road Manaus-Caracaraí km 328. 16.XI.1977, I. Araújo, M.A. Sousa, J. Bernardi, K.P. Dumont, D. Hosfrod & G. Samuels 478 (FLOR 45992, duplicate from INPA 77005)

Calocera coralloide Kobayasi, Sci. Rep. Tokyo Bunrika Daig., Sect. B 4: 225 (1939)
(Figs. 21-26)

Taxonomic aspects: Basidioma tough-gelatinous, erect, dendroid, cylindrical to subulate, up to 43−90 mm in height, 8−30 mm in diam., drying darker, scattered to gregarious, hymenium amphigenous. Probasidia subcylindrical to reniformes, up to 30−32(−35)×2−3(−4) µm, metabasidia bifurcate, sterigmata cylindrical, basidiospores ovoid to curved-cylindrical 4−6(−8) × 2.5−3 µm, 1-septate.

Remarks: *Calocera coralloide* is being recorded for the first time in Brazil (state of Roraima, Amazonian biome). This species differs from *C. cornea* (Batsch) Fr., commonly found in the various Brazilian states, by having an often dendroid basidioma, and from *C. viscosa* (Pers.) Fr. For having smaller basidioma and spores, and for the bifurcation in the apex of the basidioma.

Distribution: Bolivia, Japan and Mexico.

Examined material: BRAZIL, RORAIMA, Road Manaus-Caracaraí km 328, 16.XI.1977, I. Araújo, M.A. Sousa, J. Bernardi, K.P. Dumont, D. Hosford & G. Samuels 495 (FLOR 45947, duplicate from INPA 77022).

Dacrymyces microsporus P. Karst., Bidr.Känn.Finl. Nat. Folk 48: 459 (1889)
(Figs. 27-32)

Taxonomic aspects: Basidioma scattered or gregarious, sometimes coalesced, turbinate to stoutly cylindrical, stipitate bearing a concave or rugose semiglobose pileus, pale yellow, soft-cartilaginous to firm-gelatinous, 2.0–6.0 mm high, 0.4−2.5 mm diam. Internal hyphae branched, thin-walled, gelatinous, septate, hyaline, 2–3.5 µm diam, without clamp connections. Hymenium limited to upper surface of the pileus. Probasidia cylindrical to clavate, subhyaline, 27.5–35 × 3–4.5 µm, becoming bifurcate. Basidiospores reniform, with an apiculum at the base, thin-walled, sub-hyaline, 8–12(−14) × 2.5–4(−6) µm 0–1 septate, germination by means of conidial production and germ tubes

Remarks: The species is being reported to Brazil for the first time (state of Pará, Amazonian biome). *Dacrymyces microsporus* differs from *C. arborea* by the absence of branches, and for having smaller basidioma and basidiospores.

Distribution: Finland and Japan.

Examined material: BRAZIL, PARÁ, Oriximiná, Rio Trombetas, 1 km from Cachoeira Porteira Apt. Climax terra firme florest. On long. Jelly fungus, yellow-orange, 3.VI.1980, P. Dunn 80 PHD-60 (FLOR 46139, duplicate from INPA, number not supplied).

Dacryopinax elegans (Berk. & M.A. Curtis) G.W. Martin, Lloydia 11: 116 (1948)

Taxonomic aspects: Basidioma sacattered or gregarious, tough-gelatinous, pileus spreading-orbiculate, dark brownish when fresh, drying blackish, horny, stipe up to 6(−20) × 5 mm, brownish-tomentose, hairs numerous, septate, thick-walled, hymenium unilateral, inferior, smooth, abhymenium coarsely brown-tomentose, hyphae without clamp connections. Probasidia cylindrical to clavate 35−41 × 3−5 µm, metabasidia cylindrical to clavate, aseptate, bifurcate with 23 × 3 µm. Basidiospores curved-cylindrical, 1−3 septate with 12−16 × 4−6 µm.

Remarks: Despite being widely distributed in Brazil, the species is being recorded for the first time for the states of Roraima and Santa Catarina. See Alvarenga & Xavier-Santos (*in press*) for illustrations, extensive description and discussion on the species.

Distribution: States of AM, SP, RJ, PR, RS.

Examined material: BRAZIL, RORAIMA, Vicinty of Aurais, 64°25'W, 4°6'N. 800m alt. Manihot plantatiu. Frutification spathulate with short stipe. 0.8−2.3 × 0.4−1.5× 0.1−0.2 including stipe, 30.VII.1974, C.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos (FLOR

45981, duplicate from INPA 21546), SANTA CATARINA, Mondaí, Linha Saga Forte. 25.V.2007. Campos-Santana & Santana 302 (FLOR 32214).

Dacryopinax maxidorii Lowy, Mycotaxon 13(2): 428 (1981)

Taxonomic aspects: Basidioma when fresh, stipitate bearing sinuate flabellate, orange-yellow, at the sterile surface of basidioma, soft-cartilaginous, 12−25 × 12−23 mm. Internal hyphae branched, thin-walled, septate, 1.8−3.4 µm diam., without clamp connections. Hymenium unilateral. Probasidia cylindrical to clavate, pale yellow, 31−37.2 × 4−5.3 µm, becoming bifurcate. Basidiospores curved-cylindrical, with an apiculum at the base, thin-walled, pale yellow, (8−)9−10 × 4−5 µm, 0−1 septate.

Remarks: With previous records only in northern Brazil, namely states of Amazonas and Pará, Amazonian biome (Lowy 1981, Campos *et al*. 2005), the species is being recorded for the first time for the state of Paraíba (in the Brazilian semiarid). See Alvarenga & Xavier-Santos (*in press*) for illustrations and extensive description. *Dacryopinax maxidorii* Lowy resembles *D. indacocheae* Lowy and *D. martinii* Lowy, with the difference of having a densely pilose abhymenial surface and pileus. The species may also be confused with species of the genus *Tremella* for having inflated hairs similar to the globose to subglobose metabasidia, on its abhymenial surface. Therefore, a proper recognition of the hymenium is necessary to determine the species.

Distribution: States of AM and PA.

Examined material: BRAZIL, PARAÍBA, João Pessoa, 15.VII.2010, M.A. Neves, A.C. Magnago & J. Seravalli 592 (FLOR 48852), João Pessoa, Universidade Federal da Paraíba, 28.IV.2010, A.C. Magnago 215 (FLOR 42337).

Specimen consulted: BRAZIL, AMAZONAS, km 405 Manaus-Porto Velho road. 16.IX.1980. B. Lowy & D. Coelho BR190 (INPA 101201). Det. B. Lowy [Holotype]

Dacryopinax spathularia (Schwein.) G.W. Martin, Lloydia 11: 116 (1948)

Taxonomic aspects: Basidioma scattered or gregarious, spathulate, stipitate bearing sinuate flabellate to petaloid pileus, orange, white-yellow at the sterile surface , soft-cartilaginous, 5−16 mm high, 0.6−2 mm diam. at stipe. Internal hyphae branched, thin-walled, septate, pale yellow, 1−2.5 µm diam, without clamp connections. Hymenium unilateral. Probasidia cylindrical to clavate, pale yellow, 20.1−38 × 2−4 µm, becoming bifurcate. Basidiospores subglobose to reniform, with an apiculum at the base, thin-walled, pale yellow, 9−10 × 3−4 µm, 0−1 septate.

Remarks: Despite widely distributed in Brazil, the species is being recorded for the first time in the states of Pará and Santa Carina. See Alvarenga & Xavier-Santos (*in press*) for illustrations, extensive description and discussion on the species.

Distribution: States of AM, RJ, SP, PR, RS.

Examined material: BRAZIL, PARÁ, Lageira, airstrip on Rio Maicuru, 0°55'S, 54°26'W. Alt. ca. 800 ft. Near airstrip. Yellow. On rotten wood. 17.VI.1981, J.J. Strudwick, G.L. Sobel, B.W. Nelson, A. Nazaré Pinheiro, C. Silva Rosário & N. Alves da Silva 3024 (FLOR 44598 duplicate from INPA, number not dupplied), SANTA CATARINA, Florianópolis. 14.IX.1983, L.C. Leite *s/nº* (FLOR 10003), Florianópolis, Universidade Federal de Santa Catarina. N. Zimmermann 37 (FLOR 31868), Itapoá, Reserva Volta Velha, Sambaqui trail. 24.II.2011, M.A. Neves 681 (FLOR 48863).

TREMELLALES

Tremellaceae

Tremella brasiliensis (Möller) Lloyd, Mycol. Writ. 7(Letter 67): 1152 (1922)

(Figs. 33-41)

Taxonomic aspects: Basidioma gelatinous, compactly lobed to sub-foliaceous, up to 7 mm, yellow to orange when fresh. Internal hyphae in a dense gelatinous matrix, 1−2.5 µm, with thickened and clamp connections. Metabasidia 2−4 celled, subglobose to oblong, very large 20−27 µm, with diagonal or vertical septa, some thick-walled, oily contents, basidiospores globose, 14.3−20(−27) × 15−21(−26) µm

Remarks: With previous records only for the South of Brazil (Paraná and Rio Grande do Sul), in the Atlantic forest, the species is being recorded for the first time in the state of Santa Catarina. *Tremella brasiliensis* differs for having larger basidia and basidiospores compared to the related species *Tremella mesenterica*.

Distribution: States of RS and PR.

Examined material: BRAZIL, SANTA CATARINA, Florianópolis, Conservation Unit Desterro-UCAD, Santa Catarina island. 08.X.2011, M.A. Neves 815 (FLOR 49190).

Tremella dysenterica Möller, Bot. Mitt.Trop. 8: 172 (1896) [1895]

(Figs. 42-50)

Taxonomic aspects: Basidioma cerebriform, foliose with gyrose-folded lobes when mature, up to 20–30 mm in diam., consistency firmly gelatinous, from bright yellow when fresh. Internal hyphae thin-walled to thick-walled, inflated, hyaline, with abundant clamp

connections. Basidia subglobose to ellipsoid or ovoid, 4−celled, with basal clamp connections, becoming longitudinally septate, 10–14 × 6–10 μm. Basidiospores broadly ellipsoid to ovoid, hyaline, thin-walled, with oil drop, apiculate, 6–8 × (3–)4–5 μm.

Remarks: With previous records only for the south of Brazil (state or Paraná; Atlantic forest), the species is being recorded for the first time for the state of Santa Catarina. *Tremella dysenterica* is not addressed by Lowy (1971), however, its description is quite similar to *T. rubromaculata* Lowy (Lowy 1971), known only for the state of São Paulo. Therefore, analyzing the two holotypes is necessary in order to distinguish these species, or to synonymize them as suggested by Roberts & Meijer (1997).

Distribution: State of PR.

Examined material: BRAZIL, SANTA CATARINA, Florianópolis, Conservation Unit Desterro-UCAD. 21.I.2003, N. Zimmermann 17 (FLOR 31866).

Tremella foliacea Pers., Observ. mycol. (Lipsiae) 2: 98 (1800) [1799]

(Figs. 51-54)

Taxonomic aspects: Basidioma foliose, with undulate caespitose lobes, 20–60 mm in diam., consistency firmly gelatinous, from brown to dark brown when fresh and black in dry condition. Internal hyphae thin-walled or slightly thick-walled, inflated, hyaline, with clamp connections and frequent anastomoses. Metabasidia globose to subglobose or widely ellipsoid, with basal clamp connections, becoming longitudinally septate, 13–16 × 10–12 μm. Basidiospores globose or broadly ellipsoid, hyaline, thin-walled, apiculate, with guttulate, (7−)9−12 × 7−10(−12) μm in diam., germinating by germ tubes or secondary spores.

Remarks: The species is being reported for the first time in the Midwest region and in the Cerrado biome. *Tremella foliacea* differs from *T. frondosa* Fr. for not producing conidia. However, this trait should not be observed alone, once the lack of conidia production may be due to the maturity stage of the basidiomata (Malysheva *et al.* 2015) and the presence of conidia has been recorded in some specimens of *T. foliaceae* (Pippola & Kotiranta 2008). Therefore, since the differences between *T. foliacea* and *T. frondosa* are particularly small, they must be synonymized, as suggested by C-J. Chen (1998) and (Malysheva *et al.* 2015).

Distribution: State of PR.

Examined material: BRAZIL, GOIÁS, Anápolis, Reserva Ecológica do Campus da Universidade Estadual de Goiás, 28.IX.2009, S. Xavier-Santos 4311 (HUEG 8464), Anápolis, Reserva Ecológica do Campus da Universidade Estadual de Goiás, 28.IX.2009, S. Xavier-Santos 4297 (HUEG 8462), Anápolis, Reserva Ecológica do Campus da Universidade

Estadual de Goiás, 28.IX.2009, S. Xavier-Santos 4297 (HUEG 8460), Anápolis,riparian forest of the Das Antas river, AmBev (Filial Cebrasa), 23.I.2008, S. Xavier-Santos 2382 (HUEG 10534).

Tremella fuciformis Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 277 (1856)
(Figs. 55-60)

Taxonomic aspects: Basidioma foliose, with undulate caespitose lobes, lobes with crenate or margins, up to 50 mm in diam.. Consistency firmly gelatinous, white when fresh and whitish yellow in dry condition. Internal hyphae thin-walled or slightly thick-walled, inflated, hyaline, with clamp connections and frequent anastomoses. Basidia subglobose to widely ellipsoid, with basal clamp connections, becoming longitudinally septate,10–16 × 8–12 μm. Basidiospores broadly ellipsoid to ellipsoid, hyaline, thin-walled, apiculate, 8–11× 5–7 μm, germinating by budding or germ tubes.

Remarks: The species is being recorded for the first time for the Midwest region and the Cerrado biome. It was previously recorded only for the Northeast, South and Southeast of Brazil, in the Atlantic forest and the Brazilian semiarid.

Distribution: States of BA, PR, RS, SP.

Examined material: BRASIL, GOIÁS, Anápolis, Reserva Ecológica do Campus da Universidade Estadual de Goiás, 10.XII.2010, R.L.M. Alvarenga 35 (HUEG 8488), Rio Quente, (17° 42’53’’S e 48° 43’ 46’’ W), 01.V.2008, S. Xavier-Santos 2735 (HUEG 8488), Caldas Novas, (17° 46’ 21’’S e 48° 39’ 07’’W), 01.V.2008, S. Xavier-Santos 2569 (HUEG 8408).

Tremella mesenterica Retz., K. svenska Vetensk-Akad. Handl. 30: 249 (1769)
(Figs. 61-70)

Taxonomic aspects: Basidioma large, pustulate at first, becoming foliose with undulate lobes when mature, up to 40 mm, consistency gelatinous, from whitish yellow and yellow to yellowish orange when fresh. Internal hyphae thin-walled to thick-walled, inflated, hyaline (or slightly tinted), with abundant clamp connections and anastomoses. Basidia subglobose to broadly ellipsoid or ovoid, 4-celled, with basal clamp connections and long sterigmata, becoming longitudinally septate, (8−)12–20 × 9–10μm. Basidiospores broadly ellipsoid to ovoid, hyaline, thin-walled, with oil drop, apiculate, 10–14× 8–11μm, germinating by repetition.

Remarks: The species is being recorded for the first time for the state of Santa Catarina. It was previously recorded only for the south and southeast of Brazil, in the states of Rio Grande do Sul and São Paulo, in the Atlantic forest.

Distribution: States of RS, SP

Examined material: BRASIL, RIO GRANDE DO SUL, Porto Alegre, Campus da Pontífica Universidade Católica. 05.X.1992. M.C.S. Mathias 349 (FLOR 4640), São Francisco de Paula, Floresta Nacional de São Francisco de Paula, 27.X.1992, M.C.S. Mathias, 373 (MPUC 4658), São Francisco de Paula, Floresta Nacional de São Francisco de Paula. 27.X.1992. M.C.S. Mathias *s/nº* (MPUC 4648), SANTA CATARINA, Florianópolis, Horto Botânico, sobre madeira. 27.IX.1984, C. Loguercio-Leite *s/nº* (FLOR 10048).

Conclusion

The knowledge of the distribution of jelly fungi in Brazil is expanded, with the record of two new occurrences for the country, four new records for the Midwest region, seven for the North, three for the Northeast, five for the South region, three for the state of Santa Catarina, one for Rio Grande do Sul, four for the Cerrado biome, two for the Amazon and two for the Semi-Arid. The data presented show the importance of reviewing material deposited in herbaria, expanding the knowledge of fungal diversity.

Acknowledgements

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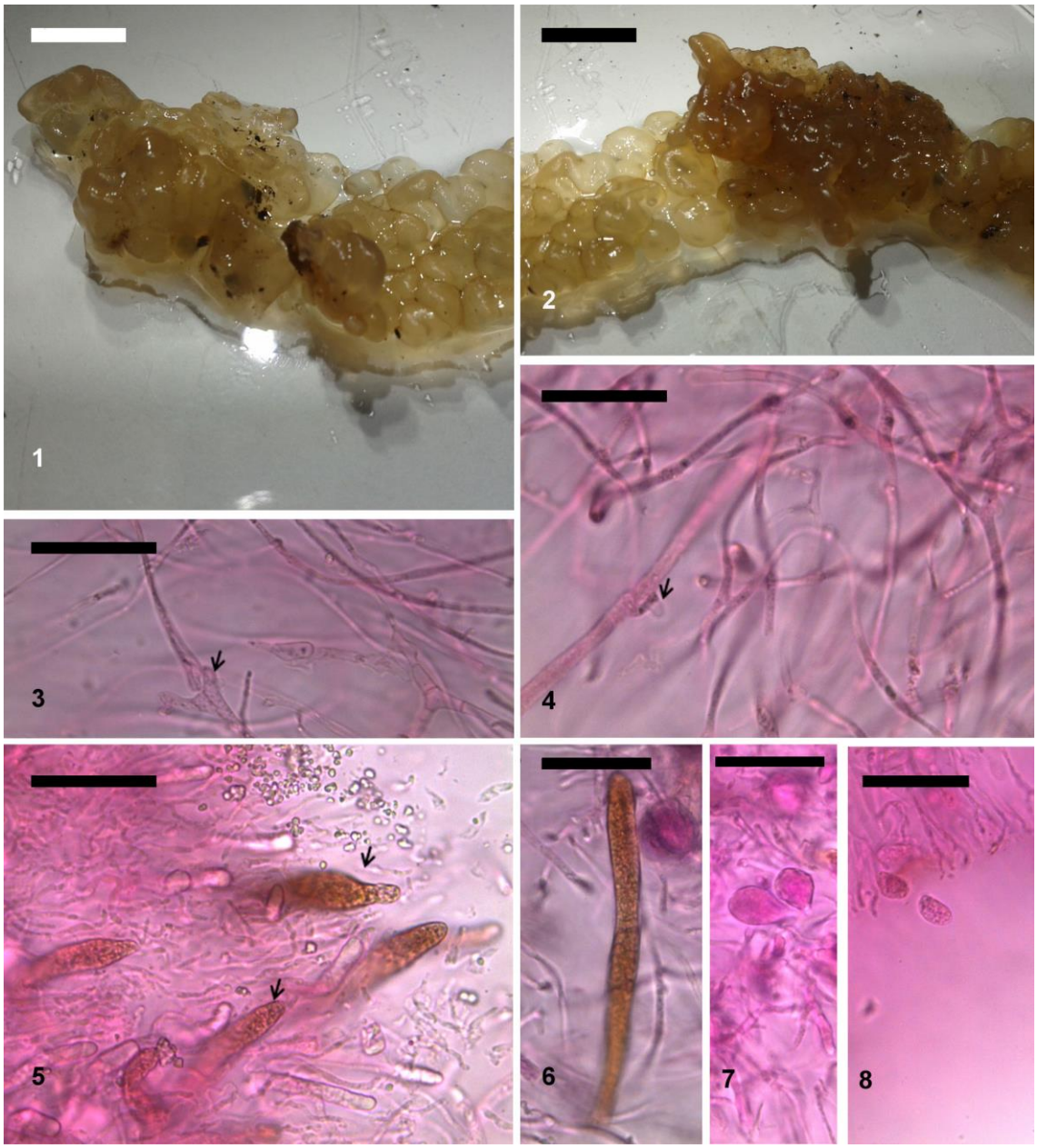
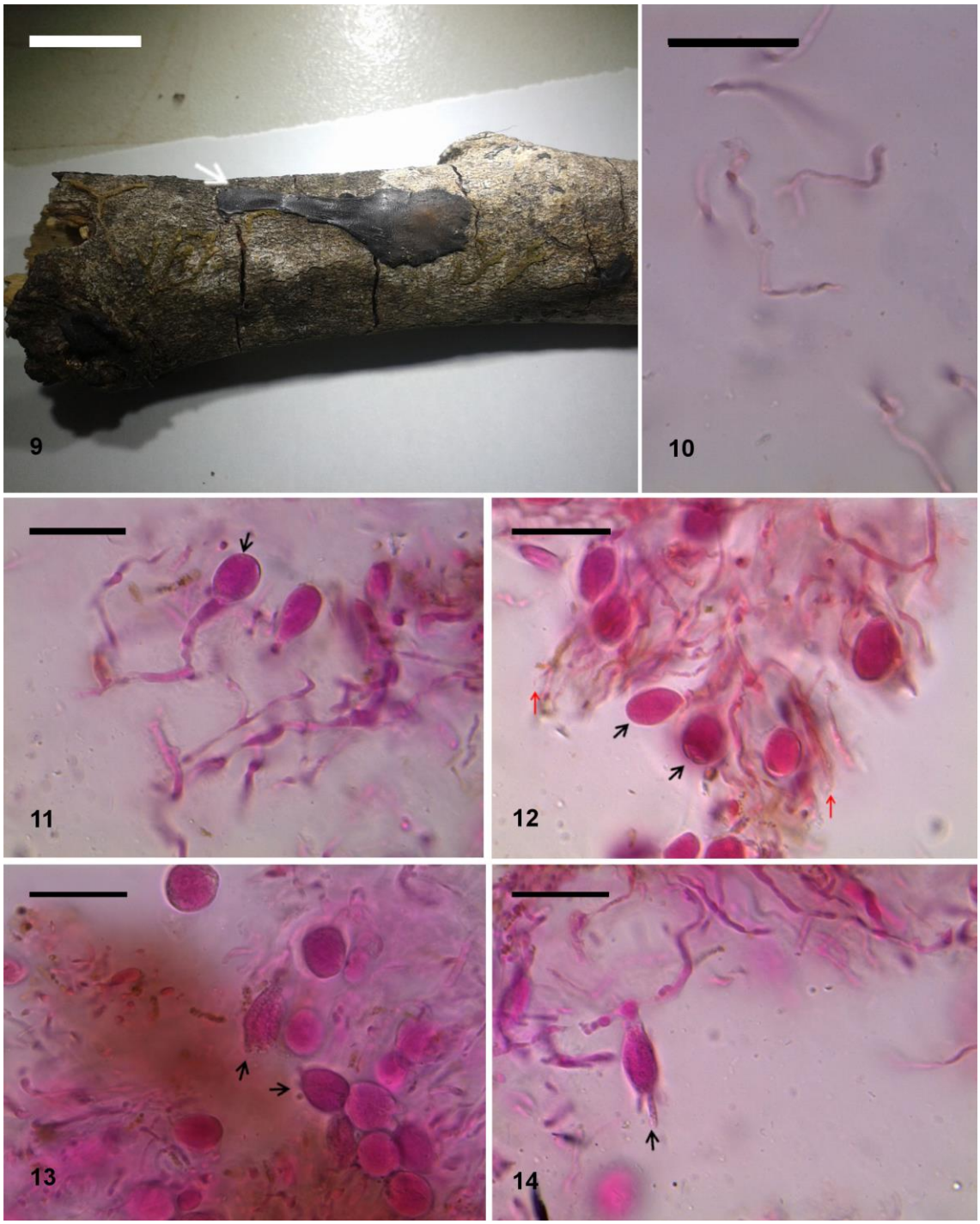
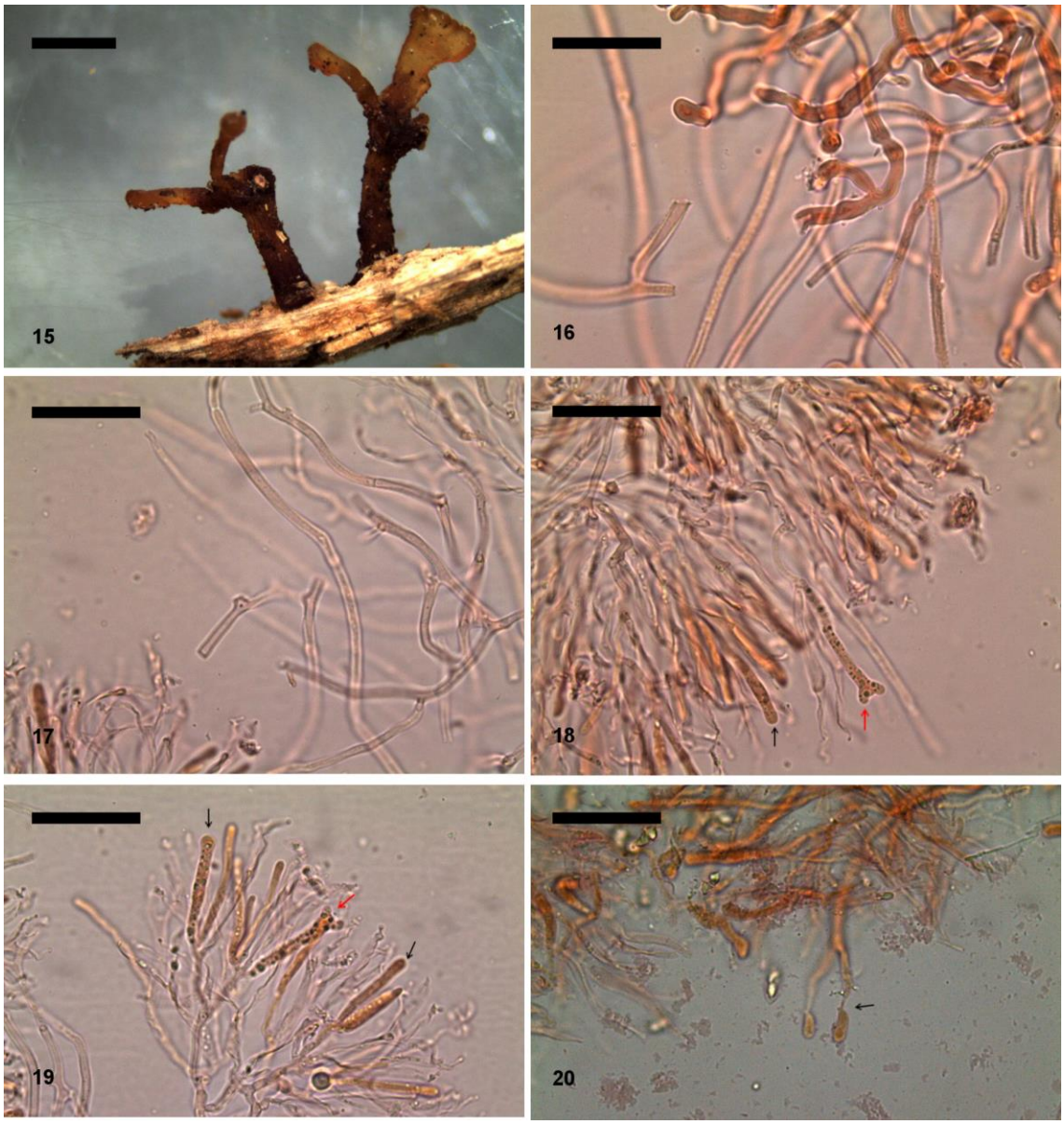
Figures and Legends



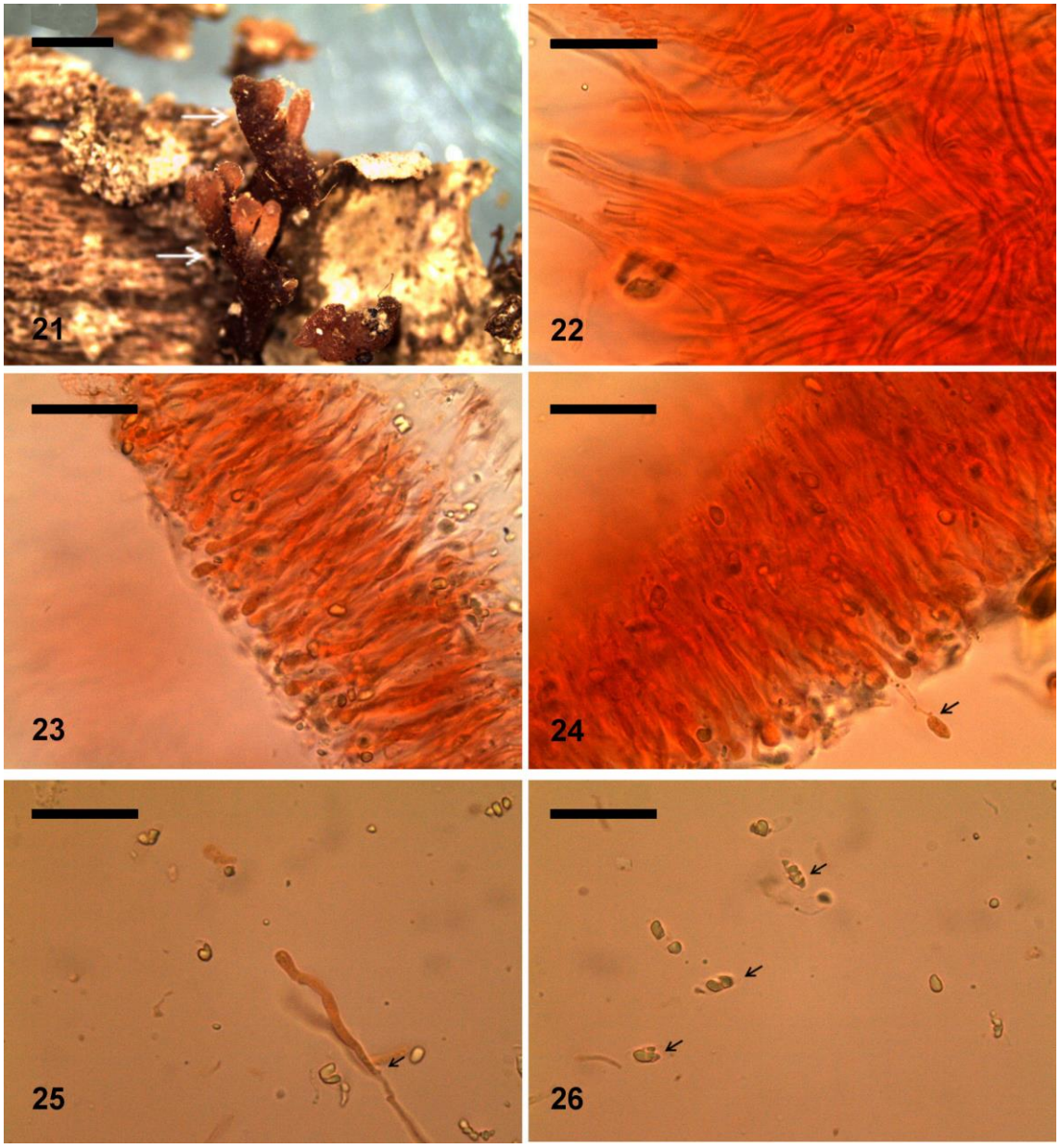
Figs. 1-8. *Ductifera sucina* (HUEG 8472): **1, 2.** Basidiome when fresh; **3, 4.** Hyphae with clamp-connection (arrows); **5.** Hymenium with gloeocystidia subclavate (arrows); **6.** Gloeocystidia clavate, golden to brownish yellow; **7.** Probasidia racket-shaped; **8.** Basidiospore without septation, elliptical apiculate. Scale bar: **Figs. 1, 2** = 1 cm; **Figs. 3-8** = 20 µm.



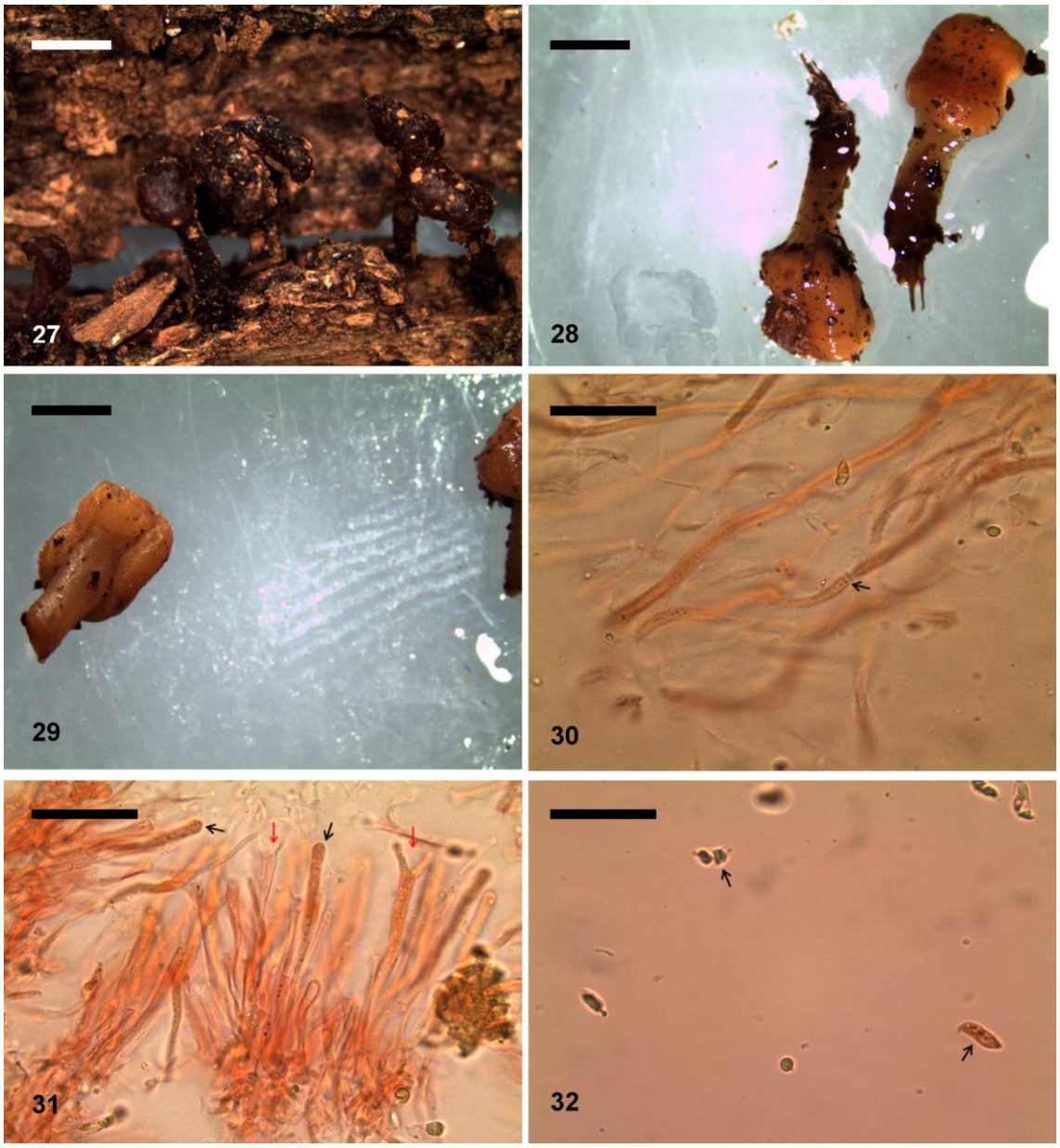
Figs. 9-14. *Exidia glandulosa* (HUEG 8384): **9.** Basidiome when dried; **10.** Hyphae immersed in gelatinous matrix; **11, 12.** Probasidia subglobose (black arrows) and dikaryophyses (red arrows); **13, 14.** Metabasidia ovoid septate initiating the formation of sterigmata (arrows). Scale bar: **Figs. 10** = 1 cm; **Figs. 11-15** = 20 µm.



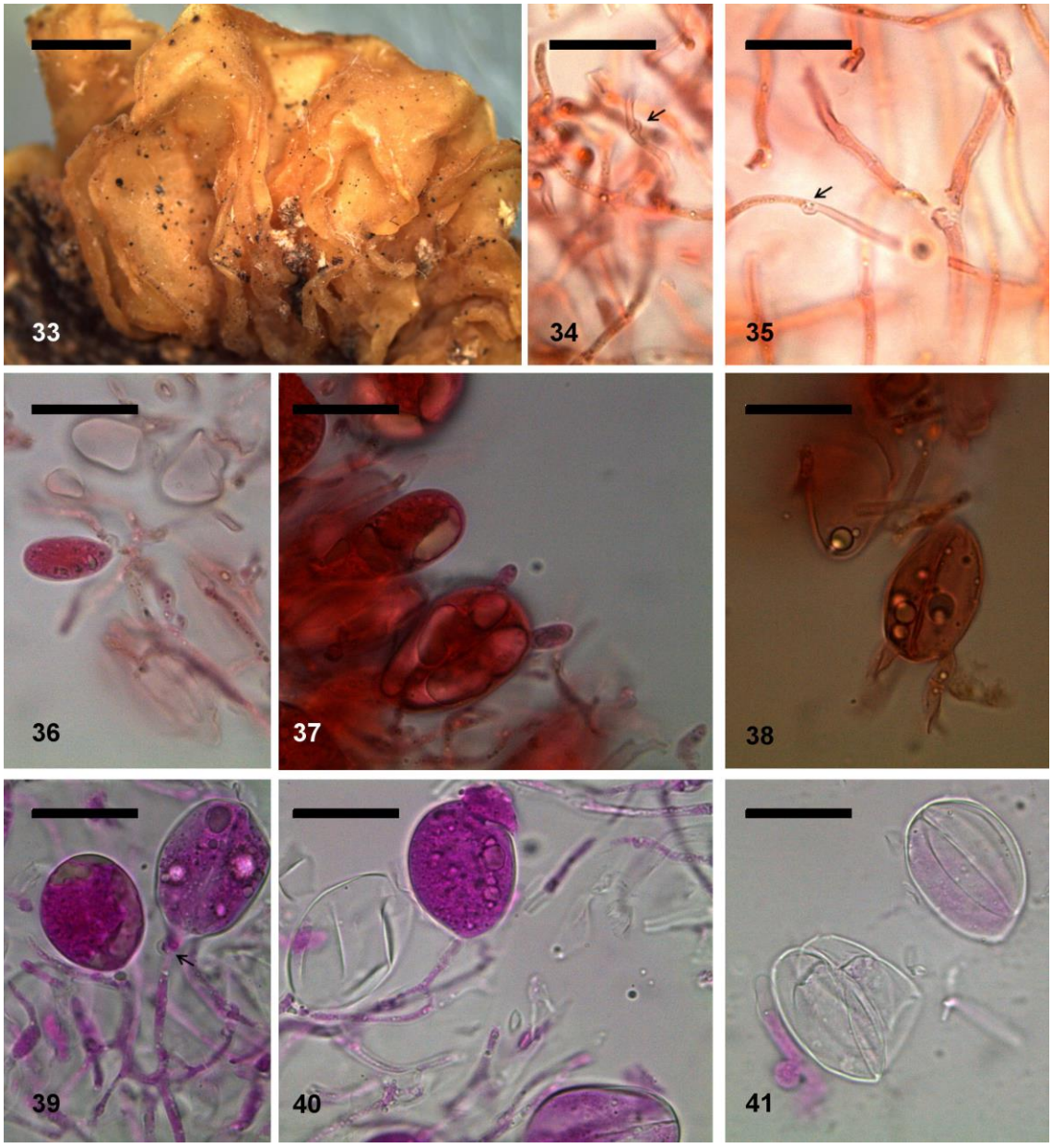
Figs. 15-20. *Calocera arborea* (FLOR 45992)*:* **15**. Basidioma dried; **16.** Marginal hairs; **17.** Hyphae without clamp-connection; **18, 19.** Probasidia (black arrows) and Metabasidia (red arrows) in different stages of maturity, without basal clamp connections; **20**. Metabasidia with two basidiospores, curved, with an apiculum at the base (arrow). Scale bar: **Figs. 16** = 2 mm; **Figs. 17-21** =20 µm.



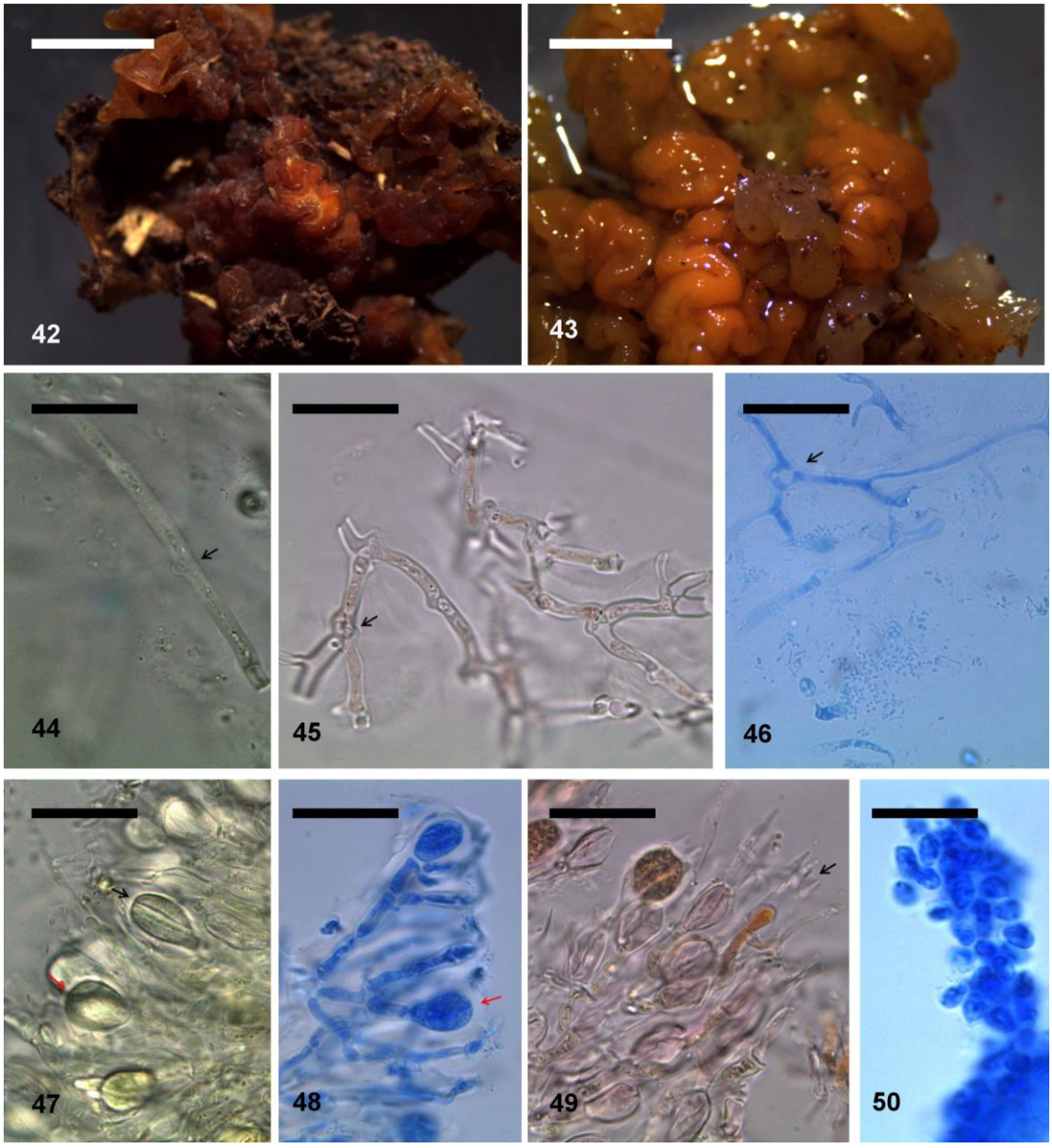
Figs. 21-26. *Calocera coralloide* (FLOR 45947): **21.** Basidioma dried; **22**. Hyphae without clamp-connection; **23, 24**. Hymenium compacted, basidiospore in sterigma (arrow); **25.** Probasidia with basal clamp connections (arrow); **26.** Basidiospores collapsed with 1 septa, because of dehydration and preservation process (arrows). Scale bar: **Fig. 21** = 2 mm; **Figs. 22-26** =20 µm.



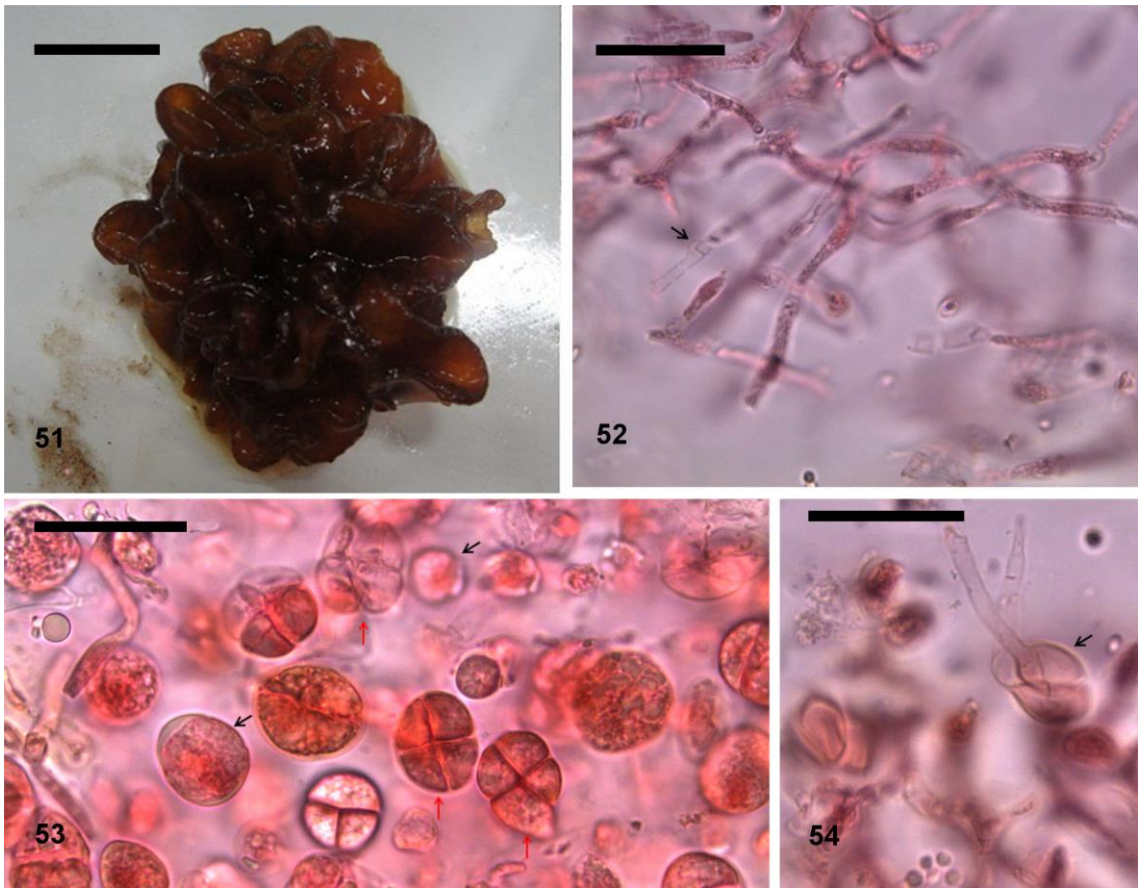
Figs. 27-32. *Dacrymyces microsporus* (FLOR 46139): **27.** Basidioma dried; **28, 29.** Basidioma fresh; **30.** Hyphae without clamp-connection (arrow); **31.** Probasidia (black arrows) and Metabasidia (red arrows) in different stages of maturity without basal clamp connections; **32.** Basidiospores collapsed, with an apiculum at the base 0–1 septate (arrows). Scale bar: **Figs. 27, 28, 28** = 2 mm; **Figs. 30-32** = 20 µm.



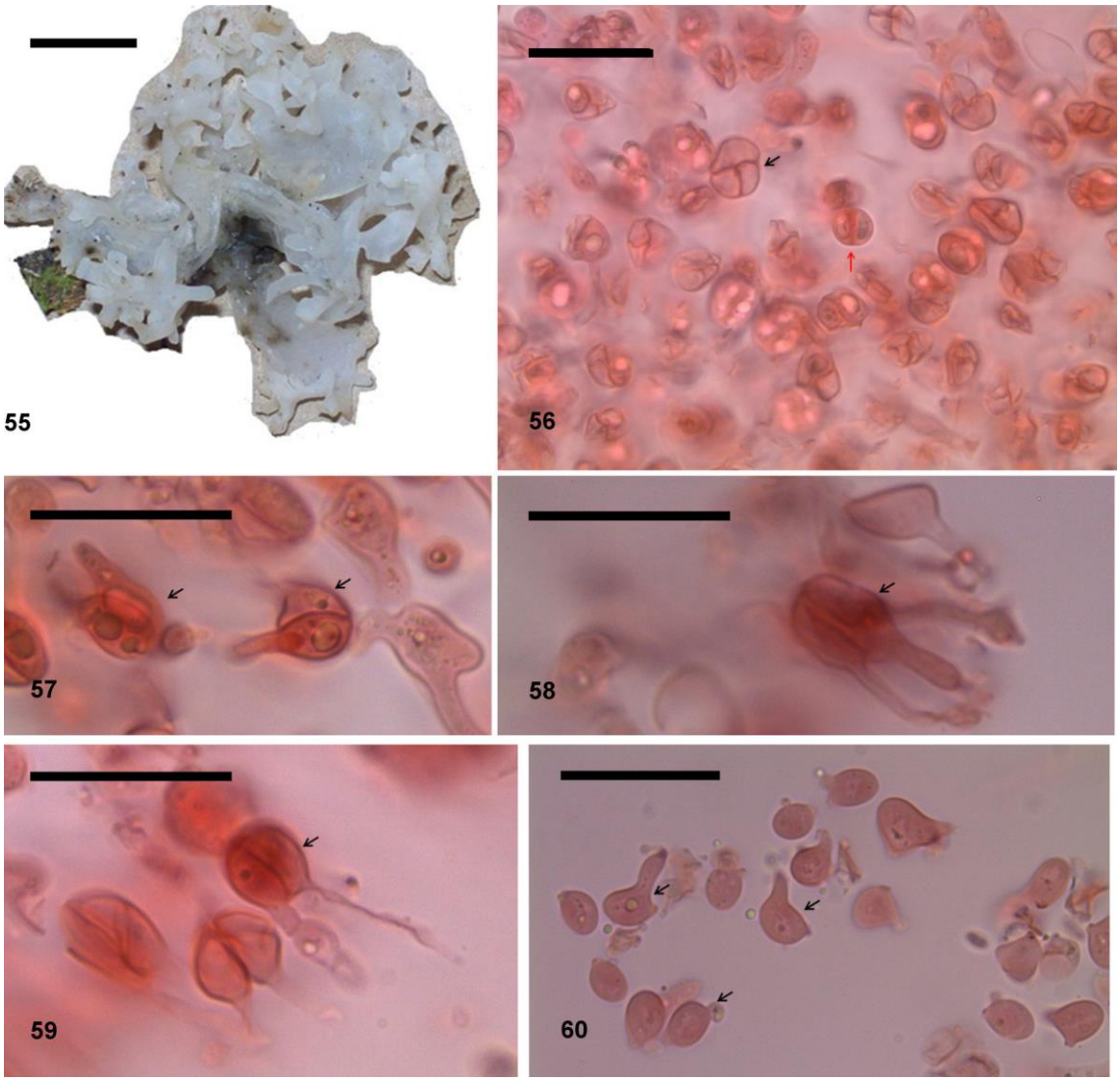
Figs 33-41. *Tremella brasiliensis* (FLOR 49190): **33.** Basidioma when dried; **34, 35.** Hyphae with clamp-connection (arrows) immersed in gelatinous matrix; **36.** Probasidia young; **37-41.** Different stages of development of Metabasidia with diagonal or vertical septa, and basal clamp (arrow). Scale bar: **Fig. 33** = 2 mm; **Figs. 34-41** =20 µm.



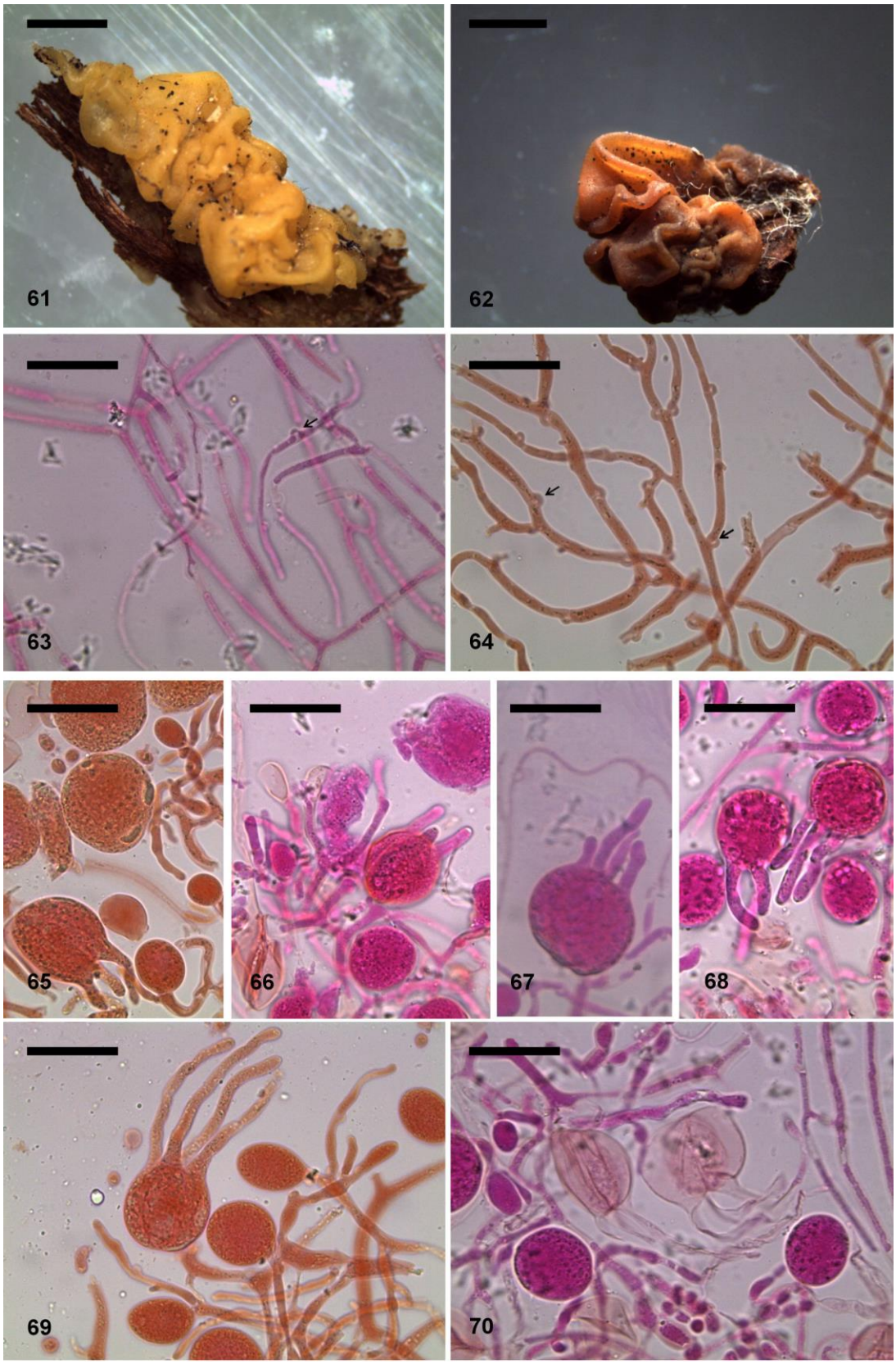
Figs. 42-50. *Tremella dysenterica* (FLOR 31866): **42.** Basidioma dried; **43.** Basidioma fresh; **44-46**. Hyphae with clamp-connection (black arrows) immersed in gelatinous matrix; **47-49.** Different stages of development of Metabasidia (black arrow) and Probasidia (red arrow); **50.** Basidiospores broadly ellipsoid to ovoid, apiculate with oil drop. Scale bar: **Figs. 42, 43**= 2 mm; **Figs. 44-50** =20 µm.



Figs. 51-54. *Tremella foliacea* (HUEG 8464): **51.** Basidioma fresh; **52.** Hyphae with clamp-connection (black arrow) immersed in gelatinous matrix; **53.** Probasidia globose (black arrow) and Metabasidia globose to subglobose whit 2-4 septum (red arrows); **54.** Metabasidia septate whit two sterigmas (arrow). Scale bar: **Fig. 51** = 0.5 cm; **Figs. 52-54** =20 µm.



Figs. 55-60. *Tremella fuciformis* (HUEG 8488): **55.** Basidioma fresh; **56.** Probasidia (red arrow) and Metabasidia (black arrow) immersed in gelatinous matrix; **57-59**. Metabasidia globose to subglobose with 2-4 septum (arrows); **60.** Basidiospores broadly ellipsoid to ellipsoid, germinating by germ tubes (arrows). Scale bar: **Fig. 55** = 0.5 cm; **Figs. 56-60** = 20 µm.



Figs. 61-70. *Tremella mesenterica* (FLOR 4640): **61, 62**. Basidioma dried; **63, 64.** Hyphae with clamp-connection (black arrows) immersed in gelatinous matrix; **65-70.** Different stages of development of Probasidia and Metabasidia immersed in gelatinous matrix. Scale bar: **Figs. 61, 62** = 2 mm; **Figs. 63-70** = 20 µm.

Artigo 6 – Alvarenga, RLM; Nabout, JC & Xavier-Santos. S. Volte ao passado e projete o futuro: Mapeando Áreas de Distribuição de Espécies do Gênero *Auricularia* (Basidiomycetes: Agaricomycotina) utilizando Modelos de Nicho Ecológico.

Volte ao passado e projete o futuro: Mapeando Áreas de Distribuição de Espécies do Gênero *Auricularia* (Basidiomycetes: Agaricomycotina) utilizando Modelos de Nicho Ecológico.

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Resumo

Modelagens biogeográficas são importantes ferramentas utilizadas para verificar possíveis áreas de ocorrência de espécies, fornecendo significativas informações nos estudos ecológicos e econômicos. A partir do levantamento dos registros de ocorrências de espécies do gênero *Auricularia*, (*A. auricula-judae, A. cornea, A. delicata, A. fuscosuccinea, A. mesenterica* e A. *nigricans*) de importância econômica e distribuição cosmopolita, este trabalho visou apresentar modelos de nicho ecológico para os cenários passado, presente e futuro, verificar a contribuição das variáveis bioclimáticas na diferenciação das espécies e mapear as áreas de estabilidade bioclimática no mundo. A distribuição geográfica dessas espécies foi verificada através de buscas na literatura, nos portais virtuais e nos principais herbários do mundo. Os modelos de nicho ecológico foram elaborados a partir do programa MAXENT e das variáveis bioclimáticas derivadas do Atmosphere-Ocean General Circulation Models em diferentes escalas temporais. *Auricularia auricula-judae* foi caracterizada como predominantemente de regiões temperadas, enquanto as demais com ampla distribuição em regiões tropicais. Os modelos evidenciaram o direcionamento das espécies do gênero para as áreas de regiões temperadas e áreas litorâneas tropicais. As relações de co-ocorrência de um grupo de espécies filogeneticamente próximas foi observado utilizando as variáveis ambientais. As áreas reconhecidas para *A. auricula-judae* estão localizadas em regiões temperadas no Norte da América do Norte e Sul da América do Sul, no Sul Europeu e Sudeste Asiático e para as demais espécies, regiões tropicais e/ou temperadas no hemisfério Sul

Introdução

Reconhecida entre os fungos gelatinsos, a família Auriculariaceae pertence a classe Agaricomycetes, e inclui espécies com grande variabilidade morfológica, as quais podem apresentar basidioma estipitado a clavado, efluxo-reflexo, cerebriforme, côncavo a aplanado, de coloração castanho avermelhada, cinza, negra ou branca, com superfície abhimenial variando de densamente pilosa a lisa. Em geral, é facilmente reconhecida, macroscopicamente por possuir basidioma gelatinoso e cartilaginoso quando fresco, e, microscopicamente, por apresentar basídios segmentados horizontalmente e basidiósporos hialinos, com ou sem septação (Lowy, 1952; 1971).

A família agrupa nove gêneros, com 151 espécies: sendo *Auricularia (*com 28 espécies), *Eichlerilla* (oito), *Exidia* (35), *Exidiopsis* (31), *Fibulosebacea* (1), *Heterochaete* (44), *Hirneolina* (1), *Pseudostypella* (1) e *Tremellochaete* (2) (Kirk, 2015). Encontradas em quase todos os continentes, algumas espécies são consideradas cosmopolitas, podendo se comportar como organismos saprobiontes ou parasitas (Lowy, 1952; Hibbett, 2006).

Estabelecido por Bulliard em 1780, apresenta basidioma gelatinoso, quando fresco, de coloração variando do branco até tons acastanhados, pileado, auriforme para orbicular, de formato côncavo, sub-estipitado, estipitado ou ressupinado com margens livres (Bulliard, 1780). Distingue-se macroscopicamente dos demais gêneros por apresentar basidioma com zoneamento de hifas internas, superfície abhimenial pilosa e superfície himenial variando de lisa (e.g. *Auricularia nigricans*) a reticulada (e.g. *Auricularia delicata*), e microscopicamente por apresentar superfície himenial densa com basídios variando de cilíndricos a clavados, com três septações, e basidiósporo branco a castanho, podendo apresentar produção de conídios (Bulliard, 1780; Lowy, 1952; 1971; Looney et al., 2013; Alvarenga et al. 2015).

São consideradas 28 espécies para o gênero: *Auricularia albida* (Romell) Rick, *A. americana* Parmasto & I. Parmasto ex Audet, Boulet & Sirard, *A. auricula-judae* (Bull.) Quél., *A. cornea* Ehrenb., *A. delicata* (Mont. ex Fr.) Henn., *A. discensa* Lloyd, *A. eximia* (Berk. & Cooke) Kobayasi, *A. fibrillifera* Kobayasi, *A. fuscosuccinea* (Mont.) Henn., *A. goossensiae* Beeli, *A. hainanensis* L.J. Li, *A. hispida* Iwade, *A. hispidula* (Berk.) Farl., *A. incrassata* Kobayasi, *A. indica* Massee, *A. mesenterica* (Dicks.) Pers. *A. minor* Kobayasi, *A. nigricans* (Fr.) Birkebak, Looney & Sánchez-García, *A. peltata* Lloyd, *A. rosea* Burt, *A. scissa* Looney, Birkebak & Matheny, *A. semipellucida* Kobayasi, *A. sordescens* Ces, *A. stellata* Lloyd, *A. subglabra* Looney, Birkebak & Matheny, *A. tenuis* (Lév.) Farl., *A. wrightii*

(Berk. & M.A. Curtis) Farl., *A. xishaensis* L.J. Li, sendo frequentemente encontradas em zonas tropicais, subtropicais e temperadas.

As espécies do gênero *Auricularia* são reconhecidas ecologicamente por atuarem na degradação da matéria lenhosa, promovendo a ciclagem de material orgânico. São comumente utilizadas na culinária e na medicina alternativa, principalmente em países orientais (Lowy, 1952, Ferraz, 2004; Devi et al., 2015) e em diferentes comunidades tradicionais neotropicais (latino-americanas). No Brasil, destacam-se *A. fuscosuccinea,* utilizada pelos povos Txição e Tucarramãe (Fidalgo & Hirata, 1979); na Colômbia, *A. delicata* é utilizada pelas comunidades Uitoto, Muinane e Andoke, (Vasco-Palacios et al., 2008), e no Peru, a população rural comumente utiliza *A. nigricans* (Bardales, 1997). Principalmente na Ásia, diversos trabalhos tem descrito as propriedades antioxidantes, antibacteriana, antitumoral e antiviral de *A. auricula-judae* e *A. nigricans* (Chang, 1999; Kho et al., 2009; Song & Du, 2011; Yu et al., 2014)

Devido à ampla distribuição deste gênero, os modelos de nicho ecológico (ENM), utilizando dados de presença - Distância Mahalanobis, Algorítimo ENFA – *Ecological Niche Factor Analysis*, MAXENT e GARP (Phillips et al., 2006; Lima-Ribeiro & Diniz-Filho, 2012), podem ser utilizados como ferramenta para verificar além da amplitude de nicho potencial e possíveis áreas de ocorrência (De Marco Júnior & Siqueira, 2009; Varela et al., 2011), áreas climaticamente estáveis ao longo de grandes escalas temporais (21ky – 2080) (Terribile et al., 2012).

Sendo assim, registros de ocorrência extraídos de museus, herbários, e da literatura científica, proporcionam um amplo conjunto de dados, que permitem realizar tais modelos (eg. Brotons et al. (2004); Guisan et al. (2006); Elith & Leathwick (2007); Wollan et al. (2008); Nabout et al. (2009); Lima-Ribeiro & Diniz-Filho (2012); González-Ávila et al (2013); Rojas et al. (2015), Hai-Sheng et al. (2015)).

Desta forma, as modelagens são realizadas utilizando o ajuste entre os pontos de ocorrências conhecidos da espécie e os dados ambientais multivariados atuantes nestes locais (Phillips et al. 2006), permitindo, assim, que os modelos possam ser aplicados em diferentes áreas das ciências ambientais, como na escolha de áreas de proteção e de conservação de uma determinada espécie (Nóbrega & De Marco, 2011; Guisan et al., 2013), na compreensão do processo de dispersão e especiação (Silva et al., 2014; Tocchio et al., 2014) e no direcionamento para escolha novas áreas de coleta (Almeida, Cortês, De Marco Jr. 2010; Feeley & Silman 2011).

O presente trabalho objetivou inventariar os registros de ocorrência mundial das espécies cosmopolitas do gênero *Auricularia* (*A. auricula-judae, A. cornea, A. delicata, A. fuscosuccinea, A. mesenterica e A. nigricans*), propor modelos de nicho ecológico dos cenários passado a futuro (21ky - 2080), verificar a contribuição das variáveis bioclimáticas na diferenciação das espécies e mapear as áreas de estabilidade bioclimática no mundo.

Materiais e Métodos

Dados de ocorrência das espécies

Os dados de ocorrência (latitude e longitude) foram obtidos a partir de um levantamento da literatura (desconsiderando os artigos que não apresentassem o registro de ocorrência em ambiente natural), através da plataforma Thomsom-ISI usando a *web of science* (http://apps.webofknowledge.com/), Google scholar (https://scholar.google.com.br/) e Scielo (http://www.scielo.org/), utilizando os nomes das espécies ("*Auricularia*" OR "*Auricularia auricula-judae*" OR "*Auricularia cornea*" OR "*Auricularia delicata*" OR "*Auricularia fuscosuccinea*" OR "*Auricularia mesenterica*" OR "*Auricularia nigricans*"). Essas plataformas foram escolhidas devido a sua ampla abrangência de artigos e jornais cadastrados.

De forma complementar, os principais herbários que apresentam coleções representativas de macromicetos, com amostras de abrangência global - New York Botanic Garden (NY) e Royal Botanic Garden (Kew) e os portais virtuais Species Links-CRIA (http://www.splink.org.br/), Mycoportal (http://mycoportal.org/), Virtual herbaria JACQ (http://herbarium.univie.ac.at/database/), NZ - virtual herbarium (http://www.virtualherbarium.org.nz/), Australia's Virtual Herbarium - AVH (http://avh.ala.org.au/) foram consultados, gerando o banco de dados utilizado para realizar as modelagens. Devido às modificações taxonômicas, as sinonímias foram consideradas e confirmadas utilizado o Index Fungorum (http://www.indexfungorum.org) e Mycobank (http://www.mycobank.org/).

Os pontos de ocorrência (longitude e latitude) foram, então, extraídos das publicações ou dos registros de herbário e quando não informados, foram consideradas as georreferências do município mais próximo utilizando a ferramenta Google Earth, sendo desconsiderados os registros que não apresentassem estas informações.

Dados Climáticos e variáveis ambientais

As 19 variáveis bioclimáticas preditores utilizadas são provenientes de simulações climáticas do pré-industrial (~1760 – Atual), último máximo glacial (21ky BP – Passado) e

projeções futuras (2080-2100 – Futuro), sendo estas derivadas dos Atmosphere-Ocean General Circulation Models (AOGCM), disponíveis no site ecoClimate (http://ecoclimate.org/about/; Lima-Ribeiro et al 2015a; 2015b) com resoluções de 0.5° × 0.5°.

Devido à forte colinearidade entre as 19 variáveis bioclimáticas para os modelos de nicho ecológico, foi realizada uma PCA (Análise de Componentes Principais), a fim de selecionar as sete variáveis menos correlacionadas, sendo que os dois primeiros eixos da PCA explicaram 73.98% da variância dos dados bioclimáticos (Figura 1). Assim as variáveis selecionadas foram: Temperatura Média Anual (Bio1), Amplitude Térmica Diária Média (Bio2), Sazonalidade da Temperatura (Bio4), Temperatura mínima do mês mais frio (Bio6), Precipitação anual (Bio12), Sazonalidade da precipitação (Bio15), Precipitação do trimestre mais úmido (Bio16), contemplando variáveis relacionadas à temperatura e precipitação.

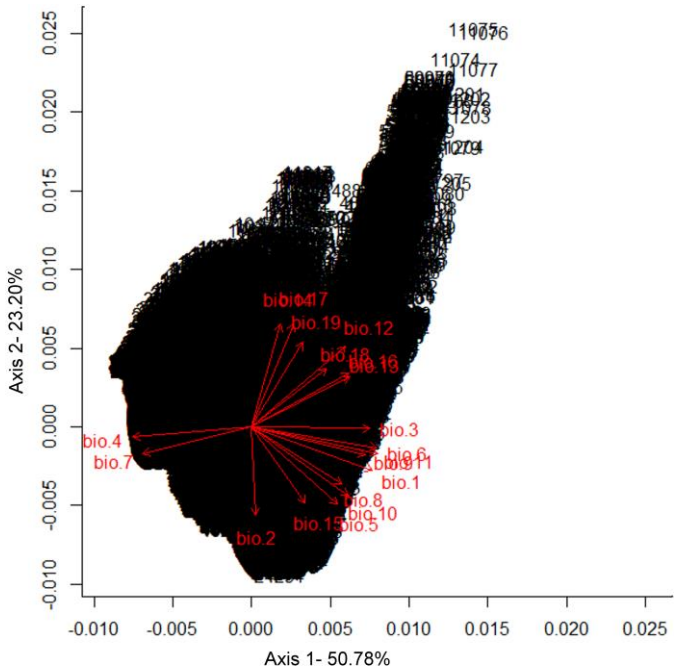

Figura 1 - Análise de Componente Principal das variáveis bioclimáticas derivadas dos Atmosphere-Ocean General Circulation Models (AOGCM)

Modelagem de Nicho Ambiental

Devido aos algoritmos de pseudoausências gerarem modelos mais robustos (Elith et al. 2006), foi utilizado o programa *Maximum Entropy* - Maxent (Phillips et al., 2006) como ferramenta de modelagem potencial, utilizando a configuração padrão do software, tanto para a modelagem de nicho ecológico no cenário atual e nas projeções futuras e passadas.

Para as avaliações dos modelos gerados, foram utilizados os valores de AUC (*Area under curve*) obtidos para as espécies, os quais variam de 0−1, sendo que valores <0.7 não caracterizam modelos significativos, entre 0.7−0.9 são moderadamente significativos e >0.9 são considerados modelos de excelente desempenho (Pearce & Ferrier, 2000; Elith et al., 2006). A importância de cada uma das variáveis bioclimáticas foi analisada através do teste Jackknife, evidenciando a contribuição de cada variável para ocorrência das espécies modeladas.

Contribuição das variáveis bioclimáticas na discriminação das espécies

As sete variáveis bioclimáticas utilizadas para a modelagem de nicho em resolução de 2.5 arco minutos (WorldClim -http://www.worldclim.org) de cada ponto de ocorrência foram extraídas utilizando o Diva-Gis (Hijmans et al., 2001), em seguida o conjunto de variáveis foi submetido à Análise Discriminante (AD) no programa R (Software R, 2015), possibilitando verificar no espaço cartesiano a sobreposição dos nichos ambientais das espécies.

Mapeamento das áreas bioclimaticamente estáveis

Após a validação dos modelos, utilizou-se o software Diva-GIS (Hijmans et al., 2001) para elaborar os mapas de áreas estáveis ao longo do tempo (21ky BA – 2080), através da soma das áreas que apresentassem valores de "*Maximum training sensitivity plus specificity*" iguais ou superiores aos preditos pelos "*logistic threshold*" no MAXENT, para cada espécie.

Resultados e Discussão

Distribuição das espécies do gênero *Auricularia*

A compilação dos dados de ocorrência (herbários + literatura) permitiu evidenciar 3.845 registros de ocorrência, após a retirada dos dados em que não foi possível identificar a localidade de coleta da amostra. Desses registros, 1.174 são de *Auricularia auricula-judae*, 293 de *A. cornea*, 566 de *A. delicata*, 639 de *A. fuscosuccinea*, 455 de *A. mesenterica*, e 718 de *A. nigricans*, perfazendo 852, 239, 308, 317, 352 e 474 pontos de ocorrência, respectivamente.

Nota-se nas distribuições geográficas elaboradas neste trabalho a ocorrência predominante das espécies do gênero *Auricularia* em áreas tropicais e temperadas, assim se diferindo dos demais dados de distribuição anteriormente apresentados por Lowy (1952). Isso certamente se deve ao fato de que o panorama atual é mais abrangente, tanto em termos de

número de registros, quanto por envolver mais localidades com registro de ocorrências. O aumento observado no número de localidades com ocorrência dessas espécies permite, além de estimar o seu nicho ecológico, a concentração de estudos nestas áreas (Figuras 2 e 3).

Modelagem de Nicho Ecológico

Os modelos gerados para todas as espécies foram categorizados como de excelente desempenho, segundo os valores de AUC obtidos, sendo encontrados valores iguais e/ou superiores a 0.90. Todos os modelos de nicho ecológicos elaborados sugerem áreas localizadas nas zonas tropicais e/ou temperadas como mais adequadas para a ocorrência das espécies (Material Suplementar 1).

Nos cenários projetados para o passado, somente a distribuição *A. auricula-judae* incluiu regiões temperadas, as demais apresentaram predominantemente áreas tropicais com pequenas áreas em regiões temperadas. Para o cenário atual, todas as espécies expandem sua distribuição em relação ao cenário passado, sendo *A. auricula-judae* e *A. fuscosuccinea* as de maior probabilidade de ocorrência em áreas litorâneas tropicais. Nos cenários futuros, os modelos sugerem que áreas litorâneas, nas regiões tropicais, serão adequadas bioclimaticamente, porém haverá o aumento nas regiões temperadas de áreas propícias para a ocorrência das espécies modeladas.

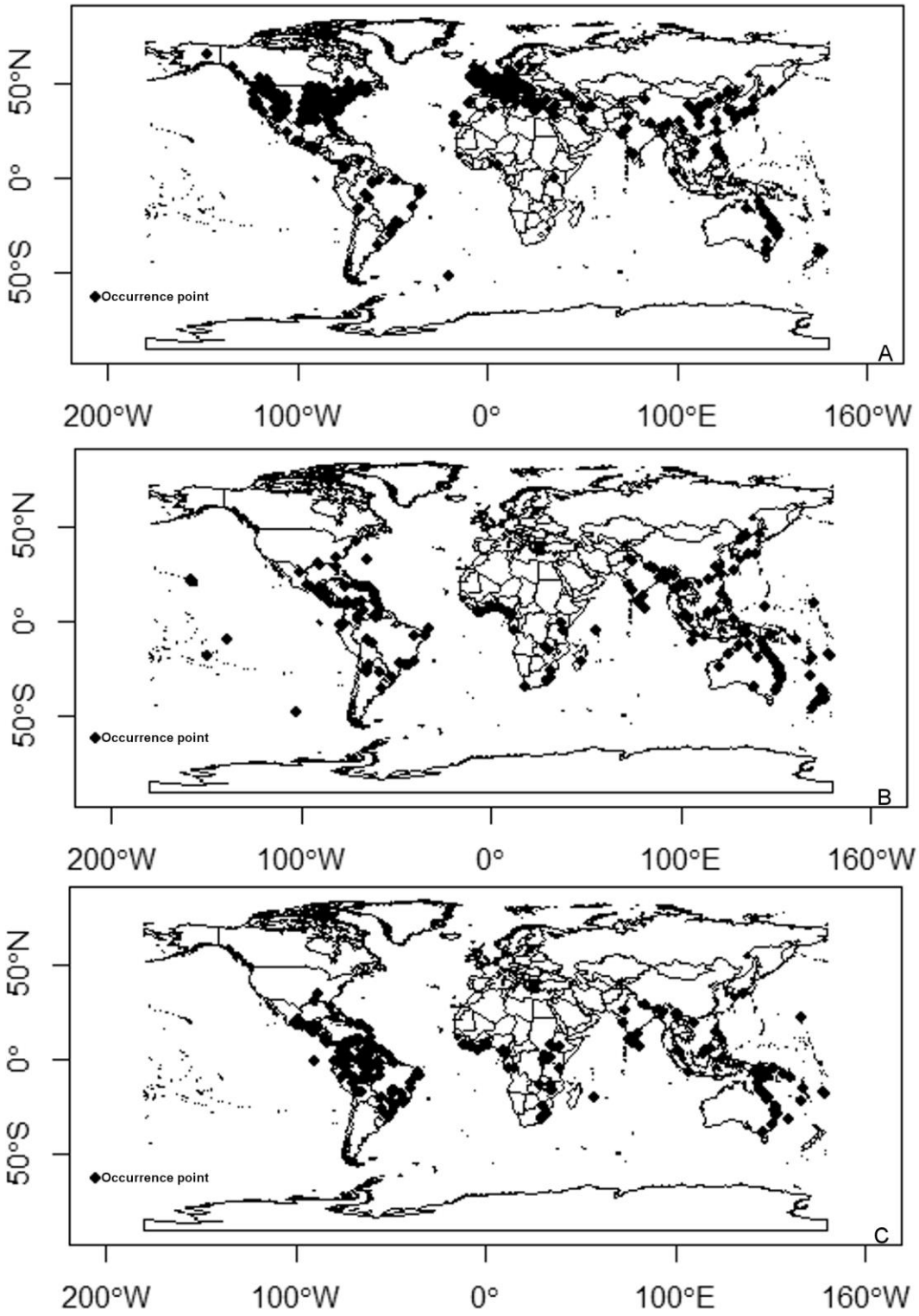

Figura 2 - Distribuição Global de espécies do Gênero *Auricularia*: A- *Auricularia auricula-judae lato sensu*; B- *A. cornea*; C- *A. delicata lato sensu.*

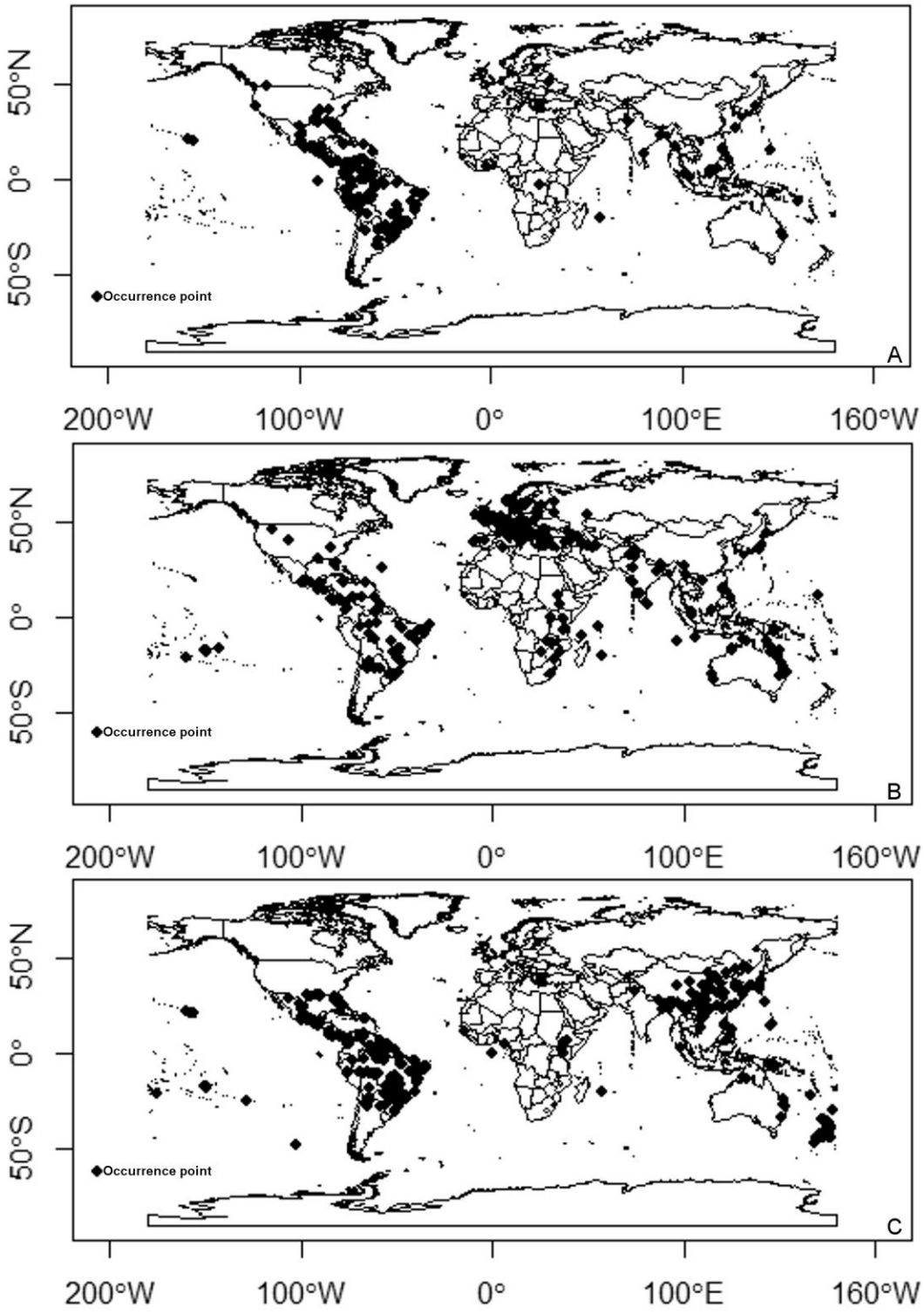

Figura 3 - Distribuição Global de espécies do Gênero *Auricularia*: A- *Auricularia fuscosuccinea*; B- *A. mesenterica*; C- *A. nigricans*.

Os deslocamentos de áreas propícias para a ocorrência das espécies para regiões temperadas nos cenários futuros sugerem que a mudança nas condições climáticas nos trópicos acarretará a perda de áreas que apresentam condições bioclimáticas necessárias para o desenvolvimento das espécies modeladas. Assim, o aumento da temperatura e a diminuição dos níveis de umidade nos trópicos poderão influenciar negativamente o desenvolvimento dessas espécies. Supõe-se que as mudanças climáticas projetadas poderiam interferir na quantidade de mucilagem e umidade presente no basidioma, diminuindo a persistência dessas espécies no ambiente.

Segundo o teste Jackknife, diferentes variáveis bioclimáticas contribuíram para a ocorrência das espécies, sendo a temperatura média anual (Bio1) com contribuição de 37.9% para *Auricularia auricula-judae*, sazonalidade da temperatura (Bio4) com 28.3% para *A. cornea*, temperatura máxima do mês mais quente (Bio5) com 26% para *A. delicata*, temperatura mínima do mês mais frio (Bio6) com 31% e 27.7% para *A. fuscosuccinea* e *A. mesenterica*, respectivamente e precipitação anual (Bio16) com 34.2% para *A. nigricans*.

As análises de Jackknife sugerem que as variáveis bioclimáticas de temperatura e precipitação (Bio1, Bio4, Bio 5, Bio6, Bio12, Bio16) sejam limitantes para a ocorrência das espécies estudadas, com exceção de *A. mesenterica* e *A. nigricans*. Para *A. mesenterica*, foram observadas como variáveis limitantes, as derivadas da temperatura (Bio6 e Bio2), contribuindo com 45.4%, enquanto que *A. nigricans* apresenta forte relação com variáveis de precipitação (Bio12 e Bio16), as quais contribuem com 60.6%.

A contribuição de diferentes variáveis bioclimáticas tem sido observada em outros trabalhos de modelagem abordando macromicetos (Wollan et al., 2008; González-Ávila et al., 2013; Yuan et al. 2015). Por essa razão, sugerimos que sejam realizados trabalhos de viés ecológico para essas espécies (e demais macromicetos) em diferentes escalas (espaciais e temporais), verificando a interação das variáveis bioclimáticas de maior contribuição nos modelos de nicho e nos processos de dispersão e colonização, testando desta forma as tendências preditas pelo teste Jackknife.

Nós ainda recomendamos avaliar as respostas das espécies em laboratório frente às mudanças climáticas preditas em diferentes cenários, observando a sensibilidade e a capacidade de adaptação de cada espécie, permitindo corroborar ou refutar as tendências previstas nas análises de modelagem.

Contribuição das variáveis bioclimáticas para discriminação das espécies

As semelhanças entre os nichos ambientais podem ser visualizadas de forma cartesiana através da Análise Discriminante, em que os dois primeiros eixos evidenciaram 96.41% da discriminação e apresenta a separação do nicho ambiental da *A. auricula-judae* em relação aos da *A. delicata* e *A. nigricans* e sobreposição das demais espécies se destacando *A. cornea* que não pode ser visualmente separada (Figura 4).

Desta forma, as semelhanças ou proximidades dos nichos ambientais observados podem refletir relações evolutivas, filogenéticas e/ou biogeográficas, como observado em *A. auricula-judae*, que apresenta um ramo basal, nas recentes filogenias do gênero, e apresentou a maior diferenciação do nicho ambiental, ao contrário das demais espécies que são filogeneticamente mais próximas e, portanto, apresentam seus nichos ambientais mais próximos ou sobrepostos (Montoya-Alvarez et al., 2011; Looney et al., 2013).

A co-ocorrência frequente de *A. cornea*, *A. fuscosuccinea*, *A. delicata*, *A. mesenterica* e *A. nigricans* em uma mesma área é comumente observada (Lowy, 1952; 1971; Musngi et al., 2005; Roberts, 2008; Valenzuela et al., 2008; Montoya-Alvarez et al., 2011; Sadiković et al., 2012; De Leon et al., 2013; Alvarenga et al., 2015). Isso pode ser devido a estas espécies apresentarem nichos ambientais e consequentemente histórias evolutivas/ou biogeográficas semelhantes. Assim, análises descritivas utilizando as variáveis bioclimáticas dos locais de ocorrência das espécies são importantes ferramentas e recomendadas para o conhecimento da história evolutiva e ecológica das espécies e/ou grupos taxonômicos.

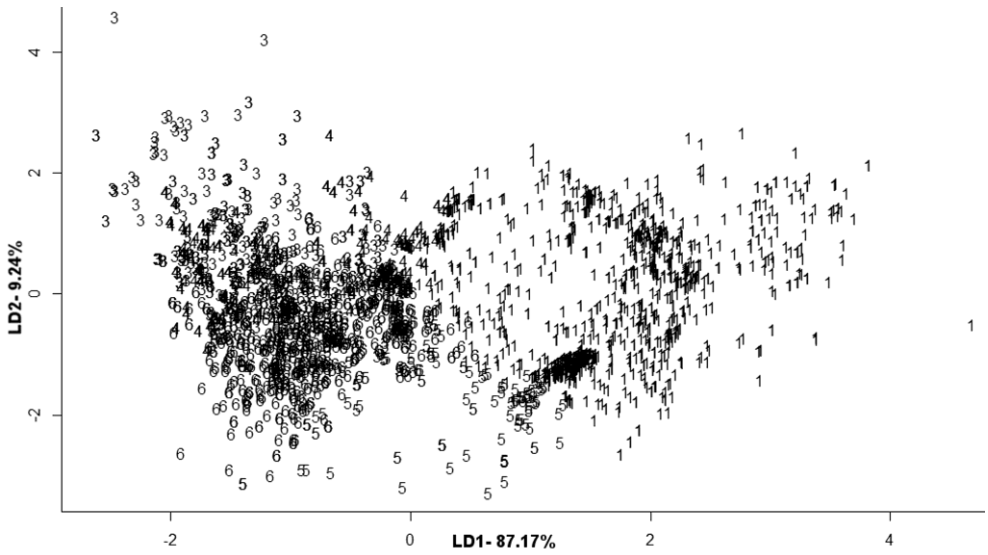

Figura 4 - Análise Discriminante das variáveis bioclimáticas das espécies do gênero Auricularia: 1- *Auricularia auricula-judae*; 2- *Auricularia cornea*; 3- *Auricularia delicata*; 4- *Auricularia fuscosuccinea*; 5- *Auricularia mesenterica* e 6- *Auricularia nigricans*

Mapeamento das áreas bioclimaticamente estáveis

O mapeamento por áreas bioclimaticamente estáveis para diferentes espécies e/ou grupos de organismos visa localizar áreas que foram adequadas no passado, são adequadas no presente e serão adequadas no futuro, assim possibilitando estudos de ecologia e conservação das espécies (Carnaval & Moritz, 2008; Araújo et al., 2011; Terribile et al., 2012; Planas et al., 2014).

O primeiro mapeamento de áreas bioclimaticamente estáveis para os macromicetos é apresentado neste trabalho e evidencia, após a sobreposição dos modelos, que *Auricularia auricula-judae* se distingue das demais espécies analisadas por apresentar o maior número de áreas estáveis em regiões temperadas no Norte da América do Norte e Sul da América do Sul, no Sul Europeu e Sudeste Asiático (Figura 6), já as demais espécies apresentam áreas estáveis na região tropical e temperada, em diferentes continentes do hemisfério Sul.

Observa-se a maior extensão de áreas estáveis bioclimaticamente para a espécie *Auricularia delicata*, seguida de *A auricula-judae*, *A. co*rnea e *A. nigricans*. Para *A. fuscosuccinea*, observa-se apenas pequenas áreas estáveis distribuídas em regiões tropicais e temperadas e a espécie *A. mesenterica* apresenta pequenas áreas distribuídas no hemisfério Sul e no continente Europeu (Figura 5 e 6).

Ressaltamos que as áreas bioclimaticamente estáveis identificadas neste trabalho, são locais de potencial refúgio para as espécies modeladas do gênero *Auricularia.* Desta forma, o mapeamento de áreas estáveis ao longo do tempo possibilita, além do reconhecimento de possíveis áreas de refúgio para as espécies (eg. Svenning et al., 2008; Nogués-Bravo, 2009), o direcionamento de fomento para a conservação e estudos dessas espécies (eg. Loyola et al., 2012).

O reconhecimento das áreas estáveis ao longo do tempo fornece subsídios para escolha e o direcionamento de áreas de cultivo mais indicadas para espécies de valor econômico já reconhecido, como o observado para as espécies *A. auricula-judae* e *A. nigricans*. Estas espécies são comumente produzidas na China, Taiwan, Thailandia, Philippinas, Indonesia e Malasia (Tang et al., 2010).

Utilizando áreas previamente identificadas em trabalhos de mapeamento, os produtores de espécies do gênero poderão diminuir o investimento na manutenção das colônias em laboratório, com o estabelecimento de cultivos sustentáveis em ambientes naturais, auxiliando ainda na conservação da diversidade genética das espécies cultivadas, através da dispersão de esporos. Isso se aplica especialmente para as comunidades, ao

poderem escolher ambientes naturais estáveis para o cultivo, complementando a renda e/ou alimentação familiar.

Considerando o reconhecido valor nutricional e medicinal dessas espécies, o desenvolvimento de metodologias que possibilitem o seu cultivo sustentável, aliadas a políticas públicas que incentivem sua produção, devem ser amplamente discutidas e estabelecidas. Assim como, o estudo com outras espécies de importância comercial e/ou medicinal permitirá a seleção de áreas adequadas climaticamente, para o cultivo de macromicetos em escala familiar e/ou comercial.

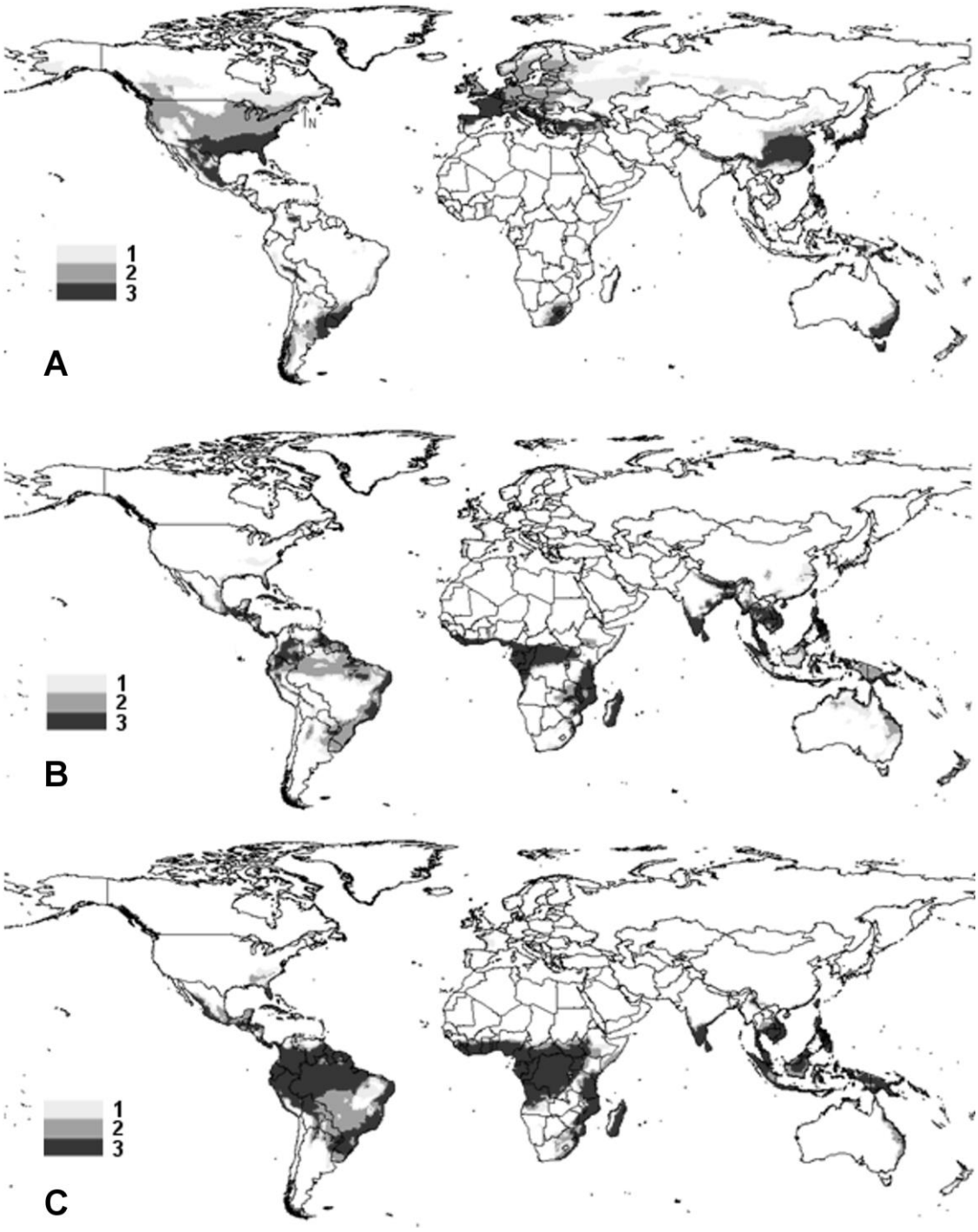

Figura 5 – Áreas climaticamente estáveis das espécies do gênero *Auricularia*: A- *Auricularia auricular-judae lato sensu*; B- *Auricularia cornea*; C- *Auricularia delicata lato sensu*. Legeda: 1 – Áreas presentes em apenas um modelo; 2 – Áreas presentes em dois modelos; 3 – Áreas presentes nos três modelos (Passado, Atual e Futuro).

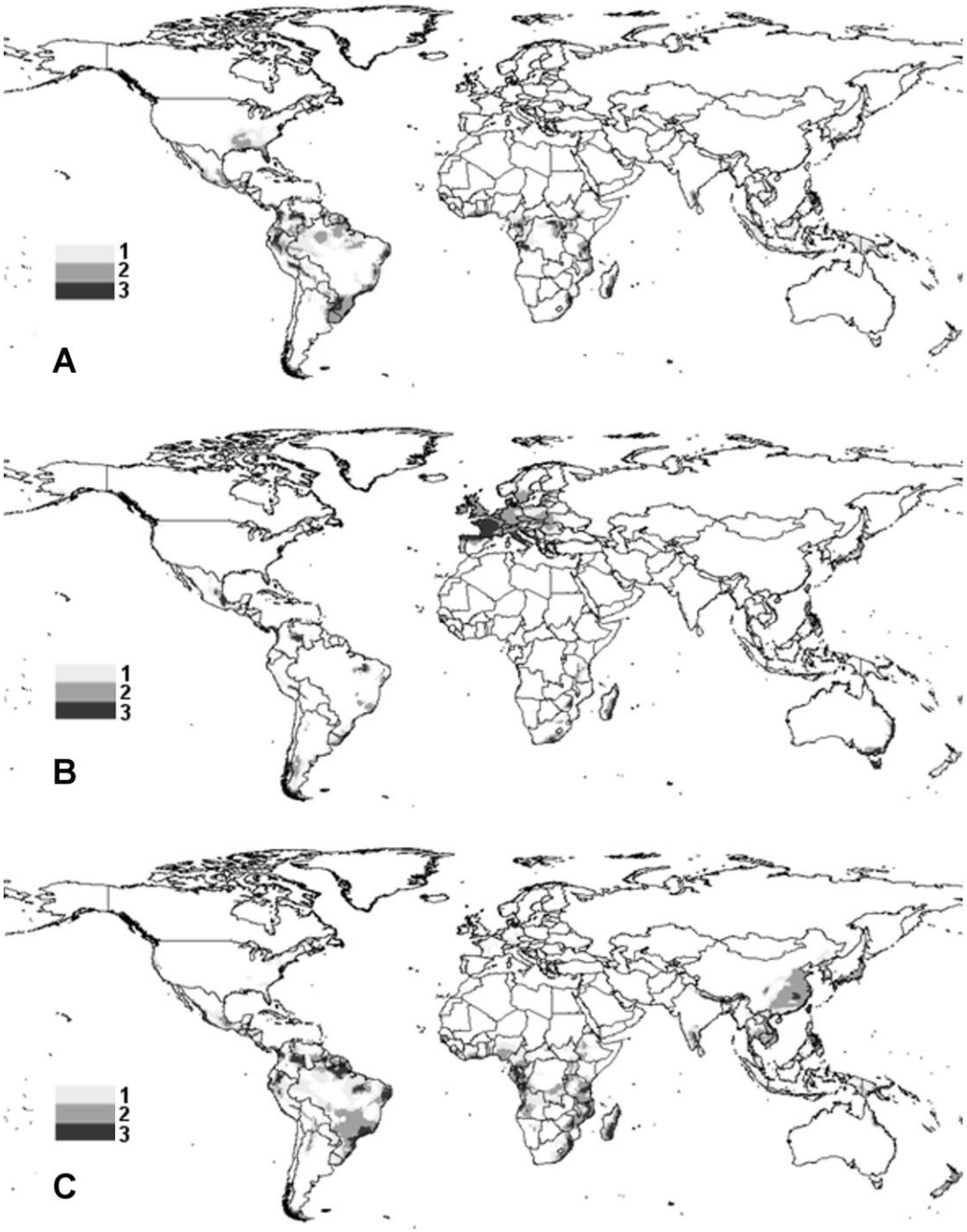

Figura 6 - Áreas climaticamente estáveis das espécies do gênero *Auricularia*: A- *Auricularia fuscosuccinea*; B- *Auricularia mesenterica*; C- *Auricularia nigricans*. Legeda: 1 – Áreas presentes em apenas um modelo; 2 – Áreas presentes em dois modelos; 3 – Áreas presentes nos três modelos (Passado, Atual e Futuro).

Conclusão

Este trabalho permitiu observar 3.845 registros de ocorrências sendo 1.174 de *Auricularia auricula-judae*, 293 de *A. cornea*, 566 de *A. delicata*, 639 de *A. fuscosuccinea*, 455 de *A. mesenterica*, e 718 de *A. nigricans*, perfazendo 852, 239, 308, 317, 352 e 474 pontos de ocorrência, respectivamente.

As distribuições geográficas das espécies do gênero *Auricularia* possibilitaram reconhecer *Auricularia auricula-judae* como uma espécie predominantemente de regiões temperadas e *A. cornea*, *A. delicata*, *A. fuscosuccinea*, *A. mesenterica* e *A. nigricans* como de ampla distribuição em regiões tropicais.

Os modelos de nicho ecológico contribuíram para entender a mudança da distribuição das espécies de fungos gelatinosos ao longo do tempo. Sendo possível observar a tendência de direcionamento das espécies de *Auricularia* para áreas de regiões temperadas e áreas litorâneas tropicais, o que possivelmente se deve ao aumento da temperatura nos trópicos e às mudanças nos regimes pluviométricos dessas áreas.

Foi possível observar a contribuição das variáveis bioclimáticas, sendo as variáveis de temperatura e precipitação (Bio1, Bio4, Bio 5, Bio6, Bio12, Bio16) com maior contribuições para as espécies *A. auricula-judae*, *A. cornea*, *A. delicata* e *A. fuscosuccinea*, as derivadas da temperatura (Bio6 e Bio2) para *A. mesenterica* e para *A. nigricans* as variáveis de precipitação (Bio12 e Bio16).

A utilização das variáveis bioclimáticas para discriminar as espécies pode auxiliar no entendimento da ecologia e evolução dessas espécies, permitindo observar as relações de co-ocorrência de um grupo de espécies filogeneticamente próximas, evidenciando tendências ligadas à sua história evolutiva.

Os mapeamentos de áreas estáveis são importantes ferramentas para o reconhecimento de áreas de refugo das espécies e ainda permite localizar áreas indicadas para o cultivo de espécies economicamente importantes de forma sustentável, auxiliando na conservação da espécie, através da manutenção de sua diversidade genética, e na redução nos custos de produção em laboratório.

Agradecimento

Gostaríamos de agradecer os herbários New York Botanic Garden (NY) e Royal Botanic Garden (Kew), os portais virtuais Species Links-CRIA, Mycoportal, Virtual herbaria JACQ, NZ - virtual herbarium, Australia's Virtual Herbarium – AVH, por ter nos disponibilizados os dados de ocorrências das espécies. Em especial a Dr. Begoña Aguirre-Hudson, Assistant Curator, Mycology do Royal Botanic Gardens Kew. A Fundação de Amparo a Pesquisa do Estado de Goiás (FAPEG) pela bolsa de mestrado ao primeiro autor e pelo suporte financeiro (Processo n°. 201210267001098 e AUXPE 2036/2013).

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Material Suplementar - **Volte ao passado e projete o futuro: Mapeando Áreas de Distribuição de Espécies do Gênero *Auricularia* (Basidiomycetes: Agaricomycotina) utilizando Modelos de Nicho Ecológico.**

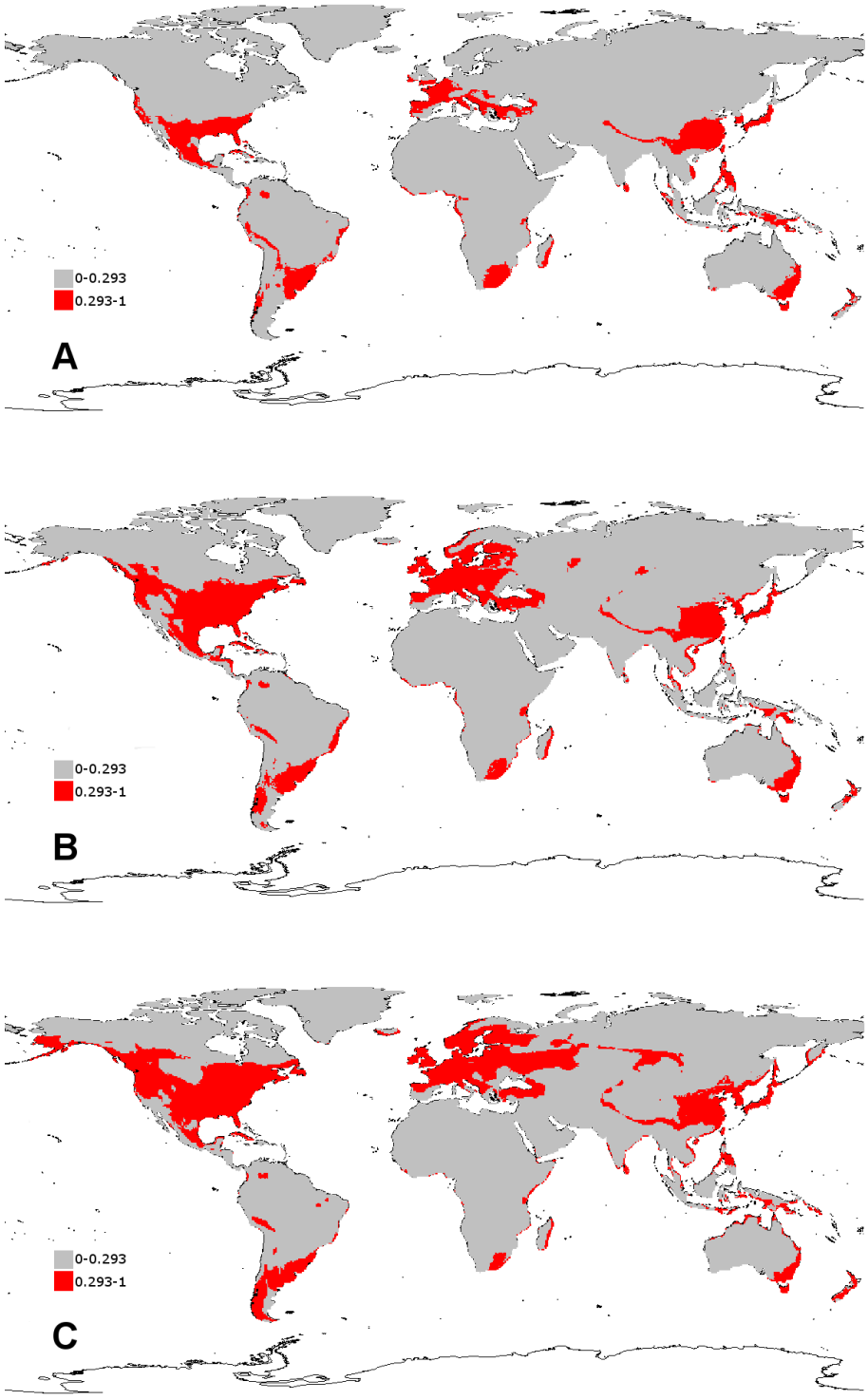

Figura 7 - Modelos de nicho ecológico de *Auricularia auricula-judae*, utilizando os logistic threshold de Maximum training sensitivity plus specificity: A-Projeção para o Passado; B-Distribuição potencial atual; C- Projeção para o futuro.

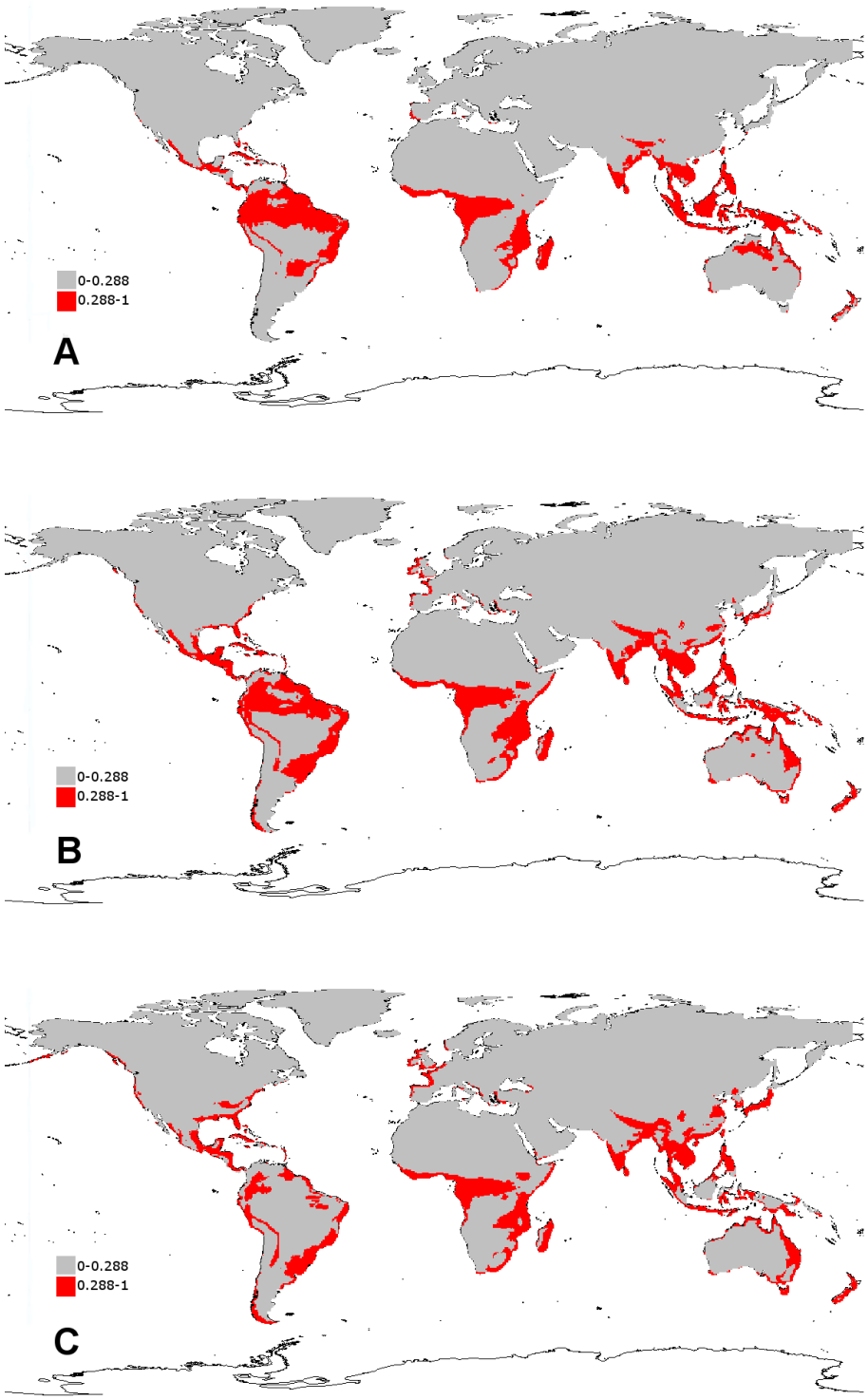

Figura 8 - Modelos de nicho ecológico de *Auricularia cornea*, utilizando os logistic threshold de Maximum training sensitivity plus specificity: A-Projeção para o Passado; B-Distribuição potencial atual; C- Projeção para o futuro.

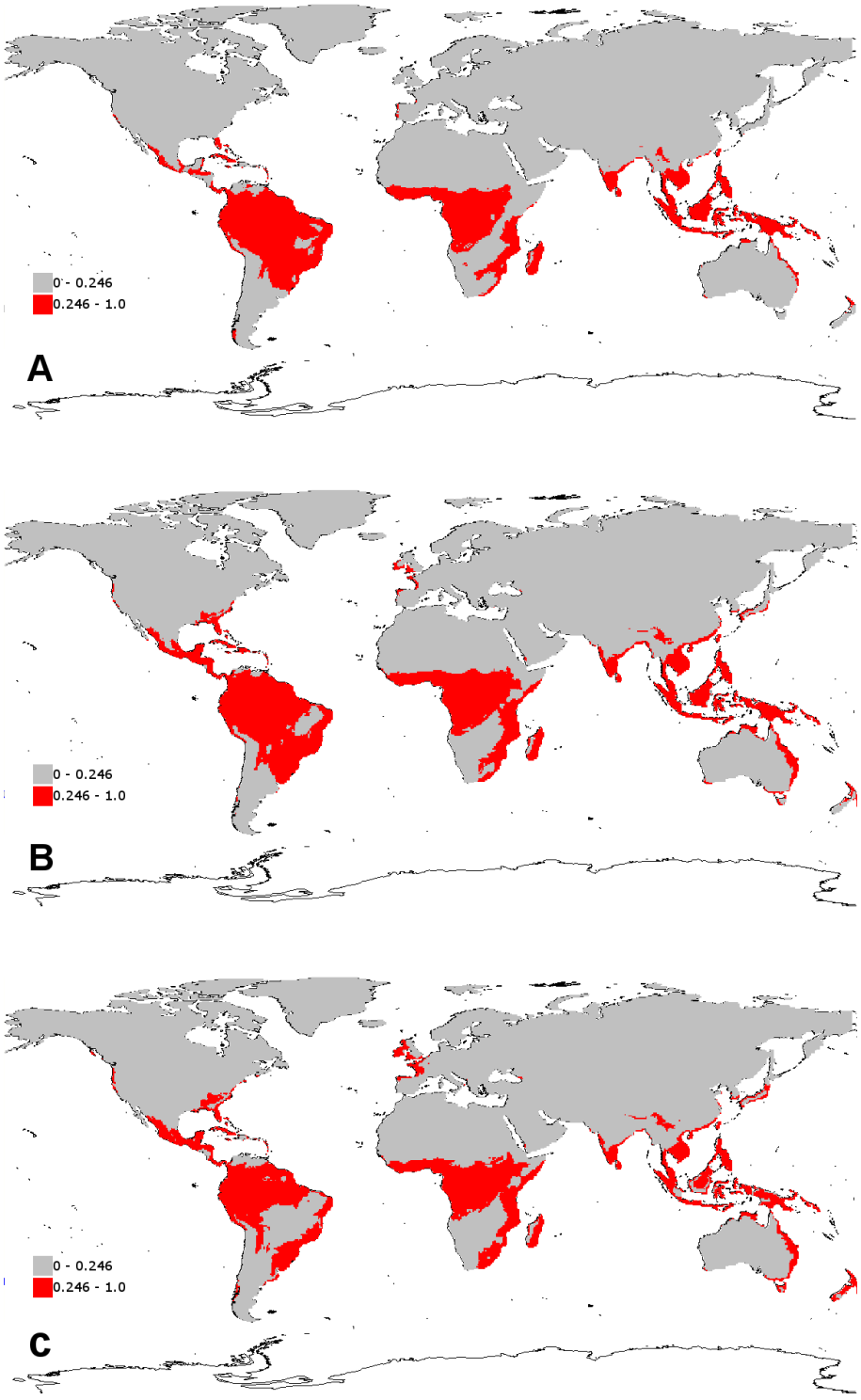

Figura 9 - Modelos de nicho ecológico de *Auricularia delicata*, utilizando os logistic threshold de Maximum training sensitivity plus specificity: A-Projeção para o Passado; B-Distribuição potencial atual; C- Projeção para o futuro.

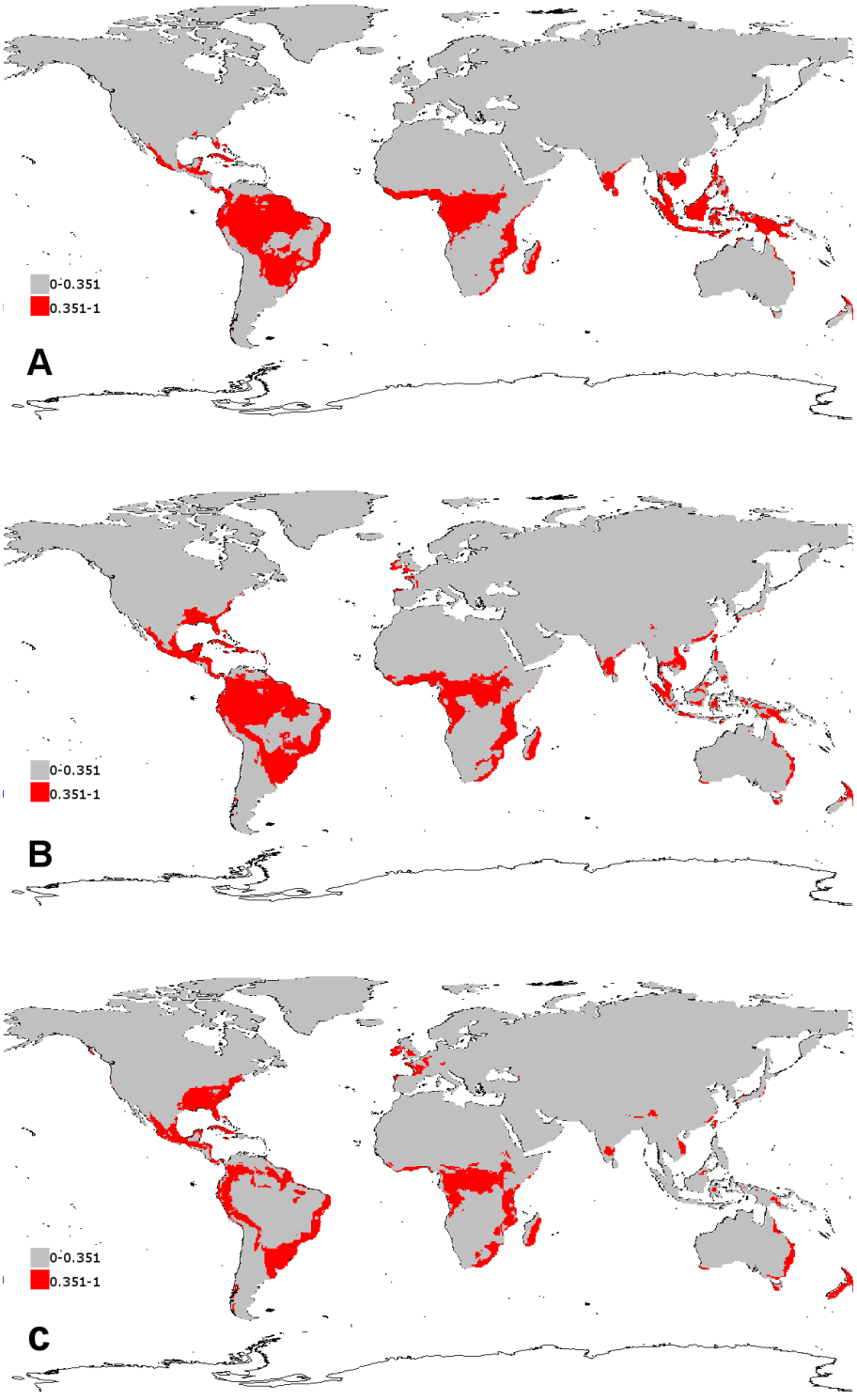

Figura 10 - Modelos de nicho ecológico de *Auricularia fuscosuccinea*, utilizando os logistic threshold de Maximum training sensitivity plus specificity: A-Projeção para o Passado; B-Distribuição potencial atual; C-Projeção para o futuro.

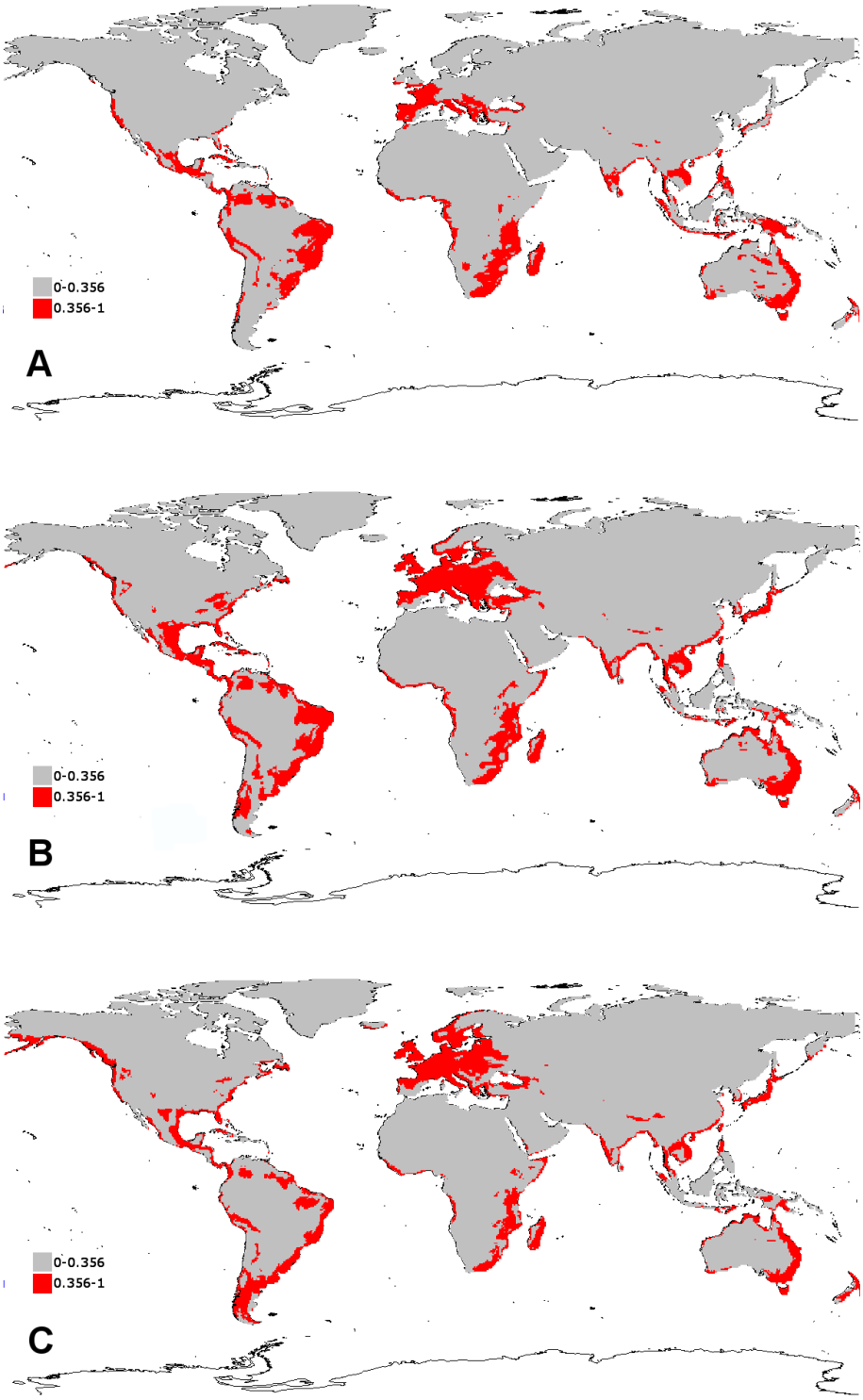

Figura 11 - Modelos de nicho ecológico de *Auricularia mesenterica*, utilizando os logistic threshold de Maximum training sensitivity plus specificity: A-Projeção para o Passado; B-Distribuição potencial atual; C-Projeção para o futuro.

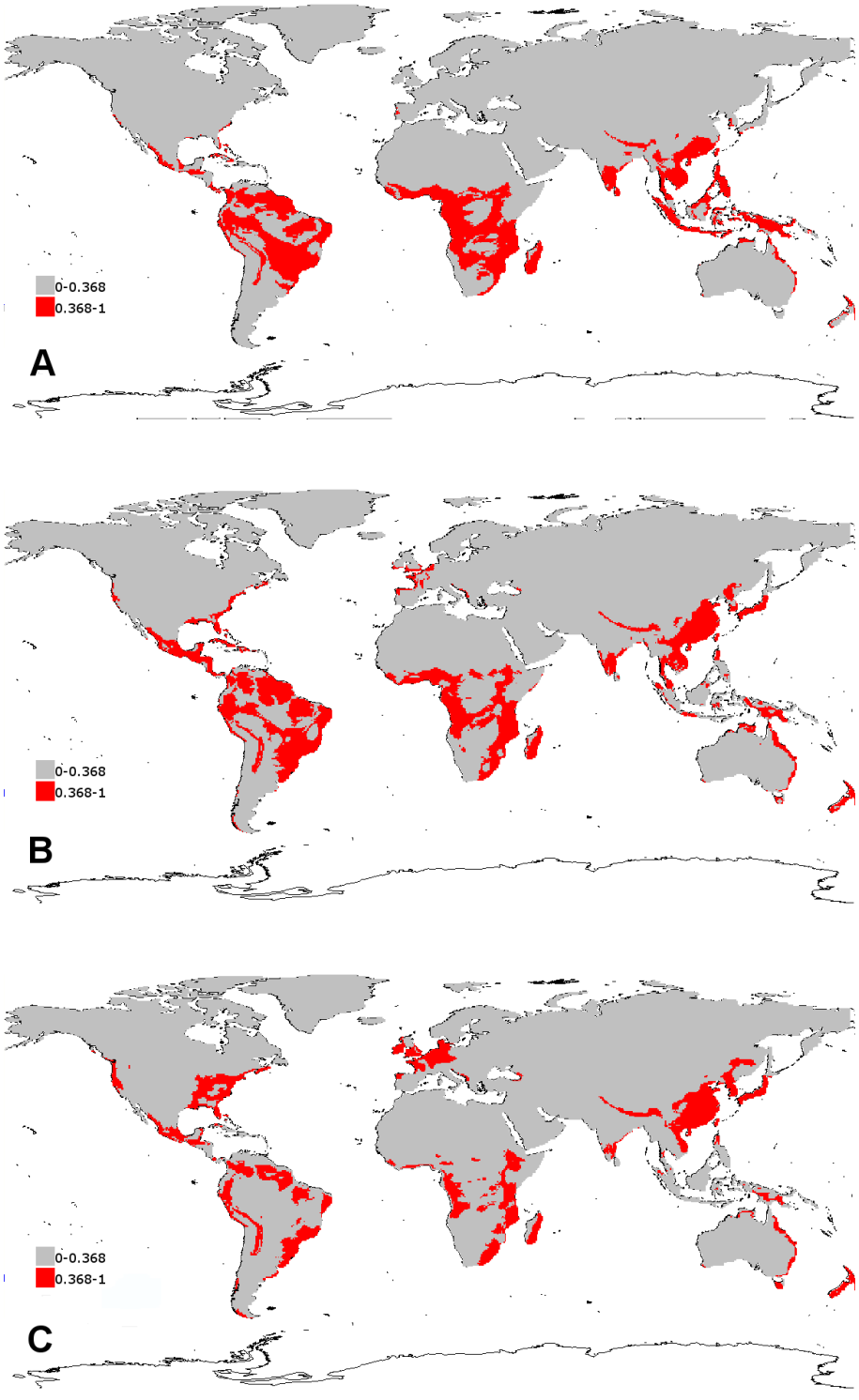

Figura 12 - Modelos de nicho ecológico de Auricularia nigricans, utilizando os logistic threshold de Maximum training sensitivity plus specificity: A-Projeção para o Passado; B-Distribuição potencial atual; C-Projeção para o futuro.

Considerações Finais

Esta dissertação fornece um panorama atualizado do conhecimento da riqueza e distribuição geográfica de fungos gelatinosos no Brasil, com predições de áreas biocliamaticamente adequadas para a ocorrêndia de espécies cosmopolitas do gênero *Auricularia* em termos mundiais. Os dados foram obtidos através da análise da literatura, da revisão das coleções dos principais herbários, bem como de coletas para o levantamento de espécies em áreas representativas do bioma Cerrado na região Centro-Oeste.

A revisão da literatura até o ano de 2014 permitiu verificar a ocorrência de 88 espécies distribuídas em três classes (Agaricomycetes, Dacrymycetes e Tremellomycetes), quatro Ordens (Auriculariales, Dacrymycetales, Sebacinales e Tremellales), sete famílias (Auriculariaceae, Dacrymycetaceae, Hyaloriaceae, Phragmoxenidiaceae, Sebacinaceae, Sirobasidiaceae e Tremellaceae). Até então o maior número de espécies era registrado para os estados do Rio Grande do Sul (50 espécies), seguidos por São Paulo (30) e Paraná (27). Desta forma, as regiãões Sudeste e Sul e o bioma Mata Atlântica abresentaram o maior número de locais amostrados.

O inventário de fungos gelatinosos no domínio do Cerrado permitiu inventariar nove áreas representativas. No estado de Goiás, a Reserva Ecológica da Trilha do Tatu no campus da Universidade Estadual de Goiás e Mata Ciliar do Ribeirão das Antas – AmBev, Filial Cebrasa, município de Anápolis; Bosque Auguste Saint-Hilaire no campus Samambaia da Universidade Federal de Goiás, município de Goiânia; Parque Estadual da Serra de Caldas Novas, municípios de Caldas Novas e de Rio Quente; Mata do Açude, município de Jataí; Parque Estadual da Serra dos Pirineus, município de Pirenópolis; Floresta Nacional (FLONA) de Silvânia, município de Silvânia, e no Distritro Federal, o Jardim Botânico de Brasília. Isso possibilitou a expansão do conhecimento da distribuição geográfica das espécies: *Dacrymyces chrysospermus, Dacryopinax elegans, D. maxidorii, D. spathularia*, *Ductifera sucina*, *Exidia glandulosa, Tremella foliacea* e *T. fuciformis* para o Cerrado e para a região Centro-Oeste; de *Auricularia delicata*, *A. fuscosuccinea*, *A. mesenterica* e *Calocera cornea* para o estado de Goiás e *A. delicata* para o Distrito Federal, possibilitando, ainda o incremento do acervo do HUEG, assim contribuindo não apenas para elevar a representatividade do herbário frente à diversidade de fungos gelatinosos da região Centro-Oeste, mas também da micobiota macroscópica do Brasil.

A revisão nos herbários FLOR, INPA, MPUC e HUEG adicionou três novas ocorrências de espécies para o Brasil: *Calocera coralloide*, coletada em Roraima, *Dacrymyces*

microsporus no Pará e Rondônia e *D. lacrymalis* no Amazonas, e contribuiu para expandir a distribuição geográfica das espécies *Auricularia delicata* para o Acre e Roraima, *A. mesenterica* e *A. nigricans* para a Paraíba, *Calocera arborea* para Roraima e Rondônia, *Dacryopinax elegans* para Roraima e Santa Catarina, *D. spathularia* para o Pará e Santa Catarina, *Ductifera sucina*, *Exidia glandulosa* para Goiás, *Tremella foliacea* e *T. fuciformis* para o Amazonas e Goiás, *Tremella compacta* para o Amazonas, *Tremella basiliensis*, *T. dysentrica* e *T. mesenterica* para Santa Catarina. Desta forma os dados apresentados evidenciam a importância de revisões no material depositado nos herbários, permitindo a ampliação do conhecimento da diversidade fúngica.

O levantamento da distribuição geográfica das espécies cosmopolitas do gênero *Auricularia* resgatou 3.845 registros de ocorrência no mundo, assim distribuídos: *Auricularia auricula-judae* (1.174), *A. nigricans* (718), *A. fuscosuccinea* (639), *A. delicata* (566), *A. mesenterica* (455) e *A. cornea* (293), perfazendo 852, 474, 317, 308, 352 e 239 pontos de ocorrência, respectivamente. *Auricularia auricula-judae* foi apontada como uma espécie predominantemente de regiões temperadas e *A. cornea*, *A. delicata*, *A. fuscosuccinea*, *A. mesenterica* e *A. nigricans* como de ampla distribuição em regiões tropicais. O mapeamento de áreas estáveis permitiu o reconhecimento de possíveis áreas de refúgios para as espécies modeladas, permitindo observar que *A. auricula-judae* se distingue das demais espécies analisadas por apresentar o maior número de áreas estáveis em regiões temperadas, já as demais espécies apresentam áreas estáveis na região tropical e pequenas áreas em regiões temperadas.

Com isso o quadro atual do conhecimento dos fungos gelatinosos no Brasil foi alterado para 91 espécies, com a inclusão de três novas ocorrências para o país, além disso 16 espécies tiveram a sua distribuição geográfica expandida para novos biomas, novas regiões e novos estados

O presente trabalho apresenta ainda ilustrações, chave de identificação, ficha de identificação (Apêndices 1 e 2), descrições das espécies, mapas de distribuição geográfica e modelos de nicho em diferentes escalas temporais, o que constitui importantes subsídios e incentivos para o reconhecimento de espécies e novos estudos abordando os fungos gelatinosos.

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Apêndices

Ficha de Identificação para o Gênero *Auricularia*

Ficha de Identificação - Amostra:_____

Macroestruturas

Forma do Basidioma: _____

Tamanho do Basidioma

Comp.										
Larg.										

Coloração:_____

Zona Pilosa: ( ) presente ( ) ausente

Comp.					
Larg.					

Microestruturas

Diâm. da hifa:_____

GC- ( ) presente ( ) ausente RM ( ) presente ( ) ausente

Obs.: _____

Zona Compacta:

Exp.					

Zona Subcompacta Superioris

Exp.					

Zona Laxa Superioris:

Exp.					

Medula ou Região Laxa Intermedia

Exp.					

Zona Laxa Inferioris:

Exp.					

Zona Subcompacta Inferioris.:

Exp.					

Hymenium:

Exp.					

Formato do esporo:_____

Tamanho do esporo

Comp.										
Larg.										

Septos: ( ) 0 ( )0-1 ( ) 2-3 ( ) 3-5 ( ) + de 5

Obs.:

_____

_____

Determinação:_____

Ficha de Identificação para Dacrymycetales e Tremellales

Ficha de Identificação - Amostra:_____

Macroestruturas

Forma do Basidioma: _____

Tamanho do Basidioma

Comp.										
Larg.										

Coloração:_____

Pêlos na região basal: ( ) presente ( ) ausente

Microestruturas

Himênio: ( ) unilateral ( ) bilateral Hifas: ( ) septadas ( ) asseptadas

Diam. da hifa:_____

GC- ( ) presente ( ) ausente RM ( ) presente ( ) ausente

Obs.: _____

Formato Probasídio:_____

Grampo de conexão: ( ) presente ( ) ausente

Tamanho do Probasídio

Comp.										
Larg.										

Forma do Metabasídio:_____

Tamanho do Metabasídio:

Comp.										
Larg.										

Grampo de conexão: ( ) presente ( ) ausente

Tamanho do Esterigma:

Comp.										
Larg.										

Formato do esporo:_____

Tamanho do esporo

Comp.										
Larg.										

Septos: ( ) 0 ( )0-1 ( ) 2-3 ( ) 3-5 ( ) + de 5

Obs.:

_____

_____

Determinação:_____

_____