FLAVIA RODRIGUES BARBOSA

MICROFUNGOS ASSOCIADOS À SUBSTRATOS VEGETAIS SUBMERSOS EM AMBIENTE LÓTICO DE UM FRAGMENTO DE MATA ATLÂNTICA, BAHIA, BRASIL

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MICROFUNGOS ASSOCIADOS À SUBSTRATOS VEGETAIS SUBMERSOS EM AMBIENTE LÓTICO DE UM FRAGMENTO DE MATA ATLÂNTICA, BAHIA, BRASIL

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Tese apresentada ao Programa de Pós-Graduação em Botânica da Universidade Estadual de Feira de Santana como parte dos requisitos para a obtenção do título de *Doutor em Botânica*.

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FEIRA DE SANTANA – BA

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À minha mãe, Maria das Graças R. Barbosa, minha fonte de aprendizado de vida e meu alicerce e ao meu irmão Fábio R. Barbosa por ser parte de minha vida, dedico.

"Paciência e perseverança tem o efeito mágico de fazer as dificuldades desaparecerem e os obstáculos sumirem." (John Quincy Adams)

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INTRODUÇÃO GERAL

1. A Mata Atlântica e seus enclaves inseridos no semi-árido brasileiro

1.1. Biodiversidade da Mata Atlântica

Dentre os países detentores de megadiversidade, o Brasil se destaca como o principal deles possuindo entre 15 e 20% do número total de espécies da Terra. Contribuindo com isso estão as duas maiores florestas tropicais do continente americano: a Floresta Amazônica e a Mata Atlântica (Ministério do Meio Ambiente 2000, Tabarelli et al. 2005). As florestas tropicais constituem a vegetação mais rica em diversidade biológica de todo o globo terrestre. Esforços que visam a adoção de práticas sustentáveis, criação de áreas protegidas com vista à conservação da riqueza biológica tem sido empreendidos pelo Ministério do Meio Ambiente (Ministério do Meio Ambiente 2002, Ribeiro et al. 2009).

Na época da colonização do Brasil, a Mata Atlântica estendia-se por 1.360.000 Km^2 desde o Piauí até o Rio Grande do Sul, incluindo um total de 17 estados brasileiros. Após um longo período de devastação, principalmente com a pecuária, a extração do Pau-Brasil e os ciclos de cana-de-açúcar e café, a Mata Atlântica teve sua área bastante reduzida causando sua fragmentação e a perda de grande parte da biodiversidade (Ranta et al. 1998, Ministério do Meio Ambiente 2000, 2002). Ribeiro et al. (2009), analisando a distribuição espacial da Mata Atlântica remanescente, observaram que apenas 11,7% da área do bioma conserva suas características bióticas originais estando distribuídas de modo esparso, ao longo da costa brasileira, no interior da região Sul e Sudeste e fragmentos de mata em Goiás, Mato Grosso do Sul e nos estados do Nordeste. Este valor atualizado é um pouco maior do que os 8% previamente considerados (Ministério do Meio Ambiente 2000) (Figura 1). Os autores ainda verificaram que na Bahia restam cerca de 17,7% da vegetação original (Figura 2). Ainda assim, esse estado possui a segunda maior área onde a floresta está mais preservada seguida da Serra do Mar, em São Paulo, que mantêm 36,5% de vegetação restante (Ribeiro et al. 2009).

Embora a Mata Atlântica tenha sido amplamente devastada ela ainda abriga grande diversidade biológica. Segundo a Conservation International (2007), em virtude da grande riqueza existente (8.000 espécies vegetais endêmicas) e da grande ameaça sofrida (cerca de 93% da sua extensão perdida), a Mata Atlântica foi considerada um dos 34 “hotspots”

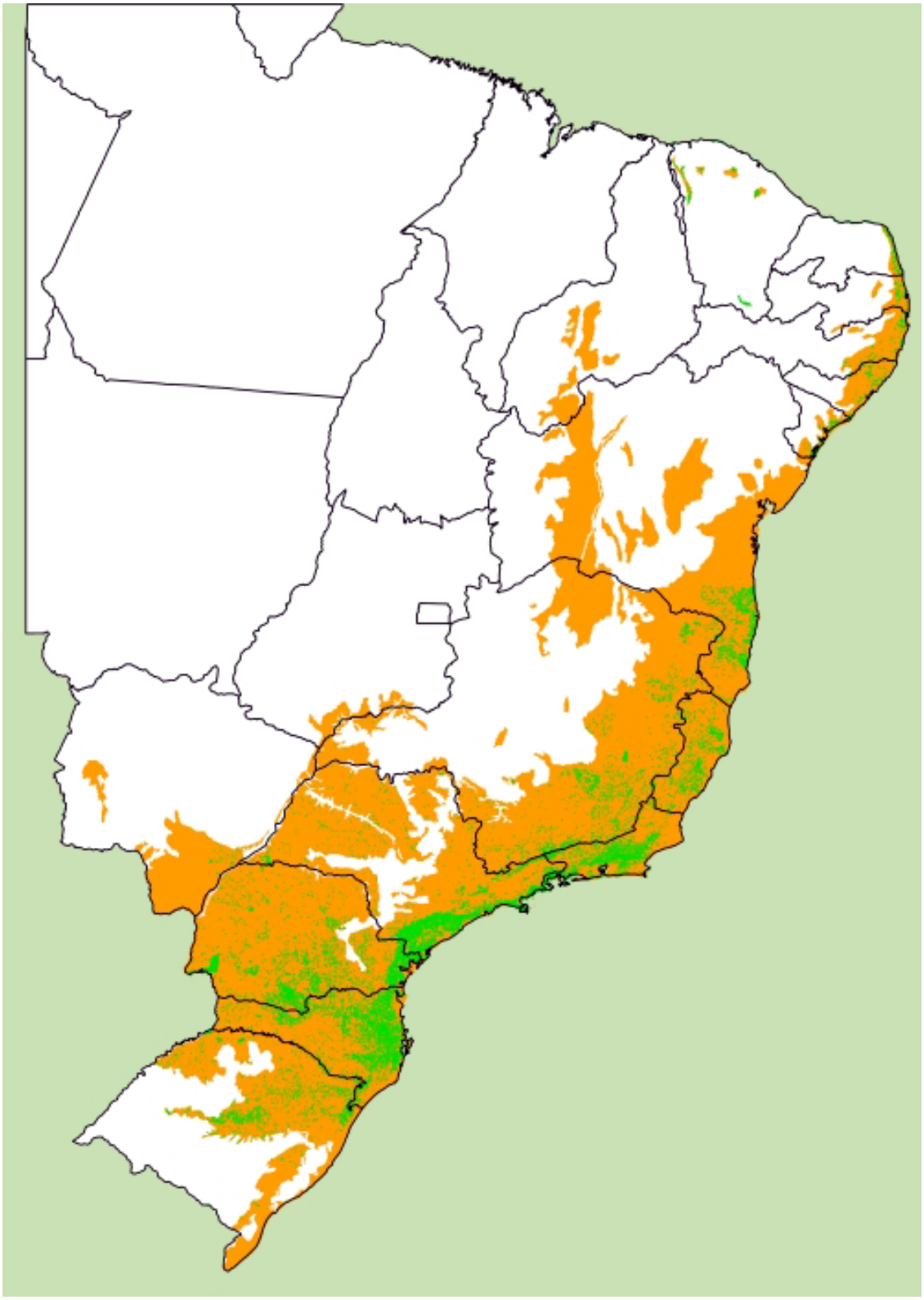

Figura 1. Mapa de cobertura da vegetação nativa da Mata Atlântica (laranja) e de seus remanescentes (verde). Fonte: Ministério do Meio Ambiente (2002).

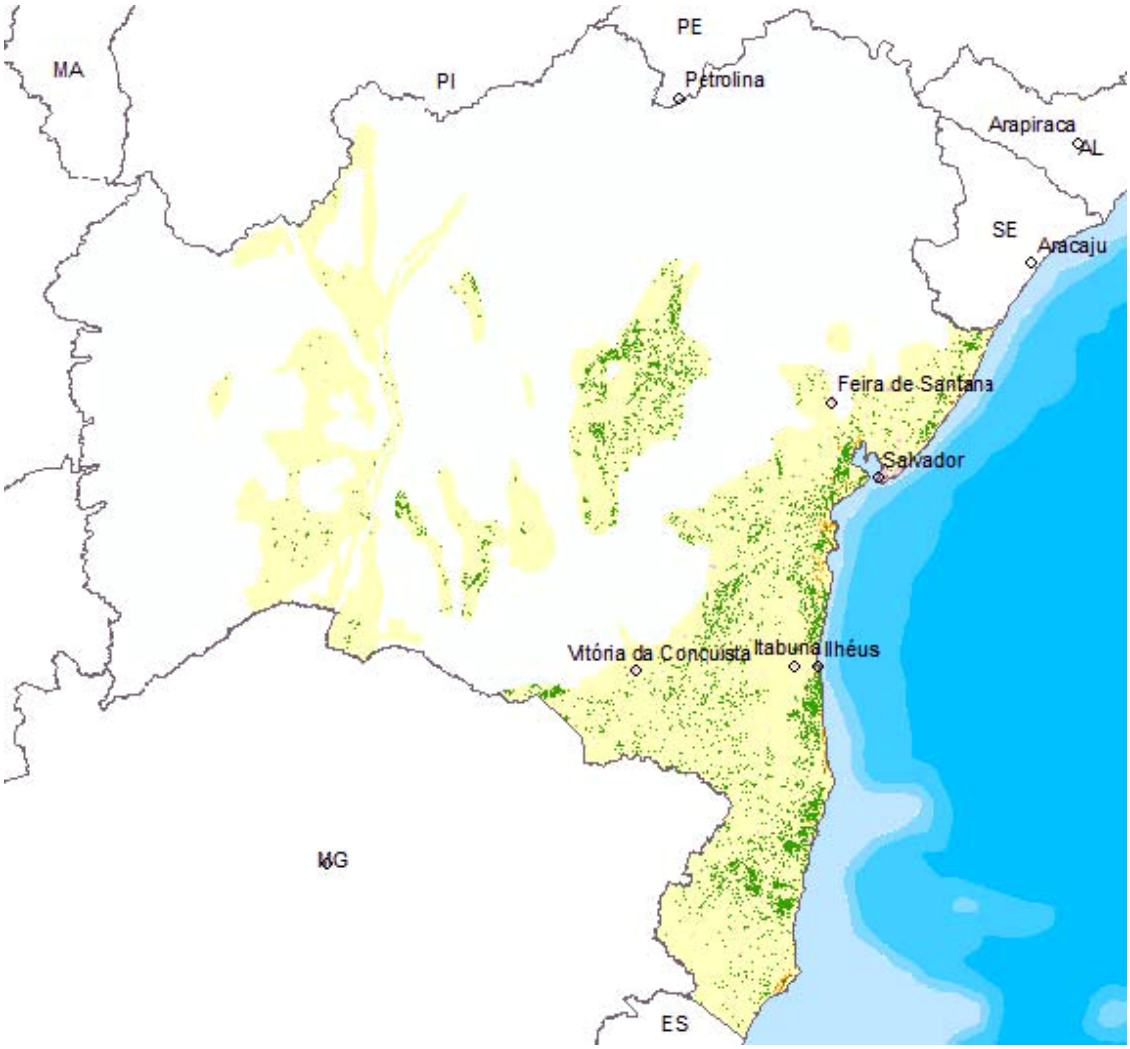

Figura 2. Remanescentes de Mata Atlântica no estado da Bahia (verde). Fonte: Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais (2009).

mundiais. Para ser considerado um “hotspot”, o ecossistema deve apresentar, no mínimo, 1.500 espécies de plantas vasculares endêmicas (0,5% do total de plantas vasculares do mundo) e apresentar perda de, no mínimo, 70% da sua área original (Conservation International 2007). Diante de perdas significativas e com o intuito de preservar o que resta desse bioma, o Ministério do Meio Ambiente determinou áreas prioritárias para a conservação da biodiversidade da Mata Atlântica incluindo os quesitos flora, invertebrados, peixes, répteis, anfíbios e aves caracterizando estas áreas como de “provável importância biológica” até de “extrema importância biológica” (Ministério do Meio Ambiente 2000).

1.2. O semi-árido na América do Sul e Brasil

Na América do Sul encontram-se três áreas semi-áridas: a região Guajira, na Venezuela e Colômbia, a diagonal seca do Cone Sul, abrangendo partes da Argentina e Chile e o nordeste do Brasil. Todas se caracterizam pela escassez de chuvas, longos períodos de ausência de água, baixa umidade e irregularidade no ritmo das precipitações. (Ab'Sáber 1999).

O semi-árido brasileiro corresponde basicamente a delimitação do Bioma Caatinga e está localizado quase que exclusivamente na região nordeste. Compreende, portanto, os estados do Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia e o norte de Minas Gerais (Giulietti & Queiroz 2006). O semi-árido apresenta atualmente cerca de 970.000 Km^2. A área geográfica de abrangência foi recentemente redelimitada pelo Ministério de Integração Nacional (Figura 3) levando-se em conta três critérios: precipitação pluviométrica média anual inferior a 800 milímetros, índice de aridez de até 0,5 e risco de seca maior que 60%. Além dos 1.031 municípios já incorporados na região, mais 102 foram enquadrados em pelo menos um dos três critérios. Dessa maneira, a área oficialmente classificada como semi-árido teve um acréscimo de 8,7% e o estado de Minas Gerais foi o que obteve mais inclusões de municípios com 45 adições (Ministério da Integração Nacional 2005).

1.3. Enclaves de Mata Atlântica na Caatinga

Dados recentes mostram que a Mata Atlântica distribui-se em 245 fragmentos sendo a maioria com menos de 50 hectares. Florestas com maior extensão podem ser encontradas no sul da Bahia e no litoral de São Paulo, Rio de Janeiro e Paraná (Ribeiro et al. 2009) (Figura 1) . A porção de Mata Atlântica situada no semi-árido brasileiro está restrita a manchas disjuntas de florestas chamadas enclaves, fragmentos de mata ou brejos de altitude. Segundo a Associação Plantas do Nordeste (2001), nove enclaves estão inseridos na caatinga e durante a proposta de ajustes dos limites desse bioma foram consideradas sistemas particulares inseridos nas ecorregiões em que estão localizados (Figura 4). Cavalcante (2005) define os enclaves como formações vegetais estranhas inseridas em comunidades naturalmente estabelecidas e em equilíbrio com o ambiente. Para esse autor, a combinação da localização geográfica, altitude, solo e disposição do relevo em relação aos ventos oriundos do litoral, mantém até hoje os enclaves. Sua origem

decorreu das glaciações no Pleistoceno quando a umidade atmosférica diminuiu e, conseqüentemente, ocorreram menos precipitações. A vegetação adaptada à seca se expandiu isolando as florestas nos topos das serras, que conseguiram manter sua umidade a partir dos ventos oriundos do litoral (Cavalcante 2005).

Figura 3. Nova delimitação do Semi-árido. Fonte: Ministério de Integração Nacional 2005.

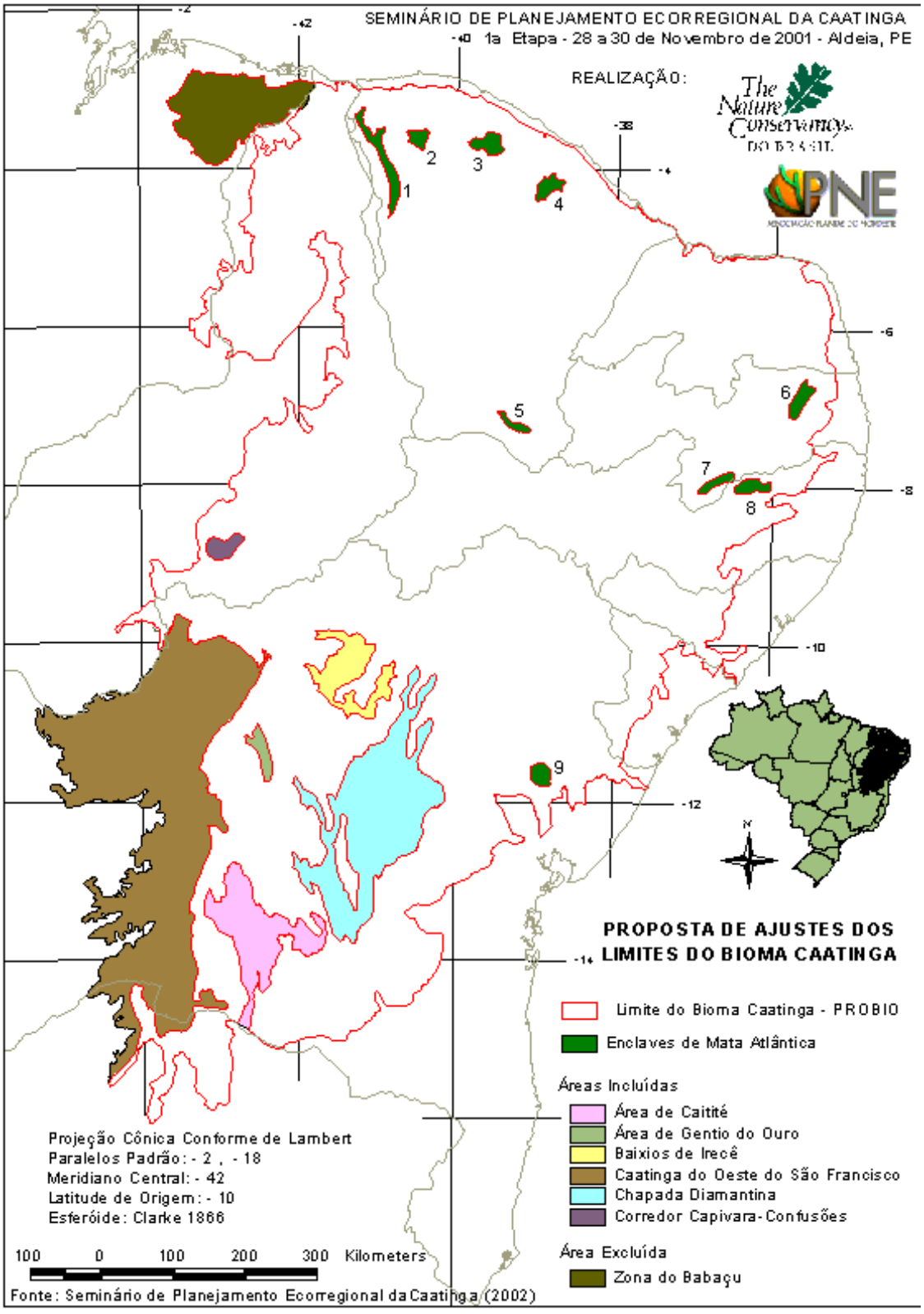

Figura 4. Enclaves de Mata Atlântica inseridos no Bioma Caatinga. (1-Serra da Ibiapaba/Ubajara, CE. 2-Sobral, CE. 3-Itapagé, CE. 4-Serra de Baturité, CE. 5-Crato, CE. 6. Brejo Paraibano, PB. 7. Camalaú, PB. 8. Brejo da Madre de Deus, PE. 9. Serra da Jibóia, BA.) Fonte: Velloso et al. (2002).

Como resultado do levantamento de fungos no semi-árido brasileiro, Gusmão et al. (2006a) registraram 955 espécies sendo a maioria registrada no estado de Pernambuco e Bahia (Gusmão & Marques 2006). O grupo mais representativo foi o dos fungos conidiais (407 spp) seguido dos ascomicetos (179 spp). Em ambos os grupos, os dados referem-se a espécies registradas em ambientes terrestres (Bezerra & Maia 2006, Gusmão et al. 2006b) indicando a inexistência de estudos com esses grupos em ambientes aquáticos na região semi-árida.

Estudos em enclaves de Mata Atlântica inseridos no semi-árido são escassos. Na Bahia, Góes-Neto et al. (2003) realizaram levantamento de basidiomicetos na Serra da Jibóia e catalogaram 26 espécies de Aphyllophorales. Com relação aos microfungos, Barbosa et al. (2009a,b) registraram 79 fungos conidiais sobre folhas em decomposição de *Clusia melchiorii* Gleason e *C. nemorosa* G. Mey. com duas novas espécies: *Deightoniella rugosa* F.R. Barbosa, Gusmão & R.F. Castañeda e *Diplocladiella cornitumida* F.R. Barbosa, Gusmão & R.F. Castañeda (Barbosa et al. 2007). Ainda no mesmo fragmento de mata, Marques et al. (2008a,b) encontraram 106 espécies de fungos conidiais na serapilheira sendo 32 espécies lignícolas (Marques et al. 2007b) e a nova espécie *Cubasinia microspora* M.F.O. Marques, Gusmão & R.F. Castañeda (Marques et al. 2007a). Para ambientes de água doce, o trabalho pioneiro, e único até o momento, foi publicado por Barbosa et al. (2008) que descreveram a espécie *Annulatascus apiculatus* F.R. Barbosa & Gusmão sobre substrato submerso na Serra da Jibóia, Bahia. Levando em consideração a escassez de estudos sobre microfungos em enclaves de Mata Atlântica no semi-árido, a realização de pesquisas de natureza taxonômica é necessária para ampliação de registros sobre a diversidade de fungos.

2. Ambientes de água doce e sua biodiversidade

Menos de 1% da superfície da terra é coberta por água doce e cerca de 100.000 espécies vivem nesse ambiente, de um total de 1,5 milhão já catalogadas por cientistas (Hawksworth & Kalin-Arroyo 1995). Isso demonstra a riqueza desproporcionalmente alta quando comparada com outros ecossistemas (Dudgeon et al. 2006).

Ecossistemas de água doce são os mais vulneráveis à atividade humana e à mudanças ambientais do mundo (Dudgeon et al. 2006). Segundo Sala et al. (2000), a perda da biodiversidade nesse ecossistema tem sido muito maior do que em qualquer ecossistema

terrestre. O conhecimento do total da biodiversidade em água doce ainda é incompleto, principalmente dentre os invertebrados e microrganismos e em regiões tropicais (Dudgeon et al. 2006). Para Gessner & Van Ryckegem (2003), a riqueza de fungos em água doce é subestimada.

Os ambientes de água doce podem se classificados quanto ao seu fluxo em lênticos e lóticos. Os ambientes lênticos são aqueles onde falta um fluxo contínuo de água compreendendo, portanto, os lagos, as lagoas e os pântanos (Thomas 1996). Caracterizando-se como áreas pouco turbulentas, oferecem ambientes tranqüilos para os fungos se desenvolverem. Contudo, essa propriedade resulta na deficiência de oxigênio e redução do número de espécies (Bärlocher 1992). Rios, riachos e córregos, onde o fluxo de água é contínuo, constituem ambientes lóticos (Thomas 1996).

Os ambientes lóticos têm sido bem investigados quanto a presença de fungos tanto em regiões tropicais (Tsui et al. 2000, Ho et al. 2001, Barbosa et al. 2008, Ferrer et al. 2008,) quanto em regiões temperadas (Ingold 1975b, Descals & Webster 1983, Fallah et al. 1999, Marvanová et al. 2003, Raja et al. 2008). Medeiros et al. (2009) sugerem que a riqueza deve-se também a altos níveis de oxigênio característicos desse ambiente. Ao relacionar fatores físico-químicos da água de rios na Índia, com a riqueza de hifomicetos, Rajashekhar & Kaveriappa (2003) encontraram correlação positiva entre o número de espécies e o teor de oxigênio dissolvido. Shearer & Raja (2011) registraram até o momento, 358 espécies de ascomicetos e 414 espécies de fungos conidiais em ambientes lóticos como decompositores de substratos vegetais submersos.

Os ambientes lênticos têm sido menos explorados, mas comportam certo número de espécies inclusive novas (Fallah & Shearer 2001). Um dos primeiros fungos registrados nesse ambiente foi *Loramyces juncicola* W. Weston um discomiceto encontrado sobre colmo de *Juncus* sp. submerso em um lago no continente americano (Weston 1929). Pesquisas em regiões temperadas (Ingold 1954, 1955, Fallah et al. 1999, Shearer et al. 1999) e tropicais (Fisher & Spooner 1987, Hyde & Goh 1998) tem sido conduzidas. Até o momento, 265 espécies de ascomicetos e 142 espécies de fungos conidiais foram catalogadas como sapróbios de material vegetal em ambientes lênticos (Shearer & Raja 2011).

Resultados sobre a similaridade entre espécies em ambientes lênticos e lóticos tem se mostrado contraditórios. Raja et al. (2009b), investigando os padrões de distribuição latitudinal de ascomicetos na Península da Flórida, observaram que a composição das espécies não era significativamente diferente entre os dois ambientes. Contudo, Hu et al.

(2010), ao estudarem os fungos na Tailândia, concluíram o oposto. Os autores sugerem que mais estudos sejam realizados em ambos os ambientes, uma vez que a maioria destes tem sido conduzida separadamente.

Não somente o meio aquático natural é colonizado por fungos. Trabalhos demonstraram que eles são capazes de crescer em ambientes artificiais como torres de resfriamento em indústria de produção de energia (Jones & Eaton 1969).

Pesquisas sobre biodiversidade em ambientes aquáticos têm aumentado de forma exponencial nos últimos 15 anos principalmente depois da convenção sobre diversidade biológica (CBD 1992). Moustaka & Karakassis (2005) compilaram dados de referências que continham o termo biodiversidade, no período de 1973-2001, e verificaram que ambientes aquáticos são bem investigados no hemisfério norte, sendo as regiões polares praticamente inexplorada.

3. Fungos em ambientes aquáticos

Nos sistemas aquáticos, os microrganismos, incluindo eucariontes e procariontes, são ecologicamente importantes, pois degradam a matéria orgânica promovendo a ciclagem de nutrientes no ecossistema (Pusch et al. 1998). Dentre estes, os fungos aquáticos são geralmente negligenciados e seu estado atual de conhecimento, ou seja, informações sobre sua sistemática, distribuição geográfica, relação com o substrato entre outras, ainda possuem lacunas a serem preenchidas. Moustakas and Karakassis (2005), revisaram a literatura sobre a biodiversidade em ambientes aquáticos e concluíram que a maioria das pesquisas envolviam organismos de interesse comercial ou de grandes dimensões. Para o grupo dos fungos apenas 16 referências foram listadas. O grupo mais bem contemplado foi o dos vertebrados com 666 referências publicadas.

De acordo com Park (1972), os microrganismos presentes no ambiente aquático, chamados de residentes, podem assumir diferentes funções a depender do seu grau de adaptabilidade ao ambiente. Os residentes são classificados em dois grupos: os nativos (ou indígenas) que se mantém no ambiente aquático crescendo, esporulando e dispersando seus esporos na água. Bärlocher & Kendrick (1974) sugerem que estes sejam os principais decompositores da matéria orgânica alóctone por serem as formas dominantes no ambiente; e os imigrantes, os quais têm o ambiente terrestre como seu principal habitat, mas podem ser levados para dentro d’água por meio de materiais alóctones, ventos, chuvas ou solo (assoreamento). Dentre os imigrantes, os que são capazes de alternar

periodicamente seu ciclo de vida entre o ambiente aquático e terrestre são chamados de migrantes. Os versáteis são aqueles que utilizam a água como meio de dispersão. Estes últimos são ecologicamente ativos colonizando e degradando substratos. Já os transientes não são adaptados para viverem na água e ao entrarem nesse ambiente tem seu metabolismo diminuído sendo considerados ecologicamente não-ativos. As folhas, por exemplo, quando ainda estão presas às árvores já carregam propágulos de diferentes fungos. Ao cair na água, devido à temperatura menor, alguns fungos terrestres cessam seu crescimento, e os demais, juntamente com os fungos aquáticos que irão colonizar o substrato, participam da decomposição (Bärlocher & Kendrick 1974).

Os fungos podem desempenhar diferentes papéis no ambiente aquático: endofíticos de raízes (Iqbal et al. 1995) ou parasitas de algas, fungos, plantas e invertebrados (Shearer et al. 2007). Contudo, são como sapróbios que os fungos se destacam nesses ambientes (Wong et al. 1998, Shearer et al. 2007) sendo referidos como “engenheiros do ecossistema” por regular o fluxo de energia e nutrientes atuando na cadeia alimentar como intermediários entre plantas e invertebrados (Bärlocher & Kendrick 1976, 1981, Lawton & Jones 1995).

Os fungos presentes em ambientes aquáticos, tanto de água doce quanto de água salgada, compreendem grupos filogeneticamente diversos sendo representados, quase que totalmente, por microfungos (Shearer et al. 2007). A presença de macrofungos em ambientes aquáticos é rara, sendo estes representados por algumas espécies de Basidiomicetos como, por exemplo, *Gloiocephala aquatica* Desjardin, Martinez-Peck & Rajchenberg e *Psathyrella aquatica* J.L. Frank, Coffan & Southworth com um basidioma de até 1 mm e 10 cm de altura, respectivamente (Desjardin et al. 1995, Frank et al. 2010).

Em uma recente compilação de dados de literatura sobre fungos ocorrentes em ambientes aquáticos de diferentes áreas do mundo, Shearer et al. (2007) registraram, aproximadamente, 3.047 espécies sendo a maioria composta por ascomicetos (1.527 spp), seguida pelos fungos conidiais (785 spp), quitridiomicetos (576 spp) e basidiomicetos (21 spp). Um grupo informalmente tratado como fungo, os Saprolegniales (Oomicetos), foi registrado nesse estudo com 138 spp. Segundo os autores, uma superestimação de espécies é provável de ocorrer. A falta de conhecimento sobre conexões entre anamorfo e teleomorfo permite que uma mesma espécie seja contada duas vezes. Além disso, espécies terrestres são arrastadas para a água através da chuva ou são conduzidas sobre o substrato e são coletados ocasionalmente sendo registrados como fungos aquáticos. Dados mais recentes mostram a existência de 1.337 espécies de fungos catalogadas em ambiente de

água doce e 530 espécies em ambiente marinho (Jones & Choeyklin 2008, Jones et al. 2009). Em termos de estimativa do número de espécies, Schmit & Mueller (2007) calcularam o número limite inferior de fungos aquáticos existentes e encontraram um valor global de 8.400 espécies. Comparando esse resultado com os dados encontrados por Shearer et al. (2007) para o número de espécies descritas (3.047 spp), conclui-se que muitas espécies continuam desconhecidas.

Espécies do "Filo Zygomycota" têm sido pobremente documentadas em ambientes aquáticos. A maioria das espécies é encontrada na espuma de rios como esporos, juntamente com conídios de hifomicetos (Thomas 1996). Espécies também podem ser encontradas em intestinos de artrópodes, atuando como simbiontes, (Classe Trichomicetos) (Thomas 1996) ou como parasitas de insetos (Classe Zygomycetes) como *Erynia* sp. (Descals & Webster 1984), *Entomophthora thaxteri* (Brumpt) D.M. MacLeod & Müll.-Kög e *Acaulopage tetraceros* Drechsler (Ingold 1975a). Mais estudos são necessários para fornecer informações sobre a ecologia e a diversidade desse grupo.

Representantes do Filo Basidiomycota apresentam uma baixa ocorrência em ambientes aquáticos. Isso possivelmente se deve a combinação de diferentes fatores: i) basidiósporos imaturos são facilmente liberados dos basídios pelo movimento da água. Exceção ocorre com espécies de *Halocyphina* Kohlm. & E. Kohlm. e *Nia* R.T. Moore & Meyers, por possuírem basidioma fechado evitando o contato direto da água com o himênio e espécies de *Digitatispora* Doguet por apresentarem basidiósporos firmemente aderidos ao basídio (Ginns & Malloch 1977); ii) segundo Jones (1979), o grande tamanho dos basidiomas não é viável em um ambiente onde a água apresenta movimentos constantes. O basidioma necessitaria ser resistente, flexível e taloso; iii) a liberação ativa de basidiósporos, comum no Filo Basidiomycota, dificulta o estabelecimento do fungo no substrato submerso. Liberação passiva dos basidiósporos é encontrada em apenas poucas espécies como *Nia vibrissa* R.T. Moore & Meyers (gasteromiceto), *Digitatispora marina* Doguet e *Limnoperdon incarnatum* G.A. Escobar, por exemplo; iv) a liberação de enzimas extracelulares faz com que estas sejam diluídas na água dificultando a nutrição por decomposição do substrato e, conseqüentemente, o estabelecimento do fungo nesse ambiente (Brooks 1975, Jones 1979).

Para o Filo Glomeromycota, espécies em ambiente de água doce são escassos. Khan (1993) documentou cinco espécies de micorrizas arbusculares encontradas em raízes submersas de três diferentes plantas na Austrália.

Os hifomicetos são dominantes sobre substratos vegetais submersos e talvez mais importantes por iniciarem o processo de decomposição. Essa grande riqueza foi observada em trabalhos de sucessão fúngica (Schoenlein-Crusius & Milanez 1989, 1998, Schoenlein-Crusius et al. 1990, Kane et al. 2002, Promputtha et al. 2002, Zhou & Hyde 2002). Estudo demonstrou que a presença desses hifomicetos pode apresentar uma correlação positiva com a presença de certos elementos minerais no substrato, como: Ca^{+2}, Mg^{+2}, Fe^{+3}, Al^{+3}, Mn^{+2}, K, Zn^{+2} e Na^{+2} (Schoenlein-Crusius et al. 1999).

A fase teleomorfa tem sido documentada por ocorrer em baixas temperaturas enquanto a fase anamorfa por ocorrer em altas temperaturas (Chatmala et al. 2002). Dessa forma, a conexão anamorfo/teleomorfo não é comumente encontrada no ambiente aquático. Shearer (1993) revisou o número dessas conexões encontrando apenas quatro para regiões tropicais. Dados mais recentes de revisão mencionaram apenas 72 conexões anamorfo-teleomorfo. Para os fungos anamórficos, foram registradas 34 conexões com fungos ingoldianos e 38 com outros fungos conidiais. Dentre os fungos teleomórficos, 25 conexões foram estabelecidas com a Classe Leotiomycetes, 13 com Dothideomycetes e 27 com Sordariomycetes. Apenas cinco foram verificadas correndo com os basidiomicetos e um com os laboubeniomicetos. Esses dados mostram ainda, que a maioria das conexões foi registrada para espécies de regiões temperadas, com 26 ocorrências em regiões tropicais (Sivichai & Jones 2003).

Dentre os ambientes aquáticos, os de água doce, como rios, lagos e riachos, são os mais amplamente estudados (Sivichai et al. 2000, Raja & Shearer 2008, Ferrer et al. 2010). Isso poderia ser o fator determinante para o maior número de espécies presentes nesse tipo de ambiente aquático. Contudo, Perarman et al. (2010), comparando a composição de espécies de fungos decompondo madeira em três ambientes aquáticos (marinho, estuário e de água doce), concluíram que a diversidade dos fungos diminui em ambientes mais salinos. Além da diferença no número de espécies, parece que existe certa especificidade pelo ambiente. Em certo aspecto, o ambiente marinho tem apresentado uma barreira abiótica extremamente eficiente para a colonização por fungos de água doce e vice versa (Perarman et al. 2010).

O ambiente de água doce foi o foco desse trabalho sendo os ascomicetos e fungos conidiais os grupos investigados.

3.1 Ascomicetos em água doce

Os ascomicetos de água doce constituem um grupo polifilético e morfologicamente diverso pertencente ao subfilo Pezizomycotina e representados por numerosas linhas evolutivas dentro das Classes Leotiomycetes, Dothideomycetes e Sordariomycetes (Vijaykrishna et al. 2006). Shearer (1993) definiu os como um grupo de fungos que ocorre em substratos vegetais submersos, ou parcialmente submersos, em ambientes de água doce.

Diferentemente de outros grupos de organismos, incluve outros grupos de fungos, o conhecimento sobre ascomicetos de água doce é recente. Este grupo tem sido estudado nos últimos 60 anos desde as pesquisas pioneiras de Ingold (Ingold 1951, 1954, 1955, Ingold & Chapman 1952). Naquela época, muitos dos estudos micológicos em ambientes aquáticos se concentravam em investigar folhas submersas onde ascomas estão geralmente ausentes (Shearer 1993). Nos últimos 30 anos, estudos com diferentes substratos têm se intensificado e o conhecimento sobre a sistemática de ascomicetos de água doce tem aumentado drasticamente com diversas espécies sendo registradas (Shearer & Crane 1980, Shearer & Webster 1985a,b,c). Trabalhos de revisão (Goh & Hyde 1996a, Hyde et al. 1997, Shearer 2001, Shearer et al. 2007) e chave taxonômica com as espécies mais comuns foram publicados (Cai et al. 2003, 2006).

Shearer (1993) listou 288 ascomicetos em água doce. Atualmente, cerca de 592 espécies (excluindo leveduras e formas liquenizadas) tem sido registradas em todo o mundo sendo distribuidas em 112 Leotiomicetos, 190 Dothideomicetos e 289 Sordariomicetos (Shearer & Raja 2011). O alto número de Sordariomicetos em detrimento das demais classes já tinha sido observado por Ingold (1954). Das 60 ordens de ascomicetos existentes, 18 estão presentes em água doce. As que possuem 10 ou mais espécies registradas são: Leotiales, Pezizzales, Rhytismatales, Eurotiales, Amphisphaeriales, Diaporthales, Hypocreales, Halosphaeriales, Sordariales, Xylariales, Pleosporales, Melanommatales e Jahnulales (Pang et al. 2002, Campbell et al. 2007, Shearer et al. 2007).

Apesar dos esforços em investigar os ascomicetos, estudos ainda são fragmentados (Cai et al. 2006). A maioria das coletas tem ocorrido na América no Norte, Reino Unido, Europa e sudeste da Ásia (Ingold 1954, Fallah & Shearer 2001, Tanaka et al. 2005). Para os trópicos, Hyde (1992a,b,c,d, 1995) deu grande contribuição com o estudo desses fungos na Austrália. Uma lista com 18 espécies de água doce para os trópicos foi apresentada por

Shearer (1993), porém sem os dados obtidos por Hyde (1992a,b,c,d) no ano anterior. Posteriormente, Hyde et al. (1997) compilaram dados de literatura e observaram a ocorrência de 49 espécies. Cai et al. (2003), também analisando dados em literatura, registraram a existência de 177 espécies, sendo a maioria encontrada na Ásia tropical (Shearer et al. 2007). Países tropicais com dados sobre ascomicetos de água doce incluem: Austrália, China (Tsui et al. 2003), Costa Rica (Raja et al. 2009a, 2010, Ferrer et al. 2010), Panamá, Tailândia (Ferrer et al. 2007), Equador (Ferrer et al. 2008, 2010), Malásia, África do Sul e Brunei (Ho et al. 1997). No Brasil, estudos dessa natureza estão em fase inicial sob a responsabilidade de Gusmão e colaboradores. Como fruto desse trabalho inicial, *Annulatascus apiculatus* F.R. Barbosa & Gusmão foi encontrada e representa o primeiro registro de ascomiceto de água doce para o Brasil (Barbosa et al. 2008). Diante da falta de estudos em outras partes do mundo, ainda é prematuro afirmar a existência de espécies endêmicas. Além disso, Hyde et al. (1997) afirmam que, por haver espécies diferentes de ascomicetos nas regiões tropical e temperada, poucas espécies devem ser cosmopolitas.

Os ascomicetos parecem exibir uma moderada especificidade ao habitat (terrestre, aquático e marinho). Poucas espécies têm sido registradas para mais de um habitat (Vijaykrishna et al. 2006). Estudo recente com 35 espécies mostrou não haver similaridade entre aquelas encontradas em ambiente marinho e de água doce, havendo baixa similaridade (Índice de Sorensen 0,18) entre as espécies de ambiente estuarino e de água doce (Pearman et al. 2010). Dados contraditórios mostram que ainda é prematuro afirmar sobre a existência de especificidade dentre as espécies de água doce. Raja et al. (2009b) encontrou alta similaridade entre espécies de ambiente lêntico e lótico na Flórida. Contudo Hu et al. (2010), na Tailândia, não verificou similaridade entre as espécies desses ambientes.

A maioria dos gêneros de ascomicetos exclusivos de água doce está presente na família Annulatascaceae (*Aquaticola* W.H. Ho, K.M. Tsui, Hodgkiss & K.D. Hyde, *Cataractispora* K.D. Hyde, S.W. Wong & E.B.G. Jones, *Pseudoproboscispora* Punith., *Rivulicola* K.D. Hyde e *Torrentispora* K.D. Hyde, W.H. Ho, E.B.G. Jones, K.M. Tsui & S.W. Wong) que incorpora representantes com adaptações ao ambiente aquático. As adaptações de ascomicetos nesse tipo de ambiente incluem: ascos deliqüescentes, estruturas tipo rizóide no ascoma e ascósporos com apêndices, paredes ornamentadas e bainha mucilaginosa. Este último representa o tipo mais comum de adaptação. Apêndices são mucilaginosos não envolvendo fragmentação e/ou extensão da parede do esporo como salientado por Shearer (1993). A natureza do asco deliqüescente permite que os ascósporos

se acumulem ao redor do ostíolo do ascoma sendo disperso pelo movimento da água (Wong et al. 1998). Todas as adaptações são, provavelmente, eficazes na dispersão dos esporos e fixação no substrato (Hawksworth 1984, Jones 1994) (Figura 5).

Shearer (1993) classificou os ascomicetos de água doce pelo seu papel ecológico em: parasitas de plantas e algas, endofíticos e sapróbios. Contudo, a maioria das espécies é conhecida por atuar como sapróbios e ocorrerem sobre madeira e substratos herbáceos, sendo que poucas espécies ocorrem em ambos os tipos de substratos (Shearer 2001). A madeira como substrato vem sendo estudada mais intensamente tanto em regiões temperadas (Shearer 1993, Kane et al. 2002) quanto tropicais (Sivichai et al. 2002) e subtropicais (Hyde et al. 1998). Abdeal-Raheem & Shearer (2002) investigaram a capacidade de 30 espécies isoladas de madeira e/ou substrato herbáceo, enquanto Simonis et al. (2008) testaram outras 27 espécies, em produzirem enzimas extracelulares. Esses estudos mostraram que os ascomicetos de água doce são capazes de produzir uma grande variedade de enzimas degradando a lignocelulose e outros componentes complexos desempenhando um papel decisivo na ciclagem do carbono.

A presença de um ascomiceto sobre um substrato submerso em água doce não é um fator determinante para classificá-lo como exclusivamente aquático. Algumas espécies registradas nesse tipo de ambiente também já foram previamente encontradas no ambiente terrestre devido, por exemplo, ao transporte de substratos para a água (Shearer 1993) levados pelo vento, chuva, etc. Wong et al. (1998) pontuaram que somente as espécies encontradas em água doce e não registradas para o ambiente terrestre devem ser categorizadas como verdadeiramente aquáticas. Porém, uma vez que estudos ainda são escassos, pouco se pode afirmar sobre a real relação dessas espécies com o ambiente. Devido a muitas controvérsias associadas à delimitação desse grupo ecológico, pesquisadores ainda preferem considerar qualquer ascomiceto isolado de substrato vegetal submerso como ascomicetos de água doce (Vijaykrishna et al. 2006). Diante de uma pesquisa com ascomicetos de água doce, importante é analisar aspectos como: grau de decomposição do substrato coletado e a presença de adaptações ao ambiente aquático, além de consultar bancos de dados a fim de verificar a ocorrência da espécie em outros ambientes. Uma metodologia de coleta correta é indispensável para excluir parte dos ascomicetos terrestres previamente presentes sobre os substratos vegetais que se tornam submersos (Shearer com. pess.).

3.2 Fungos conidiais em água doce

Os fungos conidiais formam um grupo artificial, anteriormente conhecido como fungos imperfeitos, fungos anamórficos ou Deuteromicetos, e constituem a fase assexuada (anamórfica) de basidiomicetos e, principalmente, ascomicetos. São divididos em três classes artificiais: coelomicetos, hifomicetos e agonomicetos que podem estar presentes tanto no ambiente terrestre quanto no aquático (Alexopoulos et al. 1996 Seifert & Gams 2001). Neste último caso, eles são definidos como aqueles que apresentam todo ou parte do seu ciclo de vida na água. Esta definição é considerada vaga uma vez que não considera a sua origem (Chan et al. 2000).

Investigando a biodiversidade de fungos em ambientes aquáticos Shearer et al. (2007) compilaram dados de 785 espécies de fungos conidiais. Para o ambiente de água doce, dado recente de revisão revelou a existência de 660 espécies (Jones & Choeyklin 2008).

Registros sobre coelomicetos em ambientes de água doce têm sido escassos. Apenas 13 espécies foram registradas no mundo (Shearer & Raja 2011). Shearer et al. (2007) acreditam que a falta de especialistas trabalhando com o grupo justifica a baixa ocorrência dos dados. Segundo Descals & Moralejo (2001), os coelomicetos são abundantes no ambiente aquático, contudo são ignorados, uma vez que alguns são difíceis de ser identificados.

Os hifomicetos têm recebido maior atenção dos pesquisadores. Eles são constituídos de estruturas reprodutivas básicas como: conidióforo (variando quanto a coloração, septação, organização, semelhança com a hifa somática, etc.); células conidiogênicas (que variam quanto à posição, tipo de conidiogênese, proliferação, forma, etc.) e conídios. Estes últimos apresentam grande variedade de formas sendo produzidos de maneira rápida uma vez que requerem menos energia do que os esporos sexuais (Alexopoulos et al. 1996, Seifert & Gams 2001). Os conídios têm como principal função a dispersão, garantindo a sobrevivência da espécie. No ambiente aquático, os hifomicetos podem ser encontrados dispersos ou envolvidos na espuma (Ingold 1975b, Fisher 1979, Roldán et al. 1990).

Os hifomicetos de água doce têm sido bem investigados em regiões temperadas (Sivichai et al. 2002, Mavanová et al. 2003, Abdullah et al. 2005, Shearer et al. 2007). Estudos em regiões tropicais iniciaram a cerca de 20 anos e dados de revisões disponíveis revelam a existência de, aproximadamente, 280 espécies (Goh 1997). Nessa região o

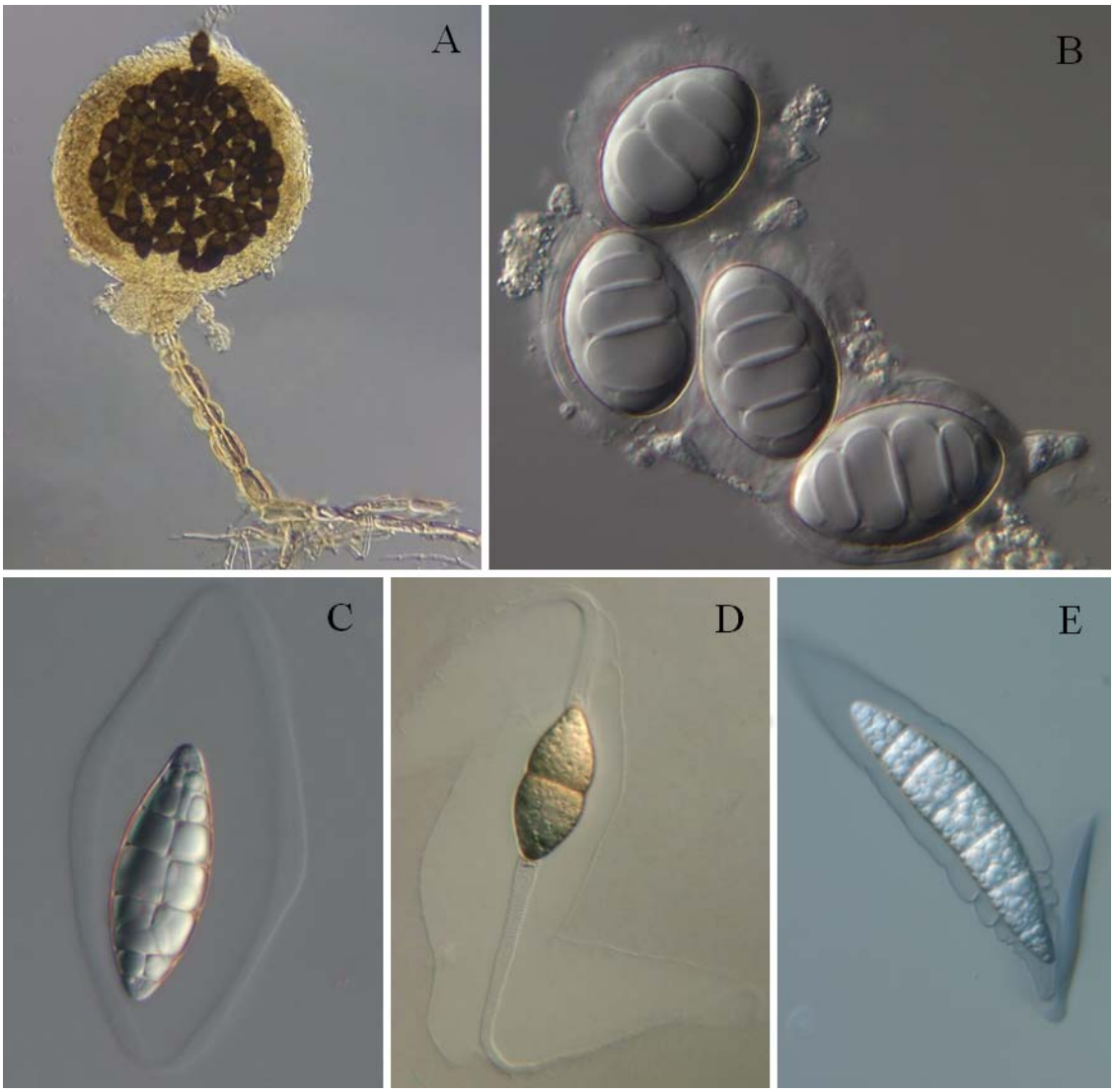

Figura 5. Adaptações em ascomicetes de água doce. A. Ascoma com rizóides em *Megalohypha aqua-dulces* A. Ferrer & Shearer. B. Asco deliqüescente em *Luttrellia halonata* A. Ferrer & Shearer. C. Bainha mucilaginosa ao redor do ascósporo de *Lucidascocarpa pulchella* A. Ferrer, Raja & Shearer D. Apêndices no ascósporo de *Jahnula appendiculata* Pinruan, K.D. Hyde & E.B.G. Jones. E. Bainha mucilaginosa ao redor do ascósporo de *Falciformispora lignatilis* K.D. Hyde formando uma estrutura em forma de esporão na base. Fotos: A por Astrid Ferrer, B por Carol Shearer, C-E por Huzefa Raja.

conhecimento é fragmentado sendo registrados em países como Índia (Sridhar & Kaveriappa 1989), Austrália (Hyde & Goh 1998), Malásia (Nawawi 1985, Kuthubutheen & Nawawi 1991), Cuba (Voglmayr & Delgado-Rodriguez 2001), Tailândia (Sivichai & Hywel-Jones 1999, Sivichai et al. 2002) entre outras localidades. Schoenlein-Crusius & Grandi (2003) compilaram dados presentes em literatura onde reportaram 90 espécies para a América do Sul incluindo Argentina, Brasil, Chile, Equador, Peru e Venezuela. Para Shearer et al. (2007) a desigualdade na amostragem em várias áreas geográficas torna a atual distribuição geográfica das espécies tendenciosa. É importante encorajar estudos dessa natureza e formar recursos humanos especializados, principalmente em regiões tropicais, uma vez que os hifomicetos são os fungos mais ativos como decompositores em ambientes aquáticos.

Algumas espécies encontradas na água também são capazes de existirem no ambiente terrestre. Isso foi enfatizado por Bandoni (1972), que registrou grande número de esporos sigmóides e tetraradiados em folhas, e corroborado por estudos posteriores (Singh & Musa 1977, Sridhar & Kaveriappa 1987). Sanders & Webster (1978) demonstraram que essas espécies sobrevivem melhor e são mais ativas em ambiente terrestre onde a chuva proporciona um meio semelhante ao aquático. Para Bandoni (1972), os resultados sugerem que algumas dessas espécies são primariamente terrestres.

É atuando no ambiente como sapróbios de substratos vegetais que os hifomicetos aquáticos se destacam. Dessa forma, atuam na cadeia alimentar como intermediários entre plantas e invertebrados (Bärlocher & Kendrick 1976, 1981). Quanto ao tipo de substrato vegetal, a maioria desses fungos tem sido reportada sobre folhas e galhos de dicotiledôneas. Sobre folhas de coníferas foram registradas poucas espécies. Bärlocher & Oertli (1978) e Michaelides & Kendrick (1978) observaram uma alta resistência da cutícula e da epiderme de folhas de coníferas à colonização por fungos. Suberkropp & Klug (1974) examinaram folhas submersas em decomposição ao microscópio eletrônico e concluíram que os hifomicetos aquáticos são predominantes sobre esse tipo de substrato e são os principais responsáveis pela decomposição. Diferentes fatores podem influenciar a presença desses fungos no substrato. Kearns & Bärlocher (2008) confirmaram que a rugosidade da superfície foliar aumenta a taxa de captura de conídios de hifomicetos aquáticos, mas talvez não seja o fator determinante. Gulis (2001) demonstrou que algumas espécies de plantas suportam hifomicetos aquáticos específicos, sugerindo uma especificidade, ao menos, para as espécies encontradas.

A fase teleomorfa do hifomicetos, quando presente, pertence em grande parte ao Filo Ascomycota (Shearer et al. 2007). Os hifomicetos de água doce formam um grupo heterogêneo e filogeneticamente artificial. Três grupos ecológicos podem ser diferenciados: os fungos ingoldianos, os fungos aeroaquáticos e os fungos aquáticos lignícolas (Goh 1997).

3.2.1 Os fungos ingoldianos

Nos primeiros anos de 1890, De Wildeman reconheceu estruturas ramificadas coletadas em água como esporos de fungos e descreveu três gêneros: *Clavariopsis* De Wild., *Lemonniera* De Wild. e *Tetracladium* De Wild. Contudo ele não trabalhou com cultura pura (Marvanová 1997). Cerca de 50 anos mais tarde, Ingold registrou diversas espécies novas ao examinar folhas em riachos na Inglaterra (Ingold 1942, 1943, 1944, 1955). Em seguida, passou a investigar espuma e folhas em riachos na África (Ingold 1956, 1958, 1959, 1961). O ponto crucial nas pesquisas com fungos ingoldianos foi a publicação de um guia ilustrado na Inglaterra que contém a descrição de diversas espécies (Ingold 1975a). Neste momento, o grupo se tornou amplamente conhecido. Muitos trabalhos se seguiram, tanto taxonômicos com chaves de identificação (Descals & Webster 1982, 1983, Marvanová 1997, Descals 2005, Schoenlein-Crusius & Malosso 2006) quanto ecológicos (Shearer & Webster 1985a,b,c, Sridhar & Bärlocher 1993b, Gulis 2001, Medeiros et al. 2009) e filogenéticos (Belliveau & Bärlocher 2005).

O termo “hifomicetos aquáticos” foi proposto para se referir aos fungos ingoldianos (Ingold 1942, Descals & Moralejo 2001). Com a publicação da primeira monografia sobre o grupo, Nilsson (1964) utilizou o termo “freshwater” diferenciando-os dos hifomicetos que ocorrem em água salgada. Marvanová (1973), no entanto, atribuiu o termo “water-borne” sugerindo sua origem na água. Posteriormente, Descals et al. (1978) introduziu o termo “Ingoldianos” em homenagem ao pesquisador C.T. Ingold. O termo inicialmente proposto voltou a ser usado em algumas publicações, inclusive recentemente (Swart 1986, Sridhar & Kaveriappa 1989, Shearer et al. 2007). Os nomes sugeridos devem ser discutidos e mais estudos devem ser realizados a fim de compreender melhor o grupo e atribuir-lhe o nome mais adequado.

Do ponto de vista taxonômico, os fungos ingoldianos formam um grupo artificial e sua identificação é baseada na morfologia dos conídios (Descals 2005). Essa conduta tem sido discutida e parece não ser segura uma vez que algumas espécies, provavelmente,

sofreram evolução convergente. Isso significa que conídios semelhantes são produzidos por conidiogêneses diferentes, o que pode levar a uma falsa identificação (Ingold 1975c) Esforços vêm sendo feitos para introduzir critérios baseados na comparação de sequências de nucleotídeos (Letourneau et al. 2010, Seena et al. 2010).

Os conídios dos fungos ingoldianos são, na grande maioria, grandes (50-100 µm) hialinos, ramificados (geralmente tetraradiados) ou sigmóides. Estas morfologias são interpretadas como adaptações ao ambiente de água corrente em que vivem, com a finalidade de ancorar e aderir ao substrato (Figura 6 A-B). Também é observado material mucilaginoso produzido pelo conídio após contato com o substrato e suas extremidades alongadas favorecem o contato com o material submerso (Dix & Webster 1995, Kearns & Bärlocher 2008). Apesar dos conídios tetraradiados apresentarem mais pontos de contato com o substrato do que os conídios sigmóides, a sua maior adaptabilidade ao ambiente aquático foi discutida por Webster & Davey (1984). Os autores demonstraram que apesar dos conídios sigmóides possuírem apenas dois pontos de contato/aderência, a sua morfologia diminui a área de contato com a água e também a probabilidade de serem arrastados pela corrente d'água.

Os fungos ingoldianos compreendem os hifomicetos que são exclusivamente dependentes do ambiente aquático para a reprodução. Estão presentes na natureza habitando, principalmente, ambientes lóticos com água limpa e clara, porém alguns já foram reportados em água poluída (Sridhar et al. 2000), lagos e no ambiente terrestre (Bandoni 1972, Schoenlein-Crusius & Malosso 2006). Nesses ambientes eles são encontrados decompondo substratos vegetais mortos de angiospermas e, em menor proporção, de gimnospermas (Michaelides & Kendrick 1978), como endofíticos de raízes submersas (Iqbal et al. 1995) ou aderidos à espuma. Esta última atua como uma armadilha para os esporos (Ingold 1956, Iqbal & Webster 1973, Sridhar & Bärlocher 1993a, Sakayaroj et al. 2005).

O registro de espécies no ambiente terrestre tem gerado questionamentos sobre sua origem. Bandoni (1972) coletou material vegetal de serapilheira em áreas distantes de qualquer ambiente aquático, no Canadá e nos Estados Unidos, submergiu-as em água destilada e esterilizada encontrando espécies com esporos tetraradiados e sigmóides. Michaelides & Kendrick (1978) utilizou o termo "anfíbios" quando observou sua ocorrência sobre coníferas sendo esse termo aceito também por Ingold (1979) e Akridge & Koehn (1987). Para Ingold (1979), esses fungos são levados à terra através dos seus esporos que se fixam a bolhas de ar na água. Quando estas sobem à superfície, estouram e

os esporos são conduzidos, com ajuda do vento, à terra. Ainda segundo o autor, isso explicaria também a colonização de substratos presentes na parte superior do rio uma vez que os esporos são levados, pelo fluxo da água, para partes mais baixas. Gönczöl & Révay (2003) estudaram fungos sobre folhas e galhos submersos presentes em orifícios de árvores na Hungria registrando também algumas espécies tetraradiadas. Trabalhos anteriores também podem ser citados (Waid 1954, Price & Talbot 1966).

Espécies morfologicamente semelhantes aos fungos ingoldianos, ou seja, com conídios ramificados e a maioria hialino, contudo com conidióforo micronemático, foram registradas no ambiente terrestre e tem sido consideradas, por alguns autores, como um grupo a parte. Essas espécies são isoladas de gotas de orvalho ou chuva na superfície de folhas ou de água de chuva que escoam de árvores (Ando & Tubaki 1984a,b). Ao coletar gotas de chuva sobre plantas intactas, Ando (1992) nomeou esses fungos de “hifomicetos aquático-terrestres”. Segundo o autor, a ausência de conidióforo seria uma adaptação a sua existência terrestre uma vez que o fungo precisaria produzir conídios rapidamente em um ambiente cuja água não é frequente. Além disso, o autor considera que a morfologia ramificada do conídio permitiria ao fungo reter a água ao redor do esporo mais tempo possível aumentando a possibilidade de germinação. Goh & Hyde (1996a) classificaram os hifomicetos de água doce em quatro diferentes grupos reconhecendo os “hifomicetos aquático-terrestres” como um grupo a parte assim como Descals & Moralejo (2001). Gönczöl & Révay (2003) sugeriram uma origem endofítica para esses fungos. Trabalho desenvolvido recentemente (Schoenlein-Crusius & Malloso 2006) considera os “hifomicetos aquático-terrestres” juntamente com os hifomicetos aquáticos lignícolas. Estudos ainda são escassos para estabelecer uma correta definição e delimitação desse grupo ecológico bem como determinar sua origem. Pesquisas adicionais são de fundamental importância para compreender essas questões.

Shearer et al. (2007) revisaram, aproximadamente, 290 espécies de fungos ingoldianos em ambientes aquáticos. Dados recentes para água doce não foram publicados, porém a maioria das espécies foi registrada nesse ambiente uma vez que, Hyde & Pointing (2000) registraram apenas 28 fungos ingoldianos para o ambiente marinho.

Em contradição com a região temperada, onde os ambientes aquáticos tem sido bem explorados quanto a presença de fungos ingoldianos (Ingold 1942, Petersen 1963a,b, Wood-eggenschwiler & Bärlocher 1983, Shearer & Webster, 1991, Mavanová et al. 2003), na região tropical esse conhecimento ainda é esporádico e disperso sendo registrados em países como: Índia (Sridhar & Kaveriappa 1989), Austrália (Swart 1986), Cuba

(Marvanová & Marvan 1969), Uganda, Rodésia (Ingold 1958), Nigéria (Ingold 1959), Gana (Dixon 1959), Jamaica (Hudson & Ingold 1960) entre outros. Para o Brasil, pesquisas se restringem ao estado de São Paulo. Estudos com esse grupo iniciaram-se no final dos anos 80 com a investigação da sucessão de fungos em folhas submersas de *Ficus microcarpa* L.f. (Schoenlein-Crusius & Milanez 1989), *Quercus robur* L. (Schoenlein-Crusius et al. 1990) e *Alchornea triplinervia* (Spreng.) Muell. Arg. (Schoenlein-Crusius & Milanez 1998) que revelaram a presença de alguns fungos ingoldianos. Estudos taxonômicos também foram publicados (Schoenlein-Crusius & Milanez 1990, Schoenlein-Crusius et al. 1992, Schoenlein-Crusius 2002, Schoenlein-Crusius et al. 2009).

Um guia para a taxonomia dos fungos ingoldianos foi publicado por Ingold (1975a). Chave taxonômica para gêneros foi publicada por Petersen (1962). Para espécies tropicais, Marvanová (1997) publicou uma chave com base em materiais coletados na Índia e Malásia.

3.2.2 Os hifomicetos aeroaquáticos

Esses hifomicetos, como grupo, têm sido estudados por mais de 60 anos (Prokhorov & Bodyagin 2007). Linder (1929) publicou uma monografia sobre fungos helicospóricos, contudo, o termo fungos aeroaquáticos foi criado por Agathe van Beverwijk ao descrever *Clathrosphaerina zalewskii* Beverw. sobre folhas submersas (Beverwijk 1951). Agathe juntamente com Janet Glen-Bott foram as pioneiras no estudo desses fungos. Elas descreveram não somente novas espécies como também perceberam qual o tipo de ambiente e substrato que os fungos aeroaquáticos são freqüentemente encontrados (Shearer et al. 2007).

Os fungos aeroaquáticos compreendem os hifomicetos que são incapazes de completar seu ciclo de vida sobre substratos submersos, ou seja, crescem vegetativamente quando o substrato se encontra sob a água, porém esporulam quando este é exposto ao ar. Na maturidade esses propágulos se destacam e flutuam livremente na superfície da água. Estão presentes na natureza habitando, principalmente, ambientes lênticos, como lagos e riachos de correnteza fraca e colonizando matéria orgânica em decomposição (Premdas & Kendrick 1991). Alguns são capazes de parasitismo (Prokhorov & Bodyagin 2007) e podem também estar presentes no solo (Fisher 1978, Abdullah & Webster 1980).

Os fungos aeroaquáticos são capazes de resistir a condições extremas. Fisher (1977) observou que esses fungos não esporulam em condições anaeróbicas, porém são capazes

de desenvolver seu micélio e sobreviver até que encontrem condições favoráveis. Esse dado foi corroborado por Field & Webster (1983) que registraram a resistência de espécies de *Helicodendron* Peyronel por um período de um ano em condição anaeróbica não havendo produção de clamidósporos. Posteriormente, Field & Webster (1985) demonstraram que esse grupo de fungo também é capaz de resistir à presença de sulfeto.

Os conídios dos fungos aeroaquáticos são estruturas geralmente multicelulares de grande diversidade morfológica, em sua maioria helicoidal ou clatróide. Essas formas são consideradas como adaptações ao ambiente uma vez que permite o aprisionamento de ar no seu interior (Figura 6 C-D). Dessa maneira, os conídios são capazes de flutuar sendo dispersos na superfície da água ou quando o substrato é submerso novamente. Esse mecanismo é auxiliado por incrustações de natureza hidrofóbica, semelhantes a verrugas, que são vistas apenas com o auxílio de microscópio eletrônico de varredura (Shearer et al. 2007).

Taxonomicamente, os fungos aeroaquáticos formam um grupo artificial. A maioria das espécies é anamorfo de ascomicetos. Apenas *Aegerita candida* Persoon e *Aegeritina tortuosa* (Bourdot & Galzin) Jülich, são anamorfos dos basidiomicetos *Bulbillomyces farinosus* (Bresàdola) Jülich e *Subulicystidium longisporum* (Patouillard) Parmasto, respectivamente. Recentemente, uma nova conexão com basidiomiceto foi apresentada: *Peyronelina glomerulata* Arnaud ex Fisher, Webster & Kane foi encontrada crescendo sobre madeira submersa juntamente com uma espécie de basidiomiceto do gênero *Flagelloscypha* Donk (Yamaguchi et al. 2009).

A maioria dos trabalhos sobre os fungos aeroaquáticos versa sobre sua taxonomia e alguns sobre sua ecologia (Prokhorov & Bodyagin 2007). Observações sobre a preferência por substrato foram realizadas. Premdas & Kendrick (1991) concluíram que algumas espécies colonizam substratos recém submersos (mais íntegros) enquanto outras preferem aqueles com mais tempo de submersão (mais decompostos). Prokhorov & Bodyagin (2007) verificaram que à medida que as folhas vão sendo decompostas, o número de fungos diminui. Segundo os autores, a maior extensão a ser decomposta em folhas íntegras, associado ao fato de que somente poucas espécies conseguem degradar a lignina (Fisher et al. 1983), podem influenciar na diferença de colonização. Prokhorov & Bodyagin (2007) observaram ainda que a maioria das espécies de fungos aeroaquáticos ocorreram sobre folhas de angiospermas ao contrário da menor incidência em folhas de gimnospermas. Resultado semelhante foi registrado anteriormente para os fungos ingoldianos (Bärlocher & Oertli 1978, Michaelides & Kendrick 1978). Devido a lacunas no estudo ecológico do

grupo, estudos adicionais são necessários para corroborar ou não com as afirmações pré-estabelecidas.

Shearer et al. (2007) compilaram 90 registros de fungos aeroaquáticos em ambientes aquáticos em todo o mundo. O conhecimento sobre a biodiversidade de fungos aeroaquáticos é mais alta em regiões temperadas (Goos & Descals 1985, Abdullah et al 2005). Contudo, muitas espécies já foram registradas para regiões tropicais (Voglmayr & Delgado-Rodriguez 2001, Hao et al. 2005, Voglmayr & Yule 2006).

Subramanian (1983) listou as espécies mais comuns enquanto Webster & Descals (1981) apresentaram informações sobre a biologia do grupo. Chaves taxonômicas para espécies comuns em ambiente de água doce foram confeccionadas por Goh & Tsui (2003) e Cai et al. (2006).

3.2.3 Os fungos aquáticos lignícolas

Esse grupo de fungos heterogêneos foi considerado por Ingold (1975a) e Descals & Moralejo (2001) como “aquáticos facultativos” por serem comuns também no ambiente terrestre. Goh & Hyde (1996a) atribuíram o termo “aquático submerso”. Devido à grande ocorrência de espécies sobre madeira, Goh (1997) nomeou o grupo como “aquáticos lignícolas”. Recentemente, Shearer et al. (2007) consideraram esse grupo como “fungos miscelaneous”. O grande número de termologias reflete o recente conhecimento sobre sua ecologia. Segundo Révay & Gönczöl (2007), “somos forçados a criar novos termos para os fungos de ambientes aquáticos, mas parece que a estratégia de vida deles é mais complicada do que as categorias ecológicas existentes”. Mais estudos são necessários para se compreender melhor o grupo e atribuir-lhe o termo mais adequado.

Os fungos aquáticos lignícolas compreendem os fungos conidiais encontrados sobre material vegetal herbáceo ou, mais comumente, lignícola submersos em ambientes lóticos (Kane et al. 2002) ou lênticos (Goh & Hyde 1999). São fungos, principalmente, dematiáceos com parede grossa e conidióforos diferenciados (macronemáticos) (Goh & Tsui 2003). Os conídios não são distintamente modificados para a sobrevivência na água apresentando formas variadas como ovóide, cilíndrico, obclavado, piriforme, fusiforme ou ramificado e a dispersão dos esporos ocorre pela água ou pelo ar (Goh & Hyde 1996a) (Figura 6 E-G).

Estudos taxonômicos desses fungos iniciaram há cerca de 25 anos atrás, principalmente em regiões tropicais como Malásia (Kuthubutheen 1987, Kuthubutheen &

Nawawi 1991), Austrália (Goh & Hyde 1996b,c,d), África do Sul (Hyde et al. 1996), Hong Kong (Tsui et al. 2001) e Tailândia (Sivichai et al. 2000). Apesar disso, a maioria dos estudos ocorre em países temperados incluindo: Áustria, Canadá, Espanha, Estados Unidos, Hungria, Inglaterra, entre outros (Shearer et al. 2007). A exposição de blocos de madeira em rios tem registrado grande riqueza de fungos lignícolas. Kane et al. (2002) submergiram madeira de *Fagus sylvatica* L. e *Pinus sylvestris* L. na Inglaterra. Na Tailândia, Sivichai et al. (2002) utilizaram blocos de *Dipterocarpus alatus* Roxb. & G.Don e *Xylia dolabriformis* Benth. No Brasil, estudos envolvendo esse grupo têm revelado algumas espécies ocorrendo apenas no ambiente terrestre (Batista et al. 1960, 1965, 1967, Grandi & Gusmão 2001, Calduch et al. 2002, Castañeda-Ruiz et al. 2003, 2007, Marques et al. 2007b, Cruz & Gusmão 2009).

Até o momento 539 espécies foram registradas para ambiente de água doce (Shearer & Raja 2011). Destas, apena 13 são coelomicetos. Para Shearer et al. (2007), a baixa ocorrência de coelomicetos no ambiente reflete a falta de recursos humanos especializados. Descals & Moralejo (2001) já tinham noticiado que estudos dessa natureza são ignorados.

Chave taxonômica com os gêneros mais comuns em água doce foi publicada por Goh & Tsui (2003) e Cai et al. (2006) incluindo ilustrações, comentários e descrições.

4. Substratos vegetais submersos e sua importância no ambiente aquático

Em comunidades aquáticas, uma parte substancial da matéria orgânica presente provém do material vegetal alóctone. Em outras palavras, um riacho que corre através de uma área arborizada obtém grande parte de sua energia da serapilheira oriunda da vegetação de entorno. A outra parte provém do material autóctone (Begon et al. 2007). Diante disso, podemos considerar como substratos vegetais submersos, folhas, galhos, cascas, frutos e flores, ou fragmentos destes, que se desprendem de plantas aquáticas e/ou que chegam aos ambientes aquáticos quando caem de plantas terrestres ou são levados pela ação do vento ou chuva (Wong et al. 1998). A importância das duas fontes de matéria orgânica (alóctone e autóctone) depende das espécies de plantas que depositam substratos vegetais no ambiente aquático e da dimensão do corpo d'água. Begon et al. (2007) consideram que um lago grande e profundo obterá pouca matéria orgânica do exterior uma vez que o perímetro do lago é pequeno em relação a sua área de superfície.

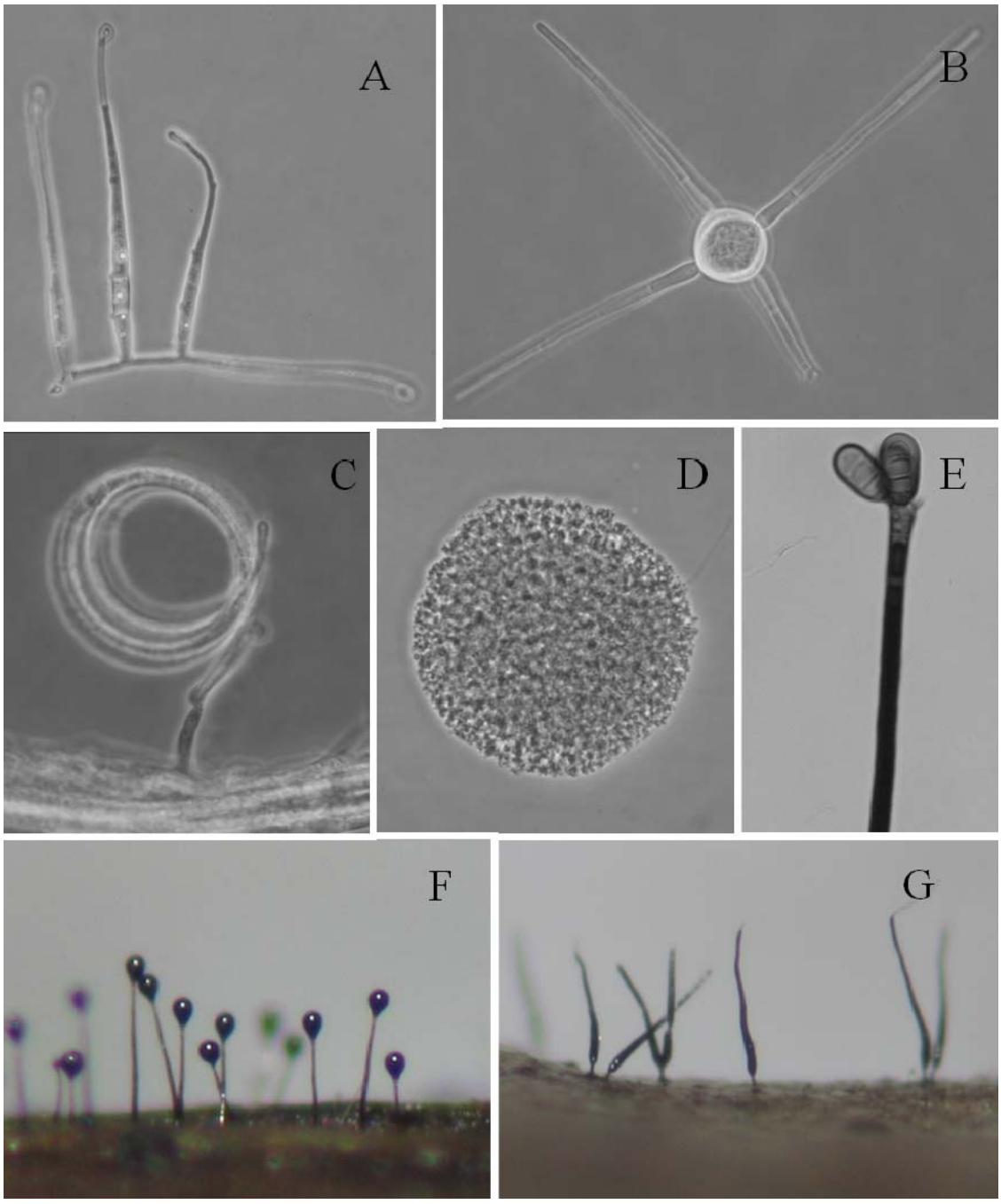

Figura 6. Características morfológicas de fungos conidiais encontrados em ambientes de água doce (fungos ingoldianos, aeroaquáticos e aquáticos lignícolas). A. Conídio ramificado de *Ingoldiella hamata* D.E. Shaw. B. Conídio tetraradiado de *Brachiosphaera tropicalis* Nawawi. C. Conídio helicoidal de *Helicomyces roseus* Link. D. Conídio clatróide em *Candelabrum brocchiatum* Tubaki. E. Conídios dematiáceos e elípticos de *Exserticlava triseptata* (Matsush.) S. Hughes. F. Conídios dematiáceos e obovóides de *Monotosporella setosa* (Berk. & M.A. Curtis) S. Hughes. G. Conídios dematiáceos e cilíndricos de *Ellisembia adscendens* (Berk.) Subram. Fotos por Flavia Barbosa.

Ao revisar o papel de galhos e cascas de árvores em ambientes aquáticos, Shearer (1992) concluiu que estes substratos permanecem mais tempo submersos na água do que as folhas por apresentar uma decomposição lenta e grande tamanho, o que faz destes, importantes reservatórios de fungos em ambientes aquáticos. Ainda segundo a autora, o longo tempo de permanência pode ser o fator determinante da grande variedade de grupos de fungos sobre o substrato (ascomicetos, basidiomicetos, fungos conidiais), o alto grau de competitividade e altas taxas de conexão anamorfo-teleomorfo. Estudos sobre a decomposição de folhas são mais amplamente conhecidos, visto que, dentre os materiais alóctones, estas são mais abundantes (Mathuriau & Chauvet 2002, Elosegi & Pozo 2005). Isso fica bem evidente no período de outono em regiões temperadas quando árvores perdem suas folhas (Premdas & Kendrick 1991, Marvanová 1997). Diferentemente de folhas de angiospermas, as folhas de coníferas eram consideradas como substratos pobres em fungos (Ingold 1966). Contudo estudos posteriores mostraram que, mesmo possuindo barreiras para a colonização como cutícula e epiderme grossas e compostos fenólicos, elas são colonizadas após prolongada submersão na água ou quando são pré-tratadas para submersão (extração química da cutícula e corte longitudinal) (Bärlocher & Oertli 1978, Michaelides & Kendrick 1978).

Ao encontrar o ambiente aquático, a matéria orgânica inicia o processo de decomposição. Este processo envolve a liberação de energia e a mineralização de nutrientes químicos, ou seja, a conversão de elementos da forma orgânica para a inorgânica (Meguro et al. 1980, Begon et al. 2007). Para Gessner et al. (1999), o processo de decomposição em ambientes aquáticos deve ser conceituadamente melhorado, uma vez que ainda são utilizados modelos do sistema terrestre. A decomposição no ambiente aquático envolve três etapas: lixiviação, condicionamento e fragmentação. A lixiviação é a etapa em que o substrato vegetal perde material solúvel (carboidratos, aminoácidos, compostos fenólicos) diminuindo, a depender da espécie, até 30% de sua massa original entre 24-48 horas após a imersão (Suberkropp et al. 1976, Bärlocher 2005).

O tempo de abscisão parece interferir nesta etapa. Gessner (1991) mostrou que a perda de material solúvel no ambiente aquático ocorre rapidamente em folhas secas quando comparadas com folhas frescas. O mesmo pode ser afirmado sobre a colonização por fungos (Bärlocher 1991, Chergui & Pattee 1992), indicando que estes conseguem se desenvolver prontamente quando certos componentes químicos já foram retirados do substrato. Inicia-se, portanto, a etapa de condicionamento, onde os microrganismos atuam na decomposição condicionando o material vegetal a se tornar mais palatável aos

invertebrados. Ao submergirem, substratos vegetais podem já conter micélio ou estruturas de reprodução de fungos terrestres. Porém, a maioria é gradativamente substituída por fungos do ambiente aquático (Chamier et al. 1984). Na última etapa, a fragmentação, o material vegetal sofre quebras físicas, pela ação do fluxo d'água, ou biológica pela ação de invertebrados que se alimentam desse material (Gessner et al. 1999). Os invertebrados são seletivos e suas preferências alimentares foram relacionadas com o conteúdo de nutrientes do substrato e os tipos de microrganismos presentes (Graça et al. 2001). Dessa forma, a presença de fungos colonizando substratos submersos desempenha papel crucial na alimentação de invertebrados aquáticos uma vez que torna o material mais palatável por ser uma rica fonte de nutrientes (Bärlocher 1985)

A importância de microrganismos e invertebrados no processo de decomposição de material vegetal submerso varia em regiões temperadas e tropicais. Irons et al. (1994) observaram que os invertebrados são mais abundantes como decompositores em regiões temperadas enquanto que a maior abundância de fungos e bactérias foi encontrada em regiões tropicais. Resultado similar foi observado por Mathuriaiu & Chauvet (2002) que registraram alta atividade fungica associada à rápida decomposição de folhas de um rio na Colômbia.

A ação de microrganismos envolvidos na decomposição de material submerso tem sido estudada (Gessner 1991, Gessner et al. 1999, Mathuriau & Chauvet 2002). Bärlocher & Kendrick (1974) ao investigarem a dinâmica de fungos no ambiente aquático, concluíram que os fungos são os principais colonizadores, pela quantidade e capacidade de degradação, seguidos das bactérias. Estudos ecológicos indicam que dentre os fungos, os hifomicetos são os mais abundantes na água doce. Contudo quitridiomicetos, ascomicetos e basidiomicetos não são menos importantes (Shearer at al. 2007, Kearns & Bärlocher 2008). Pesquisas envolvendo análise de ergosterol em folhas em decomposição com a finalidade de medir a biomassa fúngica confirmam a importância desses microrganismos (Gessner & Schwoerbel 1991, Gessner & Chauvet 1993, 1994, Gessner et al. 1991, Gessner 2005).

A habilidade de degradarem diferentes substratos e se destacarem como decompositores deve-se ao fato dos fungos produzirem uma série de enzimas extracelulares. Essas enzimas incluem celulase, xilanase, lacase, amilase, galactanase, entre outras. Para os ascomicetos de água doce, pouco se conhece sobre sua capacidade enzimática. Cerca de 150 espécies foram qualitativamente testadas em laboratório quanto à produção de enzimas extracelulares (Simonis et al. 2008). A maioria das espécies é

encontrada decompondo substrato lenhoso ou herbáceo. Poucas espécies são encontradas em ambos os substratos. Abdel-Raheem & Shearer (2002) e Simonis et al. (2008) não encontraram diferença no conteúdo enzimático entre ascomicetos lignícolas, herbáceos e generalistas, comprovando que a capacidade enzimática não é o fator limitante da colonização do substrato. Fatores como disponibilidade do substrato na água e tempo de permanência podem levar esses substratos a serem degradados por espécies diferentes. Em contrapartida, os fungos conidiais, especialmente os ingoldianos, tem sido bem documentados com respeito à produção de enzimas degradadoras de substratos vegetais submersos (Chamier 1985, Abdel-Raheem 1997).

ÁREA DE ESTUDO

A Serra da Jibóia constitui-se em um complexo de morros (Pioneira, Oiti, Monte Cruzeiro, Água Branca, Caporó, Ceará, etc) localizada na região do Recôncavo Sul, porção leste do Estado da Bahia. Com aproximadamente 22.000 ha e altitude variando entre 750 m e 840 m, a Serra da Jibóia distribui-se ao longo do território de seis municípios: Santa Terezinha, Castro Alves, Elísio Medrado, Varzedo, São Miguel das Matas e Laje (Neves 2005) (Figura 7). O local onde os estudos foram desenvolvidos está localizado no Monte da Pioneira (zona norte da Serra da Jibóia) (Figura 9 A) no município de Santa Terezinha (12º51'S e 39º28'O).

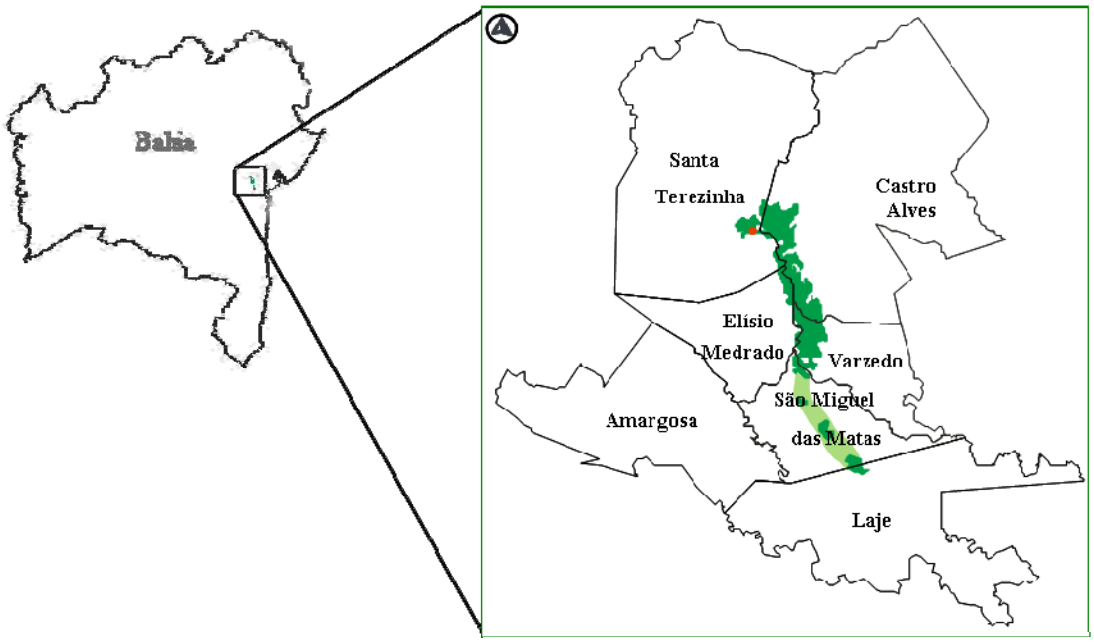

Figura 7. Mapa evidenciando a Serra da Jibóia na região do Recôncavo Sul da Bahia. Em vermelho o local de estudo no município de Santa Terezinha. Fonte: Neves (2005).

Do ponto de vista hidrográfico, a crista da Serra da Jibóia atua como um divisor de águas, separando as bacias dos rios Jiquiriçá, Dona, Jaguaripe e Paraguaçu (Figura 8). Além disso, nascem no perímetro da Serra importantes riachos que abastecem com água potável, vários municípios da região e um grande número de subafluentes abastece os

povoados circunvizinhos (Tomasoni & Santos 2003). O riacho selecionado para o estudo taxonômico tem sua nascente no Monte da Pioneira sendo margeado por diversas espécies de angiospermas (Figura 9 B). Apresenta água clara e limpa, muitas vezes com presença de pequenos peixes. Do Monte da Pioneira, é possível alcançar o riacho por dois pontos de acesso. No ponto 1 (Figura 9 C-E), além de angiospermas, estão presentes pteridófitas e briófitas. Muitas rochas são encontradas ao longo do riacho, diminuindo o fluxo do mesmo. A profundidade do riacho ao longo do seu curso é pequena, chegando até 50 cm. O ponto 2, (Figura 9 F-H) a presença de pteridófitas e briófitas não são tão notáveis quanto na área 1, bem como pedras ao longo do curso do riacho. O riacho nessa área é mais raso, chegando até 30 cm de profundidade.

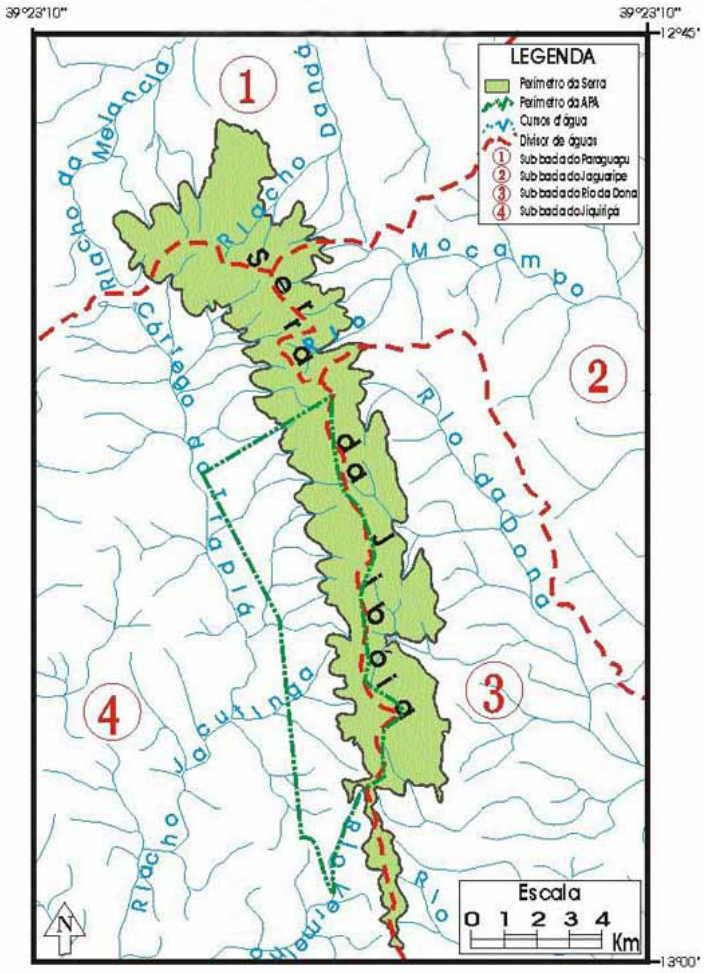

Figura 8. Hidrografia no perímetro da Serra da Jibóia. A linha verde destaca a Área de Proteção Ambiental (APA) no município de Elísio Medrado. Fonte: Tomasoni & Santos (2003).

Figura 9. Locais de coleta. A. Visão geral do Monte da Pioneira. B. No interior da mata próximo ao riacho. C-E. Ponto de coleta 1 F-H. Ponto de coleta 2. Fotos por Fábio Barbosa.

A vegetação local constitui um mosaico de formações vegetais. Devido à influência das chuvas orográficas, há predomínio de Floresta Ombrófila Densa com remanescentes de Mata Atlântica na porção oriental. Na porção ocidental, por ser menos úmida, prevalecem formações florestais, tais como: Floresta Estacional Semidecidual, Floresta Estacional Decidual e Caatinga Arbórea (Tomasoni & Santos 2003). No topo da serra há Campo Rupestre *lato sensu*, vegetação não necessariamente semelhante aos campos rupestres quartzíticos e areníticos típicos da Chapada Diamantina (Neves 2005). Segundo Tomasoni & Santos (2003), por se localizar numa zona ecótona, associada à altitude, a Serra da Jibóia pode ser considerada um dos reservatórios de biodiversidade com a presença de diversas espécies endêmicas.

A estrutura geomorfológica da Serra da Jibóia apresenta relevos planálticos com rochas de origem granítico-gnáissico. Os tipos de solo variam em função da altitude, mas predominam os latossolos e os podzólicos, com aptidão regular para agricultura (Tomasoni & Santos 2003). Neves (2005) definiu os solos como Cambiossolos, Latossolos e Argissolos, pobres em fertilidade dependentes da ciclagem de nutrientes da serapilheira.

Devido a sua posição geográfica em uma zona ecótona, a crista da serra marca o limite de uma transição climática na região, com um clima variando entre o tropical úmido, mais ao Sudeste e ao Leste, e o tropical semi-úmido, mais ao Norte e a Oeste. A temperatura média anual é de 21ºC e o índice pluviométrico é cerca de 1.200 mm/ano, variando de acordo com a altitude com chuvas concentradas entre os meses de abril a julho (Tomasoni & Santos 2003).

Características climáticas, geomorfológicas e pedológicas diferentes da área circundante garantem à Serra da Jibóia um isolamento geográfico peculiar com a presença de muitas espécies endêmicas além de algumas espécies da flora e fauna encontrarem-se na lista das espécies ameaçadas de extinção (jequitibá - *Cariniana ianeirensis* R. Knuth, jacarandá-da-bahia - *Dalbergia nigra* (Vell.) Allemao ex Benth., surucucu-pico-de-jaca - *Lachesis muta* L. 1766, tatu-bola - *Tolypeutes tricinctus* L. 1758, entre outros). Devido a essa grande riqueza paisagística e biológica foi criada, em 1999, a APA Municipal da Serra da Jibóia (Figura 8) que abrange 3.540 ha, incluindo a parte da serra pertencente ao município de Elísio Medrado (Tomasoni & Santos 2003). Dentre as 147 áreas prioritárias para a conservação da biodiversidade da Mata Atlântica determinadas pelo Ministério do Meio Ambiente (MMA), a Serra da Jibóia foi considerada área de extrema importância biológica para a conservação da flora local (Ministério do Meio Ambiente 2000).

MATERIAL E MÉTODOS

1. Expedições de coleta e procedimento de amostragem

Expedições trimestrais de coleta para a Serra da Jibóia, Bahia, Brasil, foram realizadas no período de julho de 2007 a maio de 2009. As coletas foram realizadas no riacho presente na Serra, porém em dois diferentes pontos (Figura 9 C-H). Em cada um deles, três subpontos equidistante 50 metros foram delimitados com o auxílio de uma trena e dados de posicionamento geográfico foram verificados com GPS (Global Positioning System). Amostras de galhos, cascas, folhas e pecíolos submersos e em decomposição foram coletados nos seis pontos pré-delimitados com o auxílio de uma pinça e acondicionados em sacos plásticos separados por tipo de substrato. Posteriormente, as amostras foram encaminhadas ao Laboratório de Micologia da UEFS.

2. Lavagem e acondicionamento das amostras coletadas

No Laboratório de Micologia da UEFS, as amostras foram submetidas à lavagem em água corrente (Figura 10 A) por 30 minutos para retirar sedimentos presentes na superfície (Castañeda-Ruiz 2005). A lavagem consistiu em acondicionar cada tipo de substrato em um recipiente doméstico perfurado e este em uma bandeja plástica (50 x 30 x 9 cm) que foi posicionada cerca de 45° sob uma torneira de forma que a água da lavagem pôde ser eliminada. Em seguida, as amostras foram colocadas sobre papel toalha por cerca de 20 minutos para secagem (Figura 10 B) e, posteriormente, acondicionadas em câmaras-úmidas (placa de Petri + papel filtro umedecido) (Figura 10 C). As câmaras-úmidas foram colocadas sobre um suporte dentro de uma caixa de isopor (170 L) cujas paredes e tampa foram recobertas por papel toalha umedecido (Figura 10 D). Para garantir a manutenção da umidade foram adicionados 500 mL de água na base da caixa de isopor + 2 ml de glicerina. A caixa foi aberta periodicamente por 15 minutos para circulação do ar e o papel toalha foi molhado sempre que necessário.

3. Análise das amostras e métodos de preservação

Após 72 horas de acondicionamento em câmaras-úmidas, as amostras foram analisadas sob estereomicroscópio e revisadas periodicamente, durante 90 dias, para a

coleta de fungos conidiais e ascomicetos. Durante esse período, as estruturas reprodutivas dos fungos foram obtidas com o auxílio de agulha fina (tipo insulina) e colocadas sobre lâminas contendo resina PVL (álcool polivinílico + ácido lático + fenol) (Trappe & Schenck 1982) (Figura 10 E). Para a preservação do material seco (Figura 10 F), parte do substrato que continha o fungo foi retirado da câmara-úmida e colocado para secar em temperatura ambiente para posterior acondicionamento em envelope de papel. Paralelamente, conídios e ascósporos foram transferidos diretamente dos substratos para placas de Petri contendo meio de cultura. Os fungos foram isolados inicialmente em AAg (ágar-água) com antibiótico e posteriormente transferidos para meio nutritivo, como: BDA (batata-dextrose-ágar) para os ascomicetos, AA (ágar-aveia) e CMA (cenoura-milho-ágar) para os fungos conidiais (Figura 10 G). As placas de Petri foram incubadas em BOD (cerca de 21° C) para a esporulação dos fungos. Procedimento de repicagem foi realizado até se obter uma cultura pura. Após se obter a cultura pura, o fungo foi transferido para quatro tubos de ensaio e, após seu crescimento e esporulação, foi adicionado óleo mineral para sua preservação (Figura 10 H). As lâminas permanentes e material seco dos fungos conidiais e ascomicetos foram depositados no herbário HUEFS. Culturas foram adicionadas à Coleção de Cultura de Microorganismo do Estado da Bahia (CCMB).

4. Estudo taxonômico

4.1. Fungos conidiais

A identificação dos fungos conidiais foi realizada ao nível de espécie a partir da comparação morfológica e mensuração das estruturas de importância taxonômica (conídio, célula conidiogênica, conidióforo, entre outras) com dados presentes em literatura básica e específica. Ilustrações foram realizadas na forma de fotografias obtidas de máquina fotográfica digital Canon G5 acoplada ao microscópio óptico Axioscop 40 Carl Zeiss e desenhos feitos a partir das fotos obtidas utilizando-se o programa Photoshop de acordo com Barber & Keane (2007). Descrição detalhada, comentários e a distribuição geográfica foram apresentadas para as novas espécies e novos registros de fungos conidiais.

Figura 10. Metodologia de lavagem e acondicionamento do material coletado (A-D); confecção de lâminas e preservação dos fungos (E-H).

4.2 Ascomicetos

A identificação dos ascomicetos foi realizada no Laboratório de Micologia da Universidade de Illinois - Urbana (EUA), sob a orientação da Dr[a]. Carol A. Shearer, através da comparação morfológica e da mensuração de estruturas de importância taxonômica (ascoma, asco, ascósporos, entre outras). Para isso, lâminas permanentes e material seco foram enviados pelo herbário da Universidade Estadual de Feira de Santana (HUEFS) para o herbário da Universidade de Illinois (ILL). Lâminas adicionais foram confeccionadas a partir do material seco seguindo a técnica de "Double cover glass" (Volkmann-Kohlmeyer & Kohlmeyer 1996). Essa técnica consiste em colocar o material fúngico a ser visualizado em uma gota de água destilada que está sobre uma lamínula (25 mm^2) (Figura 11 C) a qual foi previamente montada sobre uma lâmina de vidro contendo uma gota de água destilada (Figura 11 A-B). Em seguida, o material é coberto com uma lamínula menor (18 mm^2) (Figura 11 D-E). Após concluir a visualização e estudo do material ao microscópio, adicionam-se algumas gotas de glicerina entre a lamínula maior e a menor e espera-se até que a água evapore sendo substituída pela glicerina (Figura 11 F). Posteriormente, veda-se a lamínula menor com esmalte incolor (Figura 11 G). Para tornar a lâmina permanente, algumas gotas de Kleermount (Figura 11 H) são adicionadas sobre a lâmina (Figura 11 I) e o conjunto de lamínulas + material é invertido sobre o líquido (Figura 11 J-K). Para permitir que o Kleermount se espalhe homogeneamente adiciona-se um peso (Figura 11 L) sobre a lamínula por 24h, tempo em que o líquido estará completamente seco. Ilustrações foram realizadas na forma de fotografias obtidas a partir de câmera digital Spot RT acoplado a microscopio Olympus com Normarski. Descrição detalhada, comentários e a distribuição geográfica foram apresentadas para os novos registros de ascomicetos.

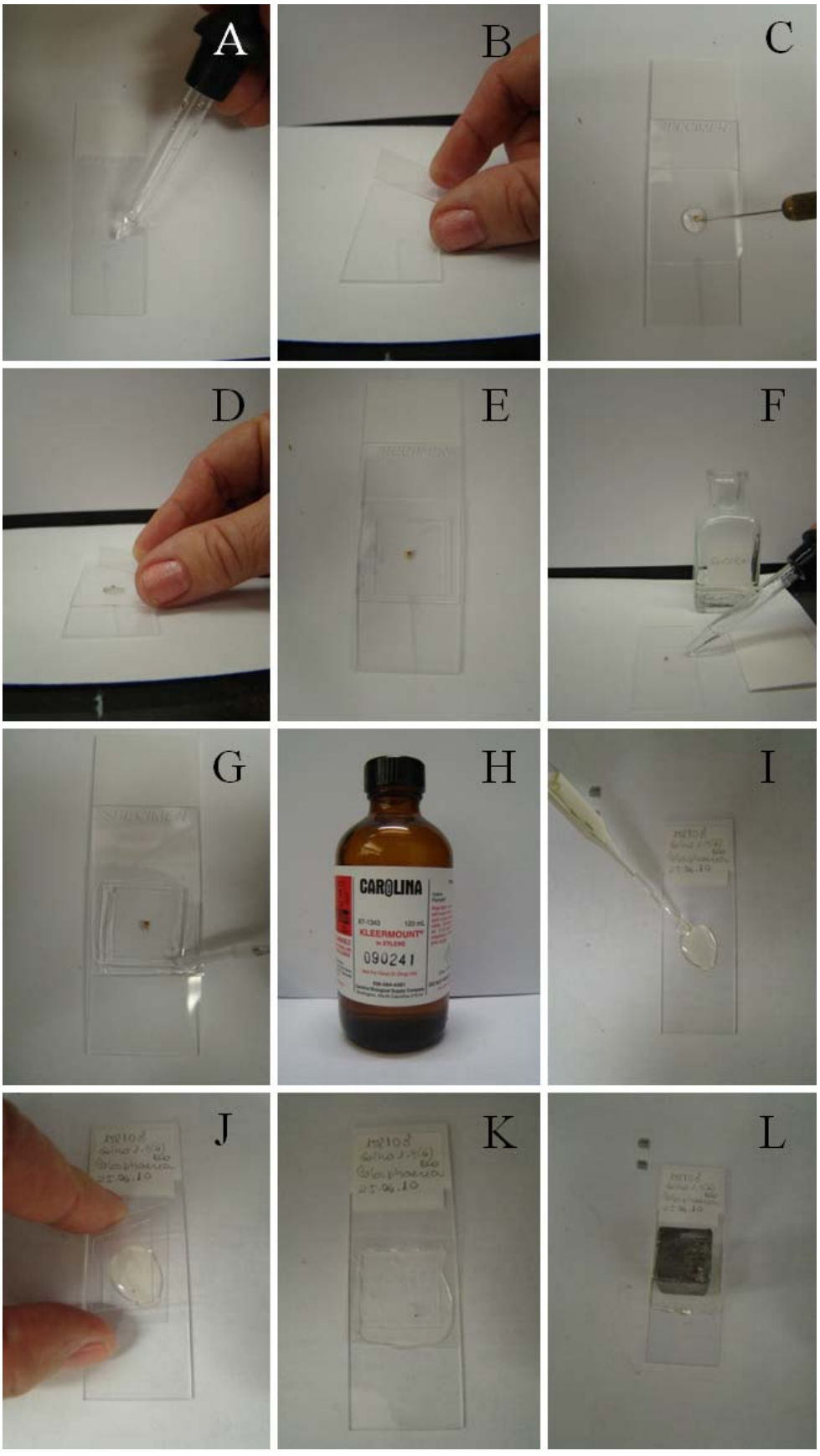

Figura 11. Método de confecção de lâminas permanentes (Double cover glass) segundo Volkmann-Kohlmeyer & Kohlmeyer (1996).

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CAPÍTULO 1

Freshwater Ascomycetes: New species and new records of Annulatascaceae from the Neotropics

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Resumo: nesse artigo são descritas duas novas espécies, *Torrentispora pilosa* e *Vertexicola ascoliberatus*, e dois novos registros para o Neotrópico, *Annulatascus biatrisporus* e *Torrentispora crassiparietis*, em Annulatascaceae. Descrição e ilustração são apresentadas para todas as espécies e chave de identificação é apresentada para os gêneros *Torrentispora* e *Vertexicola*. Adicionalmente, alteração no conceito desses dois últimos gêneros é proposta.

Freshwater Ascomycetes: New species and new records of Annulatascaceae from the Neotropics

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Abstract: During independent surveys for freshwater ascomycetes in Brazil and Costa Rica, two new species in the Annulatascaceae were discovered and two previously described species were collected from the Neotropics for the first time. Descriptions of the genera *Torrentispora* and *Vertexicola* were amended to accommodate the new species, *Torrentispora pilosa* and *Vertexicola ascoliberatus*, respectively, which are described and illustrated herein. *Annulatascus biatriisporus* and *T. crassiparietis* are reported from the Neotropics for the first time and are described and illustrated. Collections of *A. biatriisporus* and *T. crassiparietis* provide additional support for the existence of a pan-tropical freshwater ascomycota.

Key words*: Annulatascus*, streams, submerged wood, taxonomy, *Torrentispora*,*Vertexicola*

INTRODUCTION

Annulatascaceae was introduced by Wong *et al.* (1998) to accommodate a group of saprotrophic ascomycetes found on submerged wood and other submerged decaying lignocellulosic material. Currently, 21 genera are accepted in the Annulatascaceae (Kirk *et al.* 2008). Of these, 16 have been found in freshwater habitats, mostly in the tropics (Shearer & Raja 2011, http://www.fungi.life.uiuc.edu). Annulatascaceae is characterized by immersed or superficial, coriaceous, usually dark-walled ascomata with a peridium comprised of longitudinally compressed cells; relatively wide, septate paraphyses, that taper distally; long, cylindrical, unitunicate asci with a relatively massive J- refractive apical ring; and mostly hyaline or sometimes, brown ascospores. Ascospores are often equipped with gelatinous appendages or sheaths (Wong *et al.* 1998).

During independent studies of freshwater ascomycetes in Brazil and Costa Rica, four species belonging to the Annulatascaceae were found on submerged, partially decomposed wood. In this paper we describe and illustrate two new species: *Torrentispora pilosa* and *Vertexicola ascoliberatascus* and report two extant species, *Annulatascus biatriisporus* K.D. Hyde and *Torrentispora crassiparietis* S.C. Fryar & K.D. Hyde from the Neotropics.

The goal of this study was to characterize and describe two new species and the two new collections of Annulatascaceae from freshwater habitats, thereby contributing to the knowledge of neotropical ascomycetes.

MATERIALS AND METHODS

Collecting expeditions were made in two different countries in the Neotropics: Brazil and Costa Rica. Submerged woody debris was collected from streams and placed in plastic bags containing paper towels. In the laboratory, samples were removed from plastic bags and incubated in plastic boxes with moistened paper towels at ambient temperature (about 24 C) and light conditions (12/12 light and dark). Samples were examined within two weeks after collection and periodically thereafter using a dissecting microscope. For the Brazilian specimens, ascomata were placed on glass slides containing PVL resin (polyvinyl alcohol, latic acid and fenol) and for the Costa Rica specimens, ascomata were placed in a drop of distilled water on a cover glass (25 mm^2) mounted in water on a glass slide and then covered with a smaller coverslip (18 mm^2) (Volkmann-Kohlmeyer & Kohlmeyer 1996). Measurements and digital images were made using an Olympus microscope equipped with brightfield and Nomarski interference optics and a Spot RT digital camera. Specimens from Brazil were deposited in the "Herbário da Universidade Estadual de Feira de Santana" (HUEFS) and samples from Costa Rica in the Herbarium of the University of Illinois at Urbana-Champaign (ILL).

TAXONOMY

Annulatascus biatriisporus K.D. Hyde, Nova Hedwigia 61(1-2): 120 (1995) Figs. 1-6

Ascomata partially immersed in wood, solitary or grouped, venter globose, black, glabrous, coriaceous, ostiolate, with a long neck. **Necks** cylindrical, 970-1700 × 90-115 µm, periphysate, glabrous, black. **Peridium** black, of *textura prismatica* in surface view (as seen in lighter areas). **Paraphyses** long, hyaline, filamentous, unbranched, septate, 4-6 µm in diam at

base, tapering distally. **Asci** 270-340 × 13-17 µm (length to width ratio 20-23:1), separating from hymenium at maturity, discharged intact in addition to ascospores, 8-spored, cylindrical, thin-walled, unitunicate, with a massive refractive apical ring 6-7 µm high and 6-8 µm diam. that stains blue in aqueous nigrosin. Base of ascus with narrow, tail-like pedicel 7-8 µm long; pedicel present from early stages of ascus development. **Ascospores** 46-58 × 8-10 µm, uniseriate, fusiform, smooth, aseptate when young, becoming 2-4-septate at maturity, hyaline, staining blue in aqueous nigrosin, thick-walled, wall up to 1.5 µm at sides, 4-6 µm at ascospore apices, surrounded by a gelatinous sheath.

Habitat: freshwater stream.

Known distribution: Australia (Hyde 1995), Costa Rica (this paper), Hong Kong (Tsui *et al.* 2002), Seychelles (Hyde & Goh 1998).

Material examined: COSTA RICA. HEREDIA: La Selva Biological Station, 10º 25` 48``N, -84º 1` 32``W, water temperature 25 C, pH 5. On submerged wood, 18 May 2000, A464-2, *J. Anderson* and *R. Wulffen*, (ILL XXXX).

Comments: The main distinguishing feature of *A. biatriisporus* at the species level is the swollen end cells in the ascospores (Hyde 1995). This feature is prominent in our collection. The Costa Rican specimen is also morphologically similar in almost all other respects to the protologue of *A. biatriisporus* but differs from the original description as follows: the type material has a much shorter neck (up to 390 µm long), shorter asci (210-260 µm long) and a shorter apical ring (3-4 µm high). In addition, in the Costa Rican specimen, ascospores were 2–4 septate at maturity and stain in aqueous nigrosin along with the ring, characteristics not reported

in the original description. Measurements of the ascospores of the Costa Rican specimen agree with those given by Hyde (1995) (40-58 × 8-10 µm) but differ from those reported by Tsui *et al.* (2002) (48-65 × 7.5-10 µm).

The frequency of fungi found on submerged wood was investigated by Hyde & Goh (1998) in the Riviere St. Marie-Louis, Seychelles. In that study, *A. biatriisporus* occurred on 8%, of the samples examined, which they interpreted as being a common species on submerged wood in fresh water. Another species from the same genus, *A. velatisporus* K.D. Hyde, occurred more commonly with a frequency of 21% (Hyde & Goh 1998).

Torrentispora crassiparietis S.C. Fryar & K.D. Hyde, Cryptog. Mycol. 25(3): 255 (2004) Figs. 7-14

Ascomata partially immersed in wood, sometimes growing horizontally, scattered, 550-800 × 430-530 µm, coriaceous, ostiolate, with long neck, venter subglobose, black, glabrous or hairy. **Ascomatal hairs** long, mycelial, brown, septate, unbranched, up to 2 µm wide. **Neck** cylindrical, glabrous, black, 525-1320 × 180-220 µm, periphysate, periphyses up to 2 µm wide. **Peridium** in surface view brown, of *textura prismatica*. **Paraphyses** 3-5 µm thick, filamentous, unbranched, septate, hyaline. **Asci** unitunicate, 208-432 × 10-18 µm (length to width ratio 20-24:1), thin-walled, separating from the hymenium at maturity, 8-spored, cylindrical, rounded at the apex, tapering to a short hoof-shaped stalk. **Ascospores** 32-48 × 8-14 µm, uniseriate, ellipsoid-fusiform, smooth, unicellular when young but becoming 2-3-septate at maturity, hyaline, staining blue in aqueous nigrosin, thick-walled; wall 2-3 µm at sides and 3-4 µm at ends, with a small gelatinous appendage at each apex.

Habitat: freshwater stream.

Known distribution: Brazil (this paper), Brunei (Fryar & Hyde 2004; Fryar *et al.* 2004), Costa Rica (this paper).

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia, water temperature 21 C, pH 6.6. On submerged bark, 16 Jun 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158094); COSTA RICA. HEREDIA: La Selva Biological Station, Salto A60, 10º 24` 43``N, -84º 1` 0``W, water temperature 26 C, pH 5.5. On submerged wood, 17 May 2000, A642-1, *J. Anderson* and *R. Wulffen* (ILL XXXX); Carapa (experimental stream with phosphorous added), 10º 25` 17``N, -84º 1` 27``W, water temperature 24 C, pH 5.5. On submerged wood, 18 May 2000, A642-2, *J. Anderson* and *R. Wulffen* (ILL XXXX); Sura-60, 10º 25` 48``N, -84º 1` 32``W, water temperature 25 C, pH 5. On submerged wood, 18 May 2000, A488-1, *J. Anderson* and *R. Wulffen* (ILL XXXX); Sura-60. On submerged wood, 6 Feb 2001, A488-2, *C. Pringle* (ILL XXXX).

Comments: The specimens examined fit well within the concept of *Torrentispora* as modified herein and are similar to the protologue of *T. crassiparietis.* This species is characterized mainly as having ellipsoid-fusiform, thick-walled ascospores (Fryar & Hyde 2004). Some characters were found to be somewhat different from those described by Fryar & Hyde (2004). Asci of our collections are much larger and slightly wider in diam (208-432 × 10-18 µm) than those of the type species (212–300 × 10.5–12); ascospores are slightly larger and thicker (32-48 × 8-14 µm) than those of the type species (31–42.5 × 7.5–10). In addition, the ascospores of specimens from Brazil and Costa Rica possess a sheath, stain blue in aqueous nigrosin and

became 2-3 septate at maturity and the ascomata of Costa Rican specimens can be glabrous or hairy. These features have not been reported for previously described specimens**.**

Among the three species currently in *Torrentispora*, *T. crassiparietis* is most similar morphologically to *T. fusiformis* in having large ascospores and apical rings but differs in having a longer and thicker-walled ascospore (Fryar & Hyde 2004).

Torrentispora crassiparietis was known only from Brunei on submerged wood in fresh and brackish water (Fryar & Hyde 2004; Fryar *et al.* 2004). This species is reported from the Neotropics (Brazil and Costa Rica) for the first time.

Torrentispora pilosa Shearer & F.R. Barbosa sp. nov. Figs. 15-22

Ascomata 247-450 × 320-400 µm, semi-immersa, coriacea, ostiolata, pilosa, globosa vel subglobosa, nigra. Rostrum 440-770 × 55-180 µm, cylindricum, nigrum, pilosum. Peridium externe visum *textura prismatica*. Paraphyses 3-5 µm crassae, simplices, septatae, hyalinae. Asci 164-204 × 7-8 µm, octospori, cylindrici, unitunicati, apparato apicale praediti. Ascosporae 21-30 × 7-8 µm uniseriatae, ellipsoideae vel fusiformes, laeviae, unicellularae, 2-septatae ad maturam, hyalinae, crassotunicatae.

Etymology: *pilosa,* from Latin, referring to the hairy ascomata.

Ascomata partially immersed in wood, coriaceous, ostiolate, with a long neck, venter 247-450 × 320-400 µm, hairy, globose or subglobose, black. Ascomatal hairs long, mycelial, brown, septate, unbranched, 3-4 µm wide. **Neck** 440-770 × 55-180 µm, cylindrical, black, hairy; hairs short, dark brown, septate, unbranched, up to 4 µm wide. **Peridium** in surface view

comprising thick-walled, brown cells of *textura prismatica*, sometimes forming circular clusters of cells. **Paraphyses** 3-5 µm thick at base, tapering towards the apex, filamentous, unbranched, septate, hyaline. **Asci** 164-204 × 7-8 µm (length to width ratio 23-25:1), attached to hymenium at maturity or not, 8-spored, cylindrical, rounded at apex, tapering at the base, thin-walled, unitunicate, with a refractive apical ring 3-4 µm high, 4-5 µm diam., staining blue in aqueous nigrosin. **Ascospores** 21-30 × 7-8 µm, uniseriate, ellipsoid-fusiform, smooth, unicellular when young but becoming 2-septate at maturity, hyaline, staining blue in aqueous nigrosin, thick-walled, 1 µm at side and 1-2 µm at ends.

Habitat: freshwater stream.

Known distribution: Costa Rica (this paper).

HOLOTYPE: COSTA RICA. HEREDIA: La Selva Biological Station, 10º 25` 48``N, -84º 1` 32``W, water temperature 25 C, pH 5. On submerged wood, 18 May 2000, A 652-1, *J. Anderson* and *R. Wulffen* (ILL XXXX).

Comments: Hyde *et al.* (2000) established the genus *Torrentispora* K.D. Hyde *et al.* typified by *T. fibrosa* K.D. Hyde *et al.*, which was found originally on submerged wood in a stream in Thailand. This genus is characterized as having an ascoma with a neck; a peridium comprising black, thick-walled cylindrical cells in surface view, arranged in irregular rows; cylindrical asci with a relatively massive apical ring; and unicellular ascospores with a fibrillar sheath (Hyde *et al.* 2000).

Three species are currently recognized in the genus *Torrentispora*: *T. crassiparietis* S.C. Fryar & K.D. Hyde, *T. fibrosa* and *T. fusiformis* S.C. Fryar & K.D. Hyde. *Torrentispora pilosa* is

most similar to *T. fusiformis* in size and morphology of the ascospores but differs in having hairy, longer and broader ascomata and much shorter asci and ascospores that are 2-septate at maturity (Fryar & Hyde 2004, Hyde *et al.* 2000).

All previously described species have been reported from submerged wood in tropical regions (Fryar *et al.* 2004, Fryar & Hyde 2004, Hyde *et al.* 2000).

Within the Annulatascaceae, *Torrentispora* is most similar to *Annulatascus*. Following Hyde *et al.* (2000), peridium, ascus and ascospore features differentiate these two genera. *Torrentispora crassiparietis* and *T. fusiformis* were described from specimens on submerged wood in Brunei (Fryar & Hyde 2004). These two species fit well in the genus *Torrentispora* with respect to ascomal, ascus and ascospore morphology but do not appear to have a sheath surrounding the ascospores as found in the type species of the genus, *T. fibrosa*. In this case, we emend the concept of *Torrentispora* to include: ascospores with or without a gelatinous sheath, glabrous or hairy ascomata, asci with simple or bipartite apical rings, apical ring and ascospores that stain blue in aqueous nigrosin and ascospores that become septate at maturity.

Key to species of *Torrentispora*

1. Ascospores shorter than 20 µm…….....*T. fibrosa*

1`. Ascospores longer than 20 µm……...2

2. Ascospores thick-walled (2-3 µm)...……*T. crassiparietis*

2`. Ascospore walls less than 2 µm thick……...…….…3

3. Ascospores 0-2-septate at maturity, ascomata 320-400 µm diam., hairy …..….....*T. pilosa*

3`. Ascospores aseptate at maturity, ascomata 220-315 µm diam., glabrous…….. *T. fusiformis*

Vertexicola ascoliberatus Shearer & F.R. Barbosa sp. nov. Figs. 23-32

Ascomata semi-immersa, coriacea, ostiolata, glabra, globosa vel subglobosa, brunnea vel nigra. Rostrum 500-550 µm longum, 100-120 µm latum, cylindricum, gabrum, periphysatum. Peridium cellularum fuscarum compositum. Paraphyses 4-9 µm crassae, simplices vel ramosae, septatae, hyalinae. Asci 194-273 × 10-12 µm, octospori, cylindrici, unitunicati, pedicellati, apparato apicale praediti. Ascosporae 30-34 × 10-12 µm uniseriatae, ellipsoideae vel fusiformes, laeviae, hyalinae, tunica gelatinosa preditae.Etymology: Fom latin *liberatus* = liberated and *ascus* = sac, referring to the discharge of entire asci from the ascoma.

Ascomata on wood, partially immersed, coriaceous, ostiolate, with a long neck, glabrous, globose or subglobose, brown-black. **Neck** 500–550 µm long, 100–120 µm wide at base, cylindrical, phototropic, glabrous, brown toward apex, black toward the base, periphysate, periphyses up to 2 µm wide. **Peridium** comprising dark brown, thick-walled, cylindrical cells in surface view. **Paraphyses** 4–9 µm wide, filamentous, mostly unbranched but sometimes with dichotomous branches, septate, hyaline. **Asci** 194–273 × 10–12 µm (length to width ratio 19–22:1), separating from the hymenium at maturity, discharged in a mass at apex of neck, 8-spored, cylindrical, thin-walled, unitunicate, apically rounded, with a massive refractive apical ring 4–5 µm high and 6–8 µm diam staining blue in aqueous nigrosin; base of ascus with a tail-like tapering pedicel 6–13 µm long. **Ascospores** 30–34 × 10–12 µm, uniseriate, ellipsoid-fusiform,

flattened on one side, with cytoplasmatic bands, smooth, hyaline, staining blue in aqueous nigrosin and cotton blue, surrounded by a gelatinous sheath that expands in water.

Habitat: freshwater stream.

Known distribution: Costa Rica (this paper).

HOLOTYPE: COSTA RICA. HEREDIA: La Selva Biological Station, Salto 30, 10º 25` 39``N, -84º 0` 9``W, water temperature 26 C, pH 7. On submerged wood, 18 May 2000, A 653-1, *J. Anderson* and *R. Wulffen* (ILL XXXX).

Comments: *Vertexicola* K.D. Hyde *et al.*, a formerly monotypic genus, is typified by *V. caudatus*, which has been reported from submerged wood in the Philippines and China (Ranghoo *et al*. 2000). Following Ranghoo *et al*. (2000), the genus is characterized by asci with a refractive apical ring and a tail-like pedicel and distoseptate ascospores with relatively thick walls, lacking appendages or a sheath. The new species of *Vertexicola* fits well in this genus based on ascomal and ascal morphology and the presence of thick-walled ascospores. Ascospore septation was rarely observed in our specimen. In some ascospores, cytoplasmic bands were present in areas where septations would be expected to occur.

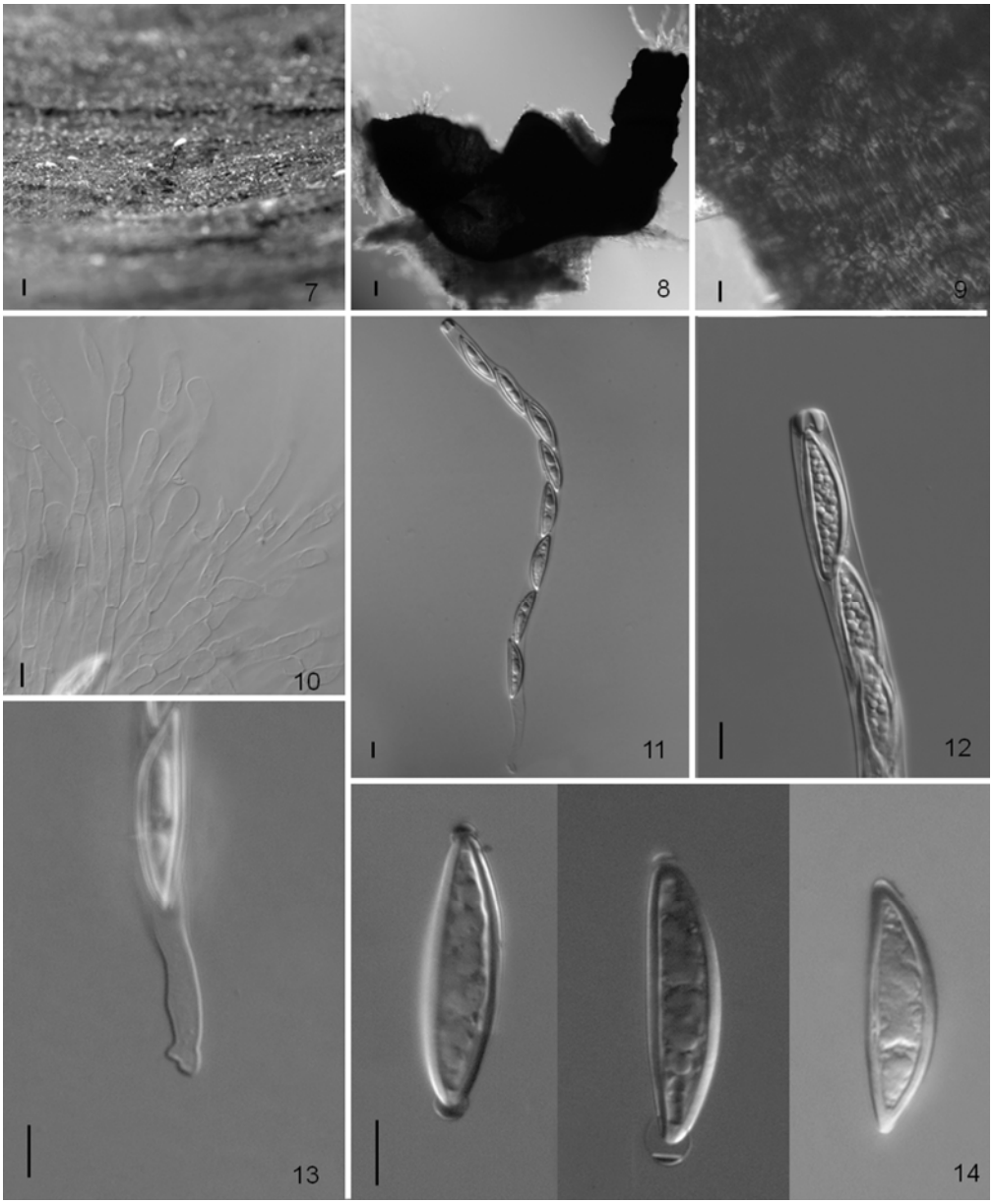
Vertexicola ascoliberatus differs from the type species as the latter has a much shorter neck (80-120 × 40-60 µm), narrower, unbranched paraphyses (6 µm wide), a narrower apical ring (5 µm diam.) and shorter, narrower, 0-6-septate ascospores (18-24 × 6-9 µm) (Ranghoo *et al.* 2000). In addition, ascospores of *V. ascoliberatus* are surrounded by a gelatinous sheath, while those of *V. caudatus* lack a sheath.

Key to species of *Vertexicola*

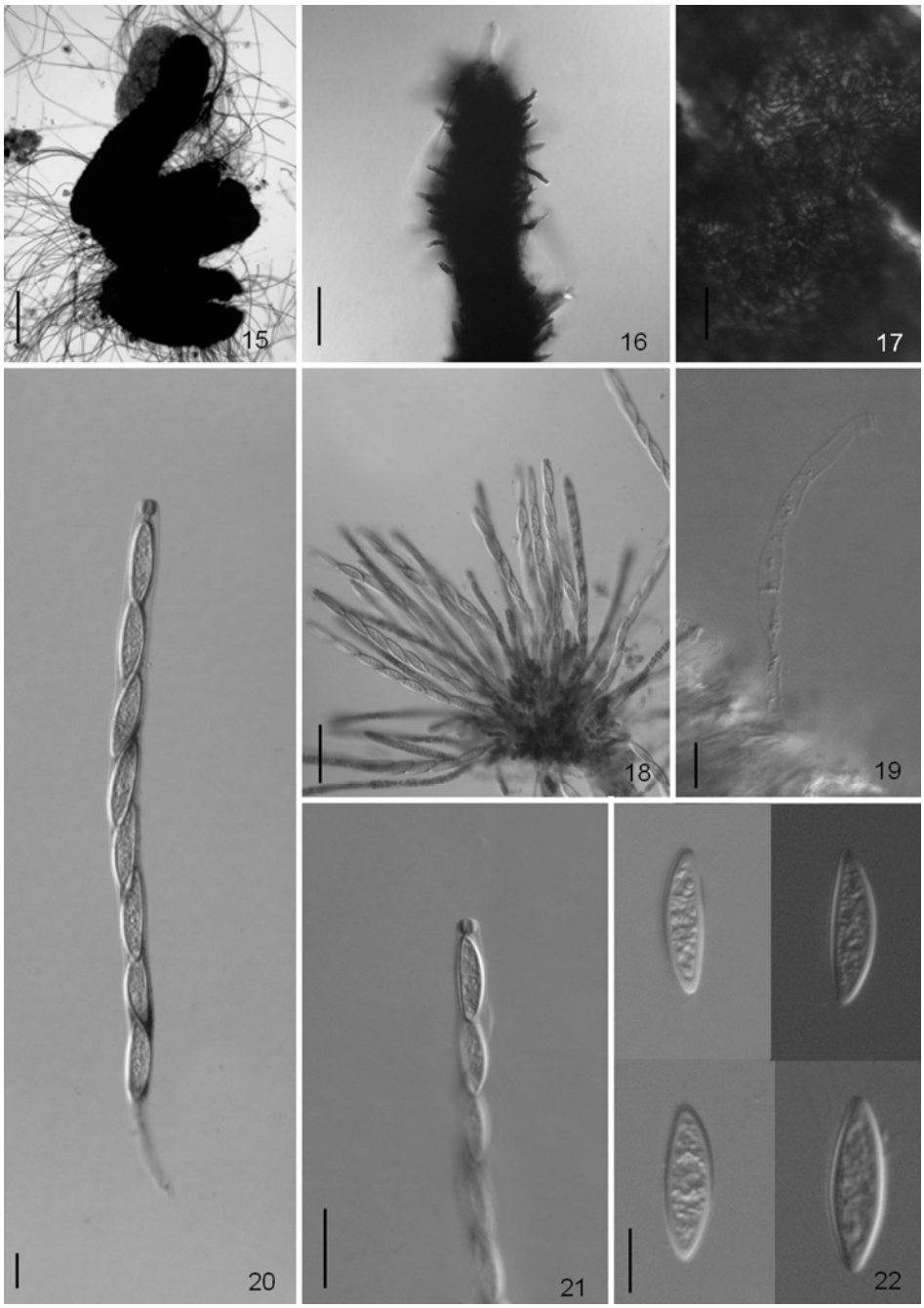
1. Ascospores 5-distoseptate lacking a sheath….……..……..…*V. caudatus*

1`Ascospores aseptate, with a gelatinous sheath ……....*V. ascoliberatus*

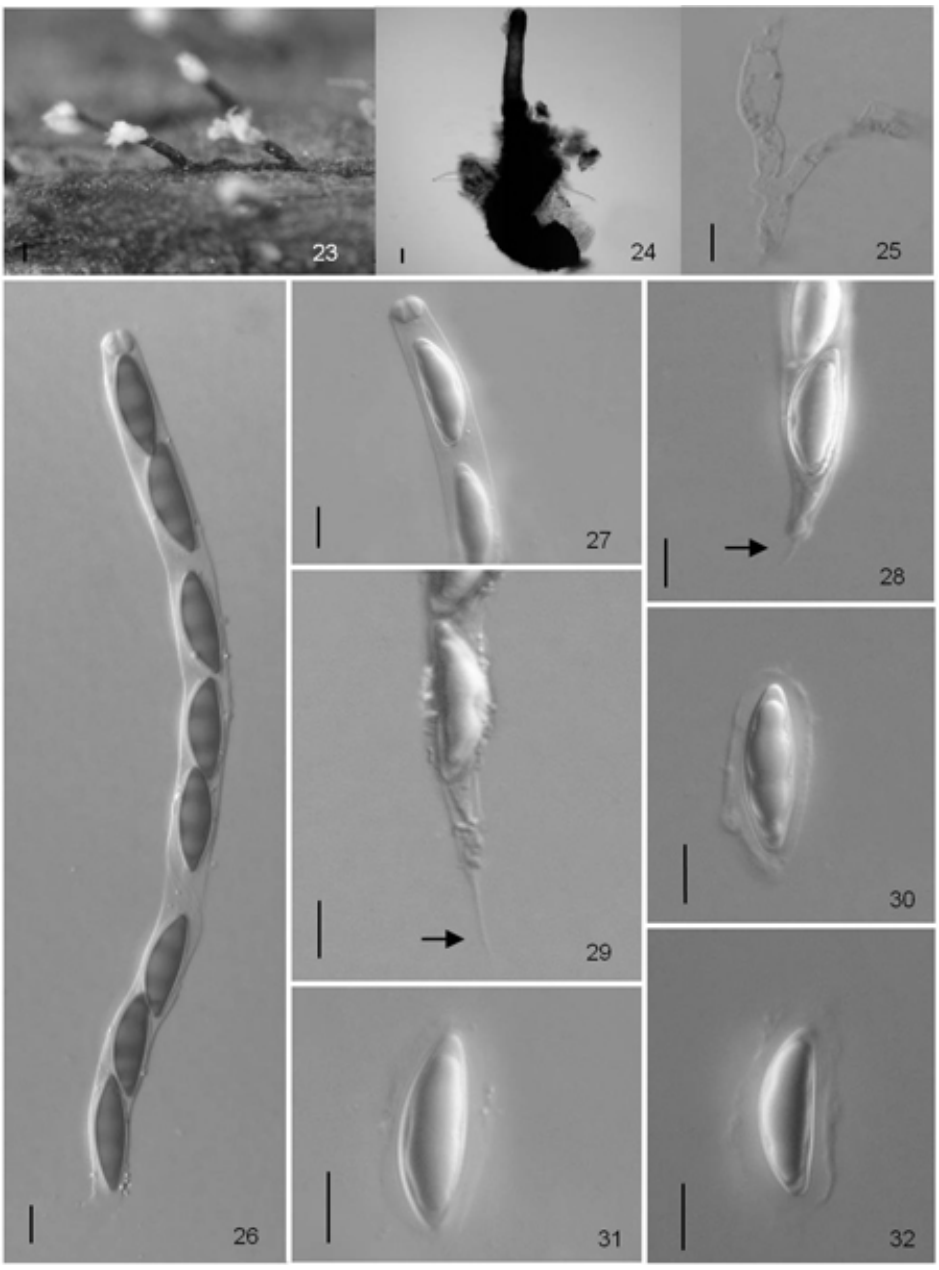
Figs 1-6. *Annulatascus biatriisporus*. 1. Ascomatal neck. 2. Paraphyses. 3. Ascus. 4. Ascus and detail of apical ring. 5. Ascus showing tail-like pedicel (arrow). 6. Ascospores. Bars: 1 = 200 µm. 2,4-6 = 10 µm. 3 = 40 µm



Figs 7-14. *Torrentispora crassiparietis.* 7. Ascoma on wood. 8. Ascoma. 9. Peridium of *textura prismatica*. 10. Paraphyses. 11. Ascus. 12. Ascus and detail of the apical ring. 13. Short hoof-shaped ascus stalk. 14. Ascospores. Bars: 7 = 200 µm. 8 = 50 µm. 9-14 = 10 µm.



Figs 15-22. *Torrentispora pilosa*. 15. Hairy ascoma. 16. Setose neck. 17. Peridium. 18. Centrum. 19. Paraphyse. 20. Ascus and ascospores. 21. Apical ring. 22. Ascospores. Bars: 15 = 150 µm. 16,18 = 40 µm. 17 = 30 µm. 21 = 20 µm. 19, 20, 22 = 10 µm.



Figs 23-32. *Vertexicola ascoliberatus*. 23. Ascomata on wood. 24. Ascoma. 25. Paraphyses. 26. Ascus with ascospores stained in cotton blue. 27. Ascus apical ring. 28. Ascus showing a small tail-like pedicel (arrow). 29. Ascus with pedicel (arrow). 30-32. Ascospores. Bars: 23 = 100 µm. 24 = 50 µm. 25-32 = 10 µm.

ACKNOWLEDGMENTS

The authors FR Barbosa and LFP Gusmão thank the CNPq for financial support to work on freshwater ascomycetes in the University of Illinois at Urbana-Champaign (process number 201670/2009-7) and the "Programa de Pós-graduação em Botânica – PPGBot/UEFS". Appreciation is expressed to J Anderson and R Wulffen for collecting samples in Costa Rica. Financial support of this study by the National Science Foundation (NSF Grant No. 03-16496, and 08-44722) is gratefully acknowledged. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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CAPÍTULO 2

Annulatascus apiculatus sp. nov., a new freshwater ascomycete from the semi-arid Caatinga biome of Brazil

Artigo publicado na revista Mycotaxon106: 403-407, 2008

Resumo: nesse artigo é descrita e ilustrada a nova espécie, *Annulatascus apiculatus* coletada no Bioma Caatinga. *Annulatascus apiculatus* se diferencia das demais espécies presentes no gênero pela presença de um apículo em ambas as extremidades do conídio. Este trabalho representa o primeiro estudo com ascomycete em material vegetal submerso no Brasil. Descrição e ilustração são incluídas.

MYCOTAXON

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Annulatascus apiculatus sp. nov., a new freshwater ascomycete from the semi-arid Caatinga biome of Brazil

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Abstract – During an inventory of lignicolous fungi in freshwater habitats in northeastern Brazil, an interesting ascomycete belonging to the genus *Annulatascus* was found. This fungus differs morphologically from other species of *Annulatascus* and is herein described as a new species, *A. apiculatus*. The new species is characterized by globose, black, semi-immersed perithecial ascomata with stout black necks; cylindrical, unitunicate asci that have a relatively large bipartite, refractive apical apparatus; hyaline, 0–3 septate ascospores with short, cellular, hyaline, tapering, bipolar apiculi, and surrounded by a narrow mucilaginous sheath. The new species differs from other described *Annulatascus* species in ascospore dimensions and the presence of bipolar apiculi.

Key words – *Annulatascaceae*, diversity, systematic, submerged wood, taxonomy

Introduction

Aquatic ascomycetes are ecologically important, ubiquitous microbial saprobes in freshwater environments (Wong et al. 1998, Tsui & Hyde 2004, Shearer et al. 2007). About 557 species have been reported from freshwater habitats worldwide (Shearer et al. 2008, http://www.fungi.life.uiuc.edu). It is surprising,

therefore, that no species have been reported from Brazil. Absence of such reports most likely reflects lack of collecting efforts rather than absence of these fungi from Brazilian freshwater habitats. To learn more about the freshwater mitosporic and meiosporic ascomycetes in Brazil, we initiated a study of the fungi colonizing dead plant substrates in freshwater habitats in the Caatinga biome in northeastern Brazil.

During this study we collected an undescribed ascomycete from submerged wood in a small stream. This ascomycete strongly resembled species in the *Annulatascaceae (Sordariomycetes)*, particularly those in the genus *Annulatascus*. The most distinctive characteristic of this family and genus is the presence of a very large ascus apical ring. Currently, *Annulatascus* includes 14 species (Tsui et al. 2002). Two of these species, *A. citriosporus* J. Fröhl. & K.D. Hyde and *A. licualae* J. Fröhl. & K.D. Hyde, were described from terrestrial habitats (Fröhlich & Hyde 2000), while most other species have been reported only from freshwater habitats in temperate and tropical latitudes (Hyde & Wong 2000, Cai et al. 2002, Tsui et al. 2002, http://www.fungi.life.uiuc.edu.).

The Brazilian specimen is described and illustrated herein as a new species of *Annulatascus* and is compared to other species in the genus.

Materials and methods

Study site. Collecting trips were made to the Caatinga biome in the Serra da Jibóia, one of nine hygrophilous forests that occur in the semi-arid region in northeast Brazil (Velloso et al. 2002). The vegetation of this area is similar to that of the Atlantic rain forest and has been described previously (Barbosa et al. 2007, Marques et al. 2007). Streams are bordered by bryophytes, pteridophytes and several vascular plants.

Collection techniques. Submerged woody debris was collected from lentic habitats and an unnamed stream in the Serra da Jibóia. Samples of submerged dead plant material were placed in plastic bags and returned to the laboratory. The plant material was then incubated at 25º C in Petri dish moist chambers stored within 50 L plastic boxes with 200 ml sterile water plus 2 ml glycerol. Samples were examined over four weeks for the presence of microfungal fruiting bodies.

Specimen examination. Fruiting structures were located on the substrates with a dissecting microscope and removed to a glass slide where they were crushed and mounted in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol). Measurements were made of fixed material. Dry material and permanent slides were deposited in Herbarium HUEFS.

Taxonomy

Annulatascus apiculatus F.R. Barbosa & Gusmão, **sp. nov.** Figs. 1–9

MycoBank MB512121

Ascomata 400–550 × 240–410 µm, semi-immersa, globosa, nigra, coriacea, aggregata, ostiolata. Colla 100–250 × 100–180 µm, cylindrica, atro-brunnea, periphysata. Peridium 15–60 µm latis. Paraphyses 2.5–6 µm crassae, hyalinae, filiformes, septatae, glabro-tunicatae, simplices. Asci 175–250 × 10–13 µm, 8-spori, cylindrici, unitunicati, persistenti, pedicellati apparato apicale 6–7.2 × 1.8–2.4 µm. Ascosporae 23–36.5 × 8.8–10 µm, uniseriatae, fusiformes, hyalinae, 0-3 septatae, laevae, cum spinulis in ambibus extremitatibus 0.7–1.2 µm et vagina mucilaginosa circundantes.

Holotype: HUEFS 134723. **BRAZIL. Bahia: Santa Terezinha,** Serra da Jibóia, on submerged wood from a stream, 19.II.2008, coll. FR Barbosa.

Etymology: Latin, *apiculatus* referring to the apiculus present at both ends of the ascospores.

Ascomata on wood, 400–550 × 240–410 µm, clustered, semi-immersed, globose, black, coriaceous, ostiolate. Neck 100–250 × 100–180 µm, cylindrical, dark brown, periphysate. Peridium 15–60 µm wide, dark brown. Paraphyses 2.5–6 × 75–100 µm, broad at the base and tapering towards the apex, hyaline, septate, smooth-walled, simple. Asci 175–250 × 10–13 µm, 8-spored, cylindrical, unitunicate, persistent, pedicellate, with a large bipartite, refractive apical ring, 6–7.2 × 1.8–2.4 µm. Ascospores 23–36.5 × 8.8–10 µm, uniseriate, fusiform, straight, hyaline, 0–3 septate, not constricted at septa, with smooth, short, cellular, hyaline tapering, bipolar apiculi; apiculi 0.7–1.2 µm high; ascospore surrounded by a narrow mucilaginous sheath.

Comments: The presence of an apiculus at both ends of the ascospores of *A. apiculatus* differentiates this species from all other species of *Annulatascus.* The bipolar apiculi on ascospores in the new species is quite different from the bipolar pad-like appendages on ascospores of *A. fusiformis* K.D. Hyde & S.W. Wong (Hyde & Wong 2000). Among the non-appendaged species of *Annulatascus, A. apiculatus* is morphologically most similar to *A. velatisporus* K.D. Hyde and *A. aquaticus* W.H. Ho et al. (Hyde 1992, Ho et al. 1999). However, *A. velatisporus* has larger asci (220–290 × 12–18 µm) and longer non-septate ascospores surrounded by a gelatinous sheath (26–42 µm), while *A. aquaticus* has smaller asci (150–175 µm) and non-septate ascospores with smaller dimensions (19–24 × 6–7 µm). *Annulatascus apiculatus* is also similar to *Annulusmagnus triseptatus* (S.W. Wong et al.) J. Campb. & Shearer in having 3-septate ascospores (Campbell & Shearer 2004). The two species differ, however, in that the ascospores of *A. triseptatus* are almost always 3-septate, while those of *A. apiculatus* are non-septate when young and may become 3-septate when older, and ascospores of *A. triseptatus* are concave or flattened on

one side while those of *A. apiculatus* are not. To our knowledge, this represents the first report of a freshwater ascomycete from Brazil.

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We are deeply indebted to Dr. Jinx Campbell (University of Southern Mississippi) and Dr. Amy Rossman (USDA) for kindly reviewing the manuscript and for many suggestions that greatly improved it. The authors FR Barbosa and LFP Gusmão thank the CNPq for financial support and the "Programa de Pós-graduação em Botânica – PPGBot/UEFS".

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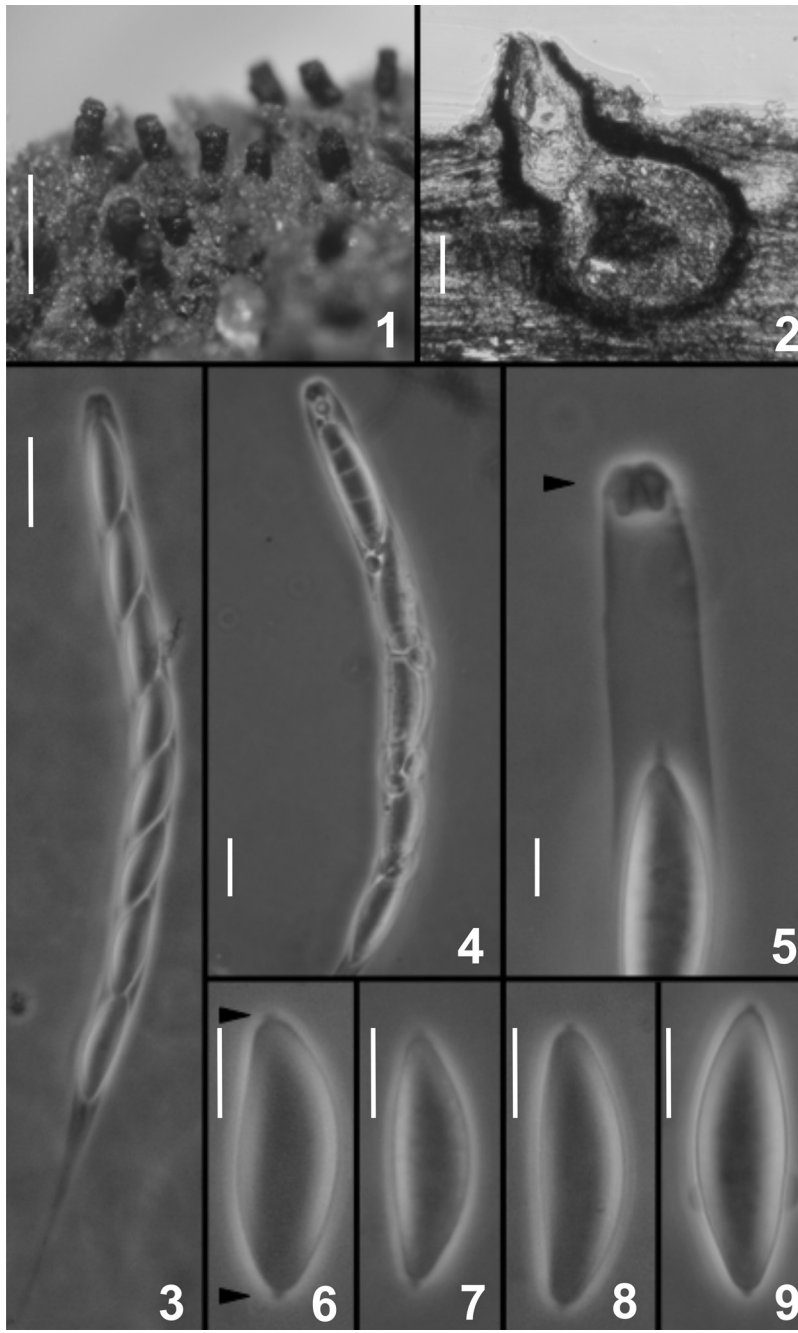
Figs. 1–9. *Annulatascus apiculatus* (from the holotype). 1. Immersed ascomata. 2. Longitudinal section of the ascoma. 3. Ascus with eight ascospores. 4. Older, hyaline septate ascospore in ascus. 5. Ascus apical ring (arrowed). 6–9. Ascospores with bipolar apiculi (arrowed).
Scale bars: 1= 0.5 mm, 2 = 100 µm, 3 = 25 µm, 4 = 15 µm, 5–9 = 10 µm.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CAPÍTULO 3

New records of freshwater ascomycetes from Brazil

Artigo a ser submetido à publicação na revista Mycosphere

Resumo: Nove novos registros de ascomycetes decompositores de material vegetal submerso em água doce são descritas e ilustradas. Dentre estes, *Anthostomella aquatica* e *Tamsiniella labiosa* são citadas pela primeira vez para o Continente americano; *Aniptodera chesapeakensis, Chaetosphaeria lignomollis* e *Jahnula seychellensis* são novas ocorrências para a América do Sul; *Annulatascus velatisporus* e *Ophioceras venezuelensis* estão sendo descritas pela primeira vez para o Brasil e *Chaetomium homopilatum* e *Chaetomium longicolleum* são primeira referência para a Bahia.

New records of freshwater ascomycetes from Brazil

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Barbosa FR, Gusmão LFP, Raja HA, Shearer CA. 2011 – New records of freshwater ascomycetes from Brazil. Mycosphere XX, xx–xx

Nine new records of freshwater ascomycetes from submerged substrates collected in Brazil are described and illustrated. Among these, *Anthostomella aquatica* and *Tamsiniella labiosa* are reported for the first time from the western hemisphere, while *Aniptodera chesapeakensis, Chaetosphaeria lignomollis,* and *Jahnula seychellensis* are new records for South America. *Annulatascus velatisporus* and *Ophioceras venezuelensis* are reported for the first time for Brazil and *Chaetomium homopilatum* and *Chaetomium longicolleum* for Bahia state. This study is an important contribution to the knowledge of the geographical distribution patterns of aquatic fungal species from tropical freshwater ecosystems.

Key words – aquatic fungi – lotic – saprobic fungi – semi-arid – taxonomy

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Introduction

Freshwater ascomycetes are an ecological group of fungi that play an important role in the decomposition of submerged plant debris in freshwater habitats (Shearer 1993, Wong et al. 1998a, Shearer et al. 2007). Currently, 592 species have been registered worldwide, with most of the species recorded from temperate regions (Shearer and Raja 2011). For the tropics, only about 177 species have been recorded (Cai et al. 2003a). Most of the earliest studies in the tropics have been carried out in the Asian tropics (Tsui et al. 1998, 2000, Ho et al. 2001, Cai & Hyde 2007) compared with little knowledge about these fungi in the Neotropics. Although our knowledge of freshwater ascomycetes has increased in the last 25 years, several areas of the world remain poorly studied, especially Brazil, and several taxa remain undescribed (Schmitt & Mueller 2007). Thus far, only one new species, *Annulatascus apiculatus* FR Barbosa & Gusmão, has been reported from submerged wood from Brazil (Barbosa et al. 2008).

During an on-going investigation of freshwater ascomycetes in the semi-arid region of Brazil, nine additional taxa belonging to Sordariomycetes and Dothideomycetes were collected from submerged substrates such as twig, bark, leaf litter and petiole. Given the lack of studies about freshwater ascomycetes in Brazil, the goal of this paper was to describe and illustrate the newly recorded fungi. This study will contribute to knowledge of the taxonomy of freshwater ascomycetes in Brazil and will help understand their geographical distributions patterns.

Methods

Submerged plant substrates (twigs, bark, leaf litter and petioles) were collected from a stream in the Caatinga Biome in northeastern Brazil and placed in plastic bags containing

paper towels. In the laboratory, substrates were incubated in Petri dishes with moistened paper towels at 25° C. Samples were examined periodically using a dissection microscope. Ascomata were placed on glass slides containing PVL resin (polyvinyl alcohol, latic acid and fenol) or a drop of distilled water. The slides made using distilled water were preserved following the double cover glass method of Volkmann-Kohlmeyer & Kohlmeyer (1996). Measurements and digital images were obtained using an Olympus microscope equipped with brightfield and Nomarski interference optics and a Spot RT digital camera. Specimens were deposited in the "Herbário da Universidade Estadual de Feira de Santana" (HUEFS).

Results

Aniptodera chesapeakensis Shearer & M.A. Mill., Mycologia 69(5): 892, 1977 Figs 1-3

Ascomata 205-405 × 205-250 µm, immersed, membranous, clustered, globose to subglobose, light brown to brown with an ostiole and neck. **Neck** 76-160 × 60-67 µm, straight, cylindrical. **Catenophyses** not seen. **Asci** 80-120 × 26-34 µm, 8-spored, unitunicate, thin-walled, persistent at maturity, clavate, rounded at the apex, tapering towards the base. **Ascospores** 22-38 x 8-12 µm, biseriate, smooth-walled, 1-septate, thick-walled with bipolar gelatinous appendages expanding in water, fusiform, hyaline.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 10 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158067); 11 Feb 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158108); 3 Jun 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158096); 9 Mar 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158112).

Known distribution: Australia, Brunei, Malaysia, Mauritius, South Africa (Hyde et al. 1999), Belize (Kohlmeyer 1984), Brazil (this paper), China (Luo et al. 2004) Panama (Shearer 1989), Sri Lanka (Koch 1982), Thailand (Koch 1986), United States (Shearer & Crane 1986, Raja et al. 2009).

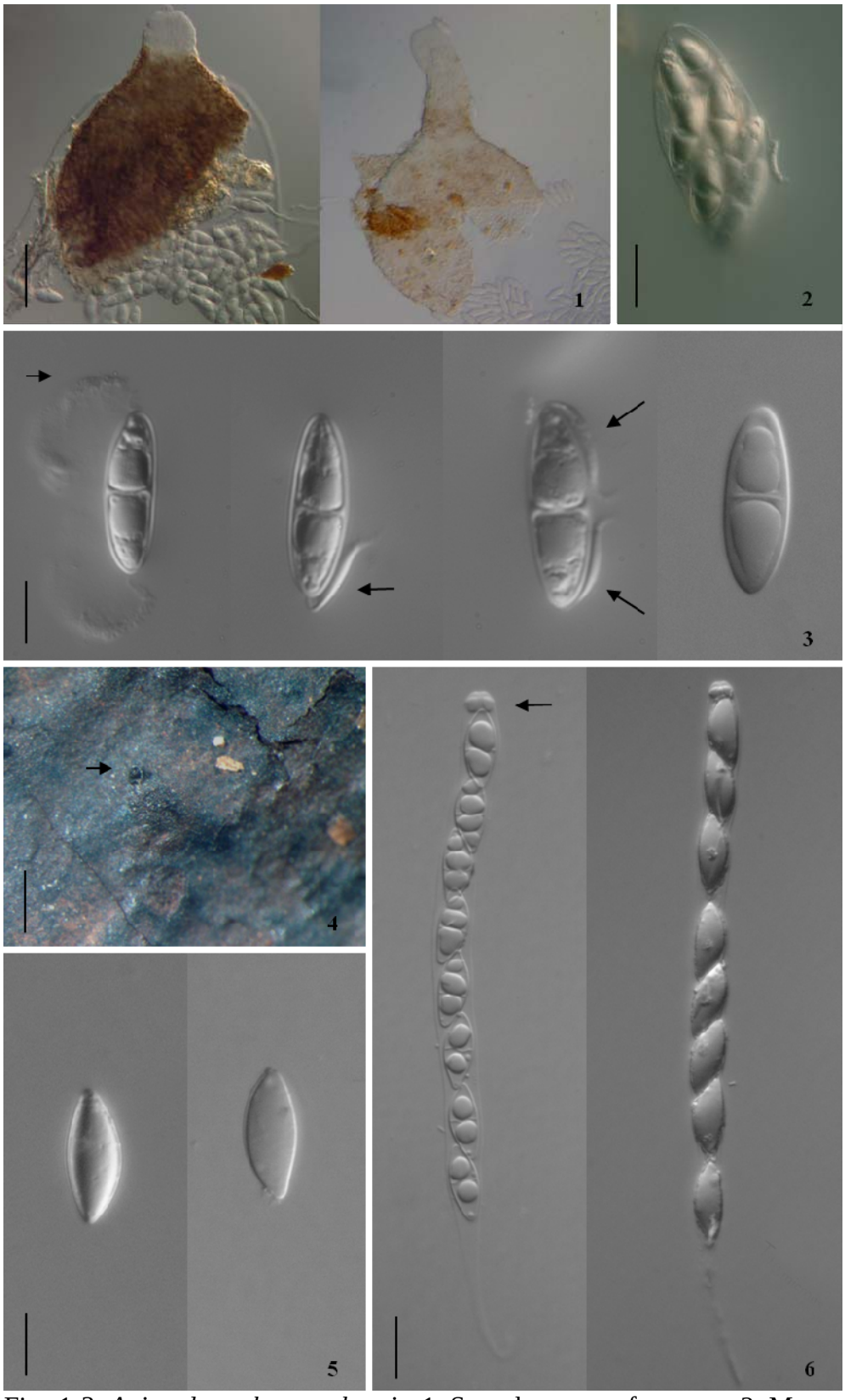
Comments: *Aniptodera* Shearer & M.A. Mill. currently consists of nine accepted species (Kirk et al. 2008). *Aniptodera chesapeakensis* is the type species of the genus and is included in the Halosphaeriaceae (Shearer & Miller 1977). The material collected from Brazil agrees well with the protolog (Shearer & Miller 1977) and the collection reported by Hyde et al. (1999). Appendaged ascospores were not reported in the original description. They were, however, noted in subsequent collections from the United States (Shearer & Crane 1980, Shearer 1989). A recent multigene molecular phylogenetic study of taxa within the Halosphaeriaceae indicates that bipolar appendages may have been evolved and lost multiple times (Sakayaroj et al. 2010). Additional studies with multiple geographical isolates of *Aniptodera* species are required to determine if collections with unappendaged or appendaged ascospores of this species constitute the same taxon (Sakayaroj et al. 2010).

Aniptodera chesapeakensis most closely resembles *A. aquadulcis* (S.Y. Hsieh, H.S. Chang & E.B.G. Jones) J. Campb., J.L. Anderson & Shearer in overall morphology but differs slightly in ascomal size and shape (Champbell et al. 2003).

In earlier studies, *A. chesapeakensis* was reported from brackish water (Shearer & Miller 1977), seawater (Kohlmeyer and Kohlmeyer 1979) and freshwater in both lotic (Hyde et al. 1999) and lentic habitats (Shearer 1989). The collections from Brazil are the first reports of this fungus from South America.

Annulatascus velatisporus K.D. Hyde, Aust. Syst. Bot. 5(1): 118, 1992 Figs 4-6

Ascomata immersed, carbonaceous, scattered, globose or subglobose, black. **Peridium** composed of angular cells. **Neck** up to 100 µm long, 50 µm diam., periphysate, straight, cylindrical. **Paraphyses** up to 5 µm wide at base, tapering toward the apex, filamentous, numerous, unbranched, septate, longer than asci, hyaline. **Asci** 190-240 × 12-14 µm, separating from the hymenium at maturity, 8-spored, unitunicate, thin-walled, cylindrical, rounded at apex, with a large, elongate, bipartite apical apparatus 4-6 µm long, up to 8



Figs 1-3. *Aniptodera chesapeakensis.* 1. Squash mount of ascoma. 2. Mature ascus. 3. Ascospores. Arrows indicate appendages. Figs 4-6. *Annulatascus velatisporus.* 4. Ascoma on wood. Arrow indicates the ostiole. 5. Ascospores. 6. Asci. Arrow indicates bipartite apical apparatus. Bars: 1 = 100 µm. 2, 6 = 25 µm. 3, 5 = 10 µm. 4 = 500 µm.

µm wide. **Ascospores** 20-30 × 8-10 µm, uniseriate, smooth-walled to sometimes verruculose, guttulate, aseptate, thin-walled, fusiform, hyaline. Ascospore sheath not observed.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 10 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158085); 8 Jun 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158116); On submerged petiole, 10 Feb 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158118).

Known distribution: Australia (Hyde 1992), Brazil (this paper), Brunei, Malaysia (Ho et al. 2001), China (Tsui et al. 2000), Philippines (Cai et al. 2003b), Seychelles (Hyde & Goh 1998a), South Africa (Hyde et al. 1998), Thailand (Pinnoi et al. 2006), United States (Raja et al. 2009), Venezuela (Shearer 2001).

Comments: Hyde (1992) established the genus *Annulatascus* K.D. Hyde typified by *A. velatisporus*, which was found originally on submerged wood in a river in Australia. Although our collections of *A. velatisporus* from Brazil fit the type description by Hyde (1992), some characters were found to be somewhat different. The neck of our collections of *A. velatisporus* is shorter (100 µm long, 140 µm diam.) compared to that of the type species (384 µm long and 140 µm diam.). Further, an ascospore sheath was not observed in our collections.

Among the 15 species currently recognized in the genus *Annulatascus* (Barbosa et al. 2008, Kirk et al. 2008), *A. velatisporus* is most similar to *A. aquaticus* W.H. Ho, K.D. Hyde & Hodgkiss and *A. apiculatus* F.R. Barbosa & Gusmão, the first freshwater ascomycete reported from Brazil. However, *A. aquaticus* differs from *A. velatisporus* in having smaller asci (150-175 × 10-12 µm) and smaller ascospores (19-24 × 6-7 µm) with a few large lipid globules (Ho et al. 1999) and *A. apiculatus* differs in having ascospores with bipolar apiculi (Barbosa et al. 2008).

Annulatascus velatisporus has been reported widely on submerged woody debris from freshwater habitats worldwide (Shearer & Raja 2011). This species seems to be very common on the submerged substrate. In a study of freshwater fungi on submerged wood, *A. velatisporus* was the second ascomycetes species most frequently reported in a stream in the Seychelles with frequency of the 21% (Hyde & Goh 1998a) and in a river in South Africa with frequency of the 15% (Hyde et al. 1998). This species is reported from the Brazil for the first time.

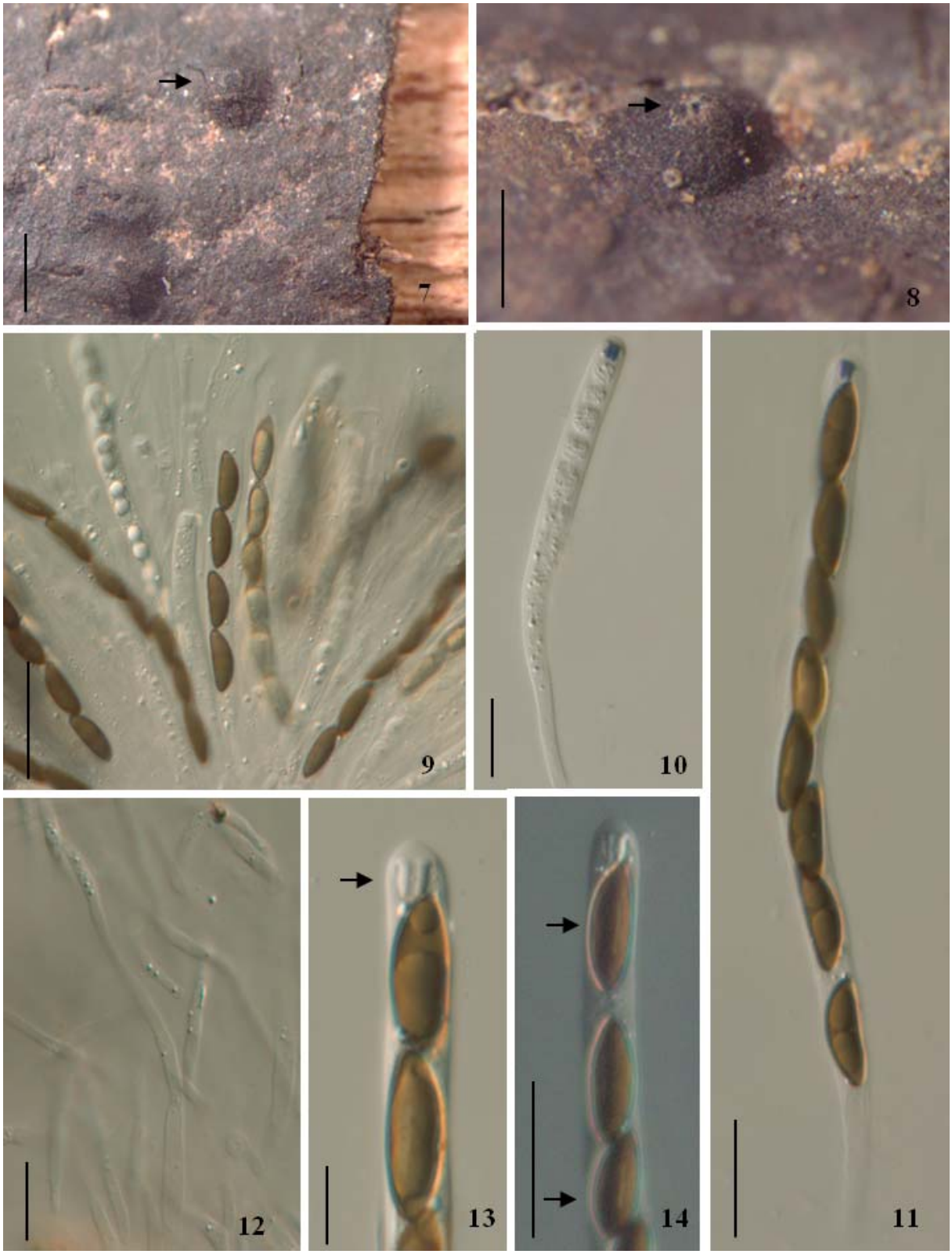
Anthostomella aquatica K.D. Hyde & Goh, Nova Hedwigia 67(1-2): 227, 1998 Figs 7-14

Ascomata 770-900 µm diam, stromatic with up to 3 ostioles, in top view, immersed, carbonaceous, fused, globose to conic, black. **Paraphyses** up to 8 µm wide at the base, filamentous, numerous, rarely branched, septate, hyaline. **Asci** 94-180 × 8-11 µm, separating from the hymenium at maturity, 8-spored, unitunicate, thin-walled, cylindrical, rounded at apex, tapering toward the base, with a J+, subapical ring 3-5 × 3-4 µm. **Ascospores** 15-22 × 7-9 µm, overlapping uniseriate, smooth-walled, guttulate, aseptate, with a central slit up to 8 µm long and an inconspicuous germ pore, thin walled, ellipsoidal, flattened on one side, dark brown.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 25 May 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158060); on submerged bark, 12 Jan 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158068); on submerged twig, 18 Mar 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158111); 5 Mar 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158126).

Known distribution: Australia, Brunei, China, South Africa (Hyde & Goh 1998b), Brazil (this paper), Thailand (Sivichai et al. 2000, 2002).

Comments: The genus *Anthostomella* K.D. Hyde & Goh possess 133 species (Kirk et al. 2008) and is characterized as having asci with a J+ ascal apical ring and unicellular brown ascospores with a germ slit (Hyde 1996). The specimens from Brazil fit well within the concept of the genus and are similar to *A. aquatica*. The collections from Brazil can be distinguished from the closest species, *A. tomicoides* Sacc., in having ascospores with a smaller germ slit, presence of a germ pore and



Figs 7-14. *Anthostomella aquatica.* 7. Ascomata (arrow) on wood. 8. Ascomata. Arrow showing ostioles. 9. Asci, ascospores and paraphyses. 10. Young ascus with a J+ subapical ring. 11. Mature ascus with a J+ subapical ring. 12. Paraphyses. 13. Ascus subapical ring (arrow). 14. Ascus and ascospores. Arrow indicates germ slit. Bars: 7 = 1 mm. 8 = 500 µm. 9, 12 = 50 µm. 10, 11, 14 = 25 µm. 13 = 10 µm.

absence of an ascospores basal cell (Hyde & Goh 1998b).

Although the genus has been recorded from fresh water, marine and terrestrial habitats (Kohlmeyer & Volkmann-Kohlmeyer 2002), previous studies have showed that *A. aquatica* has been reported only from submerged debris from freshwater habitats mainly in tropical regions. However, a survey of the freshwater ascomycetes literature suggests that it is not a common species in fresh water. Hyde et al. (1998) recorded a frequency of the 1% for *A. aquatica* on submerged wood in South Africa. This is the first record of the species for the American continent.

Chaetomium homopilatum Omvik, Mycologia 47(5): 749, 1955 Figs 15-19

Ascomata 150-206 × 84-120 µm, superficial, membranous, solitary, hairy, ovoid, brown; terminal hairs forming a dense tuft around the ostiole, up to 4 µm wide at base, septate, verrucose, tapering at apex, light brown; lateral hairs shorter, up to 4 µm wide at base and randomly distributed over the perithecium, light brown. **Peridium** composed of angular cells. **Paraphyses** not seen. **Asci** not seen. **Ascospores** 6-7 × 4.5-6 µm, discharged as a cirrus, smooth, aseptate, thin-walled, broadly oval, apiculate at both ends, brown.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 5 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158100), (CCMB 92/07).

Known distribution: Brazil (Mendes et al. 1998), Congo (as *C. wallefii*), Greenland, Honduras (as *C. brevipilium*), India (as *C. biapiculatum*), Japan (as *C. udagawae*), United States (as *C. amesii*, *C. distortum* and *C. pinnatum*) (Ames 1961, von Arx et al. 1986).

Comments: *Chaetomium* Kunze posses 95 accepted species, and is a widespread genus (Kirk et al. 2008). Different studies on *Chaetomium* species have been published in medical mycology (Zhang et al. 2010), biotechnology (Soni & Soni 2010), taxonomy (Wang & Zheng 2005) and molecular phylogenetics (Aggarwal et al. 2008). Our collection from Brazil agrees well with the original protolog of *C. homopilatum* (Omvik 1955). However, the holotype showed larger ascomata (242-345 × 127-196 µm) when compared with the Brazilian collection (150-206 × 84-120 µm) (Omvik 1955). *Chaetomium homopilatum* has been synonymyzed several times. Some collections such as *C. distortum* L.M. Ames and *C. pinnatum* L.M. Ames differ from Brazilian collection in having branched hairs on the ascomata (Ames 1961). The Brazilian material showed straight hairs as noted in the original description (Omvik 1955) and as in *C. brevipilium* L.M. Ames, which is another synonymy of the *C. homopilatum* (Ames 1961). *Chaetomium homopilatum* resembles *C. seminudum* L.M. Ames, but can be distinguished by its larger ascomata, dark colored, partly roughened hairs and smaller ascospores (Omvik 1955).

Chaetomium homopilatum can be found on different substrates, such as: dung, leaves, wood, and soil in terrestrial habitat (von Arx et al. 1986). Currently, 14 species of *Chaetomium* have been reported from freshwater habitats (Shearer & Raja 2011). For Brazil, the species was found on *Saccharum officinarum* L. in Maranhão and Paraíba states (Mendes et al. 1998). This is the first record of *C. homopilatum* from fresh water habitats and from Bahia state.

Chaetomium longicolleum Krzemien. & Badura, Acta Soc. Bot. Pol. 23: 748, 1954 Figs 20-22

Ascomata up to 560 × 73 µm, superficial, membranous, solitary, hairy, vase-shaped, brown; terminal hairs surrounding the ostiole forming a channel through which a column of ascospores emerge from the perithecium, up to 3 µm wide at base, tapering at apex, septate, light brown. **Peridium** composed of angular cells. **Neck** up to 433 × 22 µm, cylindrical, straight, hairy; terminal hairs long, septate, forming a channel through which ascospores emerge from the ascoma. **Paraphyses** not seen. **Asci** not seen. **Ascospores** 8-10 × 7-8 µm, smooth, aseptate, thin-walled, lemoniform, apiculate at both ends, brown.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 12 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158131).

Known distribution: Brazil (Grandi 1992), Congo (Meyer 1959), Costa Rica, Panama (as *Chaetoceratostoma longirostre*)

(Farrow 1955, Goos 1960), Honduras (as *Chaetoceratostoma longirostre*) (Goos 1963), India (as *Chaetoceratostoma longirostre*) (Agnihothrudu 1958), Japan (as *Chaetomium longirostre*) (Matsushima 1975), Poland (as *Chaetomium longicolleum*) (Krzemieniewska & Badura 1954), Venezuela (as *Chaetomium longicolleum*) (Castañeda-Ruiz et al. 2003).

Comments: *Chaetomium longicolleum* is a species most commonly found in soil (Agnihothrudu 1958, Goss 1960, 1963) however, it has also been reported from on leaf litter in Venezuela (Castañeda-Ruiz et al. 2003). This species was transferred to the genus *Farrowia* D. Hawksw. (through its synonymy *Chaetoceratostoma longirostre* Farrow), and typified by *F. longicollis* (Krzemien. & Badura) D. Hawksw., when Hawksworth (1975) established a new genus for the members of the Chaetomiaceae with *Botryotrichum*-like anamorphs and long-necked ascomata. Many mycologists disagree with Hawksworth's concept of *Farrowia*, and do not recognize *Farrowia* in their studies (von Arx et al. 1986, Decock & Hennebert 1997, Castañeda-Ruiz et al. 2003). A molecular phylogenetic study of *Farrowia* species using rRNA sequence data was carried out by Untereiner et al. (2001). The authors did not find strong support to recognize *Farrowia* as a separate taxon in the Chaetomiaceae. The collection from Brazil agrees with the examined descriptions (Ames 1961, Farrow 1955, von Arx et al. 1986). However, the collection from Brazil has smaller ascospores when compared with the description of *C. longicolleum* by Ames (1961) (10-12 × 9.5-10.5 µm) and the original description of *Chaetoceratostoma longirostre* (8.9-12 × 8.5-10.2 µm) (Farrow 1955). In addition, the species described by Farrow (1955) had longer necks (1012-2080 × 34-36 µm). *Chaetomium longicolleum* is morphologically similar to *C. cuyabenoensis* Decock & Hennebert and *C. malaysiense* (D. Hawksw.) Arx. All species have the same long neck. However, the ascospores are strongly lemoniform to quadrangular in face view in *C. cuyabenoensis* (Decock & Hennebert 1997), and the neck is much shorter in *C. malaysiense* (von Arx et al. 1986). The isolate from Brazil suggests that *C. longicolleum* is widespread in tropical regions. For Brazil, the species was found on dead root of *Euterpe edulis* Mart. and *Calathea zebrina* (Sims) Lindl. from São Paulo state (Grandi 1992). It represents the first report of *C. longicolleum* from fresh water and from Bahia state.

Chaetosphaeria lignomollis F.A. Fernández & Huhndorf, Fungal Diversity 18: 27, 2005

Figs 23-29

Ascomata 140-180 × 100-135 µm, superficial to sometimes immersed, membranous, solitary, papillate, ovoid or obpyriform, dark brown; few setae, up to 2 µm wide, septate, brown. **Peridium** composed of thin-walled angular cells. **Neck** 44-47 × 50-64 µm, straight, broad. **Paraphyses** up to 4 µm wide, filamentous, numerous, unbranched, septate, hyaline. **Asci** 70-90 × 8-10 µm, attached to the hymenium at maturity, 8-spored, unitunicate, thin-walled, cylindro-clavate, short stalked, with an apical ring up to 2 µm wide and 1 µm high. **Ascospores** 23-25 × 4-5 µm, biseriate, smooth, 9-septate, rarely 7-8-septate, sometimes with longitudinal septa, thin-walled, cylindrical, inequilateral, sometimes one end slightly curved, hyaline becoming light brown at maturity.

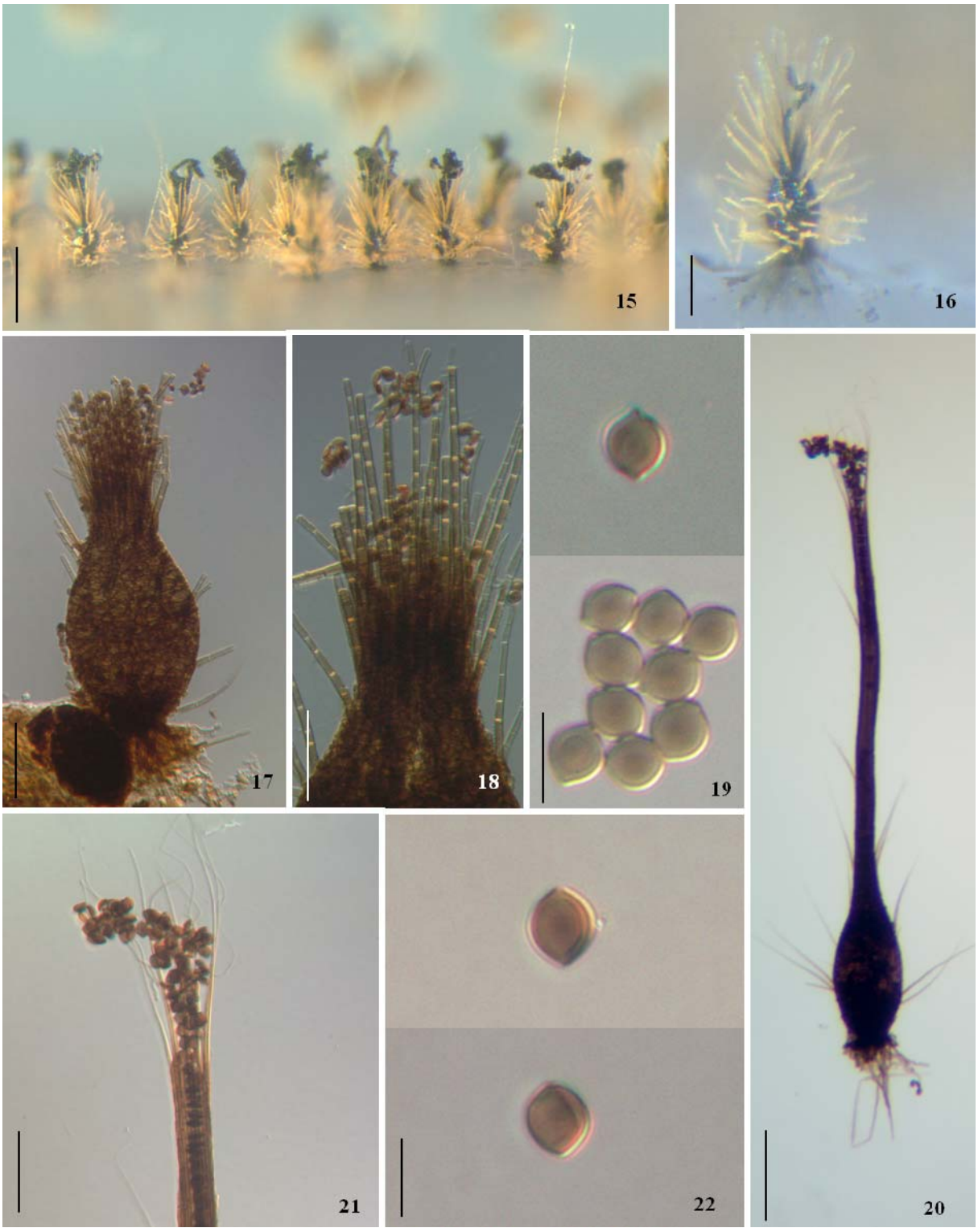
Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 22 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158056); 20 Aug 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158061); 16 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158081).

Known distribution: Brazil (this paper), Costa Rica, Porto Rico (Fernández & Huhndorf 2005).

Comments: *Chaetosphaeria* Tul. & C. Tul. is a widely defined and distributed genus with 95 accepted species (Fernández & Huhndorf 2005, Kirk et al. 2008). A recent molecular phylogenetic study of *Chaetosphaeria* species and its allied genera suggested that *Chaetosphearia* is not monophyletic (Fernández et al. 2006). The collection from Brazil agrees well with the original description of *C. lignomollis* with a few exceptions. The asci of the Brazilian material are smaller (70-90 × 8-10) compared to that of the holotype material (92-118 × 9.7-14). In addition, our collections showed

ascospores that were mainly 9-septate and sometimes 7-8-septate, whereas, those of the type species are consistently 7-septate (Fernández & Huhndorf 2005).

Fernández & Huhndorf (2005) described and illustrated *C. lignomollis* from wood and branches in terrestrial habitat in Costa Rica and



Figs 15-19 *Chaetomium homopilatum*. 15. Ascomata in culture. 16. Detail of ascoma in culture with a long cirrus. 17. Ascoma. 18. Details of the terminal hairs. 19. Ascospores. Figs 20-22 *C. longicolleum*. 20. Ascoma. 21. Terminal hairs forming a channel. 22. Lemoniform ascospores. Bars: 15 = 250 µm. 16, 20 = 100 µm. 17, 18, 21= 50 µm. 19, 22 = 10 µm.

Puerto Rico. Only three species of *Chaetosphaeria* have been recorded previously from freshwater habitats: *C. anglicana* P.J. Fisher & Petrini, *C. hiugensis* I. Hino and *C. lentomita* W. Gams & Hol.-Jech. (Shearer & Raja 2011). The specimens collected form Brazil represents the first report of *C. lignomollis* from fresh water and from South America.

Jahnula seychellensis K.D. Hyde & S.W. Wong, Nova Hedwigia 68(3-4): 504, 1999

Figs 30-34

Ascomata not observed. **Pseudoparaphyses** 2-3 µm wide, filamentous, unbranched, septate, hyaline. **Asci** 140-190 × 22-32 µm, attached to the hymenium at maturity, 8-spored, fissitunicate, thin-walled, obclavate with an apical chamber. **Ascospores** biseriate, smooth-walled, 1-septate, constricted at the septum, thin-walled, with two different morphologies: 27.5-42.5 × 7.5-15 µm, irregularly fusiform, apical cell wider tapering to a rounded tip and basal cell narrower, brown to dark brown; 35-42 × 12.5-20 µm, guttulate, apical cell broader than basal cell and mammiform, lower cell tapering and rounded towards the base, light brown to brown.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 29 May 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158073).

Known distribution: Brazil (this paper), Costa Rica (Raja & Shearer 2006), Philippines (Cai et al. 2003b), Seychelles (Hyde & Goh 1998a), Thailand (Campbell et al. 2007).

Comments: *Jahnula* Kirschst. is an aquatic genus that inhabits wood submerged in fresh water habitats (Hawksworth 1984, Hyde & Wong 1999, Raja & Shearer 2006, Prihatini et al. 2008). The collection of *J. seychellensis* from Brazil fits with the original protolog, mainly in having dimorphic ascospores. However, our material showed slightly larger ascospores when compared with the type collection (29-36 × 9-12.5 µm; 30-40 × 17-23 µm) (Hyde & Wong 1999). Our specimen also agrees with the collection from Costa Rica, although the authors did not record dimorphic ascospores. In addition, the Costa Rican collection showed asci that were slightly larger (158-268 × 26-32 µm) (Raja & Shearer 2006). Apical appendages at the ascospores were not observed in the Brazilian specimens but it may be due to the older material observed. Appendages were reported for the type and Costa Rican collections. *Jahnula seychellensis* most closely resembles *J. bipolaris* (K.D. Hyde) K.D. Hyde in having guttulate, 1-septate, appendaged ascospores. However, *J. bipolaris* has larger, ellipsoid-fusiform, minutely verruculose ascospores (Hyde & Wong 1999). Unfortunately, ascomata of *J. seychellensis* were in poor condition and could not be well preserved and characterized, but the morphology of the dimorphic ascospores is well distinguished.

Jahnula seychellensis has thus far been reported only from tropical regions. The report from Brazil suggests that *J. seychellensis* is specific to warm water habitats and shows a pantropical distribution. *Jahnula seychellensis* is reported for the first time from South America.

Ophioceras venezuelense Shearer, J.L. Crane & W. Chen, Mycologia 91(1): 151, 1999

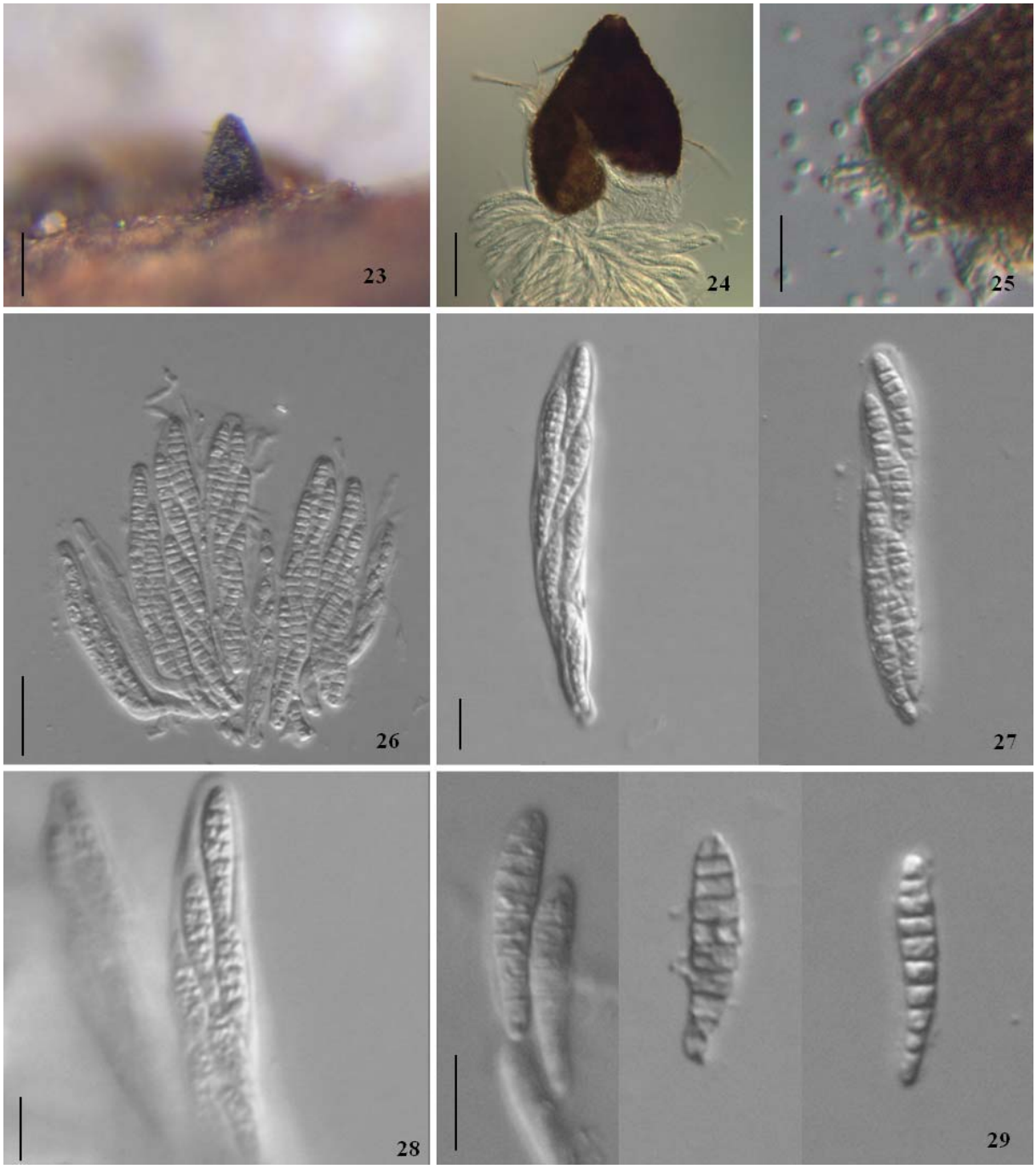
Figs 35-38

Ascomata partially immersed, carbonaceous, scattered, globose or subglobose, black. **Neck** 1440-1600 × 112-120 µm, straight or slightly curved towards one side, cylindrical. **Paraphyses** not seen. **Asci** 147-255 × 10-14 µm, separating from the hymenium at maturity, 8-spored, unitunicate, thin-walled, cylindrical, rounded apex, with a small thimble-shaped ascus apparatus. **Ascospores** 114-132 x 2-3 µm, in a fascicle, smooth, 5-6-septate, thin walled, filiform, straight or sigmoid, rounded at the ends, hyaline.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 8 Feb 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158122).

Known distribution: Brazil (this paper), Venezuela (Shearer et al. 1999).

Comments: *Ophioceras* Sacc. is a genus characterized by having long, dark brown to black necks, long, tapered, septate paraphyses with apically free ends, unitunicate, deciduous asci with a cylindrical apical apparatus and multiseptate, scolecosporous ascospores (Shearer et al. 1999). This genus is



Figs 23-29 *Chaetosphaeria lignomollis*. 23. Ascoma on wood. 24. Squash mount of ascoma showing asci. 25. Apical ring from front view. 26. Asci attached to the hymenium. 27-28. Asci. 29. Ascospores. Bars: 23 = 100 µm. 24 = 50 µm. 25, 27-29 = 10 µm. 26 = 25 µm.

Figs 30-34. *Jahnula seychellensis*. 30. Ascus attached to the hymenium. 31. Ascus and ascospores. 32. Ascospores irregularly fusiform. 33. Pseudoparaphyses. 34. Ascospores with a mammiform apical cell (arrows). Bars: 30, 31, 33 = 25 µm. 32, 34 = 10 µm.

morphologically most closely related to *Pseudohalonectria* Minoura & T. Muroi in many aspects, but can be separated by its ascomal pigmentation, which is dark brown to black in *Ophioceras* and is yellow to brown in *Pseudohalonectria*. In addition, *Pseudohalonectria* produces antifungal substances (Asthana & Shearer 1990), which are thus far not reported for species of *Ophioceras*. Molecular data reveals that *Pseudohalonectria* is a sister group of *Ophioceras* (Chen et al. 1999). Decaying wood in freshwater is a common substrate for members of *Ophioceras*. Currently, nine species are reported: *O. arcuatisporum* Shearer, J. L. Crane & W. Chen, *O. commune* Shearer, J. L. Crane & W. Chen, *O. dolichostomum*, (Berk. & M.A. Curtis) Sacc., *O. fusiforme* Shearer, J.L. Crane & W. Chen, *O. guttulatum* K.M. Tsui, H.Y.M. Leung, K.D. Hyde & Hodgkiss, *O. hongkongense* K.M. Tsui, H.Y.M. Leung, K.D. Hyde & Hodgkiss, *O. leptosporum* (S.H. Iqbal) J. Walker, *O. tenuisporum* Shearer, J.L. Crane & W. Chen and *O. venezuelense* Shearer, J. L. Crane & W. Chen (Tsui et al. 2001, Shearer & Raja 2011). A key to seven species from fresh water habitats is presented by Shearer et al. (1999) and a synopsis for additional species is reviewed by Tsui et al. (2001).

Our collection from Brazil agrees well with the original description of *O. venezuelense* from Panama with a few exceptions: the neck of our material is longer (1440-1600 × 112-120 µm) when compared to the original description (250-800 × 55-160 µm). In addition, the type material showed slightly smaller asci (148-180 × 11-18 µm) and larger (130-158 × 2-4 µm), 5-septate ascospores (Shearer et al. 1999), whereas the Brazilian material has slightly larger asci and smaller, 5-6-septate ascospores. Based on a molecular study of 18S rDNA sequence data, Chen et al. (1999) showed that *O. venezuelense* is a sister species to *O. fusiforme* and *O. tenuisporum*. However, morphologically *O. venezuelense* has larger ascomata, asci and ascospores when compared to the aforementioned taxa (Tsui et al. 2001). Our collection is the first record for Brazil and second record to world.

Tamsiniella labiosa S.W. Wong, K.D. Hyde, W.H. Ho & S.J. Stanley, Can. J. Bot. 76(2): 334, 1998 Figs 39-45

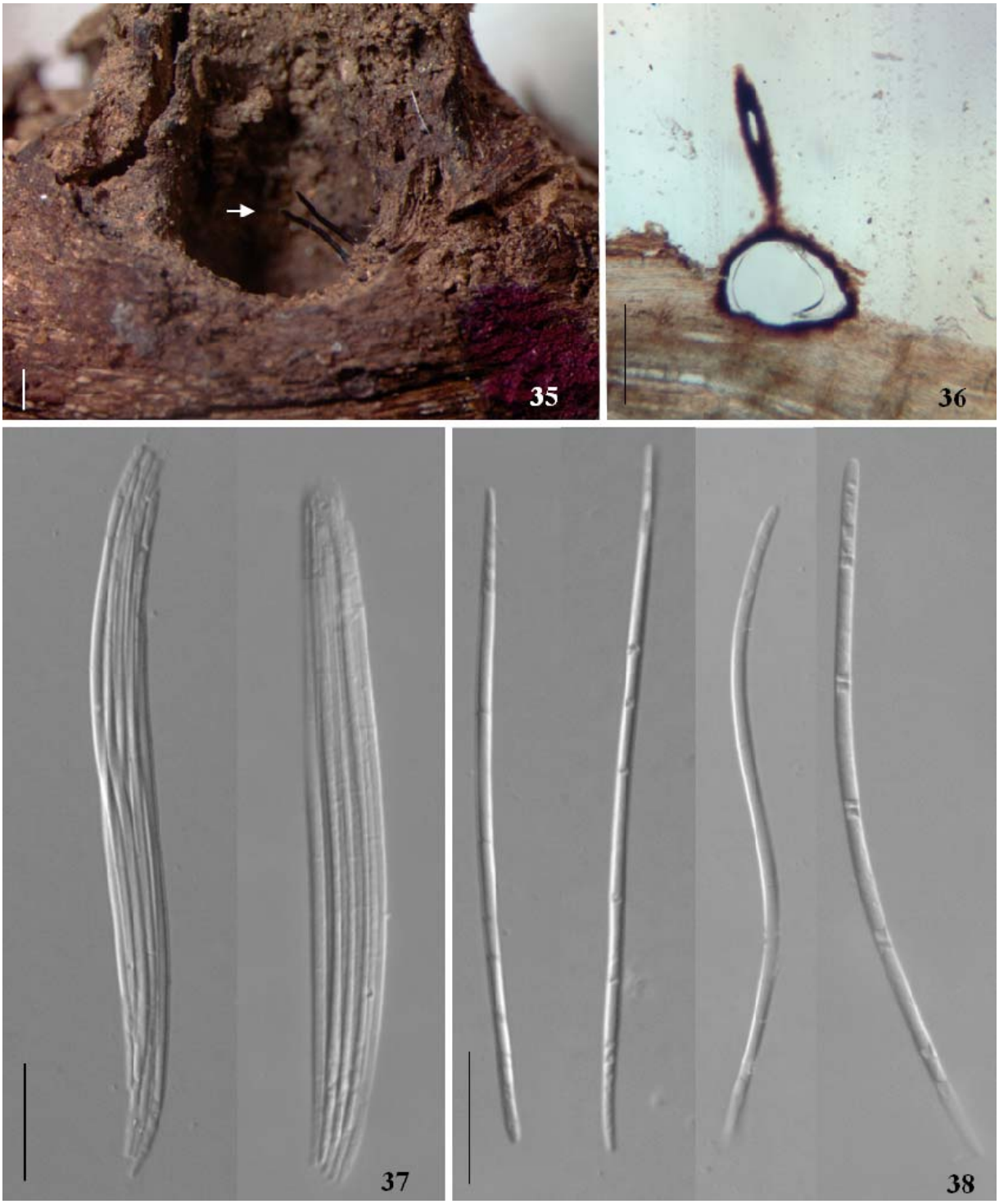
Ascomata 100-120 µm high, up to 400 µm wide, semi-immersed to immersed, carbonaceous, solitary or gregarious, ostiolate, conic, black. **Neck** short, conical. **Paraphyses** up to 5 µm wide, filamentous, numerous, sometimes branched, septate, hyaline. **Asci** 86-106 × 6-8 µm, separating from the hymenium at maturity, 8-spored, unitunicate, thin-walled, cylindrical, apically truncate, short pedicellate, with a apical ring up to 2 µm wide and an external thickening. **Ascospores** 17-22 × 4 µm, overlapping uni or biseriate, smooth, 0-septate, thin-walled, ellipsoidal-fusiform, hyaline, surrounded by a mucilaginous sheath.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 8 Jun 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 158105).

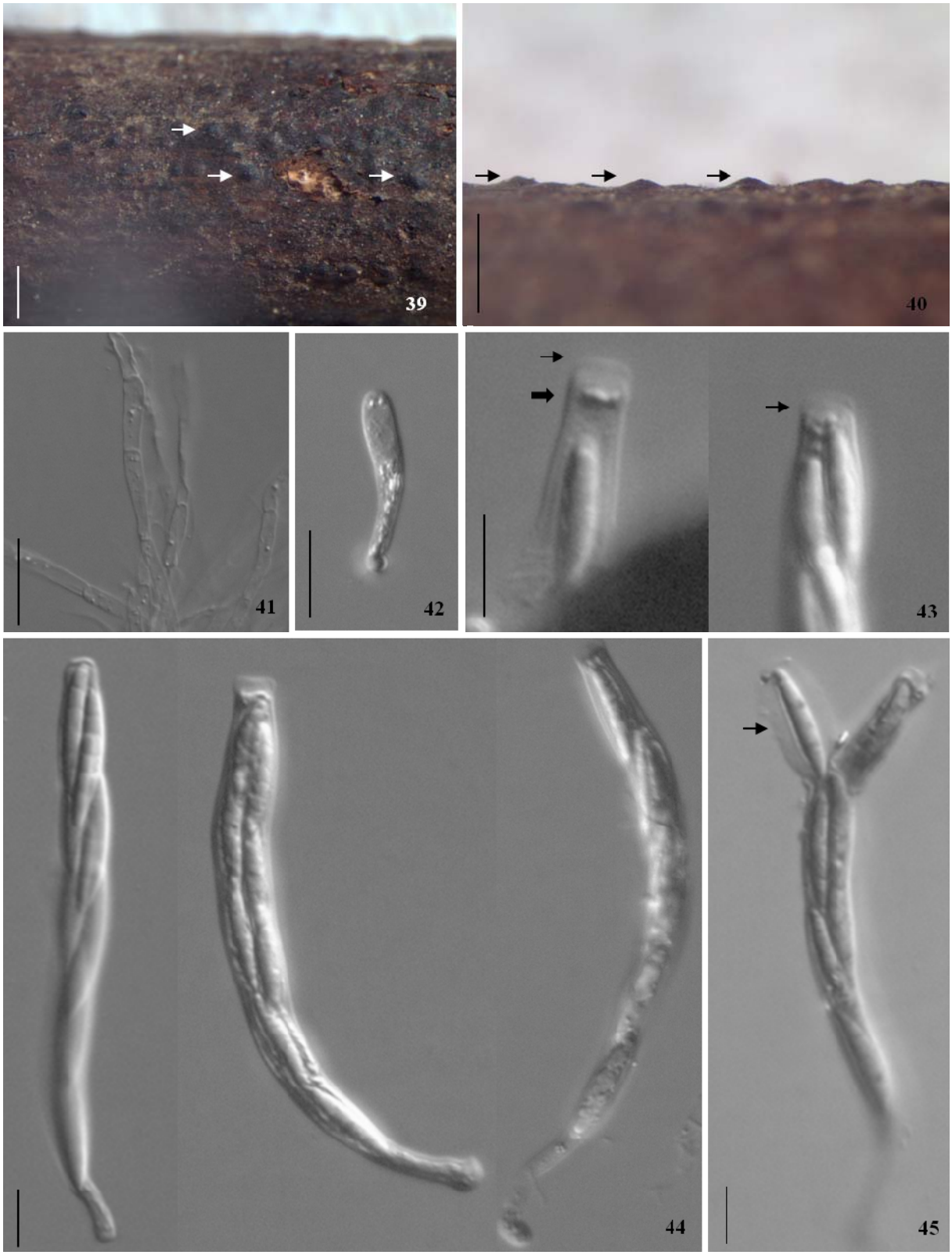
Known distribution: Australia, China (Wong et al. 1998b), Brazil (this paper).

Comments: *Tamsiniella* S.W. Wong, K.D. Hyde, W.H. Ho & S.J. Stanley is a monotypic genus typified by *T. labiosa.* The Brazilian collection agrees in all aspects with the original description. However, the type species showed larger ascomata (130-225 × 180-250) compared to the collection from Brazil (100-120 µm high, up to 400 µm wide) (Wong et al. 1998b). The apical ring of *T. labiosa* shows a unique morphology. According to Wong et al. (1998b) “the lower ring is directly differentiated from the inner ascus wall layer and consists of some thickening material between the outer and inner ascus wall layers”. *Tamsiniella labiosa* possess asci and ascospores with some similarities to those of *Myelosperma tumidium* Syd. & P. Syd. (Wong et al. 1998b)

Thus far, *T. labiosa* has been reported only from tropical regions. The report from fresh water in Brazil suggests that *T. labiosa* is specific to warm water habitats. The Brazilian collection represents the first record from American continent.



Figs 35-38. *Ophioceras venezuelense*. 35. Ascomata partially immersed in wood. Arrow showing necks. 36. Longitudinal section through ascoma. 37. Asci. 38. Ascospores. Bars: 35, 36 = 1 mm. 37, 38 = 25 µm.



Figs 39-45 *Tamsiniella labiosa*. 39. Ascomata on wood (arrows). 40. Ascomata from side view (arrows). 41. Paraphyses. 42. Young ascus. 43. Details of the ascus apex showing an external thickening (thin arrow) and apical ring (thick arrow). 44. Asci. 45. Ascus and ascospore surrounded by a mucilaginous sheath (arrow). Bars: 39, 40 = 1 mm. 41 = 25 µm. 42 = 50 µm. 43 = 5 µm. 44, 45 = 10 µm.

Acknowledgements

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CAPÍTULO 4

Some freshwater fungi from the Brazilian semi-arid region, including two new species of Hyphomycetes

Artigo a ser submetido à publicação na revista Mycoscience

Resumo: Neste artigo são descritas e ilustradas duas novas espécies para ciência, *Dactylaria saccardoana* e *Quadracaea stauroconidia*. *Dactylaria saccardoana* se diferencia das demais espécies do gênero pela presença de seta e pela morfologia do conídio. *Quadracaea stauroconidia* apresenta conídio morfologicamente distinto da única espécie presente no gênero. Além disso, é apresentada uma listagem com 151 espécies de microfungos coletados sobre material vegetal submerso.

FULL PAPER

Some freshwater fungi from the Brazilian semi-arid region, including two new species of hyphomycetes

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Abstract A preliminary study about fungi in freshwater habitats was carried out in a stream in the Brazilian semi-arid region. Thus far, knowledge concerning freshwater fungi in Brazil is lacking. Samples of submerged plant debris were collected every three months from 2007 to 2009 in a small stream in the “Serra da Jibóia” Bahia state. A checklist of one hundred and fifty-one fungi, including meiosporic and mitosporic ascomycetes are reported herein and two new species of hyphomycetes are described and illustrated.

Key words Ascomycetes · *Dactylaria* · Plant debris · *Quadracaea* · Taxonomy

Introduction

The Brazilian semi-arid region extends for 970.000 Km^2 and includes the North of Minas Gerais and eight states in the Northeast of Brazil (Giulietti & Queiroz 2006). The latest data shows that 955 fungi have been recorded from the Brazilian semi-arid. The most representative group studied includes the mitosporic ascomycetes (407 spp) followed by meiosporic ascomycetes (179 spp) (Gusmão et al. 2006b). Since these fungi were collected only from terrestrial habitats (Bezerra & Maia 2006, Gusmão et al. 2006a), our knowledge of the biodiversity of freshwater fungi in the semi-arid region remains poorly understood.

The freshwater fungi are a phylogenetically diverse group and represented almost entirely by microfungi belonging to the ascomycetes (Shearer et al. 2007). Recently, studies have shown that 1337 fungi are present in freshwater habitats (Jones & Choeyklin 2008, Jones et al. 2009). In view of the lack of knowledge concerning freshwater fungi from semi-arid region, we initiated a taxonomic study to determine the species richness and distribution patterns of these fungi (Barbosa et al. 2008).

In this paper we describe and illustrate two new mitosporic ascomycetes from freshwater habitats from the semi-arid. In addition, we present a preliminary checklist of freshwater mitosporic and meiosporic ascomycete collected during the study increasing the knowledge of fungi in Brazil.

Materials and methods

Study area

The “Serra da Jibóia”, one of nine hygrophilous forest patches in the Brazilian semi-arid extends along six cities in the eastern state of Bahia. Its area is about 22.000 ha and the altitude ranges from 750 to 840 meters. In the year 2000, about 147 priority areas in Brazil were selected for conservation of biodiversity, and the “Serra da Jibóia” was designated as an extreme biological important area (Ministério do Meio Ambiente 2000).

Sampling method

A total of eight collection trips were made in Santa Terezinha City, Bahia State every three months from July 2007 to May 2009. Submerged dead plant debris (twigs, leaves, barks and petioles) was collected from a small stream along an altitudinal gradient and placed in plastic bags. In the laboratory, samples were placed in Petri dish moist chambers and stored within 170 L polystyrene boxes with 200 ml sterile water plus 2 ml glycerol. The plant substrates were scanned at regular intervals using a dissecting microscope for microfungi and fruit bodies of ascomycetes. Fungal materials were prepared in PVL resin (polyvinyl alcohol, latic acid and fenol) on glass microscope slides for mitosporic ascomycetes. Dried herbarium samples including slides of meiosporic ascomycetes, were mailed to the Laboratory of Mycology in the University of Illinois at Urbana-Champaign for identification. Slides of material were made from dried herbarium samples following the double cover glass method of Volkmann-Kohlmeyer & Kohlmeyer (1996). All slides and dry materials of mitosporic and meiosporic ascomycetes were deposited in Herbarium HUEFS. Illustrations were made following Barber & Keane (2007).

Results

During the investigation of freshwater fungi on submerged plant debris, 151 taxa were identified and are listed herein (Table 1). Of these, 136 species were mitosporic fungi and 15 were meiosporic ascomycetes. Among the mitosporic fungi identified, 134 species were hyphomycetes and only two species, *Dinemasporium lanatum* and *Satchmopsis brasiliensis*, were coelomycetes. With respect to ecological group of the mitosporic fungi, *Brachiosphaera tropicalis* and *Ingoldiella hamata* are Ingoldian fungi and *Cancellidium applanatum, Candelabrum brocchiatum, Helicomyces roseus* and *Inesiosporium longispirale* are aeroaquatic fungi. The 130 remaining species are miscellaneous mitosporic ascomycetes. Among the meiosporic ascomycetes, 13 species belong to Sordariomycetes, one species, *Jahnula seychellensis* belongs to Dothideomycetes and one species, *Orbilia* sp., belongs to Orbiliomycetes. Woody debris was the most colonized substrate with 74 species occurring on it, while 51 species occurred on folicolous debris. Twenty-six species occurred on both debris types.

Taxonomy

Dactylaria saccardoana F.R. Barbosa & Gusmão, sp. nov. Figs. 1-6

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Setae 4-7 septatae, simplices, rectae, laeves, brunneae ad basem et pallide brunnea ad apicem. Conidiophora mononemata, macronemata, aggregata vel solitaria, simplicia, 2-3 septata, erecta, recta vel flexuosa, laevia, brunnea ad basim et dilute brunnea ad apicem, 25-76 × 2.3-3 μm. Cellulae conidiogenae polyblasticae, terminales, integratae,

sympodiales, denticulata, subhyalinae, 15-34 × 3 µm. Conidia solitaria, sicca, 0-1 septata, laevia, triangulo informes, utrinque truncata, attenuata ad basim, hyalina vel subhyalina, 9-12 × 1.5-3 × 0.8-1.5 µm.

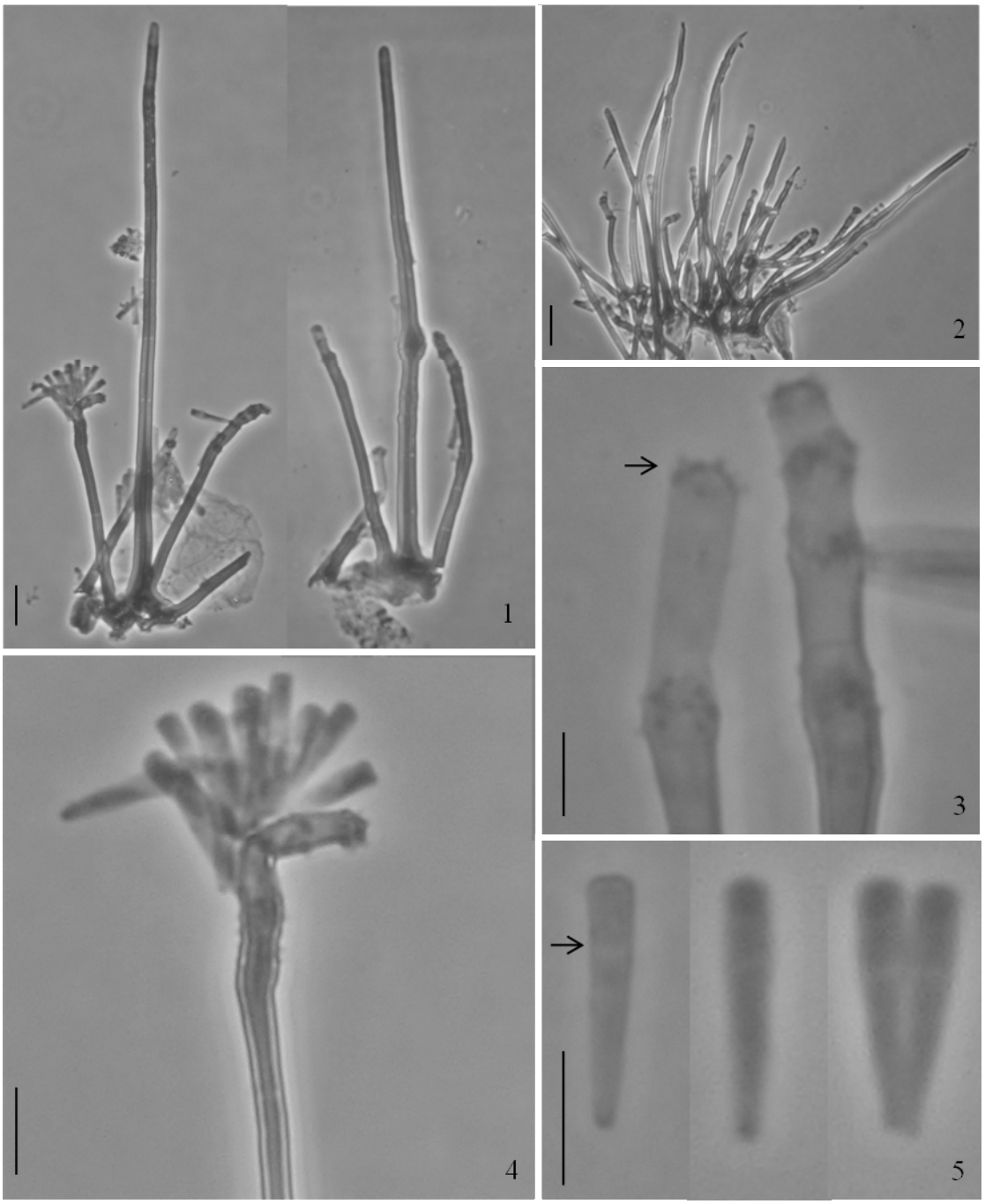
Typus: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia, water temperature 23 C, pH 7.4. On submerged leaves, 13 Apr 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155280).

Etymology: named in honor of P. A. Saccardo (1845 – 1921), who described the genus.

Teleomorph: Unknown.

Setae 4-7-septate, unbranched, rect, smooth, brown at the base becoming paler towards the rounded, sterile apex, 97-127 × 3-4.5 µm. **Conidiophores** mononematous, macronematous, aggregated or solitary, unbranched, 2-3-septate, erect, rect or flexuous, smooth-walled, brown at the base, paler above, 25-76 × 2.3-3 µm. **Conidiogenous cells** polyblastic, terminal, integrated, sympodial with inconspicuous, narrow denticles, subhyaline, 15-34 × 3-4 µm. **Conidia** solitary, dry, 0-1-septate, smooth, triangle-shaped, truncate at the apex, tapering towards the rounded base, subhyaline to hyaline, 9-12 µm high, 1.5-3 µm wide at the apex, 0.8-1.5 µm wide at the base.

Notes: *Dactylaria* Sacc. was erected to accommodate *D. purpurella* (Sacc.) Sacc. collected from decaying Oak wood from Italy and described as *Acrothecium purpurellum* Sacc. (Saccardo 1877, 1880). Since then, *Dactylaria* has been revised, but its taxonomy remains complex. In a revision of the genus, De Hoog (1985) recognized 41 species and subdivided them into four sections: *Dactylaria*, *Mirandina* (G. Arnaud ex Matsush.) de Hoog, *Diplorhinotrichum* (Höhn.) de Hoog and *Pleurophragmium* (Constantin) de Hoog. Later, Goh & Hyde (1997) provided a key to 37 species of



Figs 1-5 *Dactylaria saccardoana.* 1. Overview. 2. Setae and conidiophores. 3. Details of the conidiogenous cells. Arrow indicates denticles. 4. Conidia attached to the conidiogenous cells. 5. Conidia. Arrow indicates septum. Scale bars= 1,4 = 10 μm, 2 = 20 μm, 3,5 = 5 μm

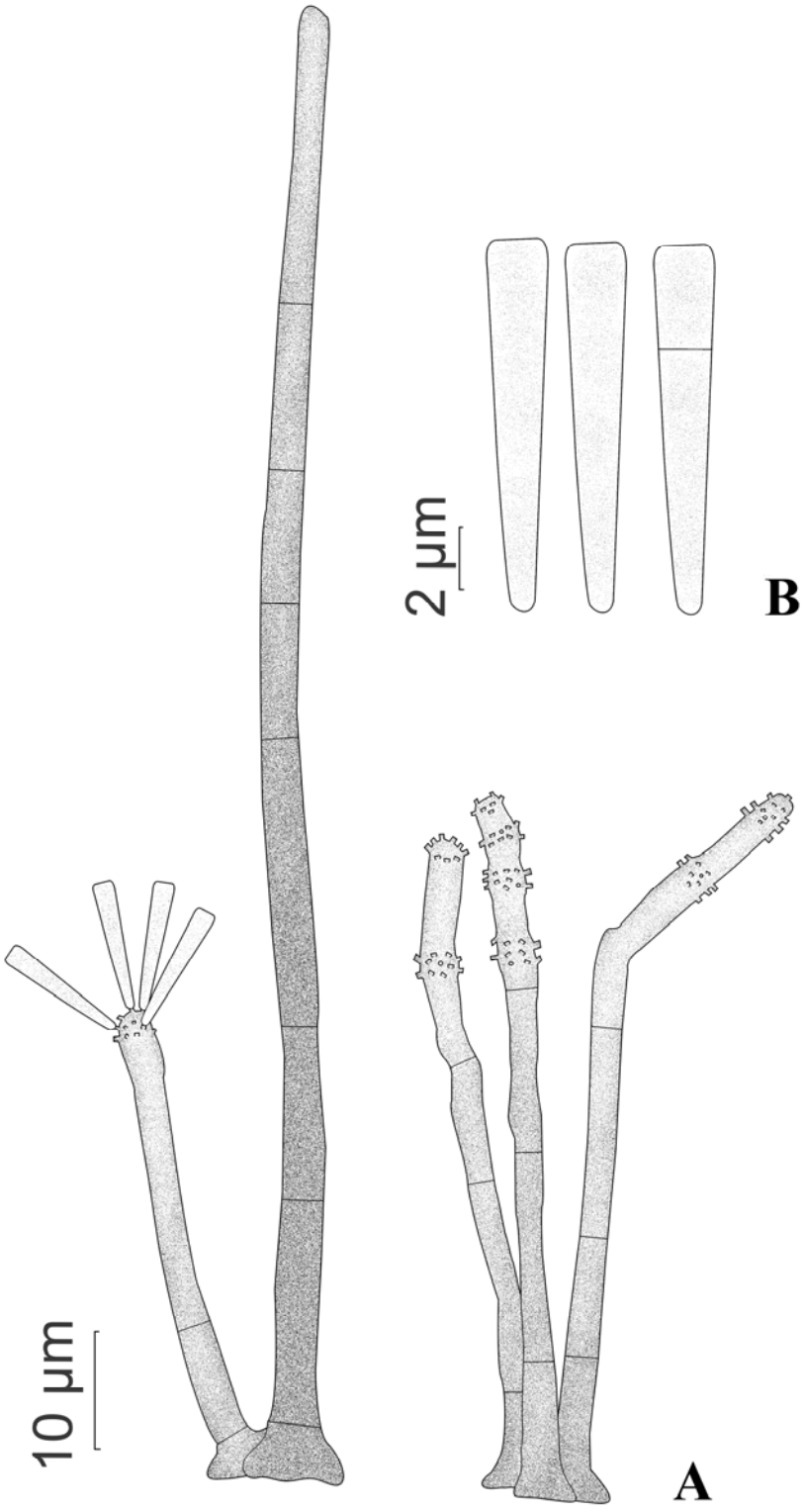


Fig 6 *Dactylaria saccardoana.* A. Setae, conidiophores and conidia. B. Conidia

Dactylaria described post De Hoog (1985). Fourteen more described species were later treated in a synopsis by Paulus et al. (2003). *Dactylaria* occurs worldwide, and it has been recorded previously as saprobes from fresh water (Hyde & Goh 1998a) and terrestrial (Gené et al. 2000) habitats. However, species can play a role as predators of nematodes, plant pathogens, as well as animal disease agents (Goh & Hyde 1997).

Dactylaria is characterized as having whitish, brownish and dark brown colonies; conidiophores cylindrical or somewhat tapering, erect, thick-walled or undifferentiated, (sub) hyaline or brown, continuous or septate, with cylindrical or tapering denticles in the apical region; conidia hyaline or pale brown, thin-walled, septate (De Hoog 1985). Our collection from Brazil differs from all previously described species in the genus in having sterile setae between the conidiophores. In this case, we emend the concept of *Dactylaria* to include presence or absence of setae.

Four species of *Dactylaria* have triangle-shaped conidia: *D. isoscelispora* W.B. Kendr. & R.F. Castañeda, *D. manifesta* R.F. Castañeda & W.B. Kendr., *D. obtriangularia* Matsush. and *D. ponapensis* Matsush. *Dactylaria obtriangularia* and *D. ponapensis* have conidia with a rounded apex (Matsushima 1980, 1985), which is distinct from the truncate apex of *D. saccardoana. Dactylaria isoscelispora* and *D. manifesta* are the closest species to *D. saccardoana.* However, *D. isoscelispora* can be distinguished from *D. saccardoana* in having much larger conidiophores (70-300 × 8-13 μm) and conidia (18-23 × 3 × 1 μm) (Castañeda & Kendrick 1990). *Dactylaria manifesta* differs from *D. saccardoana* in having larger, 2-5-septate conidia (14-20 × 3-3.5 × 1-1.5 μm) and conidiophores (55-200 × 5-9 μm) (Castañeda & Kendrick 1991).

Quadracaea stauroconidia F.R. Barbosa & Gusmão, sp. nov. Figs. 7-12

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Conidiophora mononemata, macronemata, solitaria, simplicia, septata, erecta, recta vel flexuosa, laevia, brunnea ad basim et dilute brunnea ad apicem, 84-225 × 3-9 µm. Cellulae conidiogenae polyblasticae, terminales vel intercalares, integratae, prolificantes, 12-16.5 × 3-3.8 µm. Cellulae separantes simplices vel aggregatae, tenuitunicatae, laeviae, ampulliformes, apicem versus attenuatae, pallide brunneae, 3-6 × 3 µm. Conidia solitaria, sicca, septata, ad septa constrictae, rhexolitica, laevia, tenuitunicata, staurospora; cellula centralis angularis, atrobrunnea 8.5-13 × 7.5-11 µm; cellulae apicales conica, pallide brunnea, cellula prima 4-5 × 6 µm et cellula secunda 4-5 × 3-4.5 µm; cellulae laterales conicae, pallide brunnea, 4-5 × 4-6 µm; cellula basalis conico minute fimbriata, pallide brunnea, 4-5 × 5-6 µm; Conidia falcata 7.5-9 × 0.7-0.9 µm.

Typus: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia, water temperature 20.8 C, pH 4.6. On submerged leaves, 16 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155282); water temperature 21.3 C, pH 6. On submerged leaves, 03 Feb 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155283); water temperature 21.8 C, pH 4. On submerged twigs, 01 Jul 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155281).

Etymology: From latin ‘stauroconidia’ refers to the star-shaped conidium morphology.

Teleomorph: Unknown.

Conidiophores mononematous, macronematous, unbranched, septate, erect, rect, smooth, brown at the base, becoming paler toward the apex, 84-225 × 3-9 µm. **Conidiogenous cells** polyblastic, terminal or intercalary, integrated, sometimes with percurrent proliferations, cylindrical, light brown, 12-16.5 × 3-3.8 µm. **Separation cells**

single or in clusters up to 5, thin-walled, smooth, ampulliform, pale brown, 3-6 × 3 µm. **Conidia** solitary, dry, septate, constricted at the septa, separating rhexolytically, smooth, thin-walled, stauroform; central cell angular, dark brown, 8.5-13 × 7.5-11 µm; apical cells conical, pale brown, first cell 4-5 × 6 µm and second cell phialidic, 4-5 × 3-4.5 µm; two lateral cells conical rounded at the top, pale brown 4-5 × 4-6 µm, sometimes with a middle septum that form a phialidic cell; basal cell conical, truncate at base with a short frill, pale brown, 4-5 × 5-6 µm; phialidic cells produce apical, 0-septate, smooth, falcate, hyaline, 7.5-9 × 0.7-0.9 µm conidia.

Notes: *Quadracaea* Lunghini, Pinzari & Zucconi is a monotypic genus typified by *Q. mediterranea* Lunghini, Pinzari & Zucconi collected from leaves of *Quercus ilex* L. from central Italy (Lunghini et al. 1996). The genus is characterized by percurrent proliferations, polyblastic conidiogenous cells producing ampulliform separating cells, rhexolytic conidial secession and occurrence of a synanamorph (Lunghini et al. 1996). *Uberispora* Piroz. & Hodges and *Physalidiopsis* R.F. Castañeda & W.B. Kendr. are the genera closest to *Quadracaea* in having conidia seceding rhexolytically and the presence of a synanamorph (Ichinoe 1972, Pirozynski & Hodges 1973, Castañeda-Ruiz & Kendrick 1990, Bhat & Kendrick 1993, Castañeda-Ruiz et al. 1996). In *Uberispora tropicalis* Bhat & W.B. Kendr. (Bhat & Kendrick 1993), the authors report the presence of schizolytic conidial secession. However, they illustrated and described conidia "often carrying the upper portion of the conidiogenous cell as basal frill" a feature which characterizes rhexolytic conidial secession as in *Quadracaea. Uberispora* differs from *Quadracaea* in not producing separating cells and by a different arrangement of satellite cells around the central cell of the conidium (Pirozynski & Hodges 1973, Bhat & Kendrick 1993, Castañeda-Ruiz et al. 1996). *Physalidiopsis* differs from *Quadracaea* in

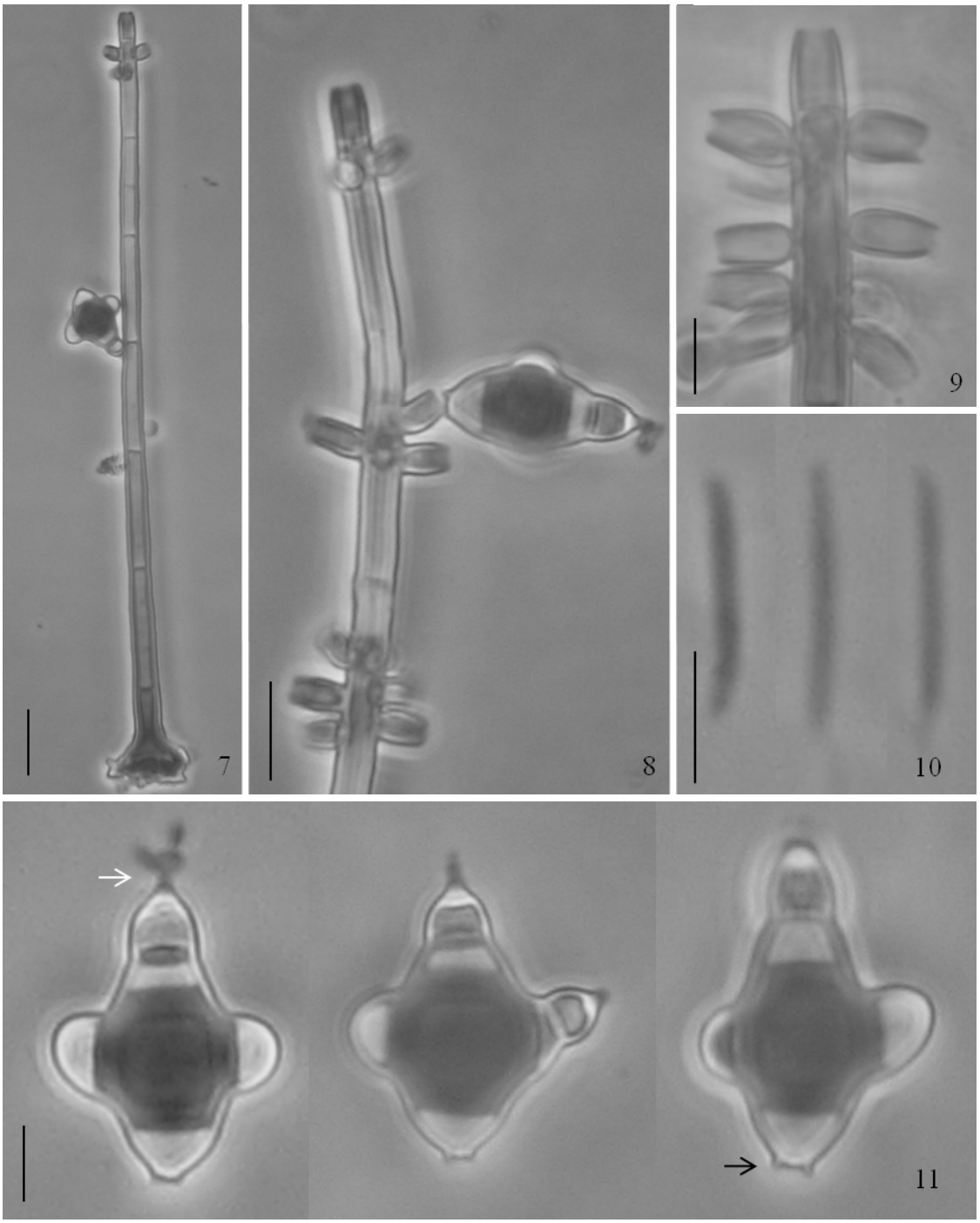
having short branches produced on conidiophores (Castañeda-Ruiz & Kendrick 1990). The presence of stauroconidia in *Physalidiopsis* was a character used by Lunghini et al. (1996) to differentiate the genus from *Quadracaea.* Due the presence of that character in *Q. stauroconidia*, we emend the concept of *Quadracaea* to include the presence of stauroform conidia.

Quadracaea stauroconidia can be differentiated from the only species in the genus, *Q. mediterranea* mainly by the morphology of the conidium. In *Q. mediterranea* the conidium is suboval to obpyriform with two central cells darker than the apical and basal cells (Lunghini et al. 1996) whereas in *Q. stauroconidia* the conidium has one dark, angular central cell and satellite cells around it.

Discussion

Fungi found in freshwater ecosystems play a key role in the degradation of dead organic plant material due their ability to break down lignocellulose (Wong MKM et al. 1998). The groups often found in fresh water are meiosporic and mitosporic ascomycetes while basidiomycetes are rare and generally absent (Shearer et al. 2007). Recent data suggest that about 592 species of meiosporic ascomycetes and 539 species of mitosporic ascomycetes (13 species of coelomycetes and 526 species of hyphomycetes) have been recorded from freshwater habitats worldwide (Shearer & Raja 2011).

A total of 151 species of fungi were found in this study (15 meiosporic ascomycetes and 136 mitosporic fungi) (Table 1). The higher prevalence of the mitosporic fungi on submerged leaves has been previously observed by Suberkropp & Klug (1974) when they analyzed the surface of leaves collected from fresh water using a scanning electron microscope.



Figs 7-11 *Quadracaea stauroconidia.* 7. Conidiophore with attached conidium. 8. Conidium detaching from the separating cell. 9. Details of the separating cells. 10. Falcate conidia. 11. Stauroform conidia. White arrow indicates phialide producing secondary conidium. Black arrow indicates basal frill. Scale bars= 7,8 = 10 μm, 9-11 = 5 μm.

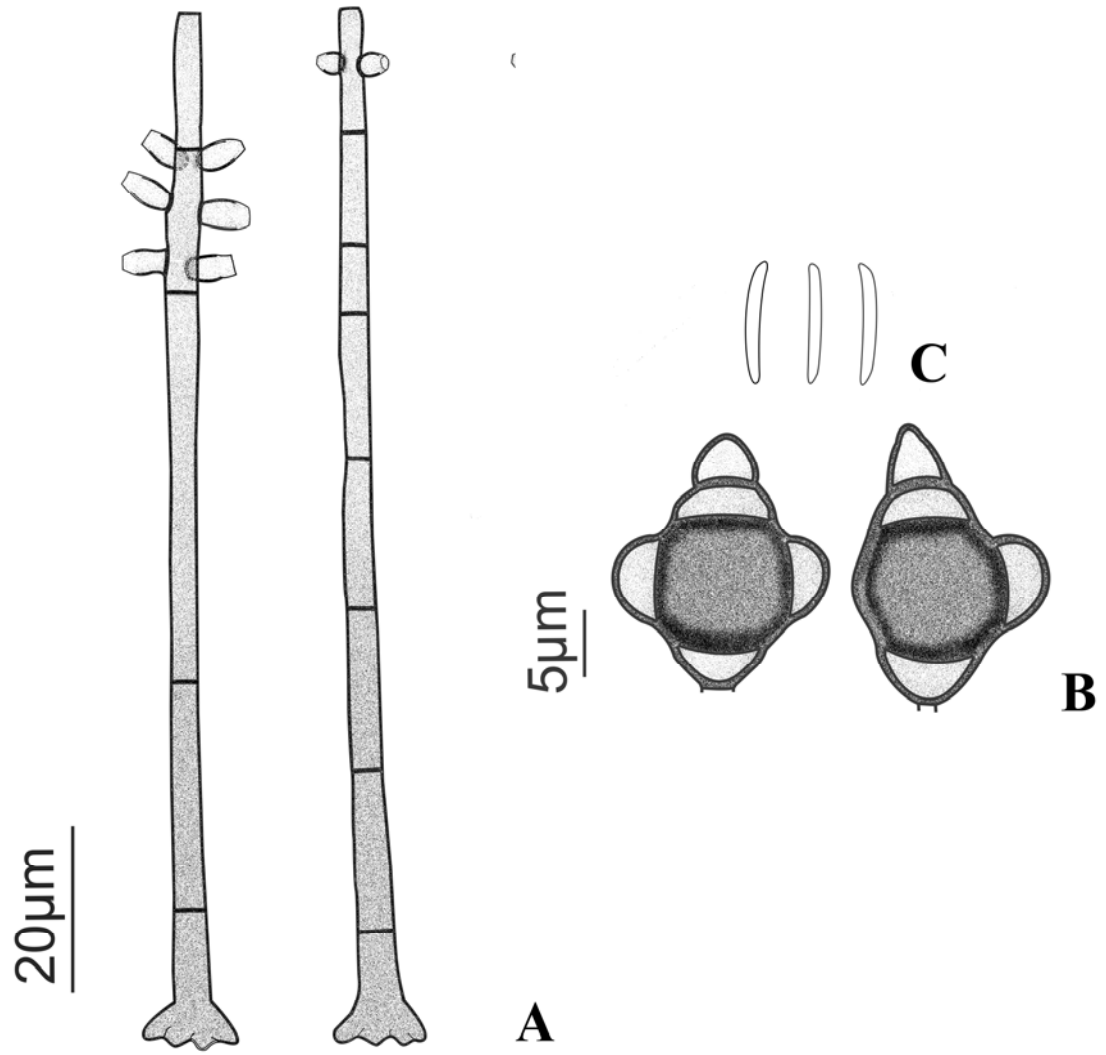


Fig 12. *Quadracaea stauroconidia.* A. Conidiophores. B. Stauroform conidia. C. Falcate conidia

Previous studies of freshwater fungi have also revealed differences in species composition in both temperate and tropical regions. Raja et al. (2009) conducted a study of freshwater fungi along the Florida Peninsula and found 74 species of mitosporic fungi and 56 species of meiosporic ascomycetes. The diversity of fungi on woody substrates in Egypt was assessed by Abdel-Aziz (2008) who found 34 mitosporic fungi and 26 meiosporic ascomycetes. In a study of freshwater fungi on submerged wood in Hong Kong, Tsui et al. (2001a) found 126 species of mitosporic fungi and 80 species of meiosporic ascomycetes. In Brazil, Schoenlein-Crusius & Milanez (1998) analyzed the fungal succession on submerged leaves of *Alchornea triplinervia* (Spreng.) Muell. Arg. and found 50 mitosporic fungi and 23 meiosporic ascomycetes species. A contradictory result was observed by Vijaykrishna & Hyde (2006) when they analyzed the biodiversity of lignicolous freshwater fungi in five tropical streams in Australia. The authors recorded 101 species of meiosporic ascomycetes and 61 species of mitosporic fungi. Vijaykrishna & Hyde (2006) concluded that the reason for the larger ratio of the teleomorphic state was unknown. In our study, freshwater mitosporic fungi occurred on different substrate types (twig, bark, leaf and petiole), while meiosporic ascomycetes, for the most part, were restricted to wood (Table 1). This could perhaps be one of the reasons why mitosporic fungi were higher in number compared to the meiosporic ascomycetes. Alternatively, mitosporic fungi produce large numbers of conidia by mitosis, which could colonize different types of organic substrates available in freshwater and also enhance their detection.

From the 136 mitosporic fungi recorded from fresh water in this study, only two species were coelomycetes (Table 1). Our results support previous study where the ratio of hyphomycetes to coelomycetes was larger, both from terrestrial (Gusmão et al. 2001,

Wong & Hyde 2001) and freshwater habitats (Tsui et al. 2000, Sivichai et al. 2002). Records on coelomycetes in fresh water have been scarce. Thus far, only thirteen species have been reported worldwide (Shearer & Raja 2011). According Shearer et al. (2007), the low occurrence of coelomycetes in freshwater habitat reflects the lack of specialized human resources. Descals & Moralejo (2001) believe that coelomycetes are abundant in the aquatic environment, but are ignored, since these fungi are not easily identified. In a study of freshwater fungi occurring on *Phragmites australis* (Cav.) Trin. ex Steud. in Egypt Abdel-Aziz (2008) observed a different result. In this study, the authors reported a higher number of coelomycetes than hyphomycetes, and noted an increase in coelomycetes species with increasing salinity. Similar results were reported in a study of diversity of fungi on *P. australis* in a brackish tidal marsh in Netherlands. Van Ryckegem & Verbeken (2005a) found 31 coelomycetes and 9 hyphomycetes species on leaves and Van Ryckegem & Verbeken (2005b) found 16 coelomycetes and 4 hyphomycetes species on stems. These results suggest that coelomycetes species richness is higher in brackish water habitats.

Two species found in this study, *Ingoldiella hamata* and *Brachiosphaera tropicalis* are Ingoldian fungi (Table 1). *Ingoldiella hamata* has a wide tropical distribution, since it was collected from fresh water in Australia (Shaw 1972), Malaysia (Nawawi 1973), India (Sridhar & Kaveriappa 1989), Singapore (Tubaki et al. 1993) and Brazil (Schoenlein-Crusius 2002). However, the species was recorded on submerged woody debris in Florida, USA (Raja et al. 2009). *Brachiosphaera tropicalis* is also a common species in tropical regions and was collected from fresh water in Malaysia (Descals et al. 1976), Thailand (Tubaki et al. 1983), Puerto Rico (Santos-Flores & Betancourt-Lopez 1994), Taiwan (Chang 1994), China (Ho et al. 2002) and Venezuela (Smits et al. 2007).

However, the species was recorded on submerged wood in South Africa by Hyde et al. (1998) and on submerged herbaceous debris in United States (Florida) by Raja et al. (2009).

Four aeroaquatic species were collected herein, namely, *Cancellidium applanatum, Candelabrum brocchiatum, Helicomyces roseus* and *Inesiosporium longispirale*. Except for *I. longispirale*, which was found in Cuba (Castañeda & Gams 1997), *Canc. applanatum, Cand. brocchiatum* and *H. roseus* have tropical and temperate distributions (Raja et al. 2007, Hyde & Goh 1998a,b Tubaki 1975, Sivichai et al. 2002, Delgado-Rodrigues et al. 2002). The 130 remaining mitosporic species recorded herein are miscellaneous mitosporic ascomycetes (Shearer et al. 2007) (Table 1). These fungi do not have conidia distinctly modified for an aquatic existence and can be found both in water and terrestrial habitats (Goh & Hyde 1996). The collection and incubation methodology employed here probably contributed to the emergence of large number of miscellaneous mitosporic ascomycetes instead of Ingoldian and aeroaquatic fungi.

Among the meiosporic ascomycetes species, *Calosphaeria* sp., *Chaetomium homopilatum*, *C. longicoleum*, *Chaetosphaeria lignomolis*, *Linocarpon* sp. and *Orbilia* sp. often occur often in terrestrial habitats (Ames 1961, Kale 1965, Liu et al. 2006, Hyde 1997, Fernández & Huhndorf 2005) and *Aniptodera chesapeakensis, Annulatascus velatisporus, Anthostomella aquatica, Jahnula seychellensis*, *Ophioceras venezuelense*, *Tamsiniella labiosa* and *Torrentispora crassiparietis* are reported from freshwater habitats (Shearer 1989, Hyde & Goh 1998a,b, Wong SW et al. 1998, Hyde & Wong 1999, Tsui et al. 2001b, Kohlmeyer & Volkmann-Kohlmeyer 2002, Fryar & Hyde 2004). *Annulatascus apiculatus* was found only once on a submerged twig in Brazil (Barbosa et al. 2008). The six meiosporic ascomycetes species previously reported from

terrestrial habitats and the 130 species of mitosporic ascomycetes, can be referred to as immigrants sensu Park (1972). Thus far, *Annulatascus velatisporus*, *A. apiculatus*, *J. seychellensis*, *Ophioceras venezuelense* and *Tamsiniella labiosa* have been reported only from fresh water (Hyde & Goh 1998b, Wong SW et al. 1998, Hyde & Wong 1999, Tsui et al. 2001b, Barbosa et al. 2008). The six meiosporic ascomycetes species previously reported from terrestrial habitats and the 130 and can be regarded as truly aquatic taxa or indwellers (Park 1972).

Most of the representatives of freshwater meiosporic ascomycetes reported here are included in Sordariomycetes (sensu Lumbsch & Huhndorf 2010). Some taxa in this class may be adapted to live in fresh water (Vijaykrishna et al. 2006). Adaptations can include: deliquescent asci, mucilaginous sheath around the ascospores, ascospores with wall ornamented and appendages etc. (Wong MKM et al. 1998, Jones 2006).

With respect to the substrate, most freshwater species found in this study (74 species) occurred exclusively on submerged woody debris (twig and/or bark). Fifty-one species were folicolous species (leaf and/or petiole) and 26 species were generalists (found on all substrate types) (Table 1). This result agrees with results in the literature (Shearer & Raja 2011). In a study with freshwater ascomycetes, Abdel-Raheem & Shearer (2002) and Simonis et al. (2008) found no difference in enzyme production among lignicolous, herbaceous and generalist species, indicating that enzymatic capacity is not a limiting factor in the colonization of substrates. Shearer (1992) concluded that wood remains available for longer durations due the low rate of decomposition and large size. The longer turnover time would allow a larger number of fungi to colonize wood than folicolous substrates, which decompose faster compared to wood.

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Table 1. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Meiosporic ascomycetes				
Aniptodera chesapeakensis Shearer & M.A. Mill.	+			
Annulatascus apiculatus F.R. Barbosa & Gusmão	+			
Annulatascus velatisporus K.D. Hyde	+			+
Anthostomella aquatica K.D. Hyde & Goh	+	+		+
Calosphaeria sp.	+			
Chaetomium homopilatum Omvik	+			
C. longicolleum Krzemien. & Badura			+	
Chaetosphaeria lignomollis F.A. Fernández & Huhndorf	+			
Jahnulla seychellensis K.D. Hyde & S.W. Wong	+			
Nectria sp.				+
Linocarpon sp.	+			
Ophioceras venezuelensis Shearer et al.	+			
Orbilia sp.				+
Tamsiniella labiosa S.W. Wong et al.	+			
Torrentispora crassiparietis Fryar & K.D. Hyde		+		
Coelomycetes				
Dinemasporium lanatum Nag Raj & R.F. Castañeda			+	+
Satchmopsis brasiliensis B. Sutton & Hodges			+	

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Hyphomycetes				
Acrogenospora sphaerocephala (Berk. & Broome) M.B. Ellis	+	+	+	
Actinocladium rhodosporum Ehrenb.	+			
A. verruculosum W.P. Wu	+			
Arthrobotrys oligospora Fresen.			+	
Bactrodesmium longisporum M.B. Ellis	+	+		
Beltrania rhombica Penz.			+	+
Beltraniella portoricensis (F. Stevens) Piroz. & S.D. Patil			+	
Berkleasmium corticola (P. Karst.) R.T. Moore		+		
Brachiosphaera tropicalis Nawawi		+		
Brachydesmiella anthostomelloidea Goh & K.D. Hyde				+
B. caudata V. Rao & de Hoog				+
Brachysporiella gayana Bat.	+	+		
B. pulchra (Subram.) S. Hughes	+			
Cacumisporium pleuroconidiophorum (Davydkina & Melnik) R.F. Castañeda et al.	+	+		
C. sigmoideum Mercado & R.F. Castañeda	+			
Camposporidium cristatum Nawawi & Kuthub.			+	+
Canalisporium caribense (Hol.-Jech. & Mercado) Nawawi & Kuthub.		+		

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
C. exiguum Goh & K.D. Hyde			+	
Cancellidium applanatum Tubaki	+			
*Candelabrum brocchiatum*Tubaki	+	+		
Chaetopsina fulva Rambelli			+	+
C. splendida B. Sutton & Hodges				+
Chalara alabamensis Morgan-Jones & E.G. Ingram				+
Chloridium obclaviforme J. Mena & Mercado		+		
C. virescens (Pers.) W. Gams & Hol.-Jech.	+			
Circinotrichum papakurae S. Hughes & Piroz.			+	
Craspedodidymum sp.	+			
C. cubense J. Mena & Mercado		+		
Cryptophiale kakombensis Piroz.			+	
C. udagawae Piroz. & Ichinoe	+		+	
Cryptophialoidea fasciculata Kuthub. & Nawawi	+			+
C. secunda (Kuthub. & B. Sutton) Kuthub. & Nawawi	+			
Dactylaria botulispora R.F. Castañeda & W.B. Kendr.	+			
D. candidula (Höhn.) G.C. Bhatt & W.B. Kendr.	+			
D. fusiformis Shearer & J.L. Crane			+	+
D. hyalotunicata K.M. Tsui et al.	+	+		
D. saccardoana F.R. Barbosa & Gusmão			+	

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Dactylella ellipsospora (Preuss) Grove	+			
Dendryphiopsis atra (Corda) S. Hughes	+			
Dictyochaeta anam. *Chaetosphaeria pulchriseta* S. Hughes et al.	+	+		
D. britannica (M.B. Ellis) Whitton et al.				+
D. fertilis (S. Hughes & W.B. Kendr.) Hol.-Jech.	+	+	+	+
D. heteroderae (Morgan-Jones) Carris & Glawe	+			
D. microcylindrospora Whitton et al.	+		+	+
D. pluriguttulata Kuthub. & Nawawi	+			
D. simplex (S. Hughes & W.B. Kendr.) Hol.-Jech.	+	+	+	+
Dictyochaetopsis gonytrichoides (Shearer & J.L. Crane) Whitton et al.	+		+	
D. polysetosa R.F. Castañeda et al.			+	+
Dictyosporium digitatum J.L. Chen et al.			+	+
D. elegans Corda	+		+	+
Dischloridium inaequiseptatum (Matsush.) Hol.-Jech.		+		
Ellisembia adscendens (Berk.) Subram.	+	+		
E. bambusicola (M.B. Ellis) J. Mena & G. Delgado	+			
Endophragmiella boothii (M.B. Ellis) S. Hughes		+		
E. fasciata (R.F. Castañeda) R.F. Castañeda			+	
E. rostrata P.M. Kirk	+			

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Exserticlava sp.	+			
E. triseptata (Matsush.) S. Hughes	+	+		
E. vasiformis (Matsush.) S. Hughes		+		
Gonytrichum chlamydosporium G.L. Barron & G.C. Bhatt	+	+	+	
Gyrothrix circinata (Berk. & M.A. Curtis) S. Hughes	+			+
G. cornuta V. Rao & de Hoog			+	
G. magica Lunghini & Onofri			+	
G. microsperma (Höhn.) Piroz.	+		+	+
G. podosperma (Corda) Rabenh.			+	
G. verticiclada (Goid.) S. Hughes & Piroz.			+	
Helicomyces roseus Link		+	+	
Heliocephala elegans (R.F. Castañeda) R.F. Castañeda & Unter.			+	
Hermatomyces sphaericus (Sacc.) S. Hughes	+			
Idriella cagnizarii R.F. Castañeda & W.B. Kendr.			+	
I. ramosa Matsush.			+	+
Inesiosporium longispirale (R.F. Castañeda) R.F. Castañeda & W. Gams		+	+	
Ingoldiella hamata D.E. Shaw		+		+
Ityorhoptrum verruculosum (M.B. Ellis) P.M. Kirk		+		

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Junewangia martinii (J.L. Crane & Dumont) W.A. Baker & Morgan-Jones		+		
Kionochaeta ramifera (Matsush.) P.M. Kirk & B. Sutton			+	
Lauriomyces sakaeratensis Somrith. et al.			+	+
Linkosia ponapensis (Matsush.) R.F. Castañeda et al.			+	
Melanocephala australiensis (G.W. Beaton & M.B. Ellis) S. Hughes	+	+		
Menisporopsis novae-zelandiae S. Hughes & W.B. Kendr.	+		+	+
M. pirozynskii Varghese & V.G. Rao			+	
M. theobromae S. Hughes	+		+	+
Mirandina corticola G. Arnaud	+			
Monodictys putredinis (Wallr.) S. Hughes	+			
Mycoenterolobium platysporum Goos		+		
Nakataea fusispora (Matsush.) Matsush.	+			
Parasympodiella laxa (Subram. & Vittal) Ponnappa			+	
Periconia minutissima Corda	+			
Phaeoisaria clematidis (Fuckel) S. Hughes	+			
Pithomyces elaeidicola M.B. Ellis		+		
P. niger Mercado & J. Mena		+		
Pleurophragmium malaysianum Matsush.	+			

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Pseudobotrytis terrestris (Timonin) Subram.	+			
Pseudotracylla dentata B. Sutton & Hodges	+		+	+
Pyricularia rabaulensis Matsush.			+	
Quadracaea stauroconidia F.R. Barbosa & Gusmão	+		+	
Rhexoacrodictys erecta (Ellis & Everh.) W.A. Baker & Morgan-Jones	+	+		+
Scutisporus brunneus K. Ando & Tubaki				+
Selenodriella fertilis (Piroz. & Hodges) R.F. Castañeda & W.B. Kendr.			+	
S. perramosa W.B. Kendr. & R.F. Castañeda	+			
Speiropsis scopiformis Kuthub. & Nawawi			+	
Sporendocladia bactrospora (W.B. Kendr.) M.J. Wingf.	+			
Sporidesmiella ciliaspora W.P. Wu		+		
S. hyalosperma (Corda) P.M. Kirk	+			
S. parva (M.B. Ellis) P.M. Kirk	+			
S. vignalensis W.B. Kendr. & R.F. Castañeda			+	
Sporidesmium tropicale M.B. Ellis	+			
Sporoschisma juvenile Boud.	+			
S. saccardoi E.W. Mason & S. Hughes	+			
Stachybotrina sp.nov F.R. Barbosa et al.			+	

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Stachybotrys sphaerospora Morgan-Jones & R.C. Sinclair				+
Subulispora longirostrata Nawawi & Kuthub.				+
S. procurvata Tubaki	+		+	
Tetraploa aristata Berk. & Broome			+	
Thozetella cristata Piroz. & Hodges	+		+	+
T. cubensis R.F. Castañeda & G.R.W. Arnold	+		+	+
T. gigantea B.C. Paulus et al.	+		+	
T. pinicola S.Y.Q. Yeung et al.			+	
T. submersa F.R. Barbosa & Gusmão	+			
Torula herbarum (Pers.) Link	+			
Umbellidion radulans B. Sutton & Hodges			+	
Vermiculariopsiella cubensis (R.F. Castañeda) Nawawi et al.			+	+
V. immersa (Desm.) Bender			+	
Virgariella atra S. Hughes	+	+		
V. globigera (Sacc. & Ellis) S. Hughes		+		
Virgatospora echinofibrosa Finley				+
Wiesneriomyces laurinus (Tassi) P.M. Kirk			+	
Xylomyces chlamydosporus Goos et al.		+		
X. elegans Goh et al.		+		
X. foliicola W.B. Kendr. & R.F. Castañeda		+	+	+

Table 1 continued. Freshwater fungi from Brazilian semi-arid on different substrates

Fungus name	Twig	Bark	Leaf	Petiole
Zanclospora novae-zelandiae S. Hughes & W.B. Kendr.		+		
Zygosporium echinosporum Bunting & E.W. Mason			+	+
Z. masonii S. Hughes	+			
Z. minus S. Hughes	+			

CAPÍTULO 5

Conidial fungi from the semi-arid Caatinga biome of Brazil. New species and records for *Thozetella*

Artigo aceito para publicação na revista Mycotaxon 115, 2011

Resumo: nesse artigo é descrita e ilustrada a nova espécie, *Thozetella submersa* sobre galho submerso em um riacho no Bioma Caatinga. *Thozetella submersa* se diferencia das demais espécies presentes no gênero pela diferente morfologia dos microawns. Uma chave para as espécies do gênero é apresentada bem como a ilustração comparativa dos microawns presentes em todas as espécies de *Thozetella.* Além disso, *T. boonjiensis* e *T. gigantea* são apresentadas como segundo registro mundial.

MYCOTAXON

Mycotaxon Styles 2 *Revised, February, 2011*

Conidial fungi from the semi-arid Caatinga biome of Brazil. New species and records for *Thozetella*

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ABSTRACT – As a result of an investigation of microfungi in northeastern Brazil, the hyphomycete *Thozetella submersa* sp. nov. is described from submerged wood. Its diagnostic features are the smooth, elliptic-fusiform, obclavate to rarely obovoid to obclavate, slightly curved, sometimes corniculate at the ends, microawns. *T. boonjiensis* and *T. gigantea* are recorded for the first time for the American continent. A key to all described species is included. A synopsis of drawings of microawns (most based on original papers) is provided for all *Thozetella* species.

KEY WORDS – anamorphic fungi, diversity, taxonomy

Introduction

Thozetella Kuntze presently includes fifteen species (Castañeda et al. 2002, Paulus et al. 2004, Allegrucci et al. 2004, Jeewon et al. 2009) found in temperate and warm regions (Nag Raj 1976, Grandi & Gusmão 2002, Piontelli & Giusiano 2004, Barbosa et al. 2007). Among the variety of sterile structures known for the hyphomycetes, the presence of microawns is unique for the genus (Sutton & Cole 1983).

Recent phylogenetic and morphological research of five species of *Thozetella* from Australia by Paulus (et al. 2004) confirms that *Thozetella* species are anamorphs of the ascomycete *Chaetosphaeria* Tul. & C. Tul. Their key to 14 described species of *Thozetella* (Paulus et al. 2004) did not include *T. buxifolia* Allegr. et al. (Allegrucci et al. 2004). In their synoptic table of *Thozetella* species, Paulus et al. (2004), who apparently did not examine the holotype, cited a median to submedian septum for microawns in *T. canadensis* Nag Raj although this character was not mentioned in the

protologue (Nag Raj 1976). In the present work, almost all characters are based on original species descriptions.

Recently, *T. pinicola* S.Y.Q. Yeung et al. was described from leaf litter of *Pinus elliottii* Engelm. in Hong Kong. This new taxon was based on morphology and DNA sequence analyses (Jeewon et al. 2009).

Paulus et al. (2004), Allegrucci et al. (2004), and Jeewon et al. (2009) retain *T. ciliata* (R.F. Castañeda et al.) Hol.-Jech. & Mercado within *Thozetella*. However, we refer this specimen to *Venustosynnema ciliatum* (R.F. Castañeda et al.) R.F. Castañeda & W.B. Kendr. In their discussion of *V. ciliatum,* Castañeda-Ruiz et al. (2002) note that the absence microawns and presence of dark brown setae are characters that exclude the species from *Thozetella.*

Thozetella species have been reported from leaf litter (Grandi 1999, Parungao et al. 2002, Castañeda-Ruiz et al. 2003, Allegrucci et al. 2004), decaying floral parts (Agnihothrudu 1958), soil (Agnihothrudu 1962), roots (Waipara et al. 1996), stalks (Nag Raj 1976), and bark (Morris 1956). This constitutes the third report of the genus from freshwater habitats following those of *T. havanensis* R.F. Castañeda (from submerged leaf litter) and *T. nivea* (Berk.) Kuntze (from wood) (Sivichai et al. 2002, Delgado-Rodrigues & Mena-Portales 2004).

From Brazil, five *Thozetella* species have been found: *T. cristata* Piroz. & Hodges, *T. cubensis* R.F. Castañeda & G.R.W. Arnold, *T. havanensis* (Barbosa et al. 2007, Silva & Grandi 2008), *T. queenslandica* B.C. Paulus, Gadek & K.D. Hyde (Cruz & Gusmão 2009), and *T. tocklaiensis* (Agnihothr.) Piroz. & Hodges (Maia et al. 2002).

Materials & methods

STUDY SITE. Collecting trips were made to the hygrophilous forests called "Serra da Jibóia" in the semi-arid region in the northeastern of Brazil. This area has been described previously (Barbosa et al. 2007, Marques et al. 2007)

COLLECTION TECHNIQUES. Submerged leaves and wood debris were collected from a lotic habitat in an unnamed stream in the "Serra da Jibóia". Samples were placed in plastic bags and returned to the laboratory. The plant material was then incubated at 25°C in Petri dish moist chambers and stored in 50 L plastic boxes with 200 ml sterile water plus 2 ml glycerol. Samples were examined over four weeks for the presence of conidiomata.

SPECIMEN EXAMINATION. Conidiomata were located with a dissecting microscope and removed to a glass slide where they were crushed and mounted in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol). Measurements were made of fixed material. Permanent slides were deposited in HUEFS.

Taxonomy

Thozetella submersa F.R. Barbosa & Gusmão, **sp. nov.** FIG. 1–5
MYCOBANK MB518831

Ab omnibus speciebus Thozetellae differt microaristis unicellularibus ellipsoidi-fusiformibus, raro obovatis vel obclavatis, minute curvis, laevibus, utrinque interdum solo corniculatis praeditis, hyalinis, 16–25µm longis, 3–4 µm latis at basi, 2–3 µm latis at apicem.

HOLOTYPUS: Brazil. Bahia: Santa Terezinha, Serra da Jibóia, on submerged wood from a stream, 25.III.2009, coll. FR Barbosa, HUEFS 141560.

ETYMOLOGY: the Latin *submersa* refers to the submerged habitat.

CONIDIOMATA sporodochial, superficial, sessile, 200–250 × 105–150 µm, moist and white mass. CONIDIOPHORES macronematous, compact at the base but more or less free distally, septate, smooth, cylindrical, brown, paling toward the apex, ≤ 3 µm diam. CONIDIOGENOUS CELLS monophialidic, integrated, determinate, terminal, cylindrical, light brown, 7.5–10 × 2.5–3 µm, lacking an apical collarette. MICROAWNS not visible in mass on the natural substratum, smooth, elliptic-fusiform, rarely obovoid to obclavate, slightly curved, sometimes corniculate at the ends, hyaline, 16–25 µm long, 3–4 µm wide at the base, 2–3 µm wide at the apex. CONIDIA aseptate, smooth-walled, finely guttulate or eguttulate, lunate, hyaline, 14–15 × 2–2.5 µm, provided with a single filiform setula at each end, 5–7 µm long.

NOTES: *Thozetella submersa* can be easily diagnosed by the morphology and smaller size of the microawns. A synopsis of microawns (FIG. 6) and a key to the published species are included.

Thozetella boonjiensis B.C. Paulus, Gadek & K.D. Hyde, Mycologia 96: 1076. 2004.

CONIDIOMATA sporodochial. MICROAWNS L-shaped, 0-septate, hyaline, 54–63 × 3–4.5 µm, apex acerose. CONIDIA 10.5–14.3 × 1.5–3 µm. SETULAE 5.3–7.5 µm long.

EXAMINED MATERIAL: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia, on decaying wood, 01.VIII.2008, coll. Fiuza P.O. (HUEFS148834).

NOTES: *Thozetella boonjiensis* resembles *T. acerosa* B.C. Paulus et al., *T. gigantea,* and *T. tocklaiensis* in the L-shaped microawns, which are, however, septate in *T. acerosa.* Both microawns and conidia are larger in *T. gigantea* and smaller in *T. tocklaiensis* (Paulus et al. 2004, Piontelli & Giusiano 2004). *Thozetella boonjiensis* was previously known only from the type locality (Australia) (Paulus et al. 2004).

Thozetella gigantea B.C. Paulus, Gadek & K.D. Hyde, Mycologia 96: 1080. 2004.

CONIDIOMATA sporodochial; MICROAWNS L-shaped, 0-septate, hyaline, 81–141 µm long, 4.5–6 µm wide at base. CONIDIA 13–15 × 1.5–2 µm. SETULAE 7.5–9 µm long.

EXAMINED MATERIAL: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia, on decaying leaves, 02.VIII.2007, coll. Silva, S.S. (HUEFS141569).

NOTES: *T. gigantea* is characterized by its microawns, which are the largest for the genus (Paulus et al. 2004). This species has been registered only from type locality (Australia) (Paulus et al. 2004).

Key to *Thozetella* species

1. Microawns predominantly L-shaped 2
1a. Microawns not L-shaped or variously shaped 5
2. Microawns 0–2 septate ..... *T. acerosa*
2a. Microawns aseptate 3
3. Microawns 75 µm or longer ..... *T. gigantea*
3a. Microawns shorter than 75 µm 4
4. Microawns apex undulating to geniculate ..... *T. nivea*
4a. Microawn apex straight to slightly undulating ..... *T. boonjiensis*
5. Microawns predominantly sickle-shaped, uncinate, hamate or otherwise strongly curved 6
5a. Microawns predominantly straight, sigmoid or of other shape 11
6. Conidiomata predominantly synnematous 7
6a. Conidiomata predominantly sporodochial 10
7. Synnemata proliferating conidiophores form ridges 8
7a. Synnemata non-proliferating 9
8. Microawns 40–60 × 2.5–3 µm, smooth ..... *T. cristata*
8a. Microawns 25–30 × 3–3.5 µm, verrucose ..... *T. buxifolia*
9. Microawns 40–95 × 2.5–5 µm, setulae 5–8 µm long ..... *T. falcata*
9a. Microawns 30–60 × 3–4.5 µm, setulae 5 µm long ..... *T. radicata*
10. Microawns 21–34 × 2–4 µm, smooth or apically verrucose ..... *T. queenslandica*
10a. Microawns 40–100 µm long, 2.5–4 µm wide at base, 0.5–1 µm wide at apex, smooth ..... *T. cubensis*
11. Conidiomata effuse ..... *T. effusa*
11a. Conidiomata otherwise 12
12. Conidiomata sporodochial 13
12a. Conidiomata synnematous 15
13. Microawns verrucose ..... *T. canadensis*
13a. Microawns smooth 14
14. Microawns elliptic-fusiform, 16–25 × 3–4 wide at the base, 2–3 µm wide at the apex ..... *T. submersa*

14a. Microawns straight or slightly undulating with the apical end acerose, 25–55 × 2.5–5 µm.....*T. pinicola*

15. Microawns variously shaped, bulbous base, acerose apex, straight, undulate, uncinate or bent,18–38 × 1.5–4 µm.....*T. tocklaiensis*

15a. Microawns with ± uniform width, sigmoid, allantoid, uncinate, 22.4–35 × 1.5–3.2 µm.....*T. havanensis*

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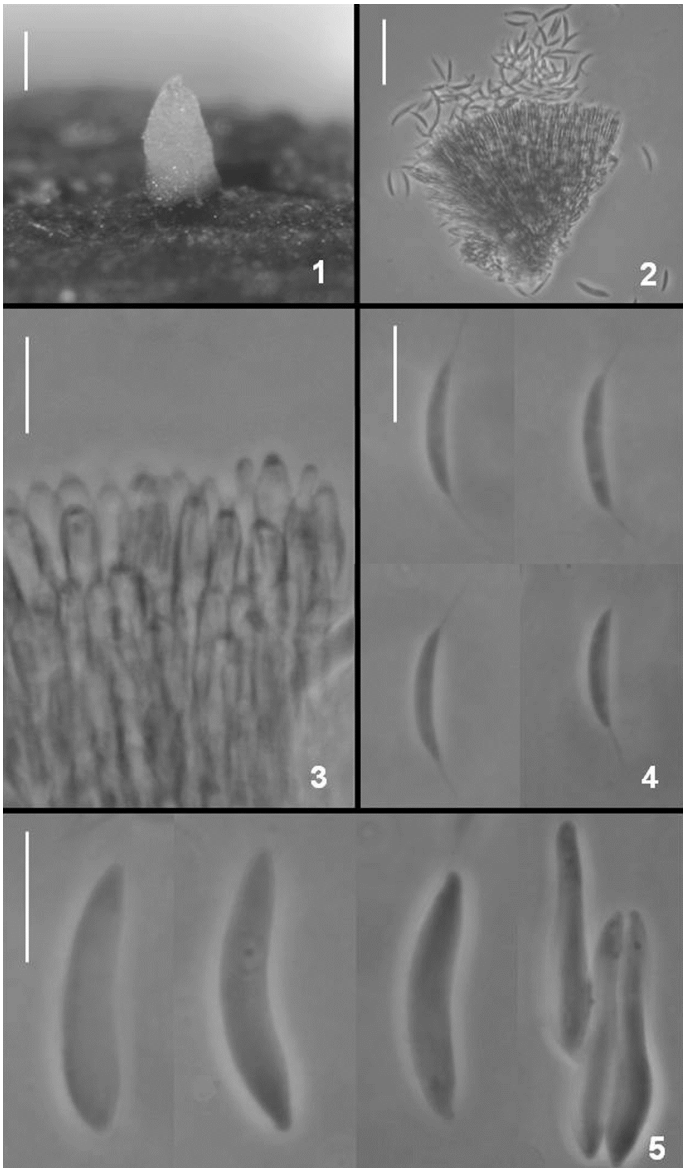

Figures 1–5. *Thozetella submersa* (from the holotype). 1. Conidioma on the natural substrate. 2. General aspect of a conidioma without the conidial mass. 3. Conidiogenous cells. 4. Conidia. 5. Microawns. (Scale bars: 1 = 100 µm; 2 = 50 µm; 3–5 = 10 µm).

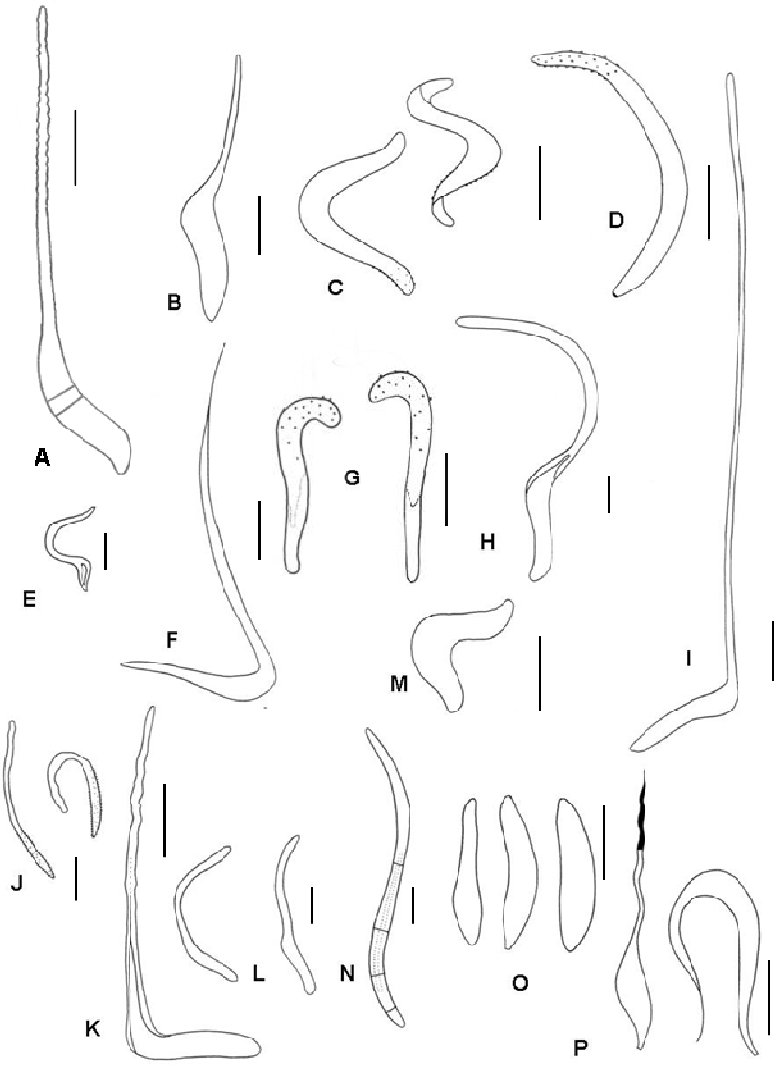

FIG. 6. Microawns of *Thozetella* species. A. *T. acerosa*; B. *T. boonjiensis*; C. *T. buxifolia*; D. *T. canadensis*; E. *T. cristata*; F. *T. cubensis*; G. *T. effusa*; H. *T. falcata*; I. *T. gigantea*; J. *T. havanensis*; K. *T. nivea*; L. *T. pinicola*; M. *T. queenslandica*; N. *T. radicata*; O. *T. submersa*; P. *T. tocklaiensis.* (Scale bars: A–P = 10 µm).

CAPÍTULO 6

Conidial fungi from semi-arid Caatinga Biome of Brazil. Rare freshwater hyphomycetes and other new records

Artigo a ser submetido à publicação na revista Mycosphere

Resumo: Seis espécies raras de hyphomycetes são descritas e ilustradas: *Brachydesmiella anthostomelloidea, Camposporidium cristatum, Dactylaria hyalotunicata, Lauriomyces sakaeratensis, Pleurophragmium malaysianum* e *Pyricularia rabaulensis*. Adicionalmente 37 novos registros de hyphomycetes para o Continente americano, Neotrópico, América do Sul, Brasil e Bahia são apresentados.

Conidial fungi from the semi-arid Caatinga biome of Brazil. Rare freshwater hyphomycetes and other new records

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During surveys for freshwater hyphomycetes on submerged plant debris in Brazil, six rare species were collected: *Brachydesmiella anthostomelloidea, Camposporidium cristatum, Dactylaria hyalotunicata, Lauriomyces sakaeratensis, Pleurophragmium malaysianum* and *Pyricularia rabaulensis*. Descriptions, illustrations and comments are showed for these species. Additionally, 37 new records for Western hemisphere, Neotropics, South America, Brazil and Bahia State are listed. These results contribute to knowledge about the geographic distribution of freshwater hyphomycetes and reflect the lack of studies of these fungi in tropical regions.

Key words – aquatic fungi – mitosporic fungi – stream – taxonomy

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Introduction

Among the freshwater conidial fungi, the hyphomycetes have received more attention from taxonomists. Species in this group have been well investigated in temperate regions (Sivichai et al. 2002, Mavanová et al. 2003, Abdullah et al. 2005, Shearer et al. 2007). The study in tropical regions began about 20 years ago and revision data showed the existence of about 280 species of freshwater hyphomycetes (Goh 1997). In this region, the knowledge of freshwater hyphomycetes is still phragmented and has been recorded in countries such as: India (Sridhar & Kaveriappa 1989), Australia (Hyde & Goh 1998), Malaysia (Nawawi 1985, Kuthubutheen & Nawawi 1991), Cuba (Voglmayr & Delgado-Rodriguez 2001), Thailand (Sivichai & Hywel-Jones 1999, Sivichai et al. 2002) and other. Schoenlein-Crusius & Grandi (2003) compiled data of literature and registered 90 species of aquatic hyphomycetes for South America, including Argentina, Brazil, Chile, Ecuador, Peru and Venezuela.

During our continuing investigation of freshwater fungi collected on submerged substrate in the semi-arid region of Brazil, six rare hyphomycetes, recorded previously for one or two times for world, and 37 other new records, including for Western hemisphere, Neotropics, South America, Brazil and Bahia, were presented.

The goal of this study was to describe and illustrate some rare species of freshwater hyphomycetes and to list other new records contributing to expand the knowledge about the distribution of freshwater hyphomycetes in tropical regions.

Methods

Expeditions to "Serra da Jibóia", Bahia, Brazil were realized every three months, from July 2007 to May 2009, to collect submerged plant debris (twig, bark, leaf and petiole). Samples were collected in a small stream and

placed in a plastic bag containing wet paper towel. In the laboratory, the samples were placed in Petri dishes moist chamber and stored within 170 L polyestyrene box with 500 ml sterile water plus 2 ml glycerol. During regular intervals, reproductive structures of fungi were scanned on the dissection microscope and slides were prepared in PVL resin (polyvinyl alcohol, latic acid and fenol). Species were isolated in culture media. Slides and dry material were deposited in Herbarium HUEFS and culture were deposited in "Coleção de Cultura de Microrganismos da Bahia" CCMB.

Results

Brachydesmiella anthostomelloidea Goh & K.D. Hyde, Mycol. Res. 100(11): 1365, 1996

Figs 1-2

Conidiophores mononematous, macronematous, solitary, unbranched, septate, erect, flexuous, geniculate, smooth-walled, pale brown, 25.5-37.5 × 4.5-6 µm. **Conidiogenous cells** polytretic, terminal, integrated, sympodial, cicatrized. **Conidia** solitary, dry, 1-septate, upper cell oval, sometimes slightly acuminate at apex, smooth, brown, 22.5-31.5 × 16.5-21 µm; lower cell cylindrical, smooth, truncate at base, light brown to subhyaline, 4.5-7.5 × 3-6 µm.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 22 Nov 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155249); on submerged petiole, 22 Oct 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155250).

Known distribution: Australia (Goh & Hyde 1996)

Comments: *Brachydesmiella* G. Arnaud presently consists of eight accepted species (Castañeda-Ruiz 2003) found both in freshwater (Goh & Hyde 1996, Sivichai et al. 1998, 2002) and in terrestrial habitats (Castañeda-Ruiz 2003, 2006). The genus was established with the type species *B. biseptata* G. Arnaud and is characterized by the pyriform or limoniform, 2-3 celled, unequally coloured conidia, produced from simple conidiophores, with integrated, terminal, polytretic, sympodial, cicatrized conidiogenous cells (Ellis 1971). *Brachydesmiella anthostomelloidea* most closely resembles *B. orientalis* (V. Rao & de Hoog) Goh in having 2-celled, obpyriform conidia but differs in having longer, narrower conidia with cylindrical basal cell (Goh & Hyde 1996). A key for all species is provided by Castañeda-Ruiz et al. (2006).

Our collection from Brazil agrees with the Australian collection (Goh & Hyde 1996). However, the Brazilian material has slight smaller conidia (29-38 × 14-18 µm; 6-9 × 3-5 µm) and smaller conidiophores (40-90 × 5-7 µm) when compared to the type description (Goh & Hyde 1996).

Brachydesmiella anthostomelloidea was originally collected on submerged wood in a rain forest stream from Queensland (Goh & Hyde 1996). This is the second record of the species for the world and is reported for the first time from the western hemisphere.

Camposporidium cristatum Nawawi & Kuthub., Mycotaxon 32(1): 161, 1988

Figs 3-5

Conidiophores mononematous, macronematous, solitary, unbranched, septate, erect, straight or slight flexuous, with percurrent proliferations, smooth-walled, brown to dark brown, 90-135 × 4.5-6 µm. **Conidiogenous cells** holoblastic, terminal, integrated, proliferating percurrently, cylindrical. **Conidia** solitary, dry, 9-11-distoseptate, cylindrical, smooth-walled or rarely slight verruculose, subhyaline to light brown, 75-105 × 9-10 µm; basal cell, truncate, darker and shorter than other conidia cells 3-4.5 × 6-7.5 µm; apical cell rounded and lighter, 4.5-7.5 × 5-6 µm, with 4-5 aseptate, hyaline to subhyaline appendages 37.5-82.5 µm. Last two transverse septa thicker.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 16 Sep 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155248); on submerged petiole, 17 Dec 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165793); on submerged leaf, 12 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155247).

Known distribution: Malaysia (Nawawi & Kuthubutheen 1988).

Comments: Three accepted species have been described in *Camposporidium* Nawawi & Kuthub.: *C. cristatum*, the type species of the genus, *C. ghindense* (Bhat) R.F.

Castañeda, Guarro & Cano and *C. hughesii* R.F. Castañeda & Guarro (Kirk et al. 2008). *Camposporidium* is close to *Camposporium* Harkn. due to multiseptate conidia with appendages (Peek & Solheim 1958). However, *Camposporium* has polyblastic, sympodial and denticulate conidiogenous cells and conidia with a persistent portion of the denticle attached (Whitton et al. 2002). Following Nawawi & Kuthubutheen (1988), *C. cristatum* has characteristic conidia with a truncate, rectangular basal cell darker and shorter than the rest of the conidia cells, apical cell is rounded and lighter in color with the last two transverse septa thicker. *Camposporidium cristatum* clearly differ from two other species in the genus. *Camposporidium hughesii* R.F. Castañeda & Guarro has euseptate, verrucose, fusiform, cylindrical-fusiform, rarely navicular conidia (Castañeda-Ruiz & Guarro 1998) and *C. ghindense* (Bhat) R.F. Castañeda, Guarro & Cano has curved, broadly ellipsoidal conidia and branched appendages (Bhat 1983).

Our collection from Brazil agrees well with the original protolog of *C. cristatum* (Nawawi & Kuthubutheen 1988). However the appendages of our collection are larger (37.5-82.5 × 1.5 µm) compared to that of the type species (up to 60 × 1.5 µm).

Camposporidium cristatum was found only on submerged leaves from Malaysia (Nawawi & Kuthubutheen 1988). This is the second record of the species for world and is reported for the first time from the western hemisphere.

Dactylaria hyalotunicata K.M. Tsui, Goh & K.D. Hyde, Sydowia 49(2): 182, 1997

Figs 6-7

Conidiophores mononematous, macronematous, solitary, unbranched, septate, erect, straight, smooth-walled, hyaline, 33-53 × 3-4.5 µm. **Conidiogenous cells** polyblastic, terminal, integrate, denticulate, proliferating sympodially; denticles conspicuous, cylindrical, hyaline, 1.5 µm long. **Conidia** solitary, 1-septate, smooth, thin-walled, with an hyaline gelatinous sheath, naviculate to fusiform, hyaline, 15-25 × 2.3-3 µm.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 30 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155284); on submerged twig, 22 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165764); on submerged twig, 16 Jul 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165763); on submerged twig, 08 Sep 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165762).

Known distribution: China (Tsui et al. 1997), United States (Raja et al. 2009)

Comments: *Dactylaria* Sacc. is a worldwide, polyphyletic genus with around 109 species (Kirk et al. 2008). *Dactylaria tunicata* Goh & K.D. Hyde is the closest species to *D. hyalotunicata. Dactylaria tunicata* have been also recorded from fresh water habitat and possess a gelatinous sheath surround the conidia (Tsui et al. 1997). However, *D. tunicata* can be distinguished from *D. hyalotunicata* in having mid olivaceous brown and larger conidiophores (75-160 × 4-4.5 µm) and larger conidia (25-31 × 3-4.5) (Goh & Hyde 1997).

Our collection from Brazil agrees in all aspects with the original description of *D. hyalotunicata* from China (Tsui et al. 1997).

Dactylaria hyalotunicata was recorded on submerged wood in China (Tsui et al. 1997) and on herbaceous and woody debris in United States (Raja et al. 2009).This represents a new record for Neotropics.

Lauriomyces sakaeratensis Somrith., Kosol & E.B.G. Jones, Nova Hedwigia 82(1-2): 210

Figs 8-9

Setae unbranched, flexuous, smooth, thick-walled, up to 1230 µm long, 5.5-6.0 µm wide at the base, brown to dark brown, paler toward the apex. **Conidiophores** mononematous, macronematous, solitary or in a few groups, septate, erect, straight or flexuous, smooth-walled, brown to dark brown, paler toward the rounded apex 75-105 × 5-6 µm; primary branches in group of 3-4, 6-7.5 × 2.3-3 µm; subsequent branches in group of 3-6, 4-4.3 × 1.5 µm. **Ramoconidia** 0-septate, smooth, cylindrical to obclavate, hyaline, 4-5 × 1.5 µm. **Conidia** catenate, dry, 0-septate, smooth, thin-walled, obclavate, hyaline, 3-4.2 µm long, up to 1 µm at base.

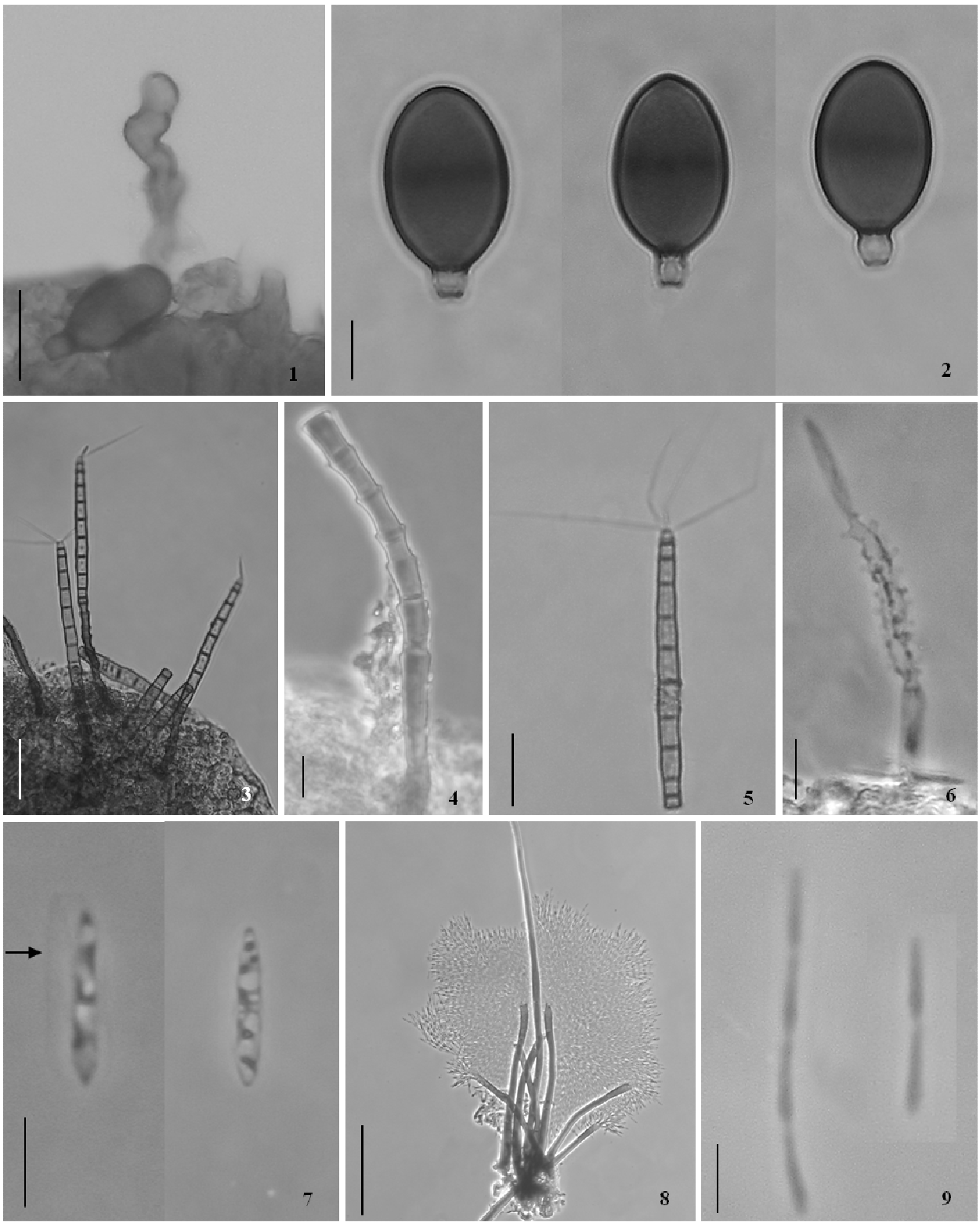

Figure 1-2. *Brachydesmiella anthostomelloidea.* 1. Conidiophore. 2. conidia. Figure 3-5. *Camposporidium cristatum.* 3. Conidia and conidiophores. 4. Conidiophore. 5. Conidium. Figure 6-7. *Dactylaria hyalotunicata.* 6. Conidiophore. 7. Conidia. Arrow shows gelatinous sheath. Figure 8-9. *Lauriomyces sakaeratensis.* 8. Setae, conidiophores and conidia. 9. Conidia. Bars: 1, 3, 8 = 50 µm; 2, 4, 6, 7 = 10 µm; 5 = 30 µm; 9 = 2.5 µm.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 25 Jul 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155252); on submerged leaf, 21 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155251) (CCMB 07/09); on submerged petiole, 23 Mar 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155253)

Known distribution: Thailand (Somrithipol et al. 2006)

Comments: Castañeda-Ruíz & Kendrick (1990) established the genus *Lauriomyces* RF Castañeda typified by *L. pulcher* R.F. Castañeda & W.B. Kendr. Currently, there are eight accepted species in the genus distinguished by conidial shape and size (Somrithipol & Jones 2007). The shapes can be: clavate, obclavate, fusiform, cylindrical or ellipsoidal. *Lauriomyces pulcher* has clavate conidia and can be distinguished of *L. sakaeratensis* that posses obclavate conidia (Castañeda-Ruíz & Kendrick 1990, Somrithipol et al. 2006). A diagrammatic comparison of conidial shape is showed by Somrithipol & Jones (2007).

The Brazilian material fits well in the concept of *L. sakaeratensis* but it showed conidiophores smaller (75-105 × 5-6 µm) as noted in the original description (100-160 × 5.0-5.5 µm) (Somrithipol et al. 2006).

Lauriomyces sakaeratensis was found on decaying *Dipterocarpus costatus* C.F. Gaertn. fruits from Thailand and represents the second record of the species for the world and is reported for the first time from the western hemisphere.

Pleurophragmium malaysianum Matsush., Matsush. Mycol. Mem. 9: 20, 1996

Figs 10-12

Conidiophores mononematous, macronematous, solitary, unbranched, septate, erect, flexuous, smooth-walled, hyaline, 25.5-37.5 × 4.5-5.5 µm. **Conidiogenous cells** polyblastic, terminal, integrated, denticulate, hyaline; denticles conspicuous, cylindrical. **Conidia** solitary, dry, 10-12-distoseptate, smooth, thick-walled, cylindrical-clavate, with a protruding base, hyaline, 45-60 × 4.5-6 µm.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 30 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155255).

Known distribution: Malaysia (Matsushima 1996), United States (Raja et al. 2009)

Comments: *Pleurophragmium* Costantin is a worldwide species with 21 species (Kirk et al. 2008) and was erected with the type species *P. bicolor* Costantin. De Hoog (1985) defined the genus as having brown conidiophores with hyaline denticles. However Matsushima (1996) described *P. malaysianum* in the genus even having hyaline conidiophores. Thus far, the species is accepted into the genus.

Pleurophragmium malaysianum was recorded on dead leaf from Malaysia (Matsushima 1996) and on submerged wood in the United States (Raja et al. 2009). It is a new record for Neotropics.

Pyricularia rabaulensis Matsush., Bull. Nat. Sci. Mus., Tokyo 14(3): 473, 1971

Figs 13-15

Conidiophores mononematous, macronematous, solitary, unbranched, septate, erect, flexuous, smooth-walled, brown, paler toward the apex, 84-165 × 3-4.5 µm. **Conidiogenous cells** polyblastic, terminal, integrate, denticulate, brown to subhyaline; denticles conspicuous. **Conidia** solitary, dry, 1-septate, smooth, thin-walled, ellipsoidal, subhyaline 15-18 × 6-7.5 µm; rostrum conical truncate, hyaline, 7.5-15 × 1.5-2.3 µm.

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 09 Nov 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 155254); (CCMB 109/08).

Known distribution: Papua-New Guinea (Matsushima 1971).

Comments: *Pyricularia* Sacc. posses about 14 accepted species (Kirk et al. 2008) and was erected with *P. grisea* Sacc. as the type species of the genus. The genus fits well in all aspects of original description (Matsushima 1971).

Pyricularia rabaulensis was collected only on decaying leaves of *Musa* sp. from Papua-New Guinea (Matsushima 1971). This is the second record of the species for the for

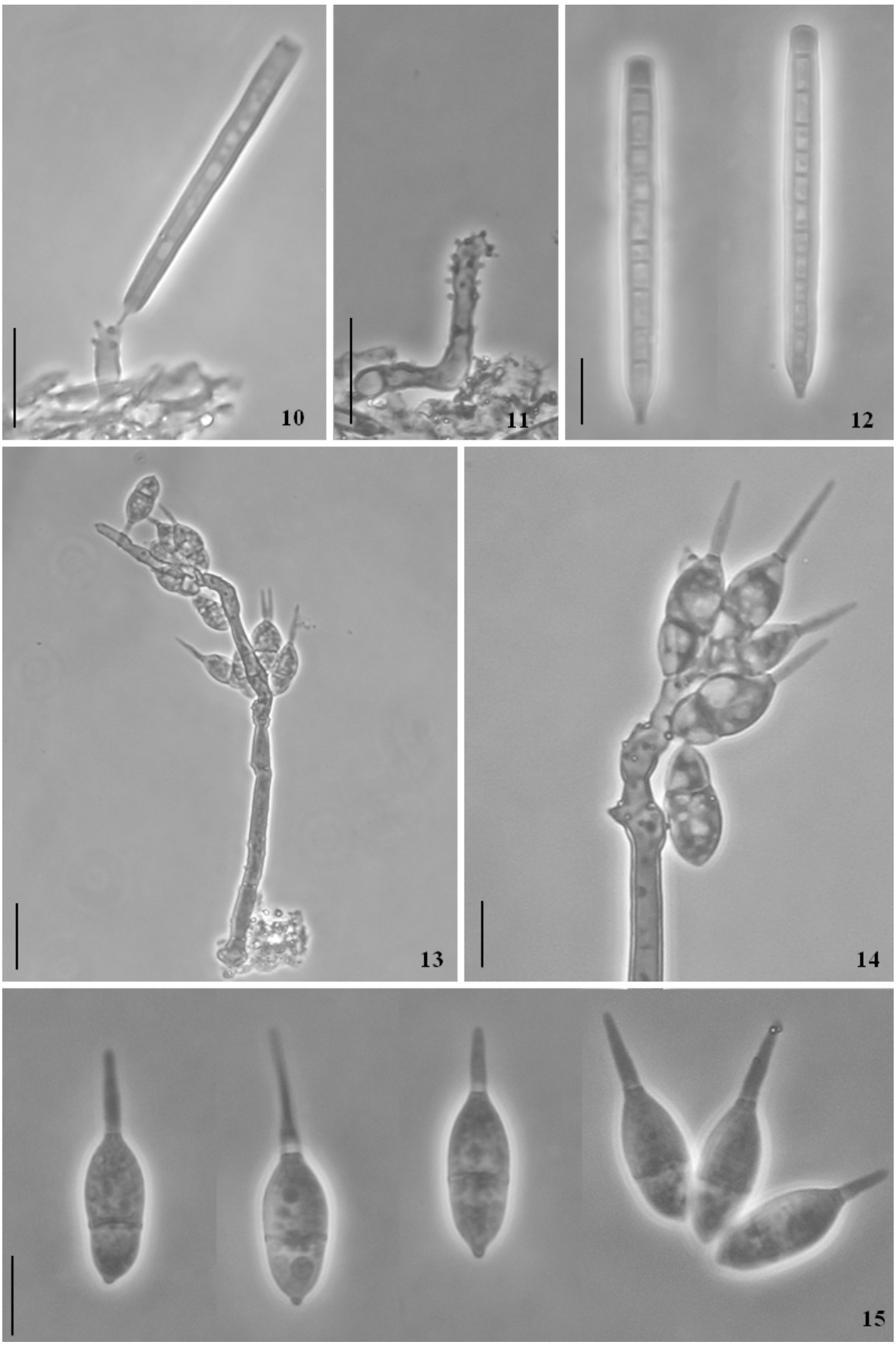

Figure 10-12. *Pleurophragmium malaysianum*. 10. Conidiophore and conidium. 11. Conidiophore with denticles. 12. Conidia. Figure 13-15. *Pyricularia rabaulensis.* 13. Conidiophore and conidia. 14. Detail of conidia attached to the conidiophore. 15. Conidia. Bars: 10,11, 13 = 25 µm; 12, 14, 15 = 10 µm.

world and is reported for the first time from the western hemisphere.

Other new records of hyphomycetes for western hemisphere

Brachydesmiella caudata V. Rao & de Hoog, Stud. Mycol. 28: 5, 1986

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 12 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165766).

Canalisporium exiguum Goh & K.D. Hyde, Can. J. Bot. 76(1): 145, 1998

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 19 Aug 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165789).

Cancellidium applanatum Tubaki, Trans. Mycol. Soc. Japan 16(4): 358, 1975

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 16 Jul 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169116).

Pithomyces elaeidicola M.B. Ellis, Mycol. Pap. 76: 10, 1960

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 27 Dec 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165790).

Sporidesmiella ciliaspora W.P.Wu, *Sporidesmium*, *Endophragmiella* and related genera from China: 160, 2005

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 08 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165787).

Stachybotrys sphaerospora Morgan-Jones & R.C. Sinclair, Mycotaxon 10(2): 372, 1980

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 28 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165767).

Thozetella pinicola S.Y.Q. Yeung, R. Jeewon & K.D. Hyde, Can. J. Bot. 55(6): 681, 2009

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 28 Oct 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165770).

Other new records of hyphomycetes for Neotropics

Sporoschisma juvenile Boud., Icon. Mycol. (Paris) 1: 12, 1904

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 05 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169120); on submerged twig, 12 Jun 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169123)

Xylomyces elegans Goh, W.H. Ho, K.D. Hyde & K.M. Tsui, Mycol. Res. 101(11): 1324, 1997

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 08 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169092); on submerged bark, 06 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169111).

New records of hyphomycetes for South America

Bactrodesmium longisporum M.B. Ellis, More Dematiaceous Hyphomycetes (Kew): 68, 1976

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 20 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169104); on submerged bark, 30 Jan 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169103); on submerged twig, 28 May 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169102).

Chloridium obclaviforme J. Mena & Mercado, Acta bot., Szeged 33(1-2): 76, 1987

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 14 Feb 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165788) (CCMB 74/08).

Cryptophialoidea secunda (Kuthub. & B. Sutton) Kuthub. & Nawawi, Trans. Br. mycol. Soc. 89(4): 583, 1987

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 09 Sep 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165786); on submerged twig, 03 Mar 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165785).

Dinemasporium lanatum Nag Raj & R.F. Castañeda, Can. J. Bot. 67(8): 2527, 1989

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 25 Jul 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165782); on submerged petiole, 09 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165783), (CCMB 74/07); on submerged leaf, 14 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165784).

Ellisembia bambusicola (M.B. Ellis) J. Mena & G. Delgado, Boln Soc. Micol. Madrid 25: 266, 2000

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 29 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169114).

Hermatomyces sphaericus (Sacc.) S. Hughes, Mycol. Pap. 50: 100, 1953

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 03 Mar 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169113), (CCMB 13/09).

Junewangia martinii (J.L. Crane & Dumont) W.A. Baker & Morgan-Jones, Mycotaxon 81: 310, 2002

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 19 Aug 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169110).

Linkosia ponapensis (Matsush.) R.F. Castañeda, Saikawa & Gené, *Cryptog. Mycol.* 21(4): 219, 2000

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 16 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169117).

Xylomyces foliicola W.B. Kendr. & R.F. Castañeda, Univ. Waterloo Biol. Ser. 33: 54, 1990

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 08 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165771); on submerged petiole, 21 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165773); on submerged leaf, 21 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165777); on submerged leaf, 29 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165778); on submerged leaf, 10 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165775); on submerged leaf, 20 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165776); on submerged bark, 22 Nov 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165772); on submerged leaf, 20 Dec 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165774).

New records of hyphomycetes for Brazil

Berkleasmium corticola (P. Karst.) R.T. Moore, Mycologia 51(5): 735, 1961

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 24 Jul 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165792).

Brachiosphaera tropicalis Nawawi, Trans. Br. mycol. Soc. 67(2): 213, 1976

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On

submerged bark, 26 May 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169105).

Brachysporiella pulchra (Subram.) S. Hughes, N.Z. Jl Bot. 17(2): 184, 1979

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 22 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169108).

Candelabrum brocchiatum Tubaki Trans. Mycol. Soc. Japan 16(2): 134, 1975

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 08 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169099); on submerged twig, 10 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169097); on submerged twig, 29 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169096); on submerged bark, 05 Jul 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169100); on submerged bark, 28 Jul 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169098).

Ityorhoptrum verruculosum (M.B. Ellis) P.M. Kirk, Trans. Br. mycol. Soc. 86(3): 419, 1986

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged bark, 05 Jul 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169106).

Mirandina corticola G. Arnaud ex Matsush., Icon. microfung. Matsush. lect. (Kobe): 96, 1975

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 13 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169091).

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Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 16 Sep 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169112).

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New records of hyphomycetes for Bahia

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Dictyochaetopsis gonytrichoides (Shearer & J.L. Crane) Whitton, McKenzie & K.D. Hyde, Fungal Diversity 4: 156, 2000

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Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged leaf, 03 Jun 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169115).

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Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 09 Aug 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169118); on submerged bark, 22 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169119).

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Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 11 Mar 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169122).

Periconia minutissima Corda, Icon. fung. (Prague) 1: 19, 1837

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 20 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169109).

Pseudotracylla dentata B. Sutton & Hodges, Nova Hedwigia 27(3-4): 699, 1976

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged petiole, 21 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165779); on submerged twig, 22 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165781); on submerged leaf, 22 Jan 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165780).

Rhexoacrodictys erecta (Ellis & Everh.) W.A. Baker & Morgan-Jones, Mycotaxon 82: 99, 2002

Material examined: BRAZIL. BAHIA: Santa Terezinha, Serra da Jibóia. On submerged twig, 05 Sep 2007, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 165765) (CCMB 93/07); on submerged bark, 15 Feb 2008, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169121); on submerged petiole, 28 Jul 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169090); on submerged twig, 29 Jul 2009, *F.R. Barbosa* and *L.F.P. Gusmão* (HUEFS 169089), (CCMB 23/09).

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CAPÍTULO 7

Fungos conidiais aquáticos-facultativos do bioma Caatinga

Artigo a ser submetido à publicação na revista Acta Botanica Brasilica

Fungos conidiais aquáticos-facultativos do bioma Caatinga

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RESUMO: (Fungos conidiais aquáticos-facultativos do bioma Caatinga). Durante o estudo de fungos conidiais sobre substratos vegetais submersos na Serra da Fumaça e na Serra da Jibóia, Bahia, 17 espécies foram identificadas, sendo cinco novos registros: *Actinocladium verruculosum* para o Continente americano, *Xylomyces aquaticus* para o Neotrópico, *Actinocladium longiramosum* e *Dischloridium inaequiseptatum* para a América do Sul e *Cacumisporium pleuroconidiophorum* para o Brasil. Descrição, ilustração, distribuição geográfica e comentário são apresentados para os novos registros além de uma lista com as demais espécies encontradas.

Palavras-chave : Biodiversidade, hifomicetos, substrato submerso, taxonomia

ABSTRACT: (aquatic facultative conidial fungi from the Caatinga Biome). During study of conidial fungi on submerged plant debris in Serra da Fumaça and Serra da Jibóia, Bahia state, 17 species were identified with five new records such as: *Actinocladium verruculosum* for American continente, *Xylomyces aquaticus* for Neotropics, *Actinocladium longiramosum* and *Dischloridium inaequiseptatum* for South america and *Cacumisporium pleuroconidiophorum* for Brazil. Description,illustration, geographic distribution and comments for the new records and a list with other species found are provided.

Keywords: Biodiversity, hyphomycetes, submerged substrate, taxonomy

Introdução

Os fungos conidiais aquáticos constituem um grupo polifilético (Belliveau & Bärlocher 2005) que são isolados de folhas em decomposição submersas em rios de todo o mundo (Medeiros et al. 2009). Estes fungos são divididos em quatro grupos principais de acordo com sua morfologia e estilo de vida: fungos ingoldianos, fungos aeroaquáticos (Alexopoulos 1996), fungos aquático-terrestres e fungos aquático-facultativos (Goh & Hyde 1996).

Os fungos ingoldianos ocorrem frequentemente em ambientes lóticos com boa aeração e estão entre os poucos grupos de fungos onde as espécies podem, em muitos casos, ser identificadas baseando-se apenas na observação dos conídios, sem a necessidade de culturas puras (Descals 2005). Seus conídios apresentam adaptações morfológicas à dispersão nesse ambiente, sendo tipicamente ramificados ou sigmóides e acumulam-se facilmente em espumas que se formam na superfície da água (Ingold 1966). Algumas espécies também podem ser encontradas, menos frequentemente, em ambientes lênticos ou não aquáticos (Descals & Moralejo 2001).

Os fungos aeroaquáticos são geralmente encontrados em ambientes lênticos como lagos estagnados e riachos com fluxo lento, crescendo sobre folhas ou madeira submersas (Shearer et al. 2004). Produzem conídios geralmente com formas helicoidais (helicosporos), esporulando apenas quando o substrato é exposto ao ar (Webster & Descals 1981, Ando & Tubaki 1984, Alexopoulos 1996).

Os fungos aquático-terrestres incluem várias espécies isoladas de água da chuva ou orvalho acumulada na superfície de folhas (Ando 1992). Esse grupo produz estaurosporos morfologicamente similares aos conídios produzidos pelos fungos Ingoldianos, mas diferenciam-se principalmente pela ausência de conidióforos macronemáticos (Ando 1992, Goh & Hyde 1996, Descals & Moralejo 2001).

Os fungos aquático-facultativos são representados por hifomicetos dematiáceos, crescendo como sapróbios em substratos vegetais submersos ou terrestres (principalmente lignificados) e esporulando sob condições terrestres ou, em alguns casos, submersas. Seus conídios apresentam parede relativamente espessa, são capazes de dispersão tanto na água quanto no ar e são produzidos a partir de conidióforos com parede espessa (Webster & Descals 1981, Goh & Hyde 1996, Descals & Moralejo 2001, Révay & Gönczöl 2007). Também são chamados de hifomicetos lignícolas e hifomicetos aquáticos-submersos (Ingold 1975, Goh & Hyde 1996). Segundo Goh & Hyde (1996), gêneros representativos desse grupo são *Bactrodesmium* Cooke, *Brachydesmiella* G. Arnaud ex S. Hughes, *Brachysporiella* Bat., *Camposporidium* Nawawi & Kuthub., *Canalisporium* Nawawi & Kuthub., *Cryptophiale* Piroz., *Cryptophialoidea* Kuthub. & Nawawi, *Dactylaria* Sacc., *Dendryphiosphaera* Lunghini & Rambelli, *Dictyochaeta* Speg., *Exserticlava* S. Hughes, *Kionochaeta* P.M. Kirk & B. Sutton, *Monotosporella* S. Hughes, *Nawawia* Marvanová, *Phaeoisaria* Höhn., *Spadicoides* S. Hughes, *Sporidesmiella* P.M. Kirk, *Sporidesmium* Link, *Sporoschisma* Berk. & Broom, *Sporoschismopsis* Hol.-Jech. & Hennebert, *Trichocladium* Harz e *Xylomyces* Goos, R.D. Brooks & Lamore. No presente trabalho são referidas apenas espécies de fungos aquático-facultativos.

As folhas e outras estruturas vegetais alóctones são as principais fontes de energia que entram nos ecossistemas dulcícolas (Bärlocher 2009), e são, portanto, de fundamental importância para a manutenção da cadeia trófica nesses ambientes, influenciando a estrutura das comunidades (Benke et al. 1988). Os fungos aquáticos têm papel crucial na decomposição desses substratos (Bärlocher 2007). Não obstante, o conhecimento sobre a diversidade dos fungos conidiais ocorrendo em ambientes aquáticos nas regiões tropicais permanece precário, uma vez que a maioria dos estudos tem sido conduzidos em regiões temperadas (Chan et al 2000, Mathuria & Chauvet 2002, Tsui et al. 2003).

Em uma compilação de dados da literatura, Schoenlein-Crusius & Grandi (2003) apresentaram um checklist com apenas 90 espécies de hifomicetos aquáticos registradas na América do Sul, incluindo Brasil, Chile, Equador, Peru e Venezuela. Essas autoras enfatizaram a forte necessidade do aprimoramento dos conhecimentos sobre a diversidade de hifomicetos aquáticos nesse continente, uma vez que artigos publicados ainda são esporádicos e dispersos. No Brasil, a maioria dos estudos realizados estão concentrados no estado de São Paulo (Schoenlein-Crusius et al. 2009). Para o bioma Caatinga, embora uma série de estudos sobre a diversidade de fungos conidiais tenham sido conduzidos na primeira década do século XXI, nenhum deles tratou sobre os fungos conidiais ocorrendo em ambientes aquáticos (Gusmão & Grandi 2001, Barbosa & Gusmão 2005, Gusmão et al. 2005, Gusmão & Barbosa 2005, Castañeda-Ruiz et al. 2006, Barbosa et al. 2007, Cruz et al. 2007a, b, c, Marques et al. 2007, Barbosa et al. 2008, Cruz et al. 2008a, b, Gusmão et al. 2008, Marques et al. 2008, Barbosa et al. 2009a, b, Cruz & Gusmão 2009a, b, Leão-Ferreira & Gusmão 2010).

O presente trabalho teve o objetivo de realizar um levantamento e estudo taxonômico dos fungos conidiais aquático-facultativos associados à decomposição de substratos vegetais submersos em duas áreas do bioma Caatina.

Materiais e Métodos

Área de Estudo

A Serra da Fumaça e a Serra da Jibóia estão localizadas no bioma Caatinga e na região semi-árida brasileira. A Serra da Fumaça está situada no município de Pindobaçu (10°74'S e 40°36'O), Bahia, e integra uma cadeia de serras denominada de Serra de Jacobina, a qual se estende por cerca de 200 Km no sentido norte-sul na porção norte do estado da Bahia, Brasil, com 15-25 Km de largura. Sua altitude pode alcançar até 1.300 m (Mascarenhas et al. 1998, Milesi et al. 2002). A Serra da Jibóia está situada na porção leste do estado da Bahia, no município de Santa Terezinha (12°77'S e 39°52'O), apresentando uma extensão de aproximadamente 22.000 ha e altitude entre 750 e 840 m (Neves 2005).

Método de amostragem

Amostras de materiais vegetais submersos em decomposição (folhas, galhos e cascas) foram coletadas no período de 2007 a 2009, acondicionadas em sacos plásticos e transportadas ao laboratório. No laboratório, as amostras foram lavadas em água corrente por 30 min e em seguida colocadas em placas de Petri com papel filtro umedecido com água. As placas de Petri foram então colocadas em uma caixa de isopor (170 L de capacidade) revestida internamente com papel toalha umedecido em água e com o fundo recoberto por 500 mL de água, acrescido de 2 mL de glicerol para manutenção da umidade (Castañeda-Ruiz 2005). Durante um período de 30 dias, as amostras foram examinadas diariamente em busca de estruturas reprodutivas dos fungos conidiais e lâminas permanentes foram confeccionadas com resina PVL (álcool polivinílico + ácido lático + fenol). Lâminas dos fungos e amostras vegetais secas foram depositadas no Herbário da Universidade Estadual de Feira de Santana (HUEFS).

Resultados

Foram identificadas 17 espécies de fungos conidiais associadas à decomposição de substratos vegetais em ambiente aquático. Destas, cinco representam novos registros e estão marcados com asteríscos antes dos nomes, sendo: um asterísco para os novos registros para o Continente Americano, dois asteríscos para os novos registros para o Neotrópico, três asteríscos para os novos registros para a América do Sul e quatro asteríscos para os novos registros para o Brasil. As demais 12 espécies já foram previamente registradas no bioma Caatinga sobre substratos vegetais coletados em ambiente terrestre contudo, estão sendo citadas aqui pela primeira vez em ambiente aquático nesse bioma (Gusmão 2003, Barbosa et al. 2007, Cruz et al. 2008a, Gusmão et al. 2008, Barbosa et al. 2009a, Cruz & Gusmão 2009a, b).

******Actinocladium longiramosum*** (R.F. Castañeda) R.F. Castañeda, Mycotaxon 60: 278. 1996.
≡ *Ceratosporella longiramosa* R.F. Castañeda, Fungi Cubenses III (La Habana): 2. 1988.
Fig. 1(a-d), Fig 2 (1-3)

Conidióforos macronemáticos, mononemáticos, retos, simples, eretos, 1–2 septados, lisos, castanhos na base, subhialianos no ápice, 15–22,5 × 4,5–6 µm. Células conidiogênicas monoblásticas, terminais, integradas, lisas, cilíndricas, subhialinas. Conídios solitários, esquizolíticos, secos, estaurosporos, constituídos por uma célula basal e 2–3 ramificações divergentes, subhialinos; ramificações lisas, retas, 5–12-pseudoseptadas, subuladas, subhialinas, 87–294 × 4–5 µm; células basais cônico-cilíndricas, truncadas na base, lisas, 4,5–6 × 4,2–6,5 µm.

Wu & Zhuang (2005) consideraram cinco espécies no gênero: *A. amazonicum* Matsush., *A. atrosporum* G.C. Zhao & N. Li, *A. longiramosum* (R.F. Castañeda) R.F. Castañeda, *A. rhodosporum* Ehrenb. e *A. verruculosum* W.P. Wu. Destas, *A. longiramosum* é a única que apresenta conídios pseudoseptados (Ellis 1971; Castañeda-Ruiz 1988; Matsushima 1993; Wu & Zhuang 2005).

Actinocladium Ehrenb. é semelhante à *Ceratosporella* Höhn., mas difere pela morfologia dos conídios. As espécies de *Actinocladium* produzem conídios estauriformes, enquanto as de *Ceratosporella* produzem conídios queiróides. Com base nessa diferença, Castañeda-Ruiz et al. (1996) transferiu *Ceratosporella longiramosa* R.F. Castañeda para o gênero *Actinocladium*. No material brasileiro, as ramificações dos conídios atingiram comprimentos maiores do que o relatado nas descrições consultadas (Ellis 1971; Castañeda-Ruiz 1988; Matsushima 1993; Wu & Zhuang 2005). Proliferações percurrentes da célula conidiogênica não foram observadas provavelmente devido à maturidade dos conidióforos. Esse é o primeiro registro da espécie para a América do Sul e em substrato lignícola submerso.

Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre casca submersa em decomposição, 19 Nov 2008, D.A.C. Almeida, s.n. (HUEFS 154966).

Distribuição conhecida: Cuba (Castañeda-Ruiz 1988).

****Actinocladium verruculosum*** W.P. Wu, Fung. Divers. Res. Ser. 15: 228. 2005.
Fig. 1(e-g), Fig. 2 (4)

Conidióforos macronemáticos, mononemáticos, retos ou levemente flexuosos, simples, eretos, 3–6 septados, lisos, castanhos, 30–85 × 5–12,5 µm; ápice 5–7,5 µm de largura. Células conidiogênicas monoblásticas, terminais, integradas, 0–2 proliferações percurrentes, lisas, cilíndricas a lageniformes, truncadas no ápice, castanhas. Conídios solitários, esquizolíticos, estaurósporos, secos, constituídos por um corpo central com 1–2 células, com 3–7 ramificações; ramificações retas, divergentes, verrucosas, 8–9 septadas, cilíndricas a subuladas, ápices arredondados a truncados, castanhas na base, castanho-claras no ápice, 27,5–95 × 7,5–10 µm; corpos centrais cilíndricos a clavados, lisos, castanhos, 10–13 × 7–10 µm; célula basal obcônica e truncada, 5–10 × 4–5 µm.

Actinocladium verruculosum foi proposta por Wu & Zhuang (2005) para um espécime isolado sobre folhas em decomposição na China. É facilmente distinguida das demais espécies do gênero pelos conídios conspicuamente verrucosos. *Actinocladium rhodosporum* Ehrenb. é similar a *A. verruculosum*, mas difere pelos conídios lisos, além do número de ramificações ser menor (3-4) (Ellis 1971; Yurchenko 2001). As características do material brasileiro estão de acordo com as descritas por Wu & Zhuang (2005), com exceção dos conidióforos que alcançaram comprimentos e larguras maiores. Este é o primeiro registro da espécie para o Continente Americano e sobre substrato lignícola.

Distribuição conhecida: China (Wu & Zhuang 2005).

Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre casca terrestre em decomposição, 20 Nov 2008, D.A.C. Almeida, s.n. (HUEFS 154967); idem, Santa Terezinha, Serra da Jibóia, sobre galho submerso em decomposição, 28 Ago 2007, Barbosa, s.n. (HUEFS 155257).

*******Cacumisporium pleuroconidiophorum*** (Davydkina & Melnik) R.F. Castañeda, Heredia & Iturr., Mycotaxon 100: 332. 2007.

Bas.: *Pyriculariopsis pleuroconidiophora* Davydkina & Melnik, Mikol. Fitopatol. 23(2): 112. 1989.

Sin.: *Cacumisporium curvularioides* R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 35: 16. 1991.

Fig. 1(h-k), Fig. 2 (5-6)

Conidióforos macronemáticos, mononemáticos, retos ou flexuosos, simples ou ramificados, eretos, 7–19 septados, lisos, castanho-escuros na base, castanho-claros a subhialinos no ápice, 212–700 × 7,5–10 µm. Células conidiogênicas poliblásticas, terminais, integradas, simpodiais, cilíndricas, lisas, castanha-claras a subhialinas. Conídios solitários, esquizolíticos, secos, obturbinados, lisos, simples, 3–septados; células basais cônico-cilíndricas, truncadas, retas ou ocasionalmente inclinadas, subhialinas; células centrais castanhas e castanho-claras; células apicais cônicas, com ápice arredondado, subhialinas; 20–30 × 7,5–15 µm;

O gênero *Cacumisporium* Preuss congrega seis espécies: *C. capitulatum* (Corda) S. Hughes; *C. pleuroconidiophorum* (Davydkina & Melnik) R.F. Castañeda, Heredia & Iturr.; *C. rugosum* K.M. Tsui, Goh, K.D. Hyde & Hodgkiss; *C. sigmoideum* Mercado & R.F. Castañeda, *C. spooneri* P.M. Kirk e *C. tropicale* R.F. Castañeda, Gusmão & Stchigel (Hughes 1958, Mercado-Sierra & Castañeda-Ruiz 1987, Kirk 1992, Tsui et al. 2001, Castañeda-Ruiz et al. 2007a, b). *Cacumisporium sigmoideum* é a espécie mais semelhante à *C. pleuroconidiophorum*, diferindo por apresentar conídios maiores (26–41 µm compr.) com células centrais concolor e célula basal curvada na mesma direção das demais células do conídio. O material brasileiro apresenta características de acordo com a descrição de Castañeda-Ruiz & Kendrick (1991) e representa o primeiro registro para o Brasil.

Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre casca terrestre em decomposição, 05 Jan 2009, D.A.C. Almeida, s.n. (HUEFS 154968); idem, Santa Terezinha, Serra da Jibóia, sobre casca submersa em decomposição, 06 Set 2007, Barbosa, s.n. (HUEFS 155263); idem, sobre galho submerso em decomposição, 21 Dez 2007, Barbosa, s.n. (HUEFS 155258).

Distribuição conhecida: Argentina (como *Cacumisporium curvularioides*, Godeas & Arambarri 2007), Antiga União das Repúblicas Socialistas Soviéticas (como *Pyriculariopsis pleuroconidiophora*, Farr et al. 2009), Cuba (como *Cacumisporium curvularioides*, Castañeda-Ruiz & Kendrick 1991), México, Venezuela (Castañeda-Ruiz et al. 2007a).

******Dischloridium inaequiseptatum*** (Matsush.) Hol.-Jech., Česká Mykol. 41(2): 111. 1987.

Basi.: *Endophragmia inaequiseptata* Matsush., Icon. microfung. Matsush. lect. (Kobe): 69. 1975.

Fig. 1(l-n), Fig. 2 (7-8)

Conidióforos macronemáticos, mononemáticos, retos, simples, eretos, septados, lisos, castanho-escuros na base, castanhos no ápice, 70–130 × 4–6 µm. Células conidiogênicas monoblásticas, enteroblásticas, terminais, integradas, com proliferação percurrente, cilíndricas, com uma leve constrição no ápice, castanhas. Conídios solitários, esquizolíticos, 3-septados, cilíndrico- elipsóides, lisos, retos ou

levemente curvos, ápice arredondado, célula basal cônico-truncada e castanho-clara, demais células castanhas, 15–22,5 × 5–7 µm.

O gênero *Dischloridium* B. Sutton é constituído por 15 espécies, apresentando ampla distribuição geográfica sobre substratos folícolas e lignícolas (Kirk 1985, Seifert & Gams 1985, Mena-Portales & Mercado-Sierra 1987, Bhat & Kendrick 1993, Sivanesan & Alcorn 2002, Schubert & Braun 2005). *Dischloridium ychaffrei* (Bhat & B. Sutton) Hol.-Jech. e *D. triseptatum* Hol.-Jech. são similares à *D. inaequiseptatum* pela produção de conídios 3-septados. Contudo *D. inaequiseptatum* difere de ambas pelos conídios assimetricamente septados, mais estreitos, castanhos e com célula basal subhialina. As características do material examinado concordam com a descrição de Matsushima (1975). Este é o primeiro registro da espécie para a América do Sul.

Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 13 Jan 2009, D.A.C. Almeida, s.n. (HUEFS 154971); idem, Santa Terezinha, Serra da Jibóia, sobre casca submersa em decomposição, 19 Dez 2009, Barbosa, s.n. (HUEFS 155259).

Distribuição conhecida: Cuba (Mercado-Sierra et al. 1997), China (como *Endophragmia inaequiseptata*, Farr et al. 2009), Japão (como *Endophragmia inaequiseptata*, Matsushima 1975).

*****Xylomyces aquaticus*** (Dudka) K. D. Hyde & Goh, Mycol. Res. 103(12): 1573. 1999.
Bas.: *Camposporium aquaticum* Dudka, Ukr. bot. Zh. 23: 91. 1966.
Sin.: *Vargamyces aquaticus* (Dudka) Tóth, Acta Mus. Silesiae, Ser. A 25(3-4):403. 1979.
Fig. 1(o-p), Fig. 2 (9)

Conidióforos, célula conidiogênicas e conídios ausentes. Clamidósporos em cadeia, 9-13 septados, fusiformes, simples, retos, secos, lisos, constrictos nos septos, castanhos a castanho-claros, 82,5-125 x 10-15 µm.

O gênero *Xylomyces* Goos, Brooks & Lamore possui oito espécies, sendo *X. chlamydosporis* a espécie-tipo. Caracteriza-se pela ausência de conídios, conidióforos e células conidiogênicas e pela produção de clamidósporos multiseptados, fusiformes e castanhos. Devido à ausência de conídios, *Xylomyces* é considerado membro dos agonomicetos (Goos et al. 1977). Com exceção de *X. foliicola* W.B. Kendr. & R.F. Castañeda, que foi encontrada sobre folha em ambiente terrestre (Castañeda-Ruiz & Kendrick 1990), todas as outras sete espécies que constituem o gênero foram isoladas de madeira submersa em corpos d'água (Goos et al. 1977; Goh et al. 1997; Kohlmeyer & Volkmann-Kohlmeyer 1998; Hyde & Goh 1999). *Xylomyces aquaticus* tem sido isolada sobre madeira e folhas submersas em decomposição (Hyde & Goh 1999; Gönczöl et al. 1990). A transferência dessa espécie para o gênero *Xylomyces* por Hyde & Goh (1999) implica que os propágulos, anteriormente interpretados como conídios, são clamidósporos em cadeia (Matsushima 1983; Cooper 2005). O material brasileiro foi isolado sobre folhas submersas em um rio na Serra da Fumaça e apresentou clamidósporos mais estreitos

do que o relatado por outros autores (Gönczöl et al. 1990; Cooper 2005; Matsushima 1983). Os clamidósporos de *X. aquaticus* são morfologicamente similares aos de *X. foliicola*, mas diferem pela ocorrência de leves constrições nos septos, maior largura e hábitat aquático. Este é o primeiro registro da espécie para o Neotrópico.

Material examinado: **BRASIL**, Bahia: Pindobaçú, Serra da Fumaça, sobre folha submersa de dicotiledônea não identificada, 10 Nov 2008, D.A.C. Almeida, s.n. (UEFS 154981); 21 Nov 2008, D.A.C. Almeida, s.n. (UEFS 154982).

Distribuição conhecida: Bielorrússia (como *Vargamyces aquaticus*, Gulis 2001), Canadá (como *Sporidesmium ontariense*, Matsushima 1983), Estados Unidos da América (como *Vargamyces aquaticus*, Shearer & Lane 1983), Hungria (como *Vargamyces aquaticus*, Gönczöl & Révay 2003), Inglaterra (Hyde & Goh 1999), Irã (como *Vargamyces aquaticus*, Zare-Maivan & Ghaderian 1993), Nova Zelândia (Cooper 2005), Polônia (Farr 2009), Tailândia (Kodsueb 2008).

Outras espécies encontradas no Bioma Caatinga

Atrosetaphiale flagelliformis Matsush., Mycol. Mem. 8: 14. 1995.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 16 Dez 2008, D.A.C. Almeida, s.n. (HUEFS 154988).

Beltrania rhombica Penz., Michelia 2(8): 474. 1882.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição, 25 Set 2008, D.A.C. Almeida, s.n. (HUEFS 154993).

Beltraniella portoricensis (F. Stevens) Piroz. & S.D. Patil, Can. J. Bot. 48(3): 575. 1970.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 10 Nov 2008, D.A.C. Almeida, s.n. (HUEFS 155006).

Chaetopsina fulva Rambelli, Diagn. IV 3: 5. 1956.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 30 Set 2008, D.A.C. Almeida s.n. (HUEFS 155013).

Chalara alabamensis Morgan-Jones & E.G. Ingram, Mycotaxon 4(2): 489. 1976.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 25 Set 2008, D.A.C Almeida, s.n. (HUEFS 155017).

Exserticlava vasiformis (Matsush.) S. Hughes, N.Z. Jl Bot. 16(3): 332. 1978.

Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, casca submersa em decomposição, 06 Nov 2008, D.A.C Almeida, s.n. (HUEFS 155040).

Kionochaeta pughii Kuthub. & Nawawi, Trans. Br. mycol. Soc. 90(3): 437. 1988.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre casca submersa em decomposição, 19 Nov 2008, D.A.C. Almeida, s.n. (HUEFS 155044); idem, sobre galho submerso em decomposição, 18 Nov 2008, D.A.C. Almeida, s.n. (HUEFS 155046).

Kionochaeta ramifera (Matsush.) P.M. Kirk & B. Sutton, Trans. Br. mycol. Soc. 85(4): 715. 1985.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre galho submerso em decomposição, 20 Set 2008, D.A.C. Almeida, s.n. (HUEFS 155047).

Paliphora intermedia Alcorn, Mycotaxon 59: 145. 1996.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre galho submerso em decomposição, 20 Set 2008, D.A.C. Almeida, s.n. (HUEFS 155053).

Paraceratocladium silvestre R.F. Castañeda, Fungi Cubenses II (La Habana) 2: 9. 1987.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre casca submersa em decomposição, 08 Set 2008, D.A.C. Almeida, s.n. (HUEFS 155055); idem, sobre galho submerso, 19 Set 2008, D.A.C. Almeida, s.n. (HUEFS 155056).

Subulispora longirostrata Nawawi & Kuthub., Mycotaxon 30: 459. 1987.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 25 Set 2008, D.A.C. Almeida, s.n. (HUEFS 155065); idem, sobre casca submersa em decomposição, 26 Ago 2008, D.A.C. Almeida, s.n. (HUEFS 155068).

Subulispora rectilineata Tubaki, Trans. Mycol. Soc. Japan 12(1): 21. 1971.
Material examinado: **BRASIL**, Bahia: Pindobaçu, Serra da Fumaça, sobre folha submersa em decomposição de dicotiledônea não identificada, 30 Set 2008, D.A.C. Almeida, s.n. (HUEFS 155070).

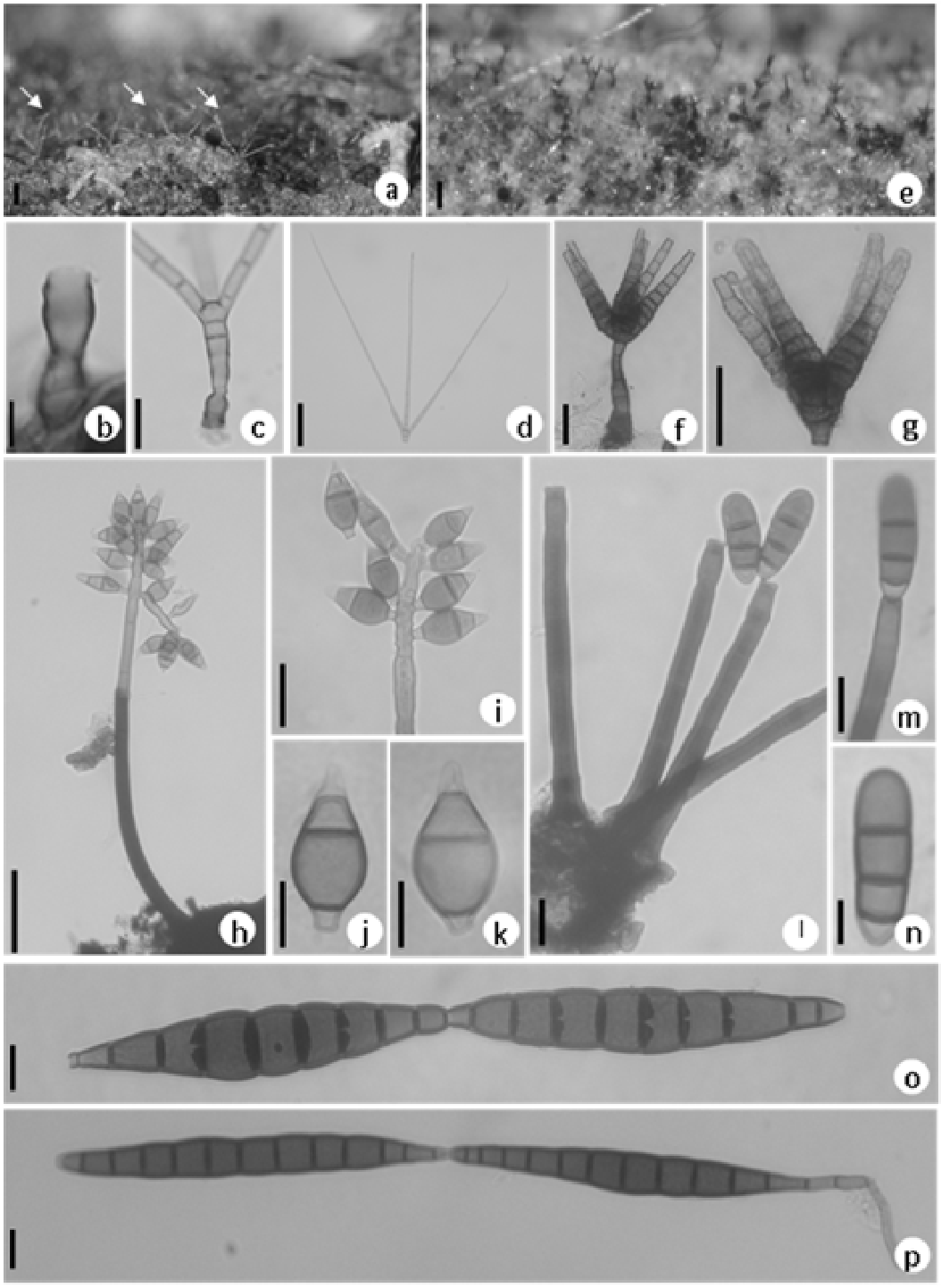

Figura 1. Fungos conidiais aquáticos-facultativos. a-d. *Actinocladium longiramosum*. a. Colônia sobre substrato natural (setas). b. Conidióforo. c. Conidióforo e conídio. d. Conídio. e-g. *Actinocladium verruculosum*. e. Colônia sobre substrato natural. f. Aspecto geral. g. Conídio. h-k. *Cacumisporium pleuroconidiophorum* . h. Aspecto geral. i. Ápice do conidióforo com conídios. j-k. Conídios. l-n. *Dischloridium inaequiseptatum*. l. Conidióforos. m. Detalhe do ápice do conidióforo com conídio. n. Conídio. o-p. *Xylomyces aquaticus.* o-p. Clamidósporos. Barras: 50 µm (a, d-e, h); 20 µm (f-g, i); 10 µm (c, j-k, l-m, o-p); 5 µm (b, n).

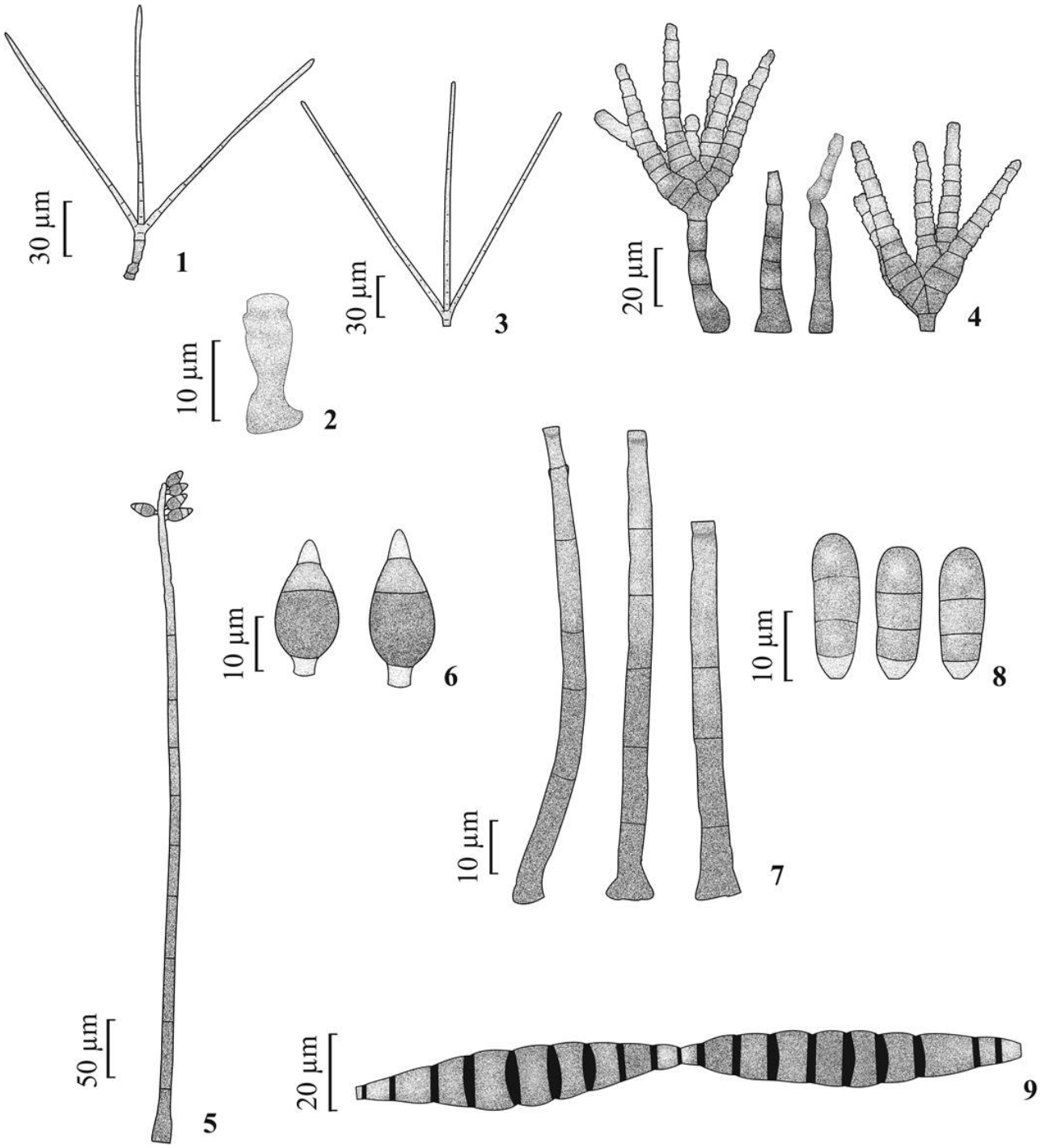

Figura 2. Fungos conidiais aquáticos-facultativos. 1-3. *Actinocladium longiramosum*. 4. *Actinocladium verruculosum*. 5-6 *Cacumisporium pleuroconidiophorum*. 7-8 *Dischloridium inaequiseptatum.* 9. *Xylomyces aquaticus.*

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CONCLUSÕES GERAIS

- Um total de 151 espécies de microfungos estão envolvidos na decomposição de substratos vegetais submersos na Serra da Jibóia;

- Dentre os microfungos responsáveis pela decomposição de materiais vegetais submersos na Serra da Jibóia estão presentes os ascomycetes e fungos conidiais (hyphomycetes e coelomycetes);

- Os fungos conidiais são encontrados em maior quantidade sobre substratos vegetais submersos do que os ascomycetes;

- Dentre os substratos estudados, os galhos apresentaram maior riqueza tanto de ascomycetes quanto de fungos conidiais;

- 60 espécies são novas ocorrências subdivididas em sete grupos:

  - *Annulatascus apiculatus*, *Dactylaria saccardoana*, *Quadracaea stauroconidia* e *Thozetella submersa* são espécies inéditas;

  - *Brachydesmiella anthostomelloidea, Camposporidium cristatum, Dactylaria hyalotunicata, Lauriomyces sakaeratensis, Pleurophragmium malaysianum* e *Pyricularia rabaulensis* constituem espécies raras, com distribuição restrita a um ou dois países.

  - *Actinocladium verruculosum, Anthostomella aquatica, Brachydesmiella caudata, Canalisporium exiguum, Cancellidium applanatum, Pithomyces elaeidicola, Sporidesmiella ciliaspora, Stachybotrys sphaerospora, Tamsiniella labiosa* e *Thozetella pinicola* representam novos registros para o Continente americano;

  - *Sporoschisma juvenile, Torrentispora crassiparietis* e *Xylomyces elegans* são novos registros para o Neotrópico

  - *Aniptodera chesapeakensis, Bactrodesmium longisporum, Chaetosphaeria lignomollis, Chloridium obclaviforme, Cryptophialoidea secunda, Dinemasporium lanatum, Dischloridium inaequiseptatum, Ellisembia bambusicola, Hermatomyces*

sphaericus, Jahnula seychellensis, Junewangia martinii, Linkosia ponapensis e *Xylomyces foliicola* constituem novos registros para a América do Sul;

- *Annulatascus velatisporus, Berkleasmium corticola, Brachiosphaera tropicalis, Brachysporiella pulchra, Cacumisporium pleuroconidiophorum, Candelabrum brocchiatum, Ityorhoptrum verruculosum, Mirandina cortícola, Scutisporus brunneus, Ophioceras venezuelensis, Xylomyces clamidosporis* e *Zygosporium minus* representam novos registros para o Brasil;
- *Chaetomium homopilatum, Chaetomium longicolleum, Chaetopsina splendida, Dictyochaetopsis gonytrichoides, Dictyochaetopsis polysetosa, Heliocephala elegans, Idriella cagnizarii, Ingoldiella hamata, Monodictys putredinis, Periconia minutíssima, Pseudotracylla dentata e Rhexoacrodictys erecta* são novos registros para a Bahia;

- O riacho presente na Serra da Jibóia representa um ambiente rico em espécies de fungos contendo inclusive espécies inéditas, espécies raras.

MICROFUNGOS ASSOCIADOS À SUBSTRATOS VEGETAIS SUBMERSOS EM AMBIENTE LÓTICO DE UM FRAGMENTO DE MATA ATLÂNTICA, BAHIA, BRASIL

Flavia Rodrigues Barbosa

RESUMO

Microfungos decompositores de substratos vegetais submersos são organismos importantes em ambientes de água doce, pois desempenham um papel vital no fluxo de energia e nutrientes. O conhecimento acerca desses fungos ainda permanece escasso, principalmente quanto a sua ecologia, diversidade e padrões de distribuição. Visando contribuir com o conhecimento da biodiversidade de ascomicetos e fungos conidiais de água doce no Brasil, foi realizado estudo taxonômico desses grupos associados a substratos vegetais submersos em um riacho na Serra da Jibóia, Bahia, Brasil. Expedições foram realizadas trimestralmente de julho de 2007 a maio de 2009 para a coleta de casca, galho, folha e pecíolo submersos. O material coletado foi lavado em água corrente e acondicionado em câmaras-úmidas por três meses. Durante esse período, os substratos foram examinados sob estereomicroscópio e lâminas permanentes foram confeccionadas com as estruturas reprodutivas dos fungos. Estudo taxonômico dos fungos conidiais foi realizado no Laboratório de Micologia da UEFS enquanto que, para os ascomicetos, o mesmo foi desenvolvido no Laboratório de Micologia da UIUC-EUA. Lâminas permanentes e material seco foram depositados no Herbário HUEFS e culturas foram depositadas na Coleção de Culturas de Microrganismos da Bahia (CCMB). A primeira seção apresenta a descrição de duas novas espécies e dois novos registros em Annulatascaceae com ilustrações e chaves de identificação; a segunda seção descreve e ilustra a nova espécie de ascomiceto, *Annulatascus apiculatus*; na terceira seção, nove novos registros de ascomicetos são descritos e ilustrados; na quarta seção duas novas espécies de hyphomycetes são descritas e ilustradas e uma lista com 151 espécies de microfungos (ascomicetos, hifomicetos e coelomicetos) é apresentada; na quinta seção a nova espécie, *Thozetella submersa*, é descrita e ilustrada; a sexta seção é dedicada ao estudo de seis espécies raras de hyphomycetes e apresenta uma lista de 37 adicionais novos registros de hyphomycetes para o Continente americano, Neotrópico, América do Sul, Brasil e Bahia; na sétima seção novos registros de fungos aquáticos facultativos são apresentados com descrição e ilustração.

Palavras-chave: ambiente aquático, ascomicetos, fungos conidiais, semi-árido, taxonomia

MICROFUNGI ON SUBMERGED PLANT DEBRIS FROM A RAINFOREST FRAGMENT STREAM, BAHIA, BRAZIL

Flavia Rodrigues Barbosa

ABSTRACT

Microfungi decomposing of submerged plant debris are important organisms in freshwater environments since they play a vital role in the flow of energy and nutrients. The knowledge of these fungi is still scarce, especially regarding their ecology, diversity and distribution patterns. To contribute to the knowledge of the biodiversity of ascomycetes and conidial fungi in fresh water in Brazil, a taxonomic study of this ecological group associated with submerged plant debris was conducted in a stream in Serra da Jibóia, Bahia, Brazil. Expeditions were conducted every three months from July 2007 to May 2009 to collect submerged bark, twig, leaf and petiole. The samples were washed in tap water and placed in moist chambers for three months. During this period, the samples were examined under a dissecting microscope and permanent slides were prepared with the reproductive structures of fungi. Taxonomic study of conidial fungi was conducted in the Mycology Laboratory of UEFS, while the taxonomic study of ascomycetes was carried out in the Mycology Laboratory of UIUC-USA. Permanent slides and dry material were deposited in the Herbarium HUEFS and cultures were deposited in "Coleção de Culturas de Microrganismos da Bahia" (CCMB). The first section presents a description of two new species and two new records of ascomycetes in the Annulatascaceae with illustrations and identification keys; the second section provides a description and illustrations of a new species of ascomycetes, *Annulatascus apiculatus*; in the third section, nine new records of ascomycetes are described and illustrated; in the fourth section, two new species of hyphomycetes are described and illustrated, and a list of 151 species of microfungi (ascomycetes, hyphomycetes and coelomycetes) is provided; in the fifth section the new species, *Thozetella submersa* is described and illustrated; the sixth section expands on the study of six rare species of hyphomycetes and lists 37 additional new records of hyphomycetes for western hemisphere, Neotropics, South America, Brazil and Bahia; in the seventh section new records of facultative freshwater aquatic fungi are provided with descriptions and illustrations.

Key words: aquatic habitat, ascomycetes, conidial fungi, semi-arid, taxonomy

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As siglas e abreviaturas, quando utilizadas pela primeira vez, deverão ser precedidas do seu significado por extenso. Ex.: Universidade Federal de Pernambuco (UFPE); Microscopia Eletrônica de Varredura (MEV). Usar abreviaturas das unidades de medida de acordo com o Sistema Internacional de Medidas (por exemplo 11 cm, 2,4 µm). O número deverá ser separado da unidade, com exceção de percentagem, graus, minutos e segundos de coordenadas geográficas (90%, 17°46'17" S, por exemplo).

Para unidades compostas, usar o símbolo de cada unidade individualmente, separado por um espaço apenas. Ex.: mg kg-1, µmol m-2 s-1, mg L-1. Litro e suas subunidades deverão ser grafados em maiúsculo. Ex.: L , mL, µL. Quando vários números forem citados em seqüência, grafar a unidade da medida apenas no último (Ex.: 20, 25, 30 e 35 °C). Escrever por extenso os números de zero a nove (não os maiores), a menos que sejam acompanhados de unidade de medida. Exemplo: quatro árvores; 10 árvores; 6,0 mm; 1,0-4,0 mm; 125 exsicatas.

Para normatização do uso de **notações matemáticas**, obtenha o arquivo contendo as instruções específicas em http://www.botanica.org.br/ojs/public/matematica.pdf.O Equation, um acessório do Word, está programado para obedecer as demais convenções matemáticas, como espaçamentos entre sinais e elementos das expressões, alinhamento das frações e outros. Assim, o uso desse acessório é recomendado.Em trabalhos taxonômicos, o material botânico examinado deverá ser selecionado de maneira a citarem-se apenas aqueles representativos do táxon em questão, na seguinte ordem e obedecendo o tipo de fonte das letras: **PAÍS. Estado**: Município, data, fenologia, coletor(es) número do(s) coletor(es) (sigla do Herbário).

Exemplo:

BRASIL. São Paulo: Santo André, 3/XI/1997, fl. fr., Milanez 435 (SP).

No caso de mais de três coletores, citar o primeiro seguido de *et al*. Ex.: Silva *et al.*

Chaves de identificação deverão ser, preferencialmente, indentadas. Nomes de autores de táxons não deverão aparecer. Os táxons da chave, se tratados no texto, deverão ser numerados seguindo a ordem alfabética.

Exemplo:

1. 1. Plantas terrestres
   2. Folhas orbiculares, mais de 10 cm diâm.
   ..... 2. S. orbicularis
   2. Folhas sagitadas, menos de 8 cm compr.
   ..... 4. S. sagittalis

1. 1. Plantas aquáticas
   3. Flores brancas ..... 1. S. albicans
   3. Flores vermelhas ..... 3. S. purpurea

O tratamento taxonômico no texto deverá reservar o itálico e o negrito simultâneos apenas para os nomes de táxons válidos. Basiônimo e sinonímia aparecerão apenas em itálico. Autores de nomes científicos deverão ser citados de forma abreviada, de acordo com o índice taxonômico do grupo em pauta (Brummit & Powell 1992 para Fanerógamas).

Exemplo:

1. ***Sepulveda albicans*** L., Sp. pl. 2: 25. 1753.

Pertencia albicans Sw., Fl. bras. 4: 37, t. 23, f. 5. 1870.

Fig. 1-12

Subdivisões dentro de Material e métodos ou de Resultados e/ou Discussão deverão ser grafadas com a primeira letra em maísculo, seguida de um traço (-) e do texto na mesma linha.

Exemplo: Área de estudo - localiza-se ...

2. DOCUMENTOS SUPLEMENTARES

2.1. Carta de submissão. Deverá ser enviada como um arquivo separado. Use a carta de submissão para explicitar o motivo da escolha da Acta Botanica Brasilica, a importância do seu trabalho para o contexto de sua área e a relevância científica do mesmo.

2.2. Figuras. Todas as figuras apresentadas deverão, obrigatoriamente, ter chamada no texto. Todas as imagens (ilustrações, fotografias, eletromicrografias e gráficos) são consideradas como 'figuras'. **Figuras coloridas poderão ser aceitas, a critério do Corpo Editorial, que deverá ser previamente consultado. O(s) autor(es) deverão se responsabilizar pelos custos de impressão.**

Não envie figuras com legendas na base das mesmas. **As legendas deverão ser enviadas no final do documento principal.**

As figuras deverão ser referidas no texto com a primeira letra em maiúsculo, de forma abreviada e sem plural (Fig.1, por exemplo).

As figuras deverão ser numeradas seqüencialmente, com algarismos arábicos, colocados no canto inferior direito. Na editoração final, a largura máxima das figuras será de: 175 mm, para duas colunas, e de 82 mm, para uma coluna.

Cada figura deverá ser editada para minimizar as áreas com espaços em branco, optimizando o tamanho final da ilustração.

Escalas das figuras deverão ser fornecidas com os valores apropriados e deverão fazer parte da própria figura (inseridas com o uso de um editor de imagens, como o Adobe® Photoshop, por exemplo), sendo posicionadas no canto inferior esquerdo, sempre que possível.Ilustrações em preto e branco deverão ser fornecidas com aproximadamente 300 dpi de resolução, em formato TIF. Ilustrações mais detalhadas, como ilustrações botânicas ou zoológicas, deverão ser fornecidas com resoluções de, pelo menos, 600 dpi, em formato TIF. Para fotografias (em preto e branco ou coloridas) e eletromicrografias, forneça imagens em formato TIF, com pelo menos, 300 dpi (ou 600 dpi se as imagens forem uma mistura de fotografias e ilustrações em preto e branco). Contudo, atenção! Como na editoração final dos trabalhos, **o tamanho útil destinado a uma figura de largura de página (duas colunas) é de 170 mm, para uma resolução de 300 dpi, a largura das figuras não deverá exceder os 2000 pixels. Para figuras de uma coluna (82 mm de largura), a largura máxima das figuras (para 300 dpi), não deverá exceder 970 pixels.**Não fornecer imagens em arquivos Microsoft® PowerPoint,

geralmente geradas com baixa resolução, nem inseridas em arquivos DOC. Arquivos contendo imagens em formato Adobe® PDF não serão aceitos. Figuras deverão ser fornecidas como arquivos separados (documentos suplementares), não incluídas no texto do trabalho.As imagens que não contiverem cor deverão ser salvas como 'grayscale', sem qualquer tipo de camada ('layer'), como as geradas no Adobe® Photoshop, por exemplo. Estes arquivos ocupam até 10 vezes mais espaço que os arquivos TIF e JPG. A ***Acta Botanica Brasilica*** não aceitará figuras submetidas no formato GIF ou comprimidas em arquivos do tipo RAR ou ZIP. Se as figuras no formato TIF forem um obstáculo para os autores, por seu tamanho muito elevado, estas poderão ser convertidas para o formato JPG, antes da sua submissão, resultando em uma significativa redução no tamanho. Entretanto, não se esqueça que a compressão no formato JPG poderá causar prejuízos na qualidade das imagens. Assim, é recomendado que os arquivos JPG sejam salvos nas qualidades 'Máxima' (Maximum).O tipo de fonte nos textos das figuras deverá ser o Times New Roman. Textos deverão ser legíveis. Abreviaturas nas figuras (sempre em minúsculas) deverão ser citadas nas legendas e fazer parte da própria figura, inseridas com o uso de um editor de imagens (Adobe® Photoshop, por exemplo). Não use abreviaturas, escalas ou sinais (setas, asteriscos), sobre as figuras, como "caixas de texto" do Microsoft® Word. **Recomenda-se a criação de uma única estampa**, contendo várias figuras reunidas, numa largura máxima de 175 milímetros (duas colunas) e altura máxima de 235 mm (página inteira). No caso de estampa, a letra indicadora de cada figura deverá estar posicionada no canto inferior direito. Inclua "A" e "B" para distingui-las, colocando na legenda, Fig. 1A, Fig. 1B e assim por diante. Não use bordas de qualquer tipo ao redor das figuras.É responsabilidade dos autores obter permissão para reproduzir figuras ou tabelas que tenham sido previamente publicadas.**2.3. Tabelas.** As tabelas deverão ser referidas no texto com a primeira letra em maiúsculo, de forma abreviada e sem plural (Tab. 1, por exemplo). **Todas as tabelas apresentadas deverão, obrigatoriamente, ter chamada no texto.** As tabelas deverão ser seqüencialmente numeradas, em arábico (Tabela 1, 2, 3, etc; não abrevie), com numeração independente das figuras. O título das tabelas deverá estar acima das mesmas. Tabelas deverão ser formatadas usando as ferramentas de criação de tabelas ('Tabela') do Microsoft® Word. Colunas e linhas da tabela deverão ser visíveis, optando-se por usar linhas pretas que serão removidas no processo de edição final. Não utilize padrões, tons de cinza, nem qualquer tipo de cor nas tabelas. Dados mais extensos poderão ser enviados como documentos suplementares, os quais estarão disponíveis como links para consulta pelo público.Mais detalhes poderão ser consultados nos últimos números da Revista.

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INSTRUCTIONS TO AUTHORS 2011

Mycologia publishes papers on all aspects of fungi, including lichens. Subjects appropriate to the journal are physiology and biochemistry, ecology, pathology, morphology and development, systematics, cell biology and ultrastructure, genetics, molecular biology, evolution, applied aspects and new techniques. Publication in *Mycologia* is for both members and nonmembers of the Mycological Society of America. Papers appropriate for the journal are: (i) regular articles reporting original research, (ii) notes or brief articles reporting research or new techniques, (iii) invited papers, (iv) reviews and minireviews. Authors should consult the editor before submitting a review manuscript.

Papers are limited to 10 printed pages, including tables and illustrations. One printed page is equivalent to 2.8 typed pages with one-inch margins, double spacing and 12-point type. These instructions represent 12 typed pages. Regular articles will be published in the approximate order of their acceptance. After a manuscript has been accepted, the author will receive page proofs and a form for publication charges. Authors will be asked to pay page charges, currently $60 per page. However, payment of page charges is not a condition of acceptance for publication.

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The guidelines for preparing a manuscript are basically the same as they were when hard copies

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- Identify each page (other than the first) with the first author's name and the page number in the top right margin.
- Leave at least a 2.5 cm margin on all sides.
- All text must be left aligned so that the right margin is uneven (not justified).
- Do not place page breaks between sections except for tables.
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- Remove all extra vertical space above or below titles, headings or paragraphs. These will be produced by the typesetting codes at the press.
- Do not use hanging indents in LITERATURE CITED. Place an extra line feed between references for improved legibility.
- Boldface, italic, small caps, subscript and superscript commands should be used. These are normally the only word-processing commands used by the typesetter.
- Distinguish among hyphens -, en dashes – and em dashes —. Hyphens are used join words, such as Douglas-fir. Use en dashes to indicate numerical or alphabetical ranges and as minus signs. Use em dashes in the *Number 2 heading*.— and to designate repeated authors' names in literature citations.
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- Use small caps in the words TABLE(S), FIG(S). Computer program settings also should be small caps (e.g. MULPARS, SUMPT, MULTREES).
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- Microsoft Word or Word Perfect is preferred.
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Manuscripts and text.—Authors should follow the suggestions in the latest edition of the *CBE Manual for Authors, Editors, and Publishers* and are urged to have one or more colleagues read and criticize the manuscript before submitting it. When in doubt about style, abbreviations or punctuation, refer to recent issues of *Mycologia*.

Articles include these items, in this order: short title for running head, title, author(s) name(s) and address(es), abstract, key words, text (with desired headings), acknowledgments, literature cited, legends and footnotes. Notes or articles of less than four printed pages, including illustrations, ordinarily will be published as brief articles. The manuscript format should be similar to regular articles, except that no primary headings are used other than to designate LITERATURE CITED. Secondary headings may be used and are encouraged for clarity of organization.

DETAILED INSTRUCTIONS

Short title.—An idea expressed by 3–5 words is recommended.

Title.—Make title short but informative; inclusion of a verb to communicate a complete idea is highly recommended (e.g. *Cytoplasmic dynein* is involved in nuclear migration in *Aspergillus nidulans*, not *Cytoplasmic dynein* and nuclear migration in *Aspergillus nidulans*). Omit names of authors of taxa. Omit higher taxonomic categories (phylum, order, family); place these in the abstract or key words. Do not abbreviate. Capitalize only the first word and proper nouns; the rest is lowercase.

Authors.—Place each author's name on a separate line, followed by the address on a new line. Addresses are italicized and typed as one paragraph. Do not indent. Authors in sequence with the same address have the address after the last author in the sequence. Provide the e-mail address of the corresponding author in a footnote after the legends.

Abstract: Include an abstract (before the text) in all articles. Abstract begins in bold italic at the left margin with the text immediately following on the same line. The abstract should be written as a single paragraph, presenting the salient points of the article. It must stand alone and be informative without the need for reference to the text.

Key words: Each article must be accompanied by a listing of several key words as an aid to abstracting journals and retrieval. Key words should supplement the title and not duplicate title words. Insert the key words in alphabetical order immediately after the abstract on a separate indented line beginning with the designation ***Key words:*** in bold italic.

Headings.—Primary headings should begin at the left margin. Usual primary headings are INTRODUCTION, MATERIALS AND METHODS, RESULTS, DISCUSSION, ACKNOWLEDGMENTS and LITERA-

TURE CITED. Make separate RESULTS and DISCUSSION sections; do not combine into one section. Other headings, such as TAXONOMY and/or taxonomic names, may be used to suit the purposes of the paper. Start second-level headings at left margin; use only as necessary for clarity; italicize (except scientific names) followed by a period and an em dash. Third-level headings also are italicized but indented and followed by a period only.

Lists.—Numbered lists in paragraphs should use lowercase Roman numerals in parentheses, such as (i), (ii), (iii), etc. They should be run in a continuous paragraph, not set off as separate paragraphs; see next paragraph.

Abbreviations.—Abbreviations follow *The CBE Manual.* Commonly used abbreviations are: (i) time—y, mo, wk, d, h, min, s; names of months by first three letters—Jan, Feb, Mar, Apr, May, Jun, Jul (ii) volume—L, mL, mL; (iii) length—km, m, cm, mm, mm, nm; (iv) concentration in molarity—M, mM, mM, nM, pM—differs from molecular amounts—mol, mmol, mmol, pmol; (v) distinguish g (grams) from *g* (force of gravity) by italics for the latter; (vi) temperature—C as 28 C, not 28°C, use the degree sign only for angular measures, latitude and longitude; (vii) *P* probability (uppercase italics). Notice that singular and plural forms are identical and periods are not used for standard abbreviations. Exceptions are FIG., FIGS. Do not abbreviate state or province names (e.g. California, not CA; Ontario, not ON).

Marks and symbols.—Parentheses enclose brackets ([]). Use the prime symbol ′, as in 5′ or 3′ in sequences; don't use an apostrophe ', an accent̀ or a single close quotation mark '. The single prime denotes minutes and double prime denotes seconds in latitude and longitude. Use the times symbol × in equations; do not use x.

Scientific names.—Italicize only generic, infrageneric (subgenus, section), specific and infraspecific taxa. Citation of nomenclatural authorities for taxa is optional except for taxonomic papers. When cited, authors of all specific and infraspecific taxa, except forma specialis, should be given but only when first used in the text or in a table. If authors for taxa are cited in a table, do not repeat in the text. For abbreviation of authors' names, see Kirk P.M. and Ansell A.E. (1992). Authors of Fungal Names. Index of Fungi supplement, also available online at: http://www.indexfungorum.org/AuthorsOfFungalNames.htm.

New taxa, keys and formal descriptions.—Place names of new taxa flush with left margin in boldface, not italics, followed by author(s) and status (e.g. sp. nov., stat. nov.) in lightface roman. Follow with brief but descriptive Latin diagnosis (required for all new taxa except fossil forms and bacteria) in paragraph form. After the English description, designate the type specimen and place of deposit. Authors are responsible for the accuracy of the Latin diagnosis; consult a Latin scholar; the editor does not check diagnoses. An English description, in paragraph form, follows the Latin. Record measurements as length by width (or diam); place exceptional dimensions in parentheses: (10–)12–15(–16.5) 3 5–6.2 mm. Note spacing, en dashes and multiplication symbol. Dates preferably should be cited as (example) 10 Aug 1995 or 10-VIII-1995, not 8/10/95. Authors are urged to deposit voucher specimens and to cite those specimens appropriately. Failure to do so might delay review and publication.

Type titles of keys in all capitals as a primary heading. Keys must be dichotomous, the couplets numbered and block indented. Leads of first couplet begin at left margin, as do those of third, fifth, etc. Leads of second (fourth, sixth, etc.) are tab indented equal to five spaces. Turnover lines should be justified at left with the preceding line. Normally, keys with four or fewer couplets will be set in one column, while keys of five or more couplets will be set across two columns.

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Literature cited.—Consult *The CBE Manual* 6th ed. for style. Cite references in the text by author-date (name-year system). All references must be cited in the text and any extras deleted. Journal citations and abbreviations must follow the rules for abbreviating titles in *The CBE Manual* 6th ed., p 743–746. When in doubt, provide the unabbreviated title. Do not include personal communications, unpublished data, Web page URLs, manuscripts or partial page numbers from books and theses in LITERATURE CITED; place such references in the text. Manuscripts must have been accepted for publication before they may be cited as ''In press.'' A copy of the letter of acceptance is required. Cite the journal name and volume number. Type references flush left with no hanging indent. Use an em dash to replace repeated author(s) name(s). Use an en dash to indicate page ranges.

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Bennett JW, Arnold J. 2001. Genomics for Fungi. In: Howard R, Gow N, eds. Biology of the fungal cell. Berlin, Germany: Springer-Verlag: The Mycota XIII:268–297.

Fallah PM. 1999. Ascomycetes from north temperature lakes in Wisconsin [Doctoral dissertation]. Urbana–Champaign: Univ. Illinois. 190 p.

Klich, MA. 2002. Biogeography of *Aspergillus* species in soil and litter. Mycologia 94:21–27.

Ridgway R. 1912. Color standards and color nomenclature. Washington, DC: Published by the author. 43 p, 53 pl.

Xiang X, Beckwith SM, Morris NR. 1994. *Cytoplasmic dynein* is involved in nuclear migration in *Aspergillus nidulans*. Proc Natl Acad Sci USA 91:2100–2104.

———, Morris N. 1999. Hyphal tip growth and nuclear migration. Curr Opin Microbiol 2:636–640.

Illustrations.—Designate all illustrations (photographs, graphs, line drawings) as figures (abbreviate FIG.) and number consecutively in Arabic numerals. A plate of drawings or photographs may be treated as one figure with letters for each element or as several figures with each figure numbered consecutively. Do not place numbers on single figures that stand alone. Type legends consecutively, in paragraph form after LITERATURE CITED. See recent issue of *Mycologia* for format. Plates and figures should be planned so that the figures are numbered (with Arabic numerals) consecutively in the order that they are referenced in the text to allow proper placement of the figures in the published paper.

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Instructions for Authors

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Authors should submit their manuscripts to the Mycoscience online manuscript submission, review, and tracking system (Editorial Manager). Electronic submission substantially reduces the editorial processing and reviewing time and shortens overall publication time. Please follow the hyperlink “Submit online” on the right and upload all your manuscript files following the instructions given on the screen (Do not upload Excel files for tables; see “Text formatting” below). If the manuscript conforms to the guidelines specified in the instructions, the date received will be the date the manuscript was uploaded to the Editorial Manager system.

Please view your Reference Checking Results during electronic submission and attempt to resolve any problems with your references prior to submitting your manuscript.

Please submit, with the manuscript, the names and e-mail addresses of three to five potential reviewers.

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The Editorial Committee reserves the right to accept or reject a manuscript for publication. The Committee may advise the author to revise the manuscript according to suggestions by reviewers. A manuscript written in poor English or in an unsuitable format may not be accepted regardless of its content. When revision of a manuscript has been requested, the revised manuscript should be returned within three months after notification. Otherwise, the manuscript will be processed as one withdrawn from submission. If the authors decide to withdraw their manuscript from consideration for publication, they should inform the editor. The accepted date will be the day when the Editor-in-Chief has judged the manuscript to be publishable after the completion of the reviewing process.

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Authors will be allowed eight printed pages for a full paper or review, including tables and figures (three typewritten pages of manuscript, each consisting of 24 lines, are approximately equivalent to one printed page). Short communications and notes should not be longer than four printed pages. For additional pages, authors will be charged JPY 12 000 per printed page.

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Editor-in-Chief of Mycoscience

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Manuscript preparation

Manuscripts should be written in English. All articles submitted to the journal must comply with the guidelines. Failure to do so will result in the return of the manuscript before peer review and a possible delay in publication. Manuscripts should be formatted with 3-cm margins, 24 lines per page, on either A4 (21.0 × 29.7 cm) or 8½ × 11-inch pages. Use a normal, plain font (e.g., 12-point Times Roman) for text. Italic and boldface type should be specified using the features of standard word-processing software.

template

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Pages should be numbered consecutively and arranged in the following order.

Page 1: Title page

The title page should include:

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The affiliation(s) and address(es) of the author(s)

The e-mail address, telephone and fax numbers of the corresponding author

Total text pages

The numbers of tables and figures

Page 2: Abstract and keywords

Abstract

Please provide an abstract of no more than 200 words for reviews and full-length articles, 100 words for short communications and notes. The abstract should not contain any undefined abbreviations or unspecified references.

Keywords

Please provide a maximum of five keywords ordered alphabetically which can be used for indexing purposes, including the name of organisms (common name or scientific name), method(s), or other words or phrases that represent the subject of the study.

Key words should supplement the title and not duplicate words in the title.

Page 3: Text

The text should be divided into the sections with headings (see below), followed by figure legends. Authors should consult recent issues of the journal for details of style and presentation. Short communications and notes should not be divided into sections, except for References.

Headings

Primary headings should begin at the left margin in boldface. Usual primary headings are Introduction, Materials and methods, Results, Discussion, Acknowledgments and References. Start second-level headings at the left margin in Roman but not boldface. Third-level headings are italicized.

Text formatting

Manuscripts should be submitted in Word.

•Use a normal, plain font (e.g., 12-point Times Roman) for text.

•Use italics for emphasis.

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•Use the automatic page numbering function.

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Scientific names

For the use of scientific names of organisms, consult the current international codes of nomenclature concerned. For descriptions of new taxa, give names of the new taxa, followed by author(s) and status (e.g., gen. nov., sp. nov.). Following the Latin diagnosis or description, designate the type specimen and place of deposit. The Latin diagnosis or description should be checked for accuracy by an expert in Latin prior to submission.

In articles of taxonomy, cite authors of all specific and infraspecific taxa only at the first use in the text. Author names are written in full or abbreviated. In principle, abbreviations follow Authors of Fungal Names (Index of Fungi Supplement, Kirk and Ansell, 1992 or http://www.indexfungorum.org/AuthorsOfFungalNames.htm).

A generic name followed by a specific epithet should be written in full at first mention; subsequently it may be abbreviated to its capitalized initial letter where this is not ambiguous. Omit names of authors of taxa in the title and abstract. Italicize only generic, infrageneric (subgenus, section), specific, and infraspecific taxa.

Specimens, cultures, molecular sequence data, and information

Authors are urged to deposit voucher specimens and cultures in public herbaria and culture collections, which should be accessible by others and be cited by the newest version or on-line issue of Index Herbariorum (http://www.nybg.org/bsci/ih/ih.html) or World Directory of Collections and Cultures of Microorganisms: Bacteria, Fungi and Yeasts (http://wdcm.nig.ac.jp/hpcc.html). The names of herbaria and/or culture collections should be provided on a separate sheet when the manuscript is submitted. The registered specimen numbers or strain numbers must be cited in the paper. Details of specimens and cultures on which work is based, including molecular sequences, must be given (country, locality, host or substrate, date of isolation or collection, isolator or collector, registered numbers). According to the recommendations in the International Code of Botanical Nomenclature, authors who are describing new species or new infraspecific taxa are recommended to deposit a living culture (ex-type culture), whenever practicable, in at least two institutional culture or genetic resource collections, and cite these in the paper. Molecular sequence data must be deposited in a molecular sequence repository (DDBJ, http://www.ddbj.nig.ac.jp; EMBL, http://www.ebi.ac.uk; GenBank, http://www.ncbi.nlm.nih.gov/Genbank/) and the accession numbers must be cited in the paper.

Authors are also expected to deposit sequence alignments in TreeBASE (http://www.treebase.org/) or other public databases, and indicate the temporary study accession number and P.I.N. number in the text for checking by reviewers. Otherwise, authors should provide sequence alignments to reviewers upon request.

Authors are requested to deposit information on newly recognized taxa in MycoBank (http://www.mycobank.org/DefaultPage.aspx) and indicate the accession number just below the new taxon name.

Acknowledgments

Acknowledgments of people, grants, funds, etc. should be placed in a separate section before the reference list. The names of funding organizations should be written in full.

References

Citation

Cite references in the text by surname of the author(s) and year of publication in parentheses. Some examples:

•Negotiation research spans many disciplines (Thompson 1990).

•This result was later contradicted (Becker and Seligman 1996).

•This effect has been widely studied (Abbott 1991; Medvec et al. 1993; Barakat et al. 1995; Kelso and Smith 1998).

Reference list

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text. Do not use footnotes or endnotes as a substitute for a reference list.

Reference list entries should be alphabetized by the last names of the first author of each work. If the same author is cited more than once, the entries should be listed in chronological order.

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LoBuglio KF, Pfister DH (2008) A Glomerella species phylogenetically related to Colletotrichum acutatum on Norway maple in Massachusetts. Mycologia 100:710–715

•Article by DOI

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•Book

South J, Blass B (2001) The future of modern genomics. Blackwell, London

•Book chapter

Brown B, Aaron M (2001) The politics of nature. In: Smith J (ed) The rise of modern genomics, 3rd edn. Wiley, New York

•Online document

Doe J (1999) Title of subordinate document. In: The dictionary of substances and their effects. Royal Society of Chemistry. Available via DIALOG. http://www.rsc.org/dose/title of subordinate document. Accessed 15 Jan 1999

Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations (see http://www.issn.org/en/node/344).

Quantity and units

All measurements should be expressed in the metric system and abbreviated. Use the recommended SI units (Système International d'Unités). When non-SI units are used, they must be adequately explained to avoid ambiguity.

Use Roman type for units, without periods. Care should be taken to italicize only absorbance, gravitational

Acceleration, and water activity. The plural should not be formed by adding 's' for abbreviated units.

Units should be abbreviated as follows:

length nm, µm, mm, cm, m

mass pg, ng, µg, mg, g, kg

amount of substance nmol, µmol, mmol, mol

molar concentration µM, mM, M

area mm2 , cm2 , m2

volume µl, ml, l, cm3 , m3

time s, min, h

temperature ºC (example: 37ºC), K

absorbance A (example: A260)

gravitational acceleration g (example: 10 000g)

light J, lx, lm, W

molecular weight Da, kDa

water activity Aw

Concentrations of solutions are preferably expressed in terms of molarity (M). The symbol “%” must be used in its correct sense, e.g., g/100 g; otherwise it must be defined as “% (v/v)” or “% (w/v).” Use μg/ml or μg/g in place of the ambiguous ppm.

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Abbreviations should be defined at first mention and used consistently thereafter. Use Roman type for abbreviations derived from the Latin or Greek (for example: ca., et al., i.e., e.g., s. str., s. l.). Never use abbreviations or symbols for names of substances unless they are internationally accepted. The Enzyme Commission (EC) number should be given at the first mention of an enzyme in the text.

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Record measurements as length by width (or diameter). Place exceptional dimensions in parentheses. Indicate mean values, etc. separately.

Example: (10–)13–16(–18.5) × 7–8(–9) μm, 15.5 × 7.5 μm on average

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All tables should be numbered with Arabic numerals (e.g., Table 1).

Tables should always be cited in the text in consecutive numerical order.

For each table, supply a table title. The table title should explain clearly and concisely the components of the table.

Identify any previously published material by giving the original source in the form of a reference at the end of the table title.

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•Supply all figures electronically.

•Indicate what graphics program was used to create the artwork.

•For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MS Office files are also acceptable.

•Vector graphics containing fonts must have the fonts embedded in the files.

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•Definition: Black and white graphic with no shading.

•Do not use faint lines and/or lettering and check that all lines and lettering within the figures are legible at final size.

•All lines should be at least 0.1 mm (0.3 pt) wide.

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•Vector graphics containing fonts must have the fonts embedded in the files.

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•Definition: Photographs, drawings, or paintings with fine shading, etc.

•If any magnification is used in the photographs, indicate this by using scale bars within the figures themselves.

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Combination Art

•Definition: a combination of halftone and line art, e.g., halftones containing line drawing, extensive lettering, color diagrams, etc.

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•Color illustrations should be submitted as RGB (8 bits per channel).

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Electronic supplementary material will be published in the online version only. It may consist of

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•Spreadsheets should be converted to PDF if no interaction with the data is intended.

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•Electronic supplementary material will be published as received from the author without any conversion, editing, or reformatting.

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Mycosphere Online - Submissions

Mycosphere is an international peer-reviewed journal with swift publication of high quality papers on fungal biology. This includes reviews, research articles, methodology papers, taxonomic works such as monographs, and checklists. All manuscripts will undergo peer review before acceptance. Mycosphere has a policy of Open Access publishing. Mycosphere will publish each manuscript as quickly as possible following acceptance by the editors.

Instructions to authors

Electronic manuscripts must be submitted in word format. All figures and tables should be inserted into the text, similar to a camera ready paper. All figures, trees and plates should also be submitted as separate jpeg or Tiff files. Excel files for Tables are not acceptable.

- The template of a manuscript can be downloaded from the journal web site.
- The content should be set out into four major sections: (i) Introduction; (ii) Materials and methods; (iii) Results; and (iv) Discussion, in most circumstances. Acknowledgements, references, figure legends, figures and tables should be followed in order.
- Commonly used abbreviations are: (i) volume: mL; (ii) length: km; (iii) concentration: M; (iv) weight: kg; (v) temperature: °C; (vi) others: Fig. - Figs – (Months are not abbreviated.)
- Take all symbols from symbol (normal text) in MS Word.
- Brackets are used in the following order: {level 3 [level 2 (level 1)]}.
- Citation of nomenclatural authorities for taxa is optional except for taxonomic papers. For abbreviation of authors' names, use http://www.indexfungorum.org/Names/AuthorsOfFungalNames.asp.
- Figures must be submitted as electronic files and they must be composed into plates. Figures must fit a maximum of 20 cm high by 13.5 wide including space for the legend after reduction. Single photographs that need mounting together are not acceptable. Electronic figures must be captured at or above 300 dpi resolution.

- Sequences must be deposited in GenBank, full alignment of datasets must be submitted to TreeBASE and a Mycobank number must be added for new taxa and any taxonomic changes.

MYCOTAXON

Instructions to Authors

Table of Contents

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MYCOTAXON

Instructions for Authors

(Updated June 7 2010)

Mycotaxon is an international mycological journal devoted to research on the taxonomy and nomenclature of fungi. Publication is open to everyone. Authors are responsible for obtaining *peer reviews* from experts in the field prior to pre-submission of their manuscripts to the **Nomenclature** Editor. The **Editor-in-Chief** reviews all expert peer reviews, pre-submission recommendations, and author submissions. **Sheridan Press** prints the digital files prepared by the *Editor-in-Chief* from accepted manuscript files, distributes volumes to subscribers, and handles reprints. Subscriptions, author invoices, and payments are handled by the **Business Manager.** Mycotaxon is indexed by *Index Editors*. The *Webmaster* oversees the **Mycotaxon** website.

What is suitable for publication in Mycotaxon?

Mycotaxon is restricted to papers on the taxonomy and nomenclature of fungi. We intend this broadly to include monographic works, reviews of taxonomic groups and/or taxonomic criteria, arguments dealing with specific nomenclatural problems, proceedings of symposia on taxonomic or nomenclatural matters, and well-documented floras. Papers that deal with other mycological disciplines (cytology, ecology, genetics, phylogenetics, physiology, etc.) should be submitted to another journal unless their primary focus is taxonomic. Prospective authors are invited to send a draft to the *Editor-in-Chief* if they have doubt the suitability of their manuscripts for publication in the journal.

Articles may be of any length. Most authors pay no page charges, although sole/senior authors who exceed 100 pages per year may be charged $18 per excess page. Authors are granted two halftone plates for every ten (10) text pages (11-20 text pages qualify for 4 halftones, 21-30 pages for 6 halftones, etc.). Fees are $20 for each excess halftone plate. Black & white line drawings, phylotrees, graphs, and tables are not considered halftones and count as text in assessing page charges. Color processing fees are $475 per color plate or $40 to prepare a color pdf for author use. There are also fees for digitizing original artwork, converting non-standard graphics files to tif format, and correcting author errors in pdf proofs.

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About regional (distributional) checklists

Since 2004, Mycotaxon has asked authors of regional fungal inventories to publish 1–4 page summaries in Mycotaxon of fully annotated species checklists to be posted on the Internet. Both urls to checklists posted on authors' own websites and downloadable PDF checklists are posted on the Mycotaxon **weblists** page. The checklists link directly to the on-line abstracts. There is a one-time $40 posting fee for uploading a distributional or annotated species pdf onto the Mycotaxon website. Weblists may be revised frequently for $10 per update

Summary papers must follow the same editorial requirements as taxonomic and nomenclatural papers, except that both original checklist and summary must undergo pre-submission expert review. Only the summary is submitted for accessioning and nomenclatural review, but both summary and complete checklist are sent to the *Editor-in-Chief* during final submission. Checklist authors are strongly encouraged to cite references used to identify their listed taxa and must include the URL to their checklist in the summary abstract. After final editorial approval, authors wishing to post on Mycotaxon's webpage should contact the **Business Manager,** who will send an invoice for payment of uploading the weblist pdf. All pdfs may be updated for a $20 revision fee and display original posting and revision dates on the first page.

Manuscript preparation and submission

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PennycookS@LandcareResearch.co.nz

Authors and coauthors are all responsible for providing error-free, properly formatted text and should download the Mycotaxon MSWord template and Instructions for Authors pdf files from the Mycotaxon **Author Instructions** page before preparing a manuscript for Mycotaxon. (All files will be E-mailed by the Editor-in-Chief on request.) Authors who need additional guidance are urged to ask their peer reviewers or the *Editor-in-Chief* for help. Those intending to submit text for scanning and digital conversion should first contact the *Editor-in-Chief* for special instructions.

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Step 1—Peer Review (Experts E-mail comments to authors and Editor-in-Chief)

Authors send formatted manuscript text & graphics files with the Mycotaxon instruction pdf and the reviewer comments form to two experts for pre-submission peer review.

Peer reviewers evaluate science, grammar, and appearance of manuscripts sent to them for review. They should Email revisions and comments on the expert review comment form directly to both authors and Mycotaxon *Editor-in-Chief.* Reviewers may request to see at least one author revision before sending in the comments form; annotated hard copy should be returned only to the authors.

Step 2—Submission (E-mail) to the Nomenclature Editor

Authors send a revised, formatted master text file (including Tables and Figures but containing no graphics) and peer reviewer E-mail addresses (required) to the *Nomenlcature Editor,* who will assign the Mycotaxon accession number.

The *Nomenclature Editor* returns annotated text files with a list of needed corrections to the authors and *Editor-in-Chief.* Authors correct the text files, consulting again with their peer reviewers when necessary.

Step 3—Final submission (E-mail) to the Editor-in-Chief

A. Mycotaxon submission form (required) in document file format (pdf format not acceptable) containing complete author responses to all 15 required items;

B. 1–3 Text files, including

—One body text file (required) with masthead, tables, figures, footnotes, legends, instructions, and hyperlinks removed, all text in black font, and editorial tracking turned off and comments removed;

—One legend text file with placement instructions for footnotes and/or illustrations; and

—One table text file with placement instructions for tables;

C. Art plates in jpg (or tif with lzw compression) format;

D. Author-prepared annotated species list (for distribution/ecology summary papers) as a document file or pdf with all graphics and tables in place; and

(optional) manuscript preview (pdf, MSWord) showing author suggestions for graphics, table, and legend placement.

Step 4—Editorial review and press-preparation by the Editor-in-Chief

All expert reviews and author messages are usually acknowledged within 2 weeks after the final submission is received. After scientific and grammatical editorial review, the *Editor-in-Chief* E-mails all co-authors with either manuscript acceptance or a request for further revision.

Authors of accepted papers either approve the revised editorial files or return final revisions. The *Editor-in-Chief* returns a press-quality pdf proof for final inspection shortly before press deadline. Any outstanding fees should be sent to the **Business Manager** after final PDF approval but prior to publication.

Guide to text formatting

Experienced authors who are accustomed to placing the research narrative before the figure legends, footnotes, and tables in manuscripts destined for other scientific journals will have no difficulty preparing text files for Mycotaxon. The following pages are written in sufficient detail to help students and less experienced authors properly format the four individual input files required for Mycotaxon review and submission. All authors will benefit by reading the information before beginning a manuscript.

Text must conform to the following specifications

Note: Title, author address, abstract, key words, body text, figure legend, acknowledgment, & literature-cited elements must adhere to all requirements. Our sample manuscript (pp. 17–22) illustrates typical formats common to "new species" papers.

The Mycotaxon **template** is formatted for a US letter paper size with 5.25 cm top/bottom & 5.3 cm side margins with a print area size of 11 × 17.5 cm (4.33" × 6.89"). It provides a mock-up of the Mycotaxon logo and header for the first page and detailed formatting instructions. All Mycotaxon text files use the same document format.

Fonts—Authors must submit text formatted in (serif) times or times new roman ["times/tnr"] and (sans serif) arial or helvetica ["arial/helv"] according to style specified below. Characters not displayed on keyboards (α, β, μ, ×, ≡) should be selected from the symbols menu if not available in the regular fonts. Courier is used only when strict columnar alignment is essential (e.g., DNA sequence data). No other font should be used without editorial permission.

Paragraphs—Lines must be single-spaced within paragraphs. Authors should use paragraph format menu options to separate paragraphs or indent first lines. (Files containing double returns to space paragraphs or tab keys to indent paragraphs will be returned for reformatting.)

Required formats

• **Title**. Font—Arial 11-pt bold, sentence (not upper or title) case; Paragraph—no period (dot) at the end (unless ending with an abbreviation), no indent, center aligned. Special: Set Latin scientific names in bold italic. Titles should not exceed three lines. Author citations are permitted only when an authority is needed in the title for clarity. Abbreviate genus names after the first use, but otherwise avoid abbreviations. Use arabic (not roman) numerals.

• **Author names**. Font—Times 10-pt regular ('plain'), 'small caps', title case; Paragraph—no indent, center aligned. Special—Given names and/or initials precede surnames. Separate authors with commas except use '&' before the last author name.

• **Address information**. Font—Times 9-pt italic; Paragraph—no indent, center aligned, no periods at line ends; Placement—E-mail address (required for first author) on top line; institution on middle line; street, city, code, and country on bottom line. Special—Junior author E-mail addresses (optional) preferred. Keep institutional information to one line. Do not end lines with commas, semi-colons, or full stops (except for abbreviations).

• **Abstract & Key words**. Font—Times 8-pt with bold ('Abstract' and 'Key words') or regular/italic as needed (em-dash, paragraph text). Paragraph: 1 cm right & left margins, no indent, fully justified.

Abstract—Abstracts briefly summarize content and conclusions and list all new taxa (without authorities unless differentiating homonyms). English abstracts are required; one abstract in another language is permitted for longer articles. Abstracts should not exceed 15 printed lines.

Key words—Limit up to five key words or phrases. Do not repeat terms already used in the title or abstract. Separate terms with commas and capitalize the first letters of proper nouns only. Do not end the list with a full stop.

• **Subheadings. Primary** (stand-alone): Font—Arial 10-pt bold/bold italic; paragraph—no indent, center aligned. **Secondary** (stand-alone): Font—Arial 9-pt bold/bold italic; paragraph: no indent, left aligned. **Taxonomic** (special): Font—Times with 10-pt bold italic (Latin name), 9-pt regular (authority & plate reference), and 9-pt bold ('nom./sp./gen./comb. nov.'). Paragraph—hanging indent, left aligned; set right tab (left-pointing arrow in tab bar ruler) to 11 cm to move plate # to right margin. Special—plate references for new names may stand on the same line as the MycoBank and/or GenBank number. (The term 'plate' is preferred over 'figure' but not mandatory.)

• **Basic text**. Font—Times 10-pt regular/italic as needed; Paragraph—fully justified, with the format>paragraph menu used to set 6 pts above the first paragraph and indent the first line of the remaining paragraphs by 0.5 cm.

Special—Present necessary abbreviations and other procedural data either as a second paragraph in the Introduction or in a separate Materials & methods section set in 9-pt font. Differentiate between generic names having the same first letter by abbreviating the less frequently cited genus with the first **two** letters of the genus name. Italics are required and exclusively reserved for Latin names (of all taxa from form to kingdom) and the Latin diagnosis; do not italicize common Latin abbreviations (e.g., i.e., et al., etc.) or book/journal titles. Cite taxonomic authorities once only: in formal species treatments, nomenclators, or tables (preferred) or where first mentioned in the text. In nomenclators cite previously misidentified taxa as 'misapplied,' not 'sensu "author"'.

Consult the current **international code of botanical nomenclature** when describing new taxa or proposing new combinations. Author citations must follow either the **international plant names index** or current **authors of fungal names**. See sample manuscript for further information.

• **Subordinate text** (e.g., MycoBank & GenBank numbers, nomenclators, Latin diagnoses, holotype information, etymologies, and examined specimens). Font—Times, 8-pt; paragraph—margins indented 1 cm, fully justified with first line flush. Special—Italicize all Latin text in diagnoses (but place scientific names in regular font) and only Latin scientific names elsewhere. Consult **index herbariorum** for herbarium/collection acronyms. Authors describing new taxa must cite relevant acronyms and numbers to facilitate retrieval by readers as well as deposit new names in **MycoBank,** sequence data in **GenBank**, type specimens in an official public herbarium, and ex-type strains in a public culture collection.

• **Acknowledgments.** Font—Times, 9-pt; paragraph—no indent, fully justified. Special—Mycotaxon requires that authors acknowledge peer reviewers here.

• **Literature cited.** FONT—Times, 8-pt; PARAGRAPH—fully justified with hanging indent, single spaced with 10-pt leading. REQUIRED—All references must be cited in the main text. Follow a consistent citation style throughout. Alphabetize according to surnames and substitute initials (no periods after initials) for given names, place surnames before initials, separate inidividual author names+initials by commas, and do not use '&' or 'and' before the last author name. Use only one space between words and after full stops. To standardize journal abbreviations, see BOTANICO-PERIODICO-HUNTIANUM (BPH: Lawrence & al. 1968), BOTANICO-PERIODICO-HUNTIANUM/SUPPLEMENTUM (BPH/S: Bridson 1991, 2004), TAXONOMIC LITERATURE, (TL2: Stafleu & Cowan 1976-2000), and SUPPLEMENTS TO TAXONOMIC LITERATURE (Stafleu & Mennenga 1992-2008). See sample manuscript for examples. Obtain DOI numbers for references using **CROSSREF**.

Two to four separate text files are needed to submit to MYCOTAXON

MYCOTAXON asks authors to submit only files with all text correctly formatted and ready for immediate proof conversion. The four MYCOTAXON text file types are BODY, LEGEND, and TABLE (for composition and final submission) and MASTER (for peer and nomenclatural review). Templates are posted on the MYCOTAXON **DOWNLOADS PAGE**.

The MASTER TEXT FILE combines the body, legend, and table text into one file for review by peer experts and the *Nomenclature Editor.* The MYCOTAXON banner, legends, tables, footnotes, and breaks & empty spaces for graphics are added to give the authors an idea of the final printed appearance. No TEXT FILE should contain ANY drawings, photos, or other illustrative material. Authors who wish to insert illustrations to provide a PREVIEW file for peer review must REMOVE them from the master text file before sending it to the *Nomenclature Editor* to accession and review.

The BODY TEXT FILE contains all formatted manuscript text except for legends, tables, and footnotes. The LEGEND TEXT FILE contains all formatted legend & footnote text. The TABLE TEXT FILE contains all formatted tables and accompanying table titles and footnotes. The body text file contains no instructions but only text intended for publication, while both legend and table text files provide instructions to the *Editor-in-Chief* for proper placement of footnotes, figure captions, and tables into the PDF press proof. Text frames should not be included in any MYCOTAXON text file.

Body text file [Label file with ACCESSION NUMBER+'body' (e.g., **10-117body.doc**)]

First, download the MYCOTAXON **TEMPLATE** from the MYCOTAXON website for instructions and formatting requirements. Then prepare the text as follows:

REVEAL FORMATTING — Turn on the 'reveal' formatting option in MSWord by following the VIEW>REVEAL FORMATTING pathway in the menu bar. Click to reveal pale gray symbols between characters: → (right arrows indicating TAB STOPS), ↵ (left arrows indicating LINE BREAKS), ¶ (backwards 'P's indicating PARAGRAPH ends), and • • • (dots indicating spaces, with one dot per *space*). These are visible only on screen and only when the application is set to 'reveal' on your own computer.

REMOVE EMPTY LINES AND DOUBLE SPACING — Composing with revealed formatting will ensure that all paragraph symbols are preceded by text. Empty lines are caused by clicking the return key twice after ending a paragraph, interfere with press processing, and MUST be removed. All files submitted to Mycotaxon must be single-spaced. Files using double, triple, or 1 1/2 line spacing will be automatically rejected.

Formatting paragraphs — In msword: select format (in the menu bar) to open the paragraph window. This window controls paragraph margins, first line indents, spacing above and below paragraphs, line spacing, font leading, and tab key options. The two most frequent paragraph types are 'block' and 'indented':

> To format block paragraphs: Under –indentation–special: select **(none)** to keep first line flush with margin. To set paragraph spacing, type [**6**] in the –spacing–before box. Click ok. [Thereafter, each keyboard return will set a new block paragraph 6 points below the previous block paragraph.] Block paragraphs stand below subheadings.
>
> To format paragraphs with indented first lines: Under –indentation–special: select (**First line**). Type **0.5 cm** into the **by:** box and type [**0**] in the –spacing–before box. Click ok. [Here, each keyboard return sets a new indented paragraph directly below the previous.] Indented paragraphs are used after initial block paragraphs or flush subheadings.

Line breaks — In msword: press shift + return simultaneously to force text onto the next line. Authors should NOT use line breaks in any text files except to separate the title or author addresses into appropriate segments, because they interfere with text flow during pdf conversion. Authors who customarily use line breaks are cautioned to read all text files prior to final submission with the formatting revealed to delete all other line breaks. (Line breaks appear in MSWord® as gray left arrows at line ends.)

Do not use section or page breaks — Section or page breaks are NEVER permitted in Mycotaxon submission text files. Authors who frequently insert section and page breaks to distribute text properly around figures & tables must eliminate them prior to final submission.

Tab key settings — Authors should remove all tab stop key settings (except the 11-cm right tab stop) from Mycotaxon body and legend text files; this reminds authors not to indent paragraph first lines with the tab key (!) and allows the tab stop to force text to the right margin when required. In Mycotaxon's MSWord template files:

> To open the tab format window: Click the tabs . . . box at the lower left of the format>paragraph window.
>
> To remove tab stops: Click clear *or* clear all, then ok to close the tab window.
>
> To force text to right margin (for key leads & figure references): Type **11 cm** in the tab stop position box. Click set, then ok to close window.
>
> To set leader dots between key entries and key leads: Set right tab to 11 cm as above but click **2**... under —leader— before setting and closing the tab format window. [NEVER type dots between entries and leads in taxonomic keys; they interfere with press processing.]

Word spacing — Computers are not typewriters! Only one space should stand between words and sentences. Use the Find & Replace All window to replace all double spaces with single spaces before final submission.

Legend text file [Label file with accession number+'legend' (e.g., **10-117legend.doc**)]

First download the **legend** text shell from the Mycotaxon website and follow the instructions. Type a placement direction for a footnote or legend (caption) in Arial 9-pt bold. On the next line, type the footnote or legend text in 8-pt Times/TNR regular (italic for scientific names only) with 'Plate' or 'Fig.' set in small caps.

After adding all footnotes and legends in the same manner, remove all template instructions. Remember that ONLY placement, footnote, and legend text (no artwork or text frames) belong in the legend text file.

(Sample PLACEMENT DIRECTION above legend: **Editor to insert Plate 1 + legend on page 3**)

Table text file [Label file with ACCESSION NUMBER+'table' (e.g., **10-117table.doc**)]

First download the **TABLE** text shell from the MYCOTAXON website and follow the instructions. Place ALL table and accompanying text into this file. Set placement directions in Arial 9-pt bold ABOVE each table title (set in 9-pt Times/TNR regular (italic for scientific names only) with 'TABLE' set in small caps. (Table titles stand above, not below, tables.)

After adding all placement directions, and titles+tables+footnotes to the file, remove all template instructions. Remember that ONLY placement, title, table, and table footnote text (no artwork or text frames) belong in the table text file.

(Sample PLACEMENT DIRECTION above table title: **Editor to insert Table 1 on page 2**)

Master text file [Label file with ***senior*** author name+'_master' (e.g., **Li_master.doc**)]

For pre-submission peer and nomenclatural review, copy the text from the above files into a new MYCOTAXON **TEMPLATE.** This MASTER file contains the MYCOTAXON banner and all manuscript text including footnotes, legends, and tables. Authors may add graphics to the file intended for peer review. Graphics do not belong in the file sent to the *Nomenclature Editor,* but empty lines that approximate the location of the missing illustrations may be added to indicate the approximate length of the published paper.

Authors who do insert figures into document or PDF files for peer review may include that file in their final submission as an aid to the *Editor-in-Chief.* The *Nomenclature Editor* always copies the *Editor-in-Chief* when returning annotated master files, so authors are asked NOT to submit master text files again during final submission.

Illustration preparation & guidelines

Illustrations are best distributed throughout the paper above or facing the first important text reference or grouped to aid species comparisons. Assemble individual photos and drawings into plates so that each plate spans (reaches across) the 11-cm wide page; full page plates should measure no more than 11 × 17.5 cm.

Authors, who are to assemble illustration plates themselves, should adjust the contrast or color of individual photos BEFORE insertion into a halftone plate (see below for halftone preparation). To ensure the highest quality published illustrations, do not intermix photos and line art figures in one plate. Instead, separate a full-page plate into two files—one with line art (requiring VERY HIGH resolution) and one with photos (requiring only HIGH resolution). The *Editor-in-Chief* will combine the two 'semi-plates' into a single plate at no charge.

Do not place borders around illustration plates. Set individual photographs within plates either flush (preferred) or separated by a NARROW 1-mm white or black band. Drawings usually appear best when there is no border separating individual figures and with the elements arranged around an identifying figure number.

The *Editor-in-Chief,* who sets plates into the press proof based on author suggestions and text flow, will place legends (captions) below illustrations or at the bottom of the page *facing* full-page illustrations when there is not enough room for both plate and legend on the same page.

Line art—drawings, phylotrees, and graphs

Authors should submit digital files produced by computerized BLACK & WHITE scans of original artwork or high quality reduced photocopies. Figures that incorporate fonts or fine lines MUST have a very high resolution [**900–1200** pixels per inch (dpi) or 360–475 pixels per cm per 11-cm width]. Prepare final files for electronic submission in **JPG** (or **TIF** with LZW compression) format and in **bitmap** or **grayscale** mode [NOT in indexed color, RGB or CMYK mode]. If absolutely necessary, drawing files may be embedded as high resolution 'pictures' in MSWord, but authors must merge all numbers and annotations into the picture plate before embedding. (Image adjustments—e.g., insertion of scales, numbers, and arrows — are usually best handled in photographic software applications.) Line art plate captions (legends) should not be included with the illustration but MUST be submitted separately in the LEGEND TEXT FILE.

Halftones—grayscale photographs and drawings

"HALFTONES" are photos (sometimes called 'black & white') and drawings that show a gradation of black, white, and gray but no other colors. MYCOTAXON grants authors two halftone pages per 1–10 full text pages free of charge (so that papers with 1–10 text pages are granted 2 halftone pages, 11–20 text pages 4 halftone pages, and so on). Drawings that have been shaded with gray washes instead of stippled in black are considered halftones. There is a $20 charge for each extra halftone page.

Halftone JPG and TIF files are prepared only from digital camera 'raw' photo files or scanned from negative-based photos using a photographic application, such as ADOBE PHOTOSHOP®. They should NOT be prepared by scanning hard-copy photos printed from DIGITAL files, because that process produces unacceptable 'moiré' artifacts. Authors should first edit art files in TIF format because detail is permanently lost each time a JPG file is revised. (LZW compressed TIFS, which do not degrade, are the same size as JPGS and transmit electronically almost as well as JPGS.) TIF or JPG formatted halftones are intended to be printed without color and MUST be set in ***grayscale*** mode with high resolution [**300–600** pixels per inch (dpi) or 125–250 pixels per cm per 11-cm width] to reduce the file to 1/3 of the color mode size; grayscale compressed digital files transmit easily electronically while color images do not.

Color—photographs, tables, graphs ($475 per journal color page; $40 per special author pdf)

COLOR IN THE PRINT JOURNAL—Authors wishing to publish color in MYCOTAXON will be $475 per color plate page. (To avoid color page charges for color fonts, tables with green dividing lines, and graphs with colored bars, prepare tables with black font and lines and use patterns instead of colors to distinguish graph bars.) Color plates intended for the print journal must be set in **CMYK** color mode with high resolution [**300** pixels per inch (dpi) or 125 pixels per cm per 11-cm width]. Composition and editing should be done in TIF format but final plates may be submitted in JPG or TIF (using LZW

compression) format. Prior to final submission, authors should contact the *Editor-in-Chief* for additional information as well as preflight color art with Sheridan Press.

Color pdfs for author use—Mycotaxon charges $40 to prepare a web-friendly pdf with color photos for authors wishing to share their color plates with colleagues. Arrangements should be made with the *Editor-in-Chief* prior to final editorial review. Color pdfs are sent to authors after Mycotaxon publication.

Labeling

Title all graphic files (jpg, tif) with the first author name+accession number+plate number (e.g., norvell10-613pl2.jpg). The label itself should contain no spaces, underlines, or dots, except for the dot placed by an application directly before the file extension (e.g., change 'norvell_10-613 pl.2.jpg' to the above example by deleting the unnecessary underline, space, and dot after 'pl.').

Final notes about digital images

The *Editor-in-Chief* cannot improve the quality of a bad image, and substandard images will be rejected. Authors should submit as clear and clean an image as possible but must remember that, in science, reality supersedes beauty. Do not 'over-photoshop' or otherwise distort images. Authors should note in their 'Materials and methods' section when artifacts have been removed from images.

Always retain digital files in their original format and edit only tif-formatted copies. (Compressed jpgs lose resolution each time a file is edited; uncompressed tifs are the least damaged by editing.)

Resolution of a low-resolution file cannot be increased by simply typing in a higher dpi. Authors with low-resolution files must either photograph or scan the objects again or decrease their image to a smaller size.

Cover selection

Mycotaxon selects volume covers from among the drawings intended to illustrate papers published within each volume. Therefore, we ask that authors acknowledge artists in their acknowledgments so we know what name to place on the cover when a drawing is selected and to notify the *Editor-in-Chief* when a drawing should not be considered for cover display.

Review and submission

Manuscript identification

Accession numbers—The *Nomenclature Editor* assigns a permanent number to a manuscript immediately after receiving a master text file and expert review Email addresses from the authors. That number stays with the manuscript until publication. Permanent accession numbers (such as **10-117**) code the year and accession order (e.g., 117th manuscript received by Mycotaxon in 2010). Using accession numbers on all files and in all E-mail subject headers prevents confusion and unnecessary delay.

Submission tracking — The *Editor-in-Chief* files expert reviews into temporary folders labeled by first author + subject until the *Nomenclature Editor* assigns a formal number. Thereafter all submission materials are tracked by accession number. Submitting authors are asked to label all files following the guidelines on pp. 7–9 & 11 and to be certain to delete '_NomEd' (added by the *Nomenclature Editor*) to prevent confusion. Approved manuscripts are placed in volumes based on submission date.

Avoid publication delays!

The following may result in rejection or request for revisions.

Spelling and grammatical errors—All coauthors should proofread all text for errors before sending manuscripts out for review; grammar and spell checkers are also helpful. Non-native English-speaking writers must ask someone fluent in English to proof-read the paper before peer/nomenclatural review and final submission. Additional attention should be given to Latin diagnoses, which should be **brief.** (Diagnoses that list only key characters separating a proposed new taxon from similar taxa generally contain fewer errors. Save details for the extended English technical description.)

Italics & underline —Reserve *italics* only for scientific names. All Latin taxonomic names and diagnoses must be italicized, but common Latin terms (e.g., et al., etc.) and reference titles must be in regular font. Never underline text intended for publication.

Symbols—Generate diacritical marks and symbols (e.g., ä, ñ, μ, ×, ≡) by using special keystroke combinations or by inserting from the 'symbols' menu. When possible, select symbols from the corresponding text font; in Word insert 'μ' via the Insert > Symbol > Times pathway.

Punctuation—Do not end any heading with a full stop (period or 'dot'). Place single punctuation marks such as commas or periods in the same font style as the preceding word (e.g., commas are in italics after italicized words and bold after bold-face words. However, paired marks such as parentheses, square brackets, quotation marks, and long dashes stay in the same font style, even when preceded by or enclosing differently styled text. With the exception of the sanctioning colon (e.g., Fr. : Fr.), no space stands between a 'single' punctuation mark and the preceding text. Likewise, no space stands between a paired mark (e.g., parentheses) and the enclosed text. Finally, only one space follows a full stop at the end of a sentence.

Deactivate hyperlinks—Text files containing active hyperlinks are unacceptable and will be returned the the authors for repair.

The hyphen, en-dash, and em-dash have different uses—Do not hyphenate long words in text files to break at line end, as the hyphen (used to separate word elements) will probably appear in midline after pdf conversion. This is considered an author error requiring a charge to correct.) The longer en-dash is used (with spaces) for 'minus' in mathematical notations and (without spaces) in range expressions. The longest em-dash replaces colons in lists or is used for emphatic terms or phrases that would be — otherwise — enclosed in parentheses.

MycoBank deposit required for all new names—MycoBank is a web site that ensures that names are unique & properly written, protects a proposed name until it is published, and provides a central location for type descriptions after formal publication. Deposit a new name by logging onto MycoBank and following the instructions there. Authors should write the MycoBank number under the name of their newly proposed taxon in 8-pt font between the name and Latin diagnosis as shown on page 18 of the sample manuscript.

GenBank deposit required for all sequences—Place GenBank numbers for new taxa after MycoBank numbers in 8-pt font or include under Specimens examined as needed.

DOI numbers required for CrossRef linked references—Place DOI numbers at the end of every Literature cited reference already listed in **CrossRef.**

Peer review

Mycotaxon is unusual among scientific journals in that authors obtain their own peer reviews before submission by contacting two scientic experts in their field outside the senior author's home institution. (When uncertain whom to approach, authors may send title+abstract to the Editor-in-Chief for a list of suitable reviewers.) Although both Mycotaxon *Editor-in-Chief* and *Nomenclature Editor* review every manuscript and may request expert assistance when needed, English grammar, nomenclature, & author citations must be checked thoroughly by at least one expert. Authors thank peer reviewers in their acknowledgements and the *Editor-in-Chief* acknowledges all (including expert consultants) in the closing pages of each volume.

The corresponding author should send each expert the Reviewer guidelines & comment form and author instruction pdf and a master text file with individual jpg files (either sent separately or embedded within a preview file. Experts then return revisions to the corresponding author and E-mail their comment form to the authors and *Editor-in-Chief. (*Mycotaxon no longer accepts comment forms forwarded by authors except in special circumstances.)

Authors then revise their manuscript according to reviewer suggestions, noting on the final submission form which reviewer suggestions were not followed and why.

Nomenclatural review

Authors next E-mail a revised master text file to the Nomenclature Editor, placing 'For [First author name] Mycotaxon nomenclature review' on the message subject line. The *Nomenclature Editor* will assign the Mycotaxon accession number, check that all nomenclature follows the Botanical Code, uses standardized author citations, and advise when a manuscript is ready for final submission by sending the authors and *Editor-in-Chief* a revised file and list of corrections .

Final submission

Final submission materials are sent to the Editor-in-Chief. Materials may be ***E-mailed*** **(preferred)** or sent by ***airmail***. The following must be received from the proper individuals before final editorial review will begin.

Two expert peer reviews [Reviewers send comment forms to the *Editor-in-Chief.*]

Nomenclature review [Sent by *Nomenclature Editor* to authors and *Editor-in-Chief.*]
[NOT to include among final author submission files]

Required files [included in author's final submission and labeled appropriately]
One body text file [labeled as 'accession number'body.doc];
One legend text file [if needed, labeled as 'accession number'legend.doc];
One table text file [if needed, labeled 'accession number'table.doc];
One Mycotaxon submission form [completed, labeled as 'first author name'+ accession number'.doc]
Necessary number of Illustration jpg or tif plate files [when artwork is present]
All image files must meet Mycotaxon requirements. Large-size photos may be sent by E-mail, uploaded to an independent server for downloading by the *Editor-in-Chief,* or sent via CD. Label each with 'first author name'+accession number'pl#]

Optional preview file
pdf or document file containing footnotes, legends, tables with/without inserted artwork

Final author checklist

• Text format

— Fonts (very important) and paragraphs conform to *Mycotaxon* requirements.

— The body text file contains **no** empty paragraph lines, initial tab settings, line breaks (main title excepted), or graphics files. **No** footnotes, legends, or tables are included.

— The legend text file contains **only** footnotes & figure legends, each accompanied by instructions noting on which page to place footnote text or plate in the final manuscript.

— All tables are placed together* in one table text **file**. *('Landscape' and 'portrait' tables may be placed in separate files according to or ientation.)

— The title is in Arial 11-pt **bold** (Latin names in ***bold italics***), sentence-case, and does not end in a full stop (abbreviations excepted). Taxonomic authorities are not included.

— Manuscript author **names** are centered & in Times, 10-pt roman (regular), 'Small Caps.'

— **Addresses** are centered, in Times, 9-pt *italic,* with **E-mails** at top with hyperlinks disabled, **institutional** information in the middle, and **Street -> Country** information at bottom.

— The Abstract and Key words are fully justified with 1-cm indented margins in Times 8-pt font. '**Abstract**' and '**Key words**' are in bold and other text is in regular except for italicized *Latin names*. The key words list contains only five terms separated by commas, does not repeat words in title or abstract, and does not end with a full stop. No author citations are present.

— **ALL** text is single-spaced. Leading is 10-pt for paragraphs containing 8-pt font (set in Word by typing in '10' following the Format>Paragraph>Line spacing>Exactly pathway).

— Latin scientific names at all taxonomic levels are *italicized*.

— Author citations conform to IPNI, occur only once for each taxon, and have been checked by the Nomenclature Editor and at least one peer reviewer.

— MycoBank and GenBank numbers are included when new names are proposed.

— No commas stand between author names and publication year in text references.

— Literature cited references follow a consistent order, conform to Mycotaxon guidelines, include doi numbers, have hanging indents, and are in 8-pt Times/Times New Roman.

• Illustrations

— Graphics do not exceed 11 cm × 17.5 cm.

— Photographs or composite plates fill the entire width of the page (11 cm or 4.33 inches).

— Digital halftones are tif (lzw compression) or jpg formatted (or embedded in MSword) in grayscale mode at 300-600 dpi/4.33" width.

— Color digital photos are tif (lzw compression)/jpg formatted in CMYK mode at 300 dpi/4.33" width and accompanied by agreement to pay a $475 per color page processing fee or a $40 color PDF conversion fee.

— Line drawings, phylotrees, & graphs are in grayscale or bitmap mode at 900-1200 dpi for a 4.33" width.

— Figures submitted for scanning are mounted separately from the text on heavy stock and are clearly numbered & labeled with author name & brief title on the reverse side.

— Legends are separate from artwork.

— The corresponding author has dated backup copies of all materials submitted.

• Files received by *Editor-in-Chief* prior to final submission

— Peer review comment forms (received directly from each of two expert reviewers)

— Nomenclature review (annotated master text & comments files received directly from the Nomenclature Review Editor)

• Final submission items [below ##-### = manuscript Mycotaxon accession number]

— Final BODY TEXT FILE labeled ##-###BODY.DOC
— Final LEGEND TEXT FILE labeled ##-###LEGEND.DOC
— Final TABLE TEXT FILE labeled ##-###TABLE.DOC
— Completed MYCOTAXON SUBMISSION FORM labeled AUTHOR##-###.DOC
— (Optional: PDF, document file, or printed MANUSCRIPT displaying Mycotaxon banner, footnote, table, legend, and figures labeled ##-###PIX.DOC)

MYCOTAXON corrections policy

MYCOTAXON expects authors to submit files that are free of errors and ready to publish when they arrive on the editorial desk. All coauthors should view and approve text prior to and during submission. All must also double-check files after final editorial review to ensure return of corrected error-free files to the *Editor-in-Chief*. No fees are charged for returning corrected files before PDF conversion begins, but fees are imposed for correction of author errors after PDF conversion.

The *Editor-in-Chief* processes text and graphics files using ADOBE INDESIGN®, which distributes text evenly and displays few unsightly gaps in justified lines. The authors are then sent proof files, at which time they should note errors introduced during PDF conversion, including unacceptable shifts in text flow. MYCOTAXON corrects errors resulting from computer or editorial error free of charge but charges a MINIMUM of **$10** PER ERROR to correct author mistakes (minimum invoice fee = $**40**). Fees increase to $**60** per error for files already sent to press. [Errors present in approved text files are considered author — NOT conversion or editorial — errors.] MYCOTAXON lists, free of charge, corrections of all published errors in the Errata.

New reprint policy

Prior to publication, MYCOTAXON sends each author and co-author a print-quality PDF file that can be used by a local printer to make high quality reprints.

Still have questions?

CHECK FAQ ON OUR WEBSITE:
http://www.mycotaxon.com/about/faq.html
OR

CONTACT OUR EDITOR-IN-CHIEF:
editor@mycotaxon.com

The sample manuscript

The following pages (17–22) contain instructions and examples in text formatted as a 'typical' new species paper with Latin diagnosis, holotype information, etymology, technical descriptions, specimens examined, commentary, keys, acknowledgments, and literature cited sections following 2010 Mycotaxon requirements.

Authors must submit the peer-reviewed manuscripts as individual text files using Times/Arial fonts (i.e., 1–4 files for primary text, legends, and tables) and separate digitial illustration files formatted in according to Mycotaxon styles and requirements.

The *Editor-in-Chief* imports all approved text files into Adobe InDesign, converts fonts to Minion Pro/Myriad Pro publication fonts, imposes Mycotaxon paragraph styles, and integrates text and illustrations before converting the complete manuscript into the pdf that will be published.

Please refer to the Mycotaxon MSWord template for styles settings.

A word about the *Minion Pro* and *Myriad Pro* font families

Mycotaxon requires Times/Times New Roman and Helvetica/Arial fonts for final submission, which the *Editor-in-Chief* converts to Minion Pro and Myriad Pro prior to publication. These complementary font families closely resemble the Times/TNR and Helvetica/Arial families but offer a greater range of styles and increased legibility in the 7- to 11-pt size range.

The following illustrates the differences in appearance between author-submitted and Mycotaxon publication fonts:

Serif	*This* is an example of text displayed in **Times.** *This* is an example of text displayed in **Minion Pro.**
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Agaricales of the Outer Hebrides

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Abstract — Authors format abstract text in Times 8-pt regular or *italic.* [only 'abstract' is in bold). The Latin name *Coprinus comatus* is properly displayed in italics without author citation. Additional guidelines and suggestions for each section are provided in the appropriate sections below. Authors of 1–4 page summary papers will cite the URL (with inactive hyperlinks) to their posted annotated species lists here: http://www.mycotaxon.com/resources/weblists.html.

Key words — author guidelines, *Chrysomphalina,* mushrooms, taxnomy, no period

Introduction

This demonstration manuscript is acceptably formatted for publication in Mycotaxon. Main title, abstract, subheading, primary text, figure legend, and subordinated text formats are formatted exactly as they should be in text submitted for formal peer and editorial review and follow the requirements explained in full in the **Mycotaxon template**. Briefly introduce your subject by citing significant background observations and documenting research observations, stressing recent discoveries. The Latin name, *Coprinus comatus* (O.F. Müll.) Gray is italicized as required. Its author citation appears for the first (and only) time and conforms to author citation standards. Small caps are used to emphasize terms within paragraphs and no text is underlined.

Present necessary abbreviations and other procedural data either as a second paragraph or in a separate 'Materials & methods' section. Differentiate between generic names having the same first letter by abbreviating the less frequently cited genus with the first **two** letters of the genus name.

*Corresponding author [footnotes should not appear in final submission body text but be included in a separate legend text file]

Materials and methods

Formatting notes

This section (in 9-pt when exceeding two paragraphs) briefly summarizes basic protocols and materials, defines abbreviations, introduces features used in technical descriptions, and provides necessary references for detailed protocols. Here and elsewhere, separate individual text references by commas (Author1 2005, Author2 1864, Author3 et al. 1588), placing **no** commas between the author and first date. Semicolons are used when one author has more than one publication following the name (Author1 1006, 1984, 2001; Author2 2005; Author3 2009). Sample paragraphs follow:

Examples

Specimen collection and examination, macrochemical tests, DNA extractions, PCR amplification of the ITS1+5.8S+ITS2 rDNA region (henceforth referred to as the ITS region), restriction digests and mapping, and phenetic and cladistic analyses using NTSYS (Rohlf 1993) and Phylip (Felsenstein 1995) were conducted using protocols outlined by Aesop (1998ab, 2000).

General non-standardized color names in lower case are followed by color references in 'small caps'. Capitalized Ridgway (1912) colors are abbreviated with a slash '/' or parentheses separating modifiers of the same base color: Mikado /Mars Brown = Mikado Brown, Mars Brown; (Pale) Pinkish Cinnamon = Pale Pinkish Cinnamon, Pinkish Cinnamon. Munsell (1976) alphanumeric color ranges are enclosed in brackets: [2.5Y 6-8/1-4]. Measurements of anatomical characters were taken from tissues rehydrated in 6% aqueous KOH unless otherwise noted. Ranges enclosed in parentheses accompany mean basidiospore dimensions with standard deviations. 'L+ll/cm' refers to the number of lamellae + lamellulae per cm at pileus edge.

Herbaria abbreviations follow Holmgren et al. (1990). Geographical coordinates were obtained from maps or from the Yale Peabody Museum of Natural History GNIS database (YALE). Separate dates are not given for date-based numbered collections: LLN1920516-02 = Norvell, May 16, 1992, collection 2. Collector abbreviations include LLN (Norvell), AHS (Smith), and HDT (Thiers). Vegetation abbreviations include GASH *(Gaultheria shallon),* TSHE *(Tsuga heterophylla).*

Taxonomy

Manuscriptea optima Farmington & A. Bowmer **sp. nov.** plate 1
MycoBank 987654

A short diagnosis (3-4 lines) in Latin that cites the most important distinguishing characters is ***required*** *for valid publication of a new taxon. The italicized diagnosis (taxonomic names in regular font: e.g.,* Manuscriptea minima*) precedes the type and etymology paragraphs; all three sections have text in 8-pt Times and are fully justified with 1-cm margins*

Type: 'Mushroom Corners' (39°20'28"N 123°46'W), Jackson SF (Mendocino Co.), California, U.S.A. in needle duff under mature 2nd growth *Pinus contorta* LLN1921116-58 w HDT (**holotype**-wtu, isotypes-sfsu daom). [Holotype MUST be designated.]

Etymology: from the Latin *optimus* = superlative of *bonus ('*good')

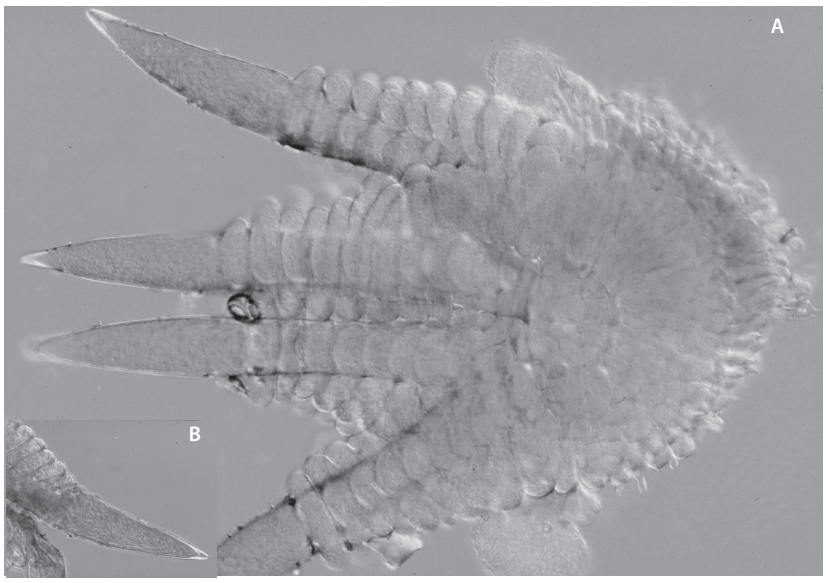

Plate 1. *Valdensia paradoxa* conidiophore (Norvell, unpub.). The author combines two grayscale files into a single plate file with 300-dpi resolution for a 4.33-inch [26 cm] width. For submission to Mycotaxon, remove the plate and submit the legend in a separate legend text file.

Basidiomes small, rigid; pilei umbonate, viscid, glabrous, cucumber-colored; young lamellae chartreuse; stipes bulbous, red. Basidiospores purple in mass, ~8 x 4 µm, limoniform, smooth, green in KOH; cheilocystidia abundant, metuloid; pileipellis with a thin yellow suprapellis composed of narrow hyphae spirally encrusted with green pigments overlying a thick blue subpellis; clamp connections absent. Tissues inert to arsenic.

Expanded description — Separate paragraphs within a technical description according to character sets. Authors may separate individual character descriptions using semi-colons or periods (be consistent!) but should end each paragraph with a full stop (period or dot). The use of one format style for all character 'names' (below in subcaps) helps readers find terms when needed.

> The three paragraphs below illustrate different character sets (i.e., macroscopical, microscopical, ecological). Additional paragraphs might cover cultural, chemical, and/or molecular attributes. Semicolons separate sample character titles (in subcaps) and associated descriptors within paragraphs. [Subcaps are preferred over **bold,** which should be used sparingly or only where required, such as in stand-alone titles & subheadings.] The first two paragraphs each represent a single, long sentence, so only the first letter stands in upper case. Dimensions (microcharacters) use en-dashes between range data and a multiplication symbol instead of Times 'x'; no space stands between range and outlier data (in parentheses) and secondary character names are shown in *italics* (here permitted). The ecology paragraph separates characters with full stops, an acceptable alternative.

Macrocharacters — pileus convex, 35 mm diam, viscid, chartreuse; context flabby; odor dusty; taste rotten; lamellae free, veined; annulus absent; stipe terete, rigid, 120 × 10–20 mm, fibrillose, brilliant blue.

Microcharacters — basidiospores 4.9–7 × 3–4(5) µm; cheilocystidia tibiiform, capitulate; pleurocystidia absent; basidia 9-spored; pileipellis a trichoderm composed of narrow hyphae 30–40 × 2-4 µm; clamp connections present at all septa.

Ecology, range, distribution — Gregarious in sandy soil under pine *(Pinus contorta)* and tan oak *(Lithocarpus densifolius)*. July. Uncommon. Known from 13 sites (36 collections) in coastal lowlands in California and Oregon.

> Additional specimen examined — **UNITED STATES. Oregon: Lane Co.,** Florence (124°5'55"W 43°58'58"N): 4.VII.1939 AHS3055 w FSipe (mich 31143 as *M. bonaria*).

Comments—A final discussion section compares related species and addresses nomenclatural or taxonomic concerns. It may comprise only a few sentences or contain several paragraphs. This section contains text references (Sisyphus 1930), which should not be included in the technical descriptive paragraphs.

Traditionally, 'Comments' are read first by those who wish to identify specimens without wading through the more densely worded technical text. Commentary text should be the most clearly written and carefully edited in the paper. Authors should compare all similar species within the genus, explain any nomenclatural inconsistencies, and provide historical or other facts that will make the taxon more interesting and memorable.

Authors should indent the first line of each succeeding paragraph and not separate the paragraphs with a space; the indent replaces the space separation.

Table 1. *Phaeocollybia* sections sensu Singer 1970, 1986*

section	cheilocystidia	basidiospore length	clamp connections
Phaeocollybia	clavate to cylindrical	>6.5 µm	absent
Subattenuatae	variable, non-capitate	>6.5 µm	present
Versicolores	acute or apically capitate	>6.5 µm	absent
Radicatae	(sub)capitate	<6.5 µm	present
Microsporae	variable; often clavate/cylindrical	<6.5 µm	absent

*adapted from Norvell (2004). This sample table (with accompanying title and footnote) was prepared in a separate table text file in Times (with 9-pt title, 8-pt subheadings (column in small caps, row in *italics*), and 7-pt entries and footnote). 7-pt is the **smallest** font size permitted in Mycotaxon.

Key to *Chrysomphalina* species of North America

The following 'American style' key (adpated from Norvell et al. 1994) presents parallel primary key choices (in 9-pt font) and sets supplementary text (in parentheses) under the species entry. Numbers after each first couplet lead refer to earlier leads — particularly helpful in longer keys.

1a. Basidiomes typically uniformly orange-colored; young pileus margin fringed by hair-like concolorous scales . . . . . ***C. aurantiaca***
(context & pellis concolorous; only yellow to rosy orange pigments present)

1b. Basidiomes typically bicolored; pileus (sub)glabrous or, if scaly, with darker scales confined to the central region **2**
(pileipellis typically darker than context; both intracellular brownish/greenish fuscous & yellow/orange pigments present)

2a (1b). Basidiomes bright greenish-yellow when young, intensifying or fading in age but never showing orange hues; tramal cells often femur-like in age; basidiospores with broadly rounded ends . . . . . ***C. grossula***

2b. Basidiomes never greenish and only with orange, pinkish, or yellow tints; tramal cells rarely femur-like; basidiospores elongated with many slightly tapered toward the apex **3**

3a (2b). Pileipellis lacking dark scales on disc . . . . . ***C. chrysophylla* var. *hoffmanii***

3b. Pileipellis with distinct dark scales on disc and inner margin **4**

4a (3b). Basidiomes with orange to orange-yellow tints; no pink to salmon tones present . . . . . ***C. chrysophylla* var. *chrysophylla***

4b. Basidiomes with pink-orange or salmon tones. . . ***C. chrysophylla* var. *salmonispora***

Acknowledgments

Colleagues, herbarium curators, technical assistance, governmental agencies owning field stations, grants and other financial support, and peer reviewers are thanked or cited here. Text hould be formatted in 9-pt Times and the paragraph is fully justified and single-spaced.

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Note: Consult the Mycotaxon template for proper formatting of the Literature cited and to learn how to obtain the required doi numbers for your references. Remember that all text references must be included in the Literature cited, and all references in this section must also be cited somewhere in the text.