MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

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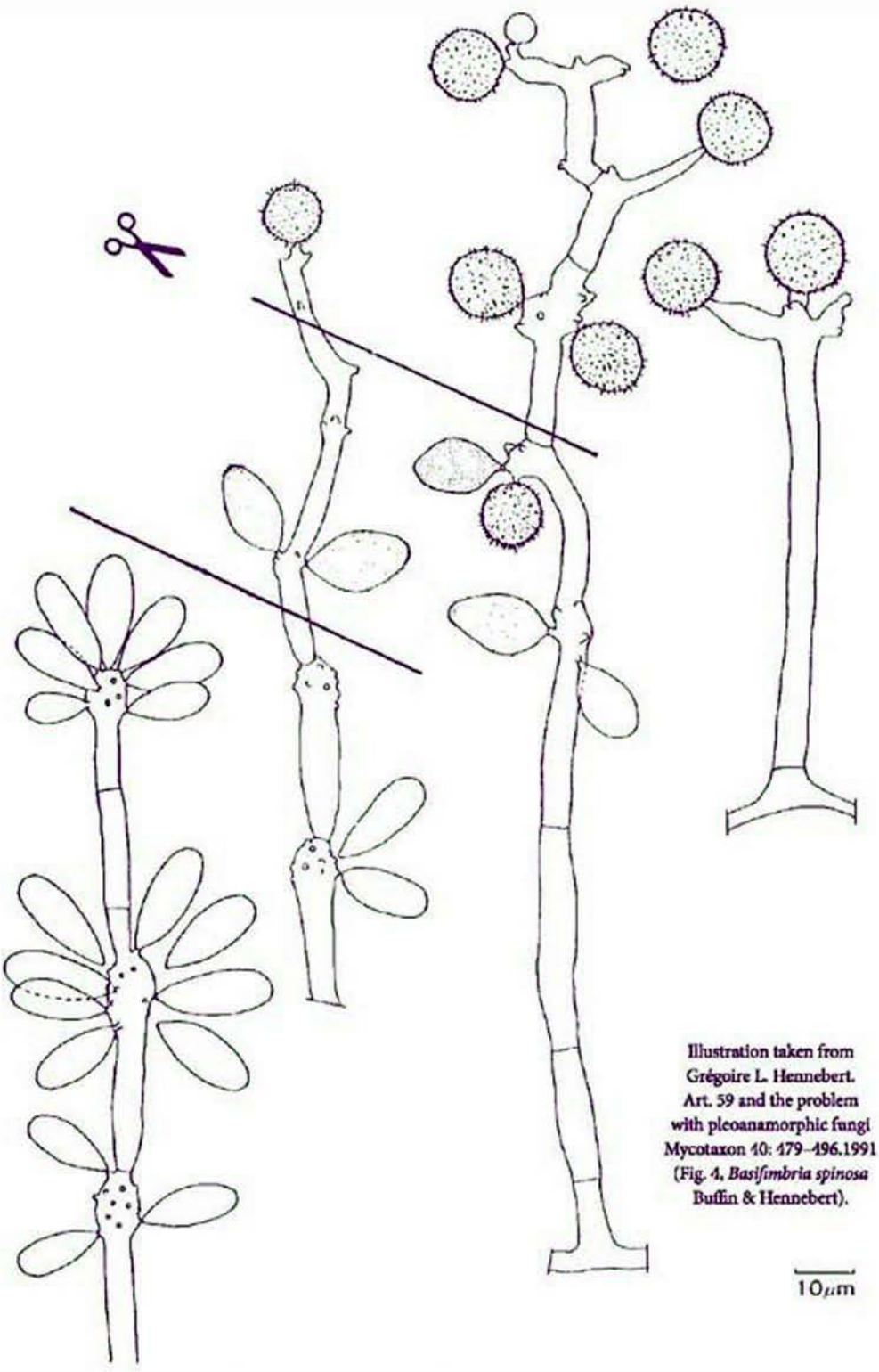

Illustration taken from Grégoire L. Hennebert. Art. 59 and the problem with pleoanamorphic fungi Mycotaxon 40: 479–496.1991 (Fig. 4, *Basifimbria spinosa* Buffin & Hennebert).

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MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

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Volume 100, pp. 1–4 *April–June 2007*

A tribute to Grégoire Laurent Hennebert and Mycotaxon's 100th volume

RICHARD P. KORF

RPK1@cornell.edu
Department of Plant Pathology, Cornell University
Ithaca, NY 14853, U.S.A.

Abstract—This 100th volume of Mycotaxon celebrates Professor Grégoire Hennebert's 32 years' involvement as a founding Co-Editor and French Language Editor. The evolution of the journal and the changes in journal technology over the years are briefly discussed, and thoughts on the future of the publication of taxonomic journals are advanced.

Key words—hard copy, online publication, registration of names, International Code of Botanical Nomenclature

The founding and evolution of Mycotaxon

The Editor-in-Chief has requested this brief history and to join with her in dedicating this 100th volume to founding Co-Editor Grégoire Hennebert for his many appreciated contributions to the journal, including 32 years as French Language Editor and 17 years as Book Review Editor. She asked me to provide the photograph (Fig. 1) showing Grégoire and me in 1973 in his laboratory at the Université Catholique de Louvain where I was on sabbatical leave, during which time we made many of our final journal decisions.

In the early 1970's Grégoire and I seriously began considering whether to start a new journal devoted solely to papers on taxonomy and nomenclature of fungi (including lichens). We were convinced that the need for rapid publication was not being met by other journals: one of our joint papers was held up for 14 months after submission. We concluded that part of the solution lay in reducing the time needed for the proofreading and correction of proofs. We designed Mycotaxon (Hennebert & Korf, 1974) to address those problems by taking advantage of publication by photo-offset lithography (as opposed to type-setting that all but a few journals were using), and by having authors send camera-ready copy with any and all errors the authors' fault, not the editors'. A second problem, the time involved in journal editors selecting and contacting reviewers, the sending back and forth of reviewers' comments, etc., we solved

in an unusual way: papers were to be reviewed *prior* to submission, and the authors were to select appropriate reviewers (Korf, 1974). Our reasoning was that authors would know—far better than we (as co-editors)—who those experts were in their area of taxonomy. We also disliked the whole concept of anonymous reviewers. Throughout my 60-year career I refused to supply any journal with an unsigned review, convinced that authors have a right to know who it is that criticizes their work. We were warned that authors would choose "easy" reviewers, but the facts are different. Authors regularly chose the very best in the field to act as their reviewers; some wrote us enthusiastic letters to thank us for this process, since they would not have dared to approach such eminent people had we not required it, and some then reported to us that years of close collaboration with these experts ensued.

When we began the journal, the typewriter was still the major tool for authors. By that time the development of the IBM Selectric® typewriter with changeable font "golf" balls allowed authors to prepare quite attractive manuscripts using a variety of typefaces including italic typestyles instead of underlining for Latin names. And, of course, the development of computer technology some years later resulted in far more easily produced author-prepared papers. Throughout my editorship (1974–1991, volumes 1–40) and those of Jean Boise Cargill (1991–1998, volumes 41–67), and Pavel Lizon (1998–2003, volumes 68–88), authors continued to submit camera-ready copy. Papers continued to vary from each other greatly in formatting, choices of typeface, literature citation, etc., though consistent within each paper. Our current Editor-in-Chief, Lorelei L. Norvell (2004–ff, volumes 89–ff), prompted by suggestions from our Editorial Advisory Board, opted for consistency in format and typefaces throughout, and eventually implemented submission of manuscripts electronically only. This is fully consistent with the changes throughout the publication industry: typesetting is no longer the rule for books or journals—these are now nearly all produced by photo-offset lithography and on computers. There is no doubt that the result renders a far more professional appearance. Changing to this new technology has resulted in a temporary loss of our goal of expediting publication, but we are confident we will again be able to make that claim by 2008.

Some thoughts on the future of taxonomic publication

Libraries face ever-increasing costs for journals, fuelled by developments in journals being taken over by profit-based publication firms that also price and package journals out of the reach of individuals. The development of online versions of print journals has completely changed the use of many university libraries, where students now rarely inhabit the stacks, but sit at computers and read their current journal articles online. For a field like ours, taxonomy, we

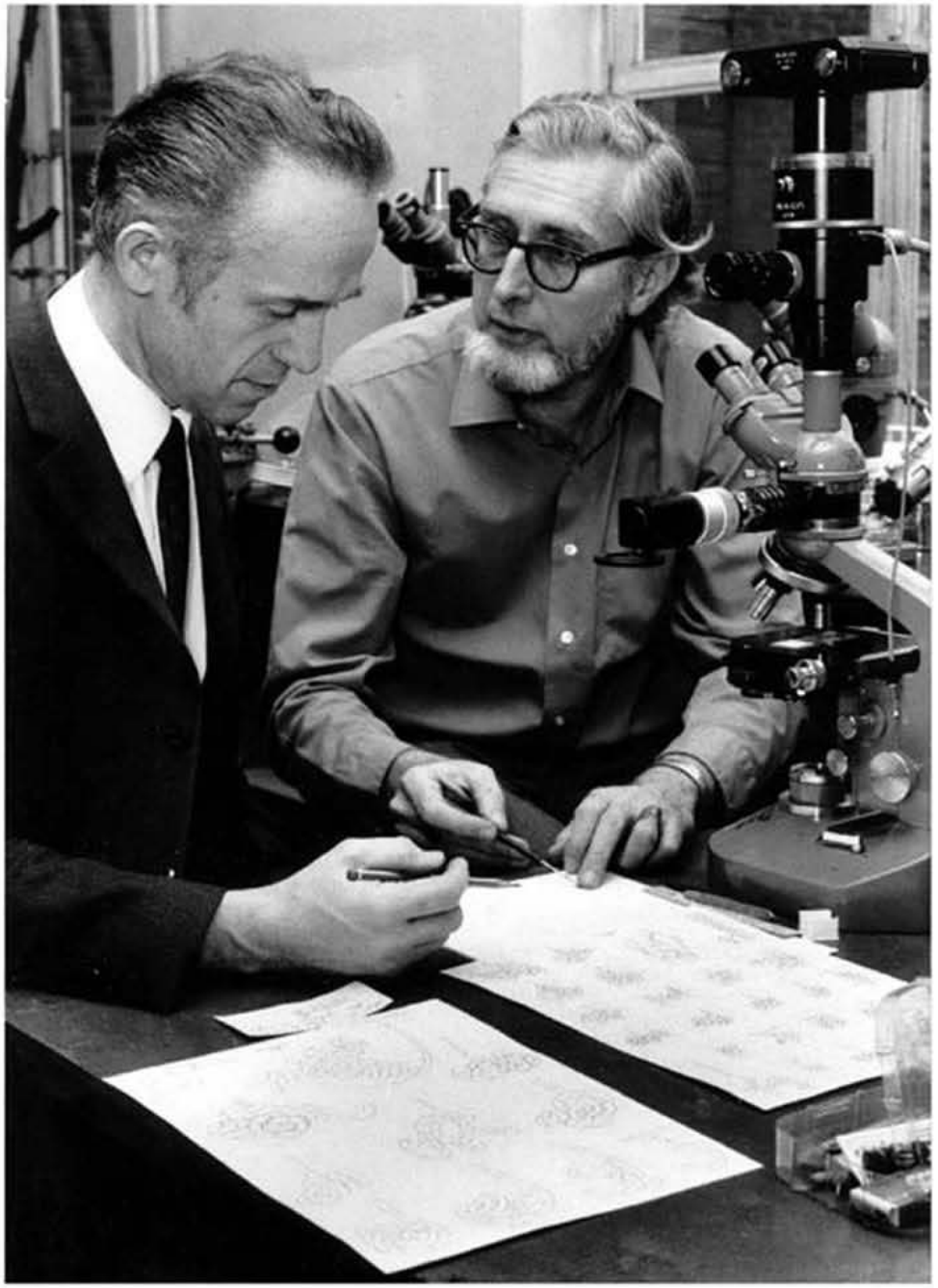

Fig. 1. Professors Grégoire L. Hennebert and Richard P. Korf at their workbench at the Université Catholique de Louvain in Heverlee, Belgium in 1973. The line drawings they are discussing are those of an anamorphic fungus, drawn by Professor Hennebert.

need libraries not only for the last few years' work, but need to access hundreds of years of literature that exists only in hard copy in libraries. A small but truly

important dent in this backlog of book and journal literature is now available to mycologists through a greatly appreciated source, Cyberliber, subtitled "an electronic library for mycology," at <www.cybertruffle.org.uk/cyberliber/index.htm>, which is in the process of making all back volumes of Mycotaxon and many other journals and valuable reference books available online.

That next technological innovation, the internet, brought still more important changes and challenges. What is the future of online journals, or more precisely, online journals that deal with taxonomy? The current International Code of Botanical Nomenclature (ICBN) does not accept online or CD publication of new names and combinations as valid. At least a few printed copies must be provided to libraries to meet its requirements. To validate publication of a major taxonomic book on fungi available only on CDs the workers at CABI printed out a few copies for library deposit to circumvent the ICBN restriction. Some new online-only journals also resort to printing out a few copies and depositing them to meet those perhaps archaic rules. A recent paper making the case for online publication of new biological names (Knapp & al. 2007) is worth consulting. Surely the next International Botanical Congress, where changes in the ICBN are approved, must act on this matter, and must attempt to resolve the ongoing debate on registration of the names of new taxa and combinations.

More to my point is: can journals like Mycotaxon survive as print-only? Economics comes sharply into play. These days many journals, particularly those printed abroad, can offer color illustrations at low or no cost. Mycotaxon cannot compete when it costs $475 to produce a color plate, which we have to pass on to the authors. Look instead at online-only journals: they can provide authors an almost limitless number of beautiful color images at no cost. Some journals with both hard copy and online versions now print the hard copies with black and white halftones but allow the online versions to be in color. My belief is that the availability of free color images in online journals will dictate the choice of journal submissions for future generations of taxonomists. Our journal has a distinguished Editorial Advisory Board. We shall look to them to see whether Mycotaxon can evolve further and survive in this new world of publication.

The first hundred volumes has been a grand voyage. *Merci beaucoup, mon cher ami, Grégoire!*

Literature cited

Hennebert GL, Korf RP. 1974. Mycotaxon, a new international journal on taxonomy and nomenclature of fungi and lichens. Mycotaxon 1: 1–2.

Knapp S, Polaszek A, Watson M. 2007. Spreading the word. Nature 446(15): 261–262.

Korf RP. 1974. Instructions to authors for preparing camera-ready manuscripts for Mycotaxon. Mycotaxon 1: 3–12.

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South American polypores: first annotated checklist from Argentinean Yungas

GERARDO L. ROBLEDO[1] & MARIO RAJCHENBERG[2]

[1]*gerardorobledo@ecosistemasarg.org.ar*
Instituto Multidisciplinario de Biología Vegetal – CONICET
Universidad Nacional de Córdoba, C.C. 495, 5000 Córdoba, Córdoba, Argentina

[2]*mrajchenberg@ciefap.org.ar*
Centro Forestal CIEFAP
C.C. 14, 9200 Esquel, Chubut, Argentina

Abstract — A preliminary checklist of the polypore mycota of "Yungas", subtropical mountain forests of northwestern Argentina, is presented. An intensive search of records in literature was done, and polypore exsiccatae from that phytogeographic province kept at the main Argentinean herbaria were studied. A total of 850 specimens were revised and 111 species were determined. *Phellinus laevigatus* and *Skeletocutis stellae* are recorded for the first time in South America; 8 species are new records for Argentina and 31 new records for the region. The new combination *Dichomitus hexagonoides* is proposed. The complete checklist is available on:
http://www.mycotaxon.com/resources/weblists.html.

Key words — fungal diversity, wood decay fungi, neotropic montane forests

Introduction

Yungas ecosystem

A system of tropical and subtropical cloud montane forests is developed on the oriental slope along the Andes in South America. This system, called Andean Yungas Forests, is mainly defined by its occurrence on the slopes in an altitudinal range where the weather is characterized by a persistent or seasonal fog and cloud cover (Brown et al. 2005).

Andean Yungas Forests have their southern limit in NW Argentina where they are called Yungas and also known as "Selva Tucumano-Boliviana" or "Selva Tucumano-Oranense". Biogeographically, Argentinean Yungas are in the Andean corridor and constitute practically the southeast expression of the Amazonic Domain (Cabrera 1994). About 50% of Argentina's biodiversity can be found in this ecosystem (Brown et al. 2005). Tree diversity is high and preliminary estimations include more than 230 tree species with particular

elements of Holarctic (*Alnus*, *Berberis*, *Juglans*, *Sambucus*), Gondwanic (*Podocarpus*, *Escallonia*, *Weinmannia*), Pantropical (*Eugenia*, *Ocotea*) and Neotropical (*Myrcianthes*) origins (Grau & Brown 2000, Brown et al. 2005).

Argentinean Yungas are characterized by a high altitudinal gradient characterized by different environmental conditions such as periods of drought, high temperatures, high humidity levels, frosts and snow in winter, a fact that reflects a particular floristic composition. As result of the environmental gradient, three main forest types can be distinguished (Brown et al. 2005), namely: premontane lowland forests (400-700 m asl); lower montane forests (700-1500 m asl); and upper, temperate montane forests (1500-2500 m asl).

Argentinean Yungas have been under strong anthropogenic pressure for many decades (Grau & Brown 2000). In the meantime, the biodiversity of Argentinean Yungas is threatened by global climate changes and human activity such as agricultural frontier expansion, intense logging, and oil and gas prospecting (Grau & Brown 2000). These activities cause a variation in occurrence and abundance of woody substrates, thus possibly producing direct effects on the populations and communities of wood decomposers, as has been shown in forests of the Northern Hemisphere (Sippola & Renvall 1999). Despite the high endemic value of plants of Argentinean Yungas (Zuloaga et al. 1999), important ecological groups as wood-rotting fungi have not yet been surveyed.

Mycological knowledge state of Yungas

The heterogeneity and diversity of woody substrates of Argentinean Yungas forests suggest a rich wood-decaying fungal diversity and a complex community structure, with taxonomic novelties, including taxa awaiting to be described (Robledo et al. 2003). In the case of polypores, the study of their diversity in Argentina has been concentrated in: the subtropical rainforests and gallery forests of E and NE in the so-called (Argentinean) Mesopotamia and the capital city surrounding areas, Buenos Aires (Popoff 2000 and references therein), the humid and subxerophytic Chaco forests of north central Argentina and southern Paraguay (Popoff 2000), and the *Nothofagus*-dominated forests of Southern Argentina (Rajchenberg 2006). Several endemic and cosmopolitan taxa have been described recently from the particular *Polylepis* (*Rosaceae*) forests of central Argentina reviewed in Robledo et al. (2006). But the research undertaken in NW Argentina has been more sporadic. Spegazzini (1919) made the first studies and deposited collections in LPS, and during the following 80 years polypore studies in this region have been restricted to field trips headed by the mycologists Rolf Singer and Jorge E. Wright. Their collections are kept mainly at BAFC, LIL and LPS. Several works published in the last 25 years have dealt with specific polypore taxa and genera, or with particular substrates

(Bazzalo & Wright 1982, Gottlieb et al. 1998, 2002; Rajchenberg & Bianchinotti 1991, Rajchenberg 1982, 1985; Robledo et al. 2003, Ryvarden et al. 1982, Silveira & Wright 2005, Urcelay & Robledo 2004, Wright 1966, 1976) but, as yet, there is no comprehensive study on the polypores of that area.

The aim of this study was to establish a baseline of knowledge of polypore diversity in Argentinean Yungas, through the construction of an annotated checklist.

Material and methods

An intensive search of fungal records in literature was done. When possible we updated and/or corroborated the records (mainly those of Spegazzini) through the study of original specimens. Also, we revised all collections deposited in the herbaria CORD, LPS, LIL, CTES, and BAFC. Type and reference materials deposited in international herbaria were also checked. Herbarium acronyms are from Holmgren et al. (1990). Morphological features of basidiocarps were observed. Microscopic examinations and measurements were made from freehand sections mounted in 3-5% KOH plus 1% phloxine and in Melzer's reagent.

Results

We checked, studied, and/or revised a total of 850 collections. Together with the literature search we established the presence of **111** species. The current annotated checklist for the polypore species from Argentinean Yungas can be downloaded from http://www.mycotaxon.com/resources/weblists.html.

Masuka & Ryvarden (1999) have shown that the tropical genus *Megasporoporia* Ryvarden & J.E. Wright does not differ from the temperate *Dichomitus* D.A. Reid sufficiently enough to merit separate status. Therefore, we propose here the following new combination:

Dichomitus hexagonoides (Speg.) Robledo & Rajchenb. **comb. nov.**
MycoBank # MB10615

Bas.: Poria hexagonoides Speg., An. Mus. Nac. Buenos Aires 6: 170, 1899 (LPS!).
≡ *Megasporoporia hexagonoides* (Speg.) J.E. Wright & Rajchenb., Mycotaxon 16: 176, 1982.

A 37 % (41 out of 111) of the species constitute novelties in distribution. The most interesting ones are the new records for South America of ***Phellinus laevigatus*** (Fr.) Bourdot & Galzin and ***Skeletocutis stellae*** (Pilát) Jean Keller. These species are well known in the North Hemisphere, viz., North America (Gilbertson & Ryvarden 1987), Europe (Ryvarden & Gilbertson 1994) and Asia (Núñez & Ryvarden 2000, 2001). No differences were observed with reference materials.

Eight rare species constitute new records for Argentina: ***Amauroderma macrosporum*** J.S. Furtado, ***Amylosporus campbellii*** (Berk.) Ryvarden,

Fomitopsis meliae (Underw.) Gilb., ***Phellinus johnsonianus*** (Murrill) Ryvarden, ***Phellinus shaferi*** (Murrill) Ryvarden, ***Phylloporia capucina*** (Mont.) Ryvarden, ***Polyporus biskeletalis*** Corner and ***Skeletocutis nivea*** (Jungh.) Jean Keller. All these taxa are known from other neotropical areas of South America.

Finally, 31 species are new records for the region, and a **Nomina incerta** of 25 names published by Spegazzini that require re-evaluation was established. Some combinations were not traced, representative materials were not found at the herbaria and there is no mention regarding their placement. In other cases the herbarium materials could not be identified because they were sterile or deteriorated.

Acknowledgements

Authors are grateful to the Curators of BAFC, CTES, LIL and LPS for the loan of materials under their keeping. Dr O. Popoff (CTES) is kindly acknowledged for his hospitality during the visit to his institution. Dr Leif Ryvarden and Dr Julieta Carranza are kindly acknowledged for their valuable suggestions and Dr S. Pennycook for his detailed review of nomencaltural problems. GLR is Fellow and MR Researcher of CONICET (National Research Council of Argentina). Research funded through grant CONICET-PIP 6195/05.

Literature cited

Bazzalo ME, Wright JE. 1982. Survey of the Argentine species of the *Ganoderma lucidum* complex. Mycotaxon 16: 293–325.

Brown AD, Pacheco S, Lomáscolo T, Malizia L. 2005 Ecorregión Yungas: Situación ambiental en los Bosques andinos Yungueños. In: Situación Ambiental Argentina 2005 (eds. A. Brown, U. Martinez Ortiz, M. Acerbi and J. Corcuera). Fundación Vida Silvestre Argentina, Argentina: 53–72.

Cabrera AL. 1994. Regiones Fitogeograficas Argentinas. Enciclopedia Argentina de Agricultura y Jardinería. Tomo II. Editorial ACME S.A.C.I., Buenos Aires.

Gilbertson RL, Ryvarden L. 1987. North American Polypores Vol. 2. Fungiflora, Oslo.

Gottlieb AM, Saidman B, Wright JE. 1998. Isoenzymes of *Ganoderma* species from southern South America. Mycological Research 102: 415–426.

Gottlieb AM, Wright JE, Moncalvo J. 2002. *Inonotus* s.l. in Argentina-morphology, cultural characters and molecular analyses. Mycological Progress 1: 299–313.

Grau A, Brown A. 2000. Development threats to biodiversity and opportunities for conservation in the Muntain Ranges of the Upper Bermejo River Basin, NW Argentina and SW Bolivia. Ambio 29: 445–450.

Holmgren P, Holmgren NL, Barnett LC. 1990. Index herbariorum. Part I: The herbaria of the world. New York Botanical Garden, New York: 1–693.

Masuka AJ, Ryvarden L. 1999. *Dichomitus* in Africa. Mycological Research 103: 1126–1130.

Núñez M, Ryvarden L. 2000. East Asian polypores 1. *Ganodermataceae* and *Hymenochaetaceae*. Synopsis fungorum 13: 1–168.

Núñez M, Ryvarden L. 2001. East Asian polypores 2. *Polyporaceae* s. lato. Synopsis fungorum 14: 170–522.

Popoff O. 2000. Novedades sobre "Corticioides" y "Políporos" (*Basidiomycetes*) xilófilos del nordeste argentino y Paraguay. Tesis de Doctorado. Universidad Nacional de Córdoba, Argentina.

Rajchenberg M. 1982. El género *Coriolus* (*Polyporaceae*) en la República Argentina. Boletín de la Sociedad Argentina de Botánica 21: 17–57.

Rajchenberg M. 1985. On *Trametes aethalodes* and other species of *Daedalea* (*Polyporaceae*). Canadian Journal of Botany 64: 2130–2135.

Rajchenberg M. 2006. Los Políporos (*Basidiomycetes*) de los bosques Andino Patagónicos de Argentina. Bibliotheca Mycologica 201: 1–300.

Rajchenberg M, Bianchinotti MV. 1991. *Trametes fumoso-avellanea* (*Aphyllophorales, Basidiomycetes*): a taxonomic study. Nordic Journal of Botany 11: 225–230.

Robledo G, Urcelay C, Rajchenberg M, Domínguez L. 2003. Políporos (*Aphyllophorales, Basidiomycota*) parásitos y saprófitos de *Alnus acuminata* en el noroeste argentino. Boletín de la Sociedad Argentina de Botánica 38: 207–224.

Robledo G, Urcelay C, Domínguez L, Rajchenberg M. 2006. Taxonomy, ecology and biogeography of polypores (Basidiomycetes) from Argentinian *Polylepis* woodlands. Canadian Journal of Botany 84: in press.

Ryvarden L, Gilbertson RL. 1994. European Polypores Vol. 2. Fungiflora, Oslo.

Ryvarden L, Wright JE, Rajchenberg M. 1982. *Megasporoporia*, a new genus of resupinate Polypores. Mycotaxon 16: 172–182.

Silveira RM, Wright JE. 2005. The taxonomy of *Echinochaete* and *Polyporus* s. str. in southern South America. Mycotaxon 93: 1–59.

Sippola A, Renvall P. 1999. Wood-decomposing fungi and seed-tree cutting: A 40-year perspective. Forest Ecology and Management 115: 183–201.

Spegazzini C. 1919. Los Hongos de Tucumán. 1° reunión Nacional de la Sociedad Argentina de Ciencias Naturales 1916, 254–274.

Urcelay C, Robledo G. 2004. Community structure of polypores (Basidiomycota) in Andean alder wood in Argentina: Functional groups among wood-decay fungi? Austral Ecology 29: 471–476.

Wright JE. 1966. The genus *Phaeotrametes*. Mycologia 58: 529–540.

Wright JE. 1976. *Loweporus*, a new genus of pore fungi. Memoirs of the New York Botanical Garden 28: 225–231.

Zuloaga F, Morrone O, Rodríguez D. 1999. Análisis de la biodiversidad en plantas vasculares de la Argentina. Kurtziana 27: 17–167.

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Volume 100, pp. 11–20 *April–June 2007*

Phylogenetic relationships and nomenclature of *Bremiella sphaerosperma* (*Chromista, Peronosporales*)

HERMANN VOGLMAYR[1] & MARCO THINES[2]

hermann.voglmayr@univie.ac.at
[1] *Department of Systematic and Evolutionary Botany, University of Vienna Rennweg 14, A-1030 Vienna, Austria*

thines@uni-hohenheim.de
[2] *Institute of Botany, University of Hohenheim Garbenstrasse 30, D-70599 Stuttgart, Germany*

Abstract—Molecular phylogenetic analyses using D1–3 and D7–8 nrLSU rDNA sequence data clearly show that *Bremiella sphaerosperma* is embedded within *Plasmopara* sensu stricto. Therefore, it is transferred to the genus *Plasmopara*; for nomenclatural reasons, we propose the new name *Plasmopara constantinescui*. Despite its distinct morphology, maximum parsimony and maximum likelihood analyses support a sister group relationship to *Plasmopara obducens*, the second downy mildew species parasitic of *Impatiens* spp. Both species were investigated and documented with scanning electron microscopy.

Key words—phylogeny, taxonomy, large subunit ribosomal DNA

Introduction

The genus *Bremiella* was described by Wilson (1914) for the North American *Peronospora megasperma* Berl. [=*Plasmopara megasperma*], a parasite of *Viola rafinesquii* Greene (=*Viola bicolor* Pursh) (*Violaceae*). The characters delimiting *Bremiella* from *Plasmopara* were considered to be dichotomous (vs. monopodial in *Plasmopara*) branching of the sporangiophore and pronounced terminal swellings of the sporangiophore tips (Wilson 1914, Constantinescu 1979, 1991). For a long time, *Bremiella* was considered to be monotypic, until Constantinescu (1979) transferred *Plasmopara baudysii*, a parasite of *Berula erecta* (Huds.) Coville (*Apiaceae*), to *Bremiella*. Subsequently, Tao & Quin (1982) placed three additional species parasitizing asteraceous hosts into *Bremiella* (*B. artemisiae-annuae* (L. Ling & M.C. Tai) J.F. Tao on *Artemisia annua* L., *B. chrysanthemi-coronarii* (Sawada) J.F. Tao on *Chrysanthemum coronarium* L., and *B. multiformis* J.F. Tao & Y. Qin on *Chrysanthemum coronarium* L., *Crossostephium artemisioides*

Less. and *Artemisia annua*); however, after thorough morphological studies the species parasitizing *Asteraceae* were excluded from *Bremiella* and transferred to the genus *Paraperonospora* by Constantinescu (1989). Tao & Quin (1985) described *Bremiella oenanthes* J.F. Tao & Y. Qin from *Oenanthe* (*Apiaceae*), which, however, according to Constantinescu (1991) is morphologically indistinguishable from *Bremiella baudysii* (Skalický) Constant. & Negrean. At last, Constantinescu (1991) described a new species, *Bremiella sphaerosperma*, from *Impatiens* (*Balsaminaceae*) in eastern Russia and northeastern N-America. *Bremiella sphaerosperma* was shown to be morphologically and ecologically clearly distinct from *Plasmopara obducens*, a common, widely distributed parasite of several species of *Impatiens* in the Northern Hemisphere. Most of its morphological features favoured the inclusion in the genus *Bremiella*. However, already Constantinescu (1991) noted that *Bremiella sphaerosperma* shows some differences to *B. megasperma* and *B. baudysii* and that, after addition of *B. sphaerosperma*, the genus *Bremiella* became rather heterogeneous.

In recent molecular phylogenetic analyses of representative samples of downy mildews (including *Bremiella megasperma* and *B. baudysii*), using partial sequences of the large subunit of the nuclear ribosomal DNA (nrLSU rDNA), the species of *Bremiella* turned out to be polyphyletic but all embedded within the genus *Plasmopara* (Riethmüller et al. 2002, Göker et al. 2003, Voglmayr et al. 2004). Polyphyly of *Bremiella* within *Plasmopara* was also corroborated in a recent multigene analysis (Göker et al. 2007). In addition, morphological investigations of *B. megasperma*, the generic type, and *B. baudysii* showed that sporangiophore morphology may be rather interpreted as monopodial than strictly dichotomous. Therefore, there was little reason to maintain the genus *Bremiella*, which was consequently sunk into synonymy of *Plasmopara* (Riethmüller et al. 2002). As both *B. megasperma* and *B. baudysii* had previously been combined into *Plasmopara*, no formal nomenclatural changes were necessary. However, as a consequence of synonymizing the type species of *Bremiella* with *Plasmopara*, the third accepted species, *Bremiella sphaerosperma*, became an orphaned species with unclear generic attribution. Lack of recently collected material suitable for DNA investigations precluded statements on phylogenetic relationships of *B. sphaerosperma*, and nomenclatural transfer was consequently delayed.

During a collecting trip to the eastern USA in spring 2003, two fresh collections of *B. sphaerosperma* were made by the first author. This offered the opportunity to investigate *B. sphaerosperma* in detail and to clarify its generic attribution. As a result, both molecular and SEM data were collected, which are presented in the current publication.

Materials and methods

Specimens examined—***Bremiella sphaerosperma***: USA, Virginia, Wythe Co., N of Wytheville, Jefferson Natl. Forest, Stoney Fork Campground, moist mixed deciduous forest, on *Impatiens capensis* Meerb., 26 May 2003, Hermann Voglmayr H.V.-PA16 (WU). - South Carolina, Oconee Co., Mountain Rest, at the SC 28 near the border to Georgia, damp ditch in mixed deciduous forest, on *Impatiens capensis*, 19 May 2003, Hermann Voglmayr H.V.-PA4 (WU).

Plasmopara obducens: USA, Tennessee, Knox Co., Knoxville, Third Creek Park, on *Impatiens capensis*, 5 April 2000, Hermann Voglmayr H.V.-5.4.P.O.1 (WU). - Knoxville, Woodlot of Agricultural Sciences of the University of Tennessee (UTK), on *Impatiens capensis*, 5 April 2000, Hermann Voglmayr H.V.-5.4.P.O.2 (WU). - Austria, Oberösterreich, Distr. Grieskirchen, Comm. Natternbach, swamp forest SW Haibach, on *Impatiens noli-tangere* L., 24 May 1999, Hermann Voglmayr P-H.V.207 (WU). - Distr. Schärding, Comm. Kopfing, moist ravine forest ESE Grub, on *Impatiens noli-tangere*, 25 April 2000, Hermann Voglmayr P-H.V.307 (WU). - Germany, Baden-Württemberg, Distr. Göppingen, Comm. Gruibingen, on *Impatiens noli-tangere*, 6 May 2005, Marco Thines (HOH). - China, Yunnan, Kunming, Yunnan Agricultural University, on *Impatiens balsamina* L., 10 September 2004, Marco Thines (HOH).

Microscopy

For light microscopical (LM) studies slides were prepared in anhydrous lactic acid and/or water. For scanning electron microscopy (SEM) the samples were dried over silica gel for 24h, mounted on aluminium stubs, sputtered with an alloy of gold and palladium (80:20), and examined using a Zeiss DSM940 microscope at 5 kV at 8 mm distance to the object.

DNA-extraction, PCR and sequencing

The DNA extraction, PCR, cycle sequencing and sequencing of the nuclear large subunit (nrLSU) D1–3 and D7–8 regions are described in Göker et al. (2003). GenBank accession numbers for the sequences obtained are listed in Table 1.

Data analysis

For the phylogenetic analyses, the sequences of *Plasmopara obducens* and *Bremiella sphaerosperma* obtained in the present study were added to a representative taxon sample of *Peronosporaceae*. For this, the D1–3,7–8 nrLSU rDNA sequence alignment of Göker et al. (2003) deposited at Treebase (www.treebase.org; M1589.nx) was used as basis (Table 1). Due to the lack of large indels, it was easily possible to manually align the sequences of the present study to the sequence alignment. 2177 characters of the resulting partial nrLSU alignment were included in the subsequent phylogenetic analyses. *Phytophthora arecae* and *P. litchii* were selected as outgroup species.

Maximum parsimony (MP) analysis of the sequence data was performed with PAUP* (version 4.0 b10; Swofford 2002), using 1000 replicates of heuristic search with random addition of sequences and subsequent TBR branch swapping (MULTREES option in effect, steepest descent option not in effect). All molecular characters were unordered and given equal weight; gaps were treated as missing data. Bootstrap analysis with 1000 replicates was performed in the same way, but using 10 rounds of random sequence addition and subsequent branch swapping during each bootstrap replicate.

For maximum likelihood (ML) analyses, first the appropriate model of sequence substitution was selected using Modeltest 3.6 (Posada & Crandall 1998); the model selected by the Akaike Information Criterion (AIC) was then implemented in the further analyses (Posada & Buckley 2004). Maximum likelihood analysis was performed with the fast likelihood software PhyML 2.4.4 (Guindon & Gascuel 2003), starting with a BioNJ tree (Gascuel 1997). Using the same program, a maximum likelihood bootstrap analysis was performed with 500 bootstrap replicates.

Table 1. Taxa and GenBank accession numbers of sequences used for phylogenetic reconstruction; those with collection numbers given in brackets and marked with an asterisk (*) were obtained during the present study, the others were taken from Göker et al. (2003).

Taxon (collection number)	GenBank accession numbers	
	D1–D3	D7–D8
Basidiophora entospora Roze & Cornu	AY035513	AY273990
Bremia lactucae Regel	AY035507	AY273984
Bremiella sphaerosperma Constant. (H.V.-PA4)	EF196868*	EF196871*
Bremiella sphaerosperma (H.V.-PA16)	EF196867*	EF196870*
Hyaloperonospora brassicae (Gäum.) Göker et al.	AY035503	AY273974
Hyaloperonospora erophilae (Gäum.) Göker et al.	AY271998	AY273972
Hyaloperonospora lunariae (Gäum.) Constant.	AY271997	AY273970
Hyaloperonospora parasitica (Pers.) Constant.	AY271996	AY273969
Paraperonospora leptosperma (de Bary) Constant.	AY035515	AY273989
Peronospora aestivalis Syd.	AY035482	AY273948
Peronospora alpicola Gäum.	AY271990	AY273953
Peronospora boni-henrici Gäum.	AY035475	AY273952
Peronospora calotheca de Bary	AY035483	AY273960
Peronospora dentariae Rabenh.	AY272000	AY273976
Peronospora rumicis Corda	AY035476	AY273951
Peronospora trifolii-repentis Syd.	AY271988	AY273945
Peronospora trivialis Gäum.	AY035471	AY273950
Phytophthora arecae (L.C. Coleman) Pethybr.	AY035530	AY273992
Phytophthora litchii (C.C. Chen ex W.H. Ko et al.) Voglmayr et al.	AY035531	AY273993
Plasmopara baudysii Skalický	AY035517	AY273985
Plasmopara densa (Rabenh.) J. Schröt.	AY035525	AY273983
Plasmopara megasperma (Berl.) Berl.	AY035516	AY273981
Plasmopara nivea (Unger) J. Schröt.	AY119604	AY273982
Plasmopara obducens (J. Schröt.) J. Schröt.	AY035522	AY273980
Plasmopara obducens (P-H.V.207)	EF196869*	EF196872*
Plasmopara pimpinellae Trevis. & O. Săvul.	AY035519	AY273988
Plasmopara pusilla (de Bary) J. Schröt.	AY035521	AY273979
Plasmopara viticola (Berk. & M.A. Curtis) Berl. & De Toni	AY035524	AY273978
Plasmoverna pygmaea (Unger) Constant. et al.	AY119605	AY273986
Pseudoperonospora humuli (Miyabe & Takah.) G.W. Wilson	AY035496	AY273965
Pseudoperonospora urticae (Lib.) E.S. Salmon & Ware	AY035497	AY273966

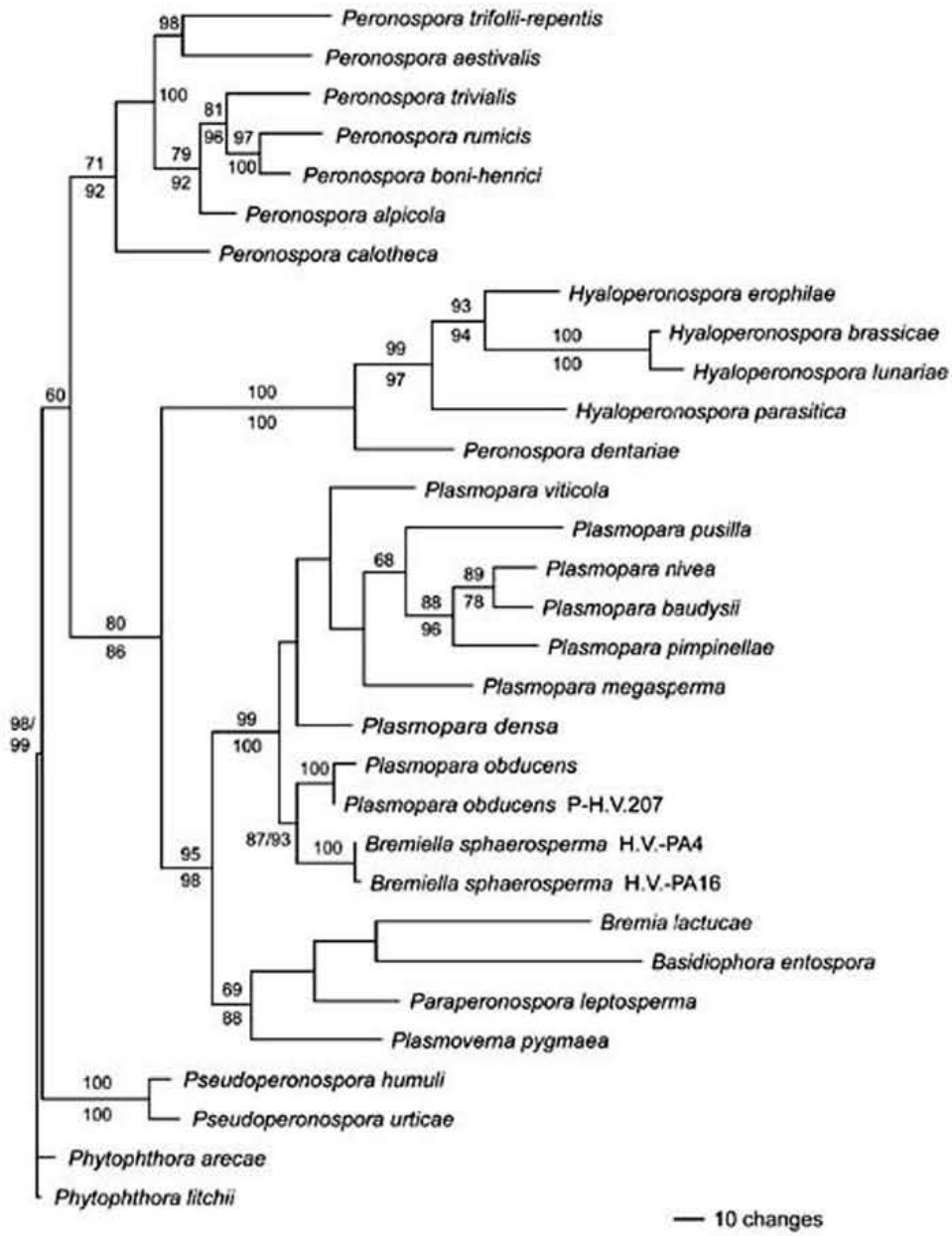

Figure 1. Most parsimonious tree revealed in a heuristic search (1000 replicates with random addition of sequences, TBR branch swapping) of the D1–3,7–8 nrLSU rDNA sequence alignment; numbers above branches/first number represent MP bootstrap values above 60% (1000 replicates, with 10 rounds of random sequence addition and subsequent branch swapping during each bootstrap replicate); below branches/second number ML bootstrap values above 70% (500 replicates using PhyML with GTR+I+G as substitution model).

Results

Molecular phylogeny

The result of the MP analysis is shown in Fig. 1. Of the 2177 characters, 333 were parsimony-informative, and one MP tree of score 1209 was obtained. For the ML analysis, the general time-reversible model was selected, additionally assuming a proportion of invariant sites with gamma-distributed substitution rates of the remaining sites (GTR+I+G; see Swofford et al. 1996). ML analysis revealed a tree largely compatible with the MP analysis except for a slightly different position of *Plasmopara densa* and *Basidiophora entospora* (tree not shown). Inclusion of *Bremiella sphaerosperma* within *Plasmopara* sensu stricto is highly supported in both ML and MP bootstrap analyses (Fig. 1); sister group relationship of *Bremiella sphaerosperma* and *Plasmopara obducens* is highly supported.

LM

Light microscopical investigations fully confirmed the results of the detailed investigations of Constantinescu (1991). Therefore, there is no need to repeat LM descriptions and illustrations here.

SEM

Sporangiophores of *Plasmopara obducens* are collapsed on herbarized material (Fig. 2A). Also the ultimate branchlets are usually collapsed, revealing an annulus at the slightly broadened tip (Fig. 2B). Sporangia show a dense ornamentation, which consists of irregularly shaped protuberances. These form an almost contiguous plate around the pedicel, with about 2.5-3.5 µm diam. (Fig. 2C). A papilla is mostly visible in SEM, although it is sometimes not easily detected.

The swelling of the annulate tips of the ultimate branchlets is very conspicuous in *Bremiella sphaerosperma* (Fig. 2F). The sporangiophores are hardly collapsed (Fig. 2E); especially the ultimate branchlets have retained their round shape (Fig. 2F). This is due to the remarkably thick wall of the sporangiophore in this species, which has already been noted by Constantinescu (1991). Sporangia are densely covered with irregularly shaped protuberances, which form a contiguous plate around the pedicel, about 3-4 µm diam. (Fig. 2G). A papilla is not or only hardly visible in SEM (Fig. 2H).

Discussion

The results of the phylogenetic analyses clearly demonstrate that *Bremiella sphaerosperma* belongs to the genus *Plasmopara* (Fig. 1). In addition, there is some evidence that *Bremiella sphaerosperma* may be closely related to *Plasmopara obducens*, despite the pronounced differences in sporangiophore morphology and ultrastructure; however, the taxon sampling for *Plasmopara*

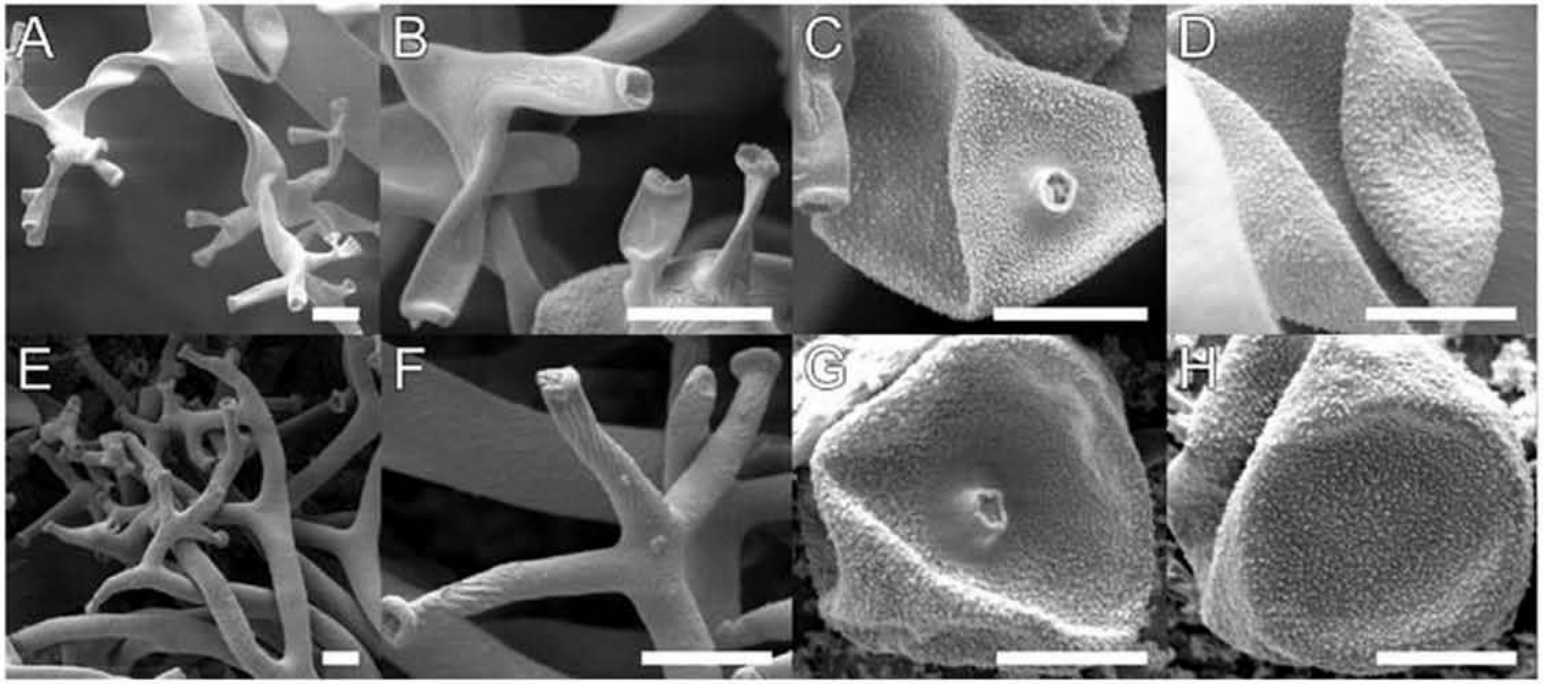

Figure 2. Characteristics of *Plasmopara obducens* (A-D) and *Bremiella sphaerosperma* (E-G) as seen in SEM. A, E: sporangiophores; B, F: ultimate branchlets; C, G: basal part of the sporangia; D, H: apical part of the sporangia. Bar = 5 µm in all pictures.

in the D1–3,7–8 nrLSU dataset is too small to make any definite statements. After addition of the *Bremiella sphaerosperma* sequences to the D1–2 LSU rDNA alignment of Voglmayr et al. (2004), sister group relationship did not receive significant support in subsequent MP and ML bootstrap analyses (data not shown). However, this may be due to the fewer characters available in the D1–2 alignment, and this reduced dataset is often unsuitable for evaluation of phylogenetic relationships within *Plasmopara* (Voglmayr et al. 2004).

Bremiella sphaerosperma again illustrates that sporangiophore morphology is not always indicative of phylogenetic relationships, and sporangiophore morphology may have been overestimated in previous classifications (Riethmüller et al. 2002, Voglmayr et al. 2004, Thines et al. 2006). Especially the subdivision into genera with dichotomous versus monopodial sporangiophore morphology does not pass detailed analyses, as both characters can intergrade, and unequivocal attribution is often dependent on subjective appraisal of the observer rather than on sound differences. This is also true for *Bremiella sphaerosperma* and, although at first sight the branching is apparently dichotomous, it can be interpreted as monopodial as well, if the term monopodial is not restricted to branching at more or less right angles.

Besides the branching of the sporangiophore, the main characteristic of *Bremiella* was thought to be the broadening of the tips of the ultimate branchlets. However, this feature is not restricted to the downy mildews previously classified in *Bremiella*, but is found in almost any species of the downy mildews with pyriform, globose or ellipsoid haustoria (DMPH). This has been revealed through SEM investigations of the genera of the *Peronosporaceae* (Thines 2006). The distal broadening of the ultimate branchlets is mostly caused by an annulus at the sporangiophore tip, which often has a significantly larger diameter than the trunk of the ultimate branchlet. This characteristic is depicted for *Plasmopara nivea* and *Plasmoverna pygmaea* by Constantinescu et al. (2005). Hence, molecular genetic similarity with *Plasmopara* species and the lack of genus specific morphological features favours the relegation of *Bremiella* into synonymy with *Plasmopara*.

Taxonomy

Transfer of *Bremiella sphaerosperma* into *Plasmopara* necessitates the proposal of a nomen novum, as the epithet is already occupied by *Plasmopara sphaerosperma* (Săvulescu 1941), the basionym of *Protobremia sphaerosperma* (Săvul.) Voglmayr et al. (Voglmayr et al. 2004).

Plasmopara constantinescui Voglmayr & Thines, **nom. nov.**

MycoBank MB 510528

Replaced synonym: *Bremiella sphaerosperma* Constant., Mycologia 83: 473, 1991 [non *Plasmopara sphaerosperma* Săvul., Bulletin de la Section Scientifique de l'Académie Roumaine 24: 65-66, 1941]

Etymology: named after Ovidiu Constantinescu to honour his important contributions to downy mildew systematics and taxonomy.

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Literature cited

Constantinescu O. 1979. Revision of *Bremiella* (*Peronosporales*). Transactions of the British Mycological Society 72: 510-515.

Constantinescu O. 1989. *Peronospora* complex on *Compositae*. Sydowia 41: 79-107.

Constantinescu O. 1991. *Bremiella sphaerosperma* sp. nov. and *Plasmopara borreriae* comb. nov. Mycologia 83: 473-479.

Constantinescu O, Voglmayr H, Fatehi J, Thines M. 2005. *Plasmoverna* gen. nov., and the nomenclature and taxonomy of *Plasmopara* (Chromista, *Peronosporales*). Taxon 54: 813-821.

Gascuel O. 1997. BIONJ, an improved version of the NJ algorithm based on a simple model of sequence data. Molecular Biology and Evolution 14: 685-695.

Göker M, Voglmayr H, Riethmüller A, Weiß M, Oberwinkler F. 2003. Taxonomic aspects of *Peronosporaceae* inferred from Bayesian molecular phylogenetics. Canadian Journal of Botany 81: 672-683.

Göker M, Voglmayr H, Riethmüller A, Oberwinkler F. 2007. How do obligate parasites evolve? A multi-gene phylogenetic analysis of downy mildews. Fungal Genetics and Biology 44 (in press).

Guindon S, Gascuel O. 2003. A simple, fast, and accurate algorithm to estimate large phylogenies by maximum likelihood. Systematic Biology 52: 696-704.

Posada D, Buckley TR. 2004. Model selection and model averaging in phylogenetics: advantages of the AIC and Bayesian approaches over likelihood ratio tests. Systematic Biology 53: 793-808.

Posada D, Crandall KA. 1998. Modeltest: testing the model of DNA substitution. Bioinformatics 14: 817-818.

Riethmüller A, Voglmayr H, Göker M, Weiß M, Oberwinkler F. 2002. Phylogenetic relationships of the downy mildews (*Peronosporales*) and related groups based on nuclear large subunit ribosomal DNA sequences. Mycologia 94: 834-849.

Săvulescu T. 1941. Die auf Compositen parasitierenden *Plasmopara*-Arten. Bulletin de la Section Scientifique de l'Académie Roumaine 24: 45-67.

Swofford DL, Olsen GJ, Waddell PJ, Hillis DM. 1996. Phylogenetic inference. In: Hillis DM, Moritz C, Mable BK. (eds.), Molecular Systematics. Sinauer Associates: Sunderland (Mass., USA). pp. 407-514.

Swofford DL. 2002. PAUP*: Phylogenetic analysis using parsimony (*and other methods). Version 4.0 b10. Sinauer Associates, Sunderland, Massachusetts.

Tao J-F, Qin Y. 1982. New species and new combinations of the genus *Bremiella* on *Compositae* of China. Acta Mycologica Sinica 1: 61-67. [In Chinese]

Tao J-F, Qin Y. 1985. Taxonomic studies on the genus *Bremiella* in China. II. New species of *Bremiella* on *Umbelliferae*. Acta Mycologica Sinica 4: 12-15.

Thines M. 2006. Evaluation of characters available from herbarium vouchers for the phylogeny of the downy mildew genera (Chromista, *Peronosporales*), with focus on scanning electron microscopy. Mycotaxon 97: 195-218.

Thines M, Göker M, Spring O, Oberwinkler F. 2006. A revision of *Bremia graminicola*. Mycological Research 110: 646-656.

Voglmayr H, Riethmüller A, Göker M, Weiss M, Oberwinkler F. 2004. Phylogenetic relationships of *Plasmopara*, *Bremia* and other genera of downy mildew pathogens with pyriform haustoria based on Bayesian analysis of partial LSU rDNA sequence data. Mycological Research 108: 1011-1024.

Wilson GW. 1914. Studies in North American *Peronosporales* – VI. Notes on miscellaneous species. Mycologia 6: 192-210.

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Five lichens new to Turkey

KENAN YAZICI*

kcagri_1997@yahoo.com
Karadeniz Technical University, Giresun Sciences and Arts Faculty, Biology Department, Giresun, Turkey

ANDRÉ APTROOT

andreaptroot@wanadoo.nl
Adviesbureau voor Bryologie en Lichenologie
G.v.d. Veenstraat 107, NL-3762 XK Soest, The Netherlands

Abstract—Five species of lichenized fungi – *Arthonia didyma*, *Arthopyrenia cinereopruinosa*, *Arthopyrenia salicis*, *Lecania cyrtellina* and *Opegrapha niveoatra* – are new to Turkey. The latter two are also new to Asia. For each, a short description is presented.

Keywords—*Ascomycetes*, biodiversity, Bursa, Zonguldak

Large parts of the lichen flora of Turkey are still unknown. In recent years, however, there has been a substantial increase in the number of lichenological papers referring to Turkey (Aslan 2000, Aslan et al. 2002a,b, John 1996, John & Breuss 2004, John et al. 2000, Yazıcı & Aslan 2002, 2003, 2005, 2006a, Yazıcı et al. 2004, 2005). The present paper is a further contribution to this. In previous studies, Yazıcı reported 78 species from Karacabey county in Bursa (Yazıcı 1999) and 29 different species from Zonguldak (Yazıcı & Aslan 2006b, Çobanoğlu 2005, Verseghy 1982, Szatala 1960, John 1992).

The present report is based on collections from the two different provinces Bursa and Zonguldak between 04 and 29 August 2005. A stereo microscope, a light-microscope and the usual spot tests were used to identify the samples with reference to Purvis et al. (1992) and Wirth (1995). Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Giresun University.

Results

Arthonia didyma Körb.

Thallus crustose, to 6.5–7.0 mm diam, inconspicuous, immersed, mostly effuse, wide-spreading or sometimes in tiny patches, pale, fawn to pinkish or

olive-grey evanescent. Apothecia 0.08–0.30 × 0.06–0.30 mm long, rounded to linear, fleck-like, flat, purple to blackish, not pruinose; epithecium red-brown, sometimes indistinct; hymenium 30–45 µm tall, colourless; hypothecium 10–35 µm tall, red-brown; the red-brown pigmented, K + grey or olivaceous, but epithecium, hymenium and sometimes hypothecium contain an orange-red, K + purple-violet pigment. Paraphysoids rather scanty, sometimes brown-walled a few with apical caps. Ascospores 13–15 × 4–7 µm, 1-septate, ovoid, colourless but later brown and warted. Pycnidia rare, immersed, K + olive-grey; conidia bacilliform.

Arthonia didyma is a suboceanic, cool-temperate species, growing usually on smooth bark of deciduous trees and shrubs in humid areas, especially *Corylus*, mainly in woodlands; common in unpolluted areas.

Known throughout Europe (British Isles, Czech Republic, Germany, Denmark, Sweden, Ireland, Italy, France, Romania, Norway, Poland the Netherlands, Lithuania, Estonia, Slovenia), eastern North America, New Zealand and Asia (e.g. Thailand, Japan). In the Mediterranean, it has been recorded from Calabria and Puglia, in southern Italy. New to Turkey.

Zonguldak: Ereğli county; on previously built Ereğli road, Ilıksu district, roadside on *Ulmus* sp., 100 m., 41° 23' 20" N, 31° 40' 35" E, 16 August 2005, Yazici 1283.

About survey area–This area has a typical oceanic climate and lies 500 m from the Black Sea and 10m from a stream. Droughts are not seen in climate type. Rainy days occur in every season and the most rainy days in autumn and winter. Rainfall average is 1234.96 mm per year, with the highest precipitation occur in December (148.65 mm) and January (141.72 mm). The lowest relative humidity is 70 % and the average relative humidity is 75 %.

Remarks—*Arthonia didyma* is similar to *A. spadicea* and *A. vinosa*. A red-brown or sometimes indistinct epithecium helps to differentiate *A. didyma* from the other species, which always have an indistinct epithecium. Apothecial sections have K + purplish pigments in *A. spadicea* and *A. vinosa*, but those in *A. didyma* have sometimes K + purple-violet pigment. *A. didyma* and *A. vinosa* have brown ascospores when old, but those in *A. spadicea* are colourless. Apothecia in *A. vinosa* and *A. spadicea* are rounded and convex while those in *A. didyma* are flat, fleck-like, or shortly linear. The thallus in *A. didyma* is pale brown in contrast to the orange tinge or stain in *A. vinosa*.

Arthopyrenia cinereopruinosa (Schaer.) A. Massal.

Thallus non-lichenized, to 1.7cm diam., inconspicuous or slightly bleaching the bark, gray-white towards thalline exciple gray-white, mostly light brown in the center of the thallus, shining. Perithecia 0.40–050 × 0.15–0.40 mm, circular or ellipsoid, often covered by a thin layer of bark cells giving a whitish pruinose

appearance. Pseudoparaphyses 1–1.5 µm wide, distinct, persistent, slender. Asci 50–75 × 10–20 µm, cylindrical-clavate. Ascospores 14–24 × 6–9 µm, usually colorless, clavate, with rounded apices, 1-septate, constricted at the septum and each cell biguttulate; perispore distinct. Pycnidia 60–100 µm diam., with either macro- or microconidia. Macroconidia 8–11 × 1.8–2.3 µm, bacilliform; microconidia 4.5–6 × 1 µm, bacilliform. Photobiont *Trentepohlia*.

This temperate species grows on smooth bark, in clearing of long-established woodlands near rivers especially on young twigs of *Fraxinus*.

Known throughout Europe (e.g. British Isles, Ireland, Norway, Germany, Austria, Romania, Finland, Estonia, Espain, Slovenia), Asia, Australia and North America. New to Turkey.

Bursa: Karacabey county; Bayamdere village, on base of young *Fraxinus excelsior*, 15 m, 40° 22' 45" N, 28° 24' 15" E, 29 August 2005, Yazici 1286.

About survey area–The site is flat and agricultural, 700 m from the Marmara Sea, shaded, occasionaly exposed to strong winds, and with some deciduous trees present. The continental and cool Mediterranean climate is mild and cool in summer. Rainfall averages 668 mm per year, the highest precipitation occuring in January (94 mm) and December (118 mm), and the lowest in July (16 mm) and August (18mm). Normally the highest annual temperature occurs in July, 23.6 °C, the lowest in January (4.9 °C). Humidity is high, averaging 73%.

Remarks—*A.. cinereopruinosa* is close to *A. analepta*, which differs by producing thread-like and ± straight conidia, in somewhat smaller ascomata and ascospores, and bacilliform conidia. The median constriction characterizing mature ascospores of *A. cinereopruinosa* are absent in *A. analepta*. In addition *A. cinereopruinosa* possesses perithecia often covered by a thin layer of bark cells giving a whitish pruinose appearance.

Arthopyrenia salicis A. Massal.

Thallus often inconspicuous, sometimes to 15–20 mm diam, pale light-brown, sometimes pinkish when fresh, rarely dark brown. Perithecia numereous, 0.10–0.25 × 0.10–0.20 mm, to 0.3 deep, circular or elipsoid, often with depressed ostiole, mostly crowded over the thallus; involucrellum remaining brown in K. Pseudoparaphyses absent; periphysoids 6–15 × 1–1.5 µm, obpyriform. Ascospores (11–)13–17(–20) × 4–5 µm, 1-septate, constricted at the septum, each cell biguttulate, the lower cell often with a median constriction, the apices rather blunt; perispore indistinct. Pycnidia c. 60 µm diam.; conidia 3–3.5 × 1 µm, ± bacilliform.

Arthopyrenia salicis is a temperate species that colonizes the smooth bark of deciduous trees and shrubs, *Carpinus* and *Corylus*. It is most frequent in upland areas.

Known throughout Europe (e.g. British Isles, Italy, Ireland, Norway, the Netherlands, Denmark, Germany, Slovenia), Asia (e.g. New Guinea) and North America. New to Turkey.

Bursa: Karacabey county; Bayramdere village, on young *Fraxinus excelsior*, 15 m, 40° 22' 45" N, 28° 24' 15" E, 29 August 2005, Yazici 1287.

About survey area–This species was found on the same habitat together with *Arthopyrenia cinereopruinosa* at the same station. So two species can colonize on the same habitat and are exposed the same climate.

Remarks—*Arthopyrenia salicis* resembles *Naetrocymbe punctiformis*. Indistict perispores, bacilliform conidia, smaller asci and ascospores, and larger ascomata help differentiate *A. salicis* from *N. punctiformis*. In addition, *Naetrocymbe punctiformis* possesses pseudoparaphyses, but lacks the periphysoids that are present in *A. salicis*.

Lecania cyrtellina (Nyl.) Sandst.

Thallus crustose, to 5–8 mm in diam, inconspicuous or continuous, partly effuse, rather smooth, very thin, pale green to dull greenish grey. Apothecia pale-pink to brownish or sometimes piebald, closely adpressed, ± sessile, to 0.10–0.25 diam, often crowded mostly over center of the thallus; generally discs flat, margin persistent, light pink-white, partly irregular, hymenium 25–35 µm tall. Ascospores 7–12(–14) × 2–4 µm. Microconidia (11–)14–16(–17) × 0.5 µm, curved; microconidia 10–15(–18) × 1.5(–2) µm, 0– to 1–septate, curved, crescent–shaped.

This holarctic lichen grows on the base-rich bark of isolated trees, such as *Populus*, *Juglans*, *Fraxinus*, *Sambucus*.

Known throughout Europe (e.g. England, Scotland, Belgium, northern France, Germany, Norway, Austria, Luxembourg), Macaronesia, Africa and North America. New to Asia.

Zonguldak: Devrek county; Karacaören, on *Quercus* sp., 500 m, 41° 18' 10" N, 31° 57' 40" E, 04 August 2005, Yazici 1291.

About survey area–This area has *Quercus* trees and has a typical oceanic climate. It is not near to the Black Sea. Winds are very strong, the site is shaded, and the slopes are very steep. Rainfall averages is 1234.96 mm per year and occurs in every season. Humidity is high (75 %).

Remarks—*Lecania cyrtellina* is close to *L. cyrtella*, which is mostly associated with *Xanthorion* and which has broader ascospores and longer microconidia.

Opegrapha niveoatra (Borrer) J.R. Laundon

Thallus thin, superficial, sometimes minutely rimose or smooth, effuse, occasionally inconspicuous, upper surface smooth, light white or dull grey,

sometimes olive-brown mostly towards the thalline exciple. Apothecia (0.15–) 0.20–0.85(–1) × 0.10–0.20 mm, small, sessile, scattered or contiguous, simple, curved-sinuate or ± stellate, occasionally branched; disc at first a slit, becoming partially exposed with age; exciple somewhat uneven, K ± olivaceous in section, epithecium brown; hymenium 45–65 µm tall, I + red. Ascospores 25–30 × 2–4 µm, 4–7 septate, ± acicular. Conidia short and curved. 4–7(–8) × 1–1.5 µm and 7–8 × 0.7µm. Thallus Pd–, K–, KC–, C–, UV–.

Opegrapha niveoatra is a mild-temperate species, growing on old neutral and basic decidous bark, particularly *Acer, Fraxinus* and *Ulmus*, roadside and open woodland situations, more rarely on conifers and wood. It is also found coast of Spain, Morocco where microclimate is sufficiently humid and from a few littoral localities of Sardinia (from 300 to 900m).

Known throughout Europe (e.g. British Isles, Ireland, Belgium, northern France, Norway, Portugal, the Netherlands, Denmark, Sweden, Italy, Luxembourg, Slovenia, Spain, Estonia), Macaronesia (e.g. Azores), Africa (e.g. Algeria) and North and Central America. New to Asia.

Zonguldak: Ereğli county; on previously built Ereğli road, Ihksu district, roadside, on *Ulmus* sp., 100 m, 41° 23' 20" N, 31° 40' 35" E, 16 August 2005, Yazici 1283.

About survey area–This species was found on the same habitat together with *Arthonia didyma* in the same station.

Remarks—*Opegrapha niveoatra* differs from *O. vulgata* in having shorter and curved conidia (4–7 × 1–1.5µm or 6–8 × 06–07µm) and smaller apothecia.

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References

Aslan A. 2000: Lichens from the Regions of Artvin, Erzurum and Kars (Turkey). Israel J. Plant Sci. 48: 143–155.

Aslan A, Yazıcı K, Karagöz Y. 2002a: Lichen Flora of the Murgul District (Artvin, Turkey) Israel J . Plant Sci. 50: 77–81.

Aslan A, Aptroot A, Yazıcı K. 2002b: New lichens from Turkey. Mycotaxon 84: 277–280.

Çobanoğlu G. 2005: Lichen collection in the Herbarium of the University of İstanbul (ISTF). Türk J. Bot. 29: 69–74.

John V.1992: Flechten der Türkei III. Die Flechten der Pilotkartierung für Europa in der Turkei. Pollichia, Pfalzmuseum für naturkunde, Bad Dürkheim 1–20

John V, Breuss O. 2004: Flechten der Östlichen Schwarzmeer-Region in der Türkei (Blam-Exkursion 1997). Herzogia 17: 137–156.

John V, Seaward MRD, Beatty J.W. 2000. A neglected lichen collection from Turkey. Berkamsted School expedition 1971. Turk. J. Bot. 24: 239–248.

John V. 1996: Preliminary catalogue of lichenized and lichenicolous fungi of Mediterranean Turkey. Bocconea 6: 173–216.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992: The Lichen Flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.

Szatala Ö. 1960: Lichens Turcicae asiaticae ab Victor Pietschmann collecti. Sydowia 14: 312–325.

Verseghy KP. 1982: Beiträge zur Kenntnis der türkischen Flechtenflora. Studia Bot. Hun. 15: 53–65.

Wirth V. 1995: Die Flechten Baden Württembergs. Teil 1–2. Ulmer, Stuttgart.

Yazıcı K. 1999. Lichen Species in the North of Karacabey county, Bursa province, Turkey. Turk. J. Bot. 23: 271–276.

Yazıcı K, Aslan A. 2002: New records for the lichen flora of Turkey. Turk. J. Bot. 26: 117–118.

Yazıcı K, Aslan A. 2003: Lichens from the Regions of Gümüşhane, Erzincan and Bayburt (Turkey). Cryptogamie, Mycol. 24: 287–300.

Yazıcı K, Aslan A. 2005: Six new lichen records from Turkey. Mycotaxon 93: 359–363.

Yazıcı K, Aslan A. 2006a: Lichen taxonomic composition from MustafaKemalpaşa, Bursa district (Turkey). Acta Bot. Croat. 65(1): 25–39.

Yazıcı K, Aslan A. 2006b: Four New lichens from Turkey. Mycotaxon 95: 315–318.

Yazıcı K, Aslan A, Aptroot A. 2004: Four new lichen species from Turkey. Mycotaxon 90: 177–180.

Yazıcı K, Aslan A, Aptroot A. 2005: New lichen records from Turkey. Mycotaxon 92: 341–344.

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Typification and description of *Typhula buxi*

I. Olariaga[1], M.P. Hoyo[2], A. Gómez-Bolea[2] & I. Salcedo[1]

gvbolibi@lg.ehu.es

[1] *Plant Biology and Ecology Dept. (Botany), University of the Basque Country Apdo. 644, E-48080 Bilbao (Spain)*

[2] *Dept. Biologia Vegetal (Botànica). Fac. Biologia. Universitat de Barcelona Av. Diagonal, 645. E-08028 Barcelona (Spain)*

Abstract—A *Typhula* resembling *T. erythropus* was collected on dead leaves of *Buxus sempervirens* at several localities of the Northeastern Iberian Peninsula. It was identified as *T. buxi*, a species only once collected since Maire described it from the Iberian Peninsula. As no original collection is conserved, the sclerotial structure of *T. buxi* was unknown; it was not described in the protologue. Later, however, the species was assigned to the subgenus *Cnazonaria*, which contains species with sclerotia with an inverse epidermoid layer, but the material studied in this work has a normal epidermoid layer. Concerning its typification, amongst the elements cited in the protologue, the illustration given in the protologue is selected as lectotype. In order to interpret it correctly and include *T. buxi* in the subgenus *Microtyphula*, which contains species with normal epidermoid layer, material from the type location is proposed as epitype in this work. In addition, a detailed description and illustrations of *T. buxi* are given and a comparison with *T. erythropus* is made.

Key words—*Basidiomycota*, taxonomy, ecology, *Typhulaceae*

Introduction

The genus *Typhula* (Pers.) Fr. includes about 68 species that are characterized by their small and clavarioid basidiomata, arising or not from a sclerotium (Berthier 1974). Despite being a genus of wide distribution, most of the species are restricted to temperate regions (Berthier 1976). *Typhula* was created by Persoon (1801) to designate some species within the genus *Clavaria*. Later, Fries (1818) considered *Typhula* a different genus, which included small species with a distinct clavula. On the other hand, *Pistillaria* was created to include small species with indistinct stipe and without sclerotia (Fries 1821).

Typhula and *Pistillaria* were widely used in the sense of Fries until Karsten (1882) used the name *Typhula* for the sclerotia-bearing species and *Pistillaria* for the non-bearing ones. Both Remsberg (1940) and Berthier (1976) proved

this classification to be artificial, since some species can develop sclerotia or not. Remsberg (1940), however, was the first to describe the sclerotial structure. Furthermore, she considered it to possess a high taxonomic value.

Corner (1950) subsequently divided the genus into two subgenera according to the observations of Remsberg (1940). In this context, Berthier (1974) studied in detail the sclerotial structure. On the one hand, the outer layer of hyphae of the sclerotium was called epidermoid layer, which can be normal or inverse. On the other hand, he paid attention to the ornamentation and presence of cutis of the epidermoid layer, which can display a high interspecific variability. The gelification of the medulla of the sclerotium became also an important characteristic. Berthier (1974) used those sclerotial characters and the morphology of the basidiomata to propose a new classification. However, taxa whose sclerotial structure is unknown cannot be included reliably in Berthier's classification, as occurs with *Typhula buxi* and other species.

T. buxi was originally described from Catalunya by Maire (1933), who discovered it living on dead leaves of *Buxus sempervirens*. Some years later Malençon & Bertault (1968) recorded the species from Morocco, growing on *Buxus balearica* leaves. Since no specimens of *T. buxi* were kept at the herbarium of Maire at MPU, Corner (1950), Pilát (1958), Berthier (1976) and Jülich (1984) based their descriptions solely on Maire's protologue. Despite not knowing its sclerotial structure, Berthier (1976) included it in the subgenus *Cnazonaria*, which contains species with inverse epidermoid layers. He did not report or check the material from Morocco.

Apart from the report from Malençon & Bertault (1968), no further material of *T. buxi* was collected until Hoyo & Gómez-Bolea (2003) rediscovered it in several localities of the northeastern Iberian Peninsula, including the type locality, again growing on dead leaves of *Buxus sempervirens*. Examinations of those collections revealed *T. buxi* to be a species producing sclerotia with normal epidermoid layers. Therefore, we consider it necessary to select a type for *T. buxi*, in order to permit its correct interpretation, together with an adequate taxonomic position. In our descriptions, we pay particular attention to the sclerotial structure and compare features found in the collections with those described in the original protologue.

Materials and methods

Herbaria are abbreviated according to Holmgren & Holmgren (1998). The collections examined in this study are deposited in BCN, BIO and UPS herbaria. The macroscopic descriptions are based on both fresh and dried material. Colour codes are from Munsell (1994). The adopted terminology follows both Berthier (1976) and Kirk et al. (2001). Melzer's reagent was used to check for

the amyloid and dextrinoid reactions. Microscopic measurements were made in Congo Red in KOH 5%. Basidiospore measurements were made in side view. Letter abbreviations describing basidiospore size are: X = mean length × mean width, Q = mean length/width ratio. 25 basidiospores were measured per collection. Basidia measurements exclude the sterigmata.

Taxonomy

Typhula buxi Maire, Treb. Mus. Cien. Nat. Barcelona 15(2): 28. 1933.

LECTOTYPE (designated here): Figure 4 in Maire, Treb. Mus. Cienc. Nat. Barcelona 15(2): 28. 1933.

EPITYPE (designated here): Collection BCN-Hoyo 128 deposited in BCN. **Fig. 1 A, B and C.**

Description

Basidioma 1.5-8(-14) mm long, stipe and clavula well delimited. **Clavula** (0.2-) 0.5-2(-8) × (0.05-)0.1-0.2(-0.33) mm, cylindrical to claviform, straight or curved, not branched, apex blunt, rarely subacute, greyish white (5Y 8/1, 8/2), yellowish grey (5Y 7/1, 7/2), or pale ochre (10YR 8/3, 8/4) when fresh, ochre (10YR 6/4, 6/6, 7/6, 7/4), brown (5YR 5/4; 7.5YR 4/4, 3/3, 5/8; 10YR 5/8, 4/6) or olive brown (2.5Y 5/6, 5/4, 4/4; 5Y 4/4) when dried. **Stipe** longer than the clavula, (0.7-)1.5-12.5 × 0.05-0.2 mm, cylindrical, sometimes widened at the base (× 0.15-0.3 mm), sinuous, rarely branched, greyish white (5Y 8/1, 8/2) near the clavula, ochre (10YR 6/4, 6/6, 7/6, 7/4) or light brown (7.5 YR 5/8; 10YR 5/8) when dried, progressively darker brown downwards (5YR 3/3; 2.5 YR 2.5/3; 7.5 YR 3/3), pubescent or glabrous. Caulinar hairs only on the apex or throughout the stipe.

Sclerotium single, immersed or erumpent, lenticular to subglobose, 0.2-1 mm diam., slightly wrinkled, pale brown (10YR 6/4, 7/4) or ochre (10YR 7/6) when fresh, dark brown (2.5 YR 2.5/2, 2.5/3, 3/4, 3/6, 4/6; 5YR 2,5/2, 4/6) when dried. 1(-2) basidioma per sclerotium.

Medulla of the clavula formed by parallel arranged hyphae, 4-16 µm thick, cylindrical to slightly swollen, thin-walled, clamped, non-gelified, without crystals. **Hymenium** non-gelified. **Basidiospores** ellipsoidal, sometimes suballantoid, amyloid, (7-)7.5-9.5 × (3-)3.5-4.5(-5) µm (X= 7.17-8.90 × 3.22-4.21 µm; Q = 1.90-2.51). **Basidia** claviform, 4(-2)-spored, clamped, 15-32 × 5-7.5 µm. Sterigmata 3-4.5 µm long. **Subhymenial hyphae** branched, cylindrical, 2.5-4 µm thick, thin-walled, non-gelified, clamped.

Stipe surface formed by cylindrical hyphae, 3-6 µm thick, thick-walled, clamped, sometimes secondarily septate, non-gelified but tightly cohesive, hyaline near the apex, brown downwards, with crystals. **Caulinar hairs** abundant,

cylindrical, often with widened base, seldom cylindrical, sinuous, thick-walled towards the base of the stipe, sometimes septate, sometimes branched, hyaline, yellowish at the base, rarely with crystals, (10-)45-95(-140) × 1.2-2.5 µm (3-8.5 µm at the base). **Crystals** often present on the whole surface of the basidioma, bipyramidal or aggregate. **Sclerotia** non-gelified, with a normal epidermoid, without cutis. Epidermoid layer made up of hyphae with sinuous outline, thin to thick-walled, golden-brown. Medulla formed by non-gelified hyphae, 4-12 µm thick, thin to slightly thick-walled, without crystals.

SPECIMENS EXAMINED—*Typhula buxi* — SPAIN. BARCELONA: SEVA, CORRAL DE TERRERS, 31TDG43, 910 m, fallen leaves of *Buxus sempervirens*, 10/III/2001, Llimona, *BCN-Hoyo 81*. VIDRÀ, LA VILA VELLA, 31TDG46, 1030 m, dead leaves on a twig attached to a living *Buxus sempervirens*, 28/IX/2002, Hoyo & Ramírez, *BCN-Hoyo 128* (EPITYPE). CUENCA: FUENTE DE LA BOTA, VILLAR DEL HUMO, 30SXK11, 980 m, dead leaves, on dead twig attached to a living plant, of *Buxus sempervirens*, 13/X/2001, Hoyo, *BCN-Hoyo 40*. GIRONA: CAMPELLES, 31TDG28, 1600 m, fallen leaves of *Buxus sempervirens*, 22/IX/2002, Hoyo, *BCN-Hoyo 123*. LLEIDA: SALÀS DE PALLARS, BOSC DE SALÀS, 31TCG2578, 975 m, fallen leaves of *Buxus sempervirens*, 05/I/2003, Longan, *BCN-Hoyo 236*. COLL DEL BOIX, ALINYÀ, 31TCG66, 1280 m, dead leaves, on dead twig attached to a living plant, of *Buxus sempervirens*, 29/IX/2001, Hoyo, *BCN-Hoyo 39*. HUESCA: LANUZA, SALLENT DE GÁLLEGO, 30TYN2036, 1400 m, fallen leaves of *Buxus sempervirens*, 16/IX/2004, Olariaga, *BIO Fungi 10411*. Ibidem, 27/X/2004, *BIO Fungi 10558*. TARRAGONA: VILANOVA DE PRADES, PUNTA DEL CURULL, 31TCF38, 1000 m, fallen leaves of *Buxus sempervirens*, 23/X/2001, Llimona, *BCN-Hoyo 41*.

Typhula erythropus— FRANCE. ARDENNES, petioles of angiosperms, *Montagne*, UPS s.n. SPAIN. ÁLAVA: SAN ZADORNIL, 30TVN8743, 650m, petioles of angiosperm leaves, 19/X/2004, Olariaga, *BIO Fungi 10466*. GOPEGI, 30TWN2157, 600m, *Acer campestre* leaves, 2/XII/2004, Arauzo, Iglesias, Fernández, Undagoitia, Olariaga, *BIO Fungi 10705*. ÁVILA: NAVATEJERA, RÍO ARAVALLE, 30TTL8469, 1000m, *Alnus glutinosa* leaves, 9/XI/2004, Sarrionandia, Olariaga, *BIO Fungi 10629*. BIZKAIA: GETXO, MARTIARTU, 30TWN0298, 100 m, dead leaves of *Alnus glutinosa*, 22/XI/2003, Olariaga, *BIO Fungi 1009*. Idem, *BIO Fungi* 10101. BURGOS: MERINDAD DE MONTIJA, RÍO CERNEJA, 30TVN6174, 800m, dead leaves of *Corylus avellana*, 20/X/2005, Vesterholdt, Becker, Olariaga, *BIO Fungi 11217*. CÁCERES: HERVÁS, LA GARGANTA, 30TTL5963, 790m, *Alnus glutinosa* leaves, 9/XI/2004, Sarrionandia, Olariaga, *BIO Fungi 10622*. HUESCA: LANUZA, SALLENT DE GÁLLEGO, 30TYN2036, 1400m, *Populus tremula* leaves, 27/X/2004, Olariaga, *BIO Fungi 10545*. LEÓN: RIAÑO, ARROYO DE SAN PEDRO, 30TUN38, 1000m, *Acer pseudoplatanus* petioles, 1/X/2003, Olariaga, *BIO Fungi 9919*. LLEIDA: ELS BORDS, 31TCH1534, 1050m, *Populus tremula* leaves, 26/X/2004, Olariaga, *BIO Fungi 10443*. ELS BORDS, ARTIGA DE LIN, 30TCH1127, 1600m, angiosperm leaves, 26/X/2004, Olariaga, *BIO Fungi 10546*. Ibidem, leaves of *Fraxinus excelsior*, *BIO Fungi 10550*. Ibidem, *Equisetum telmateia* debris, *BIO Fungi 10551*. SWEDEN. VÄSTERGOTLAND: Göteborg, ST. ÄNGGORDEN, on decaying petioles, 14-28/IX/1943, Nathorst-Windahl, Fung. Exs. Suec. 3243 (*UPS F-05387*).

Discussion and conclusions

Typhula buxi was originally described from Vidrà (Barcelona, Spain). Maire (1933) described it as a species with a white clavula, pubescent stipe that is

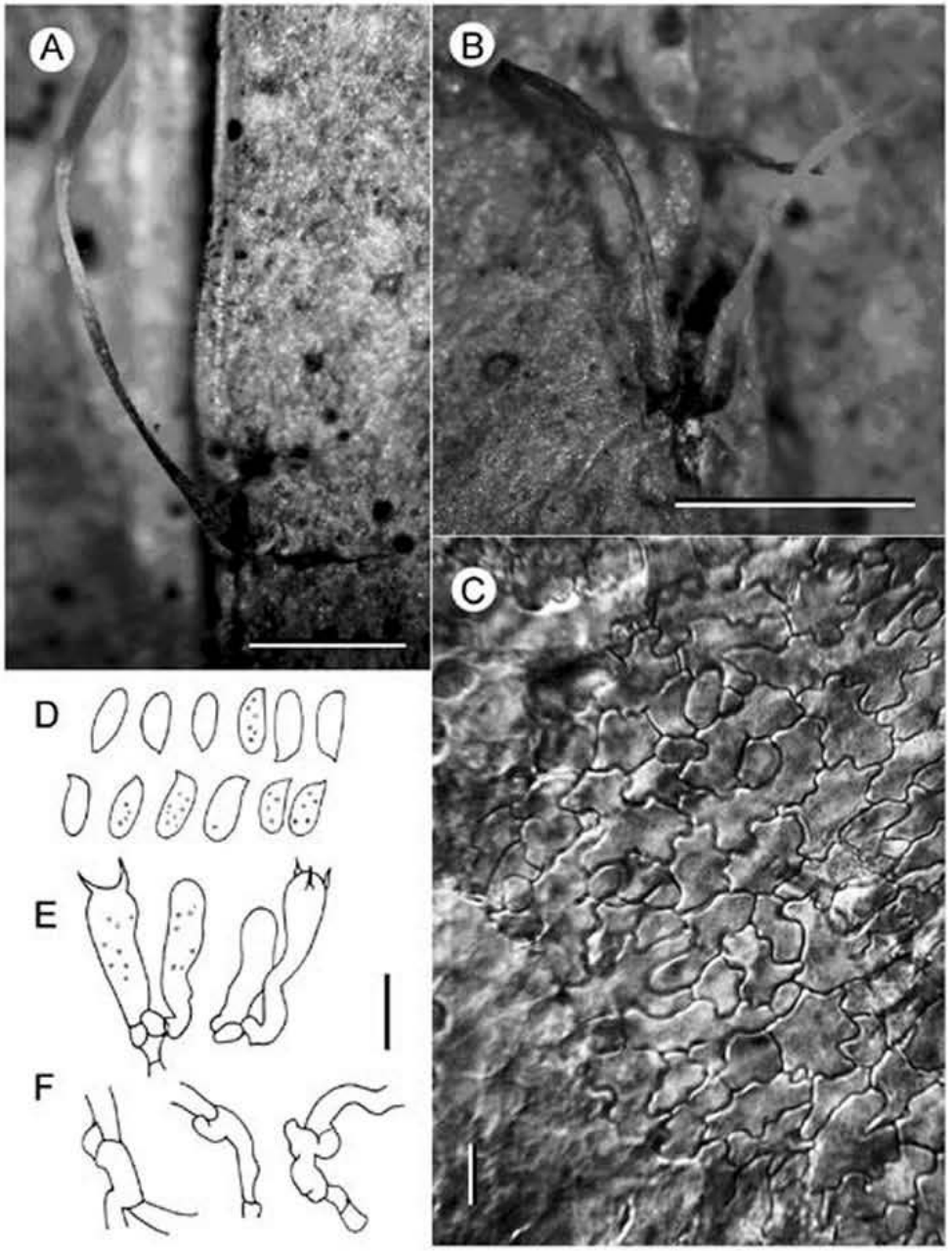

Fig. 1. *Typhula buxi* (BCN-Hoyo 128). A & B: basidiomata; C: epidermoid layer; D: basidiospores. E: basidia. F: subhymenial hyphae. (Scale bars: A & B = 1 mm; C,D,E & F = 10 µm)

dark at the base, citrine sclerotia, and basidiospores measuring 6-7 × 3-3.5 µm. *T. pallens* Maire, *T. erythropus* (Pers.) Fr. (by orthographic mistake cited as *T. erythropoda* by Maire 1933) and *T. neglecta* Pat. were regarded as related species, from which *T. buxi* could be distinguished mainly by its yellowish sclerotium

and long caulinar hairs. The collections examined for this work, including the material of the type locality, correspond with the description of the protologue. Our collections are characterized by their light clavula contrasting with the dark brown stipe, cylindrical caulinar hairs swollen at the base, amyloid basidiospores, as well as the habitat on dead leaves of *Buxus sempervirens*, as described by Maire (1933).

Table 1. Length, width and Q of selected material of *T. buxi*.

Collection	Length (µm)	Width (µm)	Q
Protologue (Maire 1933)	6-7	3-3.5	--
BCN-Hoyo 39	(7-)7.5-8.5(-9)	(3-)4-5	1.90
BCN-Hoyo 40	(7.5-)8.5-9.5(-10)	3-5	2.20
BCN-Hoyo 123	7-9(-9.5)	(3-)3-3.5	2.48
BCN-Hoyo 128	(7-)7.5-9(-9)	3-4(-5)	2.21
BCN-Hoyo 179	7-8	3-4(-4.5)	2.18

Slight differences, however, can be noticed. Firstly, the basidia and basidiospores measurements given by Maire (1933) are slightly smaller. On the one hand, a rather high variability was observed in our material, both in length and shape (Table 1). On the other hand, KOH was used to rehydrate our material, which is known to swell the structures. Conversely, the measurements of Maire were probably not taken in the same medium. Those phenomena might thus explain the differences found. Secondly, according to our observations, the colour of the sclerotia can vary from pale brown to dark brown. Although this characteristic does not exactly coincide with the protologue, the colour observed in part of the examined material is noticeably lighter than in most of *Typhula* species. The shape of the sclerotium is also variable, as Maire pointed out.

On the basis of all these observations, we consider that the examined material undoubtedly belongs to *T. buxi*. Furthermore, this view is supported by examinations of material from the type location. Berthier (1976) included *T. buxi* in the subgenus *Cnazonaria* (characterized by possessing an inverse epidermoid layer) but did not explain why he did so. Berthier was not able to verify the structure of the sclerotium because no original material of *T. buxi* was known (Berthier 1976) and the description of Maire (1933) was prior to the development of the knowledge of the sclerotial structure (Remsberg 1940, Berthier 1974, 1976). After examining our material, it is clear that *T. buxi* belongs instead to the subgenus *Microtyphula*, since it has a normal epidermoid layer without cutis.

As noted above, Maire (1933) cited *T. erythropus* as a species related to *T. buxi*. *T. erythropus* is a very well-known species that has been described and

illustrated in several works (Corner 1950; Koske 1974, 1975; Berthier 1976; Maas Gesteranus 1976; Breitenbach & Kranzlin 1986). Some characteristics are shared by both species, such as the slender basidiomata that are longer than in other *Typhula* species, a dark lower stipe, amyloid basidiospores, and a normal epidermoid layer without cutis. This last character is the reason why both species are ascribed to the subgenus *Microtyphula*. Furthermore, the epidermoid layer of both species is composed of cells with characteristic sinuous or undulate outline. The differences between the two species are summarised in Table 2.

Table 2. Distinctive characteristics between *T. buxi* and *T. erythropus*. The colours have been noted from fresh material

	T. buxi	*T. erythropus*
Caulinar hairs	Cylindrical, sinuous, with widened base	Conical, septate
Clavula	Greyish white, yellowish grey, pale ochre	White
Sclerotium	Pale brown, ochre, dark brown	Dark brown, blackish brown
Habitat	Dead leaves of *Buxus sempervirens*	Dead leaves of various hardwoods: *Acer, Alnus, Corylus, Fraxinus,...* Rarely other substrata
Basidiospores (X)	7-9 × 3-5 µm	5.5-8 × 2-4 µm

The substrates of *T. erythropus* and *T. buxi* seem to be different. While most sclerotia of *T. erythropus* are found on petioles, those of *T. buxi* are usually found on limbs. The oblong form of the sclerotia of *T. erythropus* might be an adaptation to growing on petioles, which has not been observed in the examined material of *T. buxi*. Conversely, more rounded sclerotia are found in *T. buxi*, as they develop on limbs. Basidiospore sizes sometimes overlap in both species, but the basidiospores of *T. erythropus* are often smaller than those of *T. buxi*.

No type was designated for *Typhula buxi* by Maire (1933) in his original description. Furthermore, the type specimens could not be located in any of the five herbaria where Maire's collections are curated (Stafleu & Cowan 1981, Holmgren & Holmgren 1998): **PC** (B. Duhem, pers. comm.), **MPU** (no response after repeated requests; Berthier's 1976 note, "*pas de specimens conservés dans l'herbier Maire*"), **G** (P. Clerc, pers. comm.), **NCY** (R. Pierrel, pers. comm.), and **AL** (no response after repeated requests).

Therefore, in accordance with Art. 9.2 of the International Botanical Code of Nomenclature (McNeill et al. 2006), we propose as lectotype Figure 4 in Maire

(1933), which is another element cited by the author in the protologue. As the sclerotial structure of *T. buxi* can neither be inferred from the protologue nor verified from any original collection, in accordance with Art. 9.7 of the Code (McNeill et al. 2006), we designate an epitype in order to interpret the protologue correctly and verify the taxonomic position of the species. A specimen from the type locality has been selected as epitype.

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We feel very indebted to Svengunnar Ryman, who guided us through the typification of *T. buxi*. We also thank Luis Alberto Parra for giving us useful nomenclatural advices. We express our gratitude to Irenela Melo and Jack D. Rogers for reviewing the manuscript of this article, as well as to B. Duhem (PC), P. Clerc (G) and R. Pierrel (NCY) who gently provided us information about the *T. buxi* collections. This work has been partially supported by a "grant for the Formation of Researchers of the Basque Government (2002/2003)" and by the Dept. d'Universitats Recerca i Societat de la Informació (2005SGR01047 Catalan Government).

Literature cited

Berthier J. 1974. Le genre *Typhula* (Clavariacées) et les genres affines. Classification. Espèces nouvelles Bull. Mens. Soc. Linn. Lyon 43(6): 182-188.

Berthier J. 1976. Monographie des *Typhula* Fr., *Pistillaria* Fr. et genres voisins. Número special. Bull. Mens. Soc. Linn. Lyon 45.

Breitenbach J, Kranzlin F. 1986. Champignons de Suisse. N° 2. Ed. Mykologia. Lucerne.

Corner EJH. 1950. A Monograph of *Clavaria* and allied genera. Oxford University Press. London.

Fries E. 1818. Observationes Mycologicae praecipue ad illustrandam floram Suecicam. Pars II. Hauniae.

Fries E. 1821. Systema mycologicum. I. Lund. Berlin. 520 p.

Holmgren PK, Holmgren NH. 1998 onwards (continuously updated). Index Herbariorum. New York Botanical Garden. [http://sciweb.nybg.org/science2/IndexHerbariorum.asp. (viewed online on 9 January 2007)].

Hoyo P, Gómez-Bolea A. 2003. Contribución a los hongos que viven sobre *Buxus sempervirens*. XIV Symposium of Cryptogamic Botany. Murcia.

Jülich W. 1984. Die Nichtblätterpilze, Gallerpilze und Bauchpilze Kleine. Kryptogamenflora Band II. Gustav Fischer Verlag. Stuttgart. 597 p.

Karsten PA. 1882. Rysslands, Finlands och den Skandinaviska halföns Hattsvampar. Sednare Delen: Pip-, Tagg-, Hud-, Klubb- och Gelésvampar. Bidrag till Kännedom af Finlands Natur och Folk 37. 257 p.

Koske RE. 1974. *Typhula erythropus*: Field history, germination of basidiospores, mycelial growth, and sclerotial formation. Mycologia 66: 298-318.

Koske RE. 1975. *Typhula erythropus*: II. Sclerotial germination and basidiocarp production. Mycologia 67: 128-146.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th ed. CABI Publishing, Egham. 655 p.

Maas Gesteranus RA. 1976. De fungi van Nederland de Clavarioide Fungi (*Auriscalpiaceae*, *Clavariaceae*, *Clavulinaceae*, *Gomphaceae*). Wetensch. Meded. Kon. Ned. Natuurhist. Ver. 113: 1-92.

Maire R. 1933. Fungi Catalaunici. Contributions à l'etude mycologique de la Catalogne. Treb. Mus. Cien. Nat. Barcelona 15 (2): 1-120.

Malençon G, Bertault, R. 1968. Champignons du Maroc. Bull. Soc. Sci. Nat. Maroc 47 (3-4): 237-281. (1967).

McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Regnum Vegetabile 146. 568 p.

Munsell® 1994. Soil Color Charts. New York: Macbeth Division of Kollmorgen Instruments Corporation.

Persoon CH. 1801. Synopsis fungorum. Göttingen. 706 p.

Pilát A. 1958. Přehled hub kyjankovitých-Clavariaceae se zvláštním zřetelem k československým sruhům. Sborn. Nár. Mus. v Praze, Řada B, Přír. Vědy 14 (3-4): 129-255.

Remsberg RE. 1940. Studies in the genus *Typhula*. Mycologia 32: 52-96.

Stafleu FA, Cowan RS. 1981. Taxonomic literature. Volume III: Lh-O. Bohn, Scheltema & Holkema. Utrecht.

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Cyathicula brunneospora and *Pirottaea atrofusca*, two new *Helotiales* from Tian Shan (Kazakhstan)

MARKÉTA CHLEBICKÁ[1] & ANDRZEJ CHLEBICKI[2*]

marketa_chlebicka@nm.cz
[1]Mycological Department, National Museum
Václavské nám. 68, CZ-115 79 Praha 1, Czech Republic

**ibchlebick@ib-pan.krakow.pl*
[2]Polish Academy of Sciences, W. Szafer Institute of Botany
Lubicz 46, PL-31-512 Kraków, Poland

Abstract—Two new species from Tian Shan are described: *Cyathicula brunneospora* on *Anthoxanthum alpinum* and *Carex griffithii* and *Pirottaea atrofusca* on *Festuca coelestis*. New combinations *Cyathicula melanospora* and *Cyathicula* sect. *Scelobelonium* are proposed.

Key words—discomycete, taxonomy, graminicolous fungi, caricicolous fungi

Introduction

Ascomycete fungi of the western part of Tian Shan have been described only sporadically. Schwartzman (1962) listed fungi from such genera as *Cenangium* Fr., *Erysiphe* R. Hedw. ex DC., *Geoglossum* Pers., *Gyromitra* Fr., *Helvella* L., *Lophodermium* Chevall., *Mitrula* Fr., *Morchella* Dill. ex Pers., *Naemacyclus* Fuckel, *Otidea* (Pers.) Bonord., *Phyllactinia* Lév., *Podosphaera* Kunze, *Rhytisma* Fr., *Sarcoscypha* (Fr.) Boud., *Sphaerotheca* Lév., *Terfezia* (Tul. & C. Tul.) Tul. & C. Tul., *Uncinula* Lév., and *Venturia* Sacc. Among the hyaloscyphaceous fungi from Tian Shan cited by Raitviir (2004) are *Cistella tianschanica* Raitv. and *Hyalopeziza tianschanica* Raitv. In 2005 we collected fungi from the upper limits of where plants grow in Central Tian Shan. We noted mostly saprotrophic and parasitic species, including *Cainia graminis* (Niessl) Arx & E. Müll., *Lophodermium alpinum* Rehm, *Lachnellula arida* (W. Phillips) Dennis, *Comoclathris planispora* (Ellis) Harr, *Wettsteinina oreophila* Shoemaker & C.E. Babc., and others. Amongst our materials we also found new and very rare species belonging to basidiomycete and ascomycete groups. In this article we describe two new species, which belong to *Helotiales*.

Methods

Dried material was examined, measured and prepared under a zoom stereo microscope (Nikon SMZ 1500, Olympus SZ 61), and also with a light microscope (LM) Olympus BX-51 equiped with an oil immersion lens, at magnifications of 1000x and 2000x (using a magnification changer), and in some cases using Nomarski contrast (DIC). Line drawings were produced using a drawing tube. Microscopical observations and measurements are based on herbarium material prepared in 3% KOH unless otherwise indicated. Freehand-made longitudinal sections of apothecia were observed in water or 3% KOH. Lugol's solution (IKI: 1% iodine, 3% KI in water), Melzer's reagent (MLZ), and 5% KOH were used to describe the reactions of apical rings and character of setae for *Pirottaea*. Gelatinous sheaths of free ascospores were observed in India ink. Materials are deposited at the National Museum in Prague (Czech Republic) and the W. Szafer Institute of Botany of Polish Academy of Sciences in Kraków (Poland).

Cyathicula brunneospora M. Chleb. & Chleb., **sp. nov.** FIGURES 1-3

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Diagnosis: *A specie Belonidium melanosporum Rehm ascis inamyloideis, sporis permanenter brunneis atque laevibus, absentia strato excipuli ex cellulis magnis prismaticis biserialiter ordinatis discrepat.*

Etymology: The specific epithet refers to the brown ascospores.

SPECIMENS EXAMINED: **KAZAKHSTAN, Tian Shan: Zailijskij Alatau Mts.**, valley of Issyk (Yssyk) river, upstream from the point where Issyk divides into two brooks, at the moraine of the south brook, N 43° 07' 45", E 77° 30' 32", 3490 m elev., on fallen dead culms of *Anthoxanthum alpinum* Á. Löve & D. Löve, 7 August 2005, coll.: M. Suková (Chlebická), **HOLOTYPE**–*PRM 907424*. **Tian Shan: Zailijskij Alatau Mts.**, Issyk valley, N 43° 07' 52.5", E 77° 30' 25", 3445.5 m elev., on *Carex griffithii* Boott, 3 August 2005, coll.: A. Chlebicki, PARATYPES: *KRAM "F": 55679, 55680, 55681, 55682, 55683.*

Description: **Apothecia** cupulate, 0.2-0.7 mm high, 0.3-1.1 mm in diam. when dry, shortly stipitate, margin non dentate, receptacle olive brown or dark blackish brown, covered with pale powder at margin and less densely at flanks, stalk pale brown or dark brown, disc dark olive-brown or dark brown, mature apothecia open when moist and staying open or becoming closed on drying. **Excipulum:** Outer layer of ectal excipulum dark brown, inner layer and medulla hyaline, hymenium dark brown. The ectal excipulum composed of parallel hyphae in a gelatinous matter, oriented at a low angle or almost parallel to the surface (textura oblita). Rhomboid crystals on the outer surface of the apothecium present (observed in water). The medullary excipulum composed of freely intertwined hyphae (textura intricata). **Asci** 113-119 x 13.5-16 µm, cylindric-clavate, non-stipitate or rarely very shortly stipitate, arising from croziers, 8-spored, with biseriate ascospores, apical ring without any reaction in MLZ,

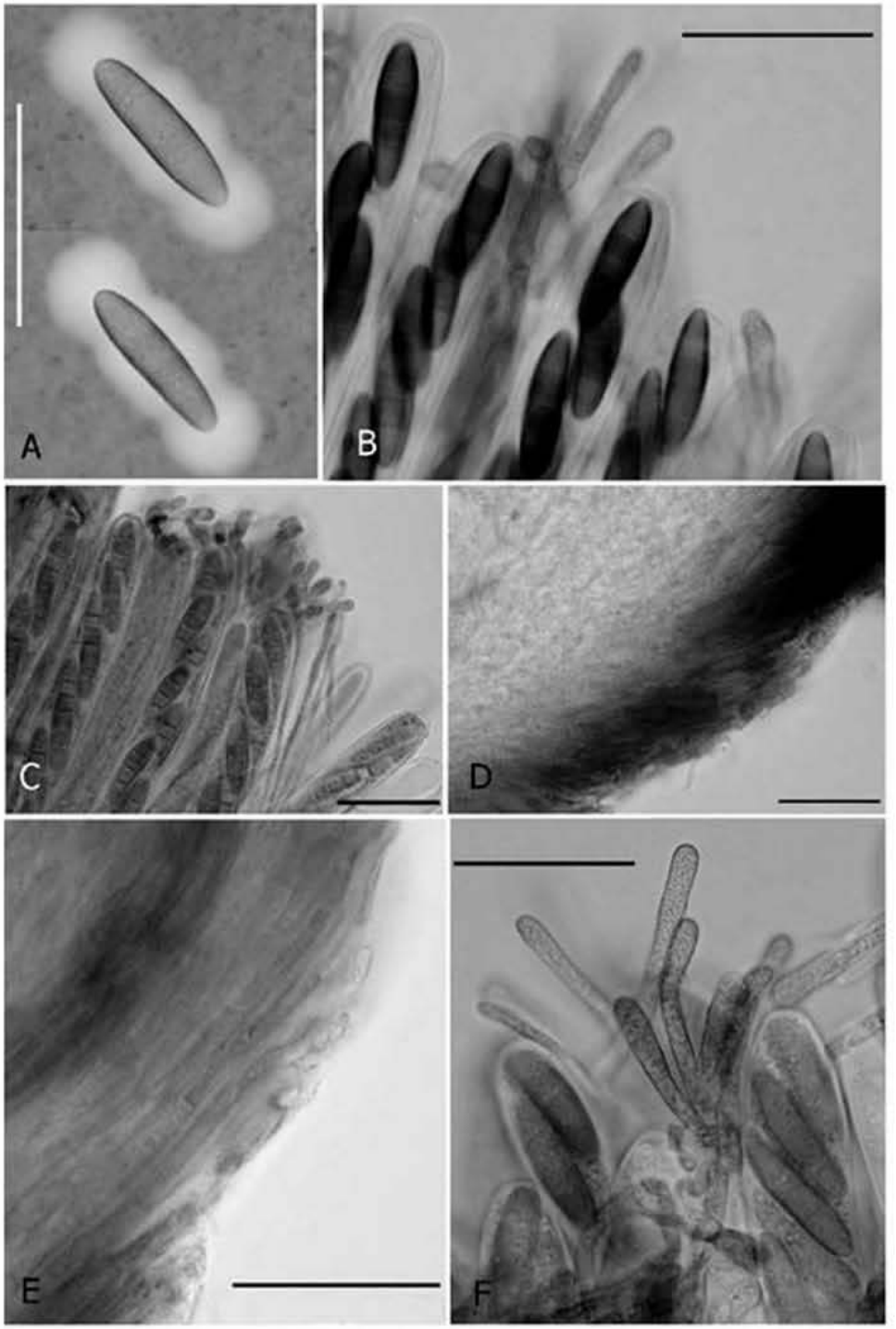

Fig. 1. *Cyathicula brunneospora*: A: ascospores with gelatinous sheaths (India ink); B: ascus apices (5% KOH/MLZ); C: hymenium (5% KOH/IKI); D: ectal excipulum and medulla (water); E: ectal excipulum (water); F: paraphyses and asci (water). Scale bars A-F: 30 µm.

KOH/MLZ, IKI, KOH/IKI. **Ascospores** elliptic-fusoid, pale brown when young, dark brown when mature (brown when observed in water), always smooth, 3-septate, very rarely up to 7-septate, 23-29.5 x 5.9-7.2 µm, surrounded by a hyaline, gelatinous sheath, which is constricted at the end spore cells, 5.8-8.6 µm thick at spore ends and 3.5-5.3 µm thick at the middle spore septum. **Paraphyses** cylindric-clavate, hyaline and septate in their lower parts (1.9-2.6 µm broad), branched and septate in their upper parts, with enlarged, 3.8-4.5 µm broad, smooth, pale brown tips (Figs. 1-3).

Comments–*Cyathicula brunneospora* is close to *Cyathicula melanospora* (syn. *Crocicreas melanosporum*). The latter occurs in arctic and alpine habitats on culms of *Poaceae*, stems of *Juncaceae* and dicotyledonous herbs and is known from Finland, Switzerland, Austria and USA (Carpenter 1981, Müller 1977, Rehm 1893, Vesterholt 2000). *Cyathicula brunneospora* is known only from the vicinity of the type locality (Asia, Kazakhstan); however, it is possible that other Asian material of the species may be deposited in herbaria currently identified as *Crocicreas melanosporum*. Ascospores of *Cyathicula melanospora* are hyaline when young (Rehm 1882, Carpenter 1981) and roughened in maturity (Carpenter 1981). In *Cyathicula brunneospora* we observed that ascospores are permanently smooth and early becoming pale brownish in youth. The main difference is in the amyloidity of the ascoapical ring, which in *C. brunneospora* is unreactive in MLZ and IKI (with or without KOH pretreatment) but in *C. melanospora* is light blue in MLZ (Carpenter 1981) and violet in IKI (Rehm 1882, Rehm 1893: 747). In contrast to *C. melanospora* of Carpenter's description and drawing, in *C. brunneospora* the excipulum lacks the thin layer with two rows of big prismatic cells. Such a layer is present on the flanks and at the margin of the excipulum in *C. melanospora*. Mature apothecia are cup-shaped in *C. brunneospora* while Carpenter (1981) describes the apothecia of *C. melanospora* as remaining closed (unopened) in maturity, citing 15 collections including the type collection. The difference in apothecial opening between *C. brunneospora* and *C. melanospora*, however, become irrelevant, when checking Rehm. Rehm (1882) originally described the apothecia of *C. melanospora* as "perithecia" urceolate-turbinate and later (Rehm 1893) reported on the same collection that apothecia are at first closed and then opening.

In agreement with Baral (2005), we accept that *Crocicreas* Fr. (type species *C. gramineum* (Fr.) Fr.) is not congeneric with *Cyathicula* De Not. (type species *C. coronata* (Bull.) De Not. ex P. Karst.). Paraphyses of *Crocicreas gramineum* are of two intergrading morphologies, lanceolate and cylindrical (Carpenter 1981), while paraphyses of *Cyathicula* are cylindrical to clavate. Further differences between the two genera include the shape of the ascus apical ring (Triebel & Baral 1996), which is, however, not well described in *C. melanospora* and non-

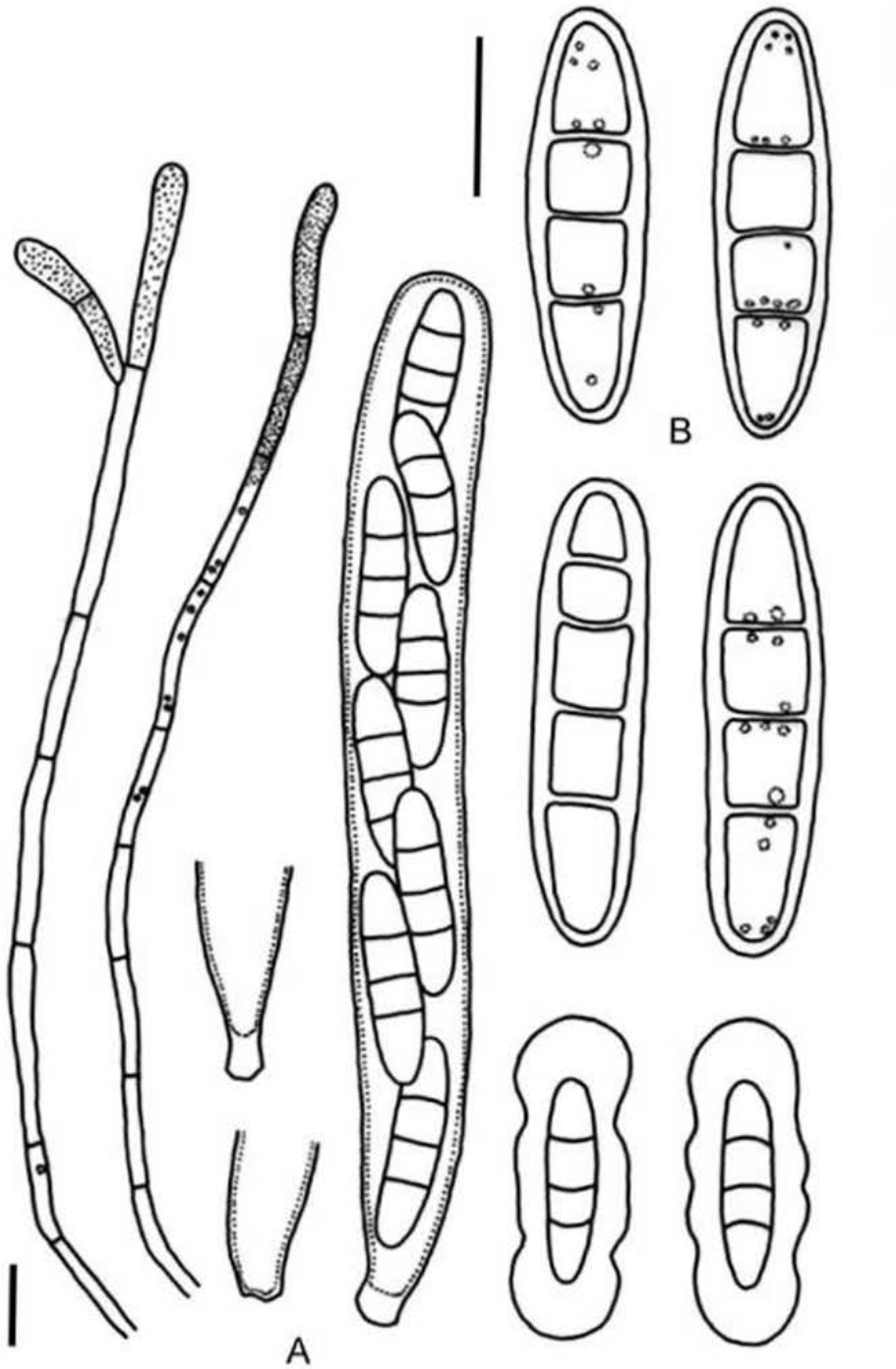

Fig. 2. *Cyathicula brunneospora*: A: paraphyses, bases of asci, ascus (3% KOH) and ascospores with gelatinous sheaths (India ink); B: ascospores (3% KOH). Scale bars A-B: 10 µm.
Note: Brown colour of ascospores is not depicted in these drawings.

amyloid in *C. brunneospora*. According to Svrček (1979), species of *Cyathicula* with apothecia without marginal dents should be placed in a separate genus, *Conchatium* Velen. We do not accept Svrček's opinion and place our new species together with *C. melanospora* (both with non-dentate apothecia) into the genus *Cyathicula*.

Cyathicula melanospora (Rehm) M. Chleb. & Chleb., **comb. nov.**

MycoBank MB 510549

Basionym: *Belonidium melanosporum* Rehm, Hedwigia 21: 100, 1882.

- = *Belonium melanosporum* (Rehm) Sacc., Sylloge Fungorum 8: 496, 1889.
- = *Belonioscypha melanospora* (Rehm) Rehm, Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, 2. Ed., 1(3): 746, 1893.
- = *Scelobelonium melanosporum* (Rehm) Höhn., Annalen des K.K. Naturhistorischen Hofmuseums Wien 20: 367, 1905.
- = *Crocicreas melanosporum* (Rehm) S.E. Carp., Brittonia 32: 270, 1980.

In our opinion, *Cyathicula culmicola* (Desm.) S.E. Carp. & Dumont, *C. melanospora,* and *C. brunneospora* form a separate group within the genus *Cyathicula* based on their characteristic ascospores (relatively thick-walled and with a gelatinous sheath) and also apically enlarged, at least rarely branched paraphyses. The members of this group occur from colline (e.g. Velenovský's material of *C. culmicola* from the vicinity of Mnichovice examined by Carpenter 1981: 60, specimens PRM 150416, 150417 and 150467) to alpine altitudes and are known from grass culms, stems of *Juncaceae* and *Cyperaceae*, and several dicotyledonous plants. We would prefer to separate this group as a section of *Cyathicula*. To separate the group at generic level, it should need molecular taxonomic methods. The name *Belonioscyphae* (derived from Rehm's *Belonioscypha*) would be appropriate for this section from a taxonomical point of view. We agree with Stadelmann (1978) and Carpenter & Dumont (1978) and accept *Belonioscypha culmicola* (Desm.) Dennis as the lectotype species of the genus. Von Höhnel (1918) and Nannfeldt (1932) considered another species—*Belonioscypha campanula* (Nees) Rehm—as the lectotype ("die Grundart", pseudotypus), however, this lectotypification is based on mechanical method of selection (Art. 10.5.b. of the Vienna Code). The characters sketched in the original generic description of *Belonioscypha* by Rehm (1893) generally agree with our conception of the section, with these few differences: we here include only species with ascospores enclosed by gelatinous sheath, species with as well as without reaction of ascoapical ring in IKI and species with hyaline as well as brown paraphyses. According to Stadelmann (1978), two additional species (*Belonioscypha miniata* Kanouse and *B. alpina* Stadelmann) with ascospores sometimes encased in gelatinous sheaths might possibly belong to the section, but we cannot judge the character of the ascospore wall from Stadelmann's drawings.

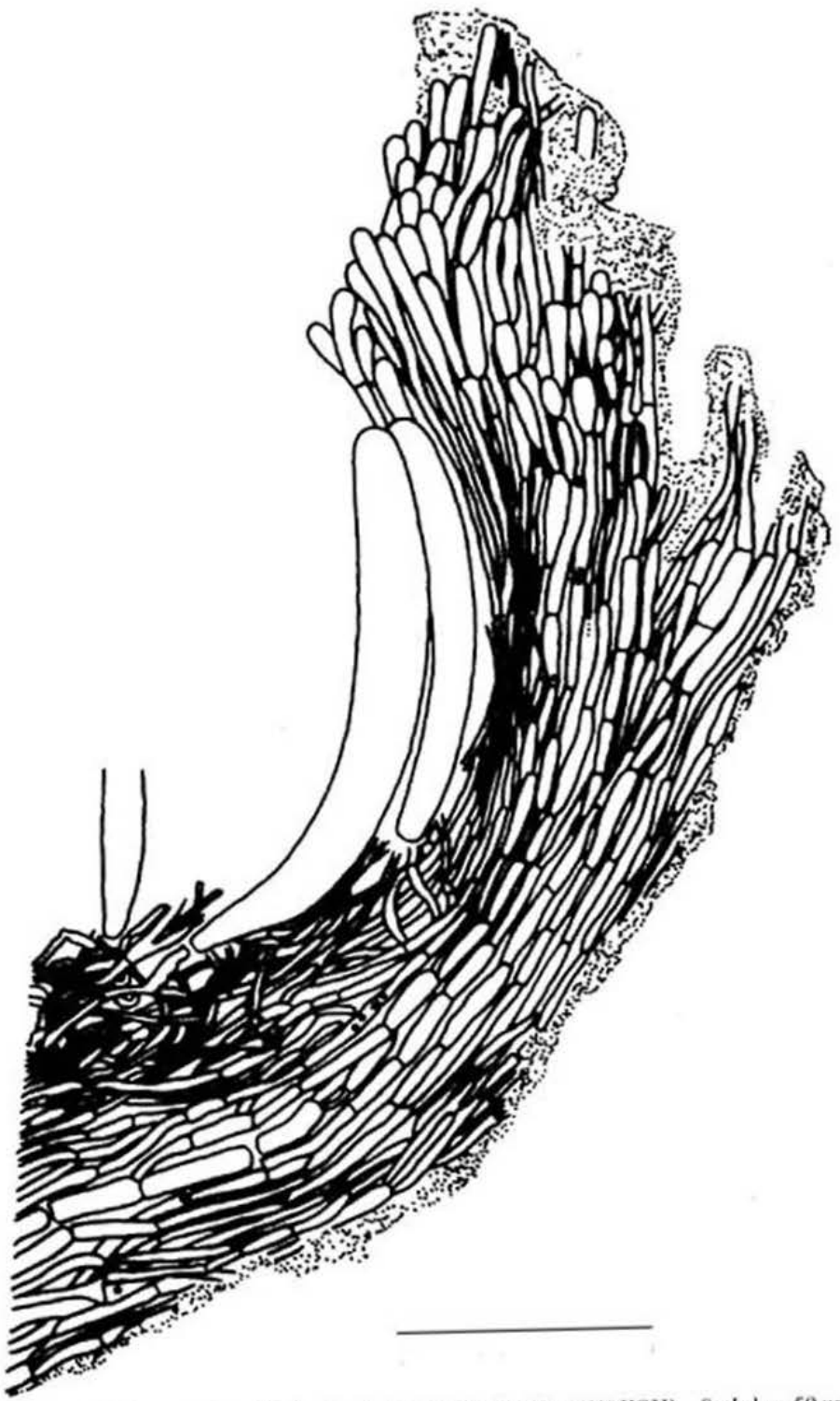

Fig. 3. *Cyathicula brunneospora*: Excipulum in longitudinal section (3% KOH). Scale bar: 50 µm.

Saccardo (1889) had another concept: he considered the colour of the apothecia as a defining character. On this basis he distinguished between *Belonium* Sacc. (species with black or brown apothecia) and *Belonidium* Mont. et Durieu (species with apothecia of pale colours). Representatives of Rehm's genus *Belonioscypha* belonged in Saccardo's work to *Belonium* sect. *Scelobelonium* Sacc. and *Belonidium* sect. *Podobelonium* Sacc. Saccardo created these two sections for those species of each genus with stalked apothecia.

Section *Scelobelonium* (Saccardo 1889) originally contained only *Belonium melanosporum* (Rehm) Sacc., one of the species of our proposed section within *Cyathicula*. *Belonioscypha* has priority over *Scelobelonium* at generic rank, but the latter has priority at the rank of section. We therefore retain the name *Scelobelonium* for our proposed section, although this involves far greater emendation than would be required for a section based on *Belonioscypha*. We include in the section also a species with pale-coloured apothecia, *Cyathicula culmicola*, which Saccardo placed under *Belonidium* sect. *Podobelonium* as *B. vexatum* De Not.

No lectotype was probably proposed for *Podobelonium* (Sacc.) Sacc. & D. Sacc. until Carpenter (1981) designated *Peziza campanula* Nees. As we agree with Dennis (1956: 40) and Cooke (1961) that *Peziza campanula* (*Calyptella campanula* (Nees) W.B. Cooke) represents a basidiomycete, the name *Podobelonium* has no relevance to our section.

Cyathicula* sect. *Scelobelonium (Sacc.) M. Chleb. & Chleb., **comb. nov.**
MycoBank MB 510550

Basionym: *Belonium* sect. *Scelobelonium* Sacc., Sylloge Fungorum 8: 496, 1889.

= *Scelobelonium* (Sacc.) Höhn., Annalen des K.K. Naturhistorischen Hofmuseums Wien 20: 367, 1905.

Type species: *Belonium melanosporum* (Rehm) Sacc.

Syn.: *Belonioscypha* Rehm, Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, 2. Ed., 1(3): 743, 1893. – Type species: *B. vexata* (De Not.) Rehm [= *B. culmicola* (Desm.) Dennis fide Saccardo (1889: 503), Dennis (1956: 39)], lectotype designated by Clements & Shear (1931).

Our delimitation of the section: Apothecia white, pale-coloured to blackish-brown, ascospores hyaline to brown, (septate), relatively thick-walled and with gelatinous sheath, paraphyses hyaline to brown, apically enlarged, at least rarely branched. We include in the section *Cyathicula culmicola, C. melanospora* and *C. brunneospora*.

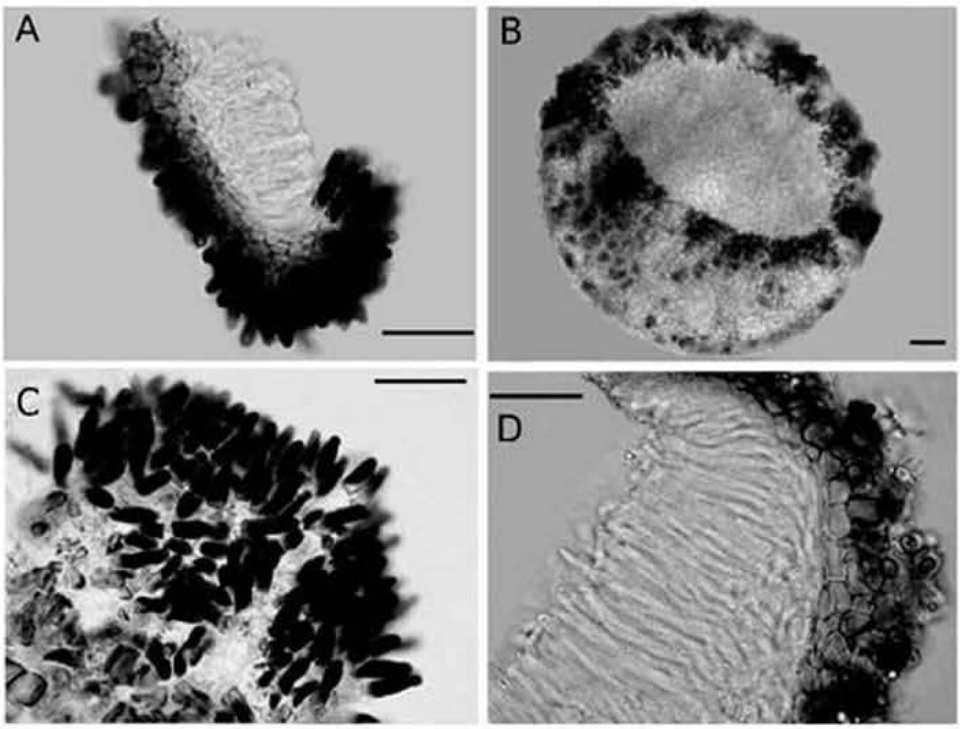

Fig. 4. A-C: *Pirottaea atrofusca*: A: excipulum in longitudinal section (3% KOH); B: apothecium rehydrated in water; C: setae on outer surface of apothecium (3% KOH); D: *Pirottaea* cf. *imbricata* PRM 877304: excipulum in longitudinal section (3% KOH). Scale bars A-D: 20 µm.

Pirottaea atrofusca Chleb. & M. Chleb., **sp. nov.** FIGURES 4, 5

MycoBank MB 510375

Diagnosis: *Apotheciis minutis 50-180 µm diam., Pirottaeae imbricatae similis sed differt setis spathulatiformibus vel navicularibus, minoribus 4-13.5 x 4-4.5(-5) µm, non-septatis et sporiis longioribus (8)9-11 x 1.5-2.2 µm, atque habitatione in Festuca coelestis.*

Etymology: The specific epithet refers to the distinctly brown-black apothecia.

SPECIMENS EXAMINED: **KAZAKHSTAN, Tian Shan: Zailijskij Alatau Mts.,** valley of Issyk (Yssyk) river, N 43° 07' 52.5", E 77° 30' 25", 3445.5 m elev., on leaves of *Festuca coelestis* (St.-Yves) Krecz. & Bobr., 3 August 2005, coll.: A. Chlebicki, **HOLOTYPE**-*KRAM "F" 55672.*

Description: Apothecia cup-shaped, sessile or rarely very shortly stalked, (50-) 60-120 µm in diam. when dry, rehydrated up to 180 µm diam., 40-60 µm high, dark brown to nearly black, disc cream-white to pale brown. **Setae** densely distributed in upper part of apothecium (**Fig.** 4), arranged into short irregular streaks narrowing toward the base, brown in water, dark brown in 5% KOH, reddish brown in MLZ after 5% KOH, main part of seta dark brown, basal part distinctly paler (Figs. 4, 5), ± spathulate to naviculate (wider in the upper

part) with slightly tapered or hemispherical head, solid part 4-13.5 x 4-4.5(-5) µm, with refractive wall, matrix not losing refractiveness in 5% KOH, lumen restricted to base. **Grana** sparse to abundant, especially below streaks of the setae, dark and thick-walled. **Ectal excipulum** textura angularis, cells pale brown. **Asci** arising from croziers, ± cylindric-clavate, 8-spored, narrower in the upper part (32-)38-42 x 4.5-5.2 µm (dead state in water), IKI+ pale blue, KOH/MLZ+ blue. **Ascospores** aseptate, hyaline, narrowly fusoid, (8-)9-11 x 1.5-2.2 µm (dead state in water), with two oil drops (in 3% KOH), irregularly biseriate in dead asci. **Paraphyses** filiform, up to 1.2 µm broad, not exceeding the asci, 0-1 septate in lower part (**Fig.** 5).

Comments–The ectal excipulum of this fungus is composed of textura angularis whereas in the similar genus *Venturiocistella* Raitv. (*Hyaloscyphaceae*) it is composed of textura angularis-prismatica (Raitviir 2004). However, a graminicolous species, *V. heterotricha* (Graddon) Baral possesses ectal excipulum composed of brownish textura globulosa characteristic to the *Dermateaceae* and belongs to an undescribed genus of the *Dermateaceae* (Raitviir 2004). Also Baral (2005) noted some differences between *V. heterotricha* and *Venturiocistella* s. str., such as smooth hairs and setae, and thick hyaline to pale brown wall of spores. The textura of our fungus is characteristic to the *Dermateaceae*. The presence of hairs or setae is also known from some *Dermateaceae*; therefore, we place the fungus into this family. Our specimen is very similar to *Pirottaea imbricata* Nannf. This species possesses mostly non-septate setae with obtuse ends. Nannfeldt (1985) pointed out that the apothecial margin of *P. imbricata* is bordered by short setae evolved from lateral hairs. Such origin of the setae can indicate connection with the genus *Pyrenopeziza* Fuckel. Apothecia of the genus *Pyrenopeziza* sensu Hütter (1958) are covered by marginal hairs (Müller 1989) and very rarely by protuberances called 'grana' ("Excipulumauswüchse"), or are devoid of any hairs, whereas lateral setae and grana are commonly found in *Pirottaea*. Setae can be considered as structures delimited with distinct, thick septa, which separate them from the ectal excipulum (Nannfeldt 1985, Müller 1989, Nauta & Spooner 2000). Lateral hairs are hypha-like, mostly hyaline or pale brown structures originated from grana or pale-walled excipular cells (Nannfeldt 1985) as in *Pyrenopeziza millegrana* Boud. The 'hair' structures of our specimen and specimen H.B. 4922a (cited below) can therefore be named true setae, sensu Nannfeldt. Hence we place the new species into the genus *Pirottaea*.

There are 52 described species of *Pirottaea* in Index Fungorum. Baral (2005) illustrated some specimens he tentatively referred to *P. imbricata*. Especially his drawing no. H.B. 4922a, illustrating a specimen collected by Karl Helm on *Laserpitium latifolium* L. in Austria, possesses setae very similar to the setae of our fungus. Setae of both fungi have the same width from base to apex, and

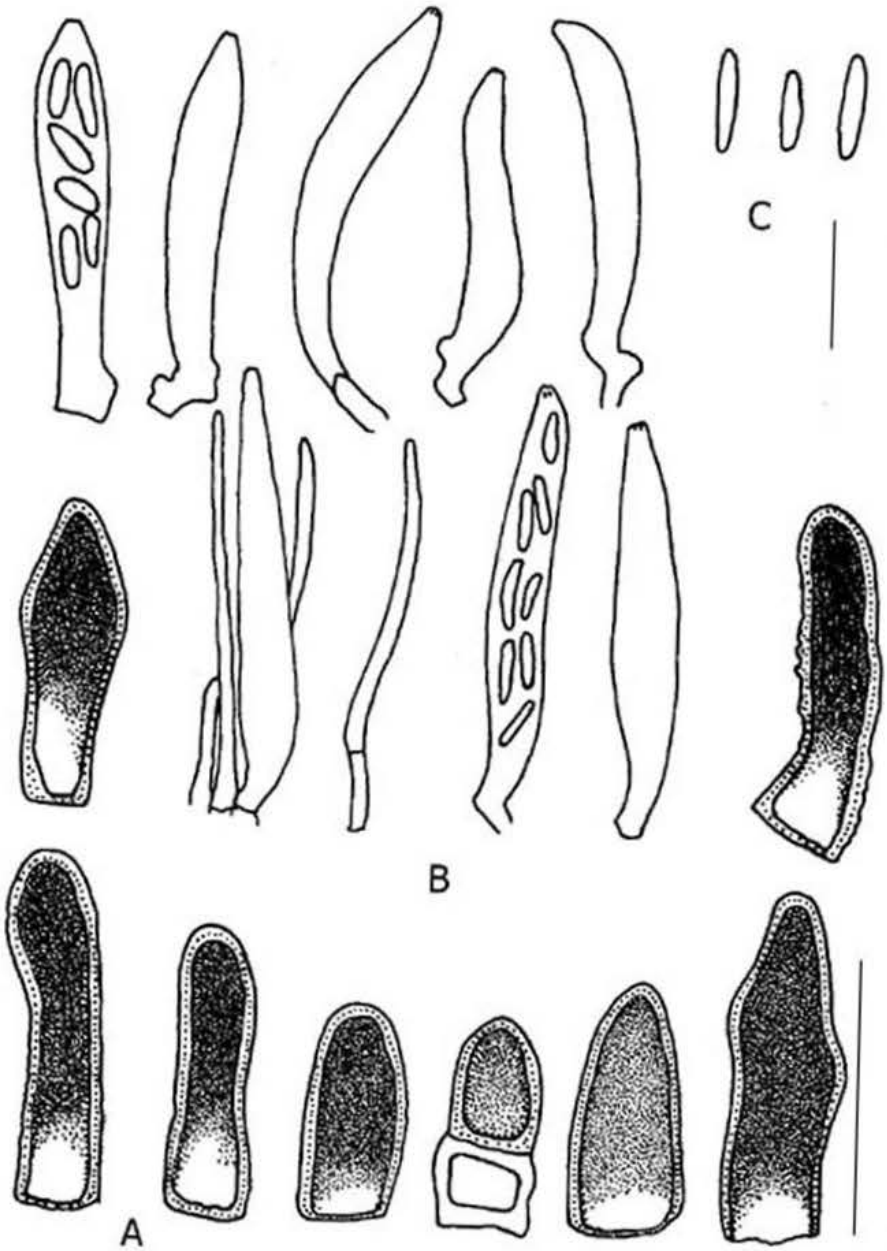

Fig. 5. *Pirottaea atrofusca*: A: setae (3% KOH); B: asci and paraphyses (water); C: ascospores (water).
Scale bars A-C: 10 µm.

their upper part is solid while the lumen is restricted to the lower 1/2-1/4 of the setae. There are also some differences. The specimen from *Laserpitium* has slightly longer (9-21 x 3.5-5.3 µm), light to medium yellowish-brown setae and distinctly bigger apothecia (450 µm diam.). Another specimen (H.B. 7551a, on *Leycesteria formosa* Wall., leg. E. Batten, from England) possesses septate setae with dark brown walls which are solid along one lateral face, not at the apex, and are arranged in more regular streaks and abundant grana. The setae of *P. imbricata* (Nannfeldt 1985) are cylindrical, with hemispherical tips, and are strongly constricted at the septa while an internal solidification is not mentioned. The setae of *P. atrofusca* are spathulate or naviculate with slightly tapered heads (see Tab 1). According to Nannfeldt (1985) and Holm & Nannfeldt (1992) a specimen published as '*P. imbricata*' on *Valeriana* spp. proved to be an independent taxon. It is possible that each of the taxa presented in Tab. 1 belongs to a separate species.

Table 1. Comparison of selected characters of *Pirottaea atrofusca* and *P. imbricata*

Characters	*P. atrofusca* This article	*P. imbricata* Nannfeldt (1985)	*P. imbricata* Baral (2005) HB 4922a	*P. imbricata* PRM 877304
Diam. of apothecia (µm)	Dry: (50)60-120 rehydrated: 180	Dry: 100-150	Fresh: up to 450	Dry: 100-160 rehydrated: 160
Setae (µm)	Non-septate, 4-13x4-4.5(5), spathulate or naviculate with slightly tapered head	Mostly non-septate, 6-15x3(4), cylindrical with hemispherical head	Non-septate, 9-21x3.5-5.3 cylindrical to naviculate with slightly tapered head	0-2-septate, 9.6-16x(3.1)4-4.8 cylindrical to clavate with rounded head
Ascus size (µm)	(32)38-42x4.5-5.2	30-40x4	39-51(57)x6-7.5	36-42x3.7-4.6
Spore size (µm)	(8)9-11x1.5-2.2	6-8x1-1.5	(6)7.5-10x2-2.2	7.3-9(10)x1.8-2
Paraphyses (µm)	1.2 wide, 0-1 septate	No information	1.7-2.3 wide, 1-septate	1.5-2.4 wide, 1-3 septate
Host	*Festuca coelestis*	*Cirsium oleraceum*	*Laserpitium latifolium*	*Valeriana sambucifolia*

Nannfeldt (1985) considered it difficult to draw precise limits between the genera *Pyrenopeziza* and *Pirottaea* because the large genus *Pyrenopeziza* is insufficiently investigated. It is also difficult to provide a clear distinction between the *Pirottaea imbricata* group and other lineages of the genus

Pirottaea. According to Nannfeldt (1985) there are four independent lineages within *Pirottaea*, each of which can be connected to hypothetical ancestors of *Pyrenopeziza* species. The *P. imbricata* group to which our species belongs, has been placed in his fourth lineage. Nannfeldt pointed out that the "crucial features of this lineage are the thick wall of the setae (including basal septum) and the "double" septa between all or most cells in septate setae". *P. atrofusca* possesses mostly non-septate setae, whereas the true *P. imbricata* and specimen H.B. 7551a have both non-septate and septate setae. There are also transitional species such as *P. geraniicola* Nannf., *P. paupercula* Nannf. and *P. trichostoma* (Kirschst.) E. Müll. & Arx, which possess distinctly septate marginal setae. Nannfeldt (1985) suggested that fungi from the genus *Pirottaea* are host specialized with narrow host-spectra. Members of the *P. imbricata* group inhabit *Laserpitium latifolium* (Baral 2005), *Cirsium oleraceum* Scop., *Valeriana sambucifolia* Eichw., *Cynanchum vincetoxicum* Pers. (Nannfeldt 1985) and *Festuca coelestis* (this article).

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Literature cited

Baral HO. 2005. In vivo veritas. Ed. 3. Manuscripts including macro- and micrographs distributed by the author on DVD.

Carpenter SE. 1981. Monograph of *Crocicreas*. Mem. New York Bot. Gard. 33: 1–290.

Carpenter SE, Dumont KP. 1978. *Leotiaceae* I. Nannfeldt's *Phialeoideae*: The genera *Belonioscypha*, *Cyathicula* and *Phialea*. Mycologia 70: 1223–1238.

Clements FE, Shear CL. 1931. The genera of fungi. H.W. Wilson & Co.: New York. 496 pp. 58 tabs.

Cooke WB. 1961. The cyphellaceous fungi. A study in the *Porotheliaceae*. Sydowia, Beih. 4: 1–144.

Dennis RWG. 1956. A revision of the British *Helotiaceae* in the herbarium of the Royal botanic gardens, Kew, with notes on related european species. Mycol. Pap. 62: 1–216.

Holm L, Nannfeldt JA. 1992. Fungi Exsiccati Suecici, praesertim Upsalienses, fascicle 69. Thunbergia 16: 1–22.

Höhnel Fv. 1918. Fragmente zur Mykologie (XXII. Mitteilung Nr. 1092–1153). Sitzungsber. Akad. Wiss. Wien, Math.-Naturwiss. Kl., Abt. 1, 127: 549–634.

Hütter R. 1958. Untersuchungen über die Gattung *Pyrenopeziza* Fuck. Phytopathol. Z. 33: 1–54.

Müller E. 1977. Zur Pilzflora des Aletschwaldreservats (Kt. Wallis, Schweiz), in: Beiträge zur Krypt. Fl. Schweiz, 15(1): 1–126.

Müller E. 1989. Two new and unusual mollisioid discomycetes. Mem. New York Bot. Gard. 49: 311–314.

Nannfeldt JA. 1932. Studie über der Morphologie und Systematik der nichtlichenisierten und inoperculaten Discomyceten. Nova Acta Reg. Soc. Sci. Upsal., ser. 4., 8: 1–368.

Nannfeldt JA. 1985. *Pirottaea* (Discomycetes Inoperculati), a critical review. Symbolae Botanicae Upsalienses 25: 1–41.

Nauta MM, Spooner B. 2000. British *Dermataceae*: 4B. *Dermateoideae* genera G-Z. Mycologist 14: 65–74.

Raitviir A. 2004. Revised synopsis of the *Hyaloscyphaceae*. Scripta Mycologica 20: 1–133.

Rehm H. 1882. Beiträge zur Ascomyceten-Flora der deutschen Alpen und Voralpen. Hedwigia 21: 97–103.

Rehm H. 1893. Ascomyceten: Hysteriaceen und Discomyceten. Lf. 39. in Rabenhorst's Krypt.-Fl. Deutschl., Oest. und Schweiz, 2. Ed., 1(3): 721–784.

Saccardo PA. 1889. Sylloge Fungorum. 8. Saccardo: Patavii. 1143 pp.

Schwartzman SR. 1962. Materialy k istorii mikoflory Kazakhstana. Izdatelstvo Akademiii Nauk Kazakhskoj SSR: Alma-Ata. 369 pp.

Stadelmann RJ. 1978. Beitrag zur Kenntnis der Discomyceten-Gattung *Belonioscypha* Rehm. Nova Hedwigia 30: 815–833.

Svrček M. 1979. New or less known Discomycetes. X. Česká Mykol. 33: 193–206.

Triebel D, Baral HO. 1996. Notes on the ascus types in *Crocicreas* (*Leotiales*, *Ascomycetes*) with a characterization of selected taxa. Sendtnera 3: 199–218.

Vesterholt J. 2000. *Crocicreas* Fr. 141–145, in L. Hansen, H. Knudsen (eds.), Nordic macromycetes. Vol. 1. Ascomycetes. Nordsvamp: Copenhagen. 309 pp.

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Amaurodon sumatranus (*Thelephorales, Basidiomycota*), a new species from Indonesia

OTTO MIETTINEN[1] & URMAS KÕLJALG[2]

otto.miettinen@helsinki.fi
[1] *Finnish Museum of Natural History, Botanical Museum*
P.O.Box 7, FI-00014 University of Helsinki, Finland

urmas.koljalg@ut.ee
[2] *Institute of Botany and Ecology, University of Tartu*
40 Lai St., EE-51005 Tartu, Estonia

Abstract—*Amaurodon sumatranus*, a resupinate thelephoroid species of *Basidiomycota*, is described from Sumatra, Indonesia. It is related to *A. viridis* and characterised by its turquoise to green, hydnoid hymenophore and broadly ellipsoid, verrucose spores. Both known collections derive from endangered peat swamp forests of the province of Riau.

Key words—taxonomy, rainforest, Southeast Asia

Introduction

Amaurodon is a small genus of currently eight species belonging to the thelephoroid fungi (*Thelephorales*, *Basidiomycota*). The genus is characterised by the resupinate, lignicolous fruit-bodies with poroid, hydnoid or smooth hymenophore, and blue to green colour, along with the violet or bluish violet reaction of spores in KOH, best seen before placing the cover glass on the preparate (Burdsall & Setliff 1974, Kõljalg 1996, Kõljalg & Ryvarden 1997, Agerer & Bougher 2001). *Amaurodon* is closely related to other resupinate thelephoroid genera, viz. *Pseudotomentella*, *Tomentella* and *Tomentellopsis*. All these genera are well-known ectomycorrhiza formers and have a worldwide distribution (Gardes & Bruns 1996, Chambers et al. 1998, Erland & Taylor 1999, Kõljalg et al. 2000, 2002). There is no evidence, however, that species of *Amaurodon* form mycorrhizas.

One of us (O.M.) found two strikingly coloured specimens of *Amaurodon* during his collecting trip to Indonesia in 2002. Both were collected from rotting wood well above ground in a peat swamp forest of the east coast of Sumatra, Indonesia. They proved to be conspecific and related to the species complex

of *A. viridis* (Alb. & Schwein. : Fr.) J.Schröt. Morphological and DNA-based analyses showed that they represent a distinct species, which is here described as the first species from the Old World tropics as *A. sumatranus*.

Materials and methods

During microscopic studies the basic mountant medium used was Cotton Blue (CB), but also 5% KOH was used (see Miettinen et al. 2006 for further detail). Spore and other measurements were made and illustrations were drawn in CB. Measurements were done using ×1000 magnification and phase contrast illumination.

The following symbols are used for spore measurements: L = mean length, W = mean width, Q = L/W, i.e. average length divided by average width, Q' = length/width ratio of individual spores, n = number of spores measured from given number of specimens, for instance 90/3 means 90 spores measured from 3 specimens. In presenting the variation of spore size and Q', the whole range is given in parentheses. The 90% range excluding the extreme 5% of values from both ends is given without parentheses. Whenever the figures within and outside parentheses are identical, parentheses are omitted.

DNA from dried fungal basidiocarps of *A. sumatranus* (holotype), *A. hydnoides* Kõljalg & Ryvarden (isotype in TAA), *A. viridis* (TAA149664), and *A. aquicoeruleus* Agerer (isotype in M) was extracted. The internal transcribed spacers ITS1 and ITS2, and 5.8S regions of nuclear ribosomal DNA were amplified, sequenced and phylogenetic analyses carried out following the methods described in Kõljalg et al. (2000). Sequences are kept in European Molecular Biology Laboratory (EMBL, accession nos AM490941–AM490944) and in UNITE (Kõljalg et al. 2005, accession nos UDB000294 and UDB002293–UDB002295).

Species desription

Amaurodon sumatranus Miettinen & Kõljalg **sp. nov.** **Fig. 1–2**

MycoBank MB510556.

Basidioma resupinatum, byssoideum, separabile. Hymenium hydnaceum, aculeis brevis, circa 1 mm longis, aliquantum spathulatis, subcaerulescens vel luteolo-viride. Systema hypharum monomiticum, hyphae tenuitunicatae, hyalinae vel leviter crassitunicatae, rufescens. Cystidia nulla. Basidiosporae ellipsoideae, verruculosae, leviter crassitunicatae, luteo-fuscae, 4.7–5.7 × 3.7–4.7 µm.

Holotype—Indonesia. Sumatra, Riau: Danau Pulau Besar / Danau Bawah Nature Reserve, on angiosperm tree stump, N 0°40': E102° 16', 13.IV.2002 O. Miettinen 5877 (BO, isotypes in H and TU).

Etymology—Epithet refers to the place of collecting of the species, island of Sumatra.

ITS rDNA sequence accession numbers—EMBL AM490943, UNITE UDB002294.

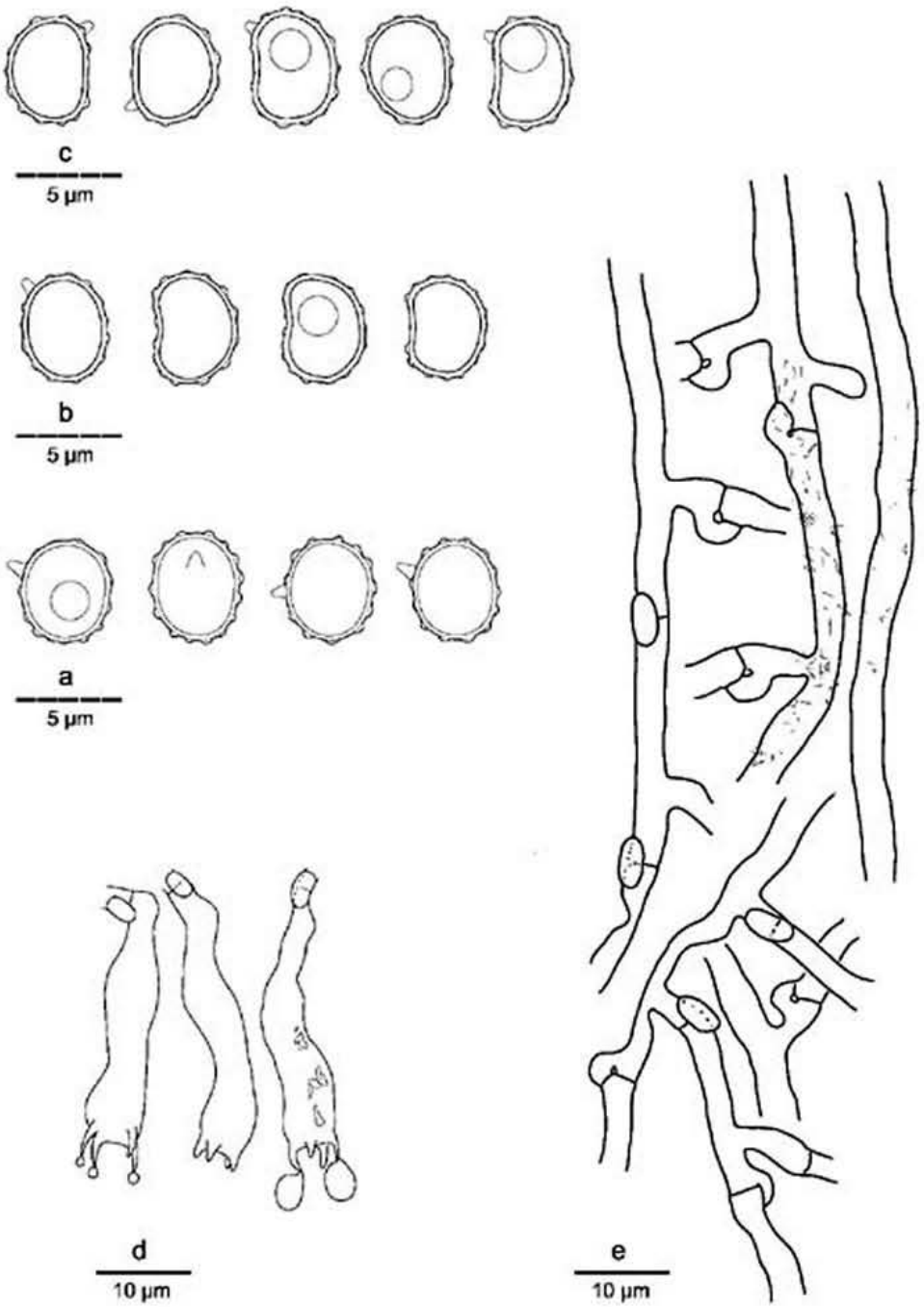

Fig. 1. *Amaurodon viridis*, lectotype, a) spores; *Amaurodon hydnoides*, isotype, b) spores; *Amaurodon sumatranus*, holotype, c) spores, d) basidia, e) subicular hyphae.

Basidiocarp resupinate, size ranging from small patches of less than 1 cm^2 up to a confluent area of about 100 cm^2, easily separable from substrate, byssoid, intensive dark turquoise when fresh, drying yellowish green. Surface sparsely hydnoid, spines mostly 1 mm long or shorter but longest spines up to 2 mm, typically somewhat spathulate, reminiscent of shark teeth. Subiculum approximately 0.05–0.1(–0.2) mm thick. Margin not differentiated, mycelial cords absent.

Hyphal system monomitic, all septa with clamps, structure loose, rather uniform throughout the basidiocarp. Small crystal grains and rods on hyphae here and there seen in CB, abundant in water. Green pigment abundant as amorphous matter in KOH.

Hyphae thin-walled and hyaline in hymenium and subhymenium; richly branched and (1.8–)2.0–3.2(–3.7) µm in diameter in subhymenium; slightly thick-walled and yellowish-brownish in trama and subiculum, (2.3–)2.8–4.0 (–4.9) µm in diameter, in water partially staining bluish violet, CB(+) to CB–, plasma light blue in CB.

Basidia long, clavate and winding, occasionally constricted, (14.5–)16.5–27.5 (–28.5)×(4.8–)5.2–6.3(–6.7) µm, L=22.5 µm, W=5.7 µm, n=46/2, with four curved, basally broad, 2–4 µm long sterigmata.

Basidiospores broadly ellipsoid to short phaseoliform in lateral face, ellipsoid in frontal face, verruculose, slightly thick-walled, yellow in CB, slightly CB+ to CB–, greyish-brownish in distilled water and turning violet in KOH, although the violet colour may fade under the cover glass. Ventral side concave, straight or convex. Warts barely projecting, at most 0.2 µm high. Spores (4.5–)4.7–5.7 (–6.6)×(3.5–)3.7–4.7(–5.3) µm, L=5.1 µm, W=4.1 µm, Q'=1.1–1.3(–1.5), Q=1.24, n=120/2.

Distribution and ecology. The known collections come from a single natural forest area in the east coast of Sumatra, Indonesia. Both grew on standing angiosperm wood in middle stages of decay, with the basidiocarps well above soil. It has not been collected from the other parts of Indonesia despite months of field work by one of us (O.M.). Because of its vivid colour it is not easily overlooked, and thus can be considered uncommon.

The habitat of the finds is peat swamp forest, a type of rainforest growing on acid peat soil. Half of Asia's peat swamp forests are found in Indonesia and are experiencing rapid conversion and draining there and elsewhere (Rieley & Page 2005). The specimens were collected in a nature reserve adjacent to the largest remaining peat swamp forest area in Sumatra, Kampar Peninsula. Both the reserve and the larger area are acutely threatened by deforestation and collapse of hydrology (Hooijer 2005).

Ectomycorrhizal tree species of the family *Dipterocarpaceae* are common at the collecting site. Although *Amaurodon* has not been recorded in studies

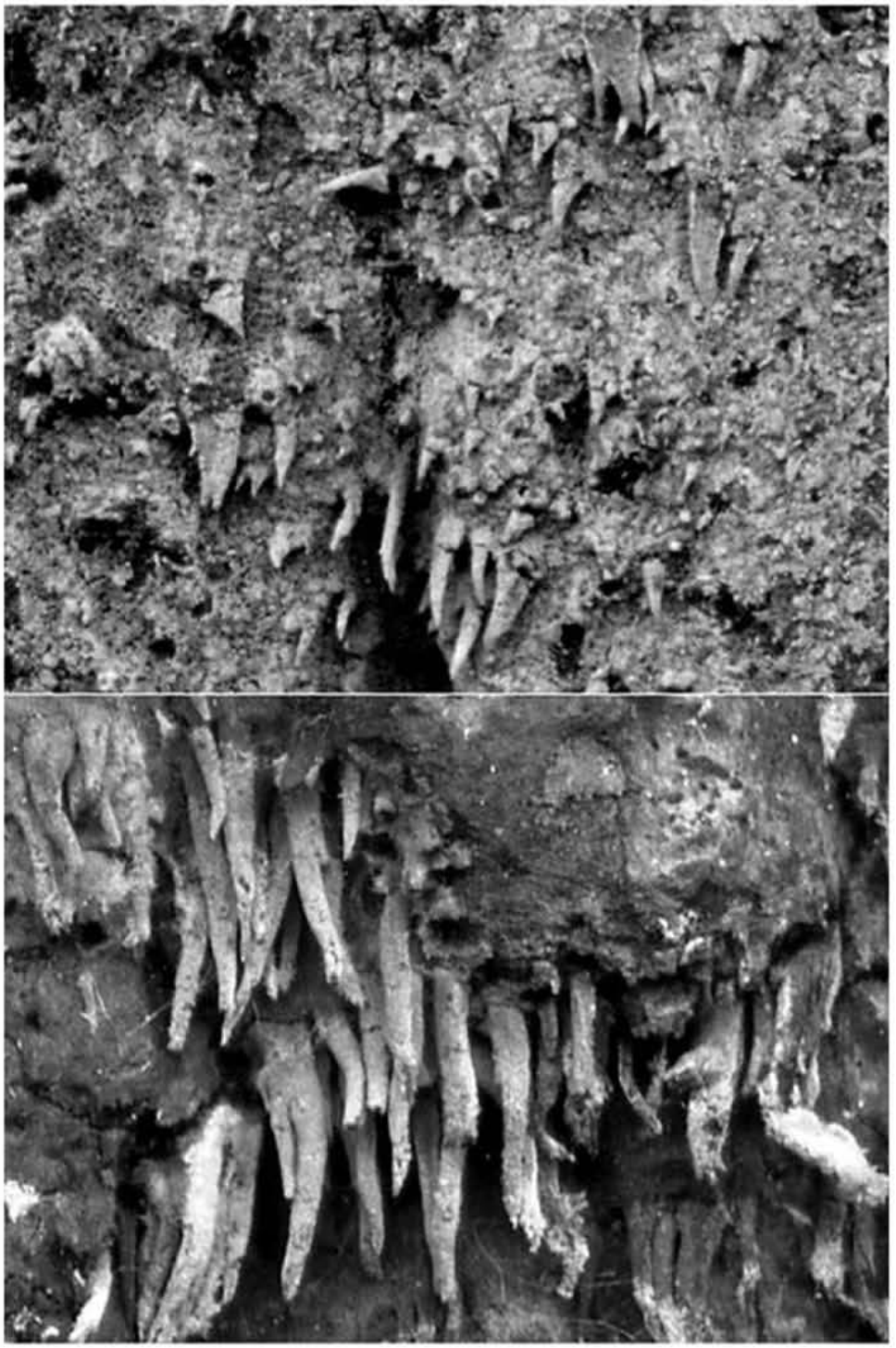

Fig. 2. Hymenophore of *Amaurodon sumatranus* (above, isotype in H) and *A. hydnoides* (below, isotype in O), magnification ×13.7.

of mycorrhizal communities so far, it is nevertheless probable that it forms ectomycorrhiza like its closest relatives. Since the species in the genus are rare they would easily be missed in mycorrhizal studies.

Remarks. *Amaurodon sumatranus* is characterised by its turquoise to green, sparsely hydnoid hymenophore with short and somewhat sphatulate spines, and broadly ellipsoid to phaseoliform, verrucose spores. This combination of microscopic and macroscopic characters sets it apart from closely related species. It is the only species of *Amaurodon* so far described (and reported as far as we know) from tropical Asia.

A temperate species *A. viridis* develops often small aculei like *A. sumatranus*. The aculei of *A. viridis* are generally smaller, 0.5(–0.7) mm at most and usually shorter. Its spores are subglobose, always with convex ventral side, and in average wider than those of *A. sumatranus*. The small difference in shape can be seen in Q-values of the spores (Tab. 1). Australian *A. aquicoeruleus* is closely related to or conspecific with *A. viridis*. Its basidiocarp is smooth or minutely granulose, and it has similarly subglobose spores as *A. viridis*, albeit slightly larger than in the material of *A. viridis* studied here. Agerer & Bougher (2001) reported a difference in spore colour between *A. aquicoeruleus* and *A. viridis* when observed in water. We found hyphae and individual spores turning faintly lilac in distilled water in the isotype of *A. aquicoeruleus*. We have not seen a similar reaction in *A. viridis*, but we can not assess the taxonomic importance of this character based on the few specimens studied here.

A. hydnoides was described recently from Venezuela (Kõljalg & Ryvarden 1997). Its hymenophore consists of dense, slender, regularly cylindrical spines

Table 1. *Amaurodon* species: basidiospore measurements of the specimens studied, and combined statistics for each species (in bold).

Specimen	Length (µm)	L	Width (µm)	W	Q'	Q	n
A. aquicoeruleus	4.8–5.5	5.12	4.2–5.0(–5.2)	4.56	1.0–1.2	1.12	30
A. hydnoides	(4.2–)4.5–5.7(–6.0)	4.89	(3.4–)3.5–4.5(–4.6)	3.92	1.1–1.4	1.25	61/2
isotype (O)	(4.5–)4.6–5.2(–5.4)	4.93	(3.4–)3.5–4.1(–4.3)	3.84	1.2–1.4	1.29	31
Ryvarden 37853	(4.2–)4.4–5.8(–6.0)	4.85	(3.5–)3.6–4.6	4.00	1.1–1.3	1.21	30
A. sumatranus	(4.5–)4.7–5.7(–6.6)	5.11	(3.5–)3.7–4.7(–5.3)	4.11	1.1–1.5	1.24	120/2
holotype	(4.5–)4.6–5.3(–5.6)	4.98	(3.5–)3.7–4.4(–4.5)	3.97	1.1–1.4	1.25	60
Miettinen 5670	(4.6–)4.8–6.1(–6.6)	5.24	3.8–4.5(–4.9)	4.17	1.1–1.5	1.23	60
A. viridis	(4.0–)4.3–5.4(–5.7)	4.83	(3.7–)3.9–4.8(–5.0)	4.25	1.1–1.3	1.14	120/4
lectotype	(4.2–)4.3–5.6(–5.7)	4.90	(3.8–)3.9–4.9(–5.0)	4.29	1.1–1.3	1.14	30
Nylander 17.III.1863	(4.2–)4.5–5.1(–5.3)	4.87	4.0–4.6(–4.8)	4.26	1.1–1.2	1.14	30
Ryvarden 22811	(4.0–)4.2–5.4(–5.6)	4.77	(3.7–)3.8–4.7(–5.0)	4.20	1.1–1.2	1.13	30
Ryvarden 43426	(4.3–)4.4–5.4(–5.6)	4.78	(3.8–)3.9–4.6(–5.0)	4.23	1.1–1.3	1.13	30

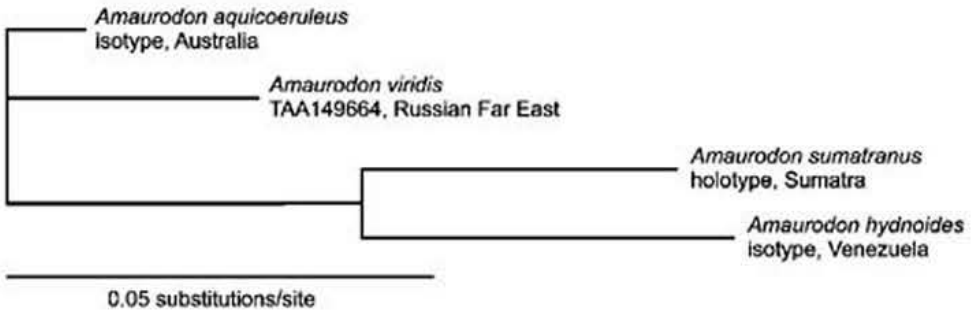

Figure 3. A neighbour-joining tree of four *Amaurodon* species, using the Hasegawa-Kishino-Yano (HKY85) substitution model.

of approximately 2 mm in length. In contrast the spines of *A. sumatranus* are sparse, usually 1 mm long, and commonly somewhat spathulate (Fig. 2). Microscopically the two are very similar. Rhomboidal large crystals, abundant in *A. hydnoides*, were not found in *A. sumatranus* when studied in CB.

Table 2. ITS rDNA sequence pairwise base differences of four *Amaurodon* species.

Species pair	Proportion of sites differing	Pairwise base difference
A. aquicoeruleus versus A. viridis	22/585	3.8%
A. aquicoeruleus versus A. sumatranus	47/583	8.0%
A. aquicoeruleus versus A. hydnoides	52/580	9.3%
A. viridis versus A. sumatranus	60/597	10.0%
A. viridis versus A. hydnoides	61/594	10.3%
A. sumatranus versus A. hydnoides	46/603	7.6%

ITS rDNA-based analysis confirms the status of *A. sumatranus* as a distinct species (Tab. 2). The closest species is *A. hydnoides* which differs by 7.6%. These two species clustered also together in a neighbour joining tree (Fig. 3). The isotype of *A. aquicoeruleus* and a specimen of *A. viridis* collected in Russian Far East are closely related differing by 3.8% (22 base pairs from 585 are different). Tedersoo et al. (2006) selected 98% of ITS sequence identity as a value of a molecular species criterion for the resupinate thelephoroid fungi. This figure (98% identity or 2% base difference) seems to be rather conservative (Kõljalg et al., unpublished data). However, in this study we have sequenced a single specimen per species only. Therefore we can not eliminate the possibility that *A. viridis* and *A. aquicoeruleus* will be synonyms based on the 2.0% threshold, when more specimens are sequenced. To solve the status of *A. aquicoeruleus*, a global survey of *A. viridis* would be needed.

Specimens studied—*Amaurodon aquicoeruleus*. **Australia.** Western Australia, Stewart Road, 3.7 km east of Brockman Highway, between Nannup and Augusta, on dead wood of *Eucalyptus marginata* or *E. calophylla*, 24.VIII.1999 R. Agerer & N. Bougher (isotype M).

Amaurodon hydnoides. **Venezuela.** Esta Bolivar: Las Nieves, on dead hardwood, 12.VI.1995 L. Ryvarden 37576 (isotypes O, TAA); L. Ryvarden 37853 (O, H).

Amaurodon sumatranus. **Indonesia.** Sumatra, Riau: Danau Pulau Besar / Danau Bawah Nature Reserve, on angiosperm log on the ground, N 0°40': E 102°16', 10.IV.2002 O. Miettinen 5670 (BO, H); see also holotype.

Amaurodon viridis. **Finland.** Uusimaa: Helsinki, Kaivopuisto ("Brunnsparken"), on rotten *Alnus*, 17.III.1863 W. Nylander (H). **Italy.** Sardinia, Nuoro Province: Lago Alto Flumenosa Fiume, on *Alnus glutinosa*, 29.XI.2000, L. Ryvarden 43426 (O, H). **Russia.** Primorye: Distr. Ternei, Sichote-Alin Nature Reserve, Maisa, on dead *Betula*, 14.IX.1990 R.H. Petersen (TAA149664). **United States.** California: San Diego County, Mt. Palomar Road, on *Quercus*, 19.III.1985 L. Ryvarden 22811 (O, H). Pennsylvania: Bethlehem, L. D. Schweinitz 562 (lectotype PH).

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Literature cited

Agerer R, Bougher NL. 2001. *Amaurodon aquicoeruleus* (*Thelephoraceae*, Hymenomycetes, *Basidiomycota*), a new species from Australia with spores distinctly blue in water. Australian Systematic Botany 14: 599–606.

Burdsall HH, Setliff EC. 1974. pH-related color changes in certain species of *Lazulinospora*, *Pseudotomentella*, and *Tomentella*. Mycologia 66: 101–106.

Chambers SM, Sharples JM, Cairney JWG. 1998. Towards a molecular identification of the *Pisonia* mycobiont. Mycorrhiza 7: 319–321.

Erland S, Taylor AFS. 1999. Resupinate ectomycorrhizal fungal genera. 347–363, in JWG Cairney, SM Chambers (eds.), Ectomycorrhizal fungi: key genera in profile. Heidelberg, Springer Verlag.

Gardes M, Bruns TD. 1996. Community structure of ectomycorrizal fungi in a *Pinus muricata* forest: above- and below-ground views. Canadian Journal of Botany 74: 1572–1583.

Hooijer A. 2005. Hydrological assessment of forest plantation impacts on tropical forested peatlands; Kampar Peninsula, Sumatra, Indonesia. Technical Report Q3975, WL | Delft Hydraulics.

Kõljalg U. 1996. *Tomentella* (*Basidiomycota*) and related genera in Temperate Eurasia. Synopsis Fungorum 9: 1–213.

Kõljalg U, Ryvarden L. 1997. A new species of *Amaurodon* (*Basidiomycota*, *Aphyllophorales*). Mycotaxon 65: 107–111.

Kõljalg U, Dahlberg A, Taylor AFS, Larsson E, Hallenberg N, Stenlid J, Larsson KH, Fransson PM, Kåren O, Jonsson L. 2000. Diversity and abundance of resupinate thelephoroid fungi as ectomycorrhizal symbionts in Swedish boreal forests. Molecular Ecology 9: 1985–1996.

Kõljalg U, Tammi H, Timonen S, Agerer R, Sen R. 2002. ITS rDNA sequence-based positioning of Pink-type ectomycorrhizas and *Tomentellopsis* species from boreal and temperate forests. Mycological Progress 1: 81–92.

Kõljalg U, Larsson KH, Abarenkov K, Nilsson RH, Alexander IJ, Eberhardt U, Erland S, Hoiland K, Kjoller R, Larsson E, Pennanen T, Sen R, Taylor AFS, Tedersoo L, Vralstad T, Ursing BM. 2005. UNITE: a database providing web-based methods for the molecular identification of ectomycorrhizal fungi. New Phytologist 166: 1063–1068.

Miettinen O, Niemelä T, Spirin W. 2006. Northern *Antrodiella* species: the identity of *A. semisupina*, and type studies of related taxa. Mycotaxon 96: 211–239.

Rieley JO, Page SE. 2005. Wise use of tropical peatlands: focus on Southeast Asia. Wageningen, Alterra.

Tedersoo L, Suvi T, Larsson E, Kõljalg U. 2006. Diversity and community structure of ectomycorrhizal fungi in a wooded meadow. Mycological Research 110: 734–748.

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Four new Chinese records of *Petriella* and *Pseudallescheria* (*Microascales*)

GUANGYU SUN, JUNLIN ZHANG, RONG ZHANG

sgy@nwsuaf.edu.cn
College of Plant Protection, Northwest A&F University
Yangling, Shaanxi, 712100, China

Abstract—The ascomycete genera *Petriella* and *Pseudallescheria* are reported for the first time from China. Two species of *Petriella* (*P. guttulata*, *P. sordida*) and two species of *Pseudallescheria* (*Ps. boydii*, *Ps. ellipsoidea*) were found on plant debris and soil from Shaanxi Province and Gansu Province, China.

Key words—taxonomy, *Petriella guttulata*, *Petriella sordida*, *Pseudallescheria boydii*, *Pseudallescheria ellipsoidea*

Introduction

Petriella Curzi is erected by Curzi in 1930 (Kirk et al. 2001). The type species is *P. sordida*. Corlett (1966) added *Petriella* to the family *Microascaceae*. Barron et al. (1961a) noted that the genus is characterized by predominantly asymmetrical, honey-coloured to reddish-brown, hairy ascocarps. Corlett (1963, 1966) observed that asci developed directly from filamentous ascogenous hyphae, not crosiers. The species of the genus grow mostly on soil, animal dung and plant seeds (Barron et al. 1961b). The specific characters of *Petriella* are the ostiolate ascocarps and the reddish brown, often asymmetrical ascospores (Arx et al. 1988, Barr 1990).

The genus *Pseudallescheria* Negroni & I. Fischer is also in the *Microascaceae*. A notable addition to the amended family description is the inclusion of species with non-ostiolate ascocarps (Benny & Kimbrough 1980; Barr 1990). The presence or absence of an ostiole is probably not significant above the generic level (Cain 1956). Thus, the non-ostiolate genera *Kernia* and *Petriellidium* (a genus based on *Allescheria boydii*) are included in the *Microascaceae* because they fit the family concept in every other way (Malloch 1970, Arx 1973). Examination of the type specimens for *Petriellidium* and *Pseudallescheria* has revealed that these two genera are congeneric and *Petriellidium* is a later synonym of *Pseudallescheria* (McGinnis et al. 1982). *Pseudallescheria* is characterised by ascocarps that are usually non-ostiolate, while the ascospores

are symmetrical and usually yellowish or rarely reddish (Benny & Kimbrough 1980). In this paper we provide the first descriptions of *P. guttulata*, *P. sordida*, *Ps. ellipsoidea* and *Ps. boydii* collected in China.

Materials and methods

Cultures were isolated from plant debris and soil during 2005-2006 (Sun et al. 2004) and were grown on potato dextrose agar (PDA, 200 g potato, 20 g dextrose, 15 g agar, 1000 ml distilled water), and cornmeal agar (CMA, 20 g cornmeal, 15 g agar, 1000 ml distilled water). For morphological studies, subcultures of all isolates were grown in glass petri dishes on PDA, at 25°C, in the dark. The morphological characteristics, including diameter of the colonies were determined 4 weeks after subculturing; photographs were also taken.

Taxonomic description

Petriella guttulata G.L. Barron & Cain, Can. J. Bot. 39: 841. 1961. Fig.1(A-B)
=*Microascus guttulatus* (G.L. Barron & Cain) Lodha, Taxonomy of Fungi (Proc. Int. Symp. Madras, 1973) 1: 254. 1978.

Colonies at 25°C with a daily growth rate of 2-3 mm, white when young, turning pale greyish and blackish with age. Growth is irregularly zonate. Ascomata produced abundantly, at first in the aerial hyphae, later in and on the agar, especially to the outside of the colonies in older cultures; ascomata black, carbonaceous, subglobose to pyriform, 100-250 μm in diameter, with papillate ostiole, hairs forming a dense mat round the ascomata, usually short, septate, pigmented, smooth, about 100 × 1.5 μm; asci ovoid to broadly clavate, 18-28 × 12-18 μm; ascospores plano-convex to concavo-convex in side view, ellipsoid in face view, 8.5-10 × 4.5-5.5 μm, single-celled, red-brown in color, containing a few (usually two) large oil droplets and several smaller oil droplets, extruded at maturity as a ball at the mouth of the ascomata or as a long dark-brown cirrhus in older cultures.

Specimen examined: soil, Yangling, Shaanxi, HMUABO 82297-1.

Petriella sordida (Zukal) G.L. Barron & J.C. Gilman, Can. J. Bot. 39: 839. 1961. Fig.1(C-D)
=*Microascus sordidus* Zukal, Ber. dt. Bot. Ges. 8: 295. 1890.

Colonies at 25°C with a daily growth rate of 2-3 mm, white when young, pale greyish with age, without distinct aerial mycelium; ascomata usually superficial,

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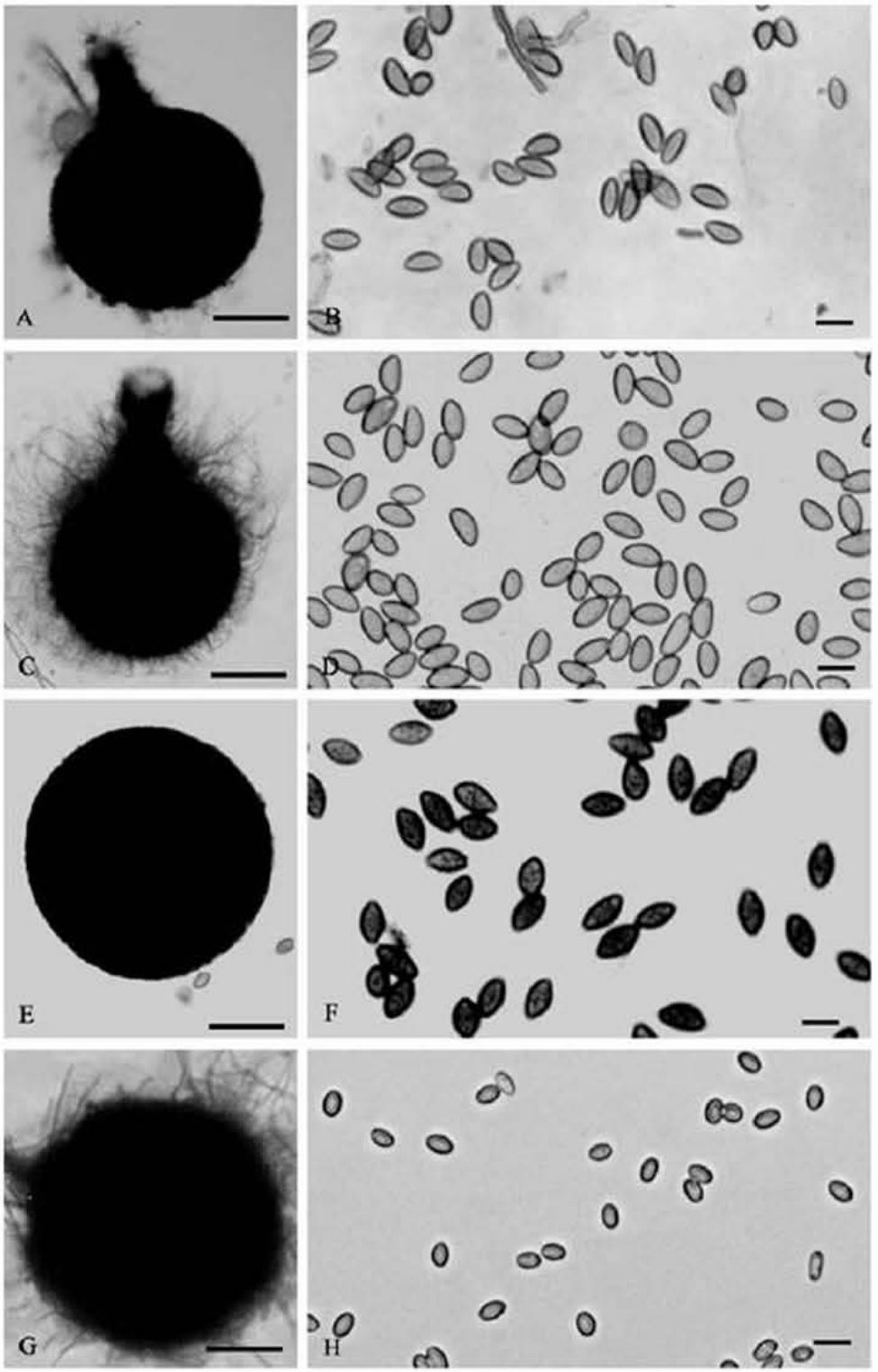
Fig1. A: ascoma of *Petriella guttulata*; B: ascospores of *P. guttulata*; C: ascoma of *P. sordida*; D: ascospores of *P. sordida*; E: Ascoma of *Pseudallescheria ellipsoidea*; F: ascospores of *Ps. ellipsoidea*; G: ascoma of *Ps. boydii*; H: ascospores of *Ps. boydii*.
Scale bars: A, C, E, G = 50 μm; B, D, F, H = 10 μm.


A
B
C
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E
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H

occasionally immersed in substances, spherical or ampulliform, black in reflected light, 190-350 μm in diameter; with a cylindrical, up to 300 μm long and 60-90 μm broad beak, usually covered with some seta-like, septate, brown hairs; ascomatal wall dark, composed of several layers of flattened cell; asci obovate or broadly clavate, 8-spored, evanescent; ascospores elongate, reniform or slightly lunate in lateral view, aseptate, dextrinoid when young, pale reddish brown when mature, 9-11 × 4.5-6 μm, with a distinct germ pore at both ends, extruded as a sticky, copper coloured mass.

Specimen examined: plant debris, Tianshui, Gansu, HMUABO 822302-1.

Pseudallescheria ellipsoidea (Arx & Fassat.) McGinnis, A.A. Padhye & Ajello, Mycotaxon 14: 98. 1982. Fig.1(E-F)

≡*Petriellidium ellipsoideum* Arx & Fassat., Persoonia 7: 370. 1973.

Colonies at 25°C with a daily growth rate of 2.5-3 mm, pale greyish, with a floccose or lanose aerial mycelium, reddish brown with age; ascomata immersed or semi-immersed, spherical, non-ostiolate, smooth or covered with hyphae, brown, 75-180 μm in diameter; ascomatal wall 4-7 μm thick, reddish brown, textura epidermoidea in surface view; asci obovate or spherical, 8-spored, very evanescent; ascospores broadly ellipsoidal, rounded at both ends, dextrinoid when young, pale straw coloured when mature, 7-9 × 5-6 μm, with two germ pores.

Specimen examined: soil, Taibai, Shaanxi, HMUABO 822118-1.

Pseudallescheria boydii (Shear) McGinnis, A.A. Padhye & Ajello, Mycotaxon 14: 97. 1982. Fig.1(G-H)

≡*Allescheria boydii* Shear, Mycologia 14: 242. 1922.

≡*Petriellidium boydii* (Shear) Malloch, Mycologia 62: 738. 1970.

=*Pseudallescheria shearii* Negroni & I. Fisch., Prensa Med. Argent. 30: 2398. 1943.

Colonies at 25°C with a daily growth rate of 4-5 mm, white or pale when young, with grey or brown shades when old, floccose or lanose; ascomata usually submerged, spherical, non-ostiolate, 140-200 μm in diameter, often covered with brown, thick-wall, septate, 2-3 μm broad hyphae; ascomatal wall 4-6 μm thick, composed of 2-3 layers of flattened, 2-6 μm broad cells, textura epidermoidea in surface view; asci obovate or nearly spherical, 8-spored, evanescent; ascospores ellipsoidal, symmetrical or slightly asymmetrical, dextrinoid when young, straw colored when mature, 6-7 × 3.5-4 μm, with two germ pores.

Specimen examined: soil, Taibai, Shaanxi, HMUABO 822111-1.

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Literature cited

Arx JA von. 1973. The genera *Petriellidium* and *Pithoascus* (*Microascaceae*). Persoonia 7: 367-375.

Arx JA von, Figueras MJ, Guarro J. 1988. Sordariaceous ascomycetes without ascospore ejaculation. Nova Hedwigia 94: 1-104.

Barr ME. 1990. Prodromus to nonlichenized, pyrenomycetous members of class *Hymenoascomycetes*. Mycotaxon 39: 43-184.

Barron GL, Cain RF, Gilman JC. 1961a. A revision of the genus *Petriella*. Canadian Journal of Botany 39: 837-845.

Barron GL, Cain RF, Gilman JC. 1961b. The genus *Microascus*. Canadian Journal of Botany 39: 1609-1631.

Benny GL, Kimbrough JW. 1980. A synopsis of the orders and families of plectomycetes with keys to genera. Mycotaxon 12: 1-91.

Cain RF. 1956. Studies of coprophilous *Ascomycetes* II. *Phaeotrichum*, a new cleistocarpus genus in a new family, and its relationships. Canadian Journal of Botany 34: 675-687.

Corlett M. 1963. The developmental morphology of two species of *Microascus*. Canadian Journal of Botany 41: 253-266.

Corlett M. 1966. Developmental studies in the *Microascaceae*. Canadian Journal of Botany 44: 79-88.

Kirk PM, Cannon PF, David JC, Stalpers JA. (eds). 2001. Dictionary of the fungi. 9th ed. Wallingford, CAB International.

Malloch D. 1970. New concepts in the *Microascaceae* illustrated by two new species. Mycologia 62: 727-740.

McGinnis MR, Padhye AA, Ajello L. 1982. *Pseudallescheria* Negroni et Fischer, 1943 and its later synonym *Petriellidium* Malloch, 1970. Mycotaxon 14: 94-102.

Sun GY, Tan YJ, Zhang R. 2004. The family *Chaetomiaceae* from China I. Species of the genus *Chaetomium*. Mycosystema 23: 333-337.

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New records of smut fungi from Korea. 1

CVETOMIR M. DENCHEV[1], YOUNG-JOON CHOI[2], SEUNG-KYU LEE[3] & HYEON-DONG SHIN[2*]

cmdenchev@yahoo.co.uk
[1]Institute of Life Science and Natural Resources
Korea University, Seoul 136-701, Korea

yjchoi@korea.ac.kr & hdshin@korea.ac.kr
[2]Division of Environmental Science and Ecological Engineering
Korea University, Seoul 136-701, Korea

leesk77@foa.go.kr
[3]Laboratory of Forest and Shade Tree Pathology
Korea Forest Research Institute, Seoul 130-712, Korea

Abstract—Four species of smut fungi, *Kochmania oxalidis*, *Thecaphora thlaspeos*, *Urocystis syncocca*, and *Vankya vaillantii*, are reported for the first time from Korea. *Arabis serrata* is recorded as a new host of *Thecaphora thlaspeos*. A list of the correct names of the known smut fungi in Korea is also given.

Key words—plant pathogenic fungi, taxonomy, *Ustilaginomycetes*

Introduction

The diversity of the smut fungi in Korea (*Ustilaginomycetes* and *Microbotryales*) is poorly known, and still not intensively studied. No regional monographic study has been carried out yet. Some information about smut fungi in the region has been published in a few phytopathological articles. Up to date, only twenty-five species on twenty-three vascular plants have been reported, making thirty-two smut-host combinations (according to Cho & Shin 2004 and BPI database). The following species are currently known from Korea: *Eballistra oryzae* (Syd. & P. Syd.) R. Bauer et al., *Macalpinomyces neglectus* (Niessl) Vánky, *Sphacelotheca hydropiperis* (Schumach.) de Bary, *Sporisorium cruentum* (J.G. Kühn) Vánky, *S. reilianum* (J.G. Kühn) Langdon & Full., *S. sorghi* Ehrenb. ex Link, *Sporisorium* sp. on *Themeda triandra* Forssk., *Tilletia barclayana* (Bref.) Sacc. & P. Syd., *T. caries* (DC.) Tul. & C. Tul., *T. corona* Scribn., *T. laevis* J.G. Kühn, *Tranzscheliella*

*Author for correspondence

hypodytes (Schltdl.) Vánky & McKenzie, *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh., *Ur. magica* Pass., *Ur. tritici* Körn., *Ustilago avenae* (Pers. : Pers.) Rostr., *U. coicis* Bref., *U. crameri* Körn., *U. hordei* (Pers. : Pers.) Lagerh., *U. maydis* (DC.) Corda, *U. nuda* (J.L. Jensen) Kellerm. & Swingle, *U. shiraiana* Henn., *U. syntherismae* (Schwein.) Peck, *U. trichophora* (Link) Körn., and *U. tritici* (Pers. : Pers.) Rostr.

The four species listed in the present article represent new records of smut fungi from Korea. They were found by the senior author during examination of specimens in phanerogamic herbaria in Seoul. Duplicates of these specimens are housed in SOMF (Mycological Collection of the Institute of Botany, Bulgarian Academy of Sciences, Sofia, Bulgaria).

Materials and methods

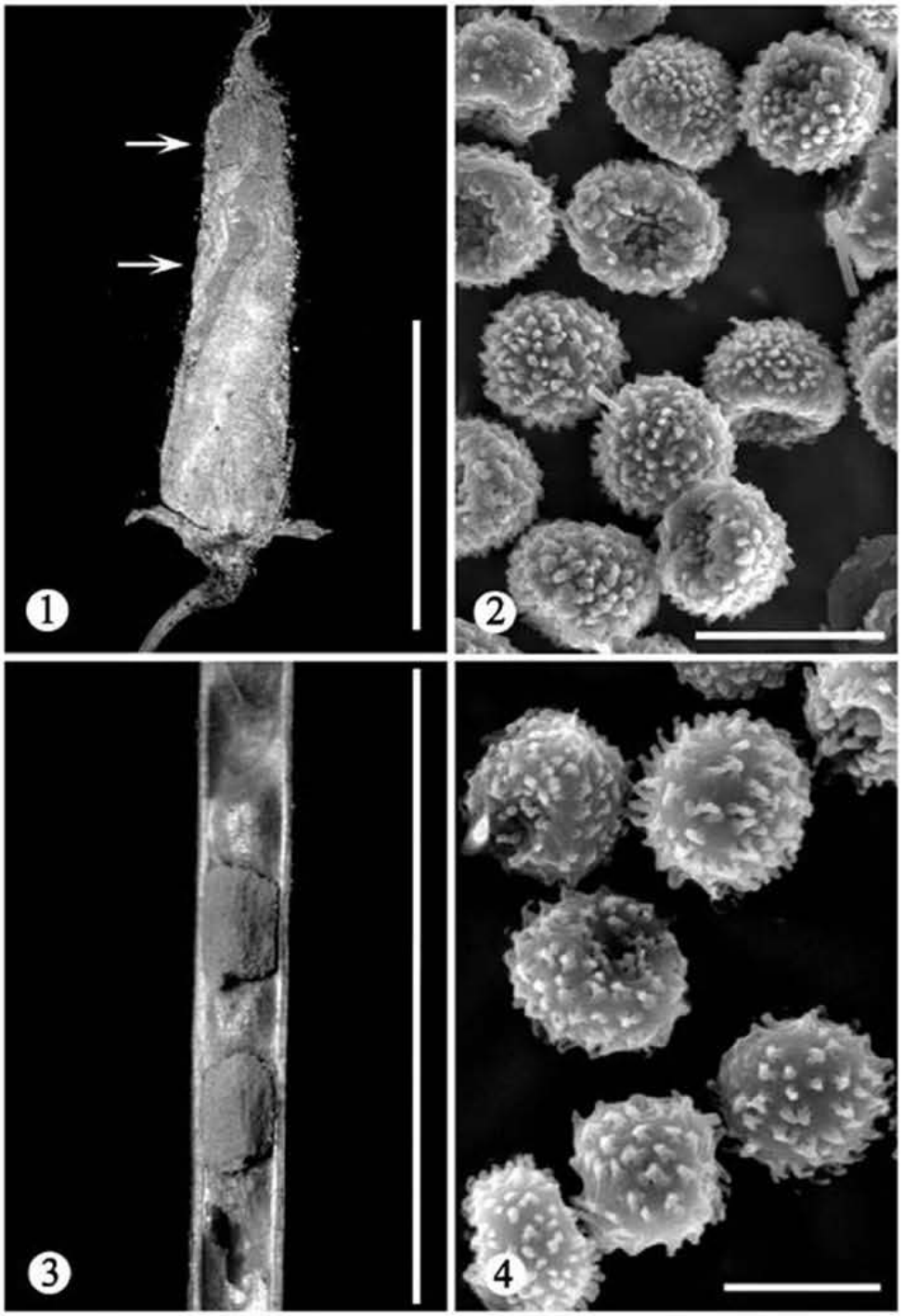
Material from the herbaria of College of Natural Sciences, Seoul National University, Seoul (SNU) and Korea University, Seoul (KUS) was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. The measurements of spores are given in the form: min-max (mean ± 1 standard deviation). In the description, the symbol '$n/_x$=' is used to indicate the total numbers of measured collections, and spore balls or spores, respectively. For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum with a Hitachi E-1010 ion sputter. The surface structure of spores was observed at 15 kV and photographed with a Hitachi S-3500N scanning electron microscope.

New records

Kochmania oxalidis (Ellis & Tracy) M. Piątek, Mycotaxon 92: 34, 2005. **Figs. 1-2**
≡ *Ustilago oxalidis* Ellis & Tracy, J. Mycol. 6: 77, 1890.

Sori in seeds, filling the capsules with spore mass, inconspicuous. **Spore mass** powdery, yellowish brown. **Spores** mainly globose, subglobose or ovoid, rarely broadly ellipsoidal, light yellowish brown, 14-18 × 12.5-16.5 (16.2±1.0 × 14.8±0.9) µm ($n/_1$=40), including the ornaments; wall 1-1.4 µm thick, densely, irregularly echinate, spines up to 1.5 µm high, often appear to anastomose at their bases.

SPECIMENS EXAMINED — On *Oxalis corniculata* L.: KOREA, Kyoungbuk Prov., Mt. Hyangro, 1 Jun 1972, leg. S.K. Kim (as *Xanthoxalis corniculata*) (SNU 46 729, SOMF 26 201); KOREA, sine loc., 31 May 1972, leg. Y.B. Yang (as *X. corniculata*) (SNU 46 728, SOMF 26 202).



Figs. 1-2. *Kochmania oxalidis* on *Oxalis corniculata* (SNU 46 729): **1.** Sorus in a capsule; **2.** Spores in SEM. Scale bars: 1 = 1 cm, 2 = 20 μm. **Figs. 3-4.** *Thecaphora thlaspeos* on *Arabis serrata* var. *hallaisanensis* (SNU 4111): **3.** Opened siliqua with a sorus in seeds; **4.** Spores in SEM. Scale bars: 3 = 1 cm, 4 = 10 μm.

Distribution. On *Oxalidaceae: Oxalis corniculata* (*Xanthoxalis corniculata* (L.) Small), *O. dillenii* Jacq. (*Xanthoxalis dillenii* (Jacq.) Holub), *O. fontana* Bunge, *O. stricta* L., Europe, Asia, North America, and South America.

Comments— The ornamentation is echinate (cfr also Kakishima 1982: 90) but not verruculose, as it is described in some recent publications (Vánky 1994, etc.). In Asia, this species is known from the Far East of Russia on *Oxalis dillenii* (Azbukina et al. 1995) and Japan and China on *O. corniculata* (Kakishima 1982, Guo 2000).

Thecaphora thlaspeos (Beck) Vánky, Mycotaxon 89: 111, 2004. **Figs. 3-4**

- *Ustilago thlaspeos* (Beck) Lagerh., in Sydow, Ust. No. 118, 1897.
- *Bauhinus thlaspeos* (Beck) Denchev, Mycotaxon 65: 424, 1997.
- *Tothiella thlaspeos* (Beck) Vánky, Mycotaxon 70: 39, 1999.

Sori in seeds, filling the siliquae with inconspicuous spore mass which is released when the siliquae open. **Spore mass** powdery, light yellow-brown. **Spores** broadly ellipsoidal, subglobose, ovoid or irregular, 10-15.5 × 10-12.5 (12.2±1.0 × 10.7±0.7) µm ($n/_1$=50), including the ornaments, pale yellowish brown; wall 0.6-1 µm thick, with irregularly arranged, coarse warts, tubercules or elongated ornaments, 0.5-1.8 µm high.

SPECIMEN EXAMINED — On *Arabis serrata* Franch. & Sav. var. *hallaisanensis* (Nakai) Ohwi: KOREA, Jeju Prov., 17 July 1935, leg. P.S. Do (SNU 4111, SOMF 26 203).

Distribution. On *Brassicaceae: Alyssum, Arabis, Cardamine, Cardaminopsis, Draba, Erysimum,* and *Thlaspi,* Europe, Asia.

Comments— *Thecaphora thlaspeos* has been previously reported only from Europe (Vánky 2004). Here is the first Asian record found on a new host species, *Arabis serrata*. The Korean specimen has some differences in the spore morphology in comparison with European specimens: (i) lower maximum values of the length and width but without discreteness in their mean values (cfr Denchev 1991: 19, 2001: 127), (ii) more coarse and irregular ornaments, that are not more elongated on one of the sides, as they were reported to be characteristic of most specimens from Europe (cfr Vánky 1994: 380, 1999: 39, Denchev 1991, 2001).

Urocystis syncocca (L.A. Kirchn.) B. Lindeb., Symb. Bot. Upsal. 16(2): 99, 1959.

Sori on the leaves, hypophyllous, forming pustules, 3.5-6 mm long, suborbicular to broadly elliptical in outline, at first covered by the epidermis which later ruptures to expose the spore balls. **Spore mass** powdery, black. **Spore balls** subglobose, broadly ellipsoidal, ovoid or irregular, 19.5-42 × 14-36 µm, composed of 1-6 (-8) central spores [1=9.8%, 2=17.9%, 3=25%, 4=26.3%, 5=12.5%, 6=6.3%, 7=1.8%, 8=0.4%; $n/_1$=224] and a discontinuous layer of peripheral sterile cells. **Sterile cells** orbicular, suborbicular, broadly elliptical

or oval in outline, 8-15 µm long, light yellowish brown; wall 0.5-0.7 µm thick, smooth. **Spores** subglobose, broadly ellipsoidal or irregular, 12.5-19 × 10-15 (14.3±1.7 × 11.6±1.3) µm ($n/_1$=45), dark- or medium reddish brown; wall 1-2 µm thick, smooth.

SPECIMEN EXAMINED — On *Hepatica asiatica* Nakai: KOREA, Chungnam Prov., Boryeong, Ungcheon-eup, Duryong-ri, 275-meter Hill, 29 May 2004, leg. M.J. Song, H.J. Bang & Y.L. Oh (KUS 2004-0809, SOMF 26 204).

Distribution. On *Ranunculaceae: Hepatica acutiloba* DC., *H. americana* (DC.) Ker-Gawl., *H. asiatica, H. nobilis* Mill. (*H. triloba* Chaix), *H. transsilvanica* Fuss, Europe, Asia (Far East of Russia, Korea), and North America.

Comments— *Hepatica asiatica* is known as a host of this species from the Far East of Russia (Azbukina et al. 1995).

Vankya vaillantii (Tul. & C. Tul.) Ershad, Rostaniha 1(1-4): 69, 2000.
■ *Ustilago vaillantii* Tul. & C. Tul., Ann. Sci. Nat. Bot., Sér. 3, 7: 90, 1847.

Sori in anthers. **Spore mass** greenish brown, powdery. Infection systemic. **Spores** variable in shape and size, mainly globose, subglobose, broadly ellipsoidal or ovoid, rarely irregularly angular, 5.5-11 × 5-7.5 (7.0±1.1 × 6.0±0.5) µm ($n/_1$=60), single spores curved, ellipsoidal to narrowly ellipsoidal, up to 12.5 µm long, light to middle greenish brown; wall *ca* 0.5 µm thick, verruculose.

SPECIMEN EXAMINED — On *Scilla scilloides* (Lindl.) Druce (*S. sinensis* (Lour.) Merr.): KOREA, Jeju Prov., Namjeju, Namwon-eup, Taeheung-ri, the seashore, 33°16'54.5" N, 126°45'05.3" E, 8 Oct 2005, leg. K.J. Kim, K.M. Ku & S.L. Bae (as *S. sinensis*) (KUS 2005-1372, SOMF 26 205).

Distribution. On *Liliaceae*: cosmopolitan.

Comments— *Scilla scilloides* is distributed in Far East Asia (China, Taiwan, Korea, and Japan). This plant has been previously found to be attacked by *Vankya vaillantii* in Japan (Kakishima 1982) and China (Guo 2000).

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Literature cited

Azbukina ZM, Karatygin IV, Govorova, OK. 1995. Class 1. *Ustomycetes* Moore. 9-205, in ZM Azbukina (ed.), Plantae non vasculares, Fungi et Bryopsida orientis extremi rossica, Fungi, 3. Nauka, Petropoli. (In Russian)

Cho WD, Shin HD. 2004. List of plant diseases in Korea. Fourth edition. The Korean Society of Plant Pathology, Seoul.

Denchev CM. 1991. New records of Bulgarian smut fungi (*Ustilaginales*). Sydowia 43: 15-22.

Denchev CM. 2001. Classis *Ustomycetes* (Ordines *Tilletiales, Ustilaginales* et *Graphiolales*). 1-286, in V. Fakirova (ed.), Fungi Bulgariae 4. Editio Academica "Prof. Marin Drinov" & Editio Pensoft, Sofia. (In Bulgarian with an English summary)

Guo L. 2000. Flora Fungorum Sinicorum. Vol. 12. *Ustilaginaceae*. Science Press, Beijing. (In Chinese)

Kakishima M. 1982. A taxonomic study on the *Ustilaginales* in Japan. Memoirs of Institute of Agriculture and Forestry, University of Tsukuba (Agricultural and Forestry Science) 1: 1-124. (In Japanese)

Vánky K. 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York.

Vánky K. 1999. The new classificatory system for smut fungi, and two new genera. Mycotaxon 70: 35-49.

Vánky K. 2004. Taxonomic studies on *Ustilaginomycetes* – 24. Mycotaxon 89: 55-118.

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New records of smut fungi from Korea. 2

CVETOMIR M. DENCHEV[1], HYEON-DONG SHIN[2*]
& SUNG MIN KIM[3]

cmdenchev@yahoo.co.uk
[1]Institute of Life Science and Natural Resources, Korea University
Seoul 136-701, Korea

hdshin@korea.ac.kr
[2]Division of Environmental Science and Ecological Engineering
Korea University, Seoul 136-701, Korea

sm6656@sungshin.ac.kr
[3]Department of Biology, Sungshin Women's University
Seoul 136-701, Korea

Abstract—*Entorrhiza casparyana* is reported for the first time from Korea and Asia. This is the fourth record of this smut fungus on *Juncus tenuis*. As the mature galls and spores of *E. casparyana*, in all collections on *Juncus tenuis* known from Korea, Europe, and Costa Rica, are smaller than those on other hosts, a new variety is proposed and illustrated, viz. *Entorrhiza casparyana* var. *tenuis*.

Key words—*Entorrhizales*, plant pathogenic fungi, taxonomy, *Ustilaginomycetes*

Introduction

The genus *Entorrhiza* C.A. Weber (*Entorrhizales, Ustilaginomycetes*) is characterised by sori that form galls on roots of *Juncaceae* and *Cyperaceae* and having single, intracellular, thick-walled spores embedded in the root tissues. The species of this genus have a peculiar type of spore germination (Fineran 1982, Vánky 2002).

In 2006, during field investigations in Korea, the first author collected *Entorrhiza casparyana* on *Juncus tenuis*. This collection is reported herein. It represents not only a new species and genus record for the smut fungi of Korea but also a first record of this species from Asia. Among the twelve known species of *Entorrhiza*, only one species has been previously reported from Asia, viz.

*Author for correspondence

E. guttiformis M. Piepenbr. & S.R. Wang on *Carex parva* Nees, described from China (Wang & Piepenbring 2002).

Morphometric characters of the sorus and spores of *Entorrhiza casparyana* on *Juncus tenuis* were compared with the known information about this fungus on other hosts. Accordingly, the taxon on *Juncus tenuis* turned out to be a new variety.

Materials and methods

The collected specimens were deposited in the Mycological Collection of the Institute of Botany, Bulgarian Academy of Sciences, Sofia (SOMF). Herbarium material was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. The measurements of spores are given in the form: min-max (mean ± 1 standard deviation). In the description, the symbol '$n/_x =$' is used to indicate the total numbers of measured collections and spores, respectively. For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum with a Hitachi E-1010 ion sputter. The surface structure of spores was observed at 15 kV and photographed with a Hitachi S-3500N scanning electron microscope.

A new Korean record of *Entorrhiza casparyana* and the taxonomic status of this species on *Juncus tenuis*

A comparative study of the Korean specimens with specimens of *Entorrhiza casparyana* on other hosts; together with an investigation of the scientific literature, indicate that *E. casparyana* on *Juncus tenuis* represents a new variety, which is described as:

Entorrhiza casparyana (Magnus) Lagerh., Hedwigia 27: 262, 1888 (Sept.-Oct.).

= *Schinzia casparyana* Magnus, Ber. Deutsch. Bot. Ges. 6: 103, 1888.

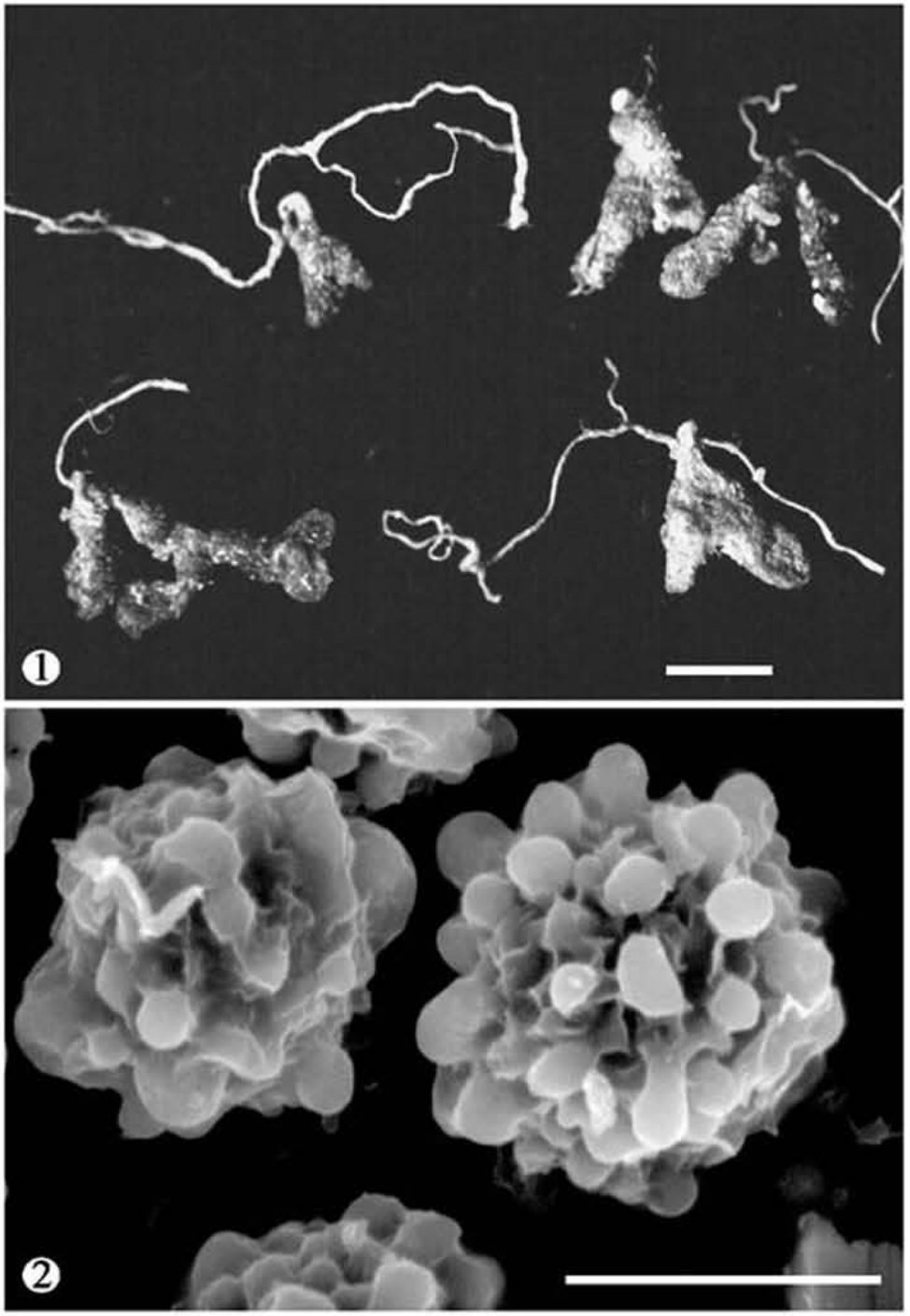
= *Entorrhiza casparyana* (Magnus) De Toni in Sacc., Syll. fung. 7(2): 497, 1888 (Oct. 28).

= *Entorrhiza digitata* Lagerh., Hedwigia 27: 264, 1888.

Entorrhiza casparyana var. ***tenuis*** Denchev & H.D. Shin, **var. nov.** FIGS 1-2

MYCOBANK # MB 510557

Holotypus in matrice Juncus tenuis Willd., Korea, Gangwon Prov., prope oppidum Hoengseong, 37°31'24.82" N, 128°17'27.98" E, 7.IX.2006, leg. C.M. Denchev (SOMF 26 206). Paratypus in matrice Juncus tenuis, Korea, Gangwon Prov., prope oppidum Hoengseong, 37°31'24.84" N, 128°17'28.11" E, 7.IX.2006, leg. C.M. Denchev (SOMF 26 207).



Figs. 1-2. *Entorrhiza casparyana* var. *tenuis* from the roots of *Juncus tenuis* (SOMF 26 206, Holotypus). 1. Sori. 2. Spores in SEM. Scale bars: 1 = 1 mm, 2 = 10 μm.

Sori gallae radicis, 1.2-3 mm longi, sporis intracellulariter evolutis impleti. Sporae globosae vel subglobosae, 11.5-20 × 10.5-20 µm, tuberculatae vel verrucosae.

Etymology: derived from the epithet of the host plant.

Previously published description & illustrations: Denchev, Mycologia Balcanica 1: 49–50, figs. 1–2, 2004 (as *Entorrhiza casparyana*).

Sori on the roots forming elongated, often branched, dark brown galls, 1.2–3 mm long (Fig. 1), filled with intracellularly developing spores. **Spores** usually solitary, sometimes in pairs, globose or subglobose, 11.5-20 × 10.5-20 (15.1±1.9 × 14.3±1.7) µm (including the ornamentations) ($n/_2$=100), L/w = 1.05, light greenish brown; wall two-layered, the inner layer 0.5-1 µm thick, the outer layer variable in thickness ((0.5-) 1-6 µm, including the ornamentations), tuberculate or verrucose, with irregularly arranged, coarse tubercules or warts, seldom smooth; as seen by SEM, tubercules and warts partly confluent (Fig. 2).

Distribution. On *Juncus tenuis*, Asia (Korea), Europe (Austria, Romania), and Central America (Costa Rica). Certainly more common but overlooked.

Comments— The spore sizes, given in the description, are based on measurements of spores from the holotype and paratype specimens. *Entorrhiza casparyana* has been previously reported on *Juncus tenuis* from Romania (Mt Căliman – Fineran 1978: 23, Vánky 1985: 50), Austria (Graz – Denchev 2004: 49), and Costa Rica (Cartago, San José – Piepenbring 2003: 13). Vánky (l.c.) noted that on *Juncus tenuis*, "the apparently mature galls and spores are somewhat smaller than those produced on *J. articulatus* L.". Measurements of the spores of the Austrian material on *J. tenuis* confirmed that conclusion, i.e., spores 13-21.5 × 12.5-21.5 (16.8±1.5 × 16.1±1.7) µm ($n/_1$=100), L/w = 1.04 (Denchev 2004). The spores of the Costa Rican specimen measured 12-15 (-17) × 11-14 (-15) µm (Piepenbring 2003).

For comparison, we give spore sizes of *E. casparyana* on other hosts, cited from the literature: chiefly 15-26 (sometimes up to 45) µm in diameter (on *Juncus alpinus* Vill., *J. arcticus* Willd., *J. articulatus* L., *J. filiformis* L., and *J. tenageia* Ehrh. from Europe, Zundel 1953), 12-26 (-41) µm in diameter (on *J. articulatus* and *J. gregiflorus* L.A.S. Johnson, Fineran 1971), (12-) 13.5-23 (-28) µm in diameter, occasionally much larger (on *J. alpinus, J. articulatus, J. bufonius* L., (?) *J. conglomeratus* L., *J. effusus* L., *J. gregiflorus, J. inflexus* L., and *J. tenageia,* results from a world revision made by Fineran 1978, and from New Zealand, Vánky & McKenzie 2002), 13-23 (-28) µm in diameter (on *J. articulatus, J. bufonius,* and *J. tenageia* from Germany, Scholz & Scholz 1988), 12-26 (-45) µm in diameter (on *J. geniculatus* Schrank from the European part of Russia, Azbukina & Karatygin 1995), 13-28 × 12.5-25.5 (17.9±2.6 × 17.1±2.5) µm ($n/_1$=100) (on *J. thomasii* Ten. from Bulgaria, Denchev 1991, 2001).

Variety *tenuis* differs from var. *casparyana* especially by the shorter spores and sori. On the base of the known data, and also according to our investigation, the sori of *E. casparyana* on hosts other than *Juncus tenuis*, are up to 15 mm in length, whereas those on *J. tenuis* are only up to 3 mm long. The spores of var. *tenuis* are 11.5-20 (-21.5) × 10.5-20 (-21.5) µm (including the ornamentations) while these of var. *casparyana* are (12-) 13.5-23 (-28) µm long. Variety *tenuis* differs from *Entorrhiza casparyanella* Vánky by having tuberculate or verrucose spore ornamentation, with coarse tubercules or warts whereas the spores of *E. casparyanella* have a smooth or undulate outer wall layer (cfr Vánky 1998: 342-343).

Four species of *Entorrhiza* are known on *Juncus*: *E. aschersoniana* (Magnus) Lagerh., *E. caricicola* Ferd. & Winge, *E. casparyana*, and *E. casparyanella* (Fineran 1978, Vánky 1994, 1998).

Key to the known *Entorrhiza* taxa on *Juncus*

1 Spores mainly broadly ellipsoidal, ellipsoidal or ovoid, occasionally subglobose, L/w > 1.06 2
1* Spores globose or subglobose, L/w < 1.06 3

2 Spore wall rugulose-undulate or smooth ..... ***E. caricicola***
2* Spore wall verrucose ..... ***E. aschersoniana***

3 Outer wall layer smooth or undulate; spores 10-17 µm long ..... ***E. casparyanella***
3* Outer wall layer coarsely tuberculate or verrucose, occasionally smooth 4

4 Spores (12-) 13.5-23 (-28) µm long, sori up to 15 mm long ..... ***E. casparyana* var. *casparyana***
4* Spores 11.5-20 µm long, sori 1.2-3 mm long ..... ***E. casparyana* var. *tenuis***

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Literature Cited

Azbukina ZM, Karatygin IV. 1995. Ordo *Ustilaginales*. 1-263 + Pls 35-58. in V.A. Melnik (ed.), Definitorium fungorum Rossiae, Fasc. 2. Nauka, Petropoli. (In Russian)

Denchev CM. 1991. New records of Bulgarian smut fungi (*Ustilaginales*). Sydowia 43: 15-22.

Denchev CM. 2001. Classis *Ustomycetes* (Ordines *Tilletiales, Ustilaginales* et *Graphiolales*). 1-286, in V. Fakirova (ed.), Fungi Bulgariae 4. Editio Academica "Prof. Marin Drinov" & Editio Pensoft, Sofia. (In Bulgarian with an English summary)

Denchev CM. 2004. Occurrence of *Entorrhiza casparyana* (*Ustilaginomycetes*) in Austria. Mycologia Balcanica 1: 49-50.

Fineran JM. 1971. *Entorrhiza* C. Weber (*Ustilaginales*) in root nodules of *Juncus* and *Scirpus* in New Zealand. New Zealand Journal of Botany 9: 494-503.

Fineran JM. 1978. A taxonomic revision of the genus *Entorrhiza* C. Weber (*Ustilaginales*). Nova Hedwigia 30: 1-68.

Fineran JM. 1982. Teliospore germination of *Entorrhiza casparyana* (*Ustilaginales*). Canadian Journal of Botany 60: 2903-2913.

Piepenbring M. 2003. Smut fungi (*Ustilaginomycetes* p.p. and *Microbotryales, Basidiomycota*). Flora Neotropica, Monograph 86. The New York Botanical Garden Press, Bronx, NY.

Scholz H, Scholz I. 1988. Die Brandpilze Deutschlands (*Ustilaginales*). Englera 8: 1-691.

Vánky K. 1985. Carpathian *Ustilaginales*. Symbolae Botanicae Upsalienses 24(2): 1-309.

Vánky K. 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York.

Vánky, K. 1998. New Australasian *Ustilaginales*. Mycotaxon 68: 327-344.

Vánky K. 2002. Illustrated genera of smut fungi. 2nd edn. APS Press, St. Paul, Minnesota, USA.

Vánky K, McKenzie EHC. 2002. Smut fungi of New Zealand. Fungi of New Zealand. Vol. 2. Fungal Diversity Press, Hong Kong.

Wang SR, Piepenbring M. 2002. New species and new records of smut fungi from China. Mycological Progress 1: 399-408.

Zundel GL. 1953. The *Ustilaginales* of the world. Contributions from the Department of Botany, School of Agriculture, The Pennsylvania State College 176: XI + 1-410.

MYCOTAXON

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A new record of *Bauhinus piperi* (*Microbotryales*) from Pakistan

MUHAMMAD ASIM SULTAN[1], CVETOMIR M. DENCHEV[2*], IKRAM-UL-HAQ[1] & A.N. KHALID[3]

asim418@yahoo.com
[1]Department of Botany, Government College University
Lahore, Pakistan

cmdenchev@yahoo.co.uk
[2]Institute of Botany, Bulgarian Academy of Sciences
23 Acad. G. Bonchev St., 1113 Sofia, Bulgaria

[3]Department of Botany, University of the Punjab
Lahore, Pakistan

Abstract—A new record of *Bauhinus piperi* is reported from the Northern Areas of Pakistan on *Aconogonon rumicifolium* var. *rumicifolium*.

Key words—*Microbotryum*, smut fungi

Introduction

During a collecting trip for parasitic fungi in the Fairy Meadows locality, in the Northern Areas of Pakistan, carried out by the senior author, leaves of *Aconogonon rumicifolium* were found infected with a smut fungus.

The Northern Areas of Pakistan are well known for their rich biodiversity, including about 3000 plant species. Most parts of the Northern Areas lie within the watershed of the Himalayas, Hindukush, and Karakoram Mountain ranges. The main watershed runs southwards, draining into the river Indus. Climatic conditions vary widely ranging from the monsoon-influenced moist temperate zone in the western Himalaya, to the arid and semi-arid cold desert in the Northern Karakoram and Hindukush (Sugong 1990, Anonymous 1994). Fairy Meadows, situated at an altitude of 3300 m, is thickly wooded with birch trees, firs and dwarf pines that spread up to snow line at 3600 meters.

*Author for correspondence

Material and methods

Dried herbarium material was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. The measurements of spores are given in the form: min-max (mean ± 1 standard deviation). For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum-palladium with a Hitachi E-1030 ion sputter. The surface structure of spores was observed at 20 kV and photographed with a Hitachi S-4200 scanning electron microscope.

New record

The collected specimen belongs to *Bauhinus piperi*. It is a new record for Pakistan (cfr Ahmed et. al. 1997).

Bauhinus piperi (G.P. Clinton) Denchev, Mycotaxon 65: 424, 1997. FIGS 1-2

= *Ustilago piperi* G.P. Clinton, Proc. Boston Soc. Nat. Hist. 31: 382, 1904. = *Microbotryum piperi* (G.P. Clinton) Vánky, Mycotaxon 67: 48, 1998.

= *Sphacelotheca polygoni-alpini* P. Cruchet, Bull. Herb. Boissier, Ser. 2, 7: 247, 1908. = *Ustilago polygoni-alpini* (P. Cruchet) Zundel, Mycologia 43: 267, 1951.

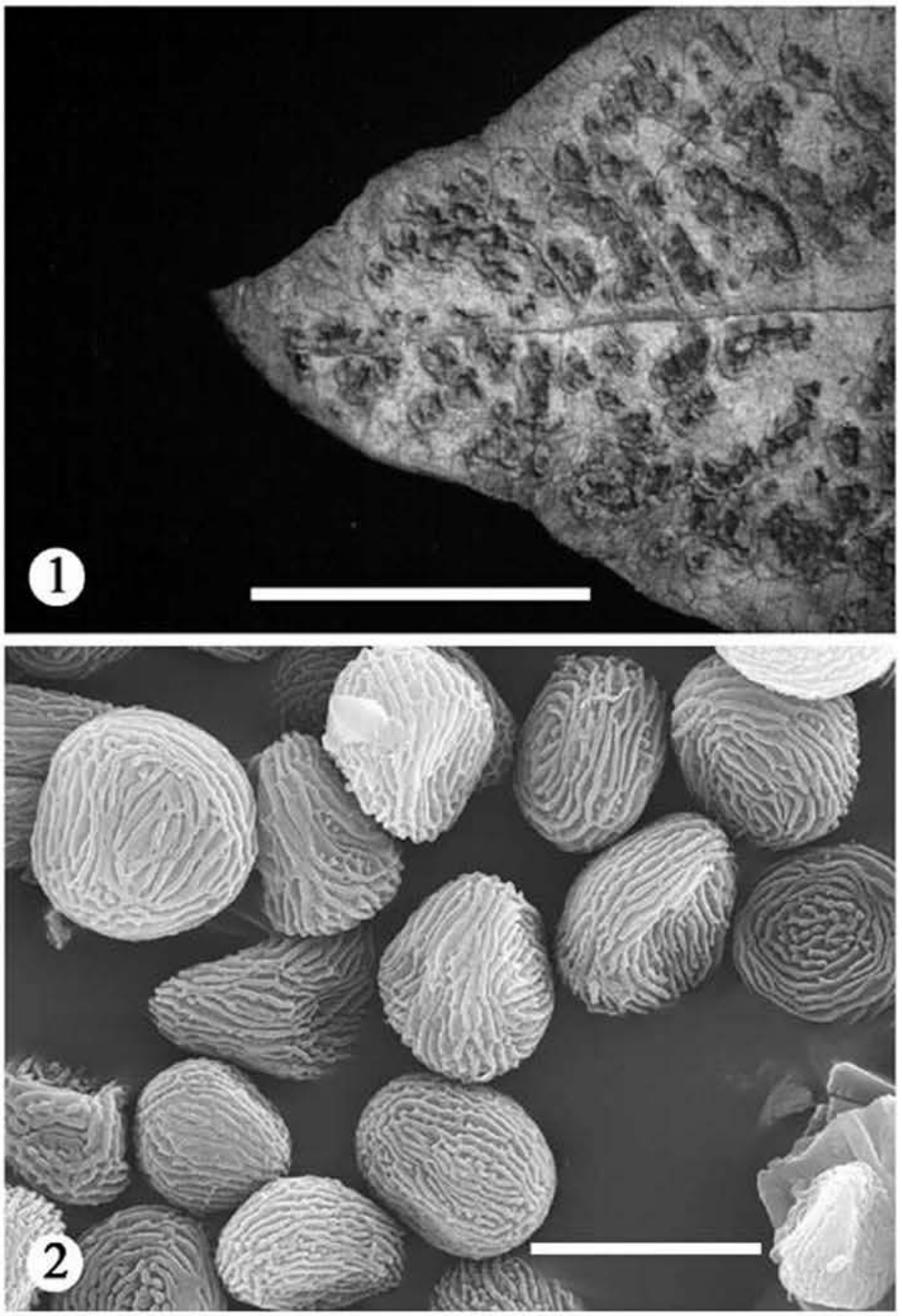
= *Ustilago sinkiangensis* Y.C. Wang, Acta Bot. Sinica 10: 134, 1962.

Sori on leaves, hypophyllous, forming pustules, limited by the veins, rounded, elongated or irregular, 0.3-2 mm long, later many of them more or less confluent, elongated or irregular and up to 5 mm in length, not situated along the margin; covered by the epidermis which ruptures irregularly disclosing the spore mass. **Spore mass** middle to dark reddish brown. **Spores** mainly globose, subglobose, broadly ellipsoidal or ovoid, rarely irregular or ellipsoidal, 6-11 × 5.5-9 µm (8.1±1.1 × 7.3±0.9) µm (n=50), light purplish brown; spore wall in LM striate, in SEM with dense, curved, parallell or ramified, anastomosing striae.

SPECIMEN EXAMINED — On leaves of *Aconogonon rumicifolium* (Royle ex Bab.) H. Hara var. *rumicifolium* (*Polygonum rumicifolium* Royle ex Bab.) (det. S.P. Hong). **PAKISTAN: Northern Areas,** FAIRY MEADOWS, alt. 3300 m, 21 August 2001, coll. M.A. Sultan, *AS # 47* (SHI).

Comments— Vánky (1998) transferred this species from *Ustilago* to *Microbotryum*. Recently, it was demonstrated that the genus *Microbotryum* should be reduced only to the group of the anthericolous species (incl. *M. majus*) on *Caryophyllaceae* (Almaraz et al. 2002, Denchev et al. 2006, 2007, Kemler et al. 2006) while the former *Ustilago* species on *Polygonaceae* have been transferred to *Bauhinus* (Denchev 1997, Denchev et al. 2006, 2007).

Bauhinus piperi has previously been reported from Europe, Central Asia (Uzbekistan, Nepal, and China), East Asia (Far East of Russia), and North



Figs. 1-2. *Bauhinus piperi* on *Aconogonon rumicifolium* var. *rumicifolium*: 1. Sori on the abaxial side of a leaf; 2. Spores in SEM. Scale bars: 1 = 1 cm, 2 = 7.5 µm.

America (U.S.A.) (Clinton 1904, Balfour-Browne 1968, Vánky 1994, Vánky & Oberwinkler 1994, Azbukina et al. 1995, Guo 2000). *B. piperi* is known only on plants of the genus *Aconogonon* (*A. alpinum* (All.) Schur, *A. davisiae* (W.H. Brewer ex A. Gray) Soják, *A. phytolaccifolium* (Meisn. ex Small) Small, *A. rumicifolium*, *A. songoricum* (Schrenk) H. Hara, *A. tripterocarpum* (A. Gray) H. Hara). It is the second record of *Bauhinus piperi* on *Aconogonon rumicifolium* which has been previously recorded from Nepal (Balfour-Browne 1968). *Aconogonon rumicifolium* is a biennial-perennial herbaceous plant found in Pakistan at altitudes from 3000-4500 m and distributed also in Afghanistan, Nepal, and Tibet (Quaiser 2006)

Acknowledgements

We gratefully acknowledge Dr Kálmán Vánky (Herbarium *Ustilaginales* Vánky, Tübingen, Germany) and Dr Roger G. Shivas (Queensland Department of Primary Industries and Fisheries, Australia) for reading the manuscript and serving as pre-submission reviewers; Prof. Makoto Kakishima (University of Tsukuba, Japan) for the opportunity to prepare SEM photographs in his laboratory; Prof. Suk-Pyo Hong (Kyunghee University, Seoul, Korea) for identification of the host plant.

Literature cited

Ahmed S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Sultan Ahmed Mycological Society of Pakistan, Department of Botany, University of Punjab, Lahore, Pakistan.

Almaraz T, Roux Ch, Maumont S, Durrieu G. 2002. Phylogenetic relationships among smut fungi parasitizing dicotyledons based on ITS sequence analysis. Mycological Research 106: 541-548.

Anonymous. 1994. Declaration of some Wilderness Areas as National Park in Northern Areas, Islamabad, Kashmir Affairs, and Northern Areas Affairs Division. Government of Pakistan.

Azbukina ZM, Karatygin IV, Govorova, OK. 1995. Class 1. *Ustomycetes* Moore. 9-205, in ZM Azbukina (ed.), Plantae non vasculares, Fungi et Bryopsida orientis extremi rossica, Fungi, 3. Petropoli, Nauka. (In Russian)

Balfour-Browne F.L. 1968. Fungi of recent Nepal expeditions. Bull. Brit. Mus. (Nat. Hist.), Bot. 4(3): 99-141.

Clinton GP. 1904. North American *Ustilagineae*. Proceedings of the Boston Society of Natural History 31: 329-529.

Denchev CM. 1997. New combinations in *Bauhinus* (*Microbotryaceae*). Mycotaxon 65: 419-426.

Denchev CM, Moore RT, Shin HD. 2006. A reappraisal of the genus *Bauhinus* (*Microbotryaceae*). Mycologia Balcanica 3: 71-75.

Denchev CM, Kakishima M, Shin HD, Lee SK. 2007. Notes on some Japanese smut fungi. III. *Ustilago moehringiae*. Mycotaxon 98[2006]: 181-184.

Guo L. 2000. Flora Fungorum Sinicorum. Vol. 12. *Ustilaginaceae*. Beijing, Science Press. (In Chinese)

Kemler M, Göker M, Oberwinkler F, Begerow D. 2006. Implications of molecular characters for the phylogeny of the *Microbotryaceae* (*Basidiomycota: Urediniomycetes*). BMC Evolutionary Biology 6. [http://www.biomedcentral.com/1471-2148/6/35 (viewed on line on 9 May 2006)]

Quaiser M. 2006. *Polygonaceae* A.L. Jussieu, in Flora of Pakistan, vol. 205 [http://www.efloras.org/florataxon.aspx?flora_id=5&taxon_id=242100004 (viewed on line on 9 Dec 2006)].

Sugong WU. 1990. General characteristics of flora of the Karakorum-Kunlun Mts. and Conservation, Exploitation, and Utilization of the plant resources. Journal of Natural Resources 5(4): 376-382.

Vánky K. 1994. European smut fungi. Stuttgart, Jena, New York, Gustav Fischer Verlag.

Vánky K. 1998. The genus *Microbotryum* (smut fungi). Mycotaxon 67: 33-60.

Vánky K, Oberwinkler F. 1994. *Ustilaginales* on *Polygonaceae*, a taxonomic revision. Nova Hedwigia, Beiheft 107: 1-96.

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Rhizomorph anatomy confirms the taxonomic position of *Sclerogaster* (*Phallomycetidae, Basidiomycota*)

H. Clémençon[1], K. Hosaka[2] & A.F.S. Taylor[3]

heinz.clemencon@bluewin.ch
[1]Musée Botanique Cantonal
Avenue de Cour 14bis, CH-1007 Lausanne, Switzerland

[2]Department of Botany, The Field Museum
1400 S Lake Shore Dr, Chicago, IL, USA

[3]Department of Forest Mycology and Pathology
Swedish University of Agricultural Sciences
P.O. Box 7026, Ulls väg 26a, SE 750 07 Uppsala, Sweden

Abstract—The anatomy of the rhizomorphs of the hypogeous gasteroid basidiomycete *Sclerogaster compactus* is described. Its molecular taxonomic position in the gomphoid-phalloid clade is confirmed on morphological grounds.

Key words—gastromycetes, taxonomy, systematics

The hypogeous gasteroid genus *Sclerogaster* Hesse (1891) was placed by its author in the «Hymenogastreen», an artificial assembly of truffle-like basidiomycetes characterized by a spongy gleba composed of innumerable small cavities lined with a hymenium. According to Hesse, *Sclerogaster* differs from the other genera of the «basidiomycete truffles» by its ochre yellow, spherical, warted spores and the copious development of a white «mycelium» surrounding the basidiomes and extending far into the substrate. Actually, the «mycelium» is formed by many white rhizomorphs.

Fischer (1900) placed *Sclerogaster* in the family *Hymenogastraceae* and stated that *Hymenogaster* shows developmental similarities with the *Phallaceae*, but he did not venture any phylogenetic conclusions. Early phylogenetic speculations placed *Sclerogaster* in the «série des Astérosporés» (i.e. the *Russulales*) leading from the agaricoid *Russula* and *Lactarius* to gasteroid fungi like *Macowanites*, *Hydnagnium* and *Gymnomyces*, and finally to *Sclerogaster* (Malençon 1931). This speculation was accepted by Gäumann (1964) and Heim (1971) but rejected by Singer (1959) and Singer & Smith (1960). More recent schemes tentatively placed *Sclerogaster* in the *Boletales* (Kirk & al. 2001; Watling 2006), but analyses

of DNA sequence data now place it in the *Geastrales* of the gomphoid-phalloid clade (Hosaka 2005; Hosaka & al. 2007).

Rhizomorph anatomy can contribute significantly to the understanding of the phylogeny and systematics of the basidiomycetes, often confirming phylogenetic classifications proposed by studies using DNA sequence data (e.g. Agerer 1999, 2002; Agerer & Iosifidou 2004; Clémençon 2004a). Several different developmental and architectural rhizomorph types are distinguished by Agerer (1999), which depend on the presence and distribution of vessel-like hyphae, ampullate swellings at the septa, fibre hyphae, secretory hyphae and backward growing hyphae. The rhizomorphs of the earth star genera *Geastrum* and *Myriostoma* (*Geastrales*) of the gomphoid-phalloid clade are characterized by the presence of «trumpet-like hyphae» with ampullate swellings at the septa, dextrinoid fibre hyphae, secretory hyphae with a yellow, granular content and short, lateral, peglike ramifications («oleoacanthohyphae»), and «yellow globular cells» with the same content (Agerer & Beenken 1998; Agerer & Iosifidou 2004, their fig. 25). This architecture is here called «geastroid». Since DNA-based analyses placed *Sclerogaster* in the *Geastrales* (Hosaka 2005; Hosaka & al. 2007), the rhizomorph anatomy of that genus is expected to be geastroid, too.

In July 2006 a large collection of *Sclerogaster compactus* (Tul. & C. Tul.) Sacc. made in Switzerland enabled a study of the anatomy of its conspicuous rhizomorphs. The results support the placement of the genus *Sclerogaster* in the *Geastrales,* as proposed by Hosaka (2005) and Hosaka & al. (2007) based on DNA sequence data analyses.

Material and methods

Basidiomes of *Sclerogaster compactus* (Tul. & C. Tul.) Sacc. with attached rhizomorphs were collected by G. Martinelli at Künten AG, Switzerland, in a small, humid depression in a mixed forest and brought to the WSL (Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft) in Birmensdorf, Switzerland. Beatrice Senn-Irlet and F. Ayer of the WSL identified the fungus that is now incorporated in the WSL collection under the accession number BSI 06/78. Part of this collection is also stored in the Botanical Museum in Lausanne, Switzerland (LAU), accession number HC 06/009.

Fresh rhizomorphs were fixed with a cold, buffered aldehyde solution, dehydrated with methyl cellosolve and embedded in a methacrylate mixtures, and the microtome sections stained with aluminum-zirconium haematoxylin as described by Clémençon (2000). Other sections were stained with iron chloride - haematoxylin - copper sulphate: 1) Iron-III-chloride 1% in distilled water, 1-2 h; 2) rinse in two charges of distilled water for about 5 min. each; 3) stain with a ripened solution of 0.1% haematoxylin in distilled water for about 1

Figure 1. Basidiomes (at the extreme lower left and upper right margins) and white rhizomorphs of *Sclerogaster compactus*, coll. HC 06/009 (LAU).

h; 4) rinse in two charges of distilled water for about 5 min. each; 5) stabilise the staining result with a 1% solution of copper sulphate in distilled water for about 15 min. 6) rinse in distilled water for about 10-15 min., air dry the sections on a hot bench of about 65-70C and mount in Entellan (Merck). Do not use the more popular ammonium iron sulphate instead of the iron chloride, as the hyphal walls do not stain after this mordant. Nuclei were stained with iron-aceto carmine using the procedure outlined by Clémençon (1986). Squash mounts of rhizomorph fragments were also stained with cotton blue 0.2% in concentrated lactic acid, toluidine blue O 0.01% in 20% glycerol, patent blue V 1% in distilled water, and with 1% Congo red with 1% SDS in distilled water (Clémençon 1998).

Results

The rhizomorphs of *Sclerogaster compactus* are chalk white, dry, profusely ramified and irregularly rounded in cross section (figs. 1,4). Their thickness ranges from about 50 µm to almost 1 mm. A cortex of rather complex anatomy surrounds a medulla of simpler architecture (figs. 2,3). No part of the rhizomorph is gelatinous.

The **cortex** is built from six elements: A coating of thick-walled, dextrinoid fibre hyphae; crystal aggregates; patches of amorphous or partly birefringent masses; secretory hyphae with a pale yellow, granular content; droplets derived from the secretory hyphae; and small chunks of a brown pigment.

The fibre hyphae of the cortex are cylindrical but sometimes strongly curved and often have a slightly uneven surface. The walls are dextrinoid and more or

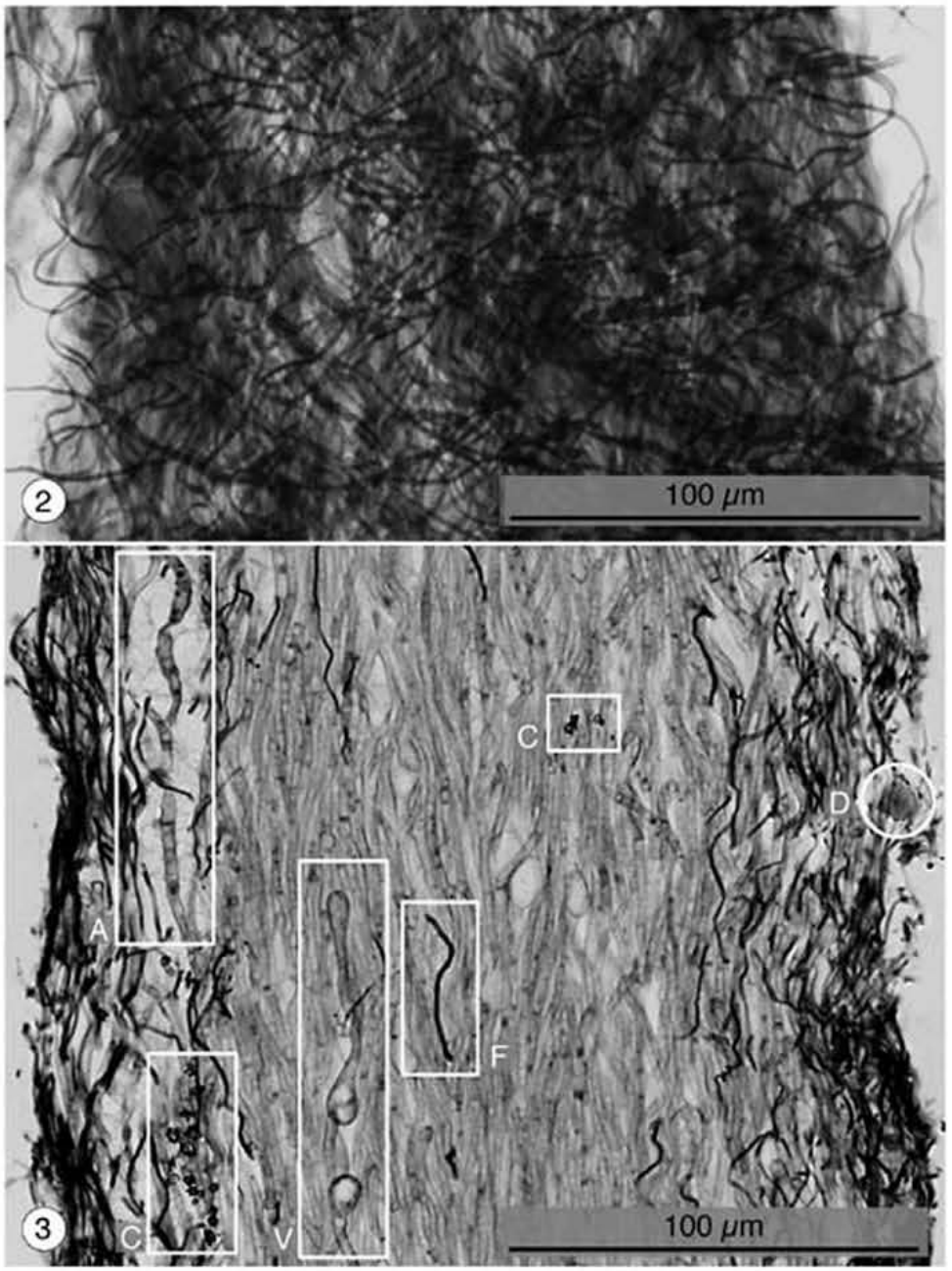


Figure 2. Superficial dextrinoid fibre hyphae mounted in Melzer's iodine solution.

Figure 3. Longitudinal section of a rhizomorph. A: Amorphous masses with central thin-walled hypha. C: Crystal aggregates. D: A droplet formed by the content of a gloeoplerous hypha. F: A fibre hypha located within the medulla (most fibre hyphae are located near the surface of the cortex). V: Vesicles formed by ampullate swellings.

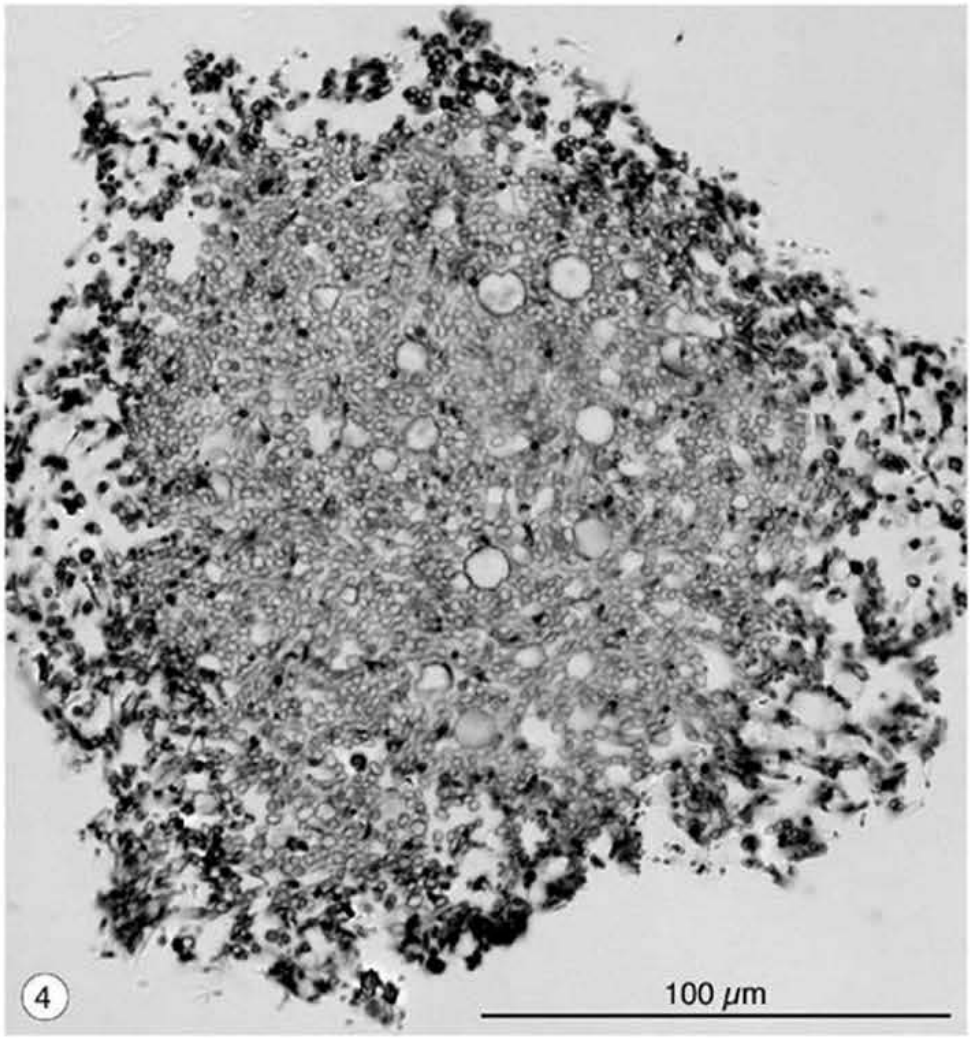
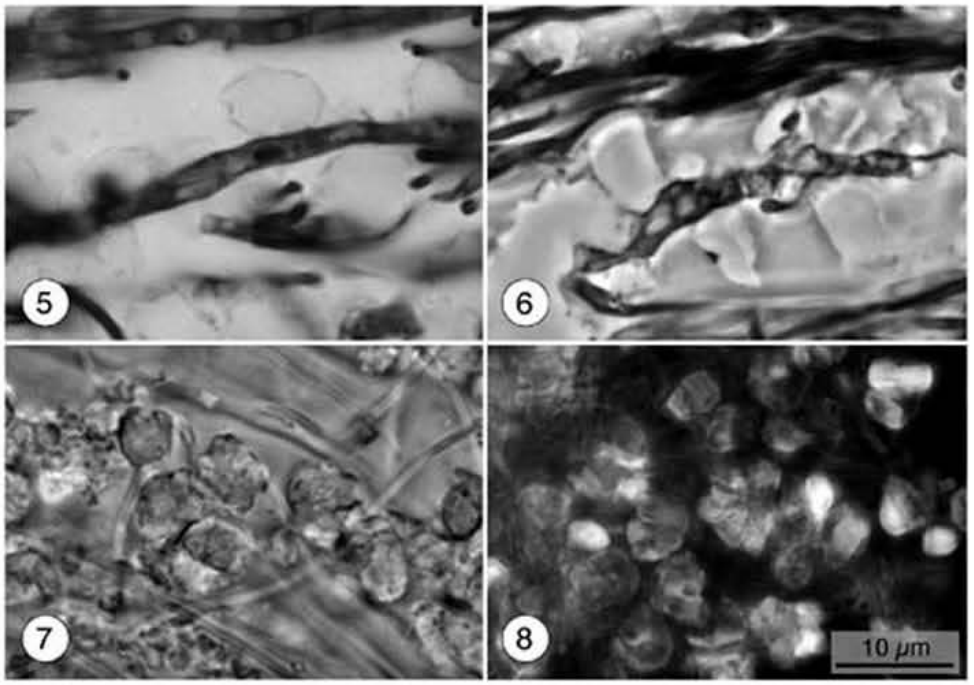


Figure 4. Cross section of a rhizomorph. The fibre hyphae appear very dark; most are located in the surface coating, but some also occur in the medulla. The large cross sections in the medulla are not tubular hyphae but ampullate swellings of generative hyphae.

less cyanophilous. They stain strongly with Congo red and lilac with toluidine blue. The diameter of the fibre hyphae and the thickness of their walls decrease slightly from the outside to the inside of the coating, from about 1-1.8 µm to 0.6-1 µm, and from 0.3-0.6 µm to 0.1-0.4 µm, respectively. Correspondingly, the strength of the dextrinoid reaction decreases slightly from the outside to the inside of the coating, while the cyanophily of the walls decreases greatly. A few dextrinoid fibre hyphae are evenly scattered throughout the medulla (figs. 3,4).

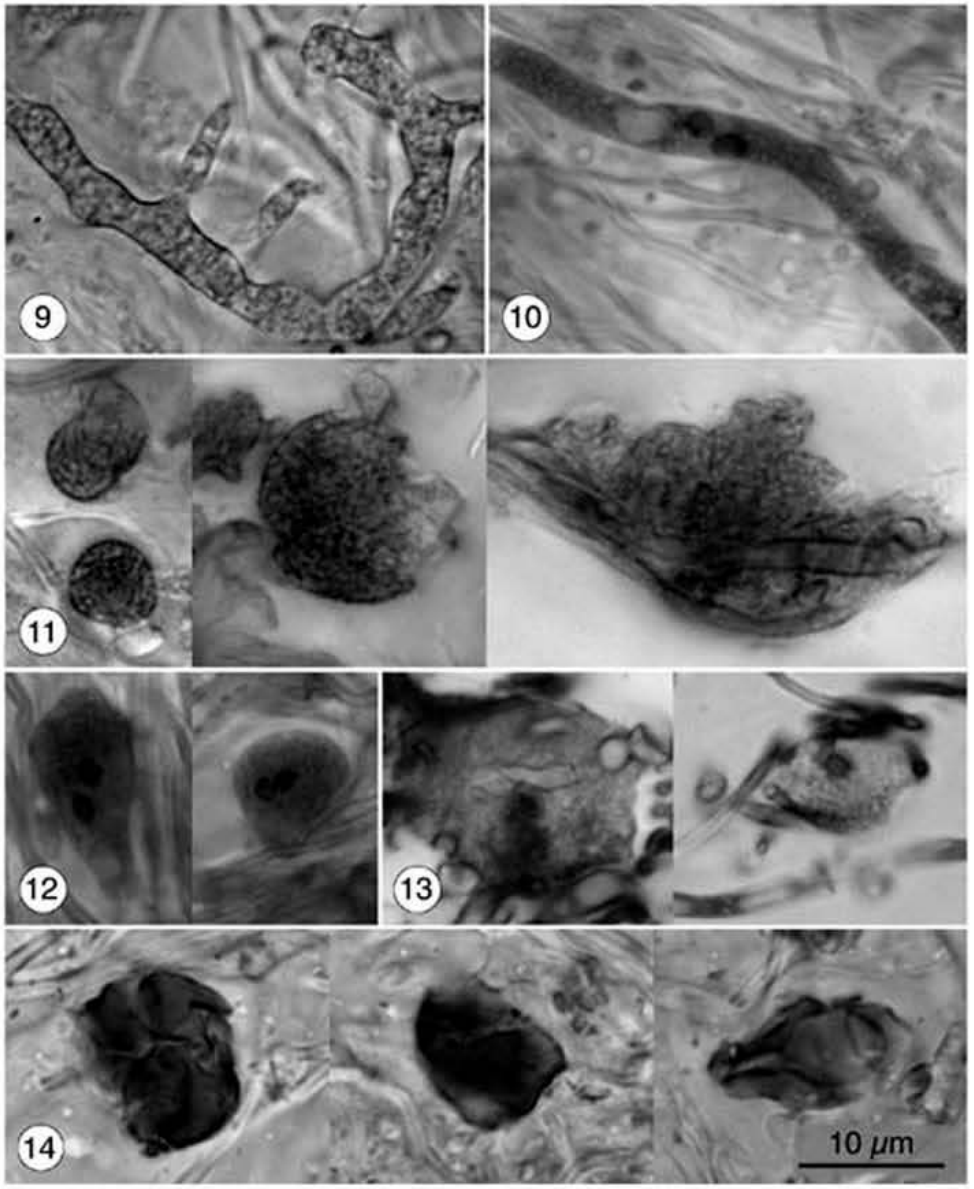


Figures 5-8. Amorphous to partly birefringent masses in the cortex. 5,6: Central hyphae surrounded by the masses viewed in bright field (5) and phase contrast (6); longitudinal sections. The originally cylindrical hyphae became more or less deformed by the masses. A nucleus is visible in the figure 5. 7–8: Partly birefringent masses in squash preparations viewed in bright field (7) and in polarised light (8). - Scale valid for all photographs.

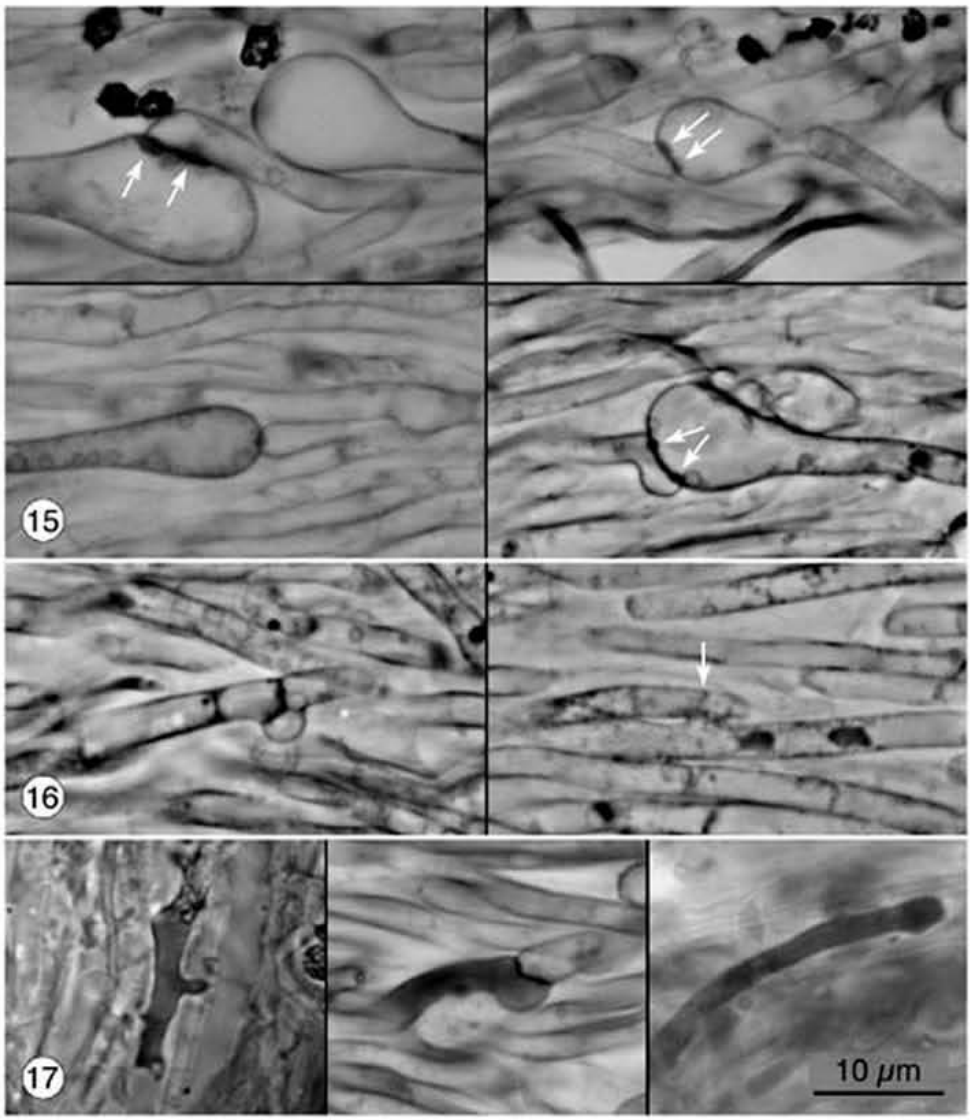
Crystal aggregates of different sizes are scattered on the surface of the rhizomorph, more rarely in deeper layers of the cortex or in the medulla (fig. 3: rectangles C).

In the deeper layers of the surface coating and just beneath it occur patches of amorphous or partly birefringent masses of unknown nature. They are easily visible in squash mounts but more difficult to see in serial sections of embedded material (fig. 3: rectangle A; figs. 5-8). In the center of the patches we find a single, wide, thin-walled hypha with nuclei and clamp connections. They are cylindrical or may become deformed by the masses surrounding them.

Secretory hyphae with a pale yellow, granular deuteroplasm (Clémençon 2004b) are located below and within the cortex (fig. 9). Short lateral pegs occur frequently and are reminiscent of «oleoacanthohyphae» (Agerer & Iosifidou 2004). Since nuclei are present (fig. 10), they are living gloeoplerous hyphae in the sense of Clémençon (2004b). The deuteroplasm is not altered by organic solvents and probably does not contain oils, so «oleoacanthohyphae» may be a misnomer. Some gloeoplerous hyphae produce terminal swellings that strech the cell wall until rupture occurs, releasing the deuteroplasm (fig. 11).



Figures 9-14. Gloeoplerous hyphae, gloeoplerous droplets and brown pigment masses from the cortex of a rhizomorph, squash preparations. **9:** Unstained gloeoplerous hypha with short lateral ramifications («oleoacanthohypha»); **10:** A binucleate gloeoplerous hypha, iron acetocarmine. **11:** Formation of gloeoplerous droplets from gloeoplerous hyphae. At left two young terminal vesicles still with an intact cell walls. The middle photograph shows an burst swelling with a thinned out, broken cell wall to the left, exposing the naked deuteroplasm towards the right. The right photograph shows the naked deuteroplasm flowing along thin hyphae and around a thicker one. Congo red. **12:** Two binucleate droplets; iron acetocarmine. **13:** Two naked droplets flowing around hyphae. Tannin-iron-haematoxylin. **14:** Brown pigment masses, the right most one showing remains of a hypha. - Scale valid for all photographs.



Figures 15-17. The medulla in longitudinal sections; aluminum-zirconium haematoxylin. **15:** Ampullate swellings. The white arrows indicate dolipore junctions. **16:** A clamp connection (left) and an H-connection (white arrow). **17:** Thromboplerous hyphal segments. The left most photograph shows an adjacent gloeoplerous segment on its top. - Scale valid for all photographs.

Free gloeoplerous droplets frequently contain nuclei (fig. 12) and often flow around neighbouring hyphae (figs. 11,13).

Near the surface of the cortex free, small chunks of a brown, brittle mass are scattered between the fibre hyphae. Some look as if they still contain remains of the hypha that secreted the pigmented mass (fig. 14).

The **medulla** consists mainly of more or less longitudinally oriented, slightly interwoven, thin-walled, cylindrical, binucleate, clamp bearing generative hyphae with ampullate inflations at many septa (figs. 3,15,16). Occasionally an H-connection occurs between two hyphae (fig. 16). A few dextrinoid fibre hyphae and some irregularly shaped crystals are scattered throughout the medulla (figs. 4, 15). Gloeoplerous hyphae are rare in the medulla, but thromboplerous segments of otherwise generative hyphae are occasionally seen (fig. 17). Wide tubular hyphae with reduced septa and octahedral crystals are lacking.

Discussion

The **unusual anatomical details** of the *Sclerogaster compactus* rhizomorphs are the naked drops of deuteroplasm and the amorphous or partly birefringent masses with a central hypha in the cortex. Together they may perhaps be characteristic of a sclerogasteroid type rhizomorph proper to the *Sclerogastraceae,* as opposed to the geastroid architecture of the *Geastraceae* lacking those structures, but more species from both families must be studied to confirm or reject this possibility.

The naked gloeoplerous droplets are reminiscent of the «globular yellow cells ... easily deformed from their very thin cell walls» of the ramarioid rhizomorph type D of Agerer & Iosifidou (2004), and the two structures may indeed be homologous. Dissolution of the cell wall of gloeoplerous hyphae may explain the isolated occurrence of the droplets far from any secretory hypha. Indeed, our observations suggest that secretory segments of a hypha could be transformed into a naked droplet by such a mechanism.

The amorphous or partly birefringent masses with a central hypha are difficult to interpret in terms of homologies. The masses may be secreted or excreted by the central hypha and remain amorphous for some time before partly crystallizing and becoming birefringent. The amorphous masses seem to be soluble in organic solvents, as they are frequently absent from microtome sections made from material passed through the alcohol series before embedding, leaving empty spaces clearly visible in phase contrast. However, the birefringent parts survive embedding and thus can be found in the microtome sections.

The **relevant phylogenetic structures** of the *Sclerogaster compactus* rhizomorphs are the ampullate septa, dextrinoid fibre hyphae, gloeoplerous, spine bearing hyphae (oleoacanthohyphae, Agerer & Iosifidou 2004), and the gloeoplerous droplets probably homologous with the «globular yellow cells». This combination is said to occur «typically in the genera *Geastrum* and its relative *Myriostoma*» (Agerer & Iosifidou 2004). These four structures indicate a phylogenetic relationship between the three genera, all three being now placed

in the *Geastrales, Phallomycetidae,* by analyses of DNA sequence data (Hosaka 2005; Hosaka & al. 2007).

So far peripheric dextrinoid fibre hyphae have been observed in the rhizomorphs of some species of three phylogenetically distinct but not closely related mushroom and puff ball groups: 1) *Agaricaceae* and *Lycoperdaceae* (*Agaricus, Lepiota, Cystolepiota, Macrolepiota, Chlorophyllum; Lycoperdon, Bovista*; Agerer 1999; personal observations by HC), 2) *Mycenaceae* (*Prunulus*; Clémençon 2004a), and 3) *Ramariaceae, Geastraceae* and *Sclerogastraceae* (*Ramaria stricta; Geastrum, Myriostoma,* Agerer & Iosifidou 2004; and *Sclerogaster*). It is therefore possible that dextrinoid fibre hyphae are polyphyletic and that they have phylogenetic and taxonomic importance on a local scale only. However, their occurrence in *Sclerogaster* together with ampullate septal swellings of the medullar hyphae is a strong indication of the placement of this genus in the gomphoid-phalloid clade.

Secretory hyphae are widespread in rhizomorphs, but mostly in the form of thromboplerous hyphae (e.g. Clémençon 2005, and further personal observations). Glocoplerous hyphae are much more restricted and occur mainly in the gomphoid-phalloid clade (Agerer & Iosifidou 2004), thus confirming the placement of *Sclerogaster* in this phylogenetic unit.

Acknowledgments

We thank Beatrice Senn-Irlet and F. Ayer of the WSL (Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft) and G. Martinelli (Zürich, Switzerland) for identifying and making available a rich collection of the fungus studied. We are grateful to D. Hibbett, Biology Department, Clark University, Worcester, MA, USA, and to R. Agerer, Ludwig-Maximilians-Universität, Munich, Germany, for reading, commenting and correcting our manuscript.

Literature cited

Agerer R. 1999. Never change a functionally successful principle: The evolution of *Boletales* s.l. (Hymenomycetes, *Basidiomycota*) as seen from below-ground features. Sendtnera 6: 5–91.

Agerer R. 2002. Rhizomorph structures confirm the relationship between *Lycoperdales* and *Agaricaceae* (Hymenomycetes, *Basidiomycota*). Nova Hedwigia 75: 367–385.

Agerer R, Beenken L. 1998. *Geastrum fimbriatum* Fr. + *Fagus sylvatica* L. Descr. Ectomyc. 3: 13-18.

Agerer R, Iosifidou P. 2004. Rhizomorph structures of Hymenomycetes: A possibility to test DNA-based phylogenetic hypotheses? In: Agerer & al. (eds.): Frontiers in Basidiomycote Mycology, pp. 249–302. IHW-Verlag, Eching.

Clémençon H. 1986. Schwärzende *Lyophyllum*-Arten Europas. Zeitschr. f. Mykologie 52: 61–84.

Clémençon H. 1998. Observing the Dolipore with the Light Microscope. Inoculum. Supplement to Mycologia Vol. 49(2): 3.

Clémençon H. 2000. Mycelial morphology, mitospores and primordium formation of *Simocybe sumptuosa* in laboratory cultures. Persoonia 17: 407–433.

Clémençon H. 2004a. Les rhizomorphes de *Prunulus* (Basidiomycètes, *Tricholomatales*, *Mycenaceae*). Bull. soc. mycol. France 120: 25–35.

Clémençon H. 2004b. Cytology and Plectology of the Hymenomycetes. Bibliotheca Mycologica Volume 199. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart.

Clémençon H. 2005. Rhizomorph anatomy of *Ossicaulis lignatilis* (*Tricholomatales*), with special attention to its haustoria-like intrahyphal hyphae. Mycol. Progress 4: 167-173.

Fischer E. 1900. Hymenogastrineae. In: Engler A & Prantl K (editors). Die natürlichen Pflanzenfamilien. I. Teil, Abteilung 1**, pp. 296-313. Engelmann Leipzig.

Gäumann E. 1964. Die Pilze. Birkhäuser, Basel.

Heim R. 1971. The interrelationships between the *Agaricales* and Gasteromycetes. In: Evolution of the Higher *Basidiomycetes*. Petersen RH (ed.), Univ. Tennessee Press, Knoxville.

Hesse R. 1891. Die Hypogaeen Deutschlands. Band I, Die Hymenogastreen. Verlag Hofstetter, Halle a.S.

Hosaka K. 2005. Systematics, phylogeny, and biogeography of the *Hysterangiales* and related taxa (*Phallomycetidae*, Homobasidiomycetes). PhD dissertation, Oregon State University, 386 pages.

Hosaka K, Bates ST, Beever RE, Castellano MA, Colgan W, Domínguez LS, Nouhra ER, Geml J, Giachini AJ, Kenney SR, Simpson NB, Spatafora JW, Trappe JM. 2006. Molecular phylogenetics of the gomphoid-phalloid fungi with an establishment of the new subclass *Phallomycetidae* and two new orders. Mycologia 98: 949-959.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th edition.CABI Publishing, CAB International, Wallingford, Oxon UK.

Malençon G. 1931. La série des Astérosporés. Trav. cryptogam. dédiés à L. Mangin. 1: 337-396.

Singer R. 1959. Type studies in *Basidiomycetes* IX. Sydowia 13: 235-238.

Singer R, Smith AH. 1960. Studies on the secotiaceous fungi IX. The astrogastraceous series. Mem. Torrey Bot. Club 21: 1-122.

Watling R. 2006. The sclerodermatoid fungi. Mycoscience 47: 18-24.

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Notes on *Amphisphaeria*-like species in HMAS, with a new combination: *Phaeodothis hainanensis* (*Pleosporales*)

YOU-ZHI WANG & WEN-HUA HE

yzwang@im.ac.cn
China General Microbiological Culture Collection Center
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China.

Abstract — Twenty-one specimens under various names of *Amphisphaeria*-like species in HMAS were re-examined. The taxa are repositioned according to modern taxonomic concepts. *Phaeodothis hainanensis* is treated here as a new combination based on *Amphisphaeria hainanensis*.

Key words — *Ascomycetes*, China, taxonomy

Introduction

Amphisphaeria Ces. & De Not. is a unitunicate pyrenomycete genus characterized by one-septate, brown ascospores. Since its establishment in 1863, several authors have contributed to research on *Amphisphaeria* (Aptroot 1995a, b; Barr 1984, 1989, 1994, 1996; Candoussau et al. 1986, Hawksworth 1985a, Hyde et al. 1996, Krug 1977, Müller & Arx 1962, Sivanesan 1975a, b; Teng 1936). Most recently, Wang et al. (2004) monographed the genus and accepted twelve species. Moreover, species excluded from *Amphisphaeria* are properly repositioned in the monograph.

Amphisphaeria has sometimes been used for many taxa with one-septate brown ascospores, however, the genus is only correctly employed for pyrenomycetes because the asci are unitunicate in structure and have an apical ring turning blue or not in iodine. The most similar genera are *Arecophila* K.D. Hyde, *Seynesia* Sacc., *Atrotorquata* Kohlm. & Volkm.-Kohlm., *Cainia* Arx & E. Müll., and *Roussoella* Sacc. (Wang et al. 2004).

There are also many extraneous bitunicate ascomycetous taxa having one-septate, brown ascospores that have been confused with *Amphisphaeria*,

such as *Astrosphaeriella*, *Byssosphaeria*, *Didymosphaeria*, *Dothidotthia*, *Kirschsteiniothelia*, *Lojkania*, *Montagnula*, *Mycomicrothelia*, and *Trematosphaeria*. However, these genera belong to loculoascomycetes, which are easily distinguished from *Amphisphaeria* by their bitunicate, J- asci (Wang et al. 2004).

Phaeodothis Syd. & P. Syd., which was recently reviewed by Aptroot (1995a), includes two species, *Phaeodothis ribesiella* (Nyl. ex Vain.) Aptroot and *P. winteri* (Niessl) Aptroot. Several *Didymosphaeria* species have been synonymized with these two species (Aptroot 1995a).

In China, nine *Amphisphaeria* species and seven *Didymosphaeria* species were recorded by Tai (1979). Unfortunately, not all the specimens are kept in the country. The study is based on dried herbarium specimens of *Amphisphaeria* and *Amphisphaeria*-like species deposited in the Hebarium Mycologicum Instituti Microbiologici Academiae Sinicae (HMAS). Chinese specimens outside the country, which have been studied by other authors, are also cited in this paper.

Taxonomy

Phaeodothis hainanensis (Teng) You Z. Wang, **comb. nov.** Figs. 1-4.
MycoBank MB 510500

≡ *Amphisphaeria hainanensis* Teng, Sinensia 7: 508, 1936 (basionym).

Ascomata semi-immersed to erumpent or superficial, conoid, black, scattered to subgregarious, papillate, 750-800 µm wide. (Fig. 1). Pseudoparaphyses filamentous, persistent, septate, branched, ca 1 µm wide (Fig. 3). Asci cylindrical, pedicellate, 8-spored, portion with spores 270-280 × 20-25 µm, bitunicate, with ocular chamber. Ascospores 1-seriate to partly overlapping, 45-58 × 12-15 µm, broadly fusiform or lanceolate, with pointed ends, light to dark brown, 1-septate, asymmetrical, mostly slightly curved, and slightly constricted at the septum, smooth-walled (Figs. 2, 4).

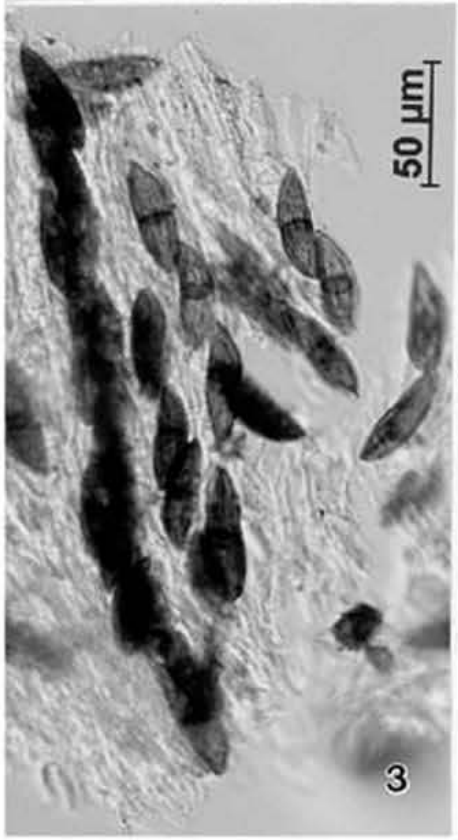
Specimen examined: CHINA, Hainan, Lingshui, on decorticated wood. 24 May 1934, X.K. Teng 2346, det. S.H. Ou, **HMAS 07210**, Holotype of ***Amphisphaeria hainanensis***.

Notes: The genus *Phaeodothis* is characterized by euseptate ascospores with a relatively broad, short and somewhat conical upper cell and a thinner, longer lower cell and by the sparse hamathecium consisting of thin pseudoparaphyses. *Phaeodothis hainanensis* differs from the two other species in the genus in having larger asci and ascospores.

Figs. 1-4. *Phaeodothis hainanensis* (from holotype of *Amphisphaeria hainanensis*). 1. Habit of ascomata on host surface. 2 & 4. Ascospores. 3. Pseudoparaphyses and ascospores.


1 mm
1


20 µm
2


50 µm
3


50 µm
4

Key to the species of *Phaeodothis*

1a. Ascospores (11-)13-16(-19) × 4-6 µm ..... ***P. winteri***
1b. Ascospores over 20 µm long 2

2a. Ascospores 20-25 × 5-7 µm, 1-3-septate, ascomata immersed ..... ***P. ribesiella***
2b. Ascospores 45-58 × 12-15 µm, 1-septate, ascomata erumpent to superficial ..... ***P. hainanensis***

Other Amphisphaeria-like species in HMAS

Arecophila serrulata (Ellis & G. Martin) K.D. Hyde, Nova Hedwigia 63: 97. 1996.

Ascomata immersed, asci unitunicate, J+, ascospores striate, ca 25 × 7.5 µm.

Specimen examined: PHILIPPINES, December 1916, H.S. Yates 25598, **HMAS 49488**, as *Didymosphaeria striatula* Penz. & Sacc.

Notes: the specimen is in poor condition, and only a few ascospores could be found.

Astrosphaeriella stellata (Pat.) Sacc. Syll. Fung. 24: 938. 1928.

Specimens examined: CHINA, Guangxi, Longlin, Jinzhong Mountain, on decayed bamboo, 19 October 1957, L.W. Xu 95, det. S.C. Teng, **HMAS 21872**, as ***Amphisphaeria fusispora*** (Syd. & P. Syd.) Teng; CHINA, Guangxi, Longlin, Jinzhong Mountain, on decayed bamboo, 23 October 1957, L.W. Xu 275, det. S.C. Teng, **HMAS 21873**, as ***A. fusispora***; CHINA, Hunan, Changsha, on bamboo culm, 11 September 1933, Q.Y Shen, det. S.C. Teng, **HMAS 07265**, as ***Amphisphaeria stellata*** Pat.; CHINA, Fujian, Nanjing, on dead bamboo, 13 June 1958, S.C. Teng, det. S.C. Teng, **HMAS 22603**, as ***A. stellata***; CHINA, Guizhou, Ceheng, Luxiong Lumbering Factory, on decayed bamboo, 2 November 1958, Q.Z. Wang 639, det. S.C. Teng, **HMAS 26065**, as ***A. stellata***; CHINA, Hainan, Tan-hsien (Danxian), on decayed culm, 29 October 1934, S.C. Teng 5729, det. S.C. Teng, **HMAS 06850**, as ***A. fusispora***.

Notes: There are three ascomyceteous fungi in the material of HMAS 06850. The first, with a rounded ostiole is *Astrosphaeriella stellata* (= *Amphisphaeria fusispora*) (Hawksworth 1981). Its ascomata are empty. The second, with a slit-like ostiole, is *Astrosphaeriella maculans* (Rehm) Aptroot et al. (Hyde et al. 2000). The third, with rounded ostiole and clypeus, is unknown because of empty ascomata. *Amphisphaeria stellata* was accepted as *Astrosphaeriella stellata* by Hawksworth (1981).

Didymosphaeria futilis (Berk. & Broome) Rehm, Hedwigia 18: 167, 1879.

Specimens examined: USA, Northville, S.D., on *Symphoricarpos occidentalis*, 20 February 1927, J.F. Brenckle, det. A. Aptroot, **HMAS 02377**, as ***Didymosphaeria albescens*** Niessl; USA, Northville, S.D., on *Polygonum emersum*, 20 May 1927, J.F. Brenckle, det. A. Aptroot, **HMAS 02378**, as ***D. brunneola*** Niessl; USA, Northville, S.D., on *Apocynum sibiricum*, 6 February 1927, J.F. Brenckle, det. A. Aptroot, **HMAS 02379**, as ***D. brunneola***.

Notes: These materials were re-examined and redisposed most recently by Aptroot (1995b).

Didymosphaeria schizostachyi (Rehm) You Z. Wang, Aptroot & K.D. Hyde, Revision of the ascomycete genus *Amphisphaeria*: 131. - Figs. 5-6.

Ascomata subglobose, semi-immersed or erumpent (Fig. 5). Peridium medium to dark brown, papilla short. Pseudoparaphyses < 1 µm, numerous, trabeculate in gelatinous matrix. Asci 104-120 × 7-10 µm, cylindrical, bitunicate, 1-seriate (Fig. 6). Ascospores 16-18 × 5-6 µm, ellipsoidal, medium brown, 2-celled, cells equal, without ornamentation, with a conspicuous median constriction and ends acute (Fig. 6).

Specimen examined: CHINA, Shaanxi, Qinling, on withered twigs, 4 August 2001, Y.Z. Wang, **HMAS 99925**.

Kirschsteiniothelia aethiops (Berk. & M.A. Curtis) D. Hawksw., Botanical Journal of the Linnean Society 91: 185. 1985. - Figs. 7-8.

Ascomata erumpent to superficial, hemispherical to subglobose, scattered, and slightly papillate (Fig. 7). Pseudoparaphyses, persistent, septate, branched, ca 2.5 µm wide. Asci 125-138 × 20-23 µm, 8-spored, cylindrical, bitunicate, with a small ocular chamber (Fig. 8). Ascospores 30-35 × 10-12 µm, 1-2 seriate, broadly fusiform, brown, 2-celled, and slightly constricted at the septum, smooth-walled, mostly inequilateral at the upper cell (Fig. 8).

Specimen examined: CHINA, Xinjiang, Urumqi, on *Clematis* sp., 24 May1981, Z.Y. Zhao et al., det. Z.Y. Zhao, **HMAS 89918** as ***Didymosphaeria*** sp.

Notes: *Kirschsteiniothelia aethiops* varies in ascospore sizes in different collections (Hawksworth 1985b). This collection has large ascospores, but within the range for *K. aethiops*.

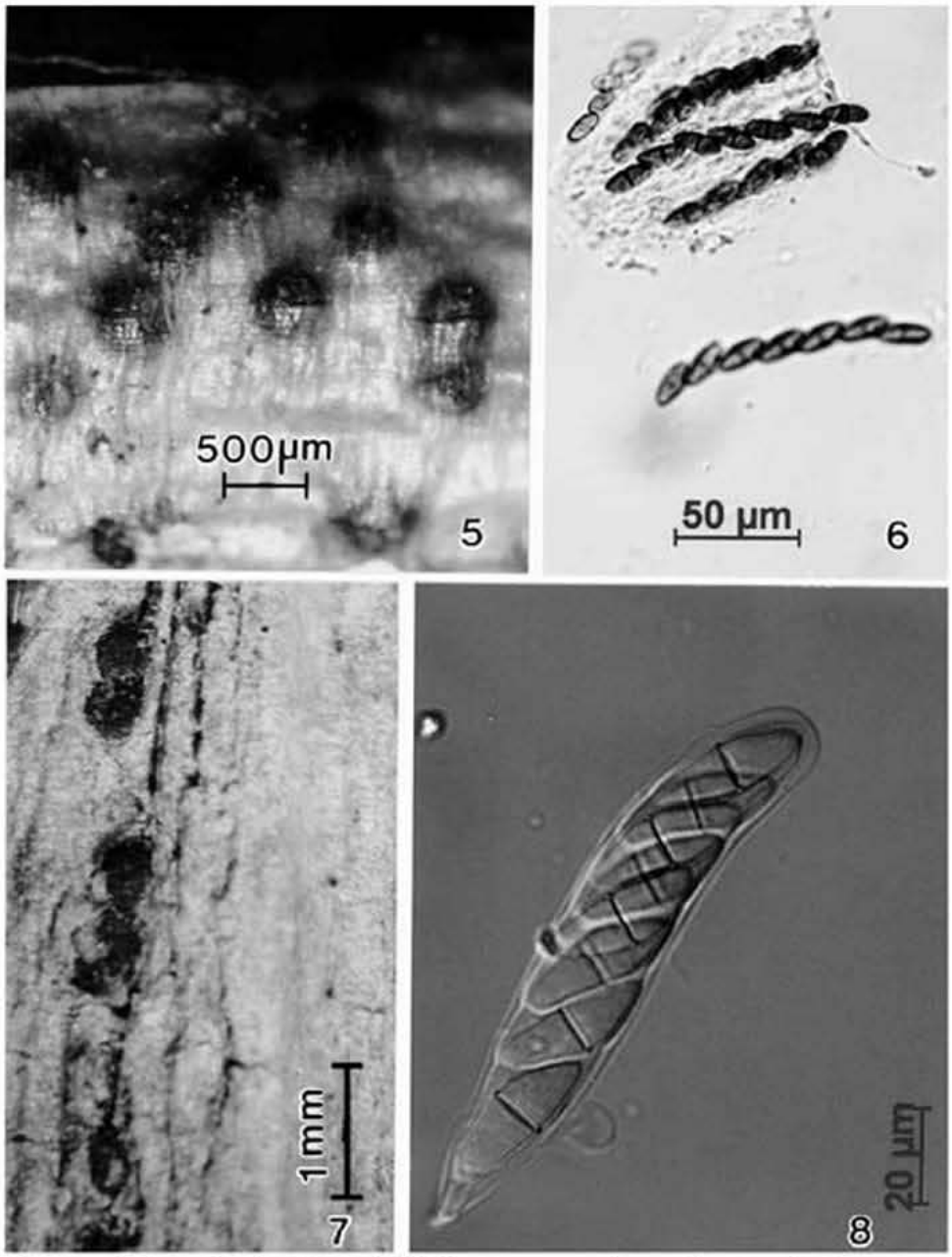
Kirschsteiniothelia populi (Tracy & Earle) You Z. Wang, Aptroot & K.D. Hyde, Revision of the ascomycete genus *Amphisphaeria*: 123. 2004.

Specimen examined: CHINA, Gansu, Kilieshan (Qilian mountain), on decorticated lims of *Populus*, 28 July 1945, S.C. Teng 4192, det. S.C. Teng, **HMAS 07178**, as ***Amphisphaeria populi*** Tracy & Earle.

Leptosphaerulina trifolii (Rostr.) Petrak, Sydowia 13: 76. 1959.

Specimens examined: PHILIPPINES, Los Banos, March 1920, on *Andropogon sorghum*, F. Gamboa, det. O.A. Reinking, **HMAS 06652**, **HMAS 14027**, as ***Didymosphaeria anisomera*** Sacc.

Notes: Aptroot (1995b) examined the isotype in HMAS, which he feels does not represent *Didymosphaeria*. The collector of the two HMAS collections (both in poor condition) may be different from the original collector of the *D. anisomera* holotype now curated in PAD.



Figs. 5-8. 5. *Didymosphaeria schizostachyi*, habit of ascomata on host surface. 6. Asci and ascospores of *D. schizostachyi*. 7. *Kirschsteiniothelia aethiops*, habit of ascomata on host surface. 8. Asci and ascospores of *K. aethiops*.

Lojkania decorticata (Cooke & Harkn.) M.E. Barr, Mycotaxon 20: 14. 1984.

Specimen examined: CHINA, Xinjiang, Turpan (吐鲁番), on decayed twigs, 18 June 1958, L.W. Xu 27, det. S.C. Teng, **HMAS 31229**, as ***Amphisphaeria decorticata*** (Cooke & Harkn.) Berl. & Voglino.

Montagnula palmacea (Cooke) Aptroot, Nova Hedwigia 60: 341. 1995.

Specimens examined: PAKISTAN, Kalar kahar, on *Phoenix dactylifera*, 31 December 1975. S. Ahmad 202126, **HMAS 46169**; S. Ahmad 25386, **HMAS 59356**, as ***Didymosphaeria smaragdina*** (Ces.) Sacc.

Notes: These two materials were re-examined and redisposed most recently by Aptroot (1995a).

Trematosphaeria insularis (S.H. Ou) You Z. Wang, Aptroot & K.D. Hyde, Revision of the ascomycete genus *Amphisphaeria*: 95. 2004.

Specimens examined: CHINA, Hainan, Ting-an, 9 December 1934, S.C. Teng 7422, det. S.H. Ou. **HMAS 07211**, as ***Amphisphaeria insularis*** S.H. Ou; CHINA, Hainan, Danxian, 26 September 1934, X.K. Teng 4787, det. S.H. Ou, **HMAS 07409**, as ***A. insularis***.

Notes: The material of HMAS 07211 is in poor condition.

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Literature cited

Aptroot A. 1995a. Redisposition of some species excluded from *Didymosphaeria* (*Ascomycotina*). Nova Hedwigia 60: 325-379.

Aptroot A. 1995b. A monograph of *Didymosphaeria*. Studies in Mycology 37: 1-160.

Barr ME. 1984. *Herpotrichia* and its segregates. Mycotaxon 20: 1-38.

Barr ME. 1989. Some unitunicate taxa excluded from *Didymosphaeria*. Studies in Mycology 31: 23-27.

Barr ME. 1994. Notes on the *Amphisphaeriaceae* and related families. Mycotaxon 51: 191-224.

Barr ME. 1996. Two more species of *Amphisphaeria* (*Xylariales*). Mycotaxon 58: 349-351.

Candoussau F, Katumoto K, Sherwood-Pike M. 1986 ('1985'). Bambusicolous fungi from the Southwest of France I. Two new species of *Pyrenomycetes* and a new genus of the *Phacidiaceae*. Sydowia 38: 28-34.

Hawksworth DL. 1981. *Astrosphaeriella* Sydow, a misunderstood genus of melanommataceous pyrenomycetes. Botanical Journal of the Linnean Society 82: 35-59.

Hawksworth DL. 1985a. A redisposition of the species referred to the ascomycete genus *Microthelia*. Bulletin of the British Museum (Natural History), Botany 14: 43-47.

Hawksworth DL. 1985b. *Kirschsteiniothelia*, a new genus for the *Microthelia incrustans*-group (*Dothideales*). Botanical Journal of the Linnean Society 91: 181-202.

Hyde KD. 1996. Fungi from palms. XXIX. *Arecophila* gen. nov. (*Amphisphaeriaceae*, *Ascomycota*), with five new species and two new combinations. Nova Hedwigia 63: 81-100.

Hyde KD, Aptroot A, Fröhlich J, Taylor JE. 2000. Fungi from palms. XLIII. *Lophiostoma* and *Astrosphaeriella* species with slit-like ostiole. Nova Hedwigia 70: 143-160.

Hyde KD, Kang JC, Kong RYC. 1996. Fungi from palms. XXX. Notes on *Amphisphaeria* species described from palms and a description of *A. umbrina*. Nova Hedwigia 63: 101-108.

Krug JC. 1977. The genus *Cainia* and a new family, *Cainiaceae*. Sydowia 30: 122-133.

Müller E, von Arx JA. 1962. Die Gattungen der didymosporen Pyrenomyceten. Beitrage zur Kryptogamenflora der Schweiz 11(2): 1-992.

Sivanesan A. 1975a. New ascomycetes and some revisions. Transactions of the British Mycological Society 65: 19-27.

Sivanesan A. 1975b. Redisposition and description of some *Amphisphaeria* species and a note on *Macrovalsaria*. Transactions of the British Mycological Society 65: 395-402.

Tai FL. 1979. Sylloge Fungorum Sinicorum. Academia Sinica, Peking, China, Science Press. 1-1527. (in Chinese)

Teng SQ. 1936. Additional Fungi from China II. Sinensia 7: 490-527.

Wang YZ, Aptroot A, Hyde KD. 2004. Revision of the ascomycete genus *Amphisphaeria*. Hong Kong, Fungal Diversity Press. 1-168.

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Mycoblastus marginatus, a new synonym for *M. affinis* (*Mycoblastaceae*, lichenized *Ascomycota*)

TOBY SPRIBILLE

tspribi@uni-goettingen.de
Albrecht von Haller Institute of Plant Sciences, University of Göttingen
Untere Karspüle 2, D-37073 Göttingen, Germany

TOR TØNSBERG

tor.tonsberg@bm.uib.no
Museum of Natural History, University of Bergen
Allégt. 41, P.O. Box 7800, N-5020 Bergen, Norway

Abstract—*Mycoblastus marginatus* was described in 1937 from a single specimen collected in southern Alaska and has not been reported since. The type material agrees morphologically and chemically with the widespread *Mycoblastus affinis*. We consider *M. marginatus* to be a synonym of the latter.

Key words—acetone insoluble pigment, crustose lichens, Pacific Northwest, planaic acid

The genus *Mycoblastus* is widespread at higher latitudes of both the Northern and Southern Hemispheres, and consists of between seven and ten mostly well characterized species. Regional European taxonomic treatments of the genus form the basis for species concepts worldwide. The genus has been discussed for central Europe by Schauer (1964) and for Great Britain by James (1971). The relationship of several poorly known taxa from other regions (e.g., *Lecidea sanguinaria* var. *melinodes* Vain. from Siberia, *M. japonicus* Müll.Arg. from Japan, *M. dissimulans* (Nyl.) Zahlbr. from Chile) to the rest of the genus is not clear. The genus is in need of a systematic revision.

In our work on northwest North American crustose lichens, we encountered the name *Mycoblastus marginatus*, an epiphytic species described from Kodiak Island (Degelius 1937). *Mycoblastus marginatus* was said to differ from all other members of the genus in the apothecia possessing a white 'border' and branched paraphyses, and it was mentioned by Schauer (1964) as a parallel

taxon to *Mycoblastus affinis* with white-margined apothecia. It was recognized by Thomson (1997) and continues to be included on the list of North American lichens (Esslinger 2006).

The type specimen of *Mycoblastus marginatus* (studied by us) strongly resembles *M. affinis*. The 'white border' mentioned by Degelius (1937) and Thomson (1997) appears to be little more than a ring of residual thalline tissue that may have persisted during apothecial ontogeny. Such a persistent ring is uncommon but not unknown; it is for instance the basis for the recognition of *Mycoblastus sanguinarius* var. *lecanoroideus* (Nyl.) Zahlbr. from Japan (Schauer 1964). Branching and anastomosing paraphyses are, in fact, given as a characteristic of the Mycoblastaceae by Hafellner (1984) and are present in the type of *Lecidea affinis* in G cited in the protologue (Schaerer 1850). We also compared acetone-insoluble pigments in the apothecia of both types and both contained a bluish pigment that is HNO_3+ mauve, K+ greyish olivaceous following pretreatment with HNO_3. The pigment appears to be similar to Cinereorufa-green as defined by Meyer & Printzen (2000), although before treatment it appears strongly bluish, not green in water and appears to be HCl– (without pretreatment).

European accounts of the chemistry of *Mycoblastus affinis* vary. Some authors report the thallus to be K– or K+ yellow (±atranorin and planaic acid; Wirth 1996), K+ yellow and UV+ white with unidentified substances (Watson & James 1992) or to contain atranorin, chloratranorin, and planaic acid (Tønsberg 1992, Foucard 2001). Schauer (1964) did not investigate the chemistry. We conducted thin layer chromatography (TLC) on a small fragment of the type of *M. affinis*. The thallus contained planaic acid (major) and atranorin (minor constituent) as well as a trace fatty acid; a single apothecium that was analyzed contained planaic acid only. It is not rare for atranorin to occur in only trace amounts in some specimens of *M. affinis*, which could explain the K– reactions reported by some authors.

When conducting TLC on the type of *M. marginatus* we found that it also contained planaic acid (major) and atranorin (minor). Given the overall agreement in morphological and chemical characteristics between *Mycoblastus marginatus* and *M. affinis*, we see no justification for maintaining *M. marginatus* as a distinct taxon. We here lectotypify *Mycoblastus affinis* and place *Mycoblastus marginatus* in its synonymy.

Mycoblastus affinis (Schaer.) T. Schauer, in Poelt & Steiner, Lichenes Alpinum 230 (1964).

Basionym: *Lecidea affinis* Schaer., Enumeratio critica lichenum Europaeorum, p. 132 (1850). Lectotype (designated here): [SWITZERLAND]: ad Abietum truncos ad radicem montis Nunenen, [collector unknown], Lichenes Helvetici Exsiccati 629 (G-00053948!); isolectotype in M (not seen, mentioned by Schauer 1964).

Synonyms:

Lecidea melina Kremp. ex Nyl., Annales des Sciences Naturelles, Botanique, 4e Série 19: 357 (1863). Type: [GERMANY:] ad truncos Pini in Bavaria superiore (M, not seen). Synonymy discussed by Schauer (1964); see also James (1971).

Mycoblastus marginatus Degel., Meddelanden från Göteborgs Botaniska Trädgård 12: 115 (1937). Holotype: U.S.A., Alaska, Kodiak Island, Kodiak, 27 Apr 1932, E. Hultén 5054 (UPS-18654!).

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Literature

Degelius G. 1937. Lichens from southern Alaska and the Aleuthian [sic] Islands, collected by Dr. E. Hultén. Meddelanden från Göteborgs Botaniska Trädgård 12: 105-144.

Esslinger TL. 2006. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm (Most Recent Update 10 April 2006).

Foucard T. 2001. Svenska skorplavar och svampar som växer på dem. Stockholm: Interpublishing. 392 pp.

Hafellner J. 1984. Studien in Richtung einer natürlicheren Gliederung der Sammelfamilien *Lecanoraceae* und *Lecideaceae*. Beiheft Nova Hedwigia 79: 241-371.

James PW. 1971. New or interesting British lichens I. Lichenologist 5: 114-148.

Meyer B, Printzen C. 2000. Proposal for a standardized nomenclature and characterization of insoluble lichen pigments. Lichenologist 32: 571-583.

Schaerer E. 1850. Enumeratio critica lichenum Europaeorum. Bernae: Staempfli. 327 pp.

Schauer T. 1964. Die Flechtengattung *Mycoblastus* in Mitteleuropa. Nova Hedwigia 8(3-4): 301-310.

Thomson JW. 1997. American Arctic lichens. 2. The microlichens. Madison: University of Wisconsin Press. 675 pp.

Tønsberg T. 1992. The sorediate and isidiate, corticolous, crustose lichens in Norway. Sommerfeltia 14: 1-331.

Watson MF, James PW. 1992. *Mycoblastus*. pp. 389-392 in: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (eds.) Lichen flora of Great Britain and Ireland. London: Natural History Museum.

Wirth V. 1995. Flechtenflora. 2. Auflage. Stuttgart: Ulmer. 660 pp.

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Fruitbodies of *Cenococcum geophilum*

L.M. Fernández-Toirán[1,2] & B. Águeda[1]

lmtoiran@pvs.uva.es

[1] *DIEF Valonsadero. Consejería de Medio Ambiente. Junta de Castilla y León Apartado de correos 175, E-42080 Soria, Spain*

[2] *Escuela Universitaria de Ingenierías Agrarias. Universidad de Valladolid Campus "Los Pajaritos", E-42005 Soria, Spain*

Abstract — Cleistothecia found in a soil sample containing abundant ectomycorrhizae and sclerotia of *Cenococcum geophilum* are described for the first time for the species. Although no connections between the ectomycorrhizae and fruitbodies were found in the sample, the cleistothecia were identified as fruitbodies of *C. geophilum* by comparing their morphology with the morphological characters of *C. geophilum* sclerotia and ectomycorrhizae.

Key Words — sexual structures, anatomical description, taxonomy

Introduction

Cenococcum geophilum Fr. is a cosmopolitan ectomycorrhizal fungus, well known for its wide habitat range (Trappe 1964) and possibly the dominant ectomycorrhizal fungus in arctic, temperate and subtropical forests (Trappe 1962, 1964; Molina & Trappe 1982). It is particularly noted for its drought resistance (Pigott 1982, Coleman et al. 1989). However, this fungus is not limited to dry places, as it has been observed in wet poorly drained soils (Trappe 1962). *C. geophilum* has a pioneering capability, although it is present also in mature stands (De Román & De Miguel 2005, Torres & Honrubia 1997). The ability of the sclerotia to survive for several years can provide sufficient inoculum to effectively colonize host species (Shaw & Sidle 1982).

The ectomycorrhiza of this fungus have been reported to occur on over 200 tree species from 40 different angiosperm and gymnosperm genera (Trappe 1962, 1964; Molina & Trappe 1982). Also, it is one of the most common ectomycorrhizal types in *Quercus ilex* L. stands in the Mediterranean area (Águeda & Fernández-Toirán 2004, De Román & De Miguel 2005, Richard et al. 2005).

Cenococcum geophilum was originally described from its black sclerotia by Sowerby in 1800 under the name *Lycoperdon graniforme* Sowerby (Cairney & Chambers 1999). Fries (1825) introduced the genus *Cenococcum* Moug. & Fr. with the species *C. geophilum* mentioned as a nom. nud. Fries (1829) gave a description of *C. geophilum*, citing *L. graniforme* in synonymy; as a sanctioned name, *C. geophilum* has priority over the earlier *L. graniforme*. The isolation of a "jet-black mycelium" that formed ectomycorrhizae was first identified by Hatch (1934) and the connection of these black ectomycorrhizae to *C. geophilum* was made by Linhell (1942). The identification of *C. geophilum* primarily relies on culture and ectomycorrhizal morphology because there are no known sexual fruitbodies. Until now, the presence of a sexual state has never been reported.

Material and methods

The harvested structures were found in a 600 ha orchard of 29-year-old oak trees (*Quercus ilex* subsp. *ballota* (Desf.) Samp.) during research on the ectomycorrhizae of a *Tuber melanosporum* Vittad. plot. Samples were collected in Oct 2000 from calcareous soil at a single site in the province of Soria, in the municipality of Villaciervos (Castilla y León, Spain), at an elevation of 1250 m. Soil samples were collected from beneath the holmoak and stored at 4 °C for later analysis in the laboratory. Roots with ectomycorrhizae and soil rhizomorphs were carefully extracted with the aid of a stereomicroscope. The excised roots and ectomycorhizae were cleaned in an ultrasonic bath with desionized water and some drops of Tween 20® detergent at 20 °C for 15 min. Samples of the ectomycorrhizae and sexual structures of *C. geophilum* fixed in FAA (Agerer 1986) and lactoglycerin were stored as voucher specimens in DIEF Valonsadero. The fruitbodies were found in a sample containing a high number of *C. geophilum* ectomycorrhizae and sclerotia.

The general methodology and terminology for characterizing the structure follows Agerer (1987-2002, 1991) and Agerer & Rambold (2004-2006). The sexual structures were fixed on slides with lacto-glycerin for microscope observation.

Description

Cleistothecia are spherical to oval (Fig. 1a). The outer layers of the cleistothecium are composed of dark pigmented hyphae, which make clusters of isodiametric cells (5 x 4 µm of diameter) surrounded by radiating bundles of elongate cells (15-25(40) x 5-8 µm) forming a stellate pattern (Fig. 1b).

The outer layer is covered with many emanating hyphae with slightly rounded bases, so that some parts of cleistothecium appear to have a layer of smooth

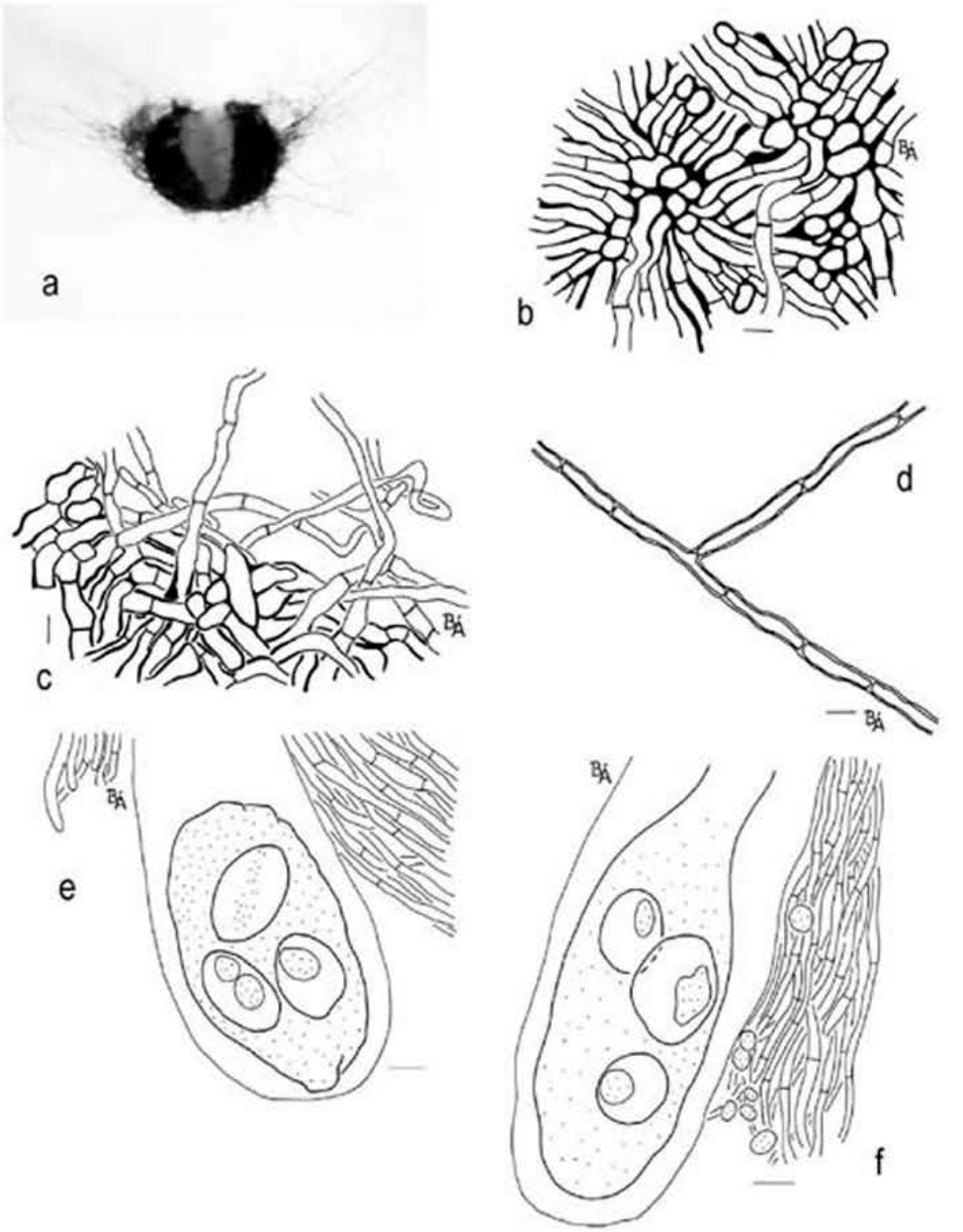

Figure 1: Anatomical characters of the cleistothecium. a. General view morphological aspects of the cleistothecium (63X). b. Outer layer of the cleistothecium with emanating hyphae. c. Margin of the cleistothecium with emanating hyphae. d. Ramified hyphae. e, f. Ascus with ascospores.
All bars 10 µm.

round cells covered by a dense net of hyphae. These hyphae are quite stiff (although they may also be sinuate), lack clamp connections, and have simple septa (Figs. 1c, d).

Inside the cleistothecia, two hyaline oval to pyriform 81.5-96 x 37.5-44 µm asci and hyaline 7.5-18 x 3-5 µm hyphae were observed. Each ascus contained three oval, hyaline, 18-29 x 15-19 µm ascospores (Figs. 1e, f).

Discussion

The morphological characterization of *Cenococcum geophilum* is very important because although it is one of the most common ectomycorrhizal fungi in different forest types, its fruitbodies have never been described. These fruitbodies were found in a sample containing many *C. geophilum* mycorrhizae and sclerotia. A comparison of these structures with the surface structures of the ectomycorrhizal mantle and the sclerotia shows that all anatomical characters are very similar.

Based on the descriptions of Chilvers (1968) and Trappe (1962), *C. geophilum* ectomycorrhizae are black with black hyphae or have seta radiating from the ectomycorrhiza surface. The mantle is composed of large, darkly pigmented hyphae (5-10 µm) near the surface, and smaller, paler hyphae (2.5-4 µm) adjacent to the host's epidermis. Surface hyphae of the mantle form a typical stellate pattern (Trappe 1971, Hawksworth 1986). All those characters are very similar to the ones found in the described cleistothecia.

The fruitbodies have the same shiny and dark colours as sclerotia. These are spherical with a shiny-smooth surface and brownish-black appearance. Surface hyphae form, as well, a stellate pattern, with thick black hyphae often radiating from the surface (Trappe 1969, Massicotte et al. 1992).

Also, the emanating hyphae have the same appearance of *C. geophilum* mycelia: dark brownish-black and are mostly 3.5-6.5 µm in diameter, generally stiff in appearance, but can be strongly sinuate, with simple septa and 0.2-0.3 µm thick cell walls (Miller & Miller 1983).

All the structures (ectomycorrhizae, sclerotia, cleistothecia) are very similar: dark and shiny colours, brownish-black hyphae without clamps connections, mostly 4-5 µm in diameter, and the outer layers of sclerotia, cleistothecia and mycorrhizae's mantle present the same star-like pattern. This constant in the morphological characters between all the structures would confirm the identification of these fruitbodies. Agerer & Rambold (2004-2006), in the case of *C. geophilum* sclerotia, advise that in the absence of an obvious connection between mycorrhizae and sclerotia, the presence of the same star-like pattern on both ectomycorrhizae and sclerotial outer layers would be sufficient evidence to establish its identity.

C. geophilum is the usual ectomycorrhizae in "truffières" (Iotti et al. 2005, De Román & De Miguel 2005), but it also exhibits a broad range of adaptation

to different ecological conditions. For those reasons, it could be a serious competitor of *T. melanosporum*.

In Spanish truffle orchards, *C. geophilum* appears only in orchards placed in previously forested sites, never orchards established in previously cultivated agricultural land (De Miguel et al. 2006). The fact that *C. geophilum* is found mixed with a high percentage of *T. melanosporum* ectomycorrhizae (Águeda et al. 2005) even in previously forested areas suggests that *Tuber melanosporum* is not easily replaced by *C. geophilum*.

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References

Agerer R. 1986. Studies on ectomycorrhizae II. Introducing remarks on characterisation and identification. Mycotaxon 26: 473-492.

Agerer R. (ed.) 1987-2002. Colour atlas of ectomycorrhizae. 1st-12th del. Schwäbisch Gmünd, Germany: Einhorn-Verlag + Druck GmbH.

Agerer R. 1991. Characterization of ectomycorrhiza. In: Norris JR, Read DJ, Varma AK, eds. Techniques for the study of mycorrhiza. London, UK: Academic Press, Methods in Microbiology 23: 25-73.

Agerer R, Rambold G. 2004-2006. 2004 – 2005 [first posted on 2004-06-01; most recent update: 2005-10-25]. DEEMY – An Information System for Determination and Characterisation of Ectomycorrhizae. München, Germany. Retrieved 2004-06-05 from http://www.deemy.de.

Águeda B, Fernández Toirán M. 2004. Ectomycorrhizae present in truffled evergreen oak forests in the North-East of Soria (Spain). Premier Symposium sur les Champignons Hypogés du Bassin Méditerranéen. Rabat (Morocco).

Águeda B, Fernández-Toirán LM, De Miguel AM. 2005. Characterization and quantification of the ectomycorrhizae of the truffle plantation "Los Quejigares" (Soria, Spain). Abstract IV International Workshop. Edible Mycorrhizal Mushrooms. Murcia (Spain).

De Miguel AM, Águeda B, Fernández-Toirán LM, Gónzalez Armada B. 2006. Dynamic of the ectomycorrhizal community in black truffle plantations in Spain. Abstracts 5th International Conference on Mycorrhiza.ICOM 2006.

De Román M, de Miguel AM. 2005. Post-fire, seasonal and annual dynamics of the ectomycorrhizal community in a *Quercus ilex* L. forest over a 3-year period. Mycorrhiza 15: 471-482.

Cairney JWG, Chambers SM. (eds.). 1999. Ectomycorrhizal fungi. Key Genera in Profile. Springer-Verlag Berlin Heidelberg.

Coleman MD, Bledsoe CS, Lopushinsky W. 1989. Pure culture response of ectomycorrhizal fungi to imposed water stress. Can J Bot 67: 29-39.

Chilvers GA. 1968. Some distinctive types of eucalypt mycorrhiza. Aust J Bot 16: 49-70.

Fries E. 1825. Systema Orbis Vegetablis I. Lundae. Typographia academica.

Fries E. 1829. Systema Mycologicum, III(Sectio Prior). Gryphiswaldae.

Hatch AB. 1934. A jet-black mycelium forming ectotrophic mycorrhizae. Sven Bot Tidskr 28: 369-383.

Hawksworth DL. 1986. The evolution and adaptation of sexual reproductive structures in the Ascomycota. In: Rayner ADM, Brasier CM, Moore D (eds.). Symposium of the British Mycological Society. Cambridge University Press.

Iotti M, Maechetti M, Bonuso E, Zambonelli A. 2005. Morphological and molecular characterization of the mycorrhizas of *Inocybe rufuloides* and *I. splendens*. Mycotaxon 94: 75-84.

Linhell D. 1942. *Cenococcum graniforme* als Mykorrizabildner von Waldbaumen. Symb Bot Ups 5:1-18.

Molina R, Trappe JM. 1982. Patterns of ectomycorrhizal host specificity and potential among Pacific Northwest conifers and fungi. For Sci 28: 423-458.

Massicotte HB, Trappe JM, Peterson RL, Melville LH. 1992. Studies on *Cenococcum geophilum*. II. Sclerotium morphology, germination and formation in pure culture and growth pouches. Can J Bot 70: 125-132.

Miller OK, Miller SL. 1983. Description and identification of selected mycorrhizal fungi in pure culture. Mycotaxon 18: 457-481.

Pigot CD. 1982. Fine structure of mycorrhiza formed by *Cenococcum geophilum* Fr. on *Tilia cordata* Mill. New Phytol 92: 501-512.

Richard F, Millot S, Gardes M, Selosse MA. 2005. Diversity and specificity of ectomycorrhizal fungi retrieved from an old-growth Mediterranean forest dominated by *Quercus ilex*. New Phytologist 166: 1011-1023.

Shaw CG, Sidle RC. 1982. Evaluation of planting sites common to a southeast Alaska clear-cut. II. Available inoculum of the ectomycorrhizal fungus *Cenococcum geophilum*. Can J For Res 13: 9-11.

Torres P, Honrubia M. 1997. Changes and effects of a natural fire on ectomycorrhizal inoculum potential of soil in a *Pinus halepensis* forest. For Ecol and Manag 96:189-196.

Trappe JM. 1962. *Cenococcum graniforme*, its distribution, ecology, mycorrhiza and inherent variation. PhD Diss, University of Washington.

Trappe JM. 1964. Mycorrhizal host and distribution of *Cenococcum graniforme*. Lloydia 27: 100-106.

Trappe JM. 1969. Studies on *Cenococcum graniforme*. I. An efficient method for isolation from sclerotia. Can J Bot 47:1389-1390.

Trappe JM. 1971. Mycorrhiza-forming Ascomycetes. In: Hacskaylo E. (ed). Mycorrhizae: Proceedings of the First North American Conference on Mycorrhizae. USDA Forest Service, Misc Publ 1189.

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Coprophilous ascomycetes in Thailand

ONUMA JEAMJITT[1], LEKA MANOCH[1*], NIPHON VISARATHANONTH[1], CHIRADEJ CHAMSWARNG[2], ROY WATLING[3], GEORGE P. SHARPLES[4] & ANAKE KIJJOA[5]

** agrlkm@ku.ac.th*

[1]Department of Plant Pathology, Faculty of Agriculture, Kasetsart University Bangkok 10900, Thailand

[2]Department of Plant Pathology, Faculty of Agriculture, Kasetsart University Kamphaengsaen Campus, Nakhon Pathom 73140, Thailand

[3]Caledonian Mycological Enterprises 26 Blinkbonny Av., Edinburgh EH4 3HU, UK

[4]Biomolecular Sciences, Liverpool John Moores University Byrom Street, Liverpool L3 3AF, UK

[5]Instituto de Ciências Biomédicas de Abel Salazar, Universidade do Porto, 4099-003 Porto, Portugal

Abstract—Dung samples of wild and domestic animals, including barking deer, buffalo, dromedary camel, cow, sambar deer, eld's deer, elephant, gaur, goat, horse, rabbit, rat and toad, were collected from fourteen locations in Thailand. Identification of the fungal isolates was based on morphological characteristics of colony growth on agar media, fruiting bodies and spore ornamentation using light and scanning electron microscopes. Sixty-eight isolates comprising 12 genera and 15 species of *Ascomycota* were found including *Ascobolus*, *Ascodesmis*, *Cercophora*, *Chaetomium*, *Emericella*, *Gelasinospora*, *Podosordaria*, *Podospora*, *Saccobolus*, *Sordaria*, *Sporormiella*, and *Zopfiella*.

Key words—dung fungi, taxonomy, ecology, pyrenomycetes, discomycetes

Introduction

Ascomycetes are the largest group of fungi, and have a worldwide distribution on various substrates (Kirk et al. 2001). Many are commonly found on dung of herbivorous animals (Bell 1983, 2005). Some are important sources of antibiotics, organic acids, enzymes, and other secondary metabolites of economic importance to pharmaceutical and agricultural enterprises, e.g. *Ascodesmis sphaerospora*, *Sporormiella vexans*, and some non-sporulating fungi (Hein et al. 1998, Soman et al. 1999, Ondeyka et al. 1998).

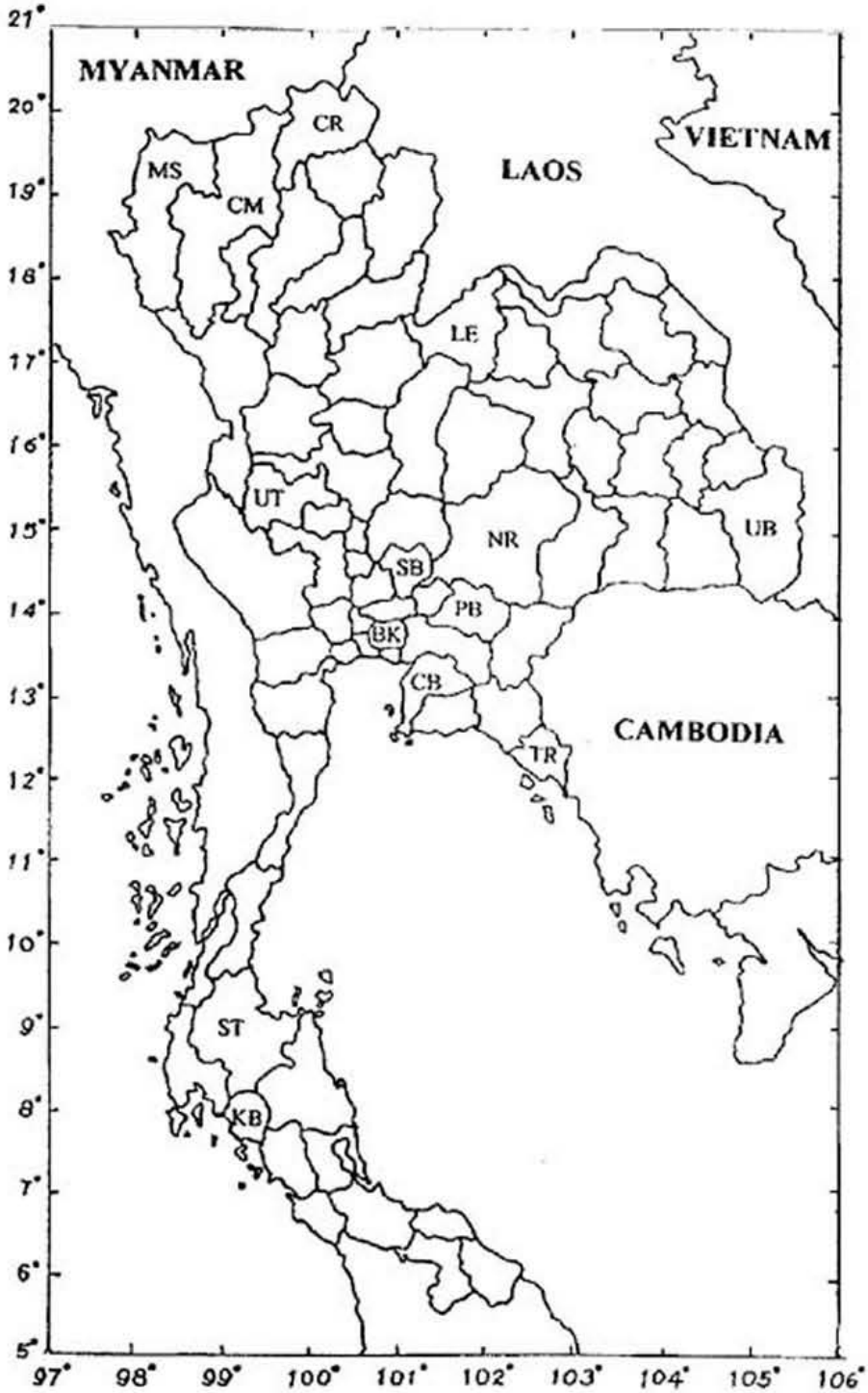

Fig. 1 Map of Thailand showing the collecting sites

However, these fungi have been little studied in Thailand. Van Brummelen (1967, 1969, 1977) reported several coprophilous ascomycetes from Thailand, including *Ascobolus siamensis*, *A. demangei*, *Saccobolus minimus*, *S. thaxteri*, *S. truncatus*, *S. succineus* and *Leptokalpion albicans* from various kinds of dung. Rogers et al. (1998) described *Podosordaria elephanti* as a new species on elephant dung from Chachoengsao Province. Also, Manoch et al. (1999) reported 19 coprophilous ascomycetes from 12 dung samples from Huay Kha Khang Wild Life Sanctuary, Uthai Thani Province and Khao Yai National Park, Nakhon Ratchasima Province. Somrithipol (2004) summarized the approximately 26 genera including 36 species coprophilous ascomycetes known in Thailand.

The present study was aimed to obtaining information on the mycobiota of coprophilous ascomycetes associated with different dung types and to compare their distribution among different sites and dung types in Thailand. In addition, pure cultures of most taxa are being maintained at Kasetsart University for further investigation.

Materials and methods

Sixty dung samples of 13 wild and domestic animals were collected from 14 provinces from June 2002 to July 2004 (Fig. 1, Table 1). Each excrement sample was placed in a moist chamber and positioned near a window. They were incubated for 2-7 days at 28 °C. Direct isolation was from the dung surface under a stereomicroscope. The ascomata were transferred directly onto water agar (WA), squashed to release the ascospores, and incubated for 48 hours. If the ascospores did not germinate, a fine needle was used to transfer the fruiting body with the remaining ascospores from WA and placed in a test tube containing 10 ml, 60-80 °C hot water, 65% ethyl alcohol, and 3% KOH for 30, 15 and 3-5 minutes respectively. The treated ascospores were spread on WA in a Petri dish and incubated for 12-24 hours. A hyphal tip from a single spore was transferred to a slant of potato dextrose agar (PDA) for all species. All isolates are being maintained as pure cultures at Kasetsart University Fungal Collection (KUFC). Dry specimens of dung samples are kept in a herbarium at Kasetsart University (KUH). The soil plate, dilution plate, heat, alcohol treatments and Gochenaur's glucose ammonium nitrate agar (Gochenaur 1964) (NH_4NO_3 1 g, K_2HPO_4 1 g, $MgSO_4.7H_2O$ 0.5 g, rose bengal 0.03 g, yeast extract 1 g, glucose 5 g, agar 15 g, streptomycin solution 4 ml, distilled water 1 l) as well as 2% malt extract agar were used to isolate the dung fungi. Identification was based on morphological characteristics such as colony growth patterns, color, texture on different agar media and spore ornamentation. Examination was by light and scanning electron microscopes.

Table 1 Frequency of coprophilous ascomycetes on different dung types collected from various locations using different isolation methods.

Fungal species	Total isolates	KUFC	Dung sample	KUH	Method *	Location **
Ascobolus albidus[a]	2	2452	elephant (*Elephas maximus*)	0017	mc	LE
		2453	elephant	0045	mc	CR
Ascodesmis macrospora	3	2454	rat (*Rattus rattus*)	0016	alc	BK
		2455	rat	0028	dp	BK
		2456	rat	0041	dp	BK
A. sphaerospora [a]	1	2457	toad (*Bufo* sp.)	0019	dp	BK
Cercophora silvatica	3	2458	elephant	0010	mc	CM
		2459	elephant	0033	mc	KB
		2460	elephant	0033	mc	KB
Chaetomium crispatum	3	2461	elephant	0004	mc	NR
		2462	cow (*Bos taurus*)	0021	mc	SB
		2463	cow	0052	sp	TR
C. cupreum	6	2464	cow	0050	mc	UB
		2465	sambar deer (*Cervus unicolor*)	0003	sp	NR
		2466	elephant	0004	alc	NR
		2467	rabbit	0030	mc	PB
		2468	cow	0044	mc	CR
		2469	eld's deer (*Cervus eldi*)	0048	mc	CB
C. globosum	19	2470	sambar deer	0003	mc	NR
		2471	sambar deer	0003	alc	NR
		2472	sambar deer	0003	ht	NR
		2473	barking deer (*Muntiacus feae*)	0002	mc	NR
		2474	rabbit (*Oryctolagus cuniculus*)	0011	mc	CM
		2475	rabbit	0011	alc	CM
		2476	rabbit	0013	mc	BK
		2477	rabbit	0013	sp	BK
		2478	gaur (*Bos gaurus*)	0026	alc	UT
		2479	rabbit	0030	mc	PB
		2480	goat (*Capra aegagrus*)	0034	sp	KB
		2481	goat	0034	alc	KB
		2482	horse (*Equus caballus*)	0035	mc	KB
		2483	cow	0031	mc	ST
		2484	cow	0031	alc	ST
		2485	cow	0031	ht	ST
		2486	cow	0044	mc	CR
		2487	dromedary camel (*Camelus dromedarius*)	0047	sp	CB
		2488	eld's deer	0047	sp	CB

Table 1 (*Cont.*)

Fungal species	Total isolates	KUFC	Dung sample	KUH	Method [a]	Location [b]
Emericella rugulosa	2	2489	rat	0041	dp	BK
		2490	cow	0044	sp	CR
Gelasinospora brevispora *	1	2491	cow	0052	ht	TR
Podosordaria leporina *	nc		rabbit	0030	mc	PB
Podospora curvicolla	1	2493	sambar deer	0003	sp	NR
Saccobolus glaber	nc		elephant	0017	mc	LE
Sordaria fimicola	16	2495	sambar deer	0003	mc	NR
		2496	sambar deer	0003	sp	NR
		2497	cow	0021	mc	SB
		2498	sambar deer	0003	alc	NR
		2499	sambar deer	0003	ht	NR
		2500	barking deer	0002	mc	NR
		2501	barking deer	0002	sp	NR
		2502	buffalo (*Bubalus bubalus*)	0012	sp	CM
		2503	gaur	0026	alc	UT
		2504	rabbit	0030	mc	PB
		2505	goat	0034	mc	KB
		2506	goat	0034	alc	KB
		2507	cow	0038	sp	MS
		2508	dromedary camel	0047	sp	CB
		2509	eld's deer	0048	sp	CB
		2510	eld's deer	0048	alc	CB
Sporormiella minima *	10	2511	sambar deer	0003	mc	NR
		2512	cow	0003	ht	NR
		2513	buffalo	0012	alc	CM
		2514	rabbit	0011	mc	CM
		2515	goat	0034	sp	KB
		2516	goat	0034	ht	KB
		2517	rat	0036	dp	BK
		2518	cow	0052	sp	TR
		2519	rat	0054	alc	BK
		2520	toad	0059	dp	BK
Zopfiella latipes	1	2451	sambar deer	0003	alc	NR

[a] alc, alcohol treatment; dp, dilution plate method; ht, heat treatment; mc, moist chamber method; sp, soil plate method

[b] BK, Bangkok; CB, Chonburi; CM, Chiang Mai; CR, Chiang Rai; KB, Krabi; LE, Loei; MS, Mae Hong Son; NR, Nakhon Ratchasima; PB, Prachinburi; SB, Saraburi; ST, Surat Thani; TR, Trat; UB, Ubol Ratchathani; UT, Uthai Thani

[c] See map for distribution

KUFC, Kasetsart University Fungal Colletion; KUH, Kasetsart University Herbarium; nc, not cultivated; *, new records for Thailand

Table 2 Occurrence (%) of coprophilous ascomycetes species on different dung types (the number of samples indicated in the brackets).

Fungal species	Dung type												
	barking deer (3)	sambar deer (2)	eld's deer (2)	elephant (8)	gaur (1)	rabbit (4)	dromedary camel (1)	buffalo (4)	cow (12)	goat (2)	horse (1)	rat (13)	toad (7)
Ascobolus albidus	-	-	-	2	-	-	-	-	-	-	-	-	-
Ascodesmis macrospora	-	-	-	-	-	-	-	-	-	-	-	3	-
A. sphaerospora	-	-	-	-	-	-	-	-	-	-	-	-	1
Cercophora silvatica	-	-	-	3	-	-	-	-	-	-	-	-	-
Chaetomium crispatum	-	-	-	1	-	-	-	-	2	-	-	-	-
C. cupreum	-	1	1	1	-	1	-	-	2	-	-	-	-
C. globosum	1	3	2	-	1	4	1	1	3	2	1	-	-
Emericella rugulosa	-	-	-	-	-	-	-	-	1	-	-	1	-
Gelasinospora brevispora	-	-	-	-	-	-	-	-	1	-	-	-	-
Podosordaria leporina	-	-	-	-	-	nc	-	-	-	-	-	-	-
Podospora curvicolla	-	1	-	-	-	-	-	-	-	-	-	-	-
Saccobolus glaber	-	-	-	nc	-	-	-	-	-	-	-	-	-
Sordaria fimicola	2	4	2	-	1	1	1	1	2	2	-	-	-
Sporormiella minima	-	1	-	-	-	1	-	1	2	2	-	2	1
Zopfiella latipes	-	1	-	-	-	-	-	-	-	-	-	-	-
Total isolate	3	11	5	7	2	7	2	3	13	6	1	6	2
% Occurrence	13	40	20	33	13	33	13	13	47	20	7	20	13

nc, not cultivated

Results and discussion

Sixty-eight isolates of coprophilous ascomycetes were found from 60 dung samples of 13 animals from 14 locations using various isolation methods (Table 1). Twelve genera and 15 species of coprophilous ascomycetes were recorded, including ten pyrenomycetes (66.7%), four discomycetes (26.7 %) and one plectomycete (6.7%). All taxa were cultivated on PDA and CMA, except *Podosordaria leporina* and *Saccobolus glaber* which failed to grow on agar media.

Chaetomium globosum was the most common species with 19 isolates found from all dung samples except elephant, buffalo, rat and toad, followed by *Sordaria fimicola* (16 isolates) and *Sporormiella minima* (10 isolates). It is interesting to note that *Ascobolus albidus*, *Ascodesmis macrospora*, *A. sphaerospora*, *Cercophora silvatica*, *Gelasinospora brevispora*, *Podosordaria leporina*, *Podospora curvicolla*, *Saccobolus glaber* and *Zopfiella latipes* were found on only one type of dung (Table 2).

The moist chamber method yielded the highest number of coprophilous ascomycetes (9 spp.), followed by the soil plate method (7 spp.), alcohol treatment (6 spp.), heat treatment (4 spp.), and dilution plate method (4 spp.). The results indicated that for wild animals, sambar deer dung yielded the highest number of fungal species (6 spp.), followed by elephant (5 spp.) and rabbit (5 spp.). For domestic animals, most fungal species were found on cow dung (7 spp.), followed by goat (3 spp.) and rat (3 spp.).

Ascobolus albidus P. Crouan & H. Crouan, Annls Sci. Nat., Bot., Sér. 4, 10: 193, 1858. **(Figs. 2, A-D)**

References: Bell (1983), Richardson & Watling (1997).

Specimens examined: Thailand. Loei: Phu Kradung National Park, on elephant dung, 31 Dec. 2002, KUH 0017 (KUFC 2452). Chiang Rai: Muang District, on elephant, 16 Jan. 2004, KUH 0045 (KUFC 2453).

Colonies on PDA growing slowly, reaching 1.5-2.0 cm diam in 7 days at 28 °C. Mycelium whitish brown, submerged, forming apothecia in 12-14 days. Apothecia submerged, colourless to pale yellowish, then dotted with the dark-colored spores. Asci 8-spored, clavate, 180-220 x 30-35 µm. Ascospores ellipsoidal, 20-30(-33) x 10-15 µm, golden brown, ornamentation consisting of anastomosing rows of striations parallel to the long axis of the spore.

Richardson & Watling (1997) described 21 species of *Ascobolus*, while 12 species were observed on dung in New Zealand (Bell 1983). *Ascobolus albidus* was found on cervid and lagomorph dung (Bell 1983). Bell (2005) reported that *Ascobolus albidus* was the only species found on five types of dung including rabbit, brumby, eastern gray kangaroo, wombat and swamp wallaby in Australia. Richardson (2001) reported *Ascobolus albidus* on sheep, deer, cattle, rabbit, hare and grouse collected worldwide from 1994 to 2000.

Van Brummelen (1967) reported *Ascobolus demangei* and *A. siamensis* from goat dung, in Uthai Thani Province. Somrithpol & Hywel-Jones (2002) recorded eight isolates of *Ascobolus* spp. from wildlife including sambar deer, barking deer, Asain elephant and cattle dung from Northeastern Thailand. In this study, two isolates of *Ascobolus albidus* were found on elephant dung from Loei and Chiang Rai Provinces collected in the cold season. This fungus is a new record for Thailand.

Ascodesmis macrospora W. Obrist, Can. J. Bot. 39: 951, 1961. (Figs. 3, A-C; 4)
References: Obrist (1961), Richardson & Watling (1997).

Specimens examined: Thailand. Bangkok: Bang Sue, on rat dung, 9 June 2002, KUH 0016 (KUFC 2454); 15 May 2003, KUH 0028 (KUFC 2455); 19 Oct. 2003, KUH 0041 (KUFC 2456).

Colonies on PDA growing rapidly, reaching 8-9 cm diam in 7 days at 28 °C. Mycelium whitish brown, with white tufts of aerial hyphae, forming apothecia in 12-14 days. Apothecia minute, hemisphaerical to subglobose, soft-fleshed, 100-200 µm, first hyaline, becoming dark brown at maturity. Asci 8-spored, broadly clavate, oblong, elliptical or ovoid, 80-90 x 20-33 µm, opening by a slightly obliquely attached operculum, thin-walled. Ascospores one-celled, broadly ellipsoid, 17-22 x 12-17 µm, first hyaline, then pale brown, becoming dark brown at maturity, ornamented with reticulum, spores discharged at once through opening of operculum.

Manoch et al. (1999) reported an *Ascodesmis* sp. from toad dung which resembled *A. macrospora* found in this study. This research confirmed the occurrence of *A. macrospora* in toad dung using the alcohol treatment method (Manoch et al. 1999). In addition, Manoch et al. (1999) reported *Ascodesmis porcina* from soil using the alcohol treatment method. Richardson & Watling (1997) presented a key to the six species of *Ascodesmis* from dung: *A. macrospora*, *A. nana*, *A. sphaerospora*, *A. microscopica*, *A. porcina* and *A. nigricans*.

Ascodesmis sphaerospora W. Obrist, Can. J. Bot. 39: 948, 1961. (Figs. 3, D-F; 5)
References: Obrist (1961), Richardson & Watling (1997).

Specimen examined: Thailand. Bangkok: Bang Sue, on toad dung, 2 Feb. 2003, KUH 0019 (KUFC 2457).

Colonies on PDA growing rapidly, reaching 8-9 cm diam in 7 days at 28 °C. Mycelium brownish white, cottony, forming apothecia in 12-14 days. Apothecia subglobose, soft-fleshed, 80-200 µm, scattered or gregarious, hyaline, superficial, without excipulum, with many asci surrounded by paraphyses. Asci 8-spored, broadly clavate, oblong or ovoid, 50-80 x 25-30 µm, opening by a slightly obliquely attached operculum, thin-walled. Ascospores one-celled, spherical to ellipsoid, 10-11 x 10.5-11 µm, L/B ratio mostly < 1.2, first hyaline, then pale brown, becoming dark brown at maturity, ornamented with a dark brown reticulations and ridges.

Ascodesmis sphaerospora was isolated from toad dung in Bangkok using the dilution plate method. This fungus is a new record in Thailand. Hein et al.

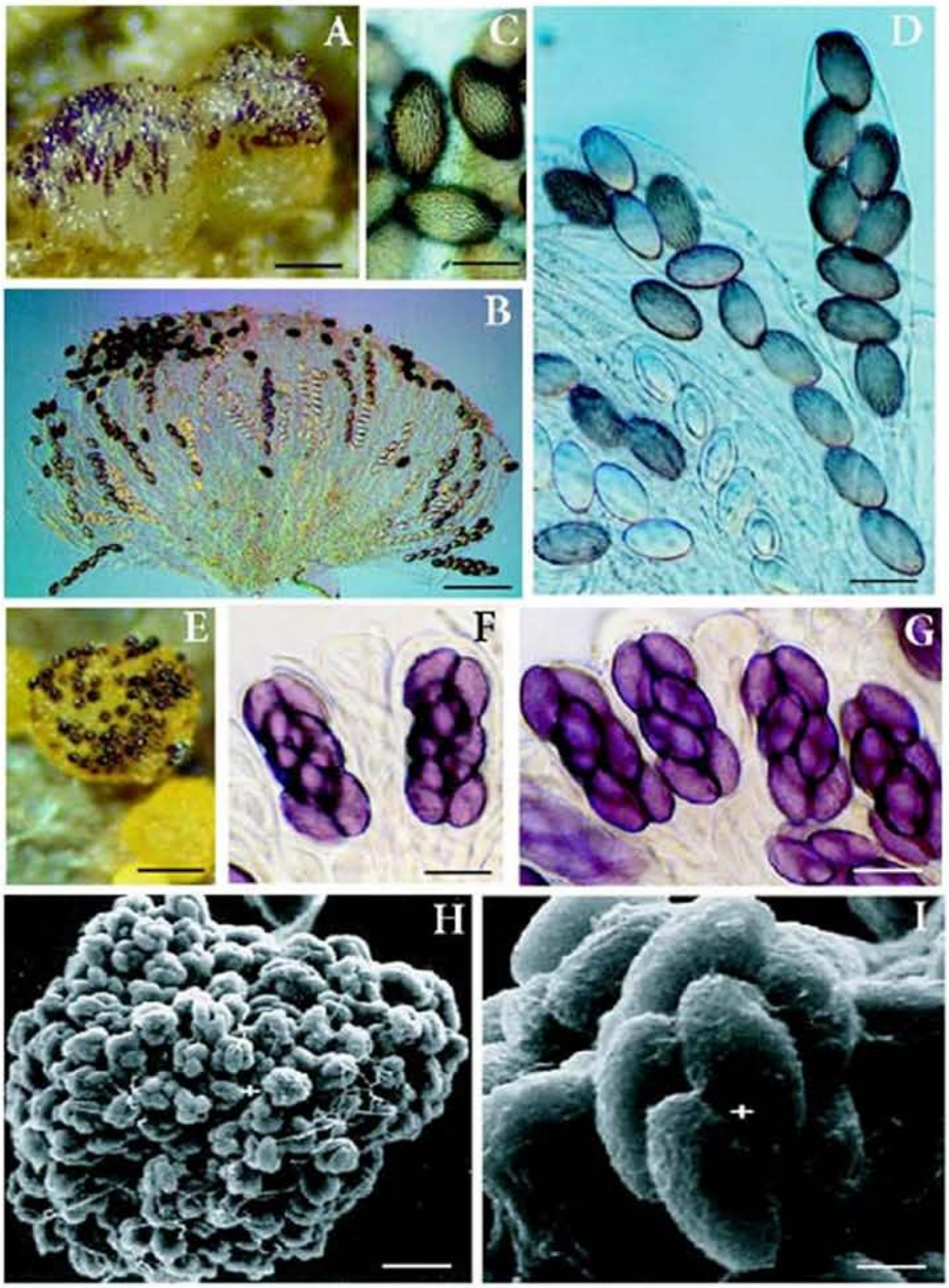

Fig. 2 A-D. *Ascobolus albidus* (KUFC 2452): A. apothecia on elephant dung, B. squash mount of apothecium; C, D. asci and ascospores; young, nearly mature and mature ascospores; E-I. *Saccobolus glaber* (KUFC 2494): E. apothecia with spore- masses inside, as seen on elephant dung; F, G. asci, spore-masses with 8 ascospores in each; H, I. SEM photomicrographs of intact apothecium with spore-masses and high magnification of ascospores.

Bars: A, E = 0.2 mm; B = 100 µm; C, F, G = 20 µm; D = 30 µm; H = 50 µm, I = 10 µm.

(1998) reported *A. sphaerospora* from bison dung in Canada which produces arugosin F and a xanthone and can inhibit *Bacillus subtilis*, *Staphylococcus aureus* and the coprophilous fungi *Ascobolus furfuraceus* and *Sordaria fimicola* in vitro. *A. sphaerospora* is a new record for Thailand.

Cercophora silvatica N. Lundq., Symb. bot. upsal. 20(1): 103, 1972.
References: Lundqvist (1972), Bell (1983), Ellis & Ellis (1998).

Specimens examined: Thailand. Chiang Mai: Mae Sa elephant camp, on elephant dung, 7 Nov. 2002, KUH 0010 (KUFC 2458). Krabi: Lanta Island, on elephant dung, 10 Aug. 2003, KUH 0033 (KUFC 2459, KUFC 2460).

Colonies on PDA growing slowly, reaching 5-6 cm diam in 14 days at 28 °C. Mycelium whitish to pale brown, forming perithecia in 10-14 days. Perithecia obpyriform, 500-530 x 300-400 µm, with protruding neck and tapered tufts of hair, immersed. Asci 8-spored, cylindrical, 200-220 x 16-18 µm, subapical globules absent. Ascospores immature sigmoid, hyaline, 35-50 x 3-3.5 µm; mature spores ellipsoid, dark brown, 15-16 x 7-9 µm; pedicel cylindrical, hyaline, 28-32 x 3-4 µm; the upper and basal cauda eccentrically attached.

Cercophora silvatica was found only on elephant dung from Chiang Mai, Northern Thailand and Krabi, Southern Thailand by the moist chamber method. This fungus was recorded from New Zealand (Bell 1983), but was not found in Australia (Bell 2005). In Thailand, Manoch et al. (1999) reported *Cercophora coprophila* from cow and rabbit dung from Loei and Bangkok, respectively. *C. silvatica* is a new record for Thailand.

Chaetomium crispatum (Fuckel) Fuckel, Jb. nassau. Ver. Naturk. 23-24: 90, 1870.
References: Arx et al. (1986), Domsch et al. (1993), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on elephant dung, 16 June 2002, KUH 0004 (KUFC 2461). Saraburi: Maung District, on cow dung, 14 April 2003, KUH 0021 (KUFC 2462). Trat: Goad Island, on cow dung, 16 March 2004, KUH 0052 (KUFC 2463).

Colonies on PDA, reaching 9 cm diam in 14 days at 28 °C. Mycelium whitish to yellow-green, forming perithecia in 7-10 days. Perithecia globose to subglobose, grey to grey-black, 300 x 200 µm; lateral hairs numerous, dark olive-brown; terminal hairs, wavy or very loosely coiled, olive-brown. Asci 8-spored, cylindrical, hyaline. Ascospores lemon-shaped with broadly apiculate ends, 9-10 x 6.5-7 µm.

This species has been reported on dung of various animals, soil, dead flies and seed of various plants (Domsch et al. 1993).

Chaetomium cupreum L.M. Ames, Mycologia 41: 642, 1949.
References: Ames (1963), Arx et al. (1986).

Specimens examined: Thailand. Ubol Ratchathani: Sirinthorn District, on cow dung, 25 Feb. 2002, KUH 0050 (KUFC 2464). Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2465); on elephant dung, 16 June 2002, KUH 0004 (KUFC 2466). Prachinburi: Tub Larn National Park, on rabbit dung, 26

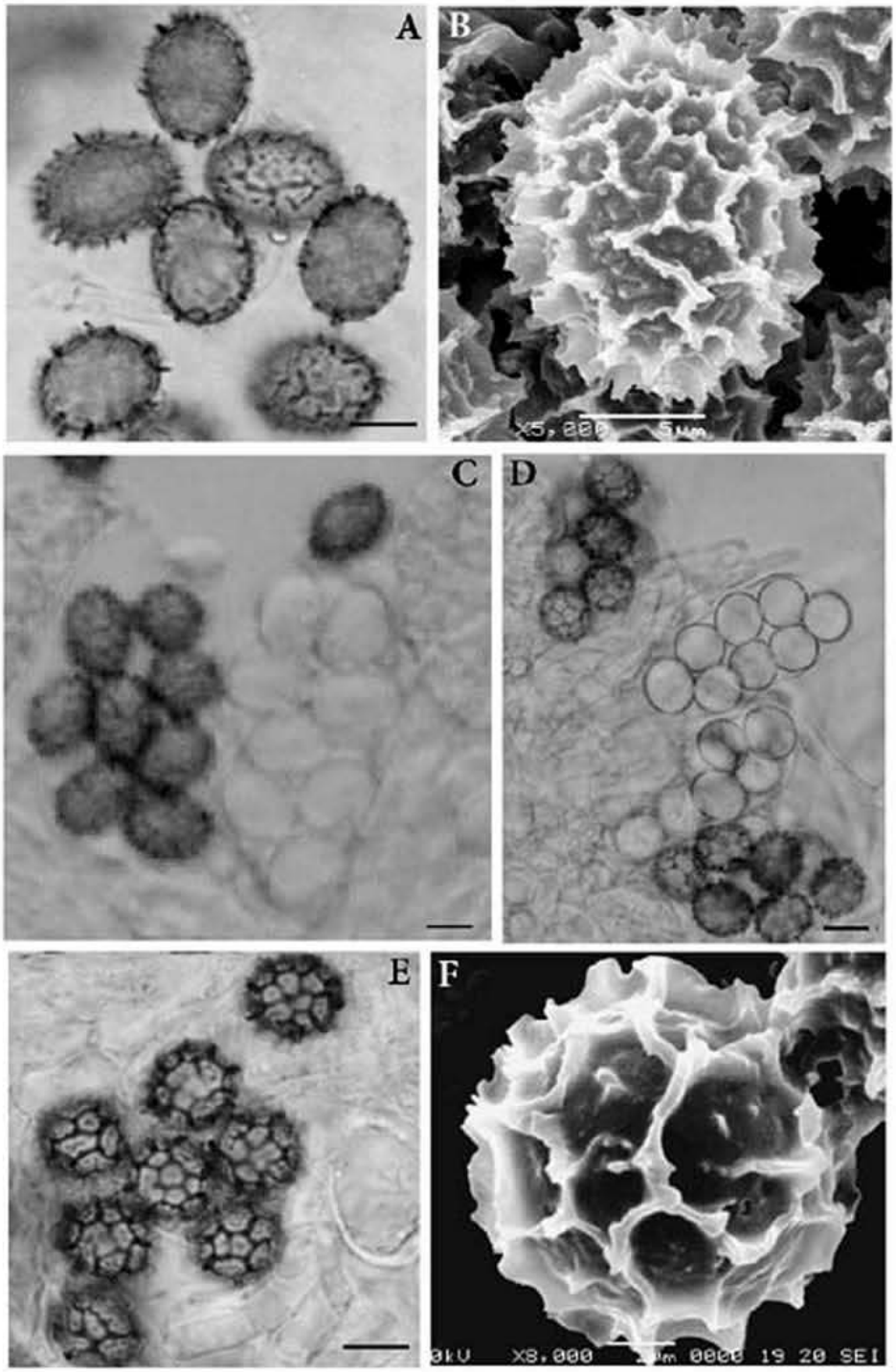

Fig. 3 A-C. *Ascodesmis macrospora* (KUFC 2454): A, B. ascospores; C. young ascus and ascospores; D-F. *A. sphaerospora* (KUFC 2457): D. young asci and ascospores; E, F. ascospores.
Bars: A, C, D, E = 10 µm; B = 5 µm; F = 2 µm.

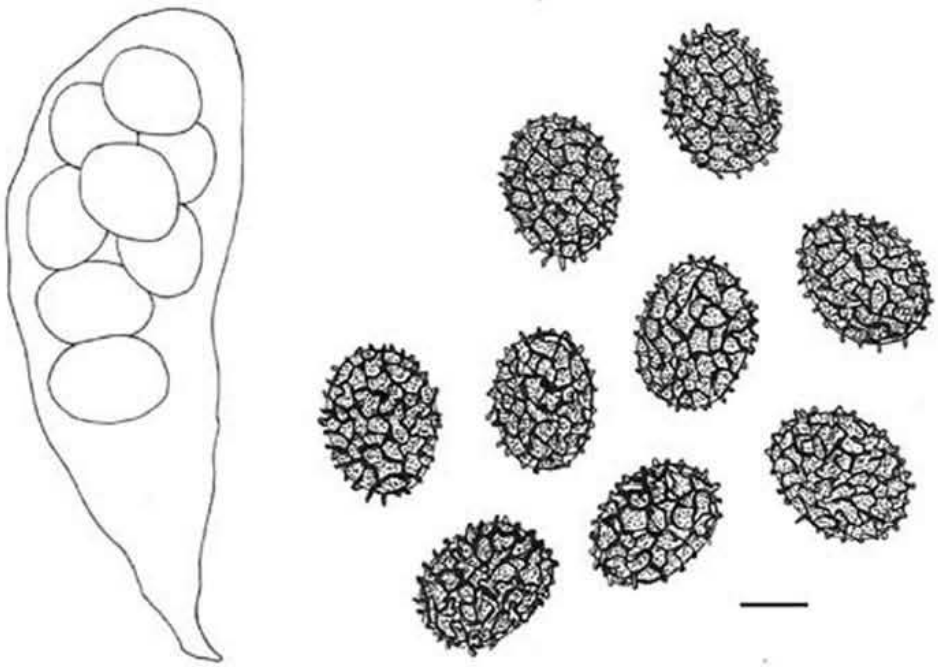

Fig. 4 *Ascodesmis macrospora* (KUFC 2454): camera lucida drawing of ascus and ascospores (bar = 10 µm).

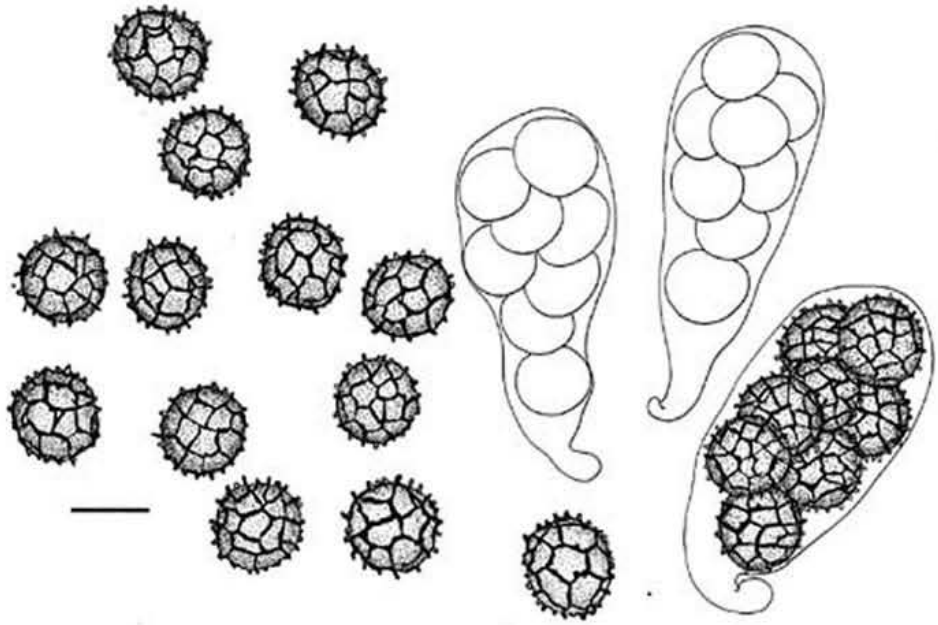

Fig. 5 *Ascodesmis sphaerospora* (KUFC 2457): camera lucida drawing of asci and ascospores (bar = 10 µm).

June 2003, KUH 0030 (KUFC 2467). Chiang Rai: Maung District, on cow dung, 16 Jan. 2004, KUH 0044 (KUFC 2468). Chonburi: Khao Kheow Open Zoo, on eld's deer dung, 17 Feb. 2004, KUH 0048 (KUFC 2469).

Colonies on PDA growing slowly, reaching 9 cm diam in 14 days at 28 °C. Mycelium whitish to grey, reverse red to brown, forming perithecia in 5-7 days. Perithecia globose to subglobose, golden red-brown, 270-300 x 180-220 µm; terminal hairs wavy or very loosely coiled, dark brown with tips. Asci 8-spored, short clavate, colourless. Ascospores one-celled, lemon-shaped, with two apical germ-pores, 8-10 x 6.5-8 µm.

Chaetomium globosum Kunze, Mykologische Hefte 1: 16, 1817.
References: Arx et al. (1986), Domsch et al. (1993), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2470, KUFC 2471, KUFC 2472); on barking deer, 16 June 2002, KUH 0002 (KUFC 2473). Chiang Mai: Queen Sirikit Botanic Garden, on rabbit dung, 7 Nov. 2002, KUH 0011 (KUFC 2474, KUFC 2475). Bangkok: Kasetsart Univ., on rabbit dung, 14 Nov. 2002, KUH 0013 (KUFC 2476, KUFC 2477). Uthai Thani: Huay Kha Khang Wild Life Sactuary, on gaur dung, 2 May 2003, KUH 0026 (KUFC 2478). Prachinburi: Tub Larn National Park, on rabbit dung, 26 June 2003, KUH 0030 (KUFC 2479). Krabi: Lanta Island, on goat dung, 10 Aug. 2003, KUH 0034 (KUFC 2480, KUFC 2481); on horse dung, 10 Aug. 2003, KUH 0035 (KUFC 2482). Surat Thani: Maung District, on cow dung, 8 Aug. 2003, KUH 0031 (KUFC 2483, KUFC 2484, KUFC 2485). Chiang Rai: Horticulture Research Institute, on cow dung, 16 Jan. 2004, KUH 0044 (KUFC 2486); Chonburi: Khao Kheow Open Zoo, on dromedary camel dung, 17 Feb. 2004, KUH 0047 (KUFC 2487); on eld's deer dung, 17 Feb. 2004, KUH 0048 (KUFC 2488).

Colonies on PDA growing rapidly, reaching 9 cm diam in 7 days at 28 °C. Mycelium dense, olivaceous, grey layer of ascomata, forming a grey layer of perithecia in 5-7 days. Perithecia globose to subglobose, dark brown, 200-300 x 200-250 µm; terminal hairs wavy or very loosely coiled, dark olive-brown. Asci 8-spored, short clavate, colourless. Ascospores one-celled, lemon-shaped, greenish brown, 8-12 x 6.5-8 µm, with two apical germ pores.

Chaetomium species occur worldwide in temperate and tropical regions and are mainly found on soil and fresh droppings of horse, squirrel, goat, rabbit and antelope (Domsch et al. 1993) and dung of various animals in New Zealand and Australia (Bell 1983, 2005). *Chaetomium cupreum* and *C. globosum* are both reported to produce secondary metabolites which are mycotoxins (Kanokmedhakul et al. 2002).

Emericella rugulosa (Thom & Raper) C.R. Benj., Mycologia 47: 680, 1955. (Fig. 6, F)
Reference: Raper & Fennell (1965).

Specimens examined: Thailand. Bangkok: Bang Sue District, on rat dung, 19 Oct. 2003, KUH 0041 (KUFC 2489). Chiang Rai: Horticulture Research Insitute, on cow dung, 16 Jan. 2004, KUH 0044 (KUFC 2490).

Colonies on PDA growing slowly, reaching 2-2.5 cm diam in 10-14 days at 28 °C. Mycelium with sparse green conidial heads. Abundant purple-brown cleistothecia

formed in 5-7 days, globose to subglobose, red-brown, 200 x 370 µm, surrounded by globose, colourless, hülle cells. Asci 8-spored, globose to subglobose, colourless. Ascospores lenticular, rugulose, with two sinuate equatorial crests, purple-red, 4.0-4.5 µm diam x 3.0-3.5 µm thick.

Anamorph: ***Aspergillus rugulosus*** Thom & Raper, Mycologia 31: 660, 1939.
Conidiophores smooth-walled, pale brownish, 40-80 µm long. Conidial head columnar. Conidia globose, rugulose, 3.5-4 µm.

E. rugulosa is a common soil fungus and was reported from several places in the USA; the type strain was isolated from New Jersey soil (Raper & Fennell 1965). Other habitats include forest nurseries, alkaline soils, mangrove mud and the rhizosphere of various cultivated plants (Domsch et al. 1993).

Gelasinospora brevispora R.S. Khan & J.C. Krug,
Mycologia 81: 226, 1989. **(Fig. 6, G)**
Reference: Khan & Krug (1989).

Specimens examined: Thailand. Trat: Goad Island, on cow dung, 16 March 2004, KUH 0052 (KUFC 2491).

Colonies on PDA growing slowly, reaching 9 cm diam in 14 days at 28 °C. Mycelium brown to dark brown, forming perithecia in 7-10 days. Perithecia scattered, immersed, globose to subglobose, brown to dark brown, ostiolate, 300-500 x 200-400 µm. Asci 8-spored, cylindrical, colourless, 140-200 x 18-30 µm. Ascospores one-celled, subglobose to ellipsoidal, hyaline when young, becoming olivaceous brown to dark brown, with walls uniformly ornamented with numerous, uniformly round or ovate depressions (or pits), provided with a circular germ pore at each end, 26.5-28 x 18-20 µm.

Khan & Krug (1989) described *Gelasinospora brevispora* as a new species on cow, herbivore and zebra dung (Holotype) from Kenya, and cow and elephant dung from Tanzania. In this study, we found only one isolate of *G. brevispora* from cow dung collected from Goad Island, Trat Province, Eastern Thailand. This fungus is a new record for Thailand.

Podosordaria leporina (Ellis & Everh.) Dennis,
Kew Bull. 1957: 306, 1957. **(Fig. 7, A-E)**
References: Richardson & Watling (1997), Ellis & Ellis (1998).

Specimens examined: Thailand. Prachinburi: Tub Larn National Park, on rabbit dung, 26 June 2003, KUH 0030 (non cultivated).

Ascostroma conspicuous on dung, 0.2-0.8 mm. Perithecia in a subglobose group at the tip of a stromatic stalk, 180-200 x 90-100 µm. Asci 8-spored, cylindrical, colourless, 150-180 x 14-16 µm. Ascospores one-celled, ellipsoidal, dark brown, with germ-slit, slightly flattened on one side, 15-17.5 x 8-10 µm.

Podosordaria leporina was reported on rabbit dung from Prachinburi Province, Thailand; its ascospores are characteristically slightly flattened on side. Richardson & Watling (1997) gave the ascospores as (12-) 14-19 x 6-9 µm.

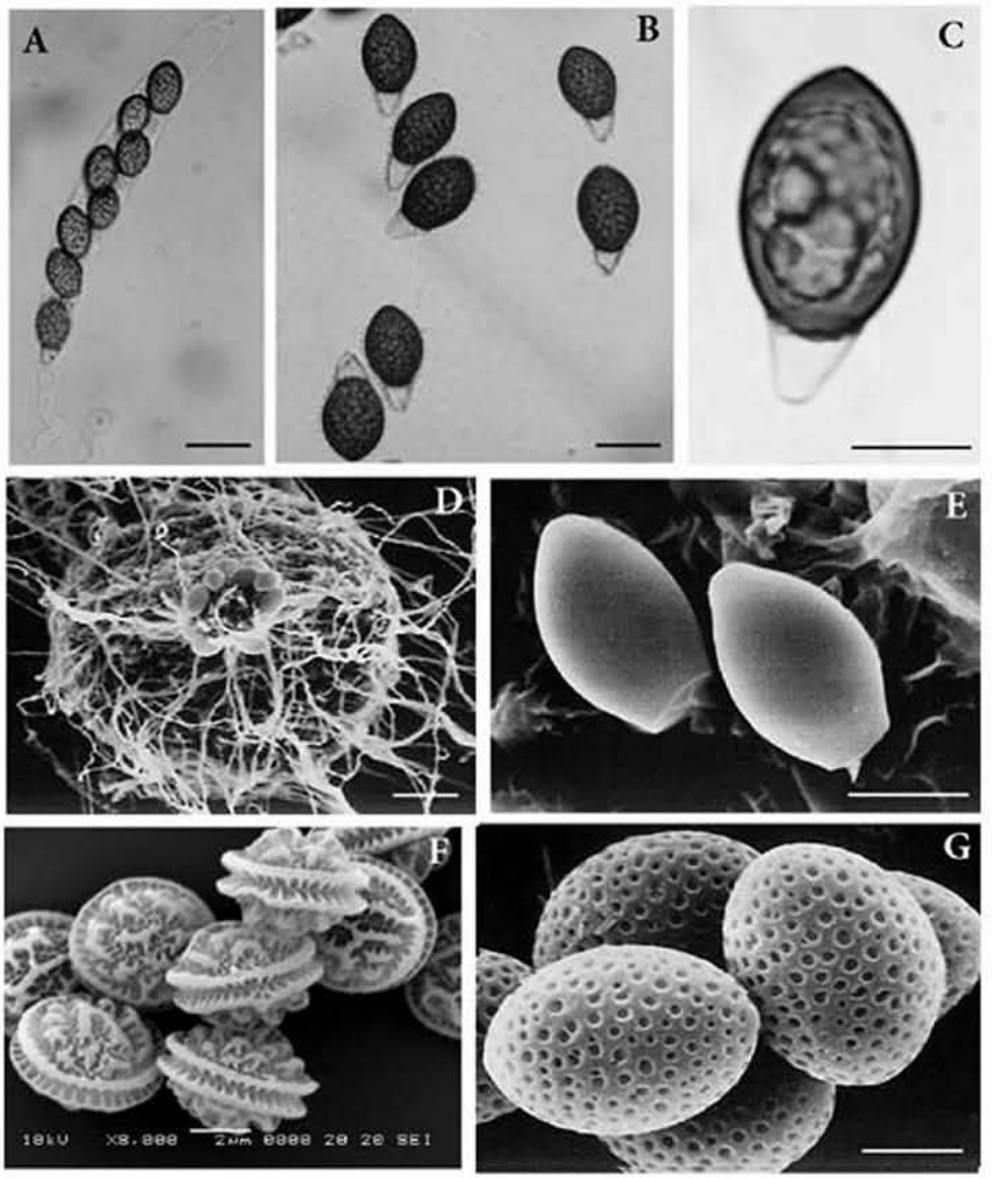

Fig. 6 A-E. *Zopfiella latipes* (KUFC 2451): A. ascus and ascospores; B, C. ascospores; D, E = SEM photomicrographs of ascoma and ascospores; F. *Emericella rugulosa* (KUFC 2489): ascospores; G. *Gelasinospora brevispora* (KUFC 2491): ascospores.

Bars: A = 30 µm; B, D, E = 20 µm; C, G = 10 µm; F = 2 µm

The stalks of stroma from our isolate were shorter than those described by Richardson & Watling (1997). Rogers et al. (1998) described *Podosordaria elephanti* as a new species from elephant dung collected in Chachoengsao Province, Thailand. Bell (2005) reported *Podosordaria violacea* from wallaby

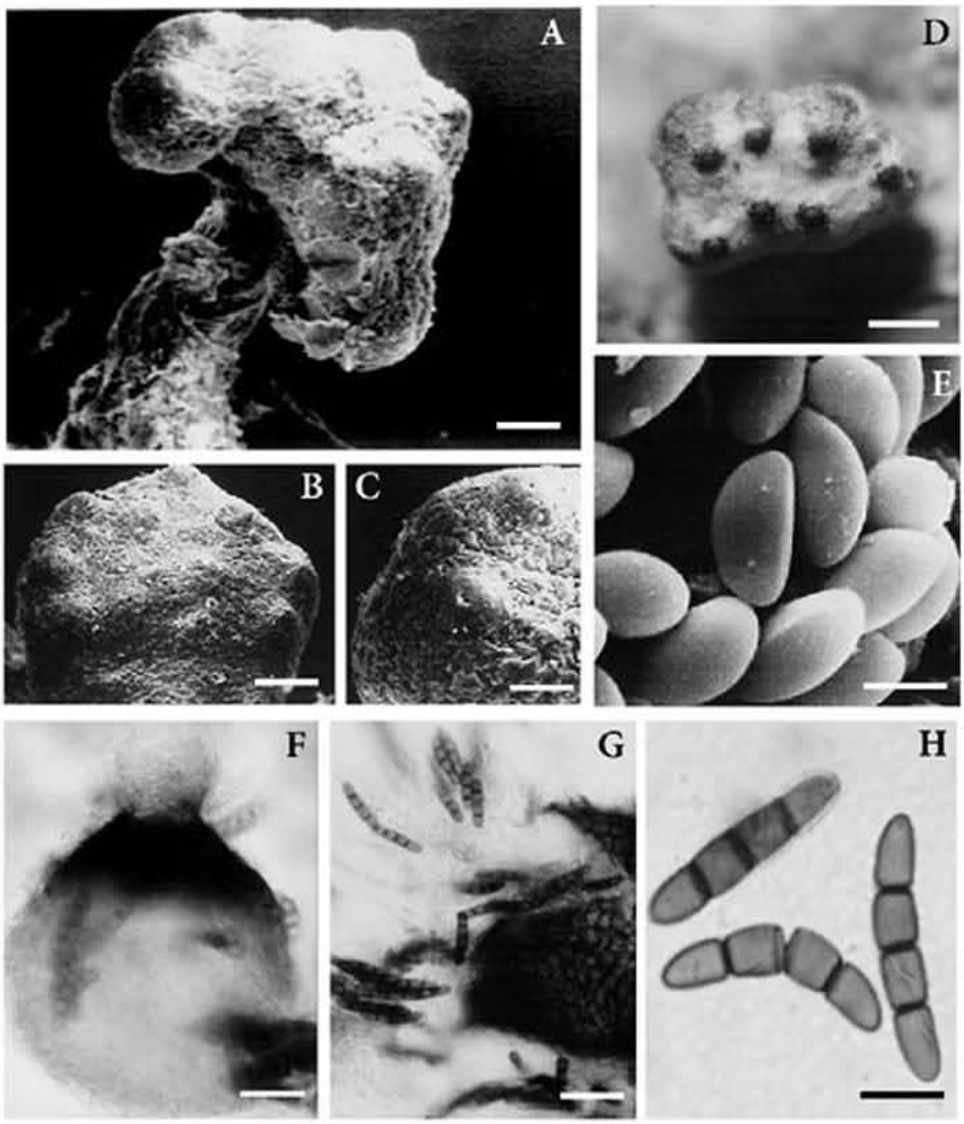

Fig. 7 A-E. *Podosordaria leporina* (KUFC 2492): A-C. SEM photomicrographs of ascostroma with perithecia; D. ascostroma on rabbit dung under stereomicroscope; E. ascospores; F-H. *Sporormiella minima* (KPFC 2514): F. perithecium, G. squash mount of perithecium, asci and ascospores, H. Ascospores with germ slit.

Bars: A, B = 100 µm; D = 0.2 mm; C = 50 µm; E, H = 10 µm; F = 20 µm; G = 30 µm

dung and *Podosordaria* sp. from Brush tail possum dung in Australia. *P. leporina* is a new record for Thailand.

Podospora curvicolla (G. Winter) Niessl, Hedwigia 22: 156, 1883.
References: Lundqvist (1972), Bell (1983), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2493).

Colonies on CMA growing slowly, reaching 5-5.5 cm diam in 14 days at 28 °C. Mycelium brown to dark brown, submerged, forming perithecia in 10-14 days. Perithecia obpyriform, with tufts of hair, immersed, brown to dark brown, 500-550 x 400-470 µm. Asci 256-spored, broadly clavate, colourless, 200-230 x 60-110 µm. Ascospores one-celled, subglobose to ellipsoidal, hyaline when young, becoming brown to dark brown, 15-16 x 9-10 µm; hyaline pedicel, 10-12 x 2-2.5 µm.

Podospora curvicolla was reported on lagomorph and possum dung in New Zealand (Bell 1983); and on cow, goat, rabbit, sheep and yellow ox dung in Taiwan (Wang 2000). In Thailand, Manoch et al. (1999) recorded *P. curvicolla*, *P. communis* and *P. anserina* from deer dung.

Saccobolus glaber (Pers.) Lambotte, Flora myc. Belg., Suppl. 1: 284, 1887. **(Fig. 2, E-I)**

References: van Brummelen (1967), Bell (1983), Richardson & Watling (1997), Ellis & Ellis (1998).

Specimens examined: Thailand. Loei: Phu Kradung National Park, on elephant dung, 31 Dec. 2002, KUH 0017 (non cultures).

Apothecia produced on dung after 2 days incubation at 28°C, soft-fleshed, pale yellowish, 100-120 x 25-30 µm. Asci 8-spored, unitunicate, cylindrical with operculum, at maturity elongating to project above the surface of apothecium, the spores within standing out as dark dots under stereomicroscope. Ascospores one-celled, ellipsoidal with truncated ends, purple, smooth-walled, 20-25 x 10-14 µm, firmly joined together with mucilage both in the ascus and after ejection.

Saccobolus glaber was found on elephant dung using the moist chamber method, but failed to grow on agar media. Somrithipol (2004) recorded the following *Saccobolus* species from Thailand: *S. citrinus*, *S. glaber*, *S. minimus*, *S. succineus*, *S. thaxteri* and *S. truncatus*. van Brummelen (1967) reported *S. minimus*, *S. thaxteri*, *S. truncatus* from animal dung in Thailand and described *S. succineus* as a new species collected from elephant and horse dung from Kanchanaburi Province (van Brummelen 1969). Manoch (2000) reported *S. citrinus* from deer, banteng and cow dung from Huay Kha Khang Wildlife Sanctuary, Uthai Thani Province; Khoa Yai National Park, Nakhon Ratchasima Province and Loei Province, Northern Thailand. Somrithipol & Hywel-Jones (2002) found *S. citrinus*, *S. glaber* and *S. thaxteri* from various dung including sambar deer, barking deer, Asian elephant and cattle from Northeastern Thailand.

Sordaria fimicola (Roberge ex Desm.) Ces. & De Not., Comm. Soc. Crittog. Ital. 1: 226, 1863.

References: Lundqvist (1972), Ellis & Ellis (1998).

Specimens examined: Thailand. Saraburi: Maung District, on cow dung, 14 April 2002, KUH 0021 (KUFC 2497). Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2495, KUFC 2496, KUFC 2498, KUFC 2499); on barking deer, 16 June 2002, KUH 0002 (KUFC 2500, KUFC 2501). Chiang Mai: Mae

Tang District, on buffalo dung, 7 Nov. 2002, KUH 0012 (KUFC 2502). Uthai Thani: Huay Kha Khang Wild Life Sactuary, on gaur dung, 2 May 2003, KUH 0026 (KUFC 2503). Prachinburi: Tub Larn National Park, on rabbit dung, 26 June 2003, KUH 0030 (KUFC 2504). Krabi: Lanta Island, on goat dung, 10 Aug. 2003, KUH 0034 (KUFC 2505, KUFC 2506). Mae Hong Son: Maung Distric, on cow dung, 9 Oct. 2003, KUH 0038 (KUFC 2507). Chonburi: Khao Kheow Open Zoo, on dromedary camel dung, 17 Feb. 2004, KUH 0047 (KUFC 2508); on eld's deer dung, 17 Feb. 2004, KUH 0048 (KUFC 2509, KUFC 2510).

Colonies on PDA growing rapidly, reaching 9 cm diam in 7 days at 28 °C. Mycelium brown to dark brown, forming perithecia in 7-10 days. Perithecia obpyriform, superficial, dark brown, 300-400 x 250-330 µm. Asci 8-spored, unitunicate, cylindrical, shortly stipitate, with truncate apex from thickened apical ring, colourless, 160-200 x 15-17 µm. Ascospores one-celled, ovoid to ellipsoidal, hyaline when young, becoming brown to dark brown, 15-20 x 10-12 µm, with germ pore at the apiculate basal end, covered with a wide gelatinous sheath.

Sordaria fimicola is recorded from horse, rabbit, cow and many other kinds of animals, mostly herbivorous dung from many countries (Bell 1983, 2005; Domsch et al. 1993, Richardson & Watling 1997, Elshafie 2005). Manoch et al. (1999) reported *S. fimicola* from deer and banteng dung in Thailand.

Sporormiella minima (Auersw.) S.I. Ahmed & Cain,
Pakist. J. scient. Ind. Res. 12: 241, 1970. **(Fig. 7, F-H; 8)**

References: Ahmed & Cain (1972), Bell (1983), Ellis & Ellis (1998).

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2511); Pak Thong Chai District, on cow dung, 25 Oct. 2002, KUH 0009 (KUFC 2512). Chiang Mai: Mae Tang District, on buffalo dung, 7 Nov. 2002, KUH 0012 (KUFC 2513); Queen Sirikit Botanic Garden, on rabbit dung, 7 Nov. 2002, KUH 0011 (KUFC 2514). Krabi: Lanta Island, on goat dung, 10 Aug. 2003, KUH 0034 (KUFC 2515, KUFC 2516). Bangkok: Kasetsart Univ., on rat dung, 26 Sept. 2003, KUH 0036 (KUFC 2517). Trat: Goad Island, on cow dung, 16 March 2003, KUH 0052 (KUFC 2518). Bangkok: Kasetsart Univ., on rat dung, 4 April 2004, KUH 0054 (KUFC 2519); on toad dung, 19 July 2004, KUH 0059 (KUFC 2520).

Colonies on PDA growing slowly, reaching 5-5.5 cm diam in 14 days at 28 °C. Mycelium whitish to pale brown, submerged, forming perithecia in 10-14 days. Perithecia subglobose or pyriform, immersed when young and becoming superficial at maturity, dark brown, peridium thin, membranaceous, scattered or loosely aggregated, 100-150 x 85-100 µm. Asci 8-spored, unitunicate, cylindrical, broadly rounded above, shortly stipitate, colourless, 80-110 x 15-18 µm. Ascospores four-celled, cylindrical, broadly rounded at the ends, straight or curved, each spore free and surrounded by its own gelatinous sheath, 32-35 x 5-6.5 µm, tending to break into two at the middle septum.

Sixty-six species of *Sporormiella* were recorded by Ahmed & Cain (1972). They also reported *S. minima* on several dung samples, such as bear, carnivore, cow, deer, fox, goat, horse, moose, rabbit and sheep from Europe, Canada, Mexico and the United States. Bell (2005) reported this fungus from brush

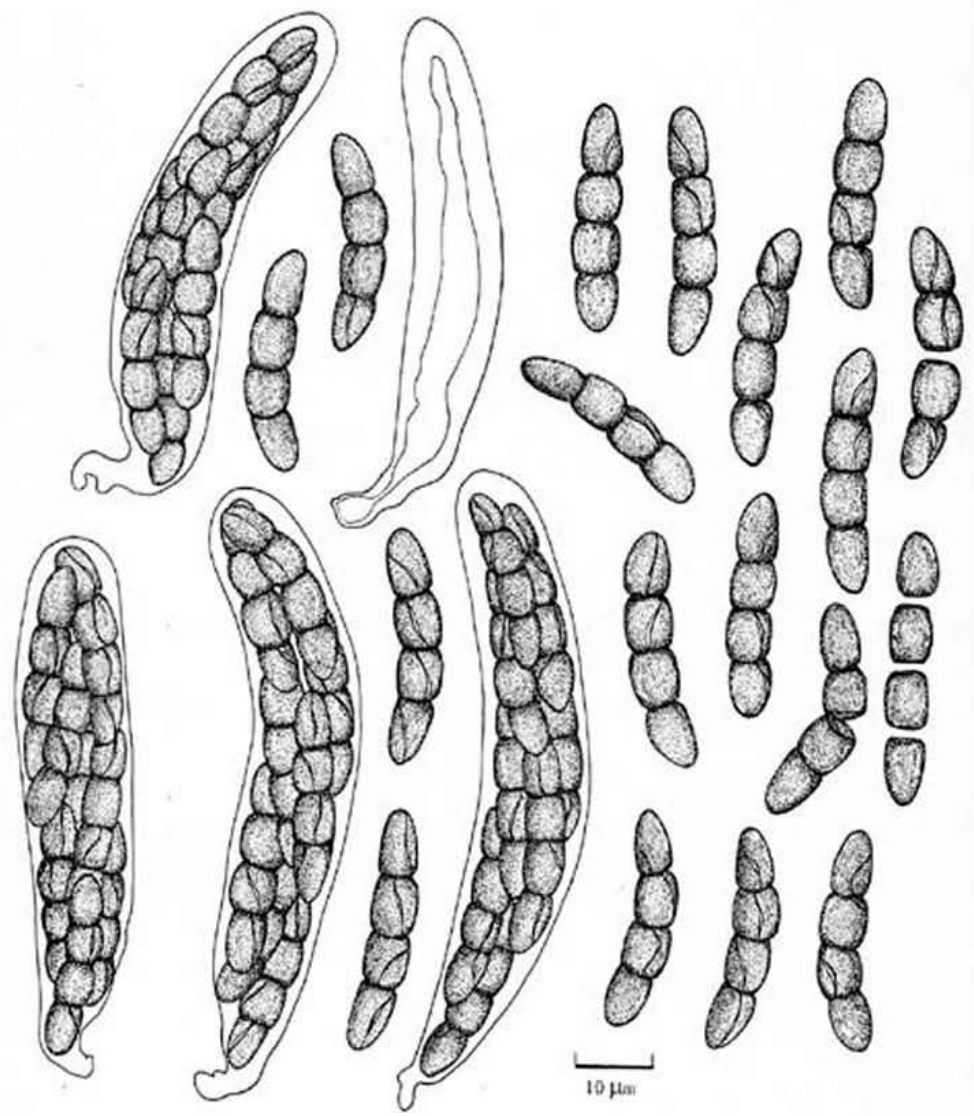

Fig. 8 *Sporormiella minima* (KUFC 2514): camera lucida drawing of bitunicate asci and ascospores showing prominent germ slits (bar = 10 µm).

tail possum, fawn footed melomys, kangaroo, nabarlek, pademelon, quokka, wallaby, wallaroo and wombat dung from Australia. Richardson (2001) found this fungus on sheep, deer, cattle, rabbit, hare and grouse. In the present study, *S. minima* was the dominant coprophilous ascomycete found on several dung samples (Table 1) and it is a new record for Thailand.

Zopfiella latipes (N. Lundq) Malloch & Cain.,Can. J. Bot. 49: 876, 1971. **(Fig. 6, A-E)**
Reference: Lundqvist (1972)

Specimens examined: Thailand. Nakhon Ratchasima: Khoa Yai National Park, on sambar deer dung, 16 June 2002, KUH 0003 (KUFC 2451).

Colonies on CMA growing slowly, reaching 5.0-5.5 cm diam in 14 days at 28 °C. Mycelium brown to dark brown, forming cleistothecia in 10-14 days. Cleistothecia dark brown, globose to subglobose, 300-500 x 200-400 µm. Asci 8-spored, cylindrical, 145-150 x 24-26 µm. Ascospores broadly clavate and unequally two-celled, 19-23 x 14-16 µm for the upper cell, dark in color and 6-7 x 5-5.5 µm for the hyaline pedicel.

Cain (1956) described *Tripterospora* as a new genus of coprophilous ascomycetes. Lundqvist (1972) reported this species, as *Tripterospora latipes*, from soil in Copenhagen and from submerged wood in Maryland, USA. However, Malloch & Cain (1971) proposed *Zopfiella latipes* as the correct name for *T. latipes*. This fungus is a new record for Thailand.

Conclusions

Twelve genera and 15 species of coprophilous Ascomycetes were recorded. All taxa were obtained in pure culture except *Podosordaria leporina* and *Saccobolus glaber*. Among them, *Ascobolus albidus*, *Ascodesmis macrospora*, *A. sphaerospora*, *Cercophora silvatica*, *Gelasinospora brevispora*, *Podosordaria leporina*, *Podospora curvicolla* *Saccobolus glaber* and *Zopfiella latipes* were found on only one type of dung. The most common species were *Chaetomium globosum*, *Sordaria fimicola* and *Sporormiella minima*. The diversity of coprophilous fungi depends on the type and number of dung samples, habitats, collecting sites and isolation techniques used.

Nothworthy ascomycetes representing new records for Thailand are *Ascobolus albidus*, *Ascodesmis sphaerospora*, *Cercophora silvatica*, *Gelasinospora brevispora*, *Podosordaria leporina*, *Sporormiella minima*, and *Zopfiella latipes*.

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Literature Cited

Ahmed SI, Cain RF. 1972. Revision of the genera *Sporormia* and *Sporormiella*. Canadian Journal of Botany 50: 419-477.

Ames LM. 1963. A monograph of the *Chaetomiaceae*. U.S. Army Res. Development Ser. 2: 1-125.

Arx JA von, Guarro J, Figueras MJ. 1986. The ascomycete genus *Chaetomium*. Beih. Nova Hedwigia 84:1-162.

Bell A. 1983. Dung fungi an illustrated guide to coprophilous fungi in New Zealand. Victoria Univ. Press: Wellington. 88 pp.

Bell A. 2005. An illustrated guide to the Coprophilous Ascomycetes of Australia. CBS: Utrecht. 172 pp.

Cain RF. 1956. Studies of coprophilous ascomycetes IV. *Tripterospora*, a new cleistocarpous genus in a new family. Canadian Journal of Botany. 34: 699-710.

Domsch KH, Gams W, Anderson TH. 1993. Compendium of Soil Fungi. Vol. 1 & 2. 2nd edn. IHW: Verlag. 859 pp., & 405 pp.

Ellis MB, Ellis JP. 1998. Microfungi on Miscellaneous Substrates: an identification handbook. 2nd edn. Richmond Publishing: Slough. 246 pp.

Elshafie AE. 2005. Coprophilous mycobiota of Oman. Mycotaxon 93: 355-357.

Gochenaur S. 1964. A modification of the immersion tube method for isolating soil fungi. Mycologia 56: 921-923.

Hein SM, Gloer JB, Scott JA, Malloch D. 1998. Arugosin F: a new antifungal metabolite from the coprophilous fungus *Ascodesmis sphaerospora*. Journal of National Product 61: 1566-1567.

Kanokmedhakul S, Kanokmedhakul K, Phonkerd N, Soytong K, Kongsaeree P, Suksamrarn A. 2002. Antimycobacterial anthraquinone-chromanone compound and diketopiperazine alkaloid from the fungus *Chaetomium globosum* KMITL-N0802. Planta Medica 68: 832-836.

Khan RS, Krug JC. 1989. New species of *Gelasinospora*. Mycologia 81(2): 226-233.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the fungi. 9th edn. CAB International. 655 pp.

Lundqvist N. 1972. Nordic *Sordariaceae* s. lat. Symbolae Botanicae Upsaliensee, 20(1):1-374.

Malloch D, Cain RF. 1971. New cleistothecial *Sordariaceae* and a new family, *Coniochaetaceae*. Canadian Journal of Botany 49: 869-880.

Manoch L. 2000. Fungi. In: Review of Biodiversity Research in Thailand. Biodiversity Research and Training Programe (BRT), Bangkok Thailand. pp. 219-246.

Manoch L, Chana C, Athipunyakom P. 1999. Diversity of coprophilous fungi in Thailand. In Proceedings of International Conference on Asean Network on Microbial Research. Chiang Mai. Thailand. Nov. 29-Dec. 1, 1999. pp. 675-688.

Obrist W. 1961. The genus *Ascodesmis*. Canadian Journal of Botany 39: 943-953.

Ondeyka JG, Giacobbe RA, Bills GF, Cuadrillero C, Schmatz DM, Goetz A, Zink DL, Singh SB. 1998. Coprophilin: an anticoccidial agent produced by a dung inhabiting fungus. Bioorganic and Medicinal Letter 8: 3439-3442.

Raper KB, Fennell DI. 1965. The Genus Aspergillus. Williams & Wilkins Company: Baltimore, Md. 686 pp.

Richardson MJ. 2001. Diversity and occurrence of coprophilous fungi. Mycological Research 105: 387-402.

Richardson MJ, Watling R. 1997. Keys to Fungi on Dung. British Mycological Society, London. 68 pp.

Rogers JD, Ju YM, San Martin F. 1998. *Podosordaria*: a redefinition based on cultural studies of the type species, *P. mexicana*, and two new species. Mycotaxon 67: 61-72.

Soman AG, Gloer JB, Koster B, Malloch D. 1999. Sporovexins A-C and a new preussomerin analog: antibacterial and antifungal metabolites from the coprophilous fungus *Sporormiella vexans*. Journal of Natural Products 62: 659-661.

Somrithipol S, Hywel-Jones NJ. 2002. A preliminary investigation on coprophilous fungi in Northeastern Thailand. In Proceedings of 40th Kasetsart University Annual Conference. Bangkok. Thailand. pp. 409-414.

Somrithipol S. 2004. Coprophilous fungi. In Thai Fungal Diversity. (Jones EBG, Tanticharoen M, Hyde KD, eds). BIOTEC. Thailand. pp. 119-128.

van Brummelen J. 1967. A world-monograph of the genus *Ascobolus* and *Saccobolus* (*Ascomycetes*, *Pezizales*). Persoonia 1: 1-260.

van Brummelen J. 1969. Studies on discomycetes-III. Persoonia 5: 225-231.

van Brummelen J. 1977. A new genus of *Pezizales* from Thailand. Kew Bulletin 31: 617-620.

Wang YZ. 2000. The genus *Podospora* in Taiwan. Mycotaxon 76: 373-391.

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Colletotrichum yunnanense sp. nov., a new endophytic species from *Buxus* sp.

XIAOYING LIU [1,2] XIANGMING XIE[1] JUNXING DUAN[2,3]

XYIL@novozymes.com
[1] *Department of Microbiology, Beijing Forestry University Beijing 100083, China*

[2] *Novozymes R/D, China,*

[3] *Key Laboratory of Systematic Mycology and Lichenology, Institute of Microbiology, Chinese Academy of Sciences, PO Box 2714, Beijing 100080, P.R. China*

Abstract—During our study of endophytic fungi from woody plants, an interesting *Colletotrichum* species was isolated. The morphological characteristics, such as slow growing, cylindrical and large conidia, and irregularly lobed appressoria, plus phylogenetic analysis based on nuclear rDNA sequences indicate that the fungus represents a distinct new species and named as *Colletotrichum yunnanense*. It is described and illustrated herewith.

Keywords—taxonomy, morphology, ITS1-5.8S-ITS2

Introduction

The genus *Colletotrichum* contains saprophytic, endophytic and plant pathogenic species. Pathogenic species cause economically significant diseases (anthracnose) of a wide range of plants such as fruits, vegetables, cereals, and forage (Bailey & Jeger 1992). Species of the genus are also one of the most frequently isolated endophytes in various herbaceous and woody plants (Lumyong et al. 2000). The species concept of *Colletotrichum* is neither well-established nor universally accepted due to the very few available morphological criteria in taxonomy, such as shape and size of conidia, setae and appressoria. Molecular techniques like Random Amplification of Polymorphic DNA (RAPD), Restriction Fragment Length Polymorphism (RFLP) and sequence analysis of the intergenic transcribed spacers (ITS) region have been used to aid identifications of *Colletotrichum* species. Sequence analyses of the rDNA ITS region have been demonstrated to be valuable in delineating the species (Sreenivasaprasad et al. 1992).

Host specificity of *Colletotrichum* species has been deemed less important and the number of species in the genus was reduced to 25 by Sutton (1980). *Colletotrichum* diversity from herbaceous plants, Proteaceae and Iwokrama Forest Reserve in South Africa provided new evidences for the host preference (Lu et al. 2004, Lubbe et al. 2004, Photita et al. 2005). New species of *Colletotrichum* were described in recent years (Moriwaki et al. 2003, Nakamura et al. 2006). During our study of the endophytic fungi from woody plants in China, an interesting fungus of *Colletotrichum* was isolated. The slow growing, larger conidia, irregularly lobed appressoria, and phylogenetic analyses based on nuclear rDNA sequences indicate that the fungus represents a new species.

Materials and methods

Fungal isolation— Fresh leaves were sampled and placed into an envelope. After taking to laboratory within a week, the leaves were cut into small pieces of 2 mm^2, sterilized in 0.1% NaClO for 1 minute and placed onto Potato Dextrose Agar (PDA, Difco) plate containing 100 $\mu g\ ml^{-1}$ streptomycin and 50$\mu g\ ml^{-1}$ tetracycline. Two weeks later, the mycelia growing from pieces of leaves were transferred onto another PDA plate for morphological study.

Morphology— The fungus was cultured on PDA plate in dark at 25°C. Morphological characteristics and the growth rate were measured after incubation for two weeks. The appressoria were induced by incubating the conidia in distilled water for 24 hours. Observation, measurement and photograph were carried out in water or cotton blue lacto-phenol mounts under Nikon80i microscope with differential interference contrast (DIC). All microscopic characteristics were measured from more than 50 individuals in water mounts.

Phylogenetic analysis—Fresh mycelium was collected from the cultures on PDA plates. Genomic DNA was extracted from fresh mycelia using a modified CTAB method (McGarvey & Kaper 1991). The ITS region including the intervening 5.8S rDNA was amplified with the standard primers, ITS1 and ITS4 (White et al. 1990). The ITS sequences obtained and additional ones of the similar species of *Colletotrichum* and *Glomerella* from GenBank were submitted to molecular phylogenetic analysis. *Plectosphaerella cucumerina* L36640 was chosen as outgroup. Sequence alignment was generated by the program package Clustal-X 1.81 (Thompson et al. 1997), then manually realigned using BioEdit version 5.0.6 (Tom Hall, Department of Microbiology, North Carolina State University, Raleigh, NC 27695). Phylogenetic analysis was performed using PAUP* 4.0 beta 10 (Swofford 2001) with gaps as missing data and all characters equally weighted.

Table 1. Sequences used in phylogenetic analyses based on sequences of rDNA ITS region

Species name	GenBank no.	Strain
Colletotrichum acutatum	AJ749677	CA318
Colletotrichum acutatum	AJ749672	CA473
Colletotrichum agaves	DQ286219	CBS318.79
Colletotrichum agaves	DQ286221	AR3920
Colletotrichum coccodes	AJ301953	BBA 62126
Colletotrichum coccodes	AB233340	MAFF 306629
Colletotrichum crassipes	AY376530	STE-U 4445
Colletotrichum crassipes	AY376529	STE-U 5302
Colletotrichum dracaenophilum	DQ286207	MEP1537
Colletotrichum dracaenophilum	DQ286211	MEP1518
Colletotrichum gloeosporioides	AY438549	IMI376909
Colletotrichum gloeosporioides	AY438550	IMI388809
Colletotrichum phormii	DQ286134	AR3389
Colletotrichum phormii	DQ286140	MEP1334
Colletotrichum sp.	AY438553	IMI377083
Colletotrichum sp.	AY442184	IMI377082
Colletotrichum truncatum	AJ301937	BBA 70523
Colletotrichum truncatum	AJ301976	BBA 71346
Colletotrichum yunnanense	EF369490	AS3.9617
Colletotrichum yunnanense	EF369491	AS3.9616
Glomerella graminicola	AF289231	99355
Glomerella graminicola	AF289222	99409
Plectosphaerella cucumerina	L36640	

Taxonomy

Colletotrichum yunnanense Xiao Ying Liu & W.P. Wu, sp. nov. **FIGURE 1**

MycoBank #: MB 510584.

Coloniae in PDA tarde crescentes, margine irregulares, albae vel cremeae, pannosae cum mycelio aerio, reversae stramineo-flavae vel avellaneae. Sclerotia presentia. Setae intra conidiomata distributae, 1-4-septatae, 50-80 × 3-6 μm, basi brunneae, ad apicem obtuso-rotundatum pallide brunneae, rectae vel undatae. Conidiophora gregaria et fasciculata, e superficie sclerotiorum producentia, tubulosa, 1-3-septata, 10-30 × 3-5 μm, ad basin brunnea, cellula conidiogena hyalina singulari reducta sunt. Cellulae conidiogenae cylindricae, pallidissime brunneae, laevigatae, monoblasticae vel polyblasticae, collarettae vel interdum ad locum conidiogenum annulatae, 6-12 μm longae, 3-5μm latae. Conidia holoblastica, cylindrica, bacilliformia vel laeviter clavata, laevia, (14-) 16-21 × 5-6 μm, utroque rotundata, ad basim cicatrice abscissa praedita, aseptata, hyalina, guttulata, facile germinantia tum medio septum formantia, tubus germinationis e extremitatibus ambabus conidiorum prodiens. Appressoria irregulariter lobata, brunnea vel fusco-brunnea, 7-12 × 6-8 μm.

Etymology: The specific epithet refers to the locality of the fungus.

Holotype: WU47182, a dried culture of 20 days old on PDA of AS3.9617, isolated from healthy leaves of *Buxus* sp., Kunmin Botanical Garden, Yunnan, China, W. P. Wu, Nov. 5, 2004, deposited in Wu's herbarium, Novozymes R/D, China. Living cultures (AS 3.9617, AS 3.9616) were deposited in China General Microbiological Culture Collection Center and preserved in liquid nitrogen.

Isolates examined: AS3.9617 and AS3.9616, isolated from healthy leaves of *Buxus* sp., Kunming Botanical Garden, Yunnan, China, Nov. 5, 2004, W. P. Wu.

Colonies on PDA slow growing, edge irregular, white to cream, felted with aerial mycelium, reverse straw yellow to hazel. Sclerotia present. Setae distributing within conidiomata, 1-4 septate, 50-80 × 3-6 µm, brown at the base, pale brown at the bluntly rounded apex, straight or wavilness. Conidiophores congregative and fasciated, produced from the surface of sclerotia, tubbiness, 1–3-septate, 10-30 × 3-5 µm, brown at the base, reduced to single hyaline conidiogenous cell. Conidiogenous cells cylindrical, slightly brown, smooth, monoblastic or polyblastic, collarette or occasionally annellide at the conidiogenous loci, 6-12 µm long, 3-5 µm wide. Conidia holoblastic, cylindrical, bacilliform or slightly clavate, smooth, (14-) 16-21 × 5-6 µm, rounded at both ends with a abscission scar at the base, no septate, hyaline with oil drops. Conidia easily germinated with formation of septum at the middle, each germ tube formed at both ends of conidia, appressorium irregularly lobed, brown to dark, 7-12 × 6-8 µm.

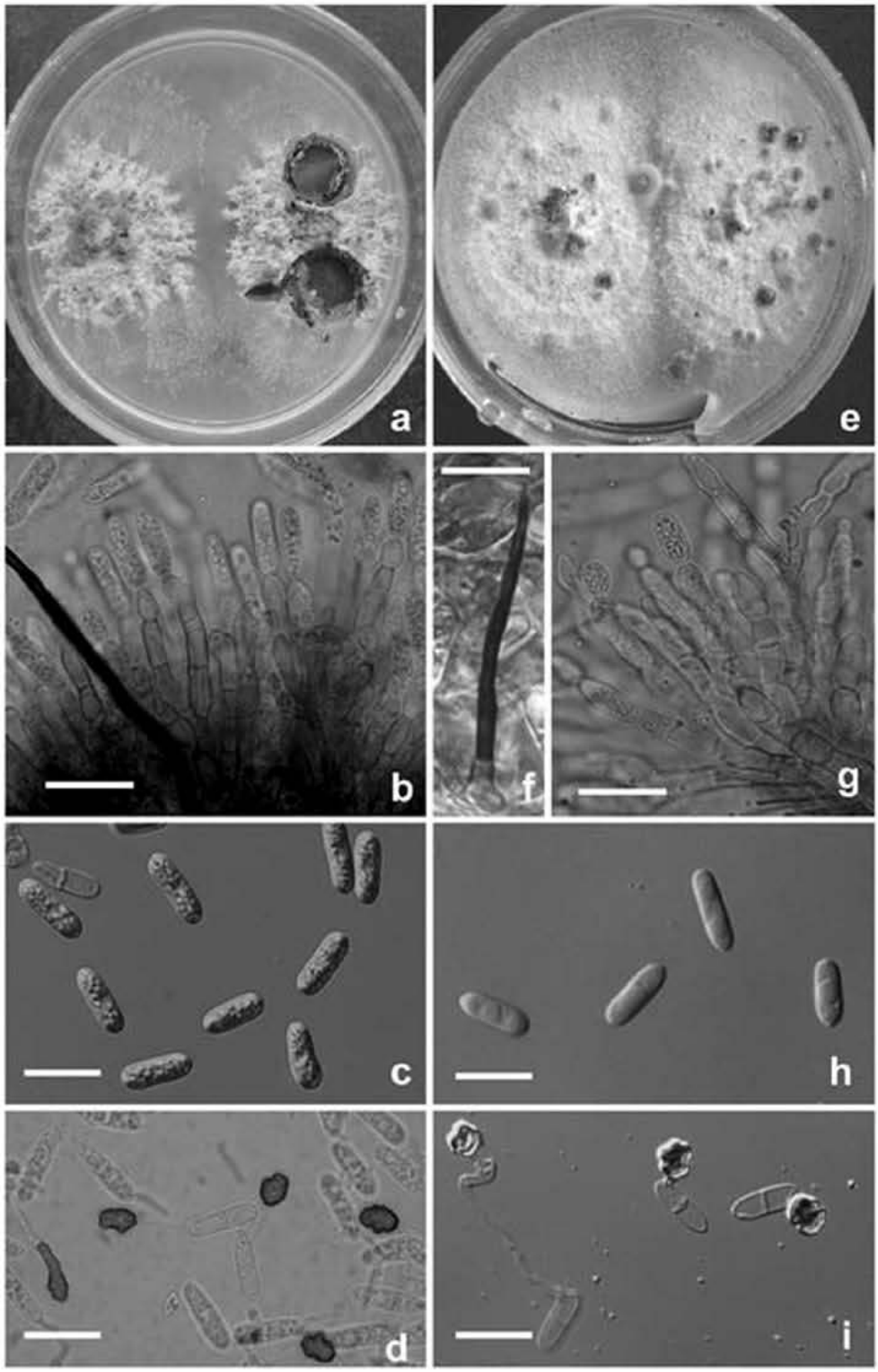
Phylogenetic analysis

Maximum parsimony analysis of the ITS sequences (Fig. 2) yielded a single tree. The phylogram showed that *C. yunnanense* was clustered together with species of *Colletotrichum* and *Glomerella* with high bootstrap support when *Plectosphaerella cucumerina* L36640 as outgroup. *C. yunnanense* represented a clade which paralleled with other species, indicating that *C. yunnanense* is a distinct species. *Colletotrichum dracaenophilum* (DQ286207 and DQ286211) grouped with *C. yunnanense* with 100% bootstrap support. However, the conidia size of *C. yunnanense* is much smaller than that of *C. dracaenophilum* [(20–) 22–34 (–38) × (5.5–) 6.5–9.5 (–10) µm].

Discussion

Both AS3.9617 and AS3.9616 were isolated from the same leaf sample in Kunming Botanical Garden, Yunnan. However, there are somewhat differences in morphology. AS3.9617 is slower growing and produces more compact

Fig. 1. *Colletotrichum yunnanense* sp. nov.: a, e. Colony on PDA; b, g. Conidiogenous cells; b, f. Setae; c, h. Conidia; d, i. Germinated conidia with appressoria. a-d from AS3.9617, e-i from AS3.9616. Scale bar = 20 µm.


a
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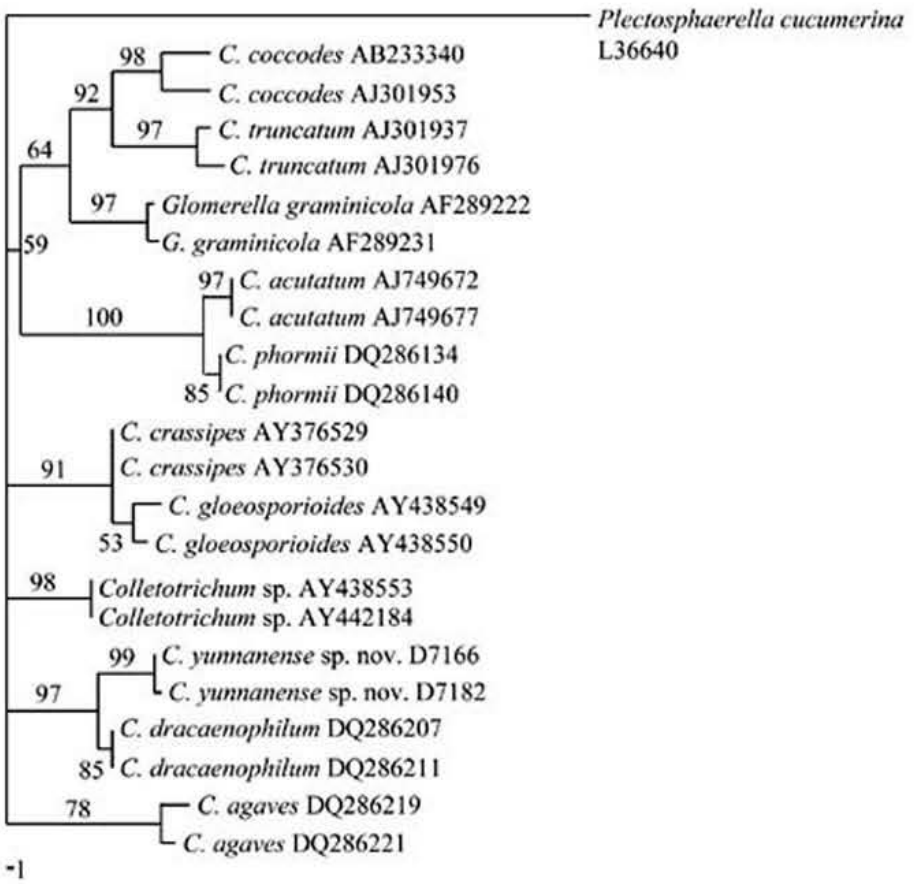

Fig. 2. Phylogram obtained from a maximum parsimony analysis of the ITS1, 5.8S rDNA and ITS2 sequence data of *Glomerella* / *Colletotrichum* species. The tree was rooted to *Plectosphaerella cucumerina* L36640. Branch support is based on 1000 bootstrap replicates and is shown at the nodes. The bar represents 1 substitution per site.

aerial mycelium than AS3.9616. Although *C. dracaenophilum* (DQ286207 and DQ286211) (Farr et al. 2006) was grouped with AS3.9616 and AS3.9617 with high bootstrap support (97%), the larger size conidia and fast growing of *C. dracaenophilum* were significant different from that of *C. yunnanense*. *Colletotrichum yunnanense* resembles *C. crassipes* in slow growing, cylindrical conidia and irregularly lobed appressoria, whereas, the latter differs in the black-brown colony on reverse side, choclate aerial mycelium and shorter conidia [10-15 × 4.5-6.5 µm vs. (14-) 16-21 × 5-6 µm] (Sutton 1980). Phylogenetic analysis based on ITS sequences also distinguished the two species.

Because morphological identification of *Colletotrichum* spp. is hampered by phenotypic variation (Nirenberg et al. 2002), it is essential to link the

morphological characteristics to molecular data. Based on independent observations (Brown & Soepena 1994), it suggests the connection and agreement between molecular analysis and morphological characteristics are necessary in separating some species of the genus. *C. yunnanense* is distinguished from other species of *Colletotrichum* either in morphology or the molecular data. Combination of detailed morphological characteristics and sequence analyses of more divergent loci will provide more comprehensive understanding of *Colletotrichum* taxonomy and are likely useful in distinguishing the very closely related taxa.

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Literature ciited

Bailey JA, Jeger MJ. 1992. *Colletotrichum*: Biology, pathology and control. Wallingford: CAB International, United Kingdom.

Brown AE, Soepena H. 1994. Pathogenicity of *Colletotrichum acutatum* and *C. gloeosporioides* on leaves of Hevea spp. Mycol. Res. 98: 264-266.

Farr DF, Aime MC, Rossman AY, Palm ME. 2006. Species of *Colletotrichum* on Agavaceae. Mycol. Res. 110: 1395-1408.

Nirenberg UF, Helgard I, Hagedorn G. 2002. Description of *Colletotrichum lupini* comb. nov. in modern terms. Mycologia 94: 307-320.

Lumyong S, Thongantha S, Lumyong P, Tomita F. 2000. Endophytic fungi from 13 bamboo species in Thailand. Biotechnology for Sustainable Utilization of Biological Resources in the Tropics 14: 96-101.

Lubbe CM, Denman S, Cannon PF, Groenewwald JZ, Lamprecht SC, Crous PW. 2004. Characteristics of *Colletotrichum* species associated with diseases of Proteaceae. Mycologia 96: 1268-1279.

Lu G, Cannon PF, Reid A, Simmons CM. 2004. Diversity and molecular relationships of endophytic *Colletotrichum* isolates from the Iwokrama Forest Reserve, Guyana. Mycol. Res. 108: 53-63.

McGarvey P, Kaper JM. 1991. A simple and rapid method for screening transgenic plants using the PCR. Biotechniques 11: 428-32.

Moriwaki J, Sato T, Tsukiboshi T. 2003. Morphological and molecular characterization of *Colletotrichum boninense* sp. nov. from Japan. Mycoscience 44: 47-53.

Nakamura M, Ohzono M, Iwai H, Arai K. 2006. Anthracnose of *Sansevieria trifasciata* caused by *Colletotrichum sansevieriae* sp. nov. J. Gen. Plant Pathol. 72: 253-256.

Photita W, Taylor PWJ, Ford R, Hyde KD, Lumyong S. 2005. Morphological and molecular characterization of *Colletotrichum* species from herbaceous plants in Thailand. Fungal Diversity 18: 117-133.

Sutton BC. 1980. The coelomycetes. 523-537. Kew: Commonwealth Mycological Institute, England.

Sreenivasaprasad S, Brown AE, Mills PR. 1992. DNA sequence variation and interrelationship among *Colletotrichum* species causing strawberry anthracnose. Physiol. Mol. Plant Pathol. 41: 265-281.

Swofford DL. 1998. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The CLUSTAL windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. 24: 4876-4882.

White TJ, Bruns TD, LEE SB, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. pp. 315-322 in: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds). PCR Protocols: a Guide to Methods and Applications. Acad. Press. San Diego, CA.

MYCOTAXON

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Additions to the lichen mycota of Iran from East Azerbaijan Province

MOHAMMAD SOHRABI[1] & VAGN ALSTRUP[2]

mohammad.sohrabi@helsinki.fi
[1]*Botanical Museum (Mycology)*
P. O. Box 7, FI-00014 Helsinki University, Finland

vagna@snm.ku.dk
[2]*Botanical Museum, University of Copenhagen*
Gothersgade 130, DK-1123 Copenhagen K, Denmark

Abstract—This paper reports 48 species of lichens and 30 lichenicolous fungi new to Iran originating from Arasbaran (Gharadaq) in the Province East Azerbaijan in northwestern Iran. The complete list of record can be downloaded online from http://www.mycotaxon.com/resources/weblists.html.

Key words— Arasbaran forests, lichenized mycota, new records

Introduction

The preliminary lichen checklist of Iran (Seaward et al. 2004) included 396 lichens and 8 lichenicolous fungi based on literature records and study of voucher material. It also summarized the literature on Iranian lichens. A study of the Golestan National Park, NE Iran (Sohrabi & Sipman, in prep.) yielded another 14 species to the list. This paper reports new collections from the Arasbaran area, East Azerbaijan Province in NW Iran, all new reports to Iran. Other papers from Arasbaran deal with *Cladonia* (Ahti & Sohrabi 2006), *Lepraria* (Sohrabi & Orange 2006), *Peltigera* (Sohrabi & Vitikainen, in prep.), *Candelariella* (Westberg & Sohrabi, in prep.) and *Caloplaca* (Søchting & Sohrabi, in prep.), all adding several new species to the list of Iranian lichens.

The Arasbaran Biosphere Reserve is located in the northwest of Iran bordering the republics Azerbaijan and Armenia ~90 km northeast of Tabriz (Fig. 1). The 164 000 ha area features high mountains, deep valleys, steep slopes, dense forests and vast rangeland. Elevations range from a high of 1500 m in the semi-arid steppic foothills in the south and ~2800 m in the alpine central mountains to the low ~700 m of the Aras River valley in the north. Moisture-laden winds from the Caspian Sea support a rather isolated patch of deciduous

forest up to c. 2000 m, an outlier of extensive forests further north, and lush alpine meadows above the tree line. Access to the Reserve has remained difficult because of the absence of all-weather roads. Land ownership is public. Large areas of forest have been cleared for cereal and vegetable crops, orchards, and pastureland, and much of the remaining forest has been degraded by grazing and cutting of fuel wood.

The reserve is influenced by three different climatic zones: the cold and semi-arid Irano-Turanian region (loc. I) to the south, the subtropical (sub) humid and relatively warm central montane Saigiram daq and south-eastern Talish region and Hyrcanian belt (locs. V and VI), and the relatively cold and sub-humid Mediterranean climates found in the west and north (locs. II-IV and VII). Such varying climate regimes favor different ecosystem types and ~1000 plant species; there are 140 woody plant species, of which the most prominent are *Quercus macranthera*, *Juniperus communis*, *Pistacia atlantica*, *Carpinus betulus*, *Fraxinus rotundifolia*, and *Acer campestre*.

Materials and methods

Materials were collected by Sohrabi in 2001, 2004 and 2005, aided by Masoomeh Ghobadnejhad at loc. III. The authors examined the collections under the microscope and with usual test reagents during the second author's stay at the Botanical Museum of Helsinki in August 2006. Nomenclature follows Santesson et al. (2004) when possible. All specimens are stored in Herbarium Sohrabi; selected duplicates are curated in H and C.

Results

The authors identified 48 species of lichens and 30 lichenicolous fungi not previously reported from Iran, all collected from seven different sites (see Fig. 1) located within the Arasbaran (Gharadaq) Bioreserve Area in the East Azerbaijan Province, in northwestern Iran. The 56 genera represented include *Abrothallus* (1), *Arthonia* (3), *Arthrorhaphis*, *Bryoria*, *Buellia*, *Caloplaca*, *Catapyrenium*, *Catillaria*, *Cetraria* (2), *Chaenotheca*, *Clypeococcum*, *Dactylospora*, *Dermatocarpon*, *Echinothecium*, *Endocarpon*, *Endococcus*, *Fuscopannaria*, *Lecania*, *Lecanora* (4), *Lecidea*, *Lecidella*, (2), *Leptogium* (2), *Lichenoconium* (2), *Lichenostigma* (2), *Lobaria*, *Marchandiomyces*, *Muellerella*, *Mycobilimbia* (2), *Opegrapha*, *Pachyphiale*, *Parmeliella*, *Phaeosporobolus* (2), *Physcia*, *Physconia* (3), *Polycoccum*, *Pronectria*, *Protopannaria*, *Protothelenella*, *Psilolechia*, *Raciborskiomyces*, *Ramalina*, *Rhizoplaca*, *Rimularia*, *Rinodina* (2), *Rosellinula*, *Scoliciosporum*, *Sphaerellothecium*, *Staurothele*, *Stigmidium* (5), *Thelenella*, *Toninia*, *Tremella*, *Umbilicaria* (4), *Verrucaria*, and *Xanthoriicola*. Of the widespread species not previously reported *Cetraria islandica* (L.) Ach. subsp. *islandica*, *Chaenotheca furfuracea* (L.) Tibell and *Umbilicaria vellea* (L.)

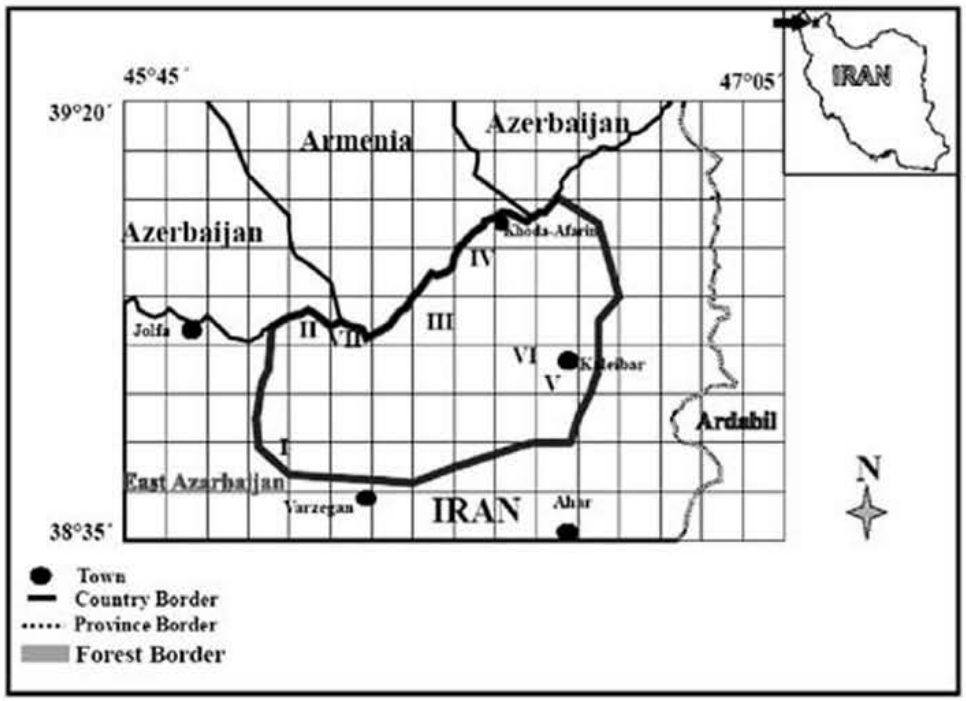

Fig.1- 2001–2005 lichen and lichenicolous fungal collection sites in Arasbaran Biosphere Reserve (East Azerbaijan Province, northwest Iran). I- Varzegan, ca. 26 km west of Varzegan and ca. 6 km east of Joshin village (Kharvana), Joshin Castle, 1700-2000 m, 46°21'N, 38° 39'E., 18.07.2005. II- Jolfa, Jolfa to Khoda-afarin, 5 km from the south of road, Missan village, 1000-1500 m, 15.7.2001. III- Kaleibar, 21 km south of the road of Khoda-afarin to Jolfa, Aynaloo, 1700-1900 m, 38°50'03"E, 46°47'29"N, 20.08.2005. IV- Kaleibar, ca. 10 km south of Aras River and the road Khoda-afarin to Jolfa, Dar-Aghzi village, 39°05'E, 46°53'N, 450 m., 19.08.2005. V- Kalibar, ca. 4 km SW of Kalibar, Galadarasi, toward Babak Castle (Bez Galasi), 1750-2500 m, 38°52'07"E, 46°58'06"N; 19.08.2005. VI- Kalibar, ca. 10 km west of Kalibar, Hejranduost village,1750-1850 m, 38°52'07"E, 46°58'06"N, 20.08.2005. VII- Jolfa, Arasbaran, the road of Khoda-afarin to Jolfa, crossing at Ooshtipin village road, Hrass, 500 m, road side lichens, 20.07. 2004.

Hoffm. were the most commonly encountered new species. *Catillaria chalybeia* (Borrer) A. Massal. represents species known previously only from one or two reports.

The full report, which provides substrate, site, and collection data for each species, is available online from http://www.mycotaxon.com/resources/weblists.html.

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Literature cited

Ahti T, Sohrabi M. 2006. Synopsis of Iranian *Cladonia* (lichens). Flora Mediterranea 16: 139-144.

Clauzade G, Diederich P, Roux C. 1989. Nelikenigintaj fungoj likenlogaj. Bulletin de la Société Linnéenne de Provence, Numero Spécial 1: 1-142.

Clauzade G, Roux C. 1985. Likenoj de Okcidenta Eurupo. Bulletin de la Societé Botanique du Centre-Ouest, Nouvelle série, Numero Spécial 7:1-893.

Esslinger TL. 2006. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. Fargo, North Dakota State University: [http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm.].

John V, Seaward MRD, Sipman HJM, Zedda L. 2004. Lichens and lichenicolous fungi of Syria, including a first checklist. Herzogia 17: 157-177.

Kårnefelt I. 1979. The brown fruticose species of *Cetraria*. Opera Botanica 46: 1-150.

Santesson R, Moberg R, Nordin A, Tønsberg T, Vitikainen O. 2004. Lichen-forming and lichenicolous fungi of Fennoscandia. Museum of Evolution, Uppsala, 359 pp.

Seaward MRD, Sipman HJM, Schultz M, Maassoumi AA, Anbaran MHM, Sohrabi M. 2004. A preliminary lichen checklist for Iran. Willdenowia 34: 543-576.

Sohrabi M, Orange A. 2006. New records of sorediate lichens from Iran. Iranian Journal of Botany 12: 103-105.

Triebel D, Rambold G, Nash TH. 1991. On lichenicolous fungi from North America. Mycotaxon 42: 263-296.

MYCOTAXON

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Taxonomic studies of *Pseudospiropes* from Yunnan, China

ZHI-QIANG SHANG[2] & XIU-GUO ZHANG[1*]

zhxg@sdau.edu.cn
[1]Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

[2]Yunnan Province Tobacco Science Research Institute
Yunnan, Yuxi, 653100, China

Abstract—Two new species of *Pseudospiropes* from dead branches are described and illustrated. They are *P. ximeniae* and *P. mussaendae*, saprophytes of *Ximenia* and *Mussaenda erosa*, respectively. Three new records are noted from the same area.

Key words—hyphomycetes, dematiaceous

Introduction

The genus *Pseudospiropes* was established by Ellis (1971), who precisely defined the distinctive features of this genus. *Pseudospiropes* is characterized by polyblastic, integrated, terminal (sometimes becoming intercalary, sometimes geniculate) cicatrized sympodially extending conidiogenous cells on unbranched conidiophores that often have dark, conspicuous large scars, and fusiform, navicular or obclavate, solitary conidia (usually with transverse pseudosepta or eusepta). These characters separate this genus from the similar *Helminthosporium* Link and *Pleurophragmium* Costantin.

The genus *Pseudospiropes* contains 31 species described from all over the world. Most species reportedly survive on plant leaves, but some species occur as saprophytes on dead branches. Until now, no *Pseudospiropes* species has been described from China.

This study proposes two new *Pseudospiropes* species discovered on dead branches from subtropical forests in Yunnan Province of China. Three other species new to China are also reported.

*Corresponding author

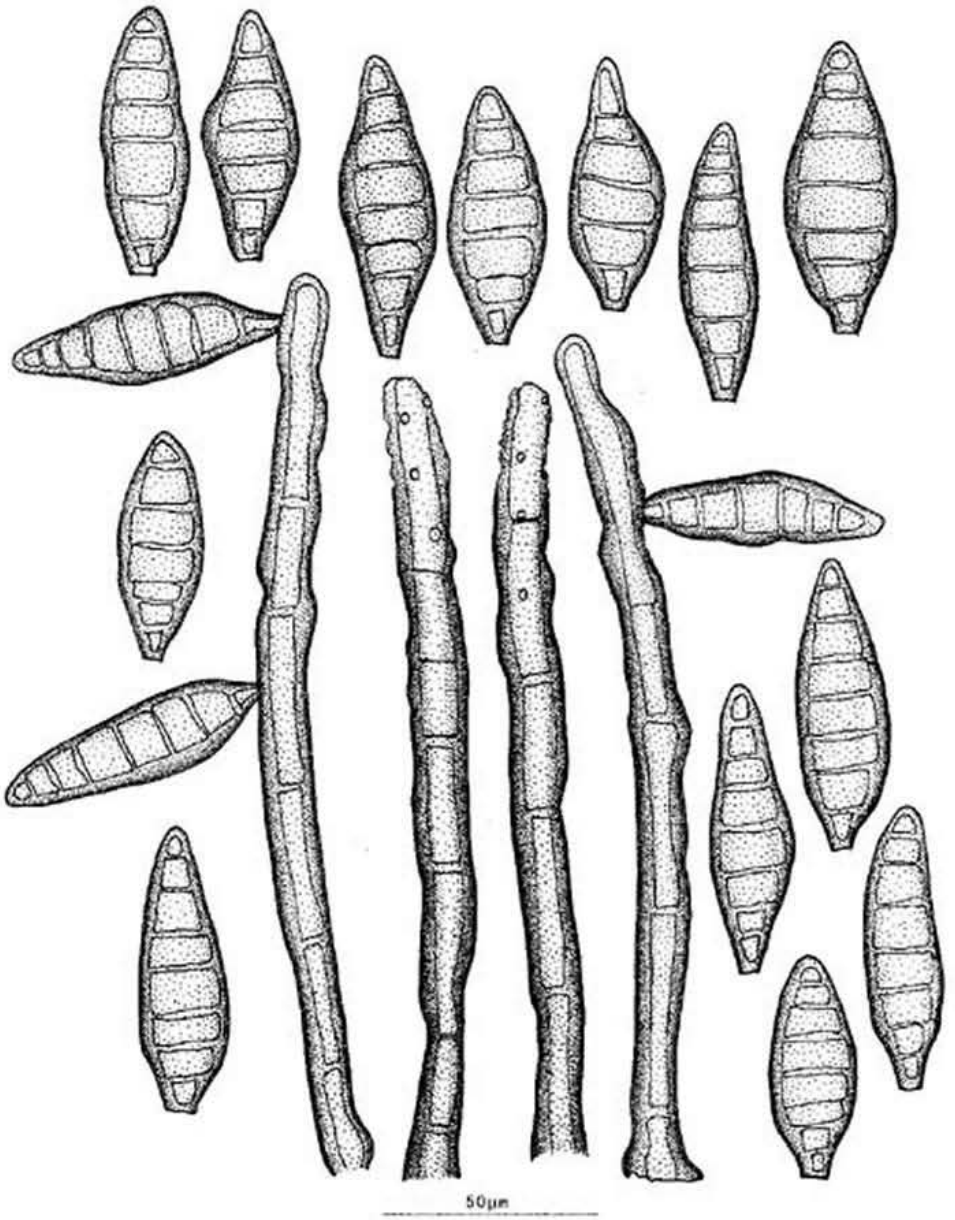

Fig. 1 Conidia and conidiophores of *P. ximeniae*

Taxonomic Description

Pseudospiropes ximeniae Zh.Q. Shang & X.G. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 510610

Coloniae effusae, olivaceo-brunneae vel fuscae, velutinae vel pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, levibus,

1.5-2.5 µm crassis compositum. Conidiophora macronemata, mononemata, solitaria vel caespitosa, erecta, recta vel flexuosa, 5-9-septata, levia, simplicia, pallide brunnea, sursum brunnea, 120-163 µm longa, 6.0-7.0 µm crassa. Cellulae conidiogenae polyblasticae, integratae, terminales vel intercalares, sympodiales, cylindricae, plurimae cicatricibus claris, planis, modice inspissatis praeditae. Conidia solitaria, sicca, acropleurogena, simplicia, fusiformia vel navicularis, basi truncata, pallide brunnea, laevia, 6-8-pseudoseptata, 29-40 µm longa, 12-14 µm crassa, basi truncata 2.0-3.0 µm lata.

Holotype: on dead branches of *Ximenia* L., Kunming, Yunnan Province, China. Sept. 8. 2003, X. G. Zhang, HSAUPIII$_0$ 0361-2 (isotype: HMAS 143717).

Etymology: in reference to the host, *Ximenia*

Colonies effuse, olivaceous brown to dark blackish brown, velvety or hairy. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, pale brown, smooth walled hyphae, 1.5-2.5 µm thick. Conidiophores macronematous, mononematous, sometimes caespitose, unbranched, erect, straight or flexuous, smooth, pale brown, paler toward the apex, 5-9-septate, 120-163 × 6.0-7.0 µm. Conidiogenous cells polyblastic, integrated, terminal or intercalary, sympodial, cylindrical, bearing a number of thin, flat, small, slightly thickened, pale, very slightly protruding scars. Conidia solitary, dry, acropleurogenous, simple, fusiform to navicular, base narrowly truncate, pale brown, smooth, 6-8-pseudoseptate, 34-40 µm long, 12-14 µm thick, 2.0-2.8 µm wide at the truncate base.

The conidia of *Pseudospiropes ximeniae* are similar to those of *P. simplex* (Ellis 1971) and *P. hachijoensis* (Matsushima 1975). However, the conidia of the new taxon are wider than those of *P. simplex* (9-12 µm) and *P. hachijoensis* (8-10 µm). In addition, the conidia of the new species have only 6-8 pseudosepta, while those of *P. simplex* have 6-11, and the conidial bases of the new taxon are narrower than those of *P. simplex* (3-4 µm) and *P. hachijoensis* (3.3-3.8 µm).

Pseudospiropes mussaendae Zh.Q. Shang & X.G. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 510611

Coloniae effusae, brunneae vel fuscae, velutinae vel pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, levibus, 2.0-2.5 µm crassis compositum. Conidiophora macronemata, mononemata, solitaria vel caespitosa, erecta, recta vel flexuosa, 8-10-septata, levia, simplicia, pallide brunnea, sursum brunnea, 145-190 µm longa, 6.0-7.0 µm crassa. Cellulae conidiogenae polyblasticae, integratae, terminales vel intercalares, sympodiales, cylindricae, plurimae cicatricibus claris, planis, modice inspissatis praeditae. Conidia solitaria, sicca, acropleurogena, simplicia, fusiformia vel obclavata, basi truncata, pallide brunnea, laevia, 8-9-pseudoseptata, 36-47 µm longa, 9-11 µm crassa, basi truncata 2.7-3.2 µm lata.

Holotype: on dead branches of *Mussaenda erosa* Champ., Kunming, Yunnan Province, China. Sept. 7. 2003, X. G. Zhang, HSAUPIII$_0$ 0046-1 (isotype: HMAS 143718).

Etymology: in reference to the host, *Mussaenda erosa*

Colonies effuse, olivaceous brown to dark blackish brown, velvety or hairy.

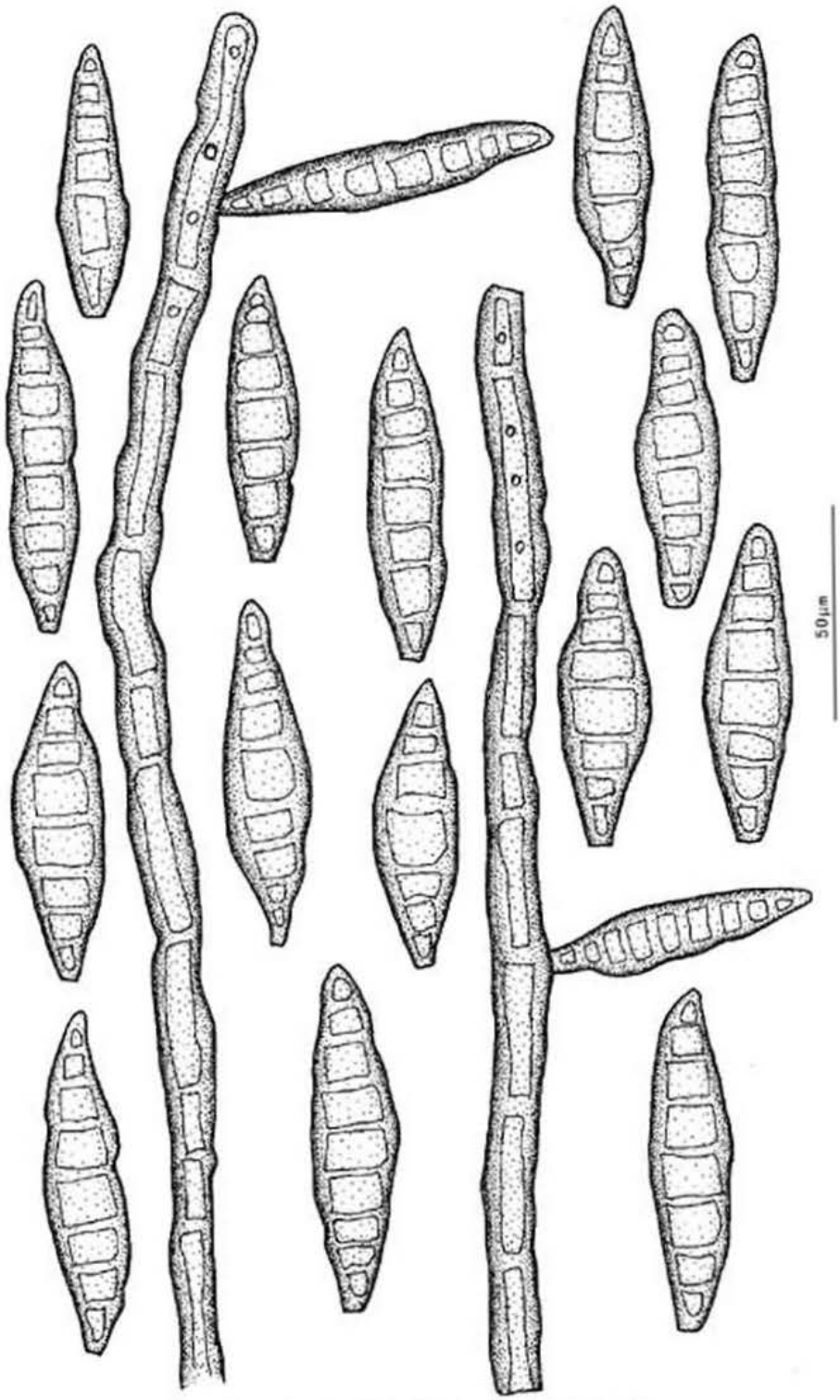

Fig. 2 Conidia and conidiophores of *P. mussaendae*

Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, pale brown, smooth walled hyphae, 2.0-2.5 µm thick. Conidiophores macronematous, mononematous, sometimes caespitose, unbranched, erect, straight or flexuous, smooth, pale brown, paler toward the apex, 8-10-septate, 145-190 × 6.0-7.0 µm. Conidiogenous cells polyblastic, integrated, terminal or intercalary, sympodial, cylindrical, bearing a number of thin, flat, small, slightly thickened, pale, very slightly protruding scars. Conidia solitary, dry, acropleurogenous, simple, fusiform to obclavate, base narrowly truncate, pale brown, smooth, 8-9-pseudoseptate, 36-47 µm long, 9-11 µm thick, 2.7-3.2 µm wide at the truncate base.

The conidia of *Pseudospiropes mussaendae* are similar to those of *P. rousselianus* (Ellis 1976) and *P. hachijoensis* (Matsushima 1975), but their size range is larger than that of *P. rousselianus* (20-37 × 5-8 µm) and *P. hachijoensis* (30-40 × 8-10 µm). In addition, the conidia in *P. mussaendae* have 8-9 pseudosepta compared to conidia with 6–7 pseudosepta in *P. hachijoensis*. In contrast, the conidia of *P. rousselianus* have only 3–7 septa and are not pseudoseptate.

New records from China

Pseudospiropes dumeti Lunghini & Pinzari, 1996, Mycotaxon 58: 343.

On dead branches of *Mangifera indica* L., Kunming, Yunnan Province, China. Sept. 7. 2003, X. G. Zhang, HSAUPIII$_0$ 0055.

Pseudospiropes simplex (Kunze) M.B. Ellis, 1971, Dematiaceous Hyphomycetes:260.

On dead branches of *Michelia champaca* L., Kunming, Yunnan Province, China. Sept. 8. 2003, X. G. Zhang, HSAUPIII$_0$ 0628.

Pseudospiropes lotorum Morgan-Jones, 1977, Mycotaxon 5: 481.

On dead branches of *Photinia serrulata* Lindl., Kunming, Yunnan Province, China. Sept. 9. 2003, X. G. Zhang, HSAUPIII$_0$ 0534.

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Literature cited

Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.

Ellis MB. 1976. More Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.

Matsushima T. 1975. Icones Microfungorum a Matsushima Lectorum. Kobe. Japan.

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Two new *Corynespora* species from Jiangsu, China

ZHI-QIANG SHANG[2] & XIU-GUO ZHANG[1]*

zhxg@sdau.edu.cn

[1]*Department of Plant Pathology, Shandong Agricultural University*
Taian, 271018, China

[2]*Yunnan Province Tobacco Science Research Institute*
Yunnan, Yuxi, 653100, China

Abstract—This paper provides descriptions and illustrations of two new species in the hyphomycete genus *Corynespora* from dead branches. *C. merrilliopanacis* and *C. micheliae* survive saprophytically on *Merrilliopanax listeri* and *Michelia champaca*, respectively.

Key words—hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on dead branches from south of China revealed two previously undescribed species of *Corynespora* Güssow (1906). These two species were collected from the Nanjing Arboretum in Jiangsu Province.

Taxonomic Description

Corynespora merrilliopanacis Zh.Q. Shang & X.G. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 510612

Coloniae fuscae, velutinae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, levibus, 3.5–4.0 µm crassis compositum. Stromata nulla. Conidiophora fasciculata, erecta, simplicia, recta vel flexuosa, pallide brunnea vel brunnea, septata, per usque ad 5 proliferationes successivas cylindricas elongascentia, 260-1200 µm longa, 12-17 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, longe attenuata, laevia, straminea vel brunnea, 12-25-pseudoseptata, 130-260 µm longa, 17-21 µm crassa, basi truncata 7-8 µm lata.

Holotype: on dead branches of *Merrilliopanax listeri* (King) Li, Arboretum of Nanjing, Jiangsu Province, China. Sept. 8. 2003, X. G. Zhang, HSAUP III$_0$ 0946 (isotype: HMAS 143713).

Etymology: in reference to the host, *Merrillopanax listeri*

*Corresponding author

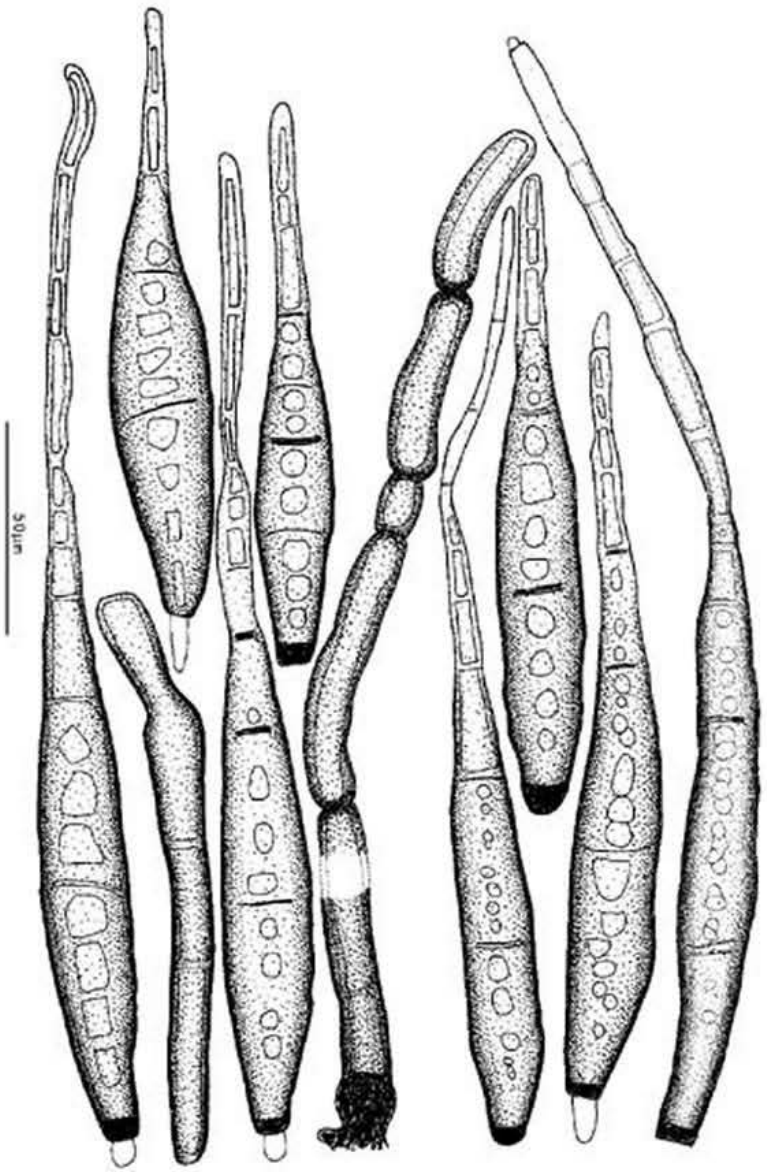

Fig. 1 Conidia and conidiophores of *C. merrilliopanacis*

Colonies dark blackish brown, velvety, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth walled hyphae, 3.5-4.0 μm thick. Stroma absent. Conidiophores fasciculate, erect, simple, straight or flexuous, pale brown to brown, septate, with up to 5 successive cylindrical proliferations, 260-1200 × 12-17 μm. Conidia formed singly through a pore at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at

the apex of the proliferation, straight or curved, obclavate, tapering to the apex, smooth, straw coloured to brown, 12-25-pseudoseptate, 130-260 µm long, 17-21 µm thick, 7-8 µm wide at the truncate base, lower cells darker brown, upper cells becoming gradually paler toward the apex.

The new species differs from *C. leptoderridicola* (Ellis 1957) in its conspicuously larger conidia. In addition, the conidia of the new species have 12-25 pseudosepta, while those of *C. leptoderridicola* have only 6-16.

Corynespora micheliae Zh.Q. Shang & X.G. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 510613

Coloniae griseae vel fuscae, velutinae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, levibus, 3.0-3.5 µm crassis compositum. Stromata nulla. Conidiophora fasciculata, erecta, simplicia, recta vel flexuosa, brunnea, septata, per usque ad 3 proliferationes successivas cylindricas elongascentia, 190-210 µm longa, 9-10 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, laevia, subhyalina vel brunnea, fere obclavata longe attenuata, recta vel curvata, 12-28-pseudoseptata, 333-360 µm longa, 15-19 µm crassa, basi truncata 7-8 µm lata.

Holotype: on dead branches of *Michelia champaca* L., Arboretum of Nanjing, Jiangsu Province, China. Sept. 9. 2003. X. G. Zhang, HSAUPIII$_0$ 0928-2 (isotype: HMAS 143714).

Etymology: in reference to the host, *Michelia champaca*

Colonies grey to dark blackish brown, velvety, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 3.0-3.5 µm thick. Stroma absent. Conidiophores fasciculate, erect, simple, straight or flexuous, brown, septate, with up to 3 successive cylindrical proliferations, 190-210 × 9-19 µm. Conidia formed singly through a pore at the apex of the conidiophore, which then proliferates through the pore and forms another conidium at the apex of the proliferation, smooth walled, subhyaline coloured to brown, usually obclavate tapering to the narrow apex, straight or curved, 12-28-pseudoseptate, 333-360 µm long, 15-19 µm thick, 6-7 µm wide at the truncate base, lower cells darker brown, upper cells becoming gradually paler toward the apex.

This species resembles *C. leptoderridicola* (Ellis 1957). However, the conidia of the new taxon are longer than those of *C. leptoderridicola* (70-120 µm). In addition, the conidia of the new taxon have 18-28 pseudosepta, while those of *C. leptoderridicola* have only 6-16 pseudosepta.

Acknowledgments

The authors are indebted to W.B. Kendrick and N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (no. 30370009, 30499340).

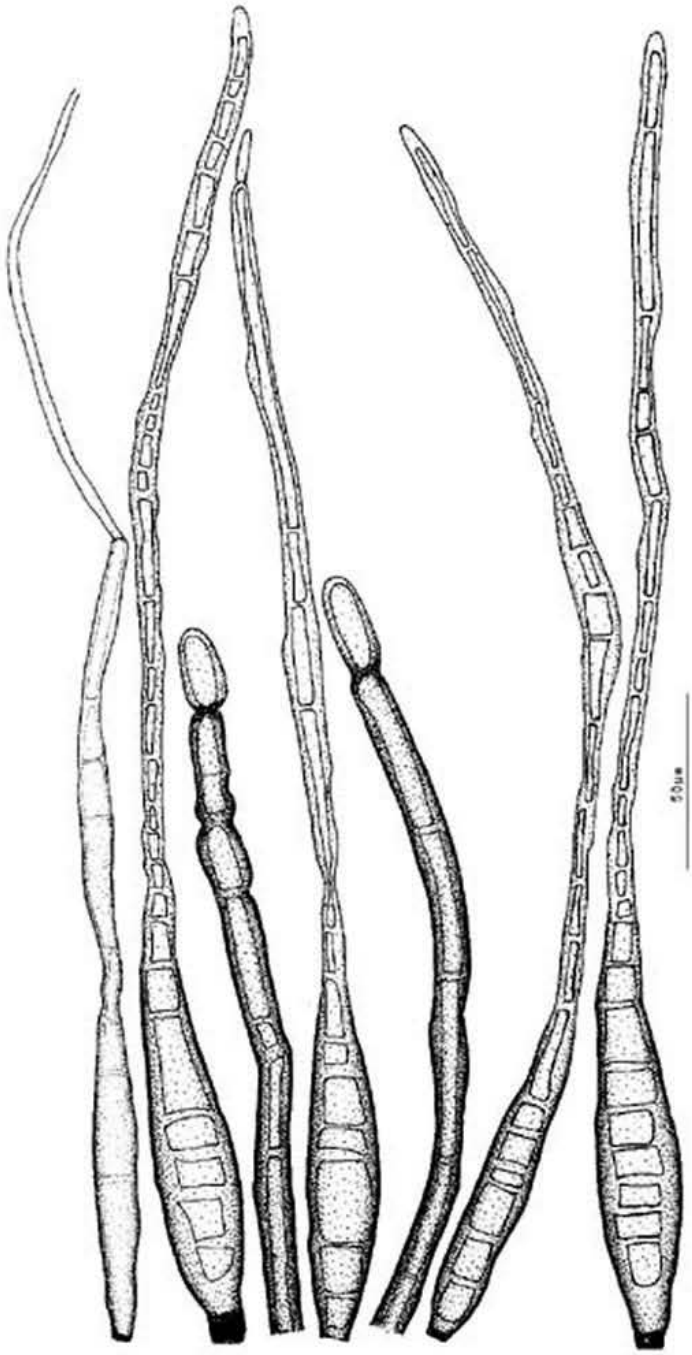

Fig. 2 Conidia and conidiophores of *C. micheliae*

Literature cited

Güssow HT. 1906. Über eine neue Krankheit an Gurken in England. Z. Pflkrankh. 16 : 10-13.
Ellis MB. 1957. Some species of *Corynespora*. Mycological papers 65 : 1-15.

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Two new species of *Alternaria* from pear fruit

RODNEY G. ROBERTS

roberts@tfrl.ars.usda.gov
USDA, ARS, Tree Fruit Research Laboratory
1104 N. Western Ave., Wenatchee, WA 98801

Abstract— Two new taxa in *Alternaria* are here described as *A. calycipyricola* from the calyces of fruits of *Pyrus communis* 'd'Anjou' grown in Washington State, and *A. ventricosa* from the stem of a fruit of *Pyrus bretschneideri* 'Ya Li' grown in Hebei, China. Conidia of both species are fundamentally erostrate but may produce elongate apical secondary conidiophores from which chain elongation and lateral branching occur late in the development of individual conidia. *A. calycipyricola* and *A. ventricosa* differ from each other in cultural characters, growth rate, and conidial morphology. Combined analyses of RAPD, RAMS and AFLP fingerprints support morphological evidence that *A. calycipyricola* and *A. ventricosa* are appropriately placed in the *A. infectoria* species-group sensu Simmons and are distinct from each other and the other species studied within the group.

Key words— *Alternaria alternata*

Introduction

The rationale for this paper extends well past a decade to 1990 when I had the pleasure of traveling through fruit production areas on Honshu with EG Simmons to collect plant material from Japanese pear orchards infected with black spot disease. Our purpose was to clarify the identity of the *Alternaria* incitant of black spot disease (at that time referred to as *A. kikuchiana* S. Tanaka or, incorrectly, as *A. alternata* 'Japanese pear pathotype') by experimentally testing the hypothesis posed some years earlier by Nishimura (1978) that the black spot pathogen had a similar range of spore sizes with *A. alternata*, and if other characters were lacking to distinguish it from *A. alternata*, it should be treated as a synonym of the earlier name *A. alternata*. This hypothesis was tested in a double-blind experiment reported by Simmons & Roberts (1993). Simmons, without prior knowledge of the toxigenicity or pathogenicity of the isolates studied, was able to select from among a large set of environmental isolates those strains which were independently demonstrated to produce AKT toxins and black spot lesions on detached 20th Century Japanese pear leaves with a high degree of accuracy based upon the pattern of sporulation

observable at 50X magnification, thereby disproving Nishimura's hypothesis. This result opened my eyes and mind to the benefits of a structured study of *Alternaria*, and to the fact that small but consistent differences, often dismissed as intraspecific variability, are indeed important indicators with taxonomic value that can and should be used to characterize new taxa when appropriate.

Such work to isolate and characterize the *Alternaria* incitants of plant diseases of economic importance has continued into the present. During the intervening years, occasional isolates of *Alternaria* have come to hand for which there are no appropriate descriptions or names in the literature. A number of such isolates have been set aside but preserved for description at a later time. This paper is the first in a series of papers whose purpose is to provide descriptions and names for those strains of *Alternaria*. As these new taxa are documented, it is hoped that a new and deeper understanding of the species diversity of *Alternaria* species that inhabit fruit and other substrates will be gained and that subsequent decisions, whether they are for disease control measures or regulatory action, will be made from a more informed position than is currently possible.

Materials and methods

Conditions of isolation, culture and observation. The media, methods and conditions for growth and observation of *Alternaria* follow those described in pages 136-137 in Simmons & Roberts (1993). All isolates that represent newly described species in this paper were obtained from fruit of *Pyrus* spp. RGR 96.0209 and RGR 96.0210 were isolated by removing bits of visible white mycelium observed in the calyx of several stored *Pyrus communis* L. 'd'Anjou' pear fruit and placing them onto plates of potato carrot agar (PCA). RGR 04.0031 and RGR 04.0032 were obtained from the stem tissues of *Pyrus bretschneideri* Rehder 'Ya Li' pear fruit purchased from a retail display in a grocery store chain. Stems were swabbed with 70% ethanol then stem slices were removed with a sterile scalpel blade and placed onto PCA. In both instances, isolation plates were held at approx. 25C under cool white fluorescent lighting (8 hr/16 hr of light/dark) until sporulation was evident, and then conidia were transferred to fresh PCA or V8 juice agar plates. Cultures were preserved by lyophilization and by refrigerated storage of small blocks of agar cut from the leading edge of cultures and placed into tubes of sterile water. Color references in the taxonomic descriptions refer to the corresponding color plates in the Methuen Handbook of Colour (Kornerup & Wanscher 1989).

Molecular analysis. Cultures were grown and DNA prepared for analysis by the methods reported previously (Roberts et al. 2000). Methods and conditions for randomly amplified polymorphic DNA (RAPD) analyses followed Roberts

et al., 2000. Randomly amplified microsatellite (RAMS) fingerprints were produced according to the method reported in Hantula & Müller (1997), and amplified fragment length polymorphism (AFLP) fingerprints were produced using the AFLP Analysis System For Microorganisms according to the vendor instructions (Invitrogen Life Technologies, Carlsbad, CA) except genomic DNA was extracted using a CTAB protocol and WellRED fluorescent dye D2-PA (Proligo LLC, Boulder, CO) was used to label the EcoR1 primers *in lieu* of ^{32}P so that a Beckman Coulter CEQ 8000 Genetic Analysis System could be used for fragment resolution. All fingerprint types for RGR 96.0209, 96.0210, 04.0031, 04.0032 and 160 additional isolates representing a wide range of authenticated, unidentified, and ex-type strains of diverse geographic and host origins were analyzed concurrently as different 'experiment' types using experiment averaging and the Ward algorithm for cluster analysis in BioNumerics 4.61 software (Applied Maths, Gent, Belgium).

RAPD fingerprints were generated as in Roberts et al. (2000) using three decameric oligonucleotide primers; OPR-02 (^{5}CACAGCTGCC^{3}), OPR-08 (^{5}CCCGTTGCCT^{3}) and OPR-12 (^{5}ACAGGTGCGT^{3}). Two replicate fingerprints produced for each isolate were digitized and imported into BioNumerics software. Band selection reflected a consensus fingerprint of both trials. All consensus banding patterns were normalized to one reference DNA ladder and then band similarities between isolates were calculated using a binary band-based coefficient (Dice). Band position tolerance settings were 1% optimization, 1% position tolerance, with minimum band height and minimum surface set at 0%.

RAMS fingerprints were generated following the method of Hantula (1997) using two primers, DDB(CCA)$_5$ and DHB(CGA)$_5$. RAMS fingerprint analysis followed the protocol described above for RAPD fingerprints.

AFLP fingerprints were generated using an Invitrogen AFLP Core Reagent Kit and AFLP Microorganism Primer Kit according to the manufacturer's instructions except that ^{32}P was not used. An AFLP primer labeled with the WellRED fluorescent dye D2-PA (Proligo) was substituted for the ^{32}P-labeled or ^{33}P-labeled EcoR1 primer specified in the Invitrogen protocol and the AFLP amplicons were resolved and analyzed using an 8-lane capillary DNA sequencer (CEQ 8000 Genetic Analysis System) and the associated Fragment Analysis module. The WellRED labeled primer was EcoR1AA-D2 (5'-(dyeD2) GACTGCGTACCAATTCAA-3'). Maximum bin width was one (1), fully populated bins and samples without qualifying peaks were excluded, with the Y-threshold set to zero (0). The resulting analysis was exported to BioNumerics and analyzed using the same consensus band similarity methods and quality criteria as RAPD and RAMS fingerprints.

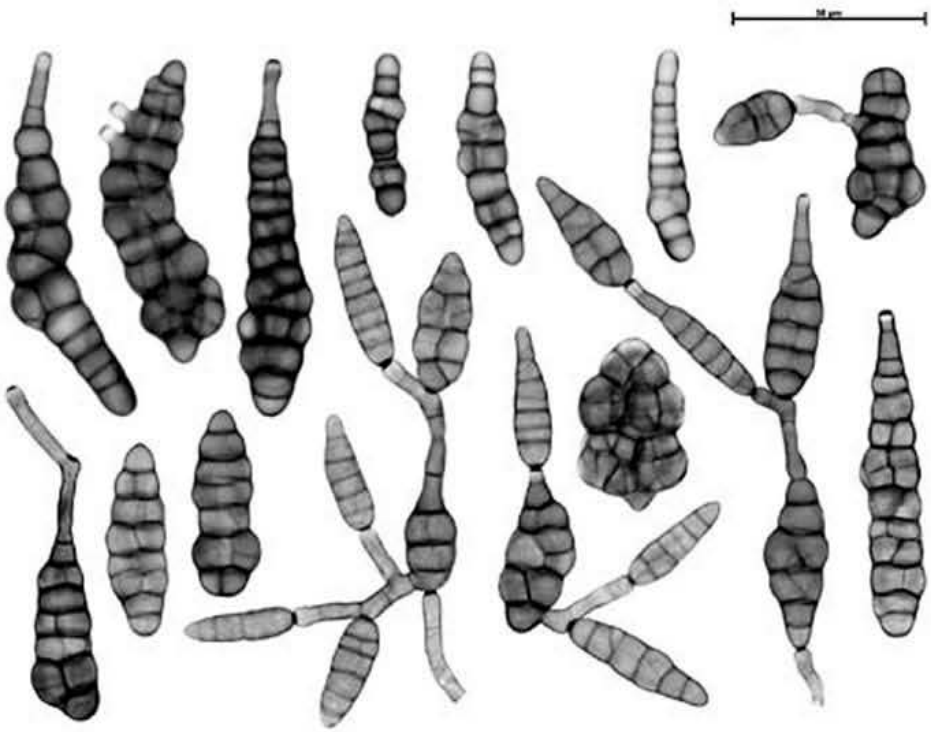

Fig. 1. Conidia of *A. calycipyricola* from V8 juice agar. Bar = 50 µm

A combined similarity matrix was calculated from the consensus RAPD, RAMS and AFLP matrices in BioNumerics, with the data treated as a composite data set and a combined similarity matrix calculated as the average from all experiments (fingerprints), obviating the need to assign weights to each fingerprint type. The Ward algorithm was used for dendrogram generation.

Taxonomic description

Alternaria calycipyricola R.G. Roberts, **sp. nov.** Figs. 1, 2

MycoBank MB 510583

Etym.: *calyx* - calyx; + *pyrus* - pear; + *-cola* - living upon

Ex cultura in agaro V-8 post 7 dies descripta. Colonia ca. 25 mm diam., diffuse concentrice zonata. Conidiophora ad 20-175 x 4-7 µm, ex hyphis funiculosis aeriis, interdum geniculata. Conidia 24-83 x 9-28 µm, erostrata, solitaria vel catenata ope conidiophororum secundariorum, obclavata, ovoidea vel cylindrica ellipsoideaque, laevia vel minute verruculosa, pallide brunnea, compluries inaequilatera ob cellulas laterales tumidas, transverse 6-12 septata, septis longitudinalibus obliquisque aliquantis.

Description from cultures grown on V8 juice agar for 7 days at 25C and 21% RH. Colonies slow-growing, becoming about 25 mm diam. at 7 days, concentrically zonate but diffuse due to sparse sporulation. Areas developed during light

exposure low, initially white to grayish white (1B1), darkening slightly with age to a medium gray (1E1). Areas developed during dark period produce relatively more aerial hyphae. Primary conidiophores are 20-175 x 4-7 µm, usually produced from tortuous aerial elements that may become funiculose with age and bear short, branching chains of 3-4 conidia, often becoming geniculate from successive extension (renewal of growth) of the secondary conidiophore. Conidia smooth to minutely verruculose, hyaline when young, becoming pale brown (6E8) with age but remaining translucent, 24-83 x 9-28 µm, erostrate, solitary or catenulate via sympodial development of apical, lateral and basal secondary conidiophores that may be up to 90 x 7 µm. Conidia obclavate to ovoid when young, with age becoming nearly cylindrical to ellipsoidal and often irregular in outline and shape due to proliferation of intercalary cells. Stromatic bodies up to 250 µm diam. that are assumed to be protoascomata are produced within and upon the agar (Fig. 2). Development of asci within stromata was not observed.

Type (holotype): BPI 872337 (dried culture preparation ex RGR 96.0209, isol. Roberts from moribund calyx elements of *Pyrus communis*, Cashmere, Washington, U.S.A., 1996.

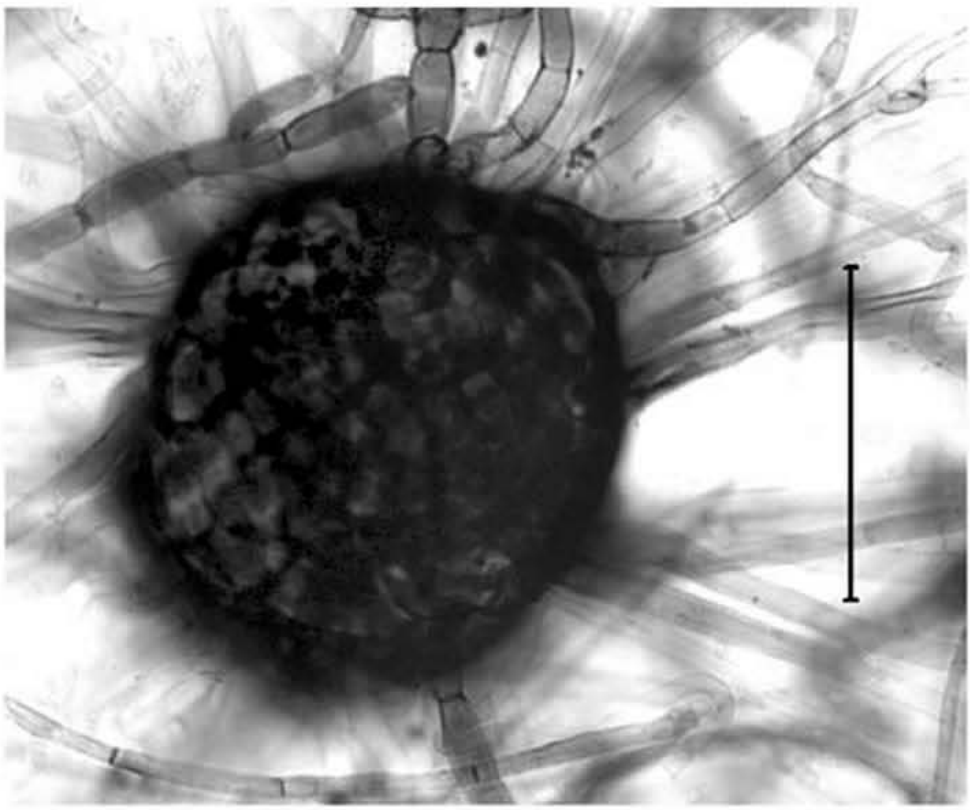

Fig. 2. Putative protoascoma of *A. calycipyricola* from V8 juice agar. Bar = 100 µm

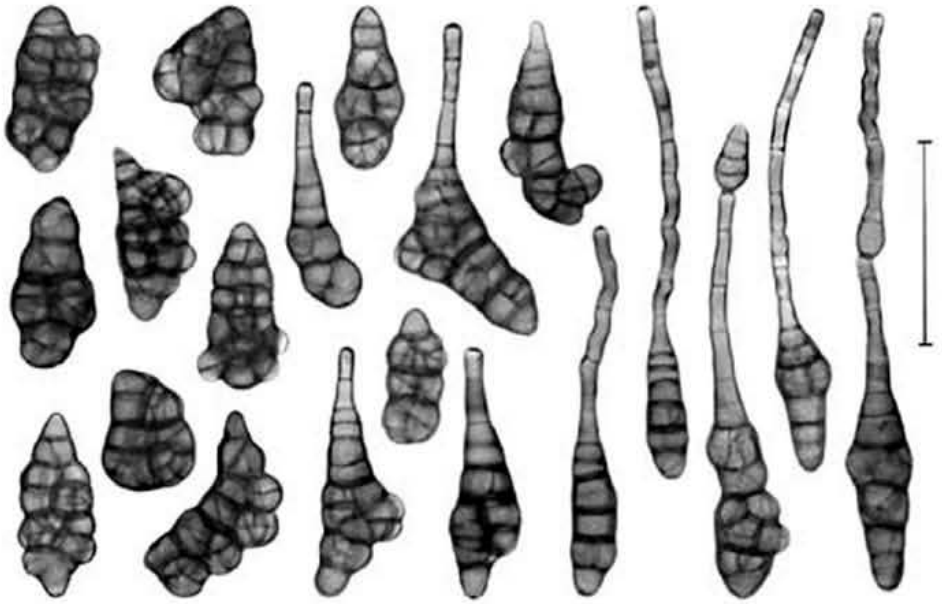

Fig. 3. Conidia of *A. ventricosa* from V8 juice agar, *Bar = 50* µm

Alternaria ventricosa R.G. Roberts, **sp. nov.** Fig. 3

MycoBank MB 510582

Etym.: *ventricosa* – ventricose; markedly swollen, distended or inflated, especially on one side.

Ex cultura in agaro V-8 post 7 dies descripta. Colonia ca. 35 mm diam., concentrice zonata. Conidiophora ad 14-420 x 4-7 µm, ramosa vel eramosa, interdum geniculata. Conidia 16-53 x 9-22 µm, erostrata, solitaria vel catenata ope conidiophororum secundariorum, ellipsoidea vel late ovoidea, verruculosa vel punctulata, pallide brunnea, compluries inaequilatera ob cellulas laterales tumidas, transverse 6-8 septata, septis longitudinalibus obliquisque aliquantis.

Description from cultures grown on V8 juice agar for 7 days at 25C and 21% RH. Colonies about 35 mm diam., concentrically zonate. Areas developed during light exposure low, granular in appearance from sporulation which is initially light grayish green, near cactus green (28E4), darkening with age to greenish black (27AH). Areas of colony produced during dark period produce abundant aerial hyphae that may become fasciculate with age from which solitary short-catenulate conidia are produced. Color of dark-grown areas similar to but lighter than light-grown areas. Conidiophores arise from agar surface when exposed to light; 14–420 x 4-7 µm, pale grey by transmitted light but the area adjacent to septa can be without pigment, solitary, branched

or unbranched, often becoming geniculate from successive production of conidia. Conidia 16-53 x 9-22 µm, erostrate and solitary or short-catenulate, producing short branching chains via sympodial development of a primarily apical secondary conidiophore, although conidiophores can also develop from the basal or (rarely) intercalary cells of the conidium with age. Lateral development of secondary conidiophores from subapical cells is rare. Conidia ellipsoidal to broadly ovoidal, becoming obclavate from apical growth of secondary conidiophores, verruculose to punctulate, translucent, near pale cinnamon brown (6D6). The appearance of juvenile conidia is dominated by one to four (rarely, six) transverse septa, which become darker and constrict the conidium outline with age. Oblique and longitudinal septa are paler than the first transverse septa and develop within the segments defined by the oldest transverse septa. Cells delimited by these paler septa may expand, giving the conidium outline an almost crenate appearance in plane section and may cause the conidium to become curved when expansion is unilateral. Secondary conidiophores usually develop from the conidium apex, and may be short or, in the case of smaller conidia, several times the length of the conidium body. Similar in appearance to primary conidiophores but slightly narrower, they are 6-77 x 3-5 µm, often becoming geniculate. The lateral branches that develop from elongated secondary apical conidiophores produce the open, 3-dimensional pattern of sporulation that unifies members of the *A. infectoria* group.

Type (holotype): BPI 872336 (dried culture preparation ex RGR 04.0031, isol. Roberts from pedicel of *Pyrus bretschneideri*, local market, Wenatchee, Washington, U.S.A, 2004; original source likely Hebei Province, China.

Discussion

The type culture of *A. calycipyricola* was isolated from moribund floral remnants in the calyx of a European pear (*P. communis* 'd'Anjou') removed from commercial cold storage in Cashmere, WA in 1996. Noticed as a cottony growth on the calyx ends of several fruit, the mycelium appeared to be entirely superficial and was not associated with any type of lesion, discoloration, or other symptom. *A. calycipyricola* is provisionally represented by one additional isolate, RGR 96.0210, that does not produce protoascomata in culture and whose conidia are slightly larger. Isolates of *A. calycipyricola* and *A. avenicola* clustered together in the lowermost dendrogram branch in Fig. 4 (next page). *A. calycipyricola* differs from *A. avenicola*, with which it shares a superficial morphological resemblance, by virtue of its much smaller conidia, lack of ascospore production on agar media, lack of chlamydospore production and known host range.

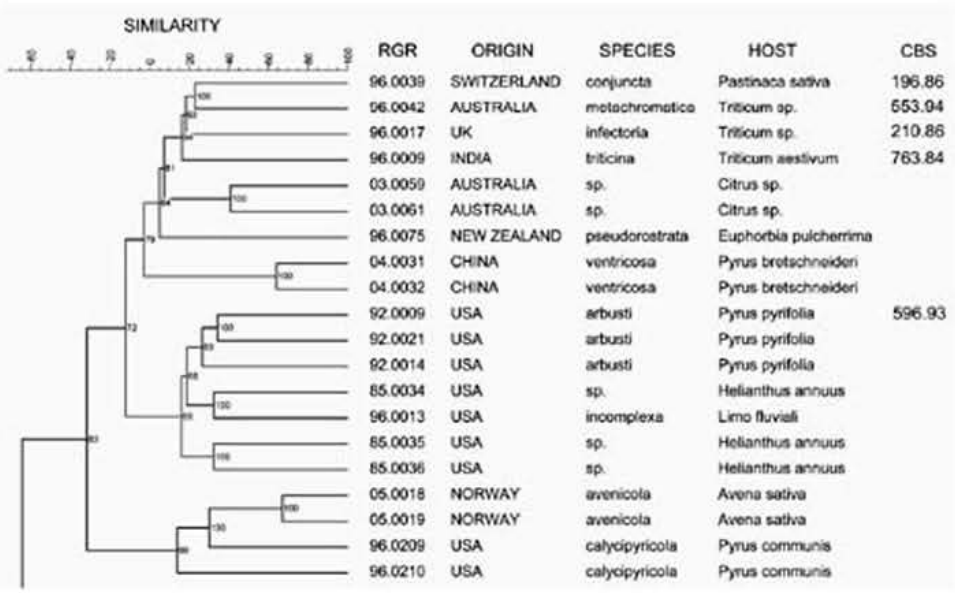

Fig. 4. Dendrogram branch from a combined cluster analysis of RAPD, RAMS and AFLP fingerprints of *Alternaria* strains belonging to the *A. infectoria* group sensu Simmons, extracted from a larger analysis of 164 isolates which represent all described sporulation pattern groups. Numbers at branch roots are cophenetic correlation values calculated for the entire dendrogram. The SIMILARITY scale is a relative measure based upon the whole-dendrogram similarity matrix, which was calculated from the combined similarity matrices for all experiments (fingerprint type) for each isolate. Corresponding Centraalbureau voor Schimmelcultures accession numbers are given for those isolates obtainable from that source.

The type culture of *A. ventricosa* was isolated from a symptomatic stem of a 'Ya Li' pear fruit (*P. bretschneideri* 'Ya Li') that had originated in Shandong or Hebei Provinces, China and was purchased from a retail market display in Wenatchee, WA. Both RGR 04.0031 and 04.0032 are notable because of the several hundred isolates studied from imported Ya Li pear fruit they are the only isolates that belong in the *A. infectoria* species group. Among the dozens of *Alternaria* isolations in the *infectoria* group studied to date, *A. ventricosa* is readily recognizable by the morphological characters of its mature erostrate conidia, and is clearly segregated from other *Alternaria* species in band-based cluster analyses. The status of *A. ventricosa* as a pathogen of *Pyrus* has not been confirmed in inoculation studies.

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The constructive comments, encouragement and Latin diagnoses provided by EG Simmons over the years and for this paper are greatly appreciated. The thoughtful and thorough review of this manuscript by Birgitte Andersen is no less appreciated. Steve Reymond conducted the supporting molecular analyses, for which I am grateful.

Literature Cited

Hantula J, Müller MM. 1997. Variation within *Gremmeniella abietina* in Finland and other countries as determined by Random Amplified Microsatellites (RAMS) Mycol. Res. 101:169-175.

Kornerup A, Wanscher JH. 1989. Methuen Handbook of Colour, 3rd ed. Methuen: London (UK). 252 pp.

Nishimura S, Sugihara M, Kohmoto K, Otani H. 1978. Two different phases in pathogenicity of the *Alternaria* pathogen causing black spot disease of Japanese pear. Journ. Fac. Agric., Tottori Univ. 13: 1-10.

Roberts RG, Reymond ST, Andersen B. 2000. RAPD fragment pattern analysis and morphological segregation of small-spored *Alternaria* species and species-groups. Mycol. Res. 104:151-160.

Roberts RG. 2005. *Alternaria yaliinficiens* sp. nov. on Ya Li pear fruit: From interception to identification. Plant Disease 89: 134-145.

Saghai-Maroof MA, Soliman KM, Jorgensen RA, Allard RW. 1984. Fungal DNA isolation. PNAS 81: 8014-8018.

Simmons EG. 1981. *Alternaria* themes and variations 1-2. Mycotaxon 13: 16-34.

Simmons EG, Roberts RG. 1993. *Alternaria* themes and variations (73). Morphology and toxigenicity of *Alternaria* associated with black spot disease of Japanese pear. Mycotaxon 48: 109-140.

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A new and noteworthy species of *Hygrophorus* from Yunnan, China

FU-QIANG YU[1,2], GUANG-BO XU[3] & PEI-GUI LIU[1]

fuqiangyu@gmail.com

[1]*Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany Chinese Academy of Sciences, Kunming 650204, China*

[2]*Graduate University of Chinese Academy of Sciences Beijing 100039, China*

[3]*Agricultural College of Yanbian University Longjing 133400, China*

Abstract—A new species, *Hygrophorus robustus*, is described and illustrated from Yunnan, China. It is characterized by a raw umber to pale ochre cap, ochre lamellae, and robust stipe. The relationship of the new species to other closely related species is discussed. The morphological characters of the shiro-like colony and carbonized blackish mycorrhiza are also presented, as well as their possible relationship to other related fungi.

Keywords—*Agaricales*, taxonomy, mushroom

Introduction

Hygrophorus species are common and conspicuous fungi around the world. They are renowned both for their often colorful sporocarps and regular occurrence in broadleaved, conifer or mixed forests of cool or warm temperate regions (Hesler & Smith 1963, Horak 1990, Candusso 1997, Yong 2005). Their macro- and micromorphological characters are quite diverse as well as their habitat conditions. Basidiocarps vary in size, with a few 8-15 cm in diameter; the hymenophore is waxy in texture; lamellae are typically thick but with sharp edges, usually distant to subdistant and characteristically with a clean appearance; stipes are confluent with the pileus and nearly always centrally attached; the gill trama is interwoven, subparallel to parallel, divergent or bilateral; basidiospores are rarely ornamented and are ellipsoidal to elongate or globose and white in deposit; basidia are typically long and narrow as

*Author for correspondence

in species of *Cantharellus* (Hesler & Smith 1963). However, knowledge about these mushrooms is still rather limited, and no studies specifically on the Chinese *Hygrophoraceae* have been published. Based upon the careful examination of four distinctive *Hygrophorus* collections (one from the field, three from local wild edible mushroom markets) from Yunnan, China, a new species, *H. robustus* is described and illustrated, including colony structure and mycorrhizal morphology.

Materials and methods

Macromorphological characters were taken from fresh specimens. Descriptions and illustrations of micromorphological characters were made using a Nikon E400 microscope with light and phase-contrast optics. Sections were made with a razor blade viewed under a stereomicroscope, mounted in 5% KOH, and Melzer's solution. Illustrations were made with a drawing tube. Specimens examined were deposited in the Cryptogamic Herbarium of Kunming Institute of Botany, Academia Sinica (HKAS).

Mycorrhizal samples were collected directly beneath sporocarps within a *Castanopsis delavayi* Franch. dominated forests in Zixi Mount. (Central Yunnan, China) in 2005. Colony samples, composed of mycelium, soil and roots which were traced back to the host tree, were placed in plastic bags, transported fresh to the laboratory and stored at 4°C. Mycorrhizal roots were cleaned of soil and debris in running tap water, and examined with a Nikon SMZ1500 stereomicroscope.

Taxonomy

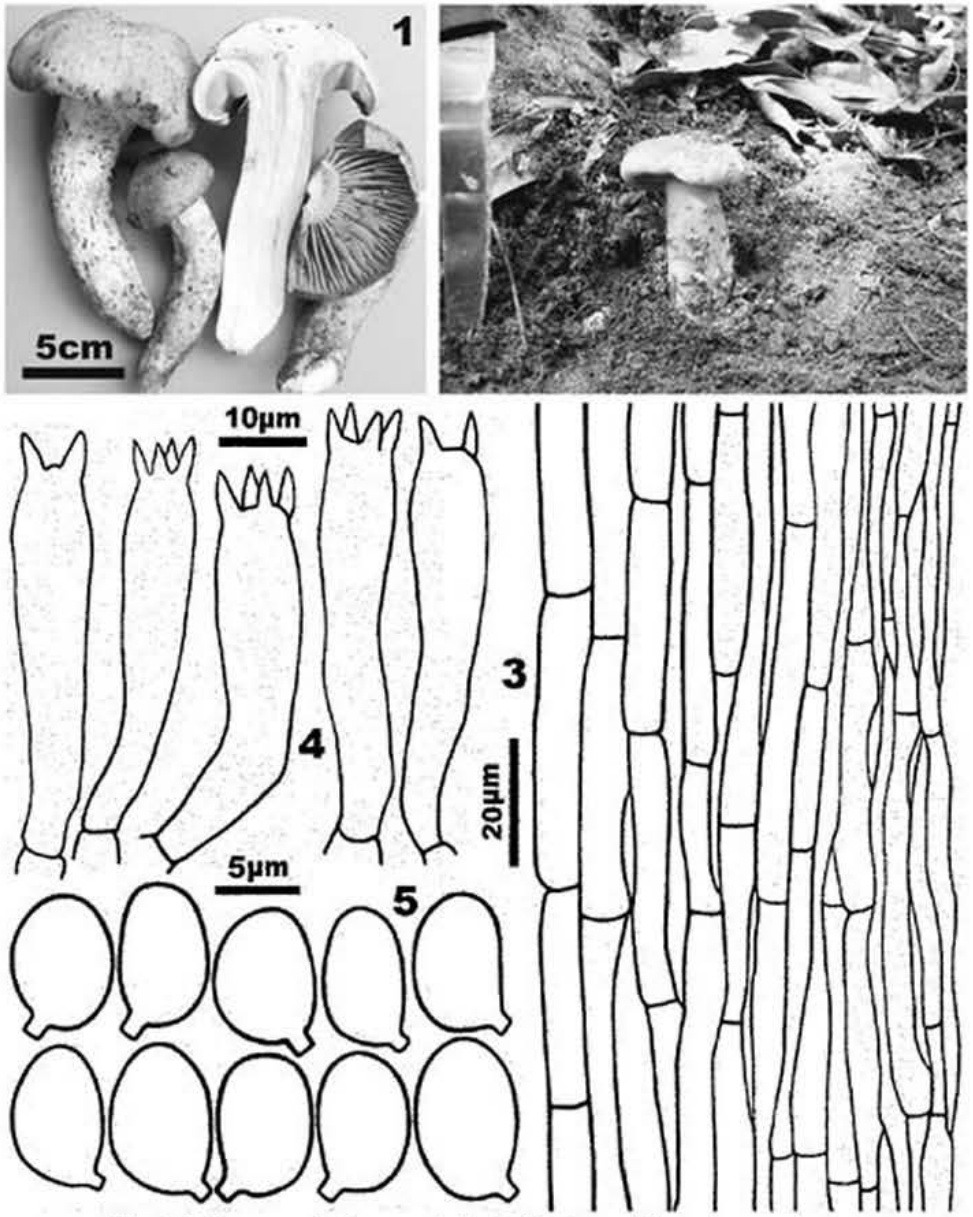
Hygrophorus robustus F.Q. Yu, **sp. nov.** Fig. 1-5

MycoBank #MB510599

Pileus 60-120 mm latus, subumbonatus vel convexus, margine involuto dein recto; glaber, rudis umber ut stilus ochre, radiately-virga per appressed fibrillose. Lamellae cum adnate, sinuate vel arcuate, distantes, umber ut ochre. Stipes 80-200 × 18-40 mm, solidus, pervalidus, deorsum attenuato, annulum non obvious. Carne alba, odor incommodus. Basidia clavata, (40)52-60(63) × (8)10-13 μm; basidiosporae 8-10(10.5) × 5-6.5(7) μm, obovate-elliptie.

Etymology—The specific epithet refers to the robust sporocarps

Macromorphological features: Pileus 60–120 mm broad, hemispherical, convex to broadly convex; surface dry, more or less glabrous, radiately streaked by appressed fibrillose, raw umber to pale ochre, margin incurved (Fig.1, 2). Context thick, hard, white; taste mild. Odor pleasant, of freshly husked corn mixed with the aroma reminiscent of *Tricholoma matsutake* (S. Ito & S. Imai) Singer. Lamellae waxy, adnate, sinuate or arcuate, broad, distant, concolorous with pileus or even darker, with some lamellulae (Fig.1). Stipe 80–200 × 18–40 mm, very robust, somewhat like that of *Termitomyces eurhizus* (Berk.) R. Heim,



Figs 1-5: Macro- and micromorphological features of *Hygrophorus robustus*.
1. Sporocarps (HKAS 49785); 2. Sporocarp in natural habitat, showing *Tricholoma matsutake* appearance at young stage (HKAS 49786); 3. Section through Pileipellis (right side – pileus surface); 4. Basidia; 5. Basidiospores.

cylindrical, tapering at the base, longitudinally fibrillous-striate, splitting readily, grey white to dirty white, covered with concolorous appressed fibrous scale. Annulus not obvious, fibrillose, concolorous with the pileus, superior, subpersistent. Context white, solid, compact (Fig.1).

Micromorphological features: Pileipellis a cutis of thin-walled hyphae, 4–9 μm wide, repent and extend in a periclinal direction, not sharply differentiated from the pileus trama, white yellow to yellowish brown; cells filamentous (Fig.3). Lamellar trama divergent or bilateral, hyphae mostly 3–6 μm in diameter, thin-walled, hyaline; cells filamentous. Subhymenium morphological undifferentiated. Basidia (40)52–60(63) × (8)10–13 μm, clavate to subcylindrical, hyaline, usually 4- or 2-spored, rarely 1-spored, sterigmata 6–10 μm long (Fig.4). Cystidia absent. Basidiospores 8–10(10.5) × 5–6.5(7) μm, 9 × 6 μm on average, Q = (1.29)1.33–1.80(2.0), thin-walled, subellipsoid, occasionally ellipsoidal, hyaline, smooth, inamyloid (Fig.5). Stipitipellis a layer of repent hyphae, 4-8 μm in diameter, thin-walled, filamentous, hyaline.

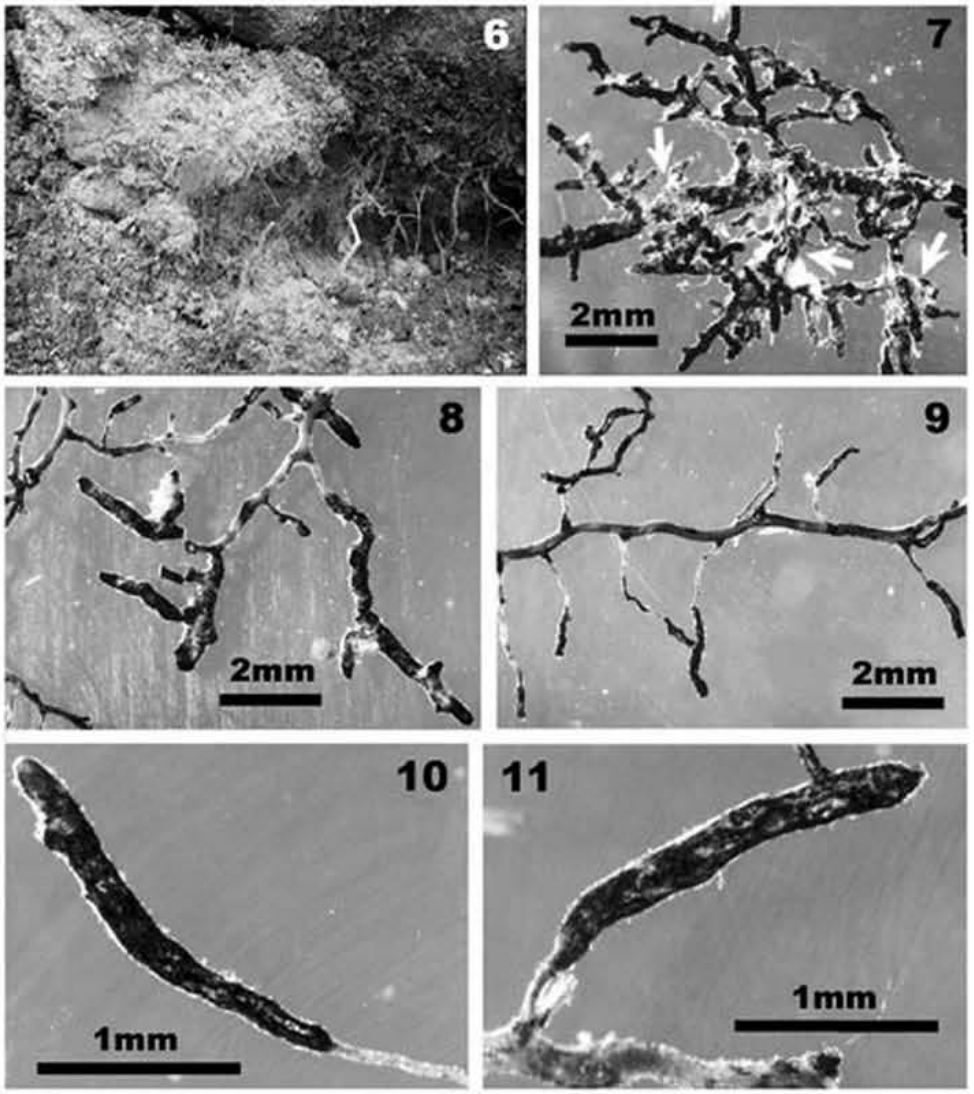
Habitats and ecology: *H. robustus* is associated with *C. delavayi* in Yunnan, China. Its exact distribution is still unknown but probably confined to subalpine regions of southwestern China. Fruiting in late July and early August.

Mycelial colony: *H. robustus* produces a dense white to pale gray mycelia mass beneath the sporocarp. This mycelium colonizes everything in the soil including plant roots, soil granules, rocks, and gaps between granules. The surface of the colony is immediately below the litter layer and in deep soil can be 10 cm from top to bottom. The diameter of the colony is about 15 cm (Fig.6).

Mycorrhizal morphology: Mycorrhizas 8–28 mm long, monopodial pinnate to irregular (Fig.7); tips 0.5–2.5 × 0.1–0.3 mm, mostly straight or bent, some slightly tortuous, yellowish brown to dark brown (Fig.8, 9), surrounded by tangled cottony hyphal masses which were difficult to separate and recognize as individual hyphae (Fig.7); surface of younger tips usually smooth, shiny, more or less clavate, plump, and yellowish brown in color (Fig.10); while the older tips are often coarse, wrinkled and pitted, easily broken, and progressively blacken and loose emanating elements (Fig.11).

Specimens examined—CHINA. YUNNAN PROVINCE: Yaoan Co. (E101°25′, N25°04′), wild edible mushroom market, 4.VIII.1998, X. H. Wang 627 (HKAS 32908); Wuding Co. (E102°37′, N25°25′), wild edible mushroom market, 12.VIII.1999, X. H. Wang 745 (HKAS 35825); Kunming City (E102°73′, N25°05′), Wujing Road, wild edible mushroom market, 23.VII.2005, F. Q. Yu 1271 (HKAS 49785) (Holotype); Chuxiong City, Zixi Mount., Camellia Garden (E101°25′2″, N24°59′96″), 27.VII.2005, alt. 2363 m, F. Q. Yu 1283 (HKAS 49786).

Notes—*Hygrophorus robustus* is a very peculiar species. It appears at first sight to belong to the *Tricholoma matsutake* group, especially in young stages (Fig.2). Specimens share a number of features including robust sporocarps, pale ochre colored pilei with radiately appressed fibrils, and a smell reminiscent of matsutakes, but the new species can be readily distinguished from *T. matsutake* sensu lato by its distant and waxy lamellae, long basidia, and divergent lamellar trama. *H. pudorinus* (Fr.) Fr. also possesses a robust stature, distinctly colored young pileus, and thick stipe, but differs in its buff to salmon colored pileus,



Figs 6-11: Colony and mycorrhiza of *Hygrophorus robustus*.

6. Shiro-like colony beneath the sporocarps, showing intermixed white mycelium, soil and mycorrhizas (HKAS 49786); 7. Mycorrhizal system on *Castanopsis delavayi*, showing monopodial pinnate to irregular ramification, adhering hydrophobic and cottony extraradical mycelium (*arrows*); 8. Straight and robust mycorrhizal tips; 9. Bent and delicate mycorrhizal tips; 10. Young mycorrhizal tip with yellow brown, smooth and plump surface; 11. Old mycorrhizal tip with dark brown, coarse and wrinkled surface.

pinkish-tinged lamella, stipe with a bright yellow base, and faintly fragrant odor (Hesler & Smith 1963).

H. robustus seldom appears at wild edible mushroom markets in Yunnan. It's often called "white matsutake", "rice water mushroom" and "false termite mushroom" by local people. One other *Hygrophorus* species commonly

encountered in Yunnan local markets is *H. russula* (Schaeff.) Kauffman. However, *H. russula* has close to crowded lamella that are white when young but which soon flush with pale pink and later develop purplish-red spots. In *H. russula,* pilei are usually smaller and pinkish-tinged while stipes are more slender and initially white, next stained, streaked, or laced with pink, and finally more or less concolorous with the pileus (Hesler & Smith 1963, Candusso 1997). The colony structure of *H. robustus* is fundamentally similar to the "Shiro" (Japanese for 'white castle' or 'fortress') found in the matsutake group [*Tricholoma bakamatsutake* Hongo (Terashima 1993), *T. caligatum* (Viv.) Ricken (Ohara & Ogawa 1982), *T. fulvocastaneum* Hongo (Ogawa 1977), *T. magnivelare* (Peck) Redhead (Ogawa 1979), *T. matsutake* (Yamada et al. 1999)]. Inside the shiro, everything is colonized (including plant roots, soil granules, rocks, and gaps between granules) and the soil appears white or pale grey, loose, and somewhat powdery and dry (Zhong 2004). The *H. robustus* colony, however, lacks the strong matsutake aroma.

Six mycorrhizal morphotypes formed by *Hygrophorus* spp. on *Larix* and *Picea* have been described. These morphotypes possess monopodial-pinnate mycorrhizas with long and straight or bent tips that are white, yellow to yellow brown with smooth or loosely cottony surfaces (Gronbach 1988, Treu 1990, Agerer 1991, Kranabetter & Friesen 2004). Externally, mycorrhizas of *H. robustus* associated with *C. delavayi* are blackish (carbonized) and have large amounts of adhesive hydrophobic extra-radical mycelia surrounding the mycorrhizas and in the soil. Other species that also possess carbonizing mycorrhizas include (in addition to *H. robustus* and members of the *T. matsutake* group) *Boletopsis leucomelaena* (Pers.) Fayod, *Hydnellum peckii* Banker, and *Phellodon niger* (Fr.) P. Karst (Ogawa 1977, 1979; Ohara & Ogawa 1982, Terashima 1993, Yamada et al. 1999), all species usually placed in the family *Thelephoraceae*. The morphological similarities of mycorrhizas among matsutake group species, thelephoraceous fungi and *H. robustus* suggest a physiological similarity of their associations.

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Literature cited

Agerer R. 1991. Characterization of ectomycorrhiza. In: Norris JR, Read DJ, Varma AK, eds. *Methods in microbiology*, vol. 23. Techniques for the study of mycorrhiza. Academic Press Ltd, London, 25-73.

Candusso M. 1997. *Hygrophorus* s.l. Fungi Europaei 6. Liberia Basso, Alassio

Gronbach E. 1988. Charakterisierung und Identifizierung von Ektomykorrhizen in einem Fichtenbestand mit Untersuchungen zur Merkmalsvariabilität in sauer beregneten Flächen. Bibliotheca Mycologica 125: 164-173.

Hesler LR, Smith AH. 1963. North American species of *Hygrophorus*. The University of Tennessee Press, Knoxville

Horak E. 1990. Monograph of the New Zealand *Hygrophoraceae* (*Agaricales*). New Zealand Journal of Botany 28: 255-309.

Kranabetter M, Friesen J. 2004. Morphotype descriptions of common ectomycorrhizae fungi. http://www.for.gov.bc.ca/rni/research/Date_Creek/Mycorrhizae_Table/Mycorrhizae.htm#Morphotypes

Ogawa M. 1977. Microbial ecology of 'Shiro' in *Tricholoma matsutake* (S. Ito et Imai) Sing. and its allied species. VI. *Tricholoma fulvocastaneum* in *Quercus serrata-Quercus acutissima* forest. Transactions of the Mycological Society of Japan 18: 286-297.

Ogawa M. 1979. Microbial ecology of 'Shiro' in *Tricholoma matsutake* (S. Ito et Imai) Sing. and its allied species. IX. *Tricholoma ponderosum* in *Pseudotusuga menziesii-Tsuga heterophylla* and *Pinus contorta* forests. Transactions of the Mycological Society of Japan 20: 370-382.

Ohara A, Ogawa M. 1982. Microbial ecology of 'Shiro' in *Tricholoma matsutake* (S. Ito et Imai) and its allied species. XI. *Tricholoma caligatum* in *Cedrus libanotica* forests. Transactions of the Mycological Society of Japan 23: 365-377.

Terashima Y. 1993. Distribution and external morphology of mycorrhizal roots at shiros of *Tricholoma bakamatsutake* in a mixed forest of *Pasania edulis* and *Castanopsis cuspidate* var. *sieboldii*. Transactions of the Mycological Society of Japan 34: 495-505.

Treu R. 1990. Charakterisierung und Identifizierung von Ektomykorrhizen aus dem Nationalpark Berchtesgaden. Bibliotheca mycological 134: 21-24.

Yamada A, Kanekawa S, Ohmasa M. 1999. Ectomycorrhiza formation of *Tricholoma matsutake* on *Pinus densiflora*. Mycoscience 40: 193-198.

Young AM. 2005. Fungi of Australia *Hygrophoraceae*. Australian Botanical resources, study and CSIRO Publishing, Victoria

Zhong SC. 2004. The North American matsutake. In: Proceedings of the Forum on Development of Matsutake Industry, Shangri-la, 17-24.

MYCOTAXON

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New morphological data on *Amauroderma brasiliense* (*Polyporales, Basidiomycota*)

GILBERTO COELHO, VAGNER G. CORTEZ & ROSA T. GUERRERO

coelhogb@yahoo.com.br
Universidade Federal do Rio Grande do Sul,
Programa de Pós-graduação em Botânica
Av. Bento Gonçalves, 9500, CEP: 91501-970 Porto Alegre, RS, BRAZIL

Abstract—Fresh basidiomes of the basidiomycete *Amauroderma brasiliense* were studied allowing the observation of new morphological structures for the species, i.e., gloeopleurous hyphae in the context and trama and dendrohyphidia. Scanning electron microphotograph showing the basidiospores ornamentation is provided for the first time.

Key words—Neotropical fungi, Brazilian mycobiota, polypore, *Ganodermataceae*

Introduction

The genus *Amauroderma* Murrill (*Ganodermataceae*, *Basidiomycota*) is characterized by its double-walled ganodermatoid spores with a smooth to ornamented exosporium and a columnar endosporium; basidiomes are usually colored in shades of brown, stipitate, and tough to woody in consistency (Furtado 1981, Ryvarden 2004). The genus comprises around 20 widespread tropical species (Kirk et al. 2001).

Amauroderma corneri was described from São Paulo State, Brazil (Gulaid & Ryvarden 1998); and was later recorded from the states of Paraná, Rio Grande do Sul (Ryvarden & de Meijer 2002) and Santa Catarina (Groposo & Loguercio-Leite 2005), besides other countries such as Guyana (Aime et al. 2003) and Venezuela (Ryvarden & Iturriaga 2004). Recently, Ryvarden (2004) transferred *Scutiger brasiliensis* – described by Singer et al. (1983) based on collections from Amazonas and Santa Catarina States – to *Amauroderma* recognizing *A. corneri* as a latter synonym of the former, as well. As stated by Ryvarden & de Meijer (2002), the species has been overlooked and rarely collected in Brazil but it seems to be widespread in the country and, more likely, throughout the Neotropics.

Our study of fresh collections contributes a better understanding of the morphology of one species by revealing structures susceptible to desiccation that are difficult to observe in dried specimens.

Materials and methods

Fresh basidiomes of *A. brasiliense* were collected at the municipality of Itaara, in the central region of the southernmost Brazilian state, Rio Grande do Sul. Typical vegetation includes subtropical seasonal forests with some deciduous tree species that originated in the Parana/Uruguay Basins and sparse remnants of relict Araucaria rain forests dominated by *Araucaria angustifolia* (Bertol.) Kuntze, a canopy emergent tree (Rambo 1956). The understory encompasses several tropical and subtropical species that develop under partial shade and wet throughout the year, except for winter period when canopy defoliation increases light exposure.

Macro- and microscopical analyses of the basidiomes followed the usual methodology for the study of polypores (Núñez & Ryvarden 2000). Color codes are those of Munsell (1994). Abbreviations are as follows: D_m = mean diameter of the hyphae; $L_m \times W_m$ = mean length and mean width (from which Q is calculated, L_m/W_m); $n = x/y$: x number of measurements from y number of specimens; P= number of pores per centimeter; Q_r = range of Q; Q_m = mean of Q. Collected specimens are deposited at the ICN herbarium (Holmgren & Holmgren 1998). For scanning electron microscopy (SEM), dried herbarium material was mounted directly on aluminium stubs and coated with a 5 nm thick layer of gold using a Balzers SCD 050 Sputter. Stubs were examined in a Jeol JSM 5800 scanning electron microscope operating with an accelerating voltage of 20 kV.

Taxonomy

Amauroderma brasiliense (Singer) Ryvarden, Synopsis Fung. 19: 44, 2004, as *A. 'brasilensis'*. FIGS. 1-6

= *Scutiger brasiliensis* Singer, Nova Hedwigia, Beih. 77: 22, 1983.

= *Amauroderma corneri* Gulaid & Ryvarden, Mycol. Helv. 10: 28, 1998.

Basidiome annual, laterally stipitate. Pileus rounded to almost flabelliform, depressed, up to about 95 × 80 × 16 mm, cartilaginous, flexible and somewhat humid when fresh, firm and light in weight when dried; pileus surface without cuticle, dull, tomentose to hirsute in some parts, light yellowish brown (6/4 10YR), brownish yellow (6/6 10YR) to yellowish brown (5/4–5/8 10YR), slightly striate near to the margin; margin rather incurved, sometimes folded, very pale yellow (7/3–7/4 10YR), smooth, wavy to fimbriate. Stipe yellowish brown (5/4–5/8 10 YR) to dark yellowish brown (4/4–4/6 10YR), eccentric to

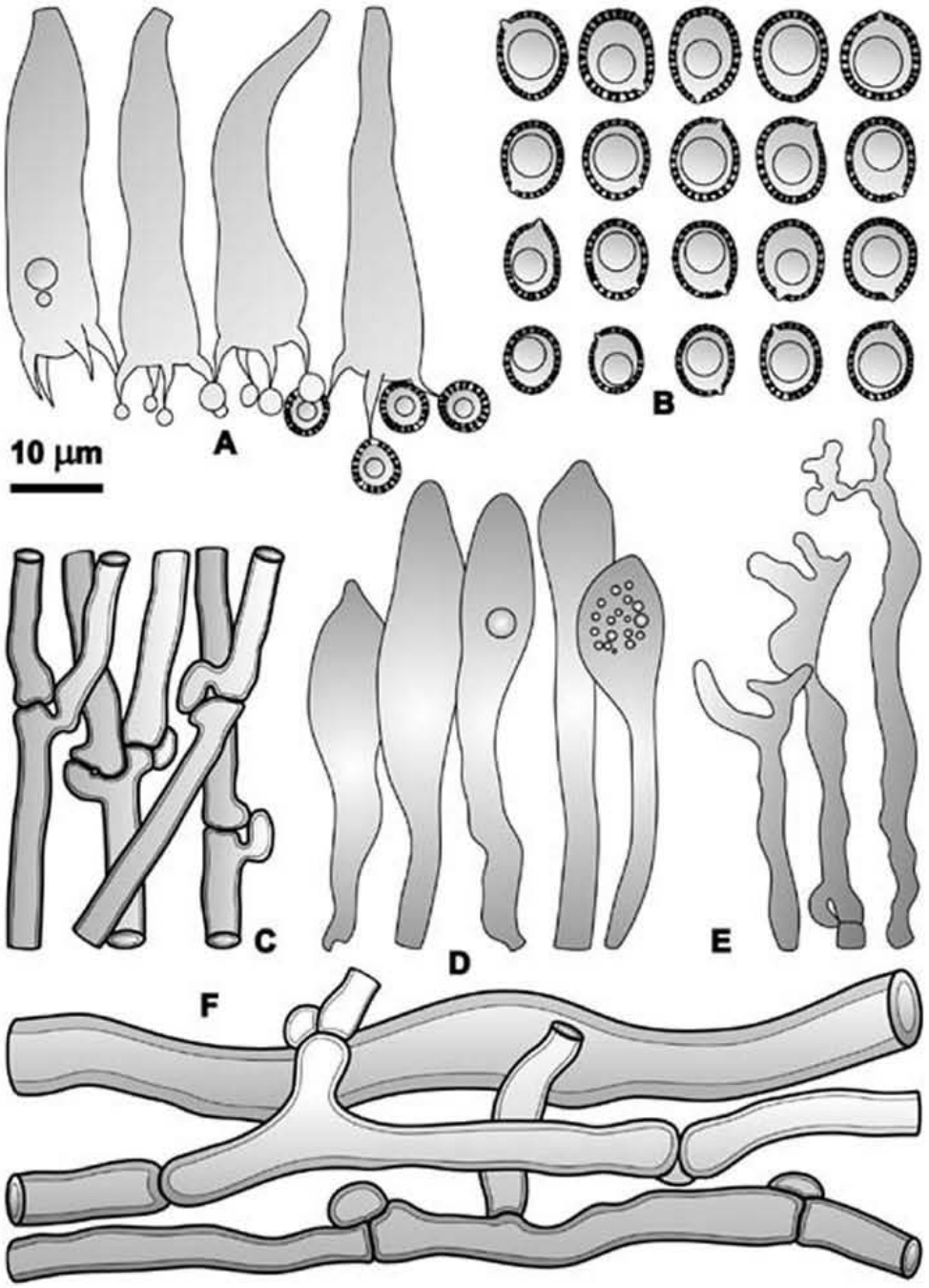


Fig. 1. *Amauroderma brasiliense*.
A. Basidia. B. Basidiospores. C. Generative hyphae from trama. D. Gloeocystidia. E. Dendrohyphidia. F. Generative hyphae from context.

lateral, more tomentose than the pileus, 34 × 15 mm, expanded towards the pileus. Hymenophore poroid to hydnoid, very pale brown (8/2–7/4 10YR) lighter than the pileus surface, extending up to a sterile marginal zone which contours the incurved margin with about 2 mm in width; pores sinuous to daedaloid at the hymenophore center, becoming intensely lacerate towards the margin, sometimes reduced to teeth or spines, (2–)3–7(–9)/cm, P = 5.27/cm, n = 45/2, usually larger; dissepiments entire to lacerate. Context conspicuous, up to 3 mm, homogeneous, white (8/1 10YR) to very pale brown (8/2–8/4 10YR), contrasting with the pileus surface, soft, almost fresh when dried, becoming hard when dried. Tube layer concolorous with the context, up to 12 mm thick, similar to the context, inseparable, soft, flexible.

Hyphal system monomitic to possibly dimitic with long and thick-walled contextual hyphae sometimes resembling skeletal hyphae, but with a basal clamp. Tramal generative hyphae clamped, thin- to slightly thick-walled, but rarely thick-walled, (1.6–)2–4.4(–5.2) µm in diam., D_m = 3.2, n = 155/3. Contextual generative hyphae (2.8–)3.6–9.2(–11.2) µm in diam., D_m = 6.3, n = 85/2, usually thick-walled and branched, with evident clamp connections. Gloeopleurous hyphae found in the context and trama, intensely staining in phloxine, content homogeneous, long, tortuous, variable in thick, branched, (2–)3.2–6.8(–8.4) µm in diam. in trama, D_m = 4.6, n = 48/1; (3.2–)4.4–17.6 (–20.8) µm in diam. in context, D_m = 8.7, n = 60/1.

Hymenium with basidia clavate, sometimes centrally constricted, (6.4–)24–60 (–96) × (6.4–)6.8–10(–13.6) µm, L_m x W_m = 40.9 × 8.62; Q_r = 1.56–11.43, Q_m = 4.88; n = 90/3, tetrasporic. Spores (5.6–)6–9.2(–10) × (4.4–)5.2–7.2(–8) µm (L_m x W_m = 7.5 × 6.24; Q_r = 1.03–1.62, Q_m =1.19; n = 136/2), subglobose to broadly-ellipsoid, hyaline, with exosporium being almost smooth under light microscopy, but verrucose under SEM. Gloeocystidia clavate to almost capitate with intensely staining content in phloxine, (28–)36.6–64(68.8) x (4.4–) 7.2–10(–14.4) µm, L_m x W_m = 44.5 × 8.74; Q= 2.56–8.91, Q_m = 5.23; n= 40/2, they were easily confounded with basidioles when weakly stained in phloxine.

Substrate: on decayed angiosperm wood, in subtropical forest.

Studied material: BRAZIL. Rio Grande do Sul State: Itaara, Parque Pinhal, leg. *V.G. Cortez & G. Coelho*, 19.V.2000, *G. Coelho 227–10* (ICN 139055); *ibid*, 22.V.2001, *G. Coelho 300–1*, (ICN 139056); *ibid*, 17.III.2002, *G. Coelho, G. Coelho 342–4* (ICN 139057).

Remarks: The studied basidiomes of *Amauroderma brasiliense* were fragile when fresh but tough when dried and possessed an elongate, tapering stipe. The hymenial surface is composed of variably large pores (2–)3–7(–9)/cm. The hyphal system is monomitic to possibly dimitic with the generative hyphae predominating. The subglobose to broadly ellipsoid spores measure 5.5–10 × 4.5–8 µm.

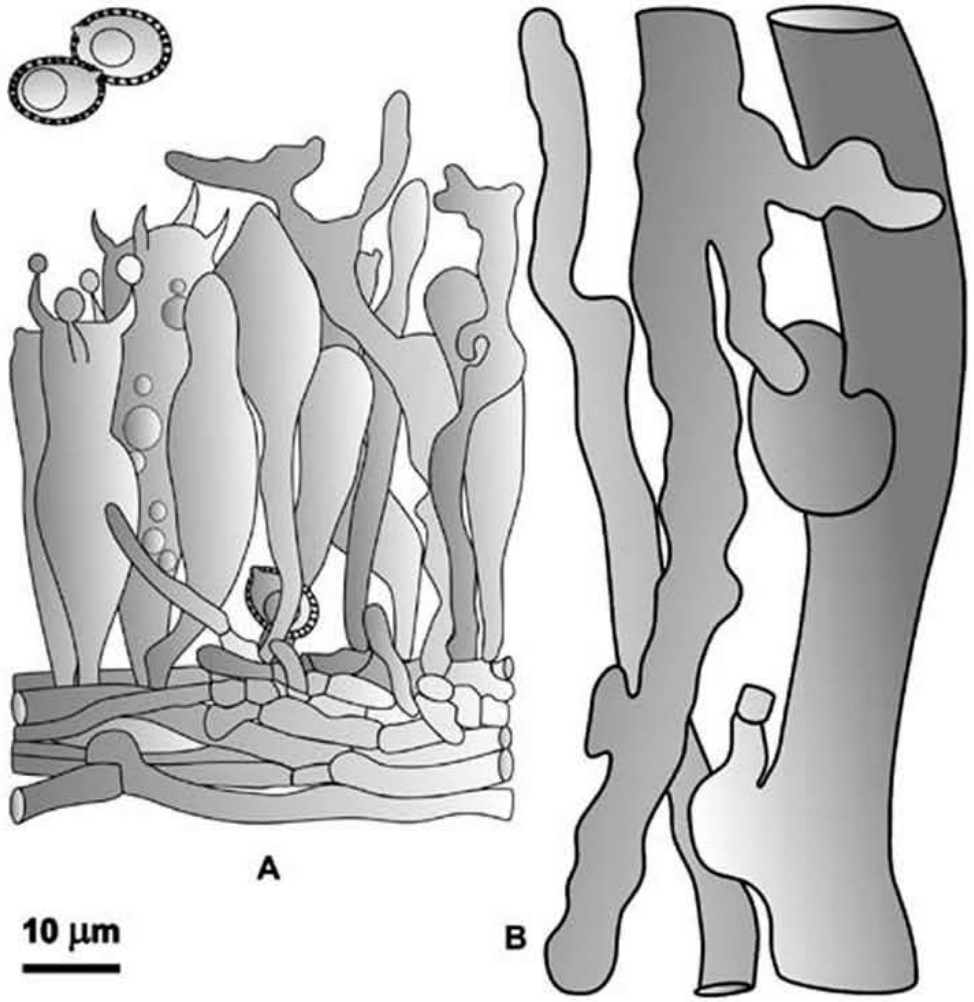
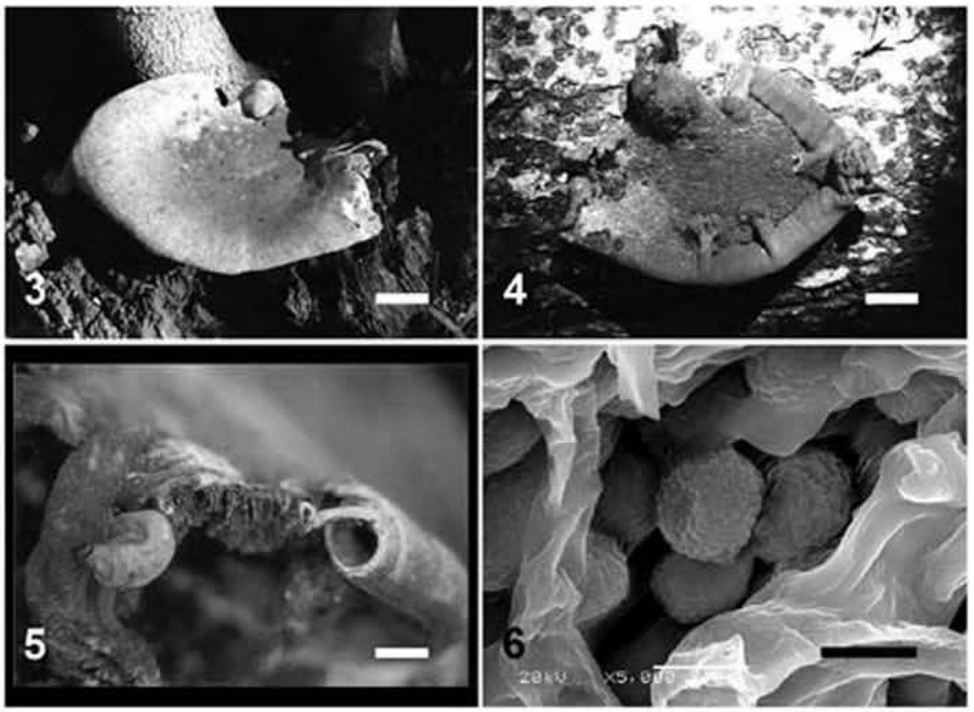


Fig. 2. *Amauroderma brasiliense*.
A. Detail of hymenium. B. Gloeopleurous hyphae from trama and context.

Structures observed in fresh basidiomes not previously reported for the species include dendrohyphidia and the presence of gloeopleurous hyphae in the context and trama. Hymenial gloeocystidia were also observed; these had not been mentioned in recent species descriptions (Gulaid & Ryvarden 1998) but had been clearly described by Singer et al. (1983) as ampullaceous cystidia, 33–53 × 10–11.3 µm. The finely asperulate basidiospore ornamentation seen in optical microscopy, a common character within the genus, is shown to be verrucose to almost rugose in SEM studies.

It must be noted that correct spelling of the species name is *A. brasiliense*, not *A. brasilensis*, as originally given in Ryvarden (2004). The name derives from the Latinized "*Brasilia*" and not the Portuguese "*Brasil*"; furthermore, the neuter



Figs. 3-6. *Amauroderma brasiliense.*
3-4. Upper (3) and lower (4) views of pileus on angiosperm decayed wood. Scale bar = 1 cm.
5. Side view of pileus near the lateral stipe showing context and tube layer. Scale bar = 0.5 cm.
6. SEM of the basidiospores. Scale bar = 8 µm (5000 x, 20 kV).

termination *-ense* is required so that the species epithet agrees with the neuter genus, *Amauroderma.*

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Literature cited

Aime MC, Henkel TW, Ryvarden L. 2003, Studies in Neotropical polypores 15: new and interesting species from Guyana. Mycologia 95: 614-619.

Furtado JS. 1981. Taxonomy of *Amauroderma* (*Basidiomycetes, Polyporaceae*). Memoirs of the New York Botanical Garden 34: 1-109.

Groposo C, Loguercio-Leite C. 2005. Contribution to the lignocellulolytic fungi (*Basidiomycetes*) of the Atlantic Rain Forest in Southern Brazil. Mycotaxon 92: 103-106.

Gulaid H, Ryvarden L. 1998 Two new species of *Amauroderma* (*Ganodermataceae*, *Basidiomycetes*). Mycologia Helvetica 10: 25-30.

Holmgren PK, Holmgren NH. 1998. Index Herbariorum. New York Botanical Garden. Available at: http://sciweb.nybg.org/science2/IndexHerbariorum.asp.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed. Wallingford (UK): CABI.

Munsell. 1994. Munsell Soil Color Charts. Macbeth (USA): Munsell Co.

Núñez M, Ryvarden L. 2003. East Asian Polypores. Oslo (Norway): Fungiflora.

Rambo B. 1956. A Fisionomia do Rio Grande do Sul. 3 ed. São Leopoldo (Brazil): Ed. Unisinos.

Ryvarden L. 2004. Neotropical Polypores. Vol. 1. Oslo (Norway): Fungiflora.

Ryvarden L, de Meijer AAR. 2002. Studies in Neotropical polypores 14: new species from the State of Paraná, Brazil. Synopsis Fungorum 15: 34-69.

Ryvarden L, Iturriaga T. 2004. Studies in Neotropical polypores 21: new and interesting species from Venezuela. Synopsis Fungorum 18: 68-75.

Singer R, Araujo I, Ivory MH. 1983. The ectotrophically mycorrhizal fungi of the neotropical lowlands, especially central Amazonia. Nova Hedwigia, Beih. 77: 1-352.

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Aphyllophoraceous wood-inhabiting fungi on *Abies alba* in Italy

ANNAROSA BERNICCHIA[1], ELENA SAVINO[2] & SERGIO PÉREZ GORJÓN[3]

[1]*annarosa.bernicchia@unibo.it* [2]*esavino@et.unipv.it* [3]*spgorjon@usal.es*

[1]*Dipartimento di Scienze e Tecnologie Agroambientali*
Patologia Vegetale Università degli Studi di Bologna
Via Fanin 42, 40127 Bologna Italy

[2]*Dipartimento di Ecologia del Territorio (DET), Università di Pavia*
Via S. Epifanio 14, 27100 Pavia Italy

[3]*Departamento de Botánica & Centro Hispano-Luso de Investigaciones Agrarias*
Universidad de Salamanca
Ldo. Méndez Nieto s/n, 37007 Salamanca Spain

Abstract — 190 species representing 101 genera of aphyllophoraceous fungi growing on *Abies alba* in Italy are listed. *Ceriporia aurantiocarnescens* is reported as new to Italy. *Fomitopsis labyrinthica* has previously been described as a new species from this substrate, while many species identified are considered rare in Italy. The complete annotated specimen list is available on

http://www.mycotaxon.com/resources/weblist.html.

Key words — lignicolous fungi, diversity, coniferous forests

Introduction

In parallel with previous reports on Italian lignicolous fungi (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006), we have compiled a list of aphyllophoraceous fungi growing on Silver Fir (*Abies alba* Mill.) in Italy. The full area covered (Figure 1) extends from the montane forests of Central Europe from the Pyrenees and adjacent mountains in northern Spain, east and south through the Italian Alps and Apennines, and east into Macedonia and the lowland forests of western France and eastern Poland (see also Chater 1964).

The two *Abies* species in Italy are *A. nebrodensis*, restricted to the Madonie Mountains of Sicily, and *A. alba*, extending from the Alps and Apennines to the north to Aspromonte in the south. *A. alba* has suffered a recent decline due to natural and/or anthropogenic causes (Bernetti 1998). Italy has a typically

Figure 1. Approximate distribution of *Abies alba* in Europe

Mediterranean climate except for the Continental and highest zones in the interior with lower temperatures where coniferous forests of *Abies, Larix, Picea* and *Pinus* are common. *A. alba* is about as resistant to low winter temperatures as *Picea* and its other climatic requirements generally resemble those of *Fagus sylvatica* and *Picea abies,* but *A. alba* requires higher summer temperatures to ripen the seeds, is more tolerant to spring frosts, and avoids areas with high humidity.

Materials and methods

During the last 25 years, fungi have been collected in the most representative regions of Italy where *A. alba* is present: Basilicata, Calabria, Emilia-Romagna, Friuli Venezia Giuila, Piemonte, Toscana, Trentino-Alto Adige, Valle d'Aosta and Veneto. Samples were taken to the laboratory for microscopical examination and identification following Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Kõljalg (1995), Ryvarden & Gilbertson (1993, 1994) and Bernicchia (2005). All the specimens are kept in Herbarium HUBO. The list is partially referred to Bernicchia (1995, 2001), Onofri (2005) and the nomenclature to Donk (1984), Parmasto (1997), Hjortstam (1998), Kirk et al. (2001) and CBS (2007). A list and map of the 26 collection localities are included in the annotated specimen list posted on http://www.mycotaxon.com/resources/weblist.html.

Results

Our survey of 536 specimens collected on *Abies alba* represents 190 species and 101 different genera of aphyllophoraceous wood-inhabiting fungi. Of these, *Ceriporia aurantiocarnescens* (Henning) M. Pieri & B. Rivoire is new to Italy. Especially rare or uncommon species include *Amphinema diadema* K.H. Larss. & Hjortstam, *Antrodia alpina* (Litsch.) Gilb. & Ryvarden, *Antrodiella parasitica* Vampola, *Flavophlebia sulfureoisabellina* (Litsch.) K.H. Larss. & Hjortstam, *Coronicium gemmiferum* (Bourdot & Galzin) J. Erikss. & Ryvarden, *Cystostereum murrayi* (Berk. & M.A. Curtis) Pouzar, *Dentipellis fragilis* (Pers.) Donk, *Fomitopsis labyrinthica* Bernicchia & Ryvarden, *Galzinia incrustans* (Höhn. & Litsch.) Parmasto, *Lobulicium occultum* K.H. Larss. & Hjortstam, *Metulodontia nivea* (P. Karst.) Parmasto, *Oligoporus cerifluus* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *O. lowei* (Pilát ex Pilát) Gilb. & Ryvarden, *O. simani* (Pilát) Bernicchia, *Paullicorticium pearsonii* (Bourdot) J. Erikss., *Phlebia georgica* Parmasto, *P. queletii* (Bourdot & Galzin) M.P. Christ., *Pycnoporellus fulgens* (Fr.) Donk, *Repetobasidium mirificum* J. Erikss. and *Tylospora asterophora* (Bonord.) Donk.

While many of these species can grow on other substrata, some of them typically fruit on *Abies*, such as *Bondarzewia montana* (Quél.) Singer, *Ganoderma carnosum* Pat., *Hymenochaete cruenta* (Pers.) Donk, *Phellinus hartigii* (Allesch. & Schnabl) Pat., and *Podofomes trogii* (Fr.) Pouzar. Species typical of deciduous substrata found also growing on *Abies* include *Abortiporus biennis* (Bull.) Singer, *Hapalopilus nidulans* (Fr.) P. Karst., *Inonotus dryadeus* (Pers.) Murrill, *Oligoporus tephroleucus* (Fr.) Gilb. & Ryvarden, *Polyporus badius* (Pers.) Schwein., *Trametes hirsuta* (Wulfen) Pilát, and *Trametes pubescens* (Schumach.) Pilát.

Conclusions

The numbers of wood-inhabiting fungi (190) identified from *Abies alba* substrata in Italy are higher than those from other substrata researched thus far: 126 species on *Castanea sativa* (Mayrhofer et al. 2001), 105 species on *Juniperus* spp. (Bernicchia 2000) and 52 species on *Arbutus unedo* (Pérez Gorjón et al. 2006). This could be partly due to the greater abundance of Silver Fir forests compared with forests of the other species mentioned. Some areas (such as the Reserve of "Sasso Fratino") that harbour a high number of rare fungal species are potential candidates for biodiversity conservation.

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Literature cited

Bernicchia A. 1995. *Aphyllophorales* della Riserva Naturale Integrale di Sasso Fratino (Forlì), Italia. Primo contributo. Gior. Bot. It. 129: 837-857.

Bernicchia A. 2000. Wood-inhabiting aphyllophoraceous fungi on *Juniperus* spp. in Italy. Mycotaxon 75: 241-256.

Bernicchia A. 2001. A checklist of Corticioid, Polyporoid and Clavarioid fungi (*Basidiomycetes*) from the Emilia-Romagna region, Italy. Sydowia 53(1): 1-33.

Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europaei, 10. Ed. Candusso. Alassio. Italy.

Bernetti G. 1998. Selvicoltura speciale. UTET Torino. Italy.

Burdsall HH. 1985. A Contribution to the Taxonomy of the Genus *Phanerochaete* (*Corticiaceae*, *Aphyllophorales*). Mycol. Mem. No. 10, Cramer, Germany.

CBS. 2007. Aphyllophorales database. www.cbs.knaw.nl/databases/index.htm.

Chater AO. 1964. *Abies* Miller, in Flora Europaea. Vol 1: 29-30. Cambridge: Cambridge University Press.

Donk MA. 1984. Check list of European polypores. North. Holland Publ. Comp. Amsterdam. The Netherlands.

Eriksson J, Ryvarden L. 1973-1975-1976. The *Corticiaceae* of North Europe. Vols. 2-3-4. Fungiflora, Oslo, Norway.

Eriksson J, Hjortstam K, Ryvarden L. 1978-1981-1984. The *Corticiaceae* of North Europe. Vols. 5-6-7. Fungiflora, Oslo, Norway.

Hjortstam K. 1998. A checklist to genera and species of corticioid fungi (*Basidiomycotina*, *Aphyllophorales*). Windahlia 23: 1-54.

Hjortstam K, Larsson KH, Ryvarden L. 1988. The *Corticiaceae* of North Europe. Vol. 8. Fungiflora, Oslo, Norway.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th edition. CABI Publishing, Oxon, U.K.

Kõljalg U. 1995. *Tomentella* (*Basidiomycota*) and related general in Temperate Eurasia. Synopsis fungorum 9: 1-213.

Mayrhofer S, Peintner U, Bernicchia A. 2001. Wood-inhabiting aphyllophoraceous fungi on *Castanea sativa* in Italy. Mycotaxon 80: 267-280.

Onofri S. (coord.). 2005. Checklist of Italian fungi. Carlo Delfino editore.

Parmasto E. 1997. CORTBASE – a nomenclatural taxa base of corticioid fungi (Hymenomycetes). Mycotaxon 61: 467-471.

Pérez Gorjón S, Bernicchia A, Baptista Gibertoni T. 2006. Aphyllophoraceous wood-inhabiting fungi on *Arbutus unedo* in Italy. Mycotaxon 98: 159-162.

Ryvarden L, Gilbertson, RL. 1993-1994. European Polypores. Vols. 1-2. Fungiflora, Oslo, Norway.

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A new species of *Phaeoramularia* on *Ranunculaceae*

FENG-YAN ZHAI [1] YING-LAN GUO [2] YU LI [1*]

[1] *fengyan780103@163.com* [1*] *yuli966@126.com*
Jilin Agricultural University
Changchun 130118, China

[2] *guoyl@sun.im.ac.cn*
Institute of Microbiology, Chinese Academy of Science
Beijing 100101, China

Abstract—A new species, *Phaeoramularia delphinii* on *Delphinium* sp. of *Ranunculaceae* is reported. Latin diagnosis, illustration and English description of the new species are provided. Distinctions between the new taxon and its closely related species: *P. clematidis*, *P. lomaensis*, and *P. sudanensis* are discussed. The type and isotype specimens are deposited in HMAS and HMJAU.

Key words—imperfect fungi, taxonomy

Introduction

Recently we found a fungus on *Delphinium* specimens collected from Inner Mongolia. Its multiseptate, ellipsoid to cylindrical, catenate conidia produced in chains on fasciculate conidiophores that emerged through stomata from substomatal stromata, and other characters, indicated that it belonged in the genus *Phaeoramularia*. We compared it with all the other *Phaeoramularia* species reported on *Ranunculaceae*, and found it was distinctly different from them. So we identified it a new *Phaeoramularia* species and describe it here.

Taxonomy

Phaeoramularia delphinii F.Y. Zhai, Y.L. Guo & Yu Li, **sp. nov.** Fig.1
MycoBank MB510634

Maculae amphigenae, ellipsoideae, subellipsoideae vel irregulares, 3.0–10.0 mm diam., primo griseo-aterae irregulatin discoloratae, demum centro olivaceae vel luteo-brunneae, margine atro-brunneae, extus haloratis pallide luteo-brunneis vel atro-brunneis. Caespituli amphigeni. Mycelium immersum. Stromata substomata, bene evoluta, subglobosa, luteo-brunnea, 18.0–79.0 µm diam. Conidiophora emergena per stomata, laxe vel dense

*Corresponding author

fasciculata, olivacea vel moderate olivaceo-brunnea, laevia, non ramosa, erecta vel leviter curvata, 1–4-geniculata, ad apicem conico-truncata, 0–1-septata, 26.0–69.0×2.5–5.0 μm. Cicatrices conspicue, incrassatae, 1.0–2.5 μm latae. Conidia ellipsoidea vel cylindrica, olivacea vel moderate olivaceo-brunnea, catenata, laevia, erecta, ad apicem conico-truncate, ad basin obconico-truncata, 0–3-septata, imprimis 0–1-septata, interdum constricta, 12.0–37.0×3.5–8.0 μm.

Leaf spots amphigenous, elliptical, subelliptical or irregular, 3.0–10.0 mm diam., at first in irregularly grayish black discolored patches, later center olivaceous to yellowish brown, margin dark brown, with a pale yellowish brown to dark brown halo on the upper surface, paler on the lower surface. Fruiting amphigenous. Mycelium immersed. Stromata substomatal, well-developed, subglobose, yellowish brown, 18.0–79.0 μm diam. Conidiophores emerging through stomata, loosely to densely fasciculate (up to about 80 in a large fascicle), olivaceous to moderate olivaceous brown, olivaceous brown when in cluster, paler towards the apex, smooth, not branched, straight to slightly curved, 1–4-geniculate, regular or irregular in width, conically truncate at the apex, 0–1-septate, 26.0–69.0×2.5–5.0 μm. Conidial scars conspicuously thickened, 1.0–2.5 μm wide. Conidia ellipsoid to cylindrical, olivaceous to moderate olivaceous brown, catenate and often in branched chains, smooth, straight, conically truncate at the apex, obconically truncate at the base, 0–3-septate, mostly 0–1-septate, sometimes constricted, 12.0–37.0×3.5–8.0 μm.

On leaves of *Delphinium* sp. (*Ranunculaceae*), Arxan, Inner Mongolia, 9 VIII 1991, coll. Y. L. Guo, no. 1533 (HMAS 143918, holotype; HMJAU 30003, isotype); no.1667 (HMAS 143919).

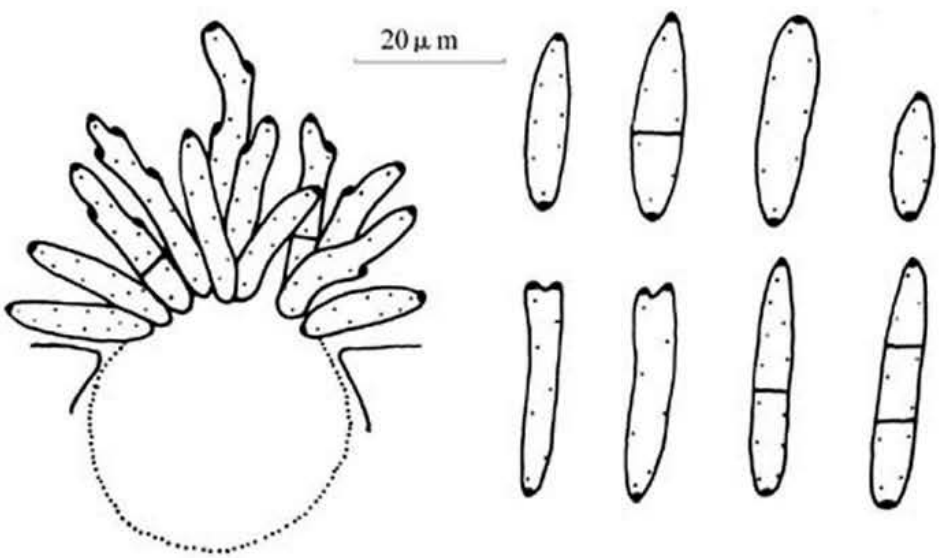

Fig. 1 *Phaeoramularia delphinii*
Conidiophores and conidia (HMAS 143918)

Table 1 Comparisons among four related *Phaeoramularia* species

Items \ Species		*P. delphinii*	*P. clematidis*	*P. lomaensis*	*P. sudanensis*
Leaf spots		+	+	–	–
Fruiting		amphigenous	hypogenous	hypogenous	hypogenous
Conidiophores	fascicle	~ 80	5–8	~ 12	~ 12
	color	olivaceous to moderate olivaceous brown	pale olivaceous brown to pale brown	moderate olivaceous	moderate olivaceous
	length	26.0–69.0	20.0–48.5	≤ 200.0	≤ 175.0
	width	2.5–5.0	2.0–4.0	4.0–6.0	4.0–5.0
Conidial scars		1.0–2.5	1.0	1.5	1.5–2.0
	color	olivaceous to moderate olivaceous brown	subhyaline to very pale brown	moderate olivaceous	pale olivaceous
Conidia					
	septa	0–3 (mostly 0–1)	1–2	0–5 (mostly 1–3)	1–5
	length	12.0–37.0	14.0–38.0	17.0–74.0	16.0–78.0
	width	3.5–8.0	2.5–5.0	4.0–6.5	4.0–6.5

Comments: Crous & Braun (2003) reduced *Phaeoramularia* to synonymy with *Passalora*, which mainly differs from *Phaeoramularia* by forming solitary conidia. Crous & Braun claimed that amongst cercosporoid hyphomycetes the formation of single or catenate conidia was not tenable as a distinguishing character at generic rank, noting that this was supported by results from ITS and 5.8S rDNA sequence analysis (Crous et al. 2001). However, we wish to emphasize morphological characteristics and believe that the mode of conidia formation, singly or in chains, is a major characteristic delimiting cercosporoid hyphomycetes, including *Phaeoramularia* and *Passalora*. We therefore maintain *Phaeoramularia* as a separate genus in this paper.

Three other Phaeoramularia species also occur on *Ranunculaceae*: *P. clematidis* S. K. Singh & R. K. Chaudhary (Singh et al. 1995), *P. lomaensis* Deighton (Deighton 1979), and *P. sudanensis* Deighton (Deighton 1979). All three species, however, are associated with *Clematis*, not *Delphinium*.

Phaeoramularia clematidis (found on *Clematis gouriana* Roxb.) exhibits hypogenous fruiting, bears 5–8 conidiophores in a fascicle that are darker, shorter and narrower and bear smaller conidial scars, and produces conidia that are mostly solitary, occasionally catenate, or (more rarely) branched, subcylindrical, paler, 1–2-septate, and narrower.

P. lomaensis and *P. sudanensis* (also on *Clematis* spp.) do not form leaf spots, exhibit hypogenous fruiting, bear ~12 conidiophores per fascicle that are paler, usually branched, rarely simple, sinuous or geniculate, and longer, and produce conidia that are paler, more septate, longer, and narrower. In addition *P. sudanensis* lacks a stroma and produces curved or sometimes slightly sigmoid conidia.

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Literature cited

Crous PW, Braun U. 2003. *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*. CBS Biodiversity Series vol.1: 19-22

Crous PW, Kang JC, Braun U. 2001. A phylogenetic redefinition of anamorph genera in *Mycosphaerella* based on ITS rDNA sequence and morphology. Mycologia. 93(6): 1081-1101.

Singh SK, Chaudhary RK, Morgan-Jones G. 1995. Notes on Hyphomycetes. LXVII. Three new species of *Phaeoramularia* from Nepal. Mycotaxon 54: 57-66

Deighton FC. 1979. Studies on *Cercospora* and allied genera. VII. New species and redispositions. Mycol. pap. No. 144: 32-45

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Two new species of *Agaricus* from the Subantarctic

JÓZSEF GEML[1]*, GARY A. LAURSEN[1], HARRIS C. NUSBAUM[2] & D. LEE TAYLOR[1]

**jgeml@iab.alaska.edu*

[1]*Institute of Arctic Biology, University of Alaska Fairbanks Fairbanks, Alaska 99775-7000, U.S.A.*

[2]*Sequence and Analysis Program, Broad Institute Cambridge, MA 02141, U.S.A.*

Abstract—Molecular and morphological data are presented for three *Agaricus* species on Campbell Island, New Zealand. Two of these are new species, *A. campbellensis* and *A. subantarcticus*. The third may be conspecific with *A. subrutilescens*, although the molecular data suggest a lack of gene flow between subantarctic and North American populations. Alternatively, it could be a closely related, but undescribed species. This is the first report of the *Subrutilescens* group from the Southern Hemisphere.

Key words— *Basidiomycota*, fungi, ITS, LSU, phylogenetics

Introduction

Agaricus L. is a diverse, cosmopolitan genus with an estimated 300 species worldwide (Cappelli 1984, Bas 1991). Recently, efforts have been made to reconstruct the evolutionary history of the genus from molecular data (Bunyard et al. 1996, Mitchell & Bresinsky 1999, Robison et al. 2001, Challen et al. 2003, Geml 2004, Geml et al. 2004) and to detect and describe new species using molecular and morphological data (Callac & Guinberteau 2005, Kerrigan 2005). Studies to date mostly have included European and North American taxa while those in the subantarctic regions remain largely unknown. Mitchell & Walter (1999) provided a taxonomic key to all known *Agaricus* species in New Zealand. Here we provide molecular phylogenetic analyses to reveal the evolutionary history of three *Agaricus* species from Campbell Island in the Subantarctic and use molecular and morphological data to describe two of these as new species.

Campbell Island (S 52° 33', E 169° 10') is located c. 300 km from the nearest land (Auckland Islands) and c. 650 km south of the main islands of New Zealand. Basement rocks of the island are composed of schist (dating from

640 Ma), Cretaceous sandstone, Tertiary limestone, and more recent volcanic flows. Deep peat is found in flat and gently sloping areas, while mineral content of the soil is more pronounced on steeper slopes (Campbell 1981, Foggo & Meurk 1983). Vegetation is predominantly tussock grassland, shrubland and herbfield divided into upper alpine, lower alpine, and subalpine zones (Meurk 1977). *Agaricus* collections were made in the shrubland to upper alpine zones characterized by dwarf forests of *Dracophyllum scoparium* and *D. longifolium*, with *Coprosma* and *Myrsine* species (Figs. 1, 2).

Methods and materials

Thirteen specimens were collected from the subantarctic Campbell Island (Table 1). Voucher specimens are deposited in the University of Alaska Fairbanks Herbarium (ALA) and in the New Zealand Fungal Herbarium (PDD). DNA was extracted from small samples of dried specimens using the E-Z 96® Fungal DNA Kit (Omega Bio-tek, Inc., Doraville, GA). ITS and LSU sequences of an additional thirty *Agaricus* species, representing the known diversity of the genus, were downloaded from GenBank (Table 1.). Homologous sequences of *Chlorophyllum molybdites* (U85309, U85303) were used to root all trees.

Table 1. Specimen code and GenBank accession numbers of *Agaricus* spp. included in this study.

Species	Collection number	GenBank accession number		Origin, reference
		ITS	LSU	
A. campbellensis	GAL9379	DQ232638	DQ232651	Campbell Island, New Zealand
	GAL9420	DQ232644	DQ232657	Campbell Island, New Zealand
	GAL9573	DQ232640	DQ232653	Campbell Island, New Zealand
	GAL9603	DQ232639	DQ232652	Campbell Island, New Zealand
	GAL9633	DQ232641	DQ232654	Campbell Island, New Zealand
	GAL9605	DQ232645	DQ232658	Campbell Island, New Zealand
	GAL9649	DQ232646	DQ232659	Campbell Island, New Zealand
A. subantarcticus	GAL9604	DQ232637	DQ232650	Campbell Island, New Zealand
	GAL9419	DQ232642	DQ232655	Campbell Island, New Zealand
	GAL9425	DQ232647	DQ232660	Campbell Island, New Zealand
	GAL9418	DQ232648	DQ232661	Campbell Island, New Zealand
	GAL9572	DQ232643	DQ232656	Campbell Island, New Zealand
A. cf. *subrutilescens*	GAL9422	DQ232649	DQ232662	Campbell Island, New Zealand
A. abruptibulbus Peck	-	AY484673	AY484673	Geml et al. (2004)
A. albolutescens Zeller	-	AY484675	AY484675	Geml et al. (2004)
A. arvensis Schaeff.	-	AY484691	AY484691	Geml et al. (2004)
A. augustus Fr.	-	AY484672	AY484672	Geml et al. (2004)

Figs. 1-2. Characteristic vegetation of the subalpine zone of Campbell Island: *Dracophyllum scoparium* and *D. longifolium* (shrub), *Poa litorosa* (tussock grass), *Polystichum vestitum* and *Histiopteris incisa* (ferns).

Table 1, concluded

Species	Collection number	GenBank accession number		Origin, reference
		ITS	LSU	
A. bernardii (Quél.) Sacc.	-	AY484678	AY484678	Geml et al. (2004)
A. bisporus (J.E. Lange) Imbach	-	AY484692	AY484692	Geml et al. (2004)
A. bitorquis (Quél.) Sacc.	-	AY484695	AY484695	Geml et al. (2004)
A. blazei Murrill	-	AY484697	AY484697	Geml et al. (2004)
A. californicus Peck	-	AY484679	AY484679	Geml et al. (2004)
A. campestris L.	-	U85307	U85273	Johnson & Vilgalys (1999)
A. cupreobrunneus (Jul. Schaeff. & Steer) Pilát	-	AY484680	AY484680	Geml et al. (2004)
A. devoniensis P.D. Orton	-	AJ418755	AF059225	Challen et al. (2003), Mitchell & Bresinsky (1999)
A. diminutivus Peck	-	AY484681	AY484681	Geml et al. (2004)
A. excellens (F.H. Møller) F.H. Møller	-	AY484682	AY484682	Geml et al. (2004)
A. fissuratus (F.H. Møller) F.H. Møller	-	AY484683	AY484683	Geml et al. (2004)
A. fuscofibrillosus (F.H. Møller) Pilát	-	AY484684	AY484684	Geml et al. (2004)
A. fuscovelatus Kerrigan	-	AY484677	AY484677	Geml et al. (2004)
A. hondensis Murrill	-	AY484685	AY484685	Geml et al. (2004)
A. inapertus Vellinga	-	AF482834	AF482878	Vellinga et al. (2003)
A. langei (F.H. Møller) F.H. Møller	-	AY484699	AY484699	Geml et al. (2004)
A. lilaceps Zeller	-	AY484676	AY484676	Geml et al. (2004)
A. macrocarpus (F.H. Møller) F.H. Møller	-	AY484686	AY484686	Geml et al. (2004)
A. macrosporus (F.H. Møller & Jul. Schäff.) Pilát	-	AY484687	AY484687	Geml et al. (2004)
A. nivescens (F.H. Møller) F.H. Møller	-	AY484670	AY484670	Geml et al. (2004)
A. pocillator Murrill	-	AF041542	U85308	Hopple & Vilgalys (1999, Johnson & Vilgalys (1999)
A. semotus Fr.	-	AJ133390	AF059224	Challen et al. (2003), Mitchell & Bresinsky (1999)
A. subfloccosus (J.E. Lange) Hlaváček	-	AY484698	AY484698	Geml et al. (2004)
A. subperonatus (J.E. Lange) Singer	-	AF432889	AF059216	Challen et al. (2003), Mitchell & Bresinsky (1999)
A. subrutilescens (Kauffman) Hotson & D.E. Stuntz	-	AY484688	AY484688	Geml et al. (2004)
A. xanthoderma Genev.	-	AY484689	AY484689	Geml et al. (2004)

Table 2. Selected characteristics of subantarctic *Agaricus* spp. included in this study.

Species	UAF/ALA Collection	Spore dimensions (µm)		Spore shape	Schaeffer reaction	KOH reaction	Color change	Pileus	Stipe length × diameter (cm)	
	number	length	width	Q-value			context	(cm)		
A. campbellensis	GAL9379	8.74 ±0.79	4.26 ±0.25	1.93 ±0.14	+	yellow	yellow, tan	3.5-4.0	4.0-5.5 × 0.8	almond
	GAL9420	7.06 ±0.49	4.29 ±0.34	1.69 ±0.22	+	yellow	yellow	3.0-5.0	4.0-6.0 × 0.8-1.1	almond
	GAL9573	7.04 ±0.66	4.48 ±0.41	1.56 ±0.17	+	yellow	N/A	N/A	N/A	N/A
A. subantarcticus	GAL9604	8.16 ±0.64	4.86 ±0.45	1.75 ±0.22	+	yellow	N/A	N/A	N/A	N/A
	GAL9419	7.78 ±1.31	4.83 ±0.28	1.68 ±0.15	+	yellow	yellow	4.0-13.0	4.0-9.0 × 0.8-3.5	almond
	GAL9425	7.72 ±1.25	4.80 ±0.41	1.53 ±0.32	+	yellow	yellow	7.0-8.0	4.0 × 1.5-2.0	almond
A. cf. *subrutilescens*	GAL9422	4.98 ±0.69	3.21 ±0.25	1.51 ±0.19	-	olive green	none	6.0	6.0 × 0.9-1.5	sweet, nutty

Symbols: + = present or positive, - = absent or negative, N/A = no data.

Spore dimensions and shape are given as mean ± standard deviation, based on twenty-five measurements per specimen.

The entire ITS and partial LSU regions were PCR amplified in reaction mixtures containing 1.75µl Ultrapure Water (Invitrogen), 1µl 10x Herculase PCR buffer (Stratagene), 0.05µl 100mM dNTP mixture, 25mM of each dNTP (Applied Biosystems), 0.2µl Herculase DNA polymerase (Stratagene), 2 µl of 1µM forward primer, ITS1F (Gardes & Bruns 1993) and reverse primer, TW13 (White et al. 1990), and 3µl of template DNA at a concentration of 0.1ng/ µl. PCR reactions were performed using the following temperature program: 95 °C/2 min, 34 cycles of 95 °C/0.5 min, 54 °C/1 min, 72 °C/2 min; and 72 °C/10 min. The concentration of the amplification products was determined using Picogreen (Molecular Probes). The amplification products were normalized to a concentration of 4ng/µl and sequenced using the Applied Biosystems (ABI) BigDye v. 3.1 terminator kit and an ABI 3730xl automated capillary DNA sequencer (Applied Biosystems, Foster City, CA). We used two internal primers for cycle sequencing, ITS4 and CTB6 (White et al. 1990), in addition to the primers used in the PCR reactions.

Sequence data obtained for both strands of each locus were edited and assembled for each isolate using Aligner v. 1.3.4 (CodonCode Corporation, Dedham, MA). Sequence alignments were initiated using Clustal W (Higgins et al. 1991) and subsequently corrected manually. Ambiguously aligned positions were recoded using INAASE 2.3b (Lutzoni et al. 2000) to retain the phylogenetic information present in the region without violating positional homology. The code matrix was attached to the alignment and was included in MP analyses. Phylogenetic analyses were conducted using the maximum-parsimony (MP) method in PAUP* 4b10 (Swofford 2002). MP analyses were carried out with the heuristic search option using the "tree bisection and reconnection" (TBR) algorithm with 100 random sequence additions to find the global optimum without limiting the maximum number of trees. Gaps were scored as "new state". The stability of clades was tested using the bootstrap test (Felsenstein 1985) with "full heuristic search" and 500 replications.

Fresh collections were described, photographed, and dried for later microscopic study. Specimens from three collections of each species were chosen for study. The ISCC-NBS Dictionary of Color Names was used to describe all combinations of basidiome color. Twenty-five basidiospores were measured from each specimen. Basidiospores, cheilocystidia and basidia were measured in 5% KOH using a 100× objective. Numerical data were analyzed by one-way analysis of variance (ANOVA) using JMP 3.2.6 (SAS Institute Inc.). Where the null-hypothesis was rejected, that all means were the same, Student's t-test (Ott 1993) was used to detect significant differences by testing each pair of means. Two chemical tests were performed on the pileus: the Schaeffer-reaction (using aniline and nitric acid) and the KOH-reaction. The Schaeffer-reaction was considered positive when the intersection of the two reagents became bright

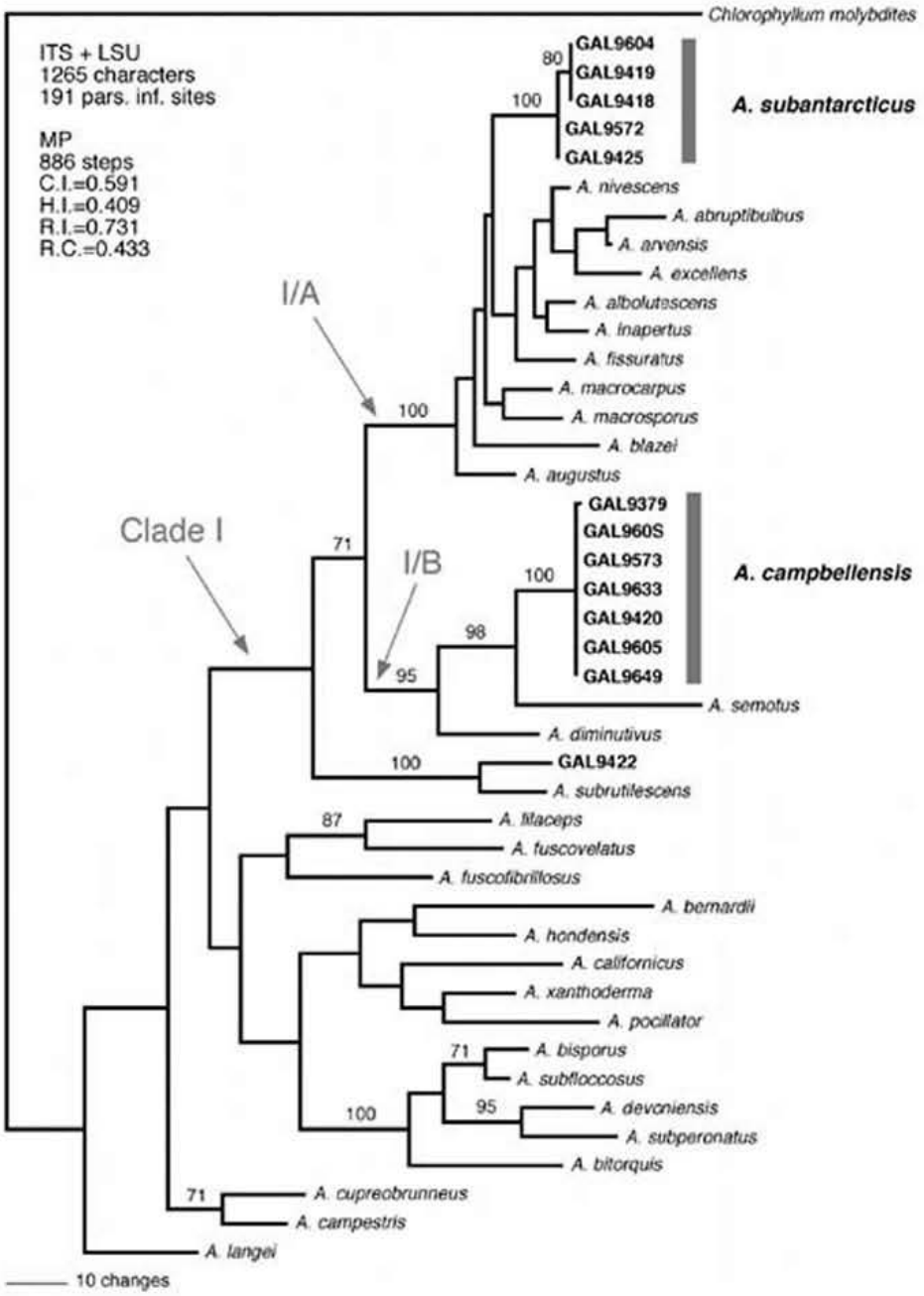

Fig. 3. Phylogram of *Agaricus* species based on maximum parsimony analyses of the combined (ITS, LSU) dataset. Bootstrap values are shown above the branches. Subantarctic isolates are in bold.

orange or red, while the KOH reaction was positive when yellow or green color was observed in the area of contact on the pileus surface.

Results

The combined ITS+LSU datasets of the 33 taxa consisted of 1414 characters, including gaps. Of these, 155 characters were excluded, containing ambiguous positions (235-239, 326-330, 558-568, 585-601, 719-731, 735-739) and incomplete data on both ends (1-44, 1360-1414). After including the character matrices of the ambiguous regions recoded by INAASE, the final alignment consisted of 1265 characters. The number of parsimony-informative sites was 191. One of the 3 most parsimonious trees is shown with bootstrap values in Fig. 3. The subantartic specimens grouped in three species clades, all within Clade I (Geml et al. 2004) that corresponds to section *Arvenses* (Heinemann 1977). One specimen (GAL9422) formed a well-supported (100%) monophyletic clade with an *A. subrutilescens* specimen from North America. Seven specimens (GAL9379, GAL9420, GAL9573, GAL9603, GAL9605, GAL9633, GAL9649) had virtually identical ITS and LSU sequences and formed a new species clade, *A. campbellensis* with 100% bootstrap support. This species clade formed a sister clade to *A. semotus* in clade I/B (Geml et al. 2004) corresponding to subsection *Minores* (Heinemann 1977). The third species clade, *A. subantarcticus*, included five collections (GAL9418, GAL9419, GAL9425, GAL9572, GAL9604) and also received 100% support. Although confidently placed in Clade I/A with species of subsection *Arvenses* (Heinemann 1977), the closest relatives of this species could not be specified with statistical support.

Selected morphological characteristics of the three species of *Agaricus* found on Campbell Island are summarized in Table 2. Macro- and microscopic characteristics of the subantarctic *A.* cf. *subrutilescens* are in agreement with those traits specified by Kerrigan (1986) for *A. subrutilescens* in California. The only difference was in habitat: in California, *A. subrutilescens* is found in *Sequoia* and *Pseudotsuga* forests, while on Campbell Island *A.* cf. *subrutilescens* was found under *Dracophyllum* shrub in the subalpine zone. *Agaricus campbellensis*, represented by GAL9379, GAL9420, and GAL9573, showed relatively low variation in spore dimensions within specimens, similar to *A.* cf. *subrutilescens*. However, variation between specimens was sometimes great, for example, GAL9379 had much more elongated basidiospores ($P<0.05$) than the other two collections. On the other hand, intraspecimen variation was substantial in *A. subantarcticus*, although statistically significant differences were not detected among collections. At the species level, basidiospore length values of *A. subantarcticus* and *A. campbellensis* were not significantly different, while the basidiospore width in *A. campbellensis* was significantly less than in *A. subantarcticus* ($P<0.05$). Both newly described species shared characteristics with species in the section *Arvenses*, notably the presence of cheilocystidia, positive Schaeffer's reaction, yellow KOH reaction, yellowish change of context, and almond-like fragrance. *Agaricus subantarcticus* produces mid-

Fig. 4. *Agaricus* cf. *subrutilescens* (GAL9422). Scale bar equals 5 cm.

sized basidiomes with well-developed fibrillose patches on the pileus, while *A. campbellensis* has small basidiomes with tiny oppressed fibrils on the pileus.

Taxonomy

Agaricus* cf. *subrutilescens (Kauffman) Hotson & D.E. Stuntz Figs. 4, 13

Pileus to 60 mm diam, broadly convex-umbonate; ground color orange to tan, radiating surface fibrils bronze to snuff brown (5E5-5F6); partial veil remnants on margin; context whitish, unchanging, to 5 mm thick. **Lamellae** to 5mm broad, unequal in length, crowded, edges entire, free, thin; pinkish clay (5B2). **Stipe** 60 mm long, 9-15 mm thick at bulbous base; apex smooth; white (5A1), surface with floccose patches to base; context white, unchanging, stuffed to solid. Smell: sweet. Taste: nutty. **Partial veil** white, forming an inferior, membranous annulus. **Chemical reactions**: pileus cuticle olive green with 5% KOH, pileus context negative; Schaeffer reaction negative. **Microscopical characteristics**: Basidiospores: 4-6.2 × 3-3.7 µm, short to medium-elliptical, wall yellow to reddish-brown (5% KOH), smooth, thick, entire, apiculate; Q=1.51±0.19. Basidia: 18.5-23.3 × 7-7.5 µm, 4-spored. Clamps: lacking throughout. Subhymenium undifferentiated. Pileipellis of interwoven, inamyloid, cylindrical hyphae 2.6-12.3 µm in diam. Pileus context of interwoven, inamyloid, cylindrical hyphae 2.2-11µm in diam. Lamellar trama of parallel to interwoven, inamyloid hyphae 4.4-22.9 µm in diam.

Habitat – On litter, under *Dracophyllum scoparium* in the subalpine belt.

Collection examined: NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, TUCKER COVE (S52° 33', E169° 10') *PDD92092, GAL9422*, 9 March 2000, coll. G. A. Laursen, Specimen deposited in ALA.

Comments -- Although this taxon has a somewhat unique ITS sequence, it is likely conspecific with or very closely related to *A. subrutilescens* described from North America, this is supported by the phylogenetic analyses and the shared characteristics (green KOH reaction, negative Schaeffer reaction, small spore size, unchanging context, and brown, fibrillose pileus surface etc.). It is worth noting, however, that the ITS sequences of the two isolates are relatively distinct, suggesting some divergence between populations in North America and the subantarctic region. Future investigations involving a substantially larger sample size are needed to learn more about the population structure of the species. It appears that this is the first report of *Subrutilescens* group (Kerrigan 1986) from New Zealand as well as the Southern Hemisphere.

Agaricus campbellensis Geml, Laursen & D. Lee Taylor, sp. nov. **Figs. 5-8, 14**

MYCOBANK # MB510665

Pileus 30-50 mm, convexus, forte convexo-planus, siccus, alutaceus, fibrillulae appressae, rufobrunneae, in margine fragmentis veli albis ornatus. Lamellae liberae, confertae, latae, e pallidis griseo- ad roseobrunneae, denique fuscae, inaequalis, exilis, acie sterili. Stipes 40-60 mm longus, 8-11 mm crassus, albidus, fibrillosus, basi clavata, attenuatus ad pileum, anguste fistulosus, superficies sicca, caro alba, mox griseolutescens. Annulus superus, albus, membranaceus, simplex. Odore amygdalino. Sporae ovatae, aliquando productae, mono- vel biguttulatae, fuscae, (6-) 7-8.8 (-10) × 4-4.5 (-4.8) µm. Basidia bi- et tetrasporigera, (20.2-) 21.1-24.6 × (6.6-) 7.0 µm. Typus: New Zealand, Campbell I.: Perseverence Harbour, Tucker Cove (S52° 33.1', E169° 9.3'), infra Dracophyllum scoparium, D. longifolium, et Polystichum vestitum in zona alpina et subalpina, 9 Mar 2000, coll. Gary A. Laursen, holotypus PDD92093, isotypus GAL9420 in herbario ALA depositur.

Etymology -- The name refers to the type locality.

Pileus 30-50 mm diam, convex to plano-convex, surface dry, tan (5A2, orange white) with appressed, clay or mustard brown (5D5, 5E6) fibrils, margin with veil remnants. **Lamellae** 4.5 mm broad, pinkish to pale grayish brown (5C3, 5D4, 5D5) at first, later dark brown (5E4, 5E5), free, crowded, unequal in length, thin. **Stipe** 40-60 mm long, 8-11 mm thick, whitish with yellow-brown fibrils (3A6, 3A7, 4A6, 4A7), base swollen, tapering toward the pileus, dry, context hollow, white, turning a marbled yellow, tan or grey. Odor and taste: almond. **Partial veil** white forming an inferior, membrane-like annulus, evanescent in age. **Chemical reactions:** pileus context and surface yellowing in 5% KOH; Schaeffer reaction positive. **Microscopical characteristics:** Basidiospores short to medium-elliptical, sometimes elongated, yellow to reddish-brown, wall smooth, thick, entire, apiculate, one- or two-guttulate, dark brown at maturity, (6-) 7-8.8 (-10) × 4-4.5 (-4.8) µm, mean and standard deviation are: L 7.61±1.03,

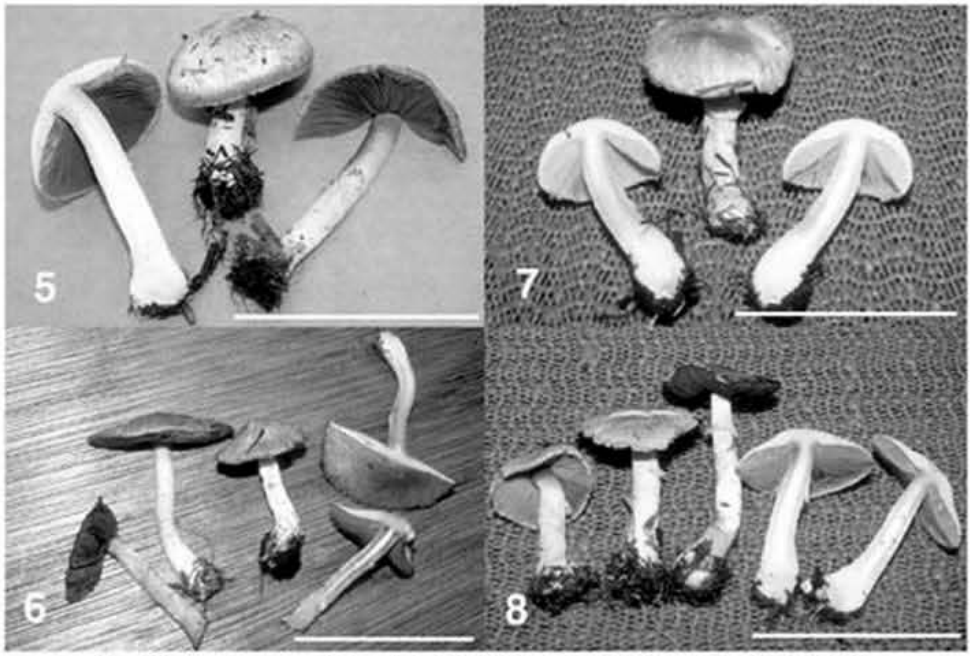

Fig. 5-8. *Agaricus campbellensis*. 5. GAL9379. 6. GAL9420. 7. GAL9573. 8. 9605. Scale bar equals 5 cm.

W 4.34±0.34; Q=1.69 ± 0.22. Basidia: 2-4-spored, (20.2-) 21.1-24.6 × (6.6-) 7.0 µm, clavate. Subhymenium of irregular, swollen, inamyloid cells. Pileipellis of interwoven, inamyloid, cylindrical hyphae, terminal cells cylindrical to slightly swollen tipped. Pileus context of interwoven, inamyloid, cylindrical hyphae. Lamellar trama of parallel to interwoven, inamyloid hyphae.

Characteristic fixed ITS rDNA polymorphisms. Characteristic fixed DNA polymorphisms were determined based on the sequence alignments used in the phylogenetic analyses. Only those characters present in all *A. campbellensis* isolates and not present in *A. semotus*, the most closely related known *Agaricus* species, were included. These fixed DNA polymorphisms are indicated with capital and italicized letters (nucleotides) or italicized numbers (gaps) with the alignment position given: tctT[-1-]tag @ 81-82; gggTat[-2-]Cgag @ 154, 157-159; aggTggtcAGcct @ 167, 172-173; ttTgct @ 189; tgtGagg @ 199; gctTtgc @ 222; tgaCccc @ 242; gttTA[-1-]ctTGcCaga @ 255-256, 260-261, 263; gtCGaat @ 296-297; cttTgaa @ 306; tctTtac @ 315; catGggc @ 321; tt[-1-]T[-1-]catgCcta @ 328, 334; aatCata[-2-]ata @ 346, 350-351; aacGcag @ 400; aaaGgca @ 617.

Habitat -- On litter, under *Dracophyllum scoparium*, *D. longifolium*, and *Polystichum vestitum* in the subalpine and alpine zones.

Collections examined: NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, TUCKER COVE (S52° 33.1', E169° 9.3') *PDD92093* (Holotype), *GAL9420* (Isotype), 9 March 2000, coll. G. A. Laursen; same location *GAL9379*, 6 March 2000, coll. G. A.

Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT HONEY (S52° 33.5', E169° 8.9') *GAL9573, GAL9603,* 14 March 2000, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT BEEMAN (S52° 33.7', E169° 9.2') *GAL9605, GAL9633, GAL9649,* 15 March 2000, coll. G. A. Laursen. Specimens deposited in ALA.

Comments -- Based on both molecular and morphological data, *Agaricus campbellensis* is placed in section *Arvenses*, subsection *Minores*. It differs from its closest known relative, *A. semotus* for which the name *A. dulcidulus* Schulzer was proposed (Nauta 2001), in particular by multiple ITS rDNA polymorphisms (see species description), much larger basidiospore size, the presence of two-guttulate basidiospores, and the color of the pileus. Although there are several other described species in this subsection with no available genetic data (e.g. *A. comtulus* Fr., *A. lutosus* (F.H. Møller) F.H. Møller, *A. purpurellus* (F.H. Møller) F.H. Møller, *A. luteomaculatus* (F.H. Møller) F.H. Møller, *A. xantholepis* (F.H. Møller) F.H. Møller), *A. campbellensis* clearly differs from these in morphology (i.e. spores size and pileus color). Similarly, the three *Minores* species specified by Mitchell & Walter (1999) to occur in New Zealand (i.e. *A. bambusae var. australis* Heinem., *A. semotus*, and *A. viridopurpurascens* Heinem) differ from *A. campbellensis* in the characters specified above.

Agaricus subantarcticus Geml, Laursen & D. Lee Taylor, **sp. nov.** **Figs. 9-12, 15**
MYCOBANK # MB510667

Pileus 40-130 mm, convexus, forte convexo-planus, albolutescens vel cremeus, denique melleus. Disco et squamuli fibrillosi cremei vel griseobrunnei, denique rufobrunnei, in margine fragmentis veli albis ornatus. Lamellae liberae, confertae, latae, e pallidis griseo- ad roseobrunneae vel aurantiobrunneae, denique fuscae, inaequalis, fragilis, acie sterili. Stipes 40-90 mm × 8-20 mm, albus, tactu lutescens, basi clavata (25-35 mm), anguste fistulosus, glabrus, caro alba, mox lutescens. Annulus inferior, albus, membranaceus, reflexus. Odore amygdalino. Sporae ovatae, fuscae, mono- vel biguttulatae, (4-) 7-9 (-9.5) × (4-) 4.5-5.5 µm. Basidia tetrasporigera, 8.8 × 17.6 µm. Typus: New Zealand, Campbell I.: Perseverence Harbour, Tucker Cove (S52° 33.1', E169° 9.3'), infra Dracophyllum scoparium et D. longifolium in zona subalpina, 9 Mar 2000, coll. Gary A. Laursen et H. H. Burdsall, holotypus PDD92094, isotypus GAL9419 in herbario ALA depositur.

Etymology -- The name refers to the geographic region, in which the species is found.

Pileus 40-130 mm diam, convex to plano-convex, surface yellow white (4A2) to cream or chamois (4A3, 4B4, 4C5) at first, later topaz or honey yellow (5C5, 5D6, 5E7). Disc and fibrillose squamules cream to grayish tan at first, later reddish brown (5D5, 5E6), margin with veil remnants. **Lamellae** 4-15 mm broad, pinkish to orange brown and pale grayish brown (5B2, 5C3, 5D4) at first, later dark brown (5E4, 5E5, 5F6), free, crowded, unequal in length, brittle. **Stipe** 40-90 mm long, 8-20 mm thick, white or dull yellow, base bulbous (25-35 mm thick), smooth, context hollow, white, turning yellow. Odor and taste: almond. **Partial veil** white forming an inferior, membrane-like, annulus, evanescent in

Fig. 9-12. *Agaricus subantarcticus*. 9. GAL9604. 10. GAL9419. 11-12. GAL9425. Scale bar equals 5 cm.

age. **Chemical reactions:** pileus context and surface yellowing in 5% KOH; Schaeffer reaction positive. **Microscopical characteristics:** Basidiospores short to medium-elliptical, yellow to reddish-brown; wall smooth, thick, entire, apiculate, chocolate brown to purple brown in deposit, one- or two-guttulate, exhibit great variation in size within specimen, (4-) 7-9 (-9.5) × (4-)4.5-5.5 µm, mean and standard deviation are: 7.89±1.11 × 4.83±0.38; Q=1.69 ± 0.15. Basidia: mostly 4-spored, 8.8 × 17.6 µm, clavate. Subhymenium of irregular, swollen, inamyloid cells. Pileipellis of interwoven, inamyloid, cylindrical hyphae, terminal cells cylindrical to slightly swollen tipped. Pileus context of interwoven, inamyloid, cylindrical hyphae. Lamellar trama of parallel to interwoven, inamyloid hyphae.

Characteristic fixed ITS rDNA polymorphisms. Characteristic fixed DNA polymorphisms were determined based on the sequence alignments used in the phylogenetic analyses. Only those characters present in all *A. subantarcticus* isolates and not present in any other species in Clade I/A sensu Geml et al. (2004) were included. These fixed DNA polymorphisms are indicated with capital and italicized letters (nucleotides) or italicized numbers (gaps) with the alignment position given: tagGgag @ 159; aagCggt @ 167; catActa @ 174; ctgCcct @ 228; ctcGcca @ 261; tgtTatt @ 275; tacCct @ 289.

Habitat -- On litter, under *Dracophyllum scoparium* and *D. longifolium* in the subalpine zone of subantarctic islands.

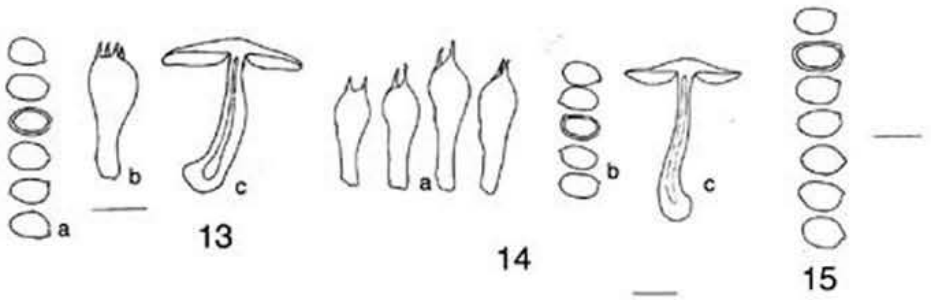

Fig. 13-15. 13. Basidiospores (a), basidium (b), and cross section of mature basidiocarp (c) of *Agaricus* cf. *subrutilescens* (GAL9422). 14. Basidia (a), basidiospores (b), and cross section (c) of mature basidiocarp of *Agaricus campbellensis* (GAL9420). 15. Basidiospores of *Agaricus subantarcticus* (GAL9419). Scale bar equals 10 µm.

Collections examined: NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, TUCKER COVE (S52° 33.1', E169° 9.3') *PDD92094* (Holotype), *GAL9419* (Isotype), 9 March 2000, coll. G. A. Laursen and H. H. Burdsall; same location and date *GAL9418*, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR (S52° 33.2', E169° 10.1') *GAL9425*, 10 March 2000, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT HONEY (S52° 33.5', E169° 8.9') *GAL9572*, 14 March 2000, coll. G. A. Laursen. NEW ZEALAND. CAMPBELL ISLAND: PERSEVERENCE HARBOUR, MOUNT BEEMAN (S52° 33.7', E169° 9.2') *GAL9604*, 15 March 2000, coll. G. A. Laursen. Specimens deposited in ALA.

Comments -- Based on molecular and morphological data, *A. subantarcticus* is placed in section *Arvenses*, subsection *Arvenses*. The cream then honey-brown colored pileus, the relatively large fibrillose squamules, and the characteristic inferior position of the annulus are unique among known species in the section *Arvenses*. Although species with brown scales are found in the section (e.g. *A. augustus*, *A. subrufescens* Peck), the squamules are much larger in *A. subantarcticus* and sometimes less pronounced, particularly in older specimens. Also these species are very different phylogenetically as well. Superficially similar pilei can be observed in *A. romagnesii* Wasser; however, this latter species is obviously different in many other aspects (ITS sequence, negative Schaeffer reaction, phenolic odor, etc.). There are three species in subsection *Arvenses* sensu Mitchell & Walter (1999) in New Zealand (i.e. *A. arvensis*, *augustus*, and *A. lanipes* (F.H. Møller & Jul. Schäff.) Hlaváček) and they clearly differ from *A. campbellensis* in both molecular and morphological characters.

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Literature cited

Bas C. 1991. A short introduction to the ecology, taxonomy and nomenclature of the genus *Agaricus*. In: Van Griensven LJLD, ed. Genetics and breeding of *Agaricus*. Proceedings of the First International Seminar on Mushroom Science. Pudoc Wageningen pp 21–24.

Bunyard BA, Nicholson MS, Royse DJ. 1996. Phylogeny of the genus *Agaricus* inferred from restriction analysis of enzymatically amplified ribosomal DNA. Fungal Genet Biol 20: 243–253.

Callac P, Guinberteau J. 2005. Morphological and molecular characterization of two novel species of *Agaricus* section *Xanthodermatei*. Mycologia 97:416–424.

Calvo-Bado L, Noble R, Challen MP, Dobrovin-Pennington A, Elliott TJ. 2000. Sexuality and genetic identity in the *Agaricus* Section *Arvenses*. Appl Environ Microbiol 66:728–734.

Campbell IB. 1981. Soil pattern of Campbell Island. New Zeal J Sci 24:11–35.

Cappelli A. 1984. *Agaricus* L.: Fr., Fungi Europaei, Vol. 1, Libreria editrice Biella Giovanna, Saronno, Italia. 560 p.

Challen MP, Kerrigan RW, Callac P. 2003. A phylogenetic reconstruction and emendation of *Agaricus* section *Duploannulatae*. Mycologia 95:61–73.

Felsenstein J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39:783–791.

Foggo MN, Meurk CD. 1983. A bioassay of some Campbell Island soils. New Zeal J Ecol 6: 121–124.

Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity of basidiomycetes: application to the identification of mycorrhizae and rusts. Mol Ecol 2:113–118.

Geml J. 2004. Evolution in action: Molecular evidence for recent emergence of secotioid genera *Endoptychum*, *Gyrophragmium* and *Longula* from *Agaricus* ancestors. Acta Microbiol Immunol Hung 51:97–108.

Geml J, Geiser DM, Royse DJ. 2004. Molecular evolution of *Agaricus* species based on ITS and LSU rDNA sequences. Mycol Progress 3:157–176.

Heinemann P. 1977. Essai d'une clé de détermination des genres *Agaricus* et *Micropsalliota*. Sydowia 30:6–37.

Higgins DG, Bleasby AJ, Fuchs A. 1991. CLUSTAL W: improved software for multiple sequence alignment. CABIOS 8:189–191.

Kerrigan RW. 1986. The *Agaricales* (Gilled Fungi) of California: 6. *Agaricaceae*. Mad River Press, Eureka, California. 62 p.

Kerrigan RW. 2005. *Agaricus subrufescens*, a cultivated edible and medicinal mushroom, and its synonyms. Mycologia 97:12–24.

Kerrigan RW, Callac P, Xu J, Noble R. 1999. Population and phylogenetic structure within the *Agaricus subfloccosus* complex. Mycol Res 103:1515–1523.

Lutzoni F, Wagner W, Reeb V, Zoller S. 2000. Integrating ambiguously aligned regions of DNA sequences in phylogenetic analyses without violating positional homology. Syst Biol 49: 628–651.

McKenzie EHC, Foggo MN. 1989. Fungi of New Zealand sub-antarctic islands. New Zeal J Bot 27:91–100.

Meurk CD. 1977. Alien plants in Campbell Island's changing vegetation. Mauri Ora 5:93–118.

Mitchell AD, Bresinsky A. 1999. Phylogenetic relationships of *Agaricus* species based on ITS-2 and 28S ribosomal DNA sequences. Mycologia 91:811–819.

Mitchell AD, Walter M. 1999. Species of *Agaricus* occurring in New Zealand. New Zeal J Bot 37:715–725.

Nauta MM. 2001. 1. *Agaricus* L. Flora Agaricina Neerlandica 5:23-61.

Ott RL. 1993. An introduction to statistical methods and data analysis. 4th ed. Duxbury Press, Belmont, CA.

Robison MM, Chiang B, Horgen PA. 2001. A phylogeny of the genus *Agaricus* based on mitochondrial atp6 sequences. Mycologia 93:30–37.

Swofford DL. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods), 4.0b4a. Sinauer Associates, Sunderland, MA.

Vellinga EC, De Kok RPJ, Bruns TD. 2003. Phylogeny and taxonomy of *Macrolepiota* (*Agaricaceae*). Mycologia 95:442–456.

White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. PCR Protocols: A Guide to Methods and Applications. Academic Press, Inc., New York, p 315–322.

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Re-examinations of *Botryosphaeriaceae* (*Dothideomycetes*) from China on deposit in HMAS

WEN-YING LI [1,2] & WEN-YING ZHUANG [1*]

**zhuangwy@sun.im.ac.cn*

[1]*Key Laboratory of Systematic Mycology and Lichenology*
Institute of Microbiology, Chinese Academy of Sciences, Beijing 100101, China

[2]*Graduate University of Chinese Academy of Sciences*
Beijing 100049, China

Abstract—Specimens of the *Botryosphaeriaceae* from China on deposit in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences were re-examined. Fifteen species were identified including an anamorphic fungus. Six taxa of *Guignardia* are treated as new species. Three species are recorded for the first time from China.

Key words—taxonomy, nomenclature, valid publication

Introduction

Members of the *Botryosphaeriaceae* are common throughout the world and occur mostly on dead or declining plants. Many of them are known as plant pathogens. Early records of *Botryosphaeria* Ces. & De Not. and related fungi from China were reported by Teng (1934) and Sawada (1943a, b, c, 1944). Later discoveries of the group up to the 1980's were summarized by Sawada (1959), Teng (1963, 1996), Huang (1977) and Tai (1979). Recent studies were carried out by Eriksson & Yue (1988) and Hyde (1995). Collections including the authentic material studied by the early mycologists were mostly on deposit in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (HMAS). In connection with our current studies on the dothidealean fungi from China, specimens of the *Botryosphaeriaceae* on deposit in HMAS were re-examined. Fifteen species belonging to *Botryosphaeria*, *Fusicoccum*, *Dothidotthia* and *Guignardia* were recognized. Following Kirk et al. (2001), we accept *Guignardia* as a member of the *Botryosphaeriaceae* even though

* Author for correspondence.

some authors have different opinions on its taxonomic placement. Several of Sawada's names were not validly published according to the International Code of Botanical Nomenclature (Greuter et al. 2000) and validations of these names are provided. Three species are new records for China.

Material and methods

Thirty-eight collections previously treated as members of the *Botryosphaeriaceae* on deposit in HMAS were re-examined. Among them, two specimens filed under *Botryosphaeria ribis* were based on mis-identifications and are not botryosphaeriaceous. Specimens labeled as *Dothidotthia aspera* (HMAS 90270), *Guignardia caricae* Sawada (HMAS 11693), *Guignardia cephalanthae* Sawada (HMAS 05306, 11694), *Guignardia coffeana* (F. Noack) Sawada (HMAS 11696), *Guignardia hibisci-sabdariffae* Sawada (HMAS 05304, 11691), *Guignardia pruni-persicae* Sawada (HMAS 11697) and *Montagnellina calami* Sawada (HMAS 11733) proved to be too scanty to study. Anamorphs associated with teleomorphs on substrates were also observed. Squash mounts and sections were examined. Methods used follow Barr (1987). New records for China are marked with an asterisk (*).

Taxonomy

Botryosphaeria cunninghamiae T.Z. Huang, Acta Microbiol. Sin. 17(4): 304, 1977.

Specimens examined: CHINA. Fujian: Nanping, on branches of *Cunninghamia lanceolata* (Lamb.) Hook., 6.V.1976, T.Z. Huang 765062-3, HMAS 37190 (holotype); Tongan, on branches of *Cunninghamia lanceolata*, 7.V.1975, T.Z. Huang & D.Y. Chen 575017, HMAS 37191.

Notes: This species is easily recognized by the ellipsoid ascospores and catenulate ascomata. Huang (1977) provided detailed description and illustrations of the fungus. Re-examinations of the holotype and HAMS 37191 reveal that the asci and ascospores are somewhat shorter and narrower than those reported by the original author (asci 72–129 × 17.5–27.5 µm vs. 93–150 × 23–28 µm, ascospores 15.5–24.5 × 8.9–12.2 µm vs. 22–26 × 12–15 µm).

Botryosphaeria dothidea (Moug. ex Fr.) Ces. & De Not., Comment. Soc. Crittog. Ital. 1: 212, 1863.

= *Sphaeria dothidea* Moug. ex Fr., Syst. Mycol. 2: 423, 1823.

= *Botryosphaeria berengeriana* De Not., Sfer. Ital. 82, 1864.

Specimens examined: CHINA. Beijing: on twigs of *Cotinus coggygria* Scop., 12.VIII.1964, Y.N. Yu & G.Z. Jiang 1818, HMAS 34007; ibid., Y.N. Yu & G.Z. Jiang 1817, HMAS 34075; on dead twigs, 19.IV.1950, G.Z. Jiang, HMAS 11998 (filed under *Botryosphaeria fuliginosa*). Shaanxi: Xi'an, on bark of dead tree, 25.IX.1963, Q.M. Ma & Y.C. Zong 3369, HMAS 33600; Taibaishan, 18.IV.1963, Q.M. Ma & Y.C. Zong 2022, HMAS 33564.

Shandong: Qingdao, bark of *Chionanthus retusus* Lindl., 1965, Q.Y. Zhang, HMAS 35803. Liaoning: Beining, on bark of *Prunus armeniaca* L., 30.VII.1955, S.J. Han, HMAS 19101 (filed under *Botryosphaeria ribis*).

Notes: This is the most common *Botryosphaeria* species in China. Slippers et al. (2004) provided a detailed description of the fungus. The conidiomata are often on the same stroma with the ascomata, aggregated and confluent except for those of HMAS 35803. HMAS 11998 differs slightly from the typical material in the narrower ascospores (5.5–7.8 µm vs. 6–10 µm in width) with fewer guttules and less-interconnected pseudothecia (Slippers et al. 2004). We treat the above distinctions as infraspecific variations. The anamorphic *B. dothidea* is *Fusicoccum aesculi* (Slippers et al. 2004).

Following the taxonomic treatment by Arx & Müller (1954) and based on information provided in Sylloge Fungorum Sinicorum (Tai 1979), the Chinese record of *Botryosphaeria fuliginosa* (Ellis) Ellis & Everh. was listed as *B. quercuum* (Schwein.) Sacc. by Eriksson & Yue (1988). Our examination of HMAS 11998 reveals that it does not fit the description of *B. quercuum* by Shoemaker (1964) in having a different ascospore shape [19–29 × 5.5–7.8 µm vs. (28–)30–33(–35) × (12–)14–15(–16) µm] but does fit the description of *B. dothidea*.

Botryosphaeria* cf. *parva Pennycook & Samuels, Mycotaxon 24: 455, 1985.

Specimen examined: CHINA. Beijing: on twigs of *Robinia pseudoacacia* L., 19.IV.1950, G.Z. Jiang, HMAS 11997 (filed under *Botryosphaeria abrupta*).

Notes: The fungus is characterized by ascomata immersed to erumpent, solitary to botryose, individual locules 134–203 µm in diam.; asci clavate, stipitate, 68–103 × 13.5–17.5 µm; and ascospores ellipsoid to broadly fusoid, 17.8–26 × 6.3–8.8(–11.3) µm (length/width ratio of 2.3), hyaline, unicellular, rarely 1- or 2-septate, thin-walled, smooth, guttulate. Its morphological features indicate that it is close to *B. parva* commonly found in the southern hemisphere in ascospore shape but with slightly larger l/w ratio (2.3 vs. 2.2) (Pennycook & Samuels 1985). We tentatively treat it as *B.* cf. *parva*. This is a new record for China.

Botryosphaeria rhodina (Berk. & M.A. Curtis) Arx, Gen. Fungi Sporul. Cult.: 143, 1970.

Specimen examined: CHINA. Shaanxi: Taibaishan, on twigs of *Pueraria* sp., 6.X.1963, Q.M. Ma & Y.C. Zong 3418, HMAS 33601 (filed under *Botryosphaeria dothidea*).

Notes: The fungus has much larger and thick-walled ascospores (26.8–36.5 × 8.3–12.4 µm vs. 19–24 × 6–10 µm) than those of *Botryosphaeria dothidea* and thick-walled ascomata which indicates that *B. rhodina* is the correct name (Sivanesan 1984). The species was previously reported from Taiwan Province and Hong Kong (Wang et al. 1999, Lu et al. 2000).

Botryosphaeria ribis Grossenb. & Duggar, Tech. Bull. N.Y. Agric. Exp. Sta. 18: 183, 1911.

Specimen examined: CHINA. Jiangsu: Paohuashan, on dead twigs, 27.IV.1930, H.N. Shen, HMAS 08902 (filed under *Botryosphaeria berengeriana*).

Notes: *Botryosphaeria ribis* seems widespread in China and was recorded from ten provinces (Tai 1979). But specimens filed under this name on deposit in HMAS are either based on mis-identifications or anamorphic.

Botryosphaeria berengeriana and *B. ribis* were both treated as synonyms of *B. dothidea* by Arx & Müller (1954). Eriksson & Yue (1988) accepted their taxonomic treatment and listed *B. dothidea* as the correct name for *B. ribis*. Following the treatment by Slippers et al. (2004), we recognize two separate species. The ascospores of HMAS 08902 are fusoid to ellipsoid, often with rounded ends and 15–24.5 × 6–8.9 µm. The morphology of the fungus fits better that of *B. ribis* (Slippers et al. 2004).

Fusicoccum aesculi Corda, in Sturm, Deutschl. Fl., Abth. 3, 2: 111, 1829.

Specimens examined: CHINA. Heilongjiang: Haerbin, on bark of dead tree, IV.1964, C.D. Xiang 22, HMAS 34042 (filed under *Botryosphaeria dothidea*). Liaoning: Xingcheng, on twigs of *Malus pumila* Mill., 10.VII.1955, B.N. Jiang & S.J. Han, HMAS 10372 (filed under *Botryosphaeria ribis*); Xiongyue, *Malus pumila*, VII.1955, R.F. Chen, HMAS 19100 (filed under *B. ribis*).

Notes: Ascomata and asci are not found but an anamorphic fungus. The diagnostic features are as follows: Conidiomata mostly solitary, occasionally aggregated and confluent in a single stroma, black externally, conidiomatal walls of textura angularis, composed of thick-walled outer cells, becoming paler and thin-walled towards the inner; conidia fusiform to narrowly fusiform, straight, subobtuse at apex, truncate and bearing a minute marginal frill at base, 16.7–27.8 × 4–5.6 µm (length/width ratio of 4.3–5), hyaline, unicellular, thin-walled, smooth. The above features indicate its correct identification as *Fusicoccum aesculi*, anamorph of *B. dothidea*.

Dothidotthia aspera (Ellis & Everh.) M.E. Barr, Mycotaxon 34: 519, 1989.

Specimens examined: CHINA. Xinjiang: Urumqi, on twigs of shrubs, 9.VII.1991, Z.Q. Yuan 910339, HMAS90271; Urumqi, on twigs of *Lonicera* sp., 10.V.1991, Z.Q. Yuan 910212, HMAS 90273.

Notes: This is the correct name for the type species of *Dothidotthia* Höhn., *D. symphoricarpi* (Rehm) Höhn. The two Chinese collections on deposit in HMAS and correctly identified by the collector are identical in morphology and fit the description of the fungus by Barr (1989). This fungus is a new record for China.

Guignardia calami (Syd.) Arx & E. Müll., Beitr. Kryptfl. Schweiz 11(1): 55, 1954.
= *Guignardia arecae* Sacc., Notae Mycol. 23: 63, 1917.

Specimen examined: CHINA. Taiwan: Taibei, Jiaoxi, on leaves of *Areca catechu* L., 28.VII.1944, 9307, HMAS 05307 (filed under *Guignardia arecae*).

Notes: *Guignardia arecae* was reported by Sawada (1943b) from Taiwan and the correct name for the fungus is *G. calami* (Arx & Müller 1954, Sivanesan 1984). It was also found in Hong Kong (Hyde 1995).

Guignardia camelliae (Cooke) E.J. Butler, in Petch, Diseases Tea Bush: 192. 1923.

Specimen examined: CHINA. Zhejiang: Hangzhou, on leaves of *Thea sinensis* L., 20.V.1954, Zhejiang Agricultural College, HMAS 17193.

Notes: This is a common *Guignardia* species in China (Teng 1963, Tai 1979).

Guignardia fici Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 1–4

MycoBank # MB 510673.

[*Montagnellina fici* Sawada, J. Taihoku Soc. Agric. 7(2): 125, 1943 ('1942'). ICBN Art. 36.1, not validly published.]

Pseudotheciis foliicolis, subglobosis, ostiolatis, 117–174 µm diam, 75–128 µm altis; ascis bitunicatis, 8-sporis, 38–55 × 7–13.8 µm; ascosporis unicellularibus, ellipsoideis vel fusoideis, 6–13 × 3–5.3 µm.

Leaf spots up to 2–8 mm diam., rounded, outer region yellow-brown, inner region necrotic and pea green. Pseudothecia forming under spherical, raised, darkened dots in the leaf spots, solitary; in vertical section 117–174 µm diam., 75–128 µm high, subglobose, immersed, with a central ostiole, 18 µm. Peridium thin, composed of a few layers of brown pseudoparenchymatous angular cells 4.7–12.4 µm diam. Asci 38–55 × 7–13.8 µm, 8-spored, broadly cylindrical or clavate, with a short stalk, bitunicate, broadly rounded above. Ascospores ellipsoid to fusoid, 6–13 × 3–5.3 µm, 2–3-seriate, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, Zhishanyan, on leaves of *Ficus nervosa* Heyne, 3.IV.1914, Y. Fujikuro, HMAS 11656. **Paratype:** ibid., HMAS 05351.

Notes: When *Montagnellina fici* was first described, Sawada did not provide a Latin diagnosis for the fungus. According to the International Code of Botanic Nomenclature (ICBN) (Greuter et al. 2000), this name was not validly published. Both collections on deposit in HMAS are identical in morphology and match well the description of the fungus by Sawada (1943a). The morphology of the fungus indicates that it should be a member of *Guignardia* (Sivanesan 1984). In agreement with the treatment by Arx & Müller (1954), *Montagnellina* Höhn. should be a synonym of *Guignardia* Viala & Ravaz. A new species of *Guignardia* is proposed here.

Morphologically, *G. dioscoreae* A.K. Pande on *Dioscorea* is similar to *G. fici* in size of asci and of ascospores but produces much larger leaf spots (10 mm vs. 2–8 mm diam.) with slightly elevated rim and much smaller pseudothecia (60–130 µm vs. 117–174 µm diam.) (Aa 1973).

Guignardia fici-septicae Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 5–6

MycoBank # MB 510674.

[*Guignardia fici-septicae* Sawada, J. Taihoku Soc. Agric. 7(2): 123, 1943 ('1942') . ICBN Art. 36.1, not validly published.]

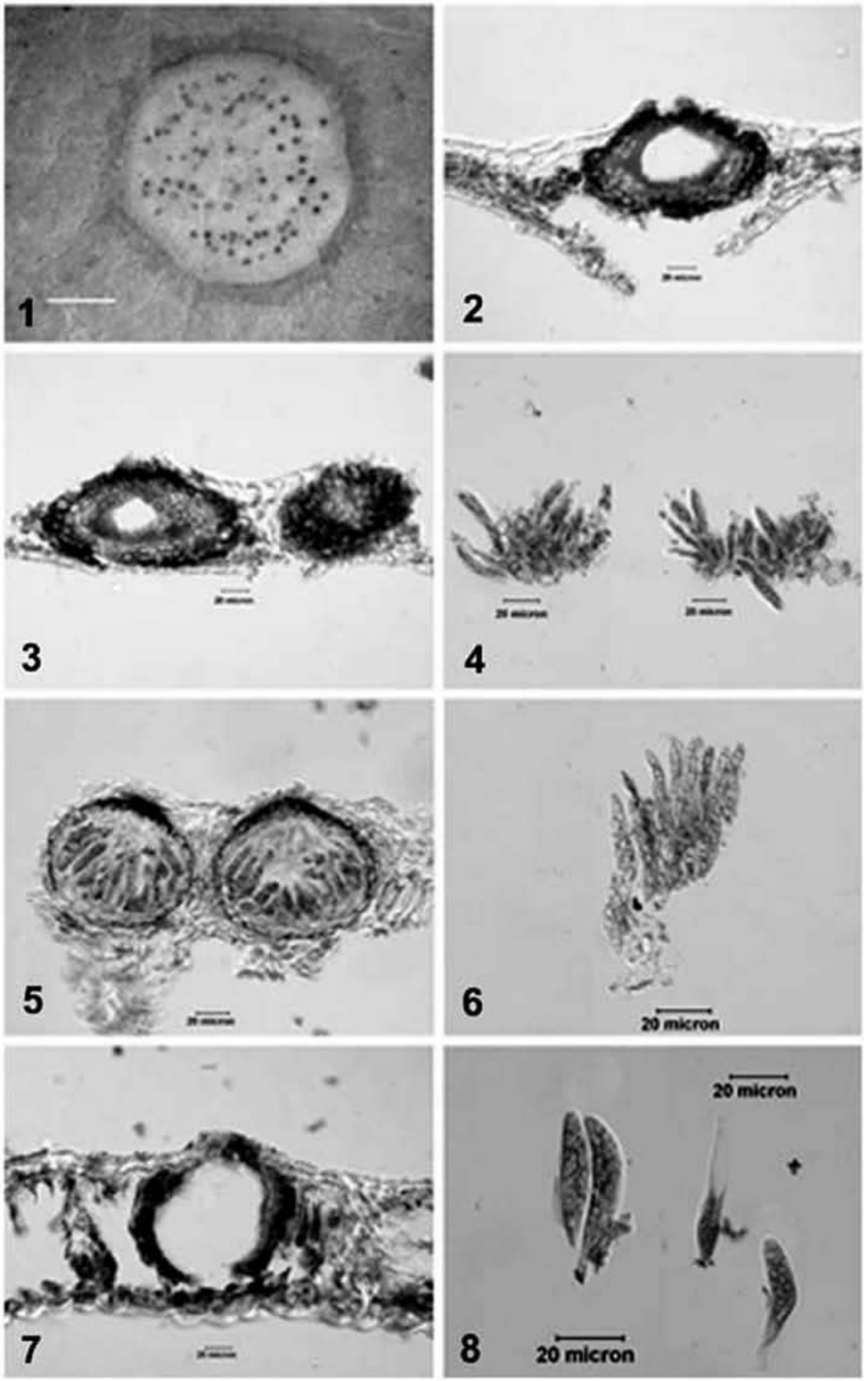
Pseudothecciis foliicolis, globosis, ostiolatis, 60–112 µm diam, 60–135 µm altis; ascis bitunicatis, 8-sporis, 50–60 × 5.5–11 µm; ascosporis unicellularibus, oblongis vel longum ellipsoideis, 11–15.7 ×3.9–5.3 µm.

Leaf spots up to 1.5–6.0 mm diam., rounded, outer region purple-brown, inner region grayish-white. Pseudothecia forming under subspherical, raised, solitary, as darkened dots in the leaf spots; in vertical section 60–112 µm diam., 60–135 µm high, globose with a central ostiole, 13–14 µm. Asci 50–60 × 5.5–11 µm, 8-spored, broadly fusoid, with a short stalk, bitunicate, broadly rounded above. Ascospores oblong to long ellipsoid, rounded at both ends, 11–15.7 × 3.9–5.3 µm, 2–3-seriate, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, Jiaoxi, on leaves of *Ficus septica* Burm. f., 6.VII.1909, Y. Fujikuro, HMAS 11689. **Paratype:** Taizhong, on leaves of *Ficus septica*, 28.VIII.1945, 9305, HMAS 05305.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia niesslii* (Kunze ex Rehm) Lindau on *Populus* from Europe is similar to *Guignardia fici-septicae* in size of ascospores (9–15 × 3.5–5 µm vs. 11–15.7 × 3.9–5.3 µm) but produces wider asci (40–60 × 10–12 µm vs. 50–60 × 5.5–11 µm) and much larger pseudothecia (150–200µm vs. 60–112 µm diam.) (Arx & Müller 1954). Among species of *Guignardia* on *Ficus*, *G. fici-septicae* is similar to *G. fici* in size of leaf spots but differs in having longer ascospores (11–15.7 µm vs. 6–13 µm) and smaller pseudothecia (60–112 µm vs. 117–174 µm diam).

Figs. 1–8. *Guignardia* spp. **1–4.** *Guignardia fici*: 1. Ascomata on natural substrates, bar = 1 mm; 2, Structure of ascoma in section; 3. Structure of ascomata in section; 4. Asci with ascospores. 1, 4 from HMAS 11656; 2, 3 from HMAS 05351. **5–6.** *Guignardia fici-septicae*: 5. Structure of ascomata in section (HMAS 11689); 6. Asci with ascospores (HMAS 05305). **7–8.** *Guignardia linderae* (HMAS 11690): 7. Structure of ascomata in section; 8. Asci with ascospores.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Guignardia linderae Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 7–8

MycoBank # MB 510680.

[*Guignardia linderae* Sawada, Rep. Govt. Res. Inst. Formosa 86: 10. 1943. ICBN Art. 36.1, not validly published.]

Pseudothecііs foliicolis, globosis, ostiolatis, 71–99 µm diam, 70–94 µm altis; ascis bitunicatis, 8-sporis, 50–60 × 6–12 µm; ascosporis unicellularibus, oblongis vel longum ellipsoideis, 10–14 × 3.3–4 µm.

Leaf spots up to 1.5–6 mm diam., rounded, outer region dark-brown, inner region grayish-yellow-brown. Pseudothecia forming under spherical, raised, darkened dots in the leaf spots, solitary; in vertical section 71–99 µm diam., 70–94 µm high, globose with a central ostiole. Peridium thin, composed of a few layers of brown pseudoparenchymatous angular cells 11–13 µm diam. Asci 50–60 × 6–12 µm, 8-spored, broadly cylindrical to clavate, with a short stalk, bitunicate, broadly rounded above. Ascospores 10–14 × 3.3–4 µm, oblong to long ellipsoid, rounded at both ends, 2–3-seriate, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Xinzhu, on leaves of *Lindera glauca* var. *kawakamii* Hayata, 16.XII.1919, E. Kurosawa, HMAS 11690.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia foeniculata* (Mont.) Arx & E. Müll. on *Umbelliferae* is similar to *Guignardia linderae* in size of ascospores (10–16 × 3–5 µm vs. 10–14 × 3.3–4 µm) but produces much shorter asci (40–50 × 8–12 µm vs. 50–60 × 6–12 µm) and much larger pseudothecia (100–160 µm vs. 71–99 µm diam.) (Arx & Müller 1954).

Guignardia manihoticola Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 9–11

MycoBank # MB 510678.

[*Guignardia manihoticola* Sawada, Spec. Publ. Coll. Agric., Nat. Taiwan Univ. 8: 59, 1959. ICBN Art. 36.1, not validly published.]

Pseudothecііs foliicolis, subglobosis vel subdeplanatis, ostiolatis, 75–216 µm diam, 62–76 µm altis; ascis bitunicatis, 8-sporis, 50–73 × 8–17.5 µm; ascosporis unicellularibus, fusoideis vel longum ellipsoideis, 13.8–20 × 4–6.6 µm.

Leaf spots grayish-white, separated from the living tissue by a light brown and more or less raised border, studded with minute black perithecia in crowd or sparsely under epidermis. Pseudothecia dark black, solitary or gregarious, in

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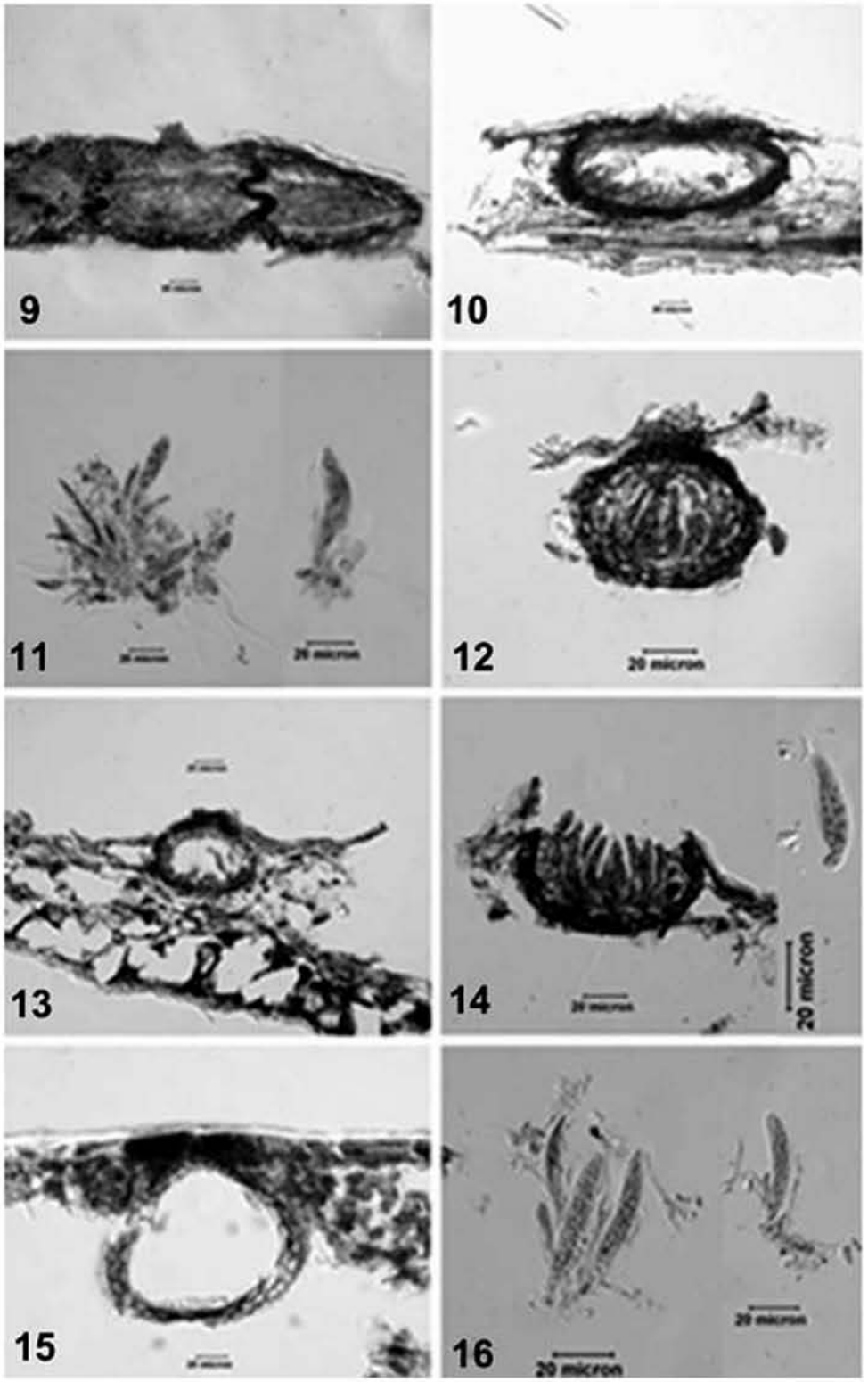
Figs. 9–16. *Guignardia* spp. **9–11.** *Guignardia manihoticola* (HMAS 11695): 9, Structure of ascomata in section; 10. Structure of an ascoma in section; 11. Asci with ascospores. **12–14.** *Guignardia polygoni-chinensis* (HMAS 11688): 12, 13. Structure of ascoma in section; 14. Asci with ascospores. **15–16.** *Guignardia smilacicola* (HMAS 11692): 15. Structure of ascoma in section; 16. Asci with ascospores.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vertical section 75–216 µm diam., 62–76 µm high, subglobose to somewhat flattened, with an ostiole 23–26 µm across. Asci 50–73 × 8–17.5 µm, 8-spore in 2 rows, cylindrical, bitunicate, round at the apex, with a short-stalk, paraphyses lacking. Ascospores 13.8–20 × 4–6.6 µm, fusoid, oblong-ellipsoid, ends rounded, hyaline, unicellular, straight or curved, filled with granules. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, on leaves of *Manihot utilissima* Pohl, 8.I.1909, Y. Fujikuro, HMAS 11695.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Among species of *Guignardia* on *Manihot*, the present fungus is similar to *Guignardia manihoti* Sacc. in asci but differs obviously in longer and multiguttulate instead of 1–2-guttlate ascospores (13.8–20 × 4–6.6 µm vs. 12–14 × 4–6 µm) (Sawada 1959).

Guignardia polygoni-chinensis Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 12–14

MycoBank # MB 510676.

[*Guignardia polygoni-chinensis* Sawada, J. Taihoku Soc. Agric. 7 (2): 124, 1943 ('1942'); as '*polygoni-chinense*'. ICBN Art. 36.1, not validly published.]

Pseudotheciis foliicolis, subglobosis, ostiolatis, 65–96 µm diam, 46–63 µm altis; ascis bitunicatis, 8-sporis, 35–47 × 8–14 µm; ascosporis unicellularibus, fusoideis, 12–18 × 3.5–5 µm.

Leaf spots up to 1–3 mm diam., rounded, outer region purple-brown, inner region necrotic and grayish-white to yellow-brown. Pseudothecia forming under spherical, raised, dark-brown dots in the leaf spots, solitary, in vertical section 65–96 µm diam., 46–63 µm high, semi-immersed, subglobose with a central ostiole, 13–18µm diam. Asci 35–47 × 8–14 µm, 8-spored, clavate, with a short stalk, bitunicate, rounded at both ends, paraphyses lacking. Ascospores 12–18 × 3.5–5 µm, fusoid, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, on leaves of *Polygonum chinense* L., 2.XI.1919, E. Kurosawa, HMAS 11688.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia haydenii* (Berk. & M.A. Curtis) Arx & E. Müll. on *Aster* and *Erigeron* is similar to *Guignardia polygoni-chinensis* in size of ascospores (12–18 × 3–5 µm vs. 12–18 × 3.5–5 µm) but possesses wider asci (30–45 × 12–18 µm vs. 35–47 × 8–14 µm) and much larger pseudothecia (100–180 µm vs. 65–96 µm diam.) (Arx & Müller 1954).

Guignardia smilacicola Sawada, W.Y. Li & W.Y. Zhuang, **sp. nov.** Figs. 15–16

MycoBank # MB 510678.

[*Guignardia smilacicola* Sawada, Spec. Publ. Coll. Agric., Nat. Taiwan Univ. 8: 59, 1959. ICBN Art. 36.1, not validly published.]

Pseudothecii foliicolis, subglobosis, ostiolatis, 90–190 µm diam., 101–156 µm altis; ascis bitunicatis, 8-sporis, 41–65 × 6.5–10 µm; ascosporis unicellularibus, oblingis, 15.5–20 × 4.5–6 µm.

Leaf spots up to 0.5–2 mm diam., angular or subcircular, outer region dark-brown, inner region yellow-brown to brown, slightly depressed, scattered with several black dots; Pseudothecia epiphyllous, subepidermal, a little convex, in vertical section 90–190 µm diam., 101–156 µm high, immersed, subglobose, ostiole 20–26 µm wide, wall consisting of angular cells which are 15–20 µm large, pseudoparenchymatous; Asci 41–65 × 6.5–10 µm, 8-spored in 2 rows, cylindrical, short stipe, bitunicate, tip rounded, base obtuse. Ascospores 15.5–20 × 4.5–6 µm, oblong to fusoid, rounded at both ends, hyaline, unicellular, smooth-walled, granulate or guttulate. Anamorph unknown.

Holotype: CHINA. Taiwan: Taibei, on leaves of *Smilax elongato-umbellata* Hayata, 10.X.1920, K. Sawada, HMAS 11692.

Notes: Sawada failed to provide a Latin diagnosis for the fungus. According to the ICBN (Greuter et al. 2000), this name was not validly published. We validate the name by providing a Latin diagnosis. Morphologically, *Guignardia cocogena* (Cooke) Punith. on *Cocos* and *Archontophoenix* is similar to *Guignardia smilacicola* in size of ascospores (13–20 × 5–6.5 µm vs. 15.5–20 × 4.5–6 µm) but possesses clavate, much larger asci (60–100 × 10–12 µm vs. 41–65 × 6.5–10 µm) (Hyde 1995).

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Literature cited

Aa HA van der. 1973. Studies in *Phyllosticta* I. Stud. Mycol. 5: 1-110.

Arx JA von, Müller E. 1954. Die Gattungen der amerosporen Pyrenomyceten. Beitr. Kryptog. Fl. Schweiz 11(1): 1- 434.

Barr ME. 1987. Prodromus to Class *Loculoascomycetes*. Published by the author, Amherst, MA. 168 pp.

Barr ME. 1989. The genus *Dothidotthia (Botryosphaeriaceae)* in North America. Mycotaxon 34: 517-526.

Ellis JB, Everhart BM. 1892. The North American *Pyrenomycetes*. Published by the authors,

Newfield, New Jersey. 793 pp.

Eriksson OE, Yue JZ. 1988. The *Pyrenomycetes* of China, an annotated Checklist. University of Umea, Sweden. 88 pp.

Greuter W., Mcneill J, Barrie FR, Burdet HM, Demoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Trehane P, Turland NJ, Hawksworth DL. 2000. International Code of Botanical Nomenclature (St. Louis Code). Regnum Veg. 138. Koeltz Scientific Books, Königstein.

Huang TZ. 1977. A new species of *Botryosphaeria*. Acta Microbiol. Sin. 17: 303-305.

Hyde KD. 1995. Fungi from palms. XX. The genus *Guignardia*. Sydowia 47: 180-198.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed. CABInternational, Wallingford. 655 pp.

Lu BS, Hyde KD, Ho WH, Tsui KM, Taylor JE, Wong KM, Yanna, Zhou DQ. 2000. Checklist of Hong Kong fungi. Fungal Diversity Press, Hong Kong. 207 pp.

Pennycook SR, Samuels GJ. 1985. *Botryosphaeria* and *Fusicoccum* species associated with ripe fruit rot of *Actinidia deliciosa* (kiwifruit) in New Zealand. Mycotaxon 24: 445-458.

Sawada K. 1943a. Fungi found in Formosa (4). J. Taihoku Soc. Agric. 7(2): 108-128.

Sawada K. 1943b. Materials of the Formosan fungi (50). J. Taiwan Soc. Nat. His. 33: 6-7.

Sawada K. 1943c. Descriptive catalogue of Taiwan (Formosan) fungi, Part IX. Rep. Govt. Res. Inst. Formosa 86: 9-11.

Sawada K. 1944. Descriptive catalogue of Taiwan (Formosan) fungi, Part X. Rep. Govt. Res. Inst. Formosa 87: 22-28.

Sawada K. 1959. Descriptive catalogue of Taiwan (Formosan) fungi, Part XI, Published Coll. Agric. Nat. Taiwan Univ. 268 pp.

Shoemaker RA. 1964. Conidial states of some *Botryosphaeria* species on *Vitis* and *Quercus*. Can. J. Bot. 42: 1297-1301.

Sivanesan A. 1984. The bitunicate ascomycetes and their anamorphs. Cramer, Vaduz. 701 pp.

Slippers B, Crous PW, Denman S, Coutinho TA, Wingfield BD, Wingfield MJ. 2004. Combined multiple gene genealogies and phenotypic characters differentiate several species previously identified as *Botryosphaeria dothidea*. Mycologia 96: 83-101.

Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing, China. 1527 pp. (in Chinese).

Teng SC. 1934. Notes on *Sphaeriales* from China. Sinensia 4: 353-433.

Teng SC. 1963. Fungi of China. Science Press, Beijing, China. 808 pp. (in Chinese).

Teng SC (Korf RP ed.). 1996. Fungi of China. Mycotaxon Ltd., Ithaca. 586 pp.

Wang YZ, Wu SH, Zhou WN, Chang DZ, Chen KY, Chen SF, Chen CL, Tzeng SS, Liou JH, Hsieh WH, Hsieh HR, Chung CH, Chien CY (eds.). 1999. List of the fungi in Taiwan. Committee for Agriculture. Taipei. 289 pp. (in Chinese).

MYCOTAXON

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Did Mussat make new combinations in Sylloge Fungorum XV, 1901?

H.-J. SCHROERS[1*], G.J. SAMUELS[2] & W. GAMS[3*]

**hans.schroers@kis.si & *gams@cbs.knaw.nl*

[1]Agricultural Institute of Slovenia
Hacquetova 17, 1000 Ljubljana, Slovenia

[2]U.S.D.A.-A.R.S., Systematic Botany and Mycology Laboratory
Rm. 304, B-011a, Beltsville, MD 20705, U.S.A.

[3]CBS Fungal Biodiversity Centre
Uppsalalaan 8, 3584 CT Utrecht, The Netherlands

Abstract—Recently, two homonymous combinations, each based on a unique type and credited to different authorities, were used for the destructive mycoparasite *Clonostachys rosea*. The existence of the binomial *Clonostachys rosea* (Preuss) Mussat 1901 would render the more recently established *C. rosea* (Link : Fr.) Schroers et al. 1999 illegitimate. A textual analysis proves, however, that Mussat's combination *Clonostachys rosea* is invalid according to Article 34.1(a) and (c) of the International Code of Botanical Nomenclature. We know of no formally published instance where Preuss himself raised *Clonostachys araucaria* var. *rosea* Preuss to species level. Therefore, the name *Clonostachys rosea* Preuss, as it was listed by Mussat, cannot be regarded as valid either. Similarly, the binomials *Alternaria citri* (Penzig) Mussat, *Alternaria macrospora* (Sacc.) Mussat and *Clonostachys compacta* (Preuss) Mussat cannot be regarded as having been validly published by Mussat.

Introduction

Clonostachys rosea (Link : Fr.) Schroers et al. 1999 (anamorphic *Bionectria ochroleuca* (Schwein.) Schroers & Samuels 1997) is a frequently isolated soil fungus and destructive mycoparasite used in the biocontrol of fungal plant pathogens (Nobre et al. 2005 and many others). Recently it also was shown to be a parasite of insects (Toledo et al. 2006). The species is also well known as *Gliocladium roseum* Bainier (see, for example, Domsch et al. 1980) after Bainier (1907) introduced that name without referring to any older name. However, the species had been described much earlier by Link as *Penicillium roseum* (Link 1816), the epithet of which was adopted by Schroers et al. (1999) and Schroers (2001) as the basionym for the species in *Clonostachys*. Because the species epithets given by Link and Bainier were identical, this transfer avoided

the introduction of a new name; Bainier's epithet, based on a different type, was considered a later synonym (Schroers et al. 1999).

The epithet "*rosea*" had also been used by Preuss for what he regarded as a variety of *Clonostachys araucaria* Corda (Preuss 1853). This variety was considered a possible synonym of *C. rosea* by Schroers et al. (1999). Although Schroers et al. (1999) erroneously reported that no *Clonostachys* structure could be seen on its original material, reexamination of the material revealed morphologically characteristic structures (see below). Recently the epithet "*rosea*" of Preuss was adopted by Berg et al. (2005) and Renker et al. (2005) as if it had been validly combined as *Clonostachys rosea* (Preuss) Mussat 1901. The existence of this binomial would indeed render the binomial introduced by Schroers et al. (1999) illegitimate.

The above references and the continued listing in Index Fungorum of binomials supposedly proposed by Mussat such as *Clonostachys rosea* (Preuss) Mussat and *Alternaria citri* (Penz.) Mussat, by which former varieties would be raised to species rank, and younger, well-established binomials displaced, prompted the following analysis.

Analysis and discussion

Mussat (1901) entitled volume XV of Sylloge Fungorum "Synonymia generum, specierum, subspecierumque in vol. I–XIV descriptorum". He presented lists of fungal names in a two-column system and the two columns were connected by an equal sign. The names *Clonostachys compacta* Preuss and *C. rosea* Preuss were listed in the left-hand column and they were linked by the equal sign to the names of varieties of "*Clonostachys araucaria* Corda, var. IV, 165" (i.e., page 165 of volume IV of the Sylloge Fungorum) in the right-hand column, respectively "*Clonostachys araucaria* Corda var. *compacta* Preuss" and "*Clonostachys araucaria* Corda var. *rosea* Preuss". Without consideration of the background, the name in the left-hand column might be considered the accepted name and the name in the right hand column the synonym.

In the introduction to the volume Mussat (1901: vi) explained the motivation and nature of his compilations. He stated:

> "Les synonymes qui se rencontrent le plus fréquemment dans les conditions susdites ont été relevés et vérifiés avec soin, puis disposés par ordre alphabétique en un index à deux colonnes, de façon à ce que, quelque soit le nom cherché, le lecteur voie immédiatement à sa suite celui qui a été adopté pour la même espèce dans le *Sylloge*, avec renvoi au volume où se trouve la description."
>
> [The synonyms that are most frequently observed in the above described conditions have been identified and checked carefully, then ordered alphabetically in a 2 column index, in such a way that whatever the searched name, the reader immediately sees the

one that was adopted for the same species in the *Sylloge*, with a link to the volume where the description can be found.]

It is evident that the volume is structured in such a way that the left-hand column contains the synonyms, which are equated to names recognized in the Sylloge Fungorum (listed in the right-hand column). Therefore, it is the name in the right-hand column that Mussat recognized. His example of *Polystigma rubrum* DC (p. 131 and 454, right columns), which he equated to left-hand column entries of *Dothidea rubra* Fr. and *Xyloma rubrum* Pers., respectively, indicates that Mussat intended to address formally published synonymy. He may have, however, also included names from undefined descriptive works, collections (public or private herbaria, exsiccates etc.) of more or less ancient origin ["les ouvrages descriptifs, les collections (Herbiers publics ou privés, Exsiccata etc.) d'une origine plus ou moins ancienne" (Mussat 1901: v)] to equate these to names adopted in the Sylloge Fungorum. While it is obvious that Mussat listed numerous basionyms in the left-hand column, he may have mentioned also names encountered, for example, on specimen labels.

The entry on page 95 reads: "*Clonostachys rosea* Preuss = *Clonostachys araucaria* Corda, *var.* IV, 165". Obviously, the latter name is the one recognized by Mussat. There is no reason to consider *Clonostachys rosea* Preuss as a newly introduced binomial accepted by Mussat.

Many other names listed in that volume by Mussat clearly illustrate how he formally annotated combining authors. For example, on the same page he placed the validly published name "*Coccotrichum brevius* B. & Br." in the left-hand column and equated it with "*Botrytis brevior* Sacc. IV, 123". Although Mussat clearly refers the epithet "*brevius*" to Berkeley & Broome, he does not refer to these authors in the right-hand column and only the combining author, Saccardo, is cited. Had Mussat ever intended to create a valid new combination, he would have written "*Clonostachys rosea* Mussat", placing this name in the right-hand column and referring to *Clonostachys araucaria* Corda var. *rosea* Preuss as its synonym in the left-hand column.

We conclude that Mussat (1901) did not make any new combinations in this volume. According to Article 34.1(a) of the International Code of Botanical Nomenclature (McNeill et al. 2006), formal acceptance by the author in the original publication is a prerequisite for valid publication of any combination. Therefore, although the binomial "*Clonostachys rosea*" is effectively published, the combination that would have to be ascribed to Mussat [Art. 34.1(a), (c)] is invalid. Because we are unaware of a combination published by Preuss himself [such as "*Clonostachys rosea* Preuss" or "*Clonostachys rosea* (Preuss) Preuss"], we also conclude that the name "*Clonostachys rosea* Preuss", as listed in the left-hand column of Mussat (1901: 95), cannot be regarded as valid either. Similarly,

the binomials *Alternaria citri*, *A. macrospora* and *Clonostachys compacta*, listed by Mussat in the left-hand column of this volume (pages 43 and 95), cannot be regarded as validly published.

Taxonomy

Clonostachys rosea (Link : Fr.) Schroers, Samuels, Seifert & W. Gams, Mycologia 91: 369. 1999.

= *Penicillium roseum* Link : Fr., Ges. Naturf. Freunde Berlin Mag. 7: 37 (1816): sanctioned by Fries, Syst. Mycol. 3: 409 (1832).

= *Clonostachys araucaria* var. *rosea* Preuss, Linnaea 25: 727 (1853) (B!).

= *Gliocladium roseum* Bainier, Bull. Soc. Mycol. France 23: 111 (1907).

Notes—For a full list of synonyms see Schroers et al. (1999) and Schroers (2001). Two specimens of variety *rosea* (herb. Preuss, file 327), nr. 527 (on an immature fruit) and nr. 529 (on a twig) were studied. Off-white or yellowish white sporodochia or aggregates of densely packed, but individually recognizable, penicillate conidiophores are the predominating fungal structures on both specimens. The penicilli of individual conidiophores are adpressed giving rise to narrow columns of imbricate conidia. On many aggregates and sporodochia, the columns appeared collapsed into a dome-shaped conidial mass. The conidia are ellipsoidal, slightly curved and have a slightly laterally displaced hilum. They measure (4.4–)5.4–5.7–6.2(–7.6) × (2.1–)2.6–2.6–2.7(–3.2) µm. This is *Clonostachys rosea* as described by Schroers et al. (1999). We here designate specimen nr. 529 (B) as the lectotype of *C. araucaria* var. *rosea* Preuss and specimen nr. 527 (B) as paratype.

Acknowledgements

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Literature cited

Bainier G. 1907. *Gliocladium roseum* sp. nov. et *Cephalosporium acremonium* (Corda). Bulletin Trimestriel de la Société Mycologique de France 23: 111–114.

Berg G, Zachow C, Lottmann J, Götz M, Costa R, Smalla K. 2005. Impact of plant species and site on rhizosphere-associated fungi antagonistic to *Verticillium dahliae* Kleb. Applied and Environmental Microbiology 71: 4203–4213.

Domsch KH, Gams W, Anderson T-H. 1980. Compendium of soil fungi. Academic Press London. Reprint 1993, IHW-Verlag Eching. [2nd Edn. 2007. IHW-Verlag and Centraalbureau voor Schimmelcultures, Utrecht.]

Link HF. 1816. Observationes in ordines plantarum naturales. 2. Gesellschaft der Naturforschenden Freunde Berlin, Magazin der Neuesten Entdeckungen aus der Gesammten Naturkunde 7: 25–45.

McNeill J, Barry FR et al., eds. 2006. International Code of Botanical Nomenclature (Vienna Code), adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Gantner Verlag, Ruggell. Regnum Vegetabile 146.

Mussat E. 1901. Synonymia generum, specierum, subspecierumque in vol. I–XIV descriptorum. Sylloge Fungorum omnium hucusque cognitorum digessit P.A. Saccardo 15: 1–455.

Nobre SAM, Maffia LA, Mizubuti ESG, Cota LV, Dias APS. 2005. Selection of *Clonostachys rosea* isolates from Brazilian ecosystems effective in controlling *Botrytis cinerea*. Biological Control 34: 132–143.

Preuss GT. 1853. Übersicht untersuchter Pilze, besonders aus der Umgegend von Hoyerswerda. Linnaea 25: 723–742.

Renker C, Otto P, Scheider K, Zimdars B, Maraun M, Buscot F. 2005. Oribatid mites as potential vectors for soil microfungi: Study of mite-associated fungal species. Microbial Ecology 50: 518–528.

Schroers H-J. 2001. A monograph of *Bionectria* (*Ascomycota, Hypocreales, Bionectriaceae*) and its *Clonostachys* anamorphs. Studies in Mycology 46: 1–214.

Schroers H-J, Samuels GJ, Seifert KA, Gams W. 1999. Classification of the mycoparasite *Gliocladium roseum* in *Clonostachys* as *C. rosea*, its relationship to *Bionectria ochroleuca*, and notes on other *Gliocladium*-like fungi. Mycologia 91: 365–385.

Toledo AV, Virla E, Humber RA, Paradell SL, Lopez Lastra CC. 2006. First record of *Clonostachys rosea* (*Ascomycota: Hypocreales*) as an entomopathogenic fungus of *Oncometopia tucumana* and *Sonesimia grossa* (*Hemiptera: Cicadellidae*) in Argentina. Journal of Invertebrate Pathology 92: 7–10.

MYCOTAXON

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A new species of *Conidiobolus* from Great Smoky Mountains National Park

Bo Huang,[1,2] Richard A. Humber,[3] Kathie T. Hodge[2]

[1] *Anhui Provincial Key Laboratory for Microbial Pest Control, Anhui Agricultural University, Hefei 230036, China*

[2] *Department of Plant Pathology, Cornell University, Ithaca, NY 14853, USA*

[3] *USDA-ARS Plant Protection Research Unit, Plant, Soil & Nutrition Laboratory, Tower Road, Ithaca, NY 14853, USA*

Abstract—*Conidiobolus margaritatus* sp. nov. is described from leaf litter in Great Smoky Mountains National Park, USA. Among the thirty accepted species of *Conidiobolus*, *C. margaritatus* exhibits the slowest growth at room temperature, a lichenoid compact mycelium on standard media, and forms unique chains of nondischarged repetitional conidia on water agar. Two species, *C. cercopidis* and *C. pseudapiculatus*, are transferred to *Batkoa* based upon molecular and morphological evidence.

Key words—*Ancylistaceae*, *Entomophthorales*, taxonomy, new combinations

Species of *Conidiobolus* Bref., most notably the ubiquitous *C. coronatus*, are isolated from decaying leaf litter, dung, and the fruiting bodies of other fungi; a few are opportunistic human pathogens or arthropod pathogens.

Little attention was paid to *Conidiobolus* for many years, until the important contributions of Charles Drechsler, who described 26 new American *Conidiobolus* species in 1950s and 60s. His detailed drawings illustrate his species, but unfortunately few useful type specimens exist. Many of Drechsler's original cultures are held by the American Type Culture Collections and provide essential complements to Drechsler's drawings. In a series of papers in the 1960s, Srinivasan and Thirumalachar described 13 new Indian species and varieties, suggesting some degree of endemism in the distribution of *Conidiobolus* species, and they reduced to synonymy eight more species. The most recent taxonomic synthesis of *Conidiobolus* is that of King (1976a, b, 1977), who studied the genus in detail using numerical taxonomy based on morphological, physiological and developmental features. King (1977) accepted 27 distinct species; his findings have been widely accepted.

Since King's revisions, six additional species have been described. Both *C. pseudapiculatus* and *C. cercopidis* have nuclei containing readily stainable condensed heterochromatin during interphase, form rhizoids with flattened holdfasts, and also show a marked apical constriction of the conidiogenous cell below the conidium. These features are atypical of the genus *Conidiobolus* (*Ancylistaceae*) but are characteristic of species of *Batkoa* Humber (Humber 1989; *Entomophthoraceae*). Molecular data (not shown) confirm that *C. pseudapiculatus* should be treated as a species of *Batkoa* (we lack data for *C. cercopidis*); both species are transferred to *Batkoa* below. *Conidiobolus chlapowskii* Bałazy et al., a pathogen of mites, *Conidiobolus gustafssonii* Bałazy; and *Conidiobolus iuxtagenitus* S.D. Waters & Callaghan appear to be correctly placed in *Conidiobolus*. Molecular data and corresponding morphological data have led to the proposal of Huang et al. (in prep.) that *Conidiobolus antarcticus* S. Tosi et al. should be treated as a later synonym of *C. osmodes* Drechsler. In all, we consider the genus *Conidiobolus* to include 30 species.

Methods and results

We assayed leaf litter for *Conidiobolus* species during an October 2006 expedition to Great Smoky Mountains National Park in the southeastern US. Our results, gathered over four days, provide only a preliminary look at *Conidiobolus* diversity in the Park.

We used a canopy plating approach similar to those of King (1976) and Drechsler (1952) that exploits the forcible discharge of *Conidiobolus* spores. Partly decomposed leaves and detritus from the interface between the O and A soil horizons were collected and transported to the lab in plastic bags. Within eight hours, the samples were processed by snipping organic fragments finely using scissors. A small amount of snipped material was embedded in molten 20% water agar in the lid of a 10 cm Petri dish. The bottom of the dish, containing potato dextrose agar (PDA: Difco), was inverted over the detritus, and the dishes were sealed with Parafilm. The dishes were incubated at room temperature, and monitored over about five days using a dissecting microscope for the development of typical compact, glassy colonies of entomophthoralean fungi. As they were detected on the PDA canopy, they were transferred to new

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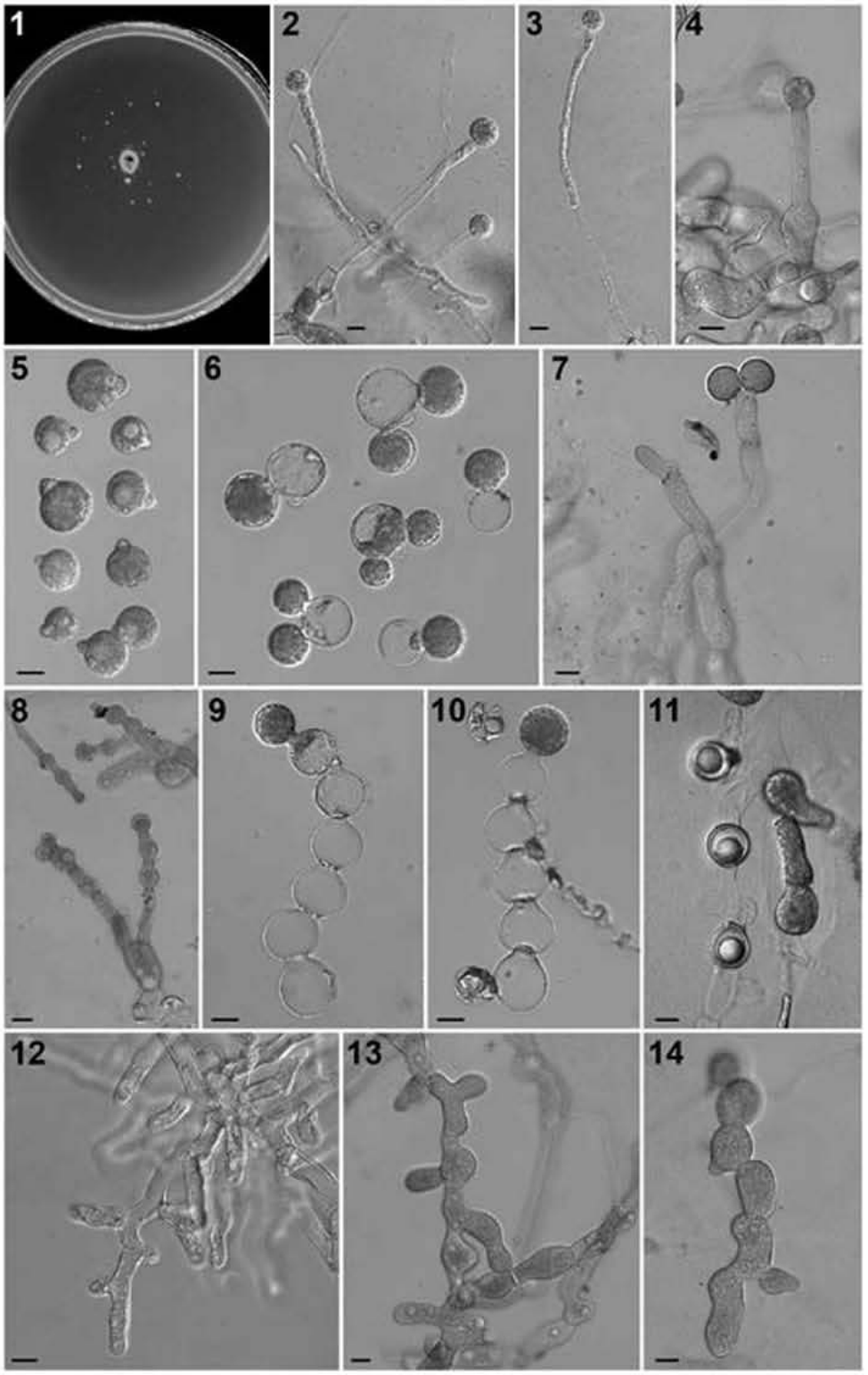
Figs.1–14. *Conidiobolus margaritatus*. 1. Colony on PDA after 4 days at 20° C. 2,3. Long primary conidiophores. 4. Short primary conidiophore. 5. Primary conidia. 6. Secondary conidia produced singly or in pairs from the primary conidia. 7. Primary conidiophore producing two primary conidia. 8. Primary conidia remaining attached to the conidiophore, and forming a chain of successively repetitional conidia. 9–10. Necklace-like chains of undischarged repetitional conidia forming from primary conidia. 11. Zygospores. 12. Young mycelium. 13–14. Old mycelium showing lobed development.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PDA plates for morphological study. Duplicate samples from seven different sites within the Park were screened.

Five species of the genus *Conidiobolus* were isolated and transferred to potato dextrose agar (PDA). These methods can also capture species of *Basidiobolus*, but none were detected during the sampling period. The most frequently detected *Conidiobolus* species was *C. coronatus* (Costantin) A. Batko, which was found in 46% of litter samples. We also isolated single instances of *C. adiaeretus* Drechsler; *C. rhysosporus* Drechsler; an unidentified *Conidiobolus* species that will be the subject of further study; and one *Conidiobolus* species that we judge to represent a new species. The latter is morphologically distinct from other species of *Conidiobolus*, and is described as new below.

Taxonomy

Conidiobolus margaritatus B. Huang, Humber & K. T. Hodge, **sp. nov.** (Figs 1–14)
MycoBank MB 510685.

Coloniae in agaro "PDA" tarde crescentia, diametris 2.5–4.0 mm post 7 dies ad 25°C, subalba, compacta, opaca. Hyphae assimilativae hyalinae, 0–5-plo ramosae, saepe contortae, 12.5–17.5 µm latae, cellulas apicales 110–180 µm longis; subapicale ubi maturae inflatae, lichenoides, contortae, cellulis inflatae globosae ellipsoideae 30–40 µm in latitudine formantes. Conidiophora hyalina, 30–450 x 8.9–15.5 µm, simplicia aut interdum bifurcata, omni ramo conidio globoso apicale singulariter. Conidia primaria hyalina, 21.2–37.5 x 15–32.7 µm, papilla 5.0–10.0 in longitudine 7.5–15.0 µm in latitudinem, expulsa vehementer eversi papillae ope autem saepe catenis margaritis inexpulsis simulantibus formantia. Conidia secundaria simplicia dupliciave, 21.2–37.5 x 15–32.7 µm, expulsa vehementer autem catenis inexpulsis conidia primaria simulantia. Sporae perdurantes zygosporae laeves, subglobosae, 27.5–42.5 µm, parietis bistratis 2.0–2.8 µm crassitie, ex cellulis contiguis formantes, globulo oleoso magnopere impletae ubi maturis.

Holotype—CUP 67624. USA: TN: Great Smoky Mountains National Park. October 7, 2006. Decayed leaf litter along West Prong Trail near Great Smoky Mountains Institute at Tremont (17256344E, 3947185N, 341m). Isolated from leaf litter by Bo Huang (3-litter-1). The ex type culture, ARSEF 8314 deposited in the USDA-ARS Collection of Entomopathogenic Fungal Cultures (Ithaca, NY).

Etymology—From the Latin, *margaritatus* (beaded; pearls). The species is named for the frequently beaded appearance of both conidiophores and secondary conidia.

Colonies on PDA extremely slow growing, attaining a diameter of 2.5 to 4.0 mm within 7 days at 20°C; off-white, compact and opaque. Assimilative hyphae colorless, moderately branched (with 0-5 branches), usually somewhat crooked; 12.5–17.5 µm wide; at the margin of an expanding mycelium often terminating in a cell 110–180 µm, later in positions behind the forefront usually undergoing conversion into swollen segments, forming a compact lichenoid mass of crooked distended hyphae intermixed with inflated ellipsoid and sphaeroid cells, 30-40µm wide. **Conidiophores** colorless, commonly

unbranched and producing a single globose conidium, quite variable in length, 30–430 x 8.9–15.5 µm, but in some instances bifurcated and bearing 2 globose conidia simultaneously. **Conidia** forcibly discharged, but in many instances a primary conidium stopping growth while on the conidiophore and forming another conidium on the top of primary conidia, with this procedure repeating several times to form a chain of undischarged conidia. Globose primary conidia forcibly discharged, colorless, 21.8–40.8 µm wide, 26.8–45.0 µm long including a basal papilla 5.0–10.0 µm high and 7.5–15.0 µm wide. After discharge onto water agar, primary conidia giving rise to 1–2 secondary conidia, 21.2–37.5 x 15–32.7 µm, or forming a chain of up to seven undischarged repetitional conidia. **Zygospores** smooth, subglobose, 27.5–42.5 µm, with a thick double-layered wall (2.0–2.8 µm), formed between adjacent conjugating cells of a hyphal body, with a relatively large lipid globule.

Conidiobolus margaritatus is distinct from other *Conidiobolus* species we have studied in culture in that it grows unusually slowly on PDA, and in its colonies that are compact, lichenoid mycelial masses. While all *Conidiobolus* species form secondary conidia, *C. margaritatus* produces several unusual repetitional structures in culture: 1) necklace-like chains of undischarged repetitional conidia are frequently formed from primary conidia after forcible discharge onto water agar (Fig. 9–10); 2) two secondary conidia can arise from a single primary conidium (Fig. 6); and 3) primary conidia that remain attached to the conidiophore can produce a chain of successively repetitional conidia (Fig. 8).

As noted above, nuclear and conidiophore characteristics suggest that *Conidiobolus pseudapiculatus* and *C. cercopidis* are best reassigned to the genus *Batkoa* (*Entomophthoraceae*). We propose the following new combinations:

Batkoa cercopidis (S. Keller) B. Huang, Humber & K.T. Hodge, **comb. nov.**
MycoBank MB 510686
Basionym: *Conidiobolus cercopidis* S. Keller, 1991, Sydowia 43: 117; validated by S. Keller, 1994, Sydowia 46: 41.

Batkoa pseudapiculata (S. Keller) B. Huang, Humber & K.T. Hodge, **comb. nov.**
MycoBank MB 510687
Basionym: *Conidiobolus pseudapiculatus* S. Keller, 1991, Sydowia 43: 118; validated by S. Keller, 1994, Sydowia 46: 42.

Discussion

It its compact vegetative hyphae, *Conidiobolus margaritatus* resembles *C. lobatus* M.C. Sriniv. & Thirum., *C. lichenicola* M.C. Sriniv. & Thirum., and *C. lachnodes* Drechsler. The new species differs from *C. lichenicola* mainly in its subglobose primary conidia, its slow growth, and the larger size of its

zygospores (Srinivasan & Thirumalachar 1968b). *Conidiobolus margaritatus* is distinguished from *C. lobatus* mainly by its larger primary conidia, its lack of passively detached elongate conidia, and in bearing zygospores (Srinivasan & Thirumalachar 1968a). *C. margaritatus* differs from *C. lachnodes* in the size of primary conidia and zygospores (Drechsler 1955). No other species have been reported to routinely form non-discharged repetitional chains of conidia akin to those we describe here, although Callaghan (pers. comm.) reports that similar structures are occasionally seen in other *Conidiobolus* species subjected to drying conditions.

Species of *Conidiobolus* are generally poorly known, and many are known from only one or a few collections. Entomophthoralean fungi are difficult to preserve as herbarium specimens, so type material is often lacking or uninformative. We have described *C. margaritatus* based on what we consider to be a robust set of unique characters, but further study is needed to clarify the concepts of many *Conidiobolus* species, to detect phylogenetically informative characters, and to elucidate evolutionary relationships. Our preliminary morphological and molecular studies suggest that *Conidiobolus* has been keeping many secrets.

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Literature cited

Bałazy S. 1993, *Entomophthorales*: Flora of Poland (Flora Polska), *Fungi* (*Mycota*), v. 24. Kraków, Poland, Polish Academy of Science, W. Szafer Inst. Botany.

Drechsler C. 1952. Widespread distribution of *Delacroixia coronata* and other saprophytic *Entomophthoraceae* in plant detritus. Science 115: 575–576.

Drechsler C. 1955. Three new species of *Conidiobolus* isolated from decaying plant detritus. Am J Bot 42:437–443.

Huang B, Humber RA, Hodge KT. In preparation. *Conidiobolus antarcticus*, a synonym of *Conidiobolus osmodes*. [Mycotaxon].

Humber RA. 1989. Synopsis of a revised classification for the *Entomophthorales* (*Zygomycotina*). Mycotaxon 34: 441–460.

Keller S. 1991. Arthropod-pathogenic *Entomophthorales* of Switzerland. II. *Erynia*, *Eryniopsis*, *Neozygites*, *Zoophthora* and *Tarichium*. Sydowia 43: 39–122.

Keller S. 1994. Validation of the description of some species of *Entomophthorales* (*Zygomycetes*). Sydowia 46: 41–43.

King DS. 1976a. Systematics of *Conidiobolus* (*Entomophthorales*) using numerical taxonomy. I. Biology and cluster analysis. Can. J. Bot. 54: 45–65.

King DS. 1976b. Systematics of *Conidiobolus* (*Entomophthorales*) using numerical taxonomy. II. Taxonomic considerations. Can. J. Bot. 54: 1285–1296.

King DS. 1977. Systematics of *Conidiobolus* (*Entomophthorales*) using numerical taxonomy. III. Descriptions of recognized species. Can. J. Bot. 55: 718–729.

Srinivasan, MC, and Thirumalachar, MJ. 1967. Evaluation of taxonomic characters in the genus *Conidiobolus* with a key to known species. Mycologia 59:698–713.

Srinivasan MC, Thirumalachar MJ. 1968a. Two new species of *Conidiobolus* from India. J. Elisha Mitchell Sci. Soc. 84: 211–212.

Srinivasan MC, Thirumalachar MJ. 1968b. Studies on species of *Conidiobolus* from India. V. Mycopathol. Mycol. Appl. 36: 341–346.

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Typification of *Umbilicaria cinereorufescens*

GEIR HESTMARK

geir.hestmark@bio.uio.no
Department of Biology, University of Oslo
Pb. 1066 Blindern, N-0316 Oslo, Norway,

Abstract — The typification of the alpine lichen-forming fungus *Umbilicaria cinereorufescens* (Schaer.) Frey is discussed. A collection from the Herbier Lichénologique Schaerer (at G) is designated as lectotype.

Key words — nomenclature, *Umbilicariaceae*

Introduction

Since the recognition of *Umbilicaria cinereorufescens* as a distinct species by Eduard Frey (1931), this alpine lichen has been shown to have a worldwide distribution (Llano 1950, Poelt 1977, Krog & Swinscow 1986, Wei & Jiang 1993, Hestmark 1997). A clear typification of the species has, however, not been made, and this is a desideratum for taxonomic work on the genus *Umbilicaria*.

Umbilicaria cinereorufescens typically occurs on large siliceous, often wind-swept boulders in the lower alpine zone, usually at sites above the snow in winter. The thallus is coriaceous, mono- or polyphyllous, often with deep incisions, up to 7 cm in diameter; the upper surface light or medium grey to brown, smooth, sometimes undulating around center; the lower side is black, trabeculate around umbilicus, covered with numerous short, peglike or more irregular coralloid, black rhizinomorphs with thalloconidia; the medulla is white. Apothecia are rare, adnate, black, gyrose; asci: clavate; ascospores: 8-15 x 4-9 µm. The thalloconidia are dark brown to black, 6-10- to 30-40-cellular, 9– 25–64 x 9 – 18 – 48 µm, gross outline spherical to more elongated or irregular, seceded from the tips of the rhizinomorphs (Hestmark 1990). Spot tests of medulla PD-, K-, C+ red, KC+ red. Secondary metabolites include gyrophoric acid, lecanoric acid and crustinic acid (Posner et al. 1992). The photobiont is unicellular green algae, probably *Trebouxia* sp.

Nomenclature

The Swiss clergyman and lichenologist Ludwig Emanuel Schaerer (1785–1853) treated the genus *Umbilicaria* in several works and made many valuable

observations on the morphology and reproductive structures of these lichens. However, with regard to the delimitation of *Umbilicaria* species, their variation and nomenclature, he appears to have been very confused, even by species previously well described, delimited and depicted by Linnaeus, Hoffmann and Acharius.

Following an excursion to the Grimsel area in the Swiss Alps in 1816, Schaerer presented a first synopsis in 1817 (Schaerer 1817). Here our species was probably referred to the taxon '*Gyrophora depressa* b. *G. spadochroa* D. *vellea*' characterized as 'thallo supra ex glauco cinereo-rufescente' (Schaerer 1817: 6). The names '*depressa*' and '*spadochroa*' had previously been used by Acharius and Hoffman for varieties. The name '*vellea*' derives from Linnaeus' '*Lichen velleus*' (1753: 1150), today *Umbilicaria vellea* (L.) Hoffm. Schaerer lists Acharius' '*G. vellea*' as synonymous. The descriptive term 'cinereo-rufescente' for the upper surface colour means 'ash grey becoming red'.

In the monograph *Umbilicariae* Helveticae, accompanied by four beautiful hand-coloured plates with a total of 59 figures, Schaerer recognized only six species in the genus *Umbilicaria*, each with a lot of variation (Schaerer 1823). The taxon '*Umbilicaria depressa*' he first divided into the two varieties '*hirsuta*' and '*spadochroa*', and these varieties into respectively five and seven forms identified by letters (A to E, and A to G) (Schaerer 1823: 93-99). And even for each of these lettered forms he in some cases presented several specimens and figures of the plates, so that plate Tab. X was devoted exclusively to the var. *hirsuta* in 21 figures, and the plate Tab. XI to the var. *spadochroa* with 17 figures. In Tab XI depicting forms of var. *spadochroa*, the form E, characterized by 'Thallo sicco supra ex glauco cinereo-rufescente' (Schaerer 1823: 95 & 99) is presented by three figures: Fig. 8, 9, and 10, all, according to the text, depicting thalli from Grimsel.

In 1823 Schaerer also started to issue the exsiccate Lichenes helvetici exciccati (1823-1852) that eventually ran into 650 numbers. To this he issued the text Lichenum helveticorum spicilegium (1823-1842), which in its 12th and final section had only reached to describe the first 450 of the specimens issued in the exsiccate. In 1826 he issued Nos. 100-150 of the exsiccate (fasc. 5 & 6)(Schaerer 1826a), and in the same year he published the description of these specimens where he states that No. 142 corresponds to the form 'E. Sicco supra ex glauco cinereo-rufescens' figured in his Umbilicariae Helveticae (1823) Tab. XI, fig. 8, 9 and 10 (Schaerer 1826b: 83).

When Schaerer published his Enumeratio critica lichenum europaeorum (Schaerer 1850), he had exchanged his own species name '*U. depressa*' with Hoffmann's *Umbilicaria vellea*. Under the latter taxon he now included the different varieties and forms previously listed for '*U. depressa*', now with three varieties: '*hirsuta*', '*depressa*' and '*spadochroa*' also distinguished by Greek

letters α, β, γ. This shows that Schaerer was still very confused about several species. *Umbilicaria vellea*, *U. hirsuta* and *U. spodochroa* were by 1850 by many lichenologists recognized as well delimited, separate species (as they remain today). (The spellings '*spadochroa*' and '*spodochroa*' were both used in the 19th century literature). Schaerer's variety 'γ. *spadochroa*' was divided into seven forms distinguished by small letters and a name, and here we find 'e. *cinereo-rufescens* Schær.; thallo sicco supra ex glauco cinereo-rufescente Spic. 83. E. 362. Exs. 142. Schær. l.c. t. 11. f. 8, 9, 10. Umb. spadochroa DC! Moug. & Nestl.! exs. 540. Gyr. vellea Ach! Lich. velleus Ehrh! phytoph. n. 80. – Apud nos satis vulgaris.' (Schaerer 1850: 25).

Thus the basionym for *Umbilicaria cinereorufescens* is: *Umbilicaria vellea* γ. *spadochroa* e. *cinereo-rufescens* Schaer., Enum. crit. lich. eur. 1850: 25. The specific epithet '*cinereorufescens*' had previously been used in other genera, among them by Acharius for an *Urceoloria* species. Schaerer's claim that his taxon is identical to taxa described or exsiccated by several others, is only partly correct but need not concern us here. More relevant is his reference to his own exsiccate No. 142 (Schaerer 1826a) and to the figures 8, 9, and 10 from Tab XI from his monograph (Schaerer 1823).

Schaerer's confused *Umbilicaria* taxonomy was largely ignored by other lichenologists in the decades after the publication of his Enumeratio. When Eduard Frey in the 1920s commenced work with a complete revision the European species of *Umbilicaria* for Rabenhorst's cryptogam flora he could not, however, ignore Schaerer's work. Frey made substantial collections in the Alps, including the Grimsel where he collected many thalli of the species he would name *U. cinereorufescens*. He also found this species on Dovre in Norway. With regard to the name of this taxon he was, however, initially led astray by Arnold (1878), who had named this '*U. spadochroa f. mammulata*' (Frey 1929: 241–244), a name originally based on the American species '*Gyrophora mammulata*' described by Acharius (now *Umbilicaria mammulata*). When Frey sent specimens of this to the Finnish botanists Linkola and Häyren for comparison with the Acharius originals in Herb. Acharius (in H), they both ascertained that it was not identical to *U. mammulata* (Frey 1931: 109-110). Frey then found recourse to Schaerer's *Umbilicaria vellea* γ. *spadochroa* e. *cinereo-rufescens*, establishing the species *Umbilicaria cinereorufescens* mainly because what he calls the original specimen (das Originalexemplar), to fig. 10 on Tab. XI in Schaerer (1823) contain typical specimens of this species.

The specimens used by Schaerer for the illustrations in Schaerer (1823) Tab. XI, figs. 8, 9, and 10 are extant and can be identified in Schaerer's herbarium, which passed through the Herbarium Boissier and is now in G. They are all in folders marked with Schaerer exsiccate No. 142. The specimens depicted as fig. 8 and fig. 9 are now in two separate small envelopes in the bigger modern

brown envelope labelled (in pin-code) G00053125 (G) and 20050103/2 in pencil. On the one small envelope is handwritten in ink 'Specimen depictum t. XI. F. 8. Grimsel 8b 1816.', on the other 'Specimen depictum tab. XI. F. 9. Grimsel 8b 1816.' In addition this collection contains a card with five specimens glued onto it. Frey, who examined this collection (cf. Frey 1929: 248, and Frey 1931: 110), states correctly that the specimen for fig. 8 is *U. vellea*. He states the same for the specimen for fig. 9, which however, is *U. cinereorufescens*. The specimens glued on the plate are *U. vellea*. Thus the exsiccate No. 142 as well as the illustrations in Schaerer (1823) Tab. XI, fig. 8, 9 are a mixture of *U. vellea* and *U. cinereorufescens*. The exemplar of Schaerer's exsiccate in O exhibits the same mixture. *Umbilicaria cinereorufescens* is probably closely related to *U. vellea*. However, the latter species is easy to distinguish by having thin, white or ivory coloured, comparatively long rhizinomorphs in addition to the shorter, peglike, black, thalloconidiogeneous ones.

The collection that Schaerer (1823) evidently used for Tab. XI, fig. 10 is in a 'modern' brown envelope in G, marked Herbarium Genavense (G) **G00053127** (pin code number), and also labelled in pencil 20050103/4. Within this envelope is a smaller original envelope from Schaerer's herbarium. On this smaller envelope is handwritten in ink 'Specimen depictum tab XI. F. 10. Grimsel Specim. fertil.' On this envelope Frey has glued a small piece of paper with the inscription 'G. mammulata Ach. Em. Frey det. 1929 Ed. Frey'. Although the collection has not up to now in any way been marked as a type, or more specifically as type of *U. cinereorufescens*, this is clearly Schaerer's 'original specimen' referred to by Frey (1931: 110) for Frey's *Umbilicaria cinereorufescens*, and accordingly should be considered the type collection for this species.

Frey's use of the term Originalexemplar raises the question whether he in fact *did* select a type for *U. cinereorufescens*, and made a valid typification. Several authors (e.g. Llano 1950: 183, Wei & Jiang 1993: 197), who explicitly state that they have *not* seen the type, state the type of *U. cinereorufescens* to be in Schaerer's Herbarium in Institute of Systematic Botany, University of Geneva, without any further specification of collection number, collector, place of collection, year of collection etc. Other authors (e.g. Poelt 1977: 417, Krog & Swinscow 1986: 81) do not cite a type for this particular species although they *do* for many other *Umbilicaria* species, thus indicating that the question regarding the typification of *U. cinereorufescens* has not been sufficiently investigated and unambiguously resolved. Frey did not use the term 'type' or 'typus', neither did he in any way mark the collection now in **G00053127** to indicate it as what we today would call a type. Neither did he write the term 'Originalexemplar' anywhere on this collection. On the other hand it seems probable that when Frey in his lichenological works used the term 'Originalexemplar', he sometimes meant the same or nearly the same that we today mean by a type. But for instance

in Frey (1929: 243) he clearly uses the term differently, namely to denote the lichen thallus that was the 'original' for a particular *illustration*. Is **G00053127** then to be identified as the holotype or a lectotype? Because of the ambiguity of Frey's use of 'Originalexemplar' I suggest that a lecotypification is appropriate.

There are several thalli in the type collection **G00053127**: two unattached and fairly complete thalli, with 4.5 and 5 cm as their largest diameter respectively, and both with a few well developed gyrose apothecia. In addition there is one large thallus fragment, pluss several smaller fragments, all identifiable as typical *Umbilicaria cinereorufescens*. It is not possible to unambiguously identify which of these items is the thallus depicted as fig. 10, plate XI in Schaerer's *Umbilicariae* Helveticae (1823). As McNeill et al. (2006: Art. 8.2) allow for the typification of a species on multiple small plants, we hereby designate as Lectotype (designated here) of *Umbilicaria cinereorufescens* (Schaer.) Frey the entire collection: Herbarium Genavense (G) **G00053127** (pin code number), and also labelled in pencil 20050103/4.

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Literature cited

Arnold F. 1878. Lichenologische Ausflüge in Tirol. 18 & 19. Verhandlungen des zoologisch-botanischer Gesellschaft Wien 28: 247-296.

Frey E. 1929. Beiträge zur Biologie, Morphologie und Systematik der Umbilicariaceen. Hedwigia 69: 219- 252.

Frey E. 1931. Weitere Beiträge zur Kenntnis der Umbilicariaceen. Hedwigia 71: 94-119.

Hestmark G. 1990. Thalloconidia in the genus *Umbilicaria*. Nordic Journal of Botany 9: 547-574.

Hestmark G. 1997. Species diversity and reproductive strategies in the family *Umbilicariaceae* on high equatorial mountains - with remarks on global patterns. Bibliotheca Lichenologica 68: 195-202.

Krog H, Swinscow TDV. 1986. The lichen genera *Lasallia* and *Umbilicaria* in East Africa. Nordic Journal of Botany 6: 75-85.

Linnaeus C. 1753. Species Plantarum. 1ed. Stockholm.

Llano GA. 1950. A Monograph of the Lichen Family *Umbilicariaceae* in the Western Hemisphere. Navexos P-831. Office of Naval Res. Dep. Navy, Washington, D. C.

McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Regnum Vegetabile 146. 568 p.

Poelt J. 1977. Die Gattung *Umbilicaria* (*Umbilicariaceae*). Flechten des Himalaya 14. Khumbu Himal 6/3: 397-435.

Posner B, Feige GB, Huneck S. 1992. Studies in the Chemistry of the Lichen Genus *Umbilicaria* Hoffm. Zeitschrift für Naturforschung 47c: 1-9.

Schaerer LE. 1817. Gyrophorum helveticarum adumbratio, ex majori opere manuscripto excerpta. Naturwissenschaftlicher Anzeiger der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften. 1 July, Vol. 1: 6-8.

Schaerer LE. 1823. *Umbilicariae* Helveticae. In: N. C. Seringe (ed.) Musée Helvétique d'Histoire-Naturelle (Partie Botanique) Tome I: 85-114. Tab. X-XIII. Berne.

Schaerer LE. 1826a. Lichenes helvetici exsiccati....Fasc. 5-6. Nos. 101-152. Bernae.

Schaerer LE. 1826b. Lichenum helveticorum spicilegium. [Pars prima.] Sectio secunda. Lichenum Exsiccatorum fasciculos V. et VI illustrans. p. [i-vi], 53-100. Bernae, Typis Ludov. Alberti Haller.

Schaerer LE. 1850. Enumeratio critica lichenum europaeorum quos ex nova methodo digerit. Bernae. Sumtibus auctoris excudebat officina Staempfliana.

Wei J, Jiang Y. 1993. The Asian *Umbilicariaceae*. Mycosystema Monographicum Series No. 1. International Academic Publishers. Beijing.

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Clitopilus amygdaliformis, a new species from tropical China

ZHU L. YANG

fungi@mail.kib.ac.cn
Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650204, Yunnan, China

Abstract—*Clitopilus amygdaliformis* is described and illustrated as new from tropical China. It is characterized by its white to chalk white, small to medium-sized basidioma with an eccentric stipe, absence of pleuro- and cheilocystidia, and broadly amygdaliform to limoniform basidiospores with 5-6 prominent longitudinal ridges and a distinct suprahilar depression. It was regarded as *C. prunulus*, but the latter has a pileus often with somewhat grayish tinge, a central to slightly eccentric stipe, longer and narrower fusiform basidiospores and a temperate habitat.

Key words—taxonomy, *Entolomataceae*, *Agaricales*, *Basidiomycota*

Introduction

The genus *Clitopilus* P. Kumm. (*Entolomataceae*, *Agaricales*) in China has received little study, although a few species, namely *C. apalus* (Berk. & Broome) Petch, *C. crispus* Pat., *C. gigantosporus* M. Zang, *C. hobsonii* (Berk.) P. D. Orton, *C. prunulus*, *C. scyphoides* f. *omphaliiformis* (Joss.) Noordel., have been recorded (Bi et al. 1997, Chang & Mao 1995, Chou 2005, Chou & Chang 2005, Yang 2000, Zang 2001). In this study, collections made from southern parts of China, including Taiwan, were re-examined. It turned out that an undescribed species was collected from the vast regions with tropical and subtropical forests. It is reported herein.

Materials and methods

Specimens were annotated and photographed in the field, dried in an electric drier, and then deposited in herbaria. Herbarium abbreviations follow Holmgren et al. (1990) but with one exception that is not included in Index Herbariorum: HKAS-the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences.

Revived tissues were mounted in 5% KOH for microscopic examination. The abbreviation [*n/m/p*] shall mean *n* basidiospores measured from *m* basidiocarps of *p* collections. Dimensions of basidiospores excluding the apiculus are given with notation of the form *(a) b-c (d)*. The range *b-c* contains a minimum of 90% of the measured values. Extreme values *a* and *d* are given in parentheses. Q refers to the length/width ratio of basidiospores; **Q** refers to the average Q of all basidiospores ± sample standard deviation.

Taxonomy

Clitopilus amygdaliformis Zhu L. Yang, **sp. nov.** **Figs. 1-4**

MycoBank MB 510601

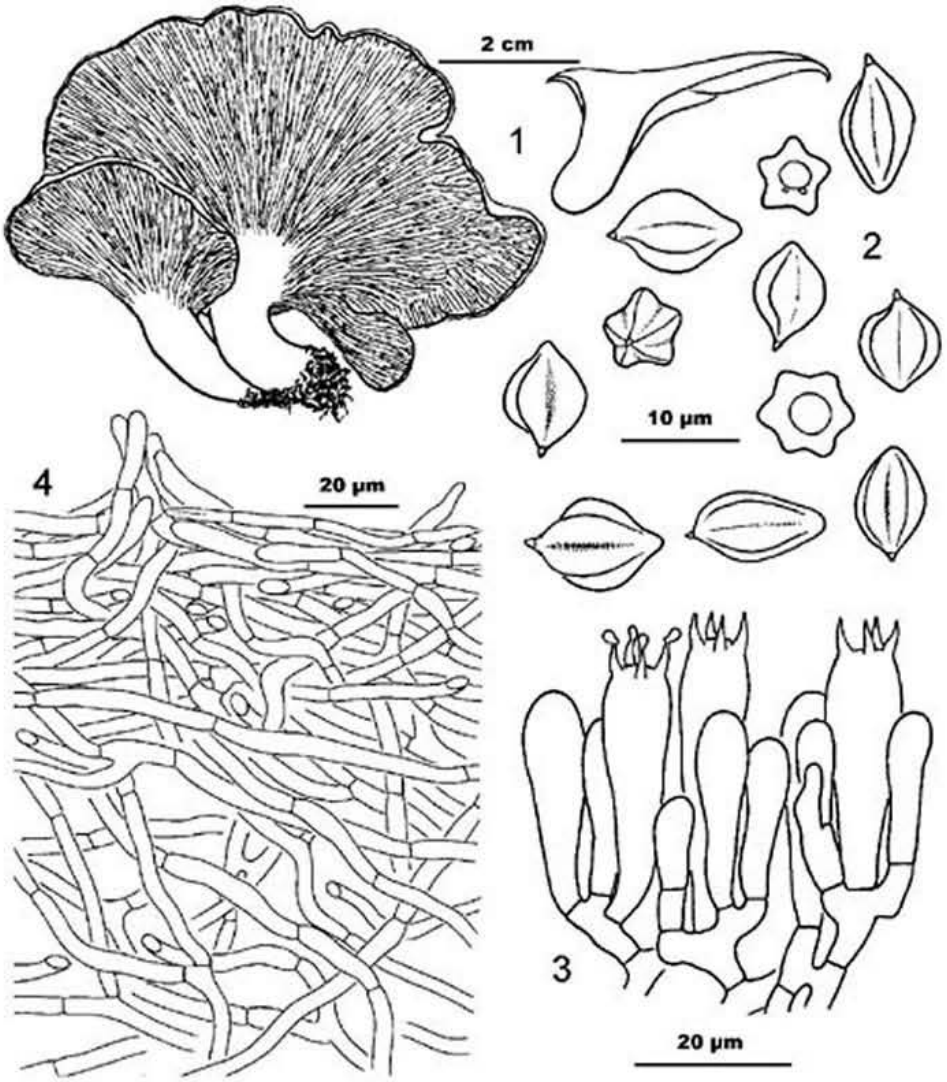
Name misapplied to the present species: *Clitopilus prunulus* sensu W. N. Chou, Fung. Flora Taiwan 3: 987, fig. 25 (2005); non *Clitopilus prunulus* (Scop.: Fr.) P. Kumm., Führ. Pilzk.: 97 (1871).

Pileus 2-8(11) cm latus, convexus vel applanatus, albus vel albidus, siccus, glaber, margine incurva et undulata. Lamellae decurrentes, primo albae deinde pallide roseolae, 3 mm latae. Stipes 1-4(6) × 0.2-1 cm, subcylindricus, albus vel albidus, excentricus, exannultus, albus vel albidus. Caro alba. Basidia 23-36 × 8-10 µm, clavata, hyalina, 4-sporigera. Basidiosporae (7.0) 8.0-11.5 (13.0) × 6.0-8.0 (8.5) µm, in aspectu frontali et obliquo amygdaliformes vel limoniformes, porcis longitudinalibus manifestis, in aspectu polari valde angulatis, 5-6 (7) pagindis praeditis. Pleurocystidia et cheilocystidia absentes. Epicutis pilei ex hyphis repentibus cylindricis non-incrustatis composita. Fibulae absentes. Habitatio: terrestris. Holotypus: L.F. Zhang 187 (HKAS 42473), 17 July 2003, Yunnan, China.

Etymology: *amygdaliformis*, amygdaliform, referring to the form of the basidiospores.

Basidiomata (Fig. 1) small to medium. **Pileus** 2-8 (11) cm in diam., convex to plano-convex, often slightly depressed above the stipe, white to chalk white, but with cream colour over disc, slightly viscid when wet, glabrous; margin at first incurved, then straight, often undulate. **Lamellae** decurrent, whitish, then pinkish, crowded, up to 3 mm in height; edge entire and concolorous; lamellulae numerous. **Stipe** 1-4 (6) × 0.2-1 cm, white to whitish, unchanging, usually eccentric, occasionally nearly lateral, subcylindrical, smooth, basal part sometimes with white cottony mycelium. **Annulus** absent. **Context** 2-5 mm in thickness, white, unchanging; odor none or farinaceous; taste mild.

Basidia (Fig. 3) 23-36 × 8-10 µm, clavate, hyaline, 4-spored, rarely 1- or 2-spored; sterigmata 3-4 (5) µm long; no clamps observed on basal septa. **Subhymenium** composed of hyphal segments 3-6 µm in diam. Lamellar trama composed of more or less regularly arranged, branching and anastomosing hyphae 3-12 µm in diam.; oleiferous hyphae rare. **Basidiospores** (Fig. 2) [96/4/3] (7.0) 8.0-11.5 (13.0) × 6.0-8.0 (8.5) µm, Q = (1.07) 1.14-1.54 (1.83) (**Q** = 1.33 ± 0.14), nearly colorless and hyaline, thin- to slightly thick-walled (wall < 0.5 µm thick),



Figs. 1-4: *Clitopilus amygdaliformis* (holotype). 1. Basidiomata; 2. Basidiospores in side view, ventral view and polar view; 3. Subhymenium and hymenium with basidia at different stages of development. 4. Pileipellis and subcutis. Note terminal cells of pileipellis often grouped into fascicles on pileal surface; subcutis composed of irregularly and somewhat loosely arranged hyphae.

amygdaliform to limoniform in side view and often with a distinct suprahilar depression, limoniform to sometimes nearly ovoid in ventral view, strongly angled in polar view, with 5-6 (7) obvious longitudinal ridges; ridegs 1-1.5 µm in height. **Pleurocystidia** and **cheilocystidia** absent. **Pileipellis** (Fig. 4) a cutis composed of more or less radially arranged, repent, colorless and hyaline, non-encrusted filamentous hyphae 2-5 µm in diam.; terminal cells subcylindric,

fusiform or narrowly clavate, 3-7 µm in diam., on pileal surface often grouped into fascicles; subcutis composed of more or less irregularly and somewhat loosely arranged, thin-walled, colorless and hyaline filamentous hyphae 3-6 µm in diam. **Clamps** absent in all tissues.

Habit, habitat, distribution and season — Single or groups, on soil in broad-leaved (*Lithocarpus*, *Ternstroemia*) or coniferous (*Pinus*) forests; China (Taiwan and Yunnan). July to August.

COLLECTIONS EXAMINED—China, Yunnan Province, Baoshan Municipality, Bawan, alt. 2100m, 17.VII.2003, L.F. Zhang *187* [holotype, HKAS *42473*]. Taiwan Province, Nantou County, Yuanfeng, 24°.07′N, 121°.14′E, alt. 2750m, 20.VII.1999, W.N. Chou *CWN 4390* [TNM-F *13317*, as *C. prunulus* by Chou (2005)]; ibid, 24°.07′N, 121°.13′E, alt. 2800m, 10.VIII.2000, W.N. Chou and Y.P. Yen *CWN 4757* [TNM-F *14390*].

Comments—*Clitopilus amygdaliformis* is characterized by its white to chalk white, small to medium-sized basidioma with an eccentric stipe, absence of pleuro- and cheilocystidia, and broadly amygdaliform to limoniform basidiospores with 5-6 prominent longitudinal ridges and a distinct suprahilar depression. It should be placed in *Clitopilus* section *Clitopilus* due to its well developed stipe and large basidiospores with less than 7 prominent longitudinal ridges (Singer 1986).

In section *Clitopilus* five species, namely *C. griseobrunneus* T.J. Baroni & Halling, *C. lignyotus* Hongo, *C. prunulus*, *C. paxilloides* Noordel. and *C. quisquiliaris* (P. Karst.) Noordel., have been recognized (Baroni & Halling 2000). *Clitopilus griseobrunneus*, originally described from Costa Rica, differs from *C. amygdaliformis* by its brown to grayish brown pileus, the usually central stipe, much longer basidiospores, and dark brown incrusted hyphae in the pileipellis with subcapitate terminal elements (Baroni & Halling 2000). *Clitopilus lignyotus*, originally described from Japan, differs from *C. amygdaliformis* by its grayish brown to blackish brown pileus, the usually central stipe, and much narrower basidiospores (Hongo 1954). *Clitopilus paxilloides*, originally described from Norway, has a stouter, thicker-fleshed basidioma with a grey-brown pileus with strongly involute margin or grey-brown spots on the pileus surface, a grey-brown to greyish stipe, narrower basidiospores with higher Q (1.45-2.1), and strongly encrusting pigment in the pileipellis (Noordeloos 1993). *Clitopilus prunulus*, originally described from Europe, usually has a pileus with somewhat grayish tinge, a central or only slightly eccentric stipe, longer and narrower fusiform basidiospores with 5-8 longitudinal ridges and size of 9-13 × 4-6.5 (8) µm with much higher Q (1.3-2.0) (Hansen & Knudsen 1992, Noordeloos 1988, 1993, Pegler & Young 1971, 1975, Yang 2000). Furthermore, *C. prunulus* is distributed in northern temperate regions. *Clitopilus quisquiliaris* is only known from Nordic regions of Europe and differs from *C. amygdaliformis* by its

reddish brown pileus, smaller basidiospores, and habit of growing on enriched soils (Hansen & Knudsen 1992, Noordeloos 1981, 1993).

In the field in tropical China, *C. amygdaliformis* may be confused with *C. apalus* var. *apalus*, *C. crispus* and *C. orientalis* T.J. Baroni & Watling, all of which were originally described from tropical south East Asia and South Asia, and found in tropical China, and *C. apalus* var. *macrosporus* T.J. Baroni & Watling, originally described from Uganda, Africa. However, all these taxa posses much smaller basidiospores with lower but more (7-12) longitudinal ridges. Furthermore, *C. apalus* usually has smaller basidiomata, *C. crispus* has radially arranged fine ridges on the pileus with a subfimbriate margin, and *C. orientalis* has cheilocystidia (Baroni & Watling 1999, Pegler 1977, 1986, Singer 1978). *Clitopilus chalybescens* T.J. Baroni & Desjardin, described from Thailand (Baroni et al. 2001), differs from *C. amygdaliformis* by its grayish blue discoloration of the infundibuliform pileus and the central stipe with age, subcapitate pileocystidia and significantly smaller ellipsoid basidiospores with 8-10 longitudinal ridges.

Acknowledgments

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Literature cited

Baroni TJ, Desjardin DE, Hywel-Jones N. 2001. *Clitopilus chalybescens*, a new species from Thailand. Fungal Diversity 6: 13-17.

Baroni TJ, Halling RE. 2000. Some *Entolomataceae* (*Agaricales*) from Costa Rica. Britonia 52: 121-135.

Baroni TJ, Watling R. 1999. Taxonomic and mycogeographic notes on some Malaysian fungi IV. Notes on *Clitopilus* and *Rhodocybe*. Mycotaxon 72: 57-72.

Bi ZS, Li TH, Zhang WM, Song B. 1997. A preliminary agaric flora of Hainan Province. Guangdong Higher Education Press: Guangzhou (China). 388 pp. (in Chinese).

Chang ST, Mao XL. 1995. Hong Kong mushrooms. The Chinese University of Hong Kong: Hong Kong (China). 470 pp.

Chou WN. 2005. *Clitopilus*. In: Tzean SS, Hsieh WH, Chang TT, Wu SH (eds). Fungal flora of Taiwan. Vol. 3: 957-1422. National Science Council: Taipei (China).

Chou WN, Chang TT. 2005. Mushrooms of Taiwan. Yuan-Liou Publishing Co., Ltd.: Taipei (China). 439 pp. (in Chinese).

Hansen L, Knudsen H (eds). 1992. Nordic macromycetes. Vol. 2. Nordsvamp: Copenhagen (Denmark). 474 pp.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I: herbaria of the world. 8th edition. New York Botanical Garden: New York (USA). 693 pp.

Hongo T. 1954. Notes on Japanese larger fungi (5). Journal of Japanese Botany 29: 87-92.

Noordeloos ME. 1981. *Entoloma* subgenera *Entoloma* and *Allocybe* in the Netherlands and adjacent regions with a reconnaissance of their remaining taxa in Europe. Persoonia 12: 153-256.

Noordeloos ME. 1988. Family *Entolomataceae*. In: Bas C, Kuyper ThW, Noordeloos ME, Vellinga EC (eds). Flora agaricina neerlandica. Vol. I. A. A. Balkema: Rotterdam (Holland). 182 pp.

Noordeloos ME. 1993. Studies in *Clitopilus* (*Basidiomycetes, Agaricales*) in Europe. Persoonia 15: 241-248.

Pegler DN. 1977. A revision of *Entolomataceae* (*Agaricales*) from India and Sri Lanka. Kew Bulletin 32: 189-220.

Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bulletin Additional Series 12: 1-519.

Pegler DN, Young TWK. 1971. Basidiospore morphology in the *Agaricales*. Nova Hedwigia Beiheft 35: 1-210.

Pegler DN, Young TWK. 1975. Basidiospore form in the British species of *Clitopilus, Rhodocybe* and *Rhodotus*. Kew Bulletin 30: 19-32.

Singer R. 1978. Keys for the identification of the species of *Agaricales* II. Sydowia 31: 193-237.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th edit. Koeltz Scientific Books: Koenigstein (Germany). 988 pp.

Yang ZL. 2000. Notes on five common but little known higher Basidiomycetes from tropical Yunnan, China. Mycotaxon 74: 45-56.

Zang M. 2001. Two new tropical mycotaxa from Yunnan, China. Acta Botanica Yunnanica 23: 295-297.

MYCOTAXON

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First record of the genus *Byssosphaeria (Pleosporales)* in Mexico and Venezuela

ROSARIO MEDEL

rosario.medel@inecol.edu.mx
Instituto de Ecología, Unidad de Micología
Apartado postal 63, Xalapa 91000, Veracruz, México

Abstract—The genus *Byssosphaeria* is recorded for first time from Mexico and Venezuela. *B. jamaicana*, is recorded from Mexico and *B. schiedermayeriana* from Venezuela, both species were found in cloud forests.

Key words—*Ascomycota*, *Melanommataceae*

Byssosphaeria Cooke is an ascomycete that belongs to the order *Pleosporales* and includes at least 10 widely distributed species (Kirk et al. 2001). Bibliographic information about this genus is scarce (Barr 1984, Hyde et al. 1999). The *Pleosporales* contain 179 genera (Kirk et al. 2001) and is a group of fungi that is little known in Mexico. According to Medel et al. (1999) only three genera had been reported by 1996: *Sporormia* De Not., *Sporormiella* Ellis & Everh. and *Delitschia* Auersw. (Ahmed & Cain 1972, Udawaga & Kobayasi 1979). On the other hand there are no records of this genus from Venezuela (Iturriaga et al. 2000). These constitute the first records of the genus *Byssosphaeria* for both countries.

The material studied was mounted in KOH 5% and Melzer's iodine reagent. The specimens are deposited in the Mycological Collection of the Instituto de Ecología (XAL).

Byssosphaeria jamaicana (Sivan.) M.E. Barr, Mycotaxon 20: 34, 1984. **Figs. 1-5**
≡ *Herpotrichia jamaicana* Sivan., Mycol. Pap. 127: 35, 1971.

Ascomata 0.3–0.5 mm in diameter, globose, with the pore region almost plane, dark brown externally, surface roughened, with a pale brown ring around the small ostiole, stroma with appendages, more evident when stromata are crowded. Pseudoparaphyses up to 1 µm diameter. Asci 130–135 x 11–12 µm, with eight spores, cylindric-clavate with a stalk. Ascospores 30–35 (–38) x 5–7

(-8) µm, fusiform, 1-3 septate, markedly constricted in the central region, hyaline to olivaceous brown, with the ends dark and acute.

Habitat: gregarious, on *Quercus* fruit cupules, on the ground, in cloud forests at 1400 m altitude.

Specimen examined—MEXICO. VERACRUZ. Municicpality of San Andrés Tlalnehuayocan, San Antonio Hidalgo, 11/XI/1999, *Jarvio 379* (XAL).

Notes—The pale brown region surrounding the ostiole, the size of ascospores, and their acute dark ends are diagnostic characters (Barr 1984). This species can be distinguished from *B. salebrosa* (Cooke & Peck) M.E. Barr, which has spores (30-) 40-50 x (6-) 7-9 µm, with 1-5 septa and ascomata without appendages. It is also different from *B. schiedermayeriana* (Fuckel) M.E. Barr, which has a bright orange zone around the ostiole. *B. jamaicana* is also reported from Puerto Rico, Trinidad and Jamaica (Barr 1984), who noted that "It is probably much more widespread than these records indicate. I suspect some collections identified as '*Herpotrichia schleidermayeriana* with pallid pore region' belong instead to *B. jamaicana.*" She reported this species on decorticated rotting wood, but the material studied here was growing on *Quercus* fruit cupules.

Byssosphaeria schiedermayeriana (Fuckel) M.E. Barr, Mycotaxon 20: 34, 1984.

Fig. 6

= *Herpotrichia schiedermayeriana* Fuckel, Jahrb. Nass. Ver. Naturk. 27-28: 27, 1873 (for an extensive synonymy see Barr, 1984).

A complete description of this species is provided in Hyde et al. (1999), and the material also fits well with the description given by Barr (1984). The material studied shows clearly the mucilaginous sheaths at the ends of the ascospores, which is unique in this species.

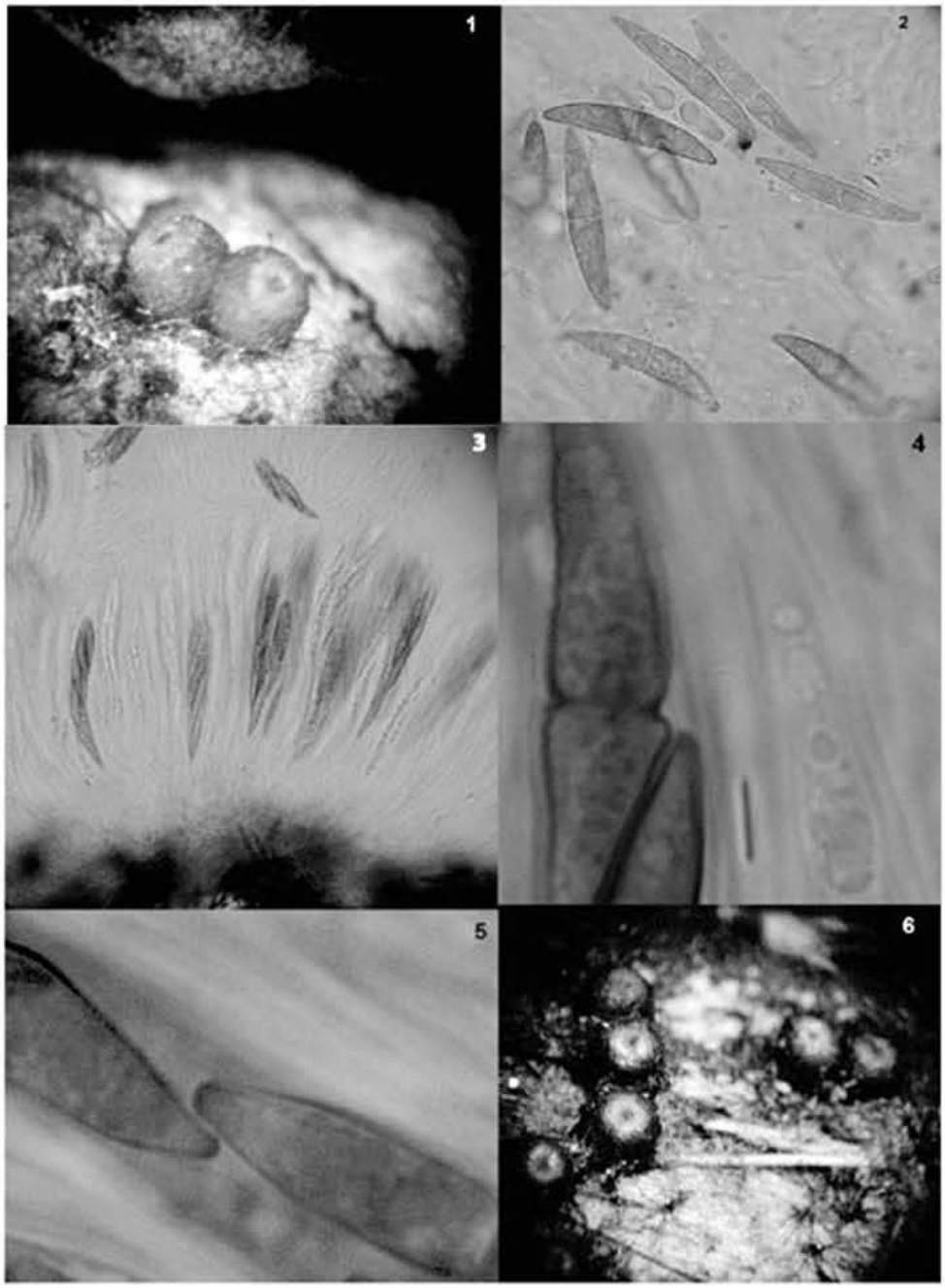
Habitat: gregarious, on decaying wood, in cloud forests.

Specimen examined—VENEZUELA. ARAGUA. Parque Nacional Henry Pittier, Rancho Grande Biological Station 29/VIII/ 1999, *Medel 730-b, Chacón 5190* (both in XAL).

Notes—The diagnostic characters of this species are the bright orange region around the ostiole and the ascospore size, 1-3 septate with a mucilaginous sheath. *B. schiedermayeriana* is known from North and South America, Europe, Africa, Asia, Australia, Malaysia and the Philippines (Barr 1984, Hyde et al. 1999) and is recorded here for the first time for Venezuela.

Acknowledgments

Thanks to Dr. Gastón Guzmán from Instituto de Ecología at Xalapa for critically reading this paper, also to Dr. Fernando Fernandez (Field Museum), especially to Dr. Richard Korf for critical review and observations to improve this work, and to Juan Lara Carmona (Instituto de Ecología) for help in the herbarium work.



Figs. 1-6. 1-5. *Byssosphaeria jamaicana*, 1: stromata (10x); 2: ascospores (100x); 3: Asci and ascospores (40x); 4: ascospores showing the septa markedly constricted in the central region (100x); 5: Ascospores showing the dark ends (100x). Fig. 6. *B. schiedermayeriana*: stromata (10x). Photographs R. Medel, from *Jarvio 379* (Figs.1-5) and *Medel 730-b* (Fig. 6).

Literature cited

Ahmed SI, Cain RF. 1972. Revision of the genus *Sporormia* and *Sporormiella*. Can. Journ. Bot. 50: 419-477.

Barr ME. 1984. *Herpotrichia* and its segregates. Mycotaxon 20: 1-38.

Kirk P, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the fungi. 9 ed. CABI Bioscience, Bakeham Lane, UK.

Iturriaga T, Páez I, Sanabria N, Holmquist O, Bracamonte L, Urbina H. 2000. Estado actual del conocimiento de la Micobiota en Venezuela. PNUD, USB, Caracas, Venezuela.

Hyde K, Goh TK, Taylor JE, Fröhlich J. 1999. *Byssosphaeria, Chaetosphaeria, Niesslia* and *Ornatispora* gen. nov. on palm. Mycological Research 103: 1423-1439.

Medel R, Guzmán G, Chacón S. 1999. Especies de macromicetos citadas de México. IX. Ascomycetes parte III: 1983-1996. Acta Bot. Mexicana 46: 57-72.

Udagawa S, Kobayasi K. 1979. Coprophilous fungi from Mexican Volcano Popocatepetl. Journ. Japan Bot. 54:1-8.

MYCOTAXON

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Phyllachora tengchongensis sp. nov. and a new record of *Phyllachora* (*Phyllachorales*) from China

NA LIU[1,2] & LIN GUO[1]*

liuna3456@163.com & guol@sun.im.ac.cn

[1]*Key Laboratory of Systematic Mycology and Lichenology*
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

[2]*Graduate University of Chinese Academy of Sciences*
Beijing 100049, China

Abstract—A new species, *Phyllachora tengchongensis* on *Miscanthus floridulus* and a new Chinese record, *Phyllachora americana* on *Capillipedium parviflorum* are reported.

Key words—*Sordariomycetidae*, tar spot, taxonomy

A new species of *Phyllachora* on leaves of *Miscanthus floridulus* was collected from Yunnan and Hunan Provinces in 2005. Two species of *Phyllachora* have been recognised on the genus of *Miscanthus*: *Phyllachora miscanthi* Syd. & P. Syd. (Sydow & Sydow 1917, Parbery 1967, 1971) and *Phyllachora ischaemi* Syd. & P. Syd. (Parbery 1967). *Phyllachora emeishana* J.Y. Li & H.R. Luo (Luo 1984) was described in Luo's master dissertation, so it was not effectively published. The new species of *Phyllachora* reported here differs from *Phyllachora miscanthi* in having narrow ascospores, while the latter has broadly ellipsoid ascospores measuring 18–24 x 12–14 µm. The new species differs from *Phyllachora ischaemi* in having large, oblong ascospores with one end acute or ovate-acuminate. Thus, a new species is described as:

Phyllachora tengchongensis Na Liu & L. Guo, **sp. nov.** **Figs. 1-4**

MYCOBANK MB510598

Maculae epiphyllae, 0.3–1.7 x 0.3–0.8 mm, nigrae, nitidae. Cellulae conidiogenae 14–20 x 1.4–1.8 µm, cylindricae. Conidia 16–25 x 0.2 µm, hyalina, filiformia. Ascomata 135–740 x 100–260 µm, supra epidermidem evoluta, ellipsoidea vel irregularia. Asci 93–159 x 15–23 µm, octospori, clavati, unitunicati, pedunculati. Ascosporae 15–26 x 5–10 µm, uniseriatae

*corresponding author

vel irregulariter biseriatae, unicellulares, hyalinae, anguste ellipsoideae, oblongae, extremo acutae vel ovato-acuminata.

Leaf spot: blackened regions sparse, roughly circular or ellipsoidal, 0.3–1.7 x 0.3–0.8 mm, shining black, 1- to 2- loculate, the ostiole inconspicuous, blackened regions may be visible from both sides of the leaves.

Anamorph: conidiogenous cells arranged in groups, cylindrical, tapering towards the apices, 14–20 x 1.4–1.8 µm. Conidia 16–25 x 0.2 µm, filiform, some curved, thin-walled, hyaline, aseptate.

Teleomorph: ascomata 135–740 x 100–260 µm, epigenous, immersed in the upper epidermis layer of the leaves, ellipsoidal, some irregularly shaped due to compression forces, asci rising from the basal and lateral wall of the ascoma. Upper wall up to 68 µm thick, composed of epidermis cells which are occluded by melanized material. Lower wall up to 43 µm thick. Lateral wall up to 43 µm thick, composed of thin-walled cells. Paraphyses up to 3 µm wide, thin-walled, gradually tapering, no branching, septate. Asci 93–159 x 15–23 µm, 8-spored, clavate, short pedunculate, thin-walled at maturity, unitunicate. Ascospores arranged uniseriate or irregularly biseriate, 15–26 x 5–10 µm, narrowly ellipsoid, oblong with one acute end or ovate-acuminate, one-celled, hyaline, thin-walled, smooth, guttulate, with a gelatinous sheath. When over-matured, the ascospores become yellow.

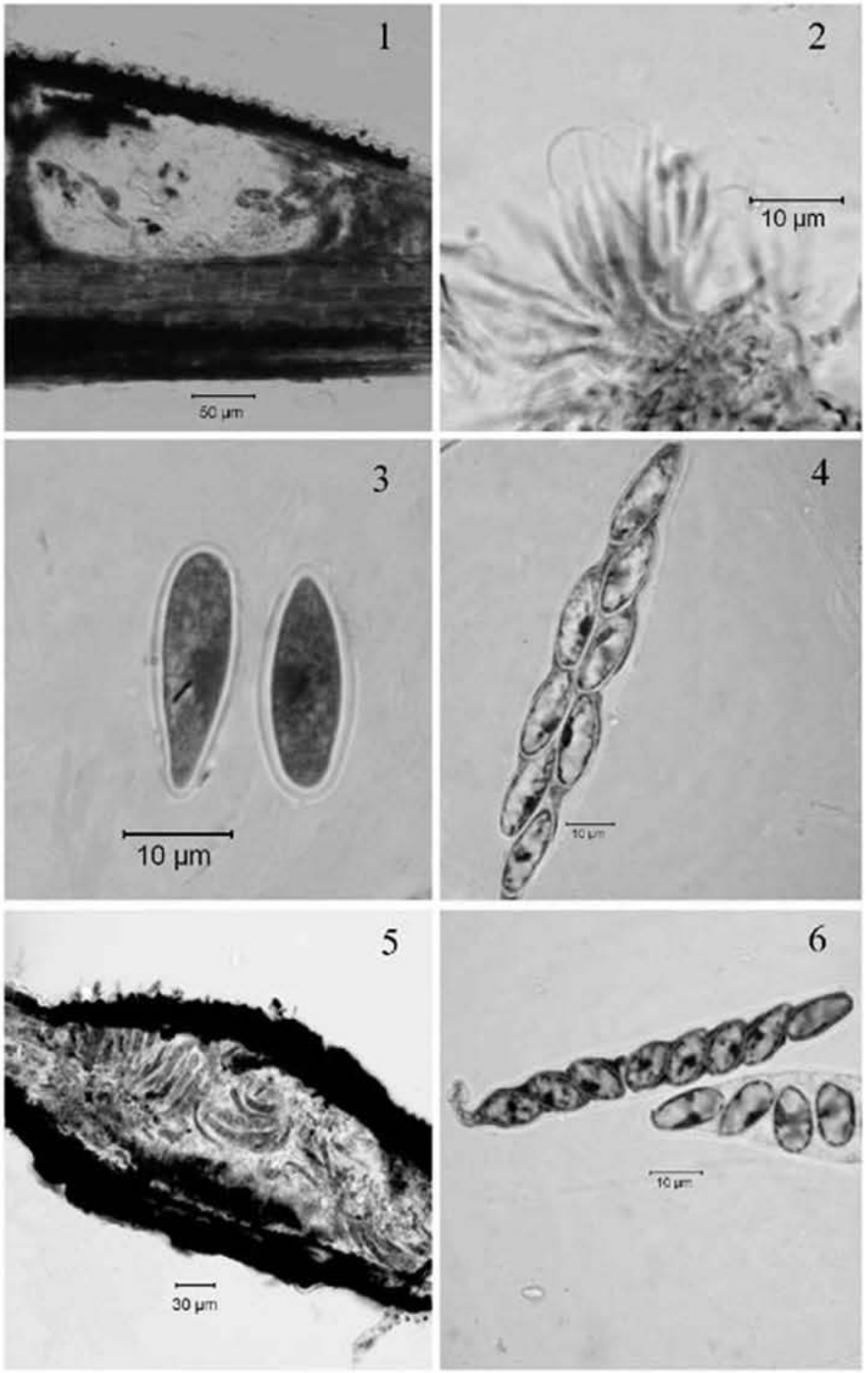
Specimens examined–On living leaves of *Miscanthus floridulus* Warb. ex K. Schum. & Lauterb. (*Poaceae*), China, Yunnan, Tengchong, alt. 1600 m, 20 IX 2005, N. Liu, Z.Y. Li & L. Guo 146, HMAS 169551 (holotype); China, Hunan, Changde, Taiyang mountain, alt. 470m, 18 IV 2005, Z.Y. Li & L. Guo 23, HMAS 169552 (Paratype).

The specimen of *Phyllachora* on *Capillipedium parviflorum* was collected from Yunnan Province. Previously, only *Phyllachora ischaemi* was reported on *Capillipedium*, which often has slightly constricted ascospores (Parbery 1967, Pearce & Hyde 2006). The specimen collected by us has similar ascospores to *Phyllachora americana*, but no constriction at the centre, since the hosts are the same plants (*Andropogon micranthus* Kunth was synonymized with *Capillipedium parviflorum*, Chen et al. 1997), so we identified it as:

Phyllachora americana Parbery, Aust. J. Bot 15: 290, 1967. Figs. 5-6

Leaf spot: blackened regions sparse, rarely aggregated, roughly circular, ellipsoidal, flattened, 0.5–1.7 x 0.2–0.5 mm, shining black, multi-loculate, sometimes up to 8- loculate, the ostiole inconspicuous, blackened regions can be seen from both sides of the leaves.

Figs. 1-4. *Phyllachora tengchongensis*. Fig. 1. Section through immersed ascoma. Fig. 2. Differential interference micrograph of conidia and conidiogenous cell. Figs. 3-4. Differential interference micrograph of ascus and ascospores. Figs. 5-6. *Phyllachora americana*. Fig. 5. Section through immersed ascoma. Fig. 6. Differential interference micrograph of asci and ascospores.


1
50 µm
2
10 µm
3
10 µm
4
10 µm
5
30 µm
6
10 µm

Anamorph: not seen.

Teleomorph: ascomata 125–425 x 50–95 µm, immersed in the mesophyll layer of the leaves, ellipsoidal, with well-developed, hyaline periphyses, asci rising from the basal and lateral wall of the ascoma. Upper wall up to 45 µm thick. Lower wall up to 25 µm thick. Lateral wall up to 20 µm thick, composed of thin-walled cells. Paraphyses abundant, longer than asci, 2 µm wide, thin-walled, no branch, septate. Asci 73–105 x 10–15 µm, 8-spored, cylindrical, obtuse at apex, with apical ring, short pedunculate, thin walled at maturity, unitunicate. Ascospores arranged uniseriate or irregularly biseriate, 9.5–17.5 x 6–8 µm, ellipsoid, ovoid, guttulate, one-celled, hyaline, smooth, without a gelatinous sheath.

Specimens examined–on living leaves of *Capillipedium parviflorum* (R. Br.) Stapf, China, Yunnan, Tengchong, 20 IX 2005, N. Liu , Z.Y. Li, L. Guo 147, HMAS 169553.

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Literature cited

Chen SL, Zhuang TD, Fang WZ, Sheng GY, Jin YX, Liu L, Sun BS, Hu ZH, Wang S. (eds.) 1997. Flora Reipublicae Popularis Sinicae, Tomus 10 (2), *Angiospermae, Monocotyledoneae, Gramineae* (*Poaceae*) (5), Science Press, Beijing, 339 pp.

Luo HY. 1984. Studies on graminicolous species and their divisional criteria of *Phyllachora* in China. Master's Dissertation. Northwest Agricultural college, Yangling, 110 pp.

Parbery DG. 1967. Studies on graminicolous species of *Phyllachora* Nke. in Fckl. V. A taxonomic monograph. Austr. J. Bot. 15: 271-375.

Parbery DG. 1971. Studies on graminicolous species of *Phyllachora* Nke. in Fckl. VI. Additions and corrections to Part V. Austr. J. Bot. 19: 207-235.

Pearce CA, Hyde KD. 2006. *Phyllachoraceae* of Australia. Fungal Diversity Research Series 18: 1-308.

Sydow H, Sydow P. 1917. Beitrag zur Kenntnis der Pilzflora der Philippinen-Inseln. Ann. Mycol. 15: 165-268.

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New records of lichenicolous and lichenized fungi from Turkey

MEHMET GÖKHAN HALICI*

mghalici@erciyes.edu.tr
Biology Department, Faculty of Science & Art, Erciyes University
Kayseri, Turkey

MEHMET CANDAN & AYŞEN ÖZDEMIR TÜRK

mecandan@anadolu.edu.tr, aturk@anadolu.edu.tr,
Department of Biology, Faculty of Science, Anadolu University
Eskişehir, Turkey

Abstract—Six species of lichenicolous fungi (*Endococcus nanellus, Polycoccum dzieduszyckii, Polycoccum sporastatiae, Stigmidium gyrophorarum, Weddellomyces heterochrous*, and *Zwackhiomyces lecanorae*) and one lichenized fungus (*Stereocaulon vesuvianum*) are reported for the first time from Turkey. Comments on their habitat and substrata and a short diagnosis are provided for each taxon.

Key words—*Ascomycota*, pyrenocarpous fungi, lichens

Introduction

Studies aiming to determine the lichenicolous fungal component of the biota of Turkey have intensified in the last three years (Halıcı et al. 2005, Hafellner & John 2006, Halıcı et al. 2006, Hawksworth & Halıcı 2007, Halıcı et al. 2007). Furthermore, Hafellner & John (2006) compiled the existing information along with new records, recognizing 63 taxa. Now, 74 infrageneric taxa of lichenicolous fungi are known from Turkey, but it is obvious that this number is too small when compared with other European countries (Faltynowicz 2003, Hawksworth 2003, Scholz 2000) and a total of at least 250 might be expected. Therefore, more studies on the lichenicolous fungi of Turkey are needed, as well as on the lichens of Turkey, to gain a sound knowledge of this element of the country's biota.

Here we aim to make a further contribution to our knowledge of the lichenicolous fungi of Turkey, and in addition report one of the host lichens encountered in this study as a new record for Turkey.

Materials and methods

The specimens are stored in ANES (Herbarium of Anadolu University, Science Faculty, Eskişehir, Turkey) and their accession numbers are given in parentheses after the locality details. The specimens were examined with a Leica MZ6 model stereomicroscope, and an Olympus BX51 microscope. Specimens were examined in water, 10% KOH, Lugol's iodine solution, or lactofuchsin. Spore measurements were generally carried out in KOH, but in the case of thin-walled spores the dimensions were also checked in water. The descriptions given below are the original descriptions of the specimens examined.

Species recorded

Endococcus nanellus Ohlert 1870

A detailed description is provided by Keissler (1930: 417-418).

The specimen was collected from the thallus of *Stereocaulon vesuvianum* on calcareous rocks. Ascomata perithecia, black, ~ 100 µm. Asci 8-spored. Ascospores 1-septate, pale brown, 8.5–13 × 3–3.5 µm. The size of the ascospores in the Turkish specimen is a little bigger than the size given by Keissler (1930), i.e. 8–9 × 2–3 µm. The hymenial gel turns red with Lugol's iodine solution without pre-treatment with K. The species seems to be commensalistic as no damage was evident on the host.

This boreal species is restricted to *Stereocaulon* species, especially to *S. tomentosum* (Zhurbenko 2000), and known from Sweden (Santesson 1993), Estonia (Suija 2005) and America (Diederich 2003).

MANISA: Salihli, West of Yağbastı Village, 38° 39' N, 28° 27' E, alt. 640 m, on thallus of *Stereocaulon vesuvianum* on calcareous rocks, 16 Aug. 2006, M. Candan (ANES 11014).

Polycoccum dzieduszyckii (Boberski) D.Hawksw. 1980

A detailed description is provided by Hawksworth & Diederich (1988).

The specimen was collected on the thallus of *Verrucaria calciseda* on limestone. Ascomata perithecia, erumpent, subglobose, black, 100–130 µm. Hamathecial filaments present, 1.5–2 µm wide. Asci clavate, c. 62 × 30 µm, consistently 2-spored. Ascospores brown, 1-septate, ellipsoid, cells ± equal in size, verruculose, 25–28 × 8 – 11 µm. The length of the ascospores is smaller in the Turkish specimen than the size given in Hawksworth & Diederich (1988), but considerable variation is to be expected when dealing with large ascospores. This species is primarily distinguished from the other species of the genus by the 2-spored asci and large ascospores (Hawksworth & Diederich 1988).

Known also from the British Isles and Poland, there growing on the thallus of *Verrucaria baldensis* (Hawksworth & Diederich 1988).

MANISA: Kula, Northwest of Kula, 38° 34' N, 28° 38' E, alt. 680 m, on thallus of *Verrucaria calciseda* on calcareous rocks, 14 Aug. 2006, M. Candan (ANES 10160).

Polycoccum sporastatiae (Anzi) Arnold 1874

A detailed description is provided by Hawksworth & Diederich (1988).

The specimen was collected on the areoles of *Sporastatia testudinea* on siliceous rocks. Ascomata perithecia, immersed on the areoles of the host, associated with a superficial network of hyphae, 170–200 µm. Hamathecial filaments present, branched and anastomosed. Asci elongate-clavate, 8-spored. Ascospores distichously arranged, broadly ellipsoid, upper cell often slightly broader and rounded, the lower often attenuated, olivaceous brown at maturity, 22–23 × 10 µm. The specimens belonging to this species generally have 4-spored asci although 8-spored asci are also known (Hawksworth & Diederich 1988). However, we observed constantly 8-spored asci in the Turkish specimen. As stated by Atienza et al. (2003) for Spanish material, no galls were observed in the areoles infected by *S. testudinea* in the Turkish specimen. The Turkish specimen seems to be commensalistic as no damage was evident in the host areoles.

Known also from Germany (Triebel & Scholz 2001), Spain (Atienza et al. 2003), Asia (Triebel & Rambold 1991), Greenland (Alstrup et al. 2000), and North America (Triebel & Rambold 1991); growing on *Sporastatia testudinea* or *S. polyspora*.

ESKIŞEHIR: Bozdağ, Türkmen Hill, 39° 54' N, 30° 41' E, alt. 1500 m, on thallus of *Sporastatia testudinea*, on siliceous rocks, 21 Nov. 2006, M. Candan (ANES 10901).

Stereocaulon vesuvianum Pers. 1811

Detailed descriptions are provided by Øvstedal & Lewis Smith (2001) and Brodo et al. (2001).

This lichenized species was found on metal-rich, hard volcanic rocks in localities in the Kula volcanic area as given below. It formed compact tufts locally, especially in sites far from anthropogenic influences. Pseudopodetia 1.5–2.5 cm tall, erect, forming compact tufts, branched, hard and almost woody at the base, phyllocladia wart-like, crowded, greenish grey, central parts surrounded by paler-grey white swollen margins. Soredia very rarely observed. Cephalodia and apothecia were not observed in Turkish samples.

This widespread species is known from Antarctica (Øvstedal & Lewis Smith 2001), North and South America, Europe, Asia, and Australasia (Purvis et al. 1992).

MANISA: Kula, Northwest of the Kula town, 38° 34' N, 28° 39' E, alt. 700 m, on volcanic rocks, 14 Aug.2006, M. Candan (ANES 10171), Salihli, West of Demirköprü dam, 38° 36' N, 28° 18' E, alt. 210 m, on volcanic rocks, 15 Aug.2006, M. Candan (ANES 10170), Salihli, Northwest of Eminbey village, 38° 36' N, 28° 25' E, alt. 610 m, on volcanic rocks, 16 Aug.2006, M. Candan (ANES 11014).

Stigmidium gyrophorarum (Arnold) D.Hawksw. 1975

A detailed description is provided by Triebel & Cáceres (2004)

The specimen was collected on the thallus of *Umbilicaria leiocarpa* and an unidentified *Umbilicaria* species on siliceous rocks. Few superficial brownish vegetative hyphae were observed. Ascomata perithecia, black, semi-immersed, ~ 80 µm. Haemathecium absent in mature ascomata. Asci clavate, 8-spored. Ascospores colourless, 1-septate, with 1 oil droplet per cell, 15–20 × 7–9 µm. The specimen seems to be weakly pathogenic as some feint discolorations were observed in the host thallus.

Previously known from Europe and North America on thallus of *Umbilicaria* species (Triebel & Cáceres 2004) and Asia (Kondratyuk & Kudratov 2002).

KAYSERI: Erciyes Mountain, North of Perikartın (North slopes of Erciyes Mountain), 38° 35' N, 35° 27' E, alt. 2300 m, on thallus of *Umbilicaria leiocarpa*, on siliceous rocks, 02 Jul.2006, leg. M. G. Halıcı (ANES 11026).

ESKIŞEHIR: Bozdağ, Türkmen Hill, alt. 1500 m, on thallus of *Umbilicaria* sp. on siliceous rocks, 16 Nov.2006, leg. M. Candan & T. Tay (ANES 10900).

Weddellomyces heterochrous Nav.- Ros. & Cl. Roux 1995

A detailed description is provided by Navarro-Rosinés & Roux (1995).

The specimen was collected on the areoles of an *Aspicilia* species on calcareous rocks which was K–. It seems to be highly pathogenic as ascomata production in the host lichen is suppressed and the thallus is deformed. Ascomata perithecia, black, opening irregularly by fragmentation of cephalothecioid plates. Hamathecium of branched and anastomosed interascal filaments. Asci 8-spored. Ascospores brown, 3-septate, the end cells always paler, 32–36(–40) × 11–13 µm.

Previously known only from Spain on the thallus of *Aspicilia calcarea* (Navarro-Rosinés & Roux 1995).

KARAMAN: Karadağ, 37° 23' N, 30° 57' E, alt. 2250 m, on thallus of *Aspicilia* sp.on calcareous rocks, 12 Jul. 2002, C. Özmen (ANES 10159).

Zwackhiomyces lecanorae (Stein) Nik. Hoffm. & Hafellner 2000

A detailed description is provided by Etayo (1994).

The specimen was collected on the areoles of *Lobothallia radiosa* growing on calcareous rocks. It seems to be commensalistic as no damage was evident in

the host thallus. Ascomata perithecia, black, ~ 0.2 mm diam, ostiole broad and urceolate, greenish. Hamathecium of branched and anastomosed interascal filaments. Asci 8-spored, 70 × 11–12 µm. Ascospores colourless, simple, tear-like, with many oil droplets, uniserially arranged in asci, 14–15× 6–7 µm.

Known on a wide range of crustose lichens on calcareous substrata, including *Aspicilia contorta*, *Candelariella aurella*, *Lecanora albescens*, *L. crenulata*, *L. dispersa*, *Lecidella stigmatea* and *Verrucaria parmigera* in Spain (Etayo 1994).

MANISA: Salihli, West of Yağbastı Village, 38° 39' N, 28° 27' E, alt. 640 m, on thallus of *Lobothallia radiosa* on calcareous rocks, 16 Aug.2006, M. Candan (ANES 10156).

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Literature Cited

Alstrup V, Hansen ES, Daniels FJA. 2000. Lichenized, lichenicolous and other fungi from north and north-east Greenland. Folia Cryptogamica Estonica 37: 1-20.

Atienza V, Calatayud V, Hawksworth DL. 2003. Notes on the genus *Polycoccum* (*Ascomycota, Decampiaceae*) in Spain, with a key to the species. Lichenologist 35: 125-135.

Brodo M, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. New Haven: Yale University Press.

Diederich P. 2003. New species and new records of American lichenicolous fungi. Herzogia 16: 41-90.

Faltynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. Biodiversity of Poland 6: 1-435.

Halıcı MG, Orange A, Aksoy A. 2005. *Weddellomyces turcicus*, a new species on a grey *Acarospora* from Turkey. Mycotaxon 94: 249-252.

Halıcı MG, Kocakaya M, Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. Mycotaxon 96: 13-19.

Halıcı MG, Özdemir Türk A, Candan M. 2007. New records of pyrenocarpous lichenicolous fungi from Turkey. Mycotaxon 99: 201-206.

Hawksworth DL, Diederich P. 1988. A synopsis of the genus *Polycoccum* (*Dothideales*), with a key to accepted species. Trans. Br. Mycol. Soc. 90: 293-312.

Hawksworth DL. 2003. The lichenicolous fungi of Great Britain and Ireland: an overview and annotated checklist. Lichenologist 35: 191-232.

Hawksworth DL, Halıcı MG. 2007. *Gemmaspora*, a new verrucarialean genus with remarkable ascospores for *Adelococcus lecanorae* growing on *Aspicilia* species in Syria and Turkey. Lichenologist 39: 121-128.

Keissler K. 1930. Die Flechtenparasiten. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz 8: i- xi, 1-712.

Kondratyuk SY, Kudratov I. 2002. New for Tajikistan lichenicolous and lichen forming fungi. Ukrayins'kyi Botanichnyi Zhurnal 59: 165-170.

Navarro-Rosinés P, Roux C. 1995. La genre *Weddellomyces* (*Dothideales, Decampiaceae*) en Catalogne et en Provence. Mycotaxon 53: 161-189.

Øvstedal DO, Lewis Smith RI. 2001. Lichens of Antarctica and South Georgia. A Guide to their Identification and Ecology. Cambridge: Cambridge University Press.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. London: Natural History Museum Publications.

Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. SBT-förlaget.

Scholz P. 2000. Katalog der Flechten und flechtenbewohnenden Pilze Deutschlands. Schriftenreihe der Vegetationskunde 31: 1-298.

Suija A. 2005. Lichenicolous fungi and lichens in Estonia I. *Ascomycota*. Nova Hedwigia 80: 247-267.

Triebel D, Rambold G. 1991. On lichenicolous fungi from continental North America. Mycotaxon 42: 263-269.

Triebel D, Scholz P. 2001. Lichenicolous fungi from Bavaria as represented in the Botanische Staatssammlung München. Sendtnera 7: 211-231.

Triebel D, Cáceres MES. 2004. *Stigmidium*, pp. 703-707. In Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F. 2004. Lichen Flora of the Greater Sonoran Desert Region.Vol. 2. Tempe: Arizona State University.

Zhurbenko MP. 2000. Key to the lichenicolous fungi occurring on the lichen genus *Stereocaulon* in the Russion Arctic. Mikologija i Fitopatalogija 34: 19-22.

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Ripartitella (*Agaricales*) from an Atlantic Forest in Pernambuco, Brazil

FELIPE WARTCHOW [1], JAIR PUTZKE[2] & MARIA A. Q. CAVALCANTI[1]

fwartchow@yahoo.com.br, jair@unisc.br, xiliamac@terra.com.br

[1]*Universidade Federal de Pernambuco, Departamento de Micologia*
Av. Prof. Nelson Chaves, s/n° CEP: 50670-901, Recife, PE, BRAZIL

[2] *Universidade de Santa Cruz do Sul, Depto.de Biologia*
CEP: 96815-900 Santa Cruz do Sul, RS, BRAZIL

Abstract—This paper presents two neotropical species of *Ripartitella* collected at Northeast Brazil: *R. alba* is a new record from Brazil, and *R. brasiliensis* is cited for the first time from this Brazilian region. A key to species, descriptions, discussion, drawings and scanning electron microscopy (SEM) are provided.

Key words—*Agaricomycetidae*, neotropics, taxonomy, *Tricholomataceae*

Introduction

Ripartitella Singer was originally placed in *Agaricaceae* Cheval. tribe *Cystodermatae* Fayod, near to the lepiotoid genus *Cystoderma* Fayod, mainly because of the similarity of cystidia (Singer 1947, 1986). Some authors, using morphological and anatomical data (e.g., Pegler 1977, 1983, Ovrebo 1988, Franco-Molano 1993) and molecular data (Johnson & Vilgalys 1998), excluded these genera from *Agaricaceae* and transferred them to *Tricholomataceae* R. Heim ex Pouzar. Hawksworth et al. (1995) and Kirk et al. (2001) also considered these genera in *Tricholomataceae*, but Moncalvo et al. (2000, 2002) conclude that the taxonomic position of *Ripartitella* and *Cystoderma* remains unresolved.

In Brazil, only *R. brasiliensis* was previously reported (Singer 1950, 1953, Pegler 1997, Matheus et al. 2000, Okino et al. 2000).

Materials and methods

The basidiomes were collected at the tropical rain forest "Reserva Ecológica da Mata do Sistema Gurjaú" (8°14'21" S and 35°03'00" W) with 1077 ha, municipality of Cabo de Santo Agostinho, Pernambuco State, in Northeast Brazil (SECTMA 2001). The measurements of microscopic structures were

made from material mounted in 5% KOH. Line drawings were made with the aid of a camera lucida. Color naming and color codes follow Maerz & Paul (1950). Exsiccata were deposited in the Herbarium of the Mycology Department of the "Universidade Federal 'de Pernambuco" (URM).

Material was prepared for scanning electron microscope (SEM) following Franco-Molano (1993), with some modifications: pileal and lamellae fragments were rehydrated for a few minutes in 10% NH_4OH and washed three times in distilled water; fixed in 1% OsO_4 in 0.1 M sodium-phosphate buffer; rinsed with the same buffer; dehydrated in a ethanol series (30, 50, 70, 90 and 100%, 10 min at each stage) and dried in a critical point dryer. The fragments were mounted on aluminum stubs with double-sided sticky tape, coated with gold, and observed in a JEOL 5600 SEM.

Taxonomy

Key for the species of *Ripartitella* found in Pernambuco

1. Pileus surface minutely floccose-tomentose, with yellow tonalities at the disc; habit solitary ..... ***R. alba***

1'. Pileus surface with small brown squamules, mainly at the disc; habit gregarious ..... ***R. brasiliensis***

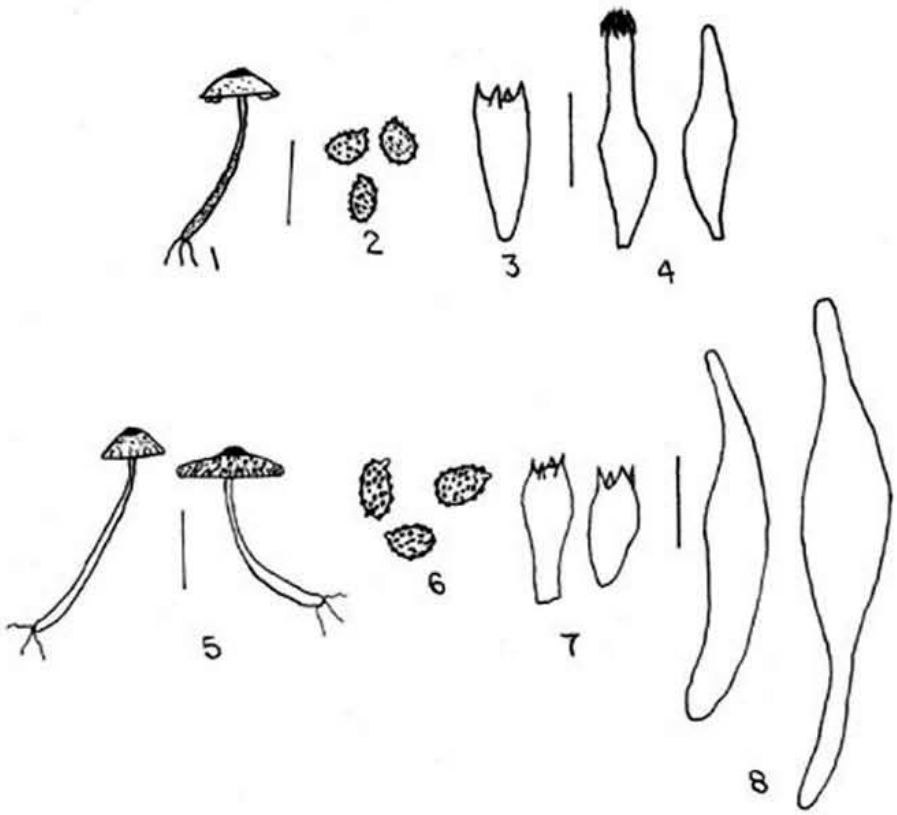
Ripartitella alba Halling & Franco-Mol., Mycologia 88: 669. 1996. FIGS. 1-4, 9-10.

Pileus 10 mm, convex broadly umbonate, white with light yellow (9D1) tints at disc; surface minutely floccose-tomentose with remnants of veil at margin. **Lamellae** adnexed, membranous, moderately crowded, white. **Stipe** 22 × 1 mm, central, cylindrical, white then yellowish at base, minutely floccose-tomentose, easily left at soil, rhizomorphs present. Context thin, white, fleshy, unchanging.

Basidiospores 4–5 × 2.5–3.2 µm, average 4.6 × 2.7 µm, Q = 1.31–1.72 (–2), subovoid to ellipsoid then occasionally elongate in side view, verrucose and echinulate, slightly thick walled, inamyloid, hyaline. **Basidia** 12.5–18 × 5–6 µm, clavate, 2 to 4 sterigmata. **Cystidia** very scarce, observed exclusively on side of the lamellae, approximately 24–27 × 7.5 µm, fusoid, thin walled, with crystals encrusting the apex immediately dissolving in KOH, but persisting in Melzer's reagent, thin walled, hyaline. **Pileipellis** formed by ascendant hyphae organized in rows, terminal elements 20–48 × 5–15 µm, subcylindrical to ovoid, smooth, moderately thick walled, hyaline. Hymenophoral trama irregular. Clamp connections present.

Habitat: solitary on rotten wood in tropical forest.

Material examined: BRAZIL. Pernambuco: Cabo de Santo Agostinho, Gurjaú ("Mata do Coxiu"), 19/VII/2004, F. Wartchow 16/2004 (URM 78672).



Figures 1–8: 1-4 *R. alba*: 1. Basidioma. 2. Basidiospores. 3. Basidium. 4. Cystidia. 5-8 *R. brasiliensis*: 5. Basidiomata. 6. Basidiospores. 7. Basidia. 8. Cystidia. Scale bar 10 mm for basidiomata and 10 µm for microstructures.

Distribution: Costa Rica (Halling & Franco-Molano 1996), Mexico (Bandala et al. 2005), the Caribbean (Great Antilles website <http://www.cortland.edu/nsf/ga.html>), Hawaii Islands and Colombia (see Macrofungi of Costa Rica website <http://www.nybg.org/bsci/res/hall>).

Remarks: This species differs from *Ripartitella brasiliensis* by the pallid and less squamulose surface of the pileus, smaller stature of basidioma and smaller basidiospores and cystidia (Halling & Franco-Molano 1996). Recently Bandala et al. (2005) reported *R. alba* with pileus ranging to (10–) 13–28 mm and brownish-orange to dull brownish-orange squamules in centre of pileus. These authors also suspect that *Lepiota armillarioides* Dennis and *Agaricus exsanguis* Mont. are two probably additional synonyms of *R. alba*.

In the Brazilian collection we observed a solitary habit and narrower spores, but several features agree with the original description of this species.

Ripartitella brasiliensis (Speg.) Singer, Lilloa 22: 452. 1951. FIGS. 5-8, 11-12.

Pileus 5–15 mm, campanulate at first then convex with a prominent umbo on maturity; surface white, smooth except the disc with densely placed small brown ("Talavera" 12A12) to dark brown ("Alamo" 14A12) squamules, margin finely sulcate. **Lamellae** adnexed, membranous, very crowded, white. **Stipe** 15–27 × 1–1.5 mm, central, cylindrical then slightly swollen at base in some specimens, with indistinct squamules concolorous to pileus, pale cream ("Polar Bear" 9B2) to pale brown ("Golden Wheat" 11D7); rhizomorphs numerous. Context thin, fleshy, white, unchanging.

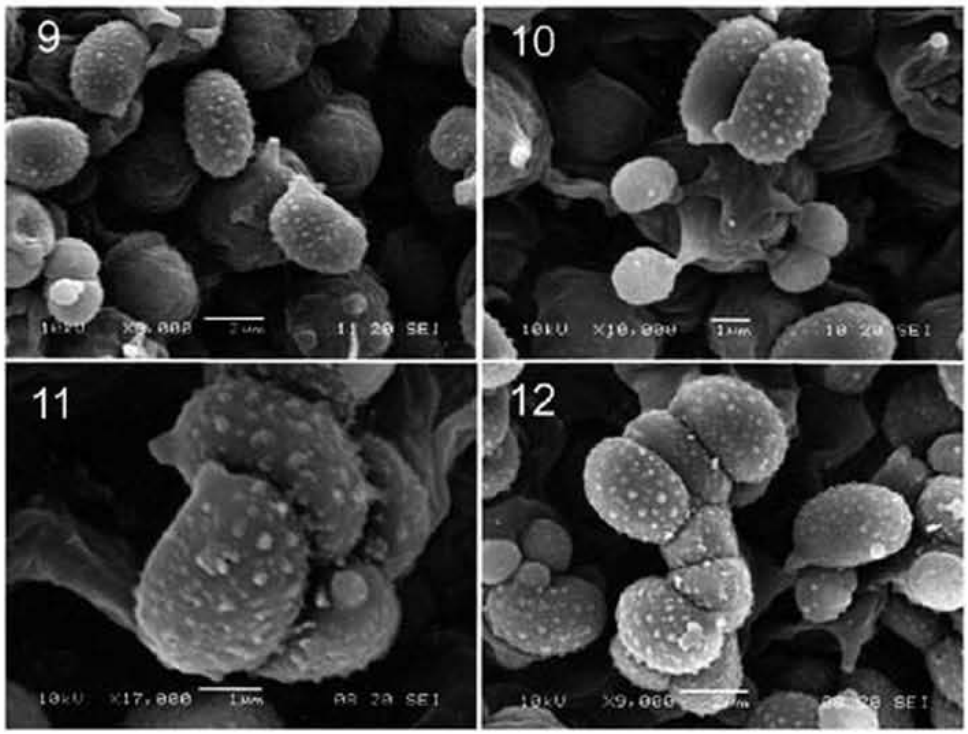
Basidiospores 4–5.8 (–6.2) × 2.5–3.8 µm, average 5 × 3 µm, Q = (1.56–) 1.67–2 (–2.16), ellipsoid to elongate in side view, distinctly verrucose and echinulate, slightly thickness walled, inamyloid, hyaline. **Basidia** 12.5–17.5 × 5–6 µm, clavate, 2 to 4 sterigmata. **Cystidia** scattered, mainly on side of the lamellae, 36–57 × 6.5–9 µm, lageniform, hyaline with yellowish wall in KOH; crystalline deposits at the top not observed, probably dissolved away. **Pileipellis** with ascendant hyphae organized in rows with more or less isodiametric terminal elements 6–15 µm diam., slightly thick walled, with yellowish-brown or slightly paler pigments. Hymenophoral trama regular to sub-regular. Clamp-connections present.

Habitat: gregarious to sub-caespitose on decayed wood in a tropical forest.

Material examined: BRAZIL. Pernambuco State, Cabo de Santo Agostinho, Gurjaú ("Mata do Xangô"), 14/V/2004, F. Wartchow 07/2004 (URM 78676; HCB 18238).

Distribution: USA (Murrill 1943 as *Lentodium floridanum*, Singer 1947), Trinidad (Dennis 1951 as *Collybia pseudoboryana*, 1952 as *Lepiota armillarioides*, 1970, Pegler 1983), Kenya and Tanzania (Pegler 1977), Japan (Hongo 1986), Polynesia and Bolivia (Ovrebo 1988), Mexico (Guzmán-Dávalos & Guzmán 1988), Panamá (Ovrebo unpub. data). Brazil: Rio Grande do Sul (Spegazzini 1889 as *Pleurotus brasiliensis*, Singer 1950, 1953), São Paulo (Pegler 1997), Paraná (De Meijer 2001) and perhaps Mato Grosso and Minas Gerais (Pegler 1990).

Remarks: Although Ovrebo (1988) found slightly broader basidiospores (4.5–5.8 × 3.5–4 (–4.6) µm) and Guzmán-Dávalos & Guzmán (1988) reported spores measuring 4.4–5.6 × 3.6–4 µm, several authors describe basidiospores having a size similar to the northeastern Brazilian *R. brasiliensis* collection. Murrill (1943) described *Lentodium floridanum* Murrill with basidiospores 5 × 3 µm; Singer (1950) reported 4.8–5 × 3.5 µm in his type examination of *Pleurotus brasiliensis* Speg.; Dennis reported 4–5.5 × 2.5–2.72 µm for *Collybia pseudoboryana* Dennis (Dennis 1951) and 5 × 3 µm for *Lepiota armillarioides* (Dennis 1952), a species possibly synonymous with *R. alba* as noted above; and



Figures 9-12: 9-10 Scanning electron microscopy (SEM), basidiospores and basidium of *R. alba*. 11-12 Basidiospores of *R. brasiliensis*. (Photos by Rafael Padilha, LIKA).

Pegler (1983) noted 3.7–4.5 × 2.9–3.5 µm for a Caribbean collection of this species.

From Southern Brazil, Rick (1920) recorded *Armillaria rhagadiosa* (Fr.) Quél. (later revised as *R. brasiliensis* by Singer, 1953) with "2.5 µm" basidiospores. Pegler (1990), who examined the drawings of several species from Brazil described by Montagne considers *Agaricus exsanguis* and *Marasmius rufopunctatus* Mont. to represent two additional *R. brasiliensis* synonyms.

A related species is *Ripartitella ponderosa* (A.H. Sm. & Singer) Franco-Mol., recently referred by Justo & Castro (2003) to *Cystoderma ponderosum* A.H. Sm. & Singer from North America, which differs in the absence of cystidia and the smaller basidiospores [3.6–4 (–5) × 2.7–3 µm, according to Franco-Molano 1993].

Recent studies show that the white-rot fungus *R. brasiliensis* (and other lignolytic tropical Basidiomycetes) have large enzymatic activities that decolorize polymeric dyes. This common species, recorded for the first time from Northeast Brazil, has been selected for biotechnological use in pollutant degradation of several complex molecules similar to lignin molecules (Okino et al. 2000).

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Literature cited

Bandala VM, Montoya L, Jarvio D. 2005. Agarics from coffee plantations in Eastern Mexico: two new records. Fungal Diversity 20: 17-29.

Dennis RWG. 1951. Some *Agaricaceae* of Trinidad and Venezuela. Leucosporae. Part I. Trans. Br. Mycol. Soc. 34: 411-482.

Dennis RWG. 1952. *Lepiota* and allied genera in Trinidad, British West Indies. Kew Bull. 7: 459–499.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Add. Ser. 3: 1–541.

Franco-Molano AE. 1993. Studies on *Cystoderma*: a new species and a new combination. Mycologia 85: 672-676.

Guzmán-Dávalos L, Guzmán G. 1988. Primer registro de *Ripartitella brasiliensis* (Fungi, *Agaricales*) en México. Acta Bot. Mex. 4: 9-13.

Halling RE, Franco-Molano AE. 1996. *Agaricales* from Costa Rica: new taxa with ornamented spores. Mycologia 88: 666-670.

Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Ainsworth & Bisby's Dictionary of the Fungi. 8th Ed. CAB International, Wallingford.

Hongo T. 1986. On the *Agaricaceae* of Japan. Trans. Mycol. Soc. Japan 27: 99-107.

Johnson J, Vilgalys R. 1998. Phylogenetic systematics of *Lepiota* sensu lato based on nuclear large subunit rDNA evidence. Mycologia 90: 971-979.

Justo A, Castro ML. 2003. *Cystoderma freirei*, une nouvelle espèce découverte en Galice (Espagne). Cryptog. Mycol. 24: 309-316.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed. CAB International, Wallingford.

Maerz AJ, Paul MR. 1950. A Dictionary of Color. 2nd ed., McGraw-Hill Book Company, Inc., New York.

Matheus DR, Bononi VLR, Machado KMG. 2000. Biodegradation of hexachlorobenzene by basidiomycetes in soil contaminated with industrial resides. World. J. Microbiol. Biotechnol. 16: 415-421.

De Meijer AAR. 2001. Mycological work in the Brazilian state of Paraná. Nova Hedwigia 72: 105-159.

Moncalvo J-M, Lutzoni FM, Rehner SA, Johnson J, Vilgalys R. 2000. Phylogenetic relationship of agaric fungi based on nuclear large subunit ribosomal DNA sequences. Syst. Biol. 49: 278-305.

Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clémençon H, Miller Jr. OK. 2002. One hundred and seventeen clades of euagarics. Mol. Phylogen. Evol. 23: 357-400.

Murrill WA. 1943. Some southern novelties. Mycologia 35: 422-433.

Okino LK, Machado KMG, Fabris C, Bononi VLR. 2000. Ligninolytic activity of tropical rainforest basidiomycetes. World J. Microbiol. Biotechnol. 16: 889-893.

Ovrebo CL. 1988. Notes on the cultural characters, morphology and distribution of *Ripartitella brasiliensis*. Mycotaxon 31: 229-237.

Pegler DN. 1977. A preliminary Agaric flora of East Africa. Kew Bull. Add. Ser. 6: 1-615

Pegler DN. 1983. Agaric Flora of the Lesser Antilles. Kew Bull. Add. Ser. 9: 1-668

Pegler DN. 1990. *Agaricales* of Brazil described by J.P.F.C. Montagne. Kew Bull. 45: 161-177.

Pegler DN. 1997. The Agarics of São Paulo, Brazil. Royal Botanical Gardens, Kew.

Rick J. 1920. Contributio III ad Monographiam Agaricacinarum Brasiliensium. Brotéria Ser. Bot. 18: 48-63.

Secretaria Estadual de Ciência, Tecnologia e Meio Ambiente (SECTMA). 2001. Diagnóstico das Reservas Ecológicas: Região Metropolitana do Recife. Secretaria Estadual de Ciência, Tecnologia e Meio Ambiente do Estado de Pernambuco, Recife.

Singer R. 1947. New genera of fungi. III. Mycologia 39: 77-89.

Singer R. 1950. Type studies on *Basidiomycetes*. IV. Lilloa 23: 147-246.

Singer R. 1953. Type studies on *Basidiomycetes* VI. Lilloa 26: 57-159.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed. Koeltz Scientific Books, Stuttgart.

Spegazzini C. 1889. Fungi Puigariani. Bol. Acad. Nac. Ciências Córdoba 11: 381-414.

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Two rare corticioid species with globose spores

María Natividad Blanco, G. Moreno & J. Checa

natividad.blanco@uah.es
Dpto. de Biología Vegetal, Universidad de Alcalá
E-28871 Alcalá de Henares, Madrid, Spain

Abstract — Two rare corticioid species with resupinate and arachnoid basidiocarps are compared. These species are similar morphologically but differ in nutritional behaviour: *Botryobasidium globosisporum* is a saprotroph while *Thanatephorus ochraceus* is an endomycorrhizal fungus. Although they differ phylogenetically, they share some microscopic characteristics that occasionally make their determination difficult. Similarities and differences between the two species are discussed and photographs comparing morphological and anatomical characters are provided.

Key words — *Cejpomyces*, *Basidiomycota*, taxonomy

Introduction

The genus *Thanatephorus* was described by Donk (1956) with the following Latin diagnosis:

> "Parasiticus. Mycelium formans statum *Rhizoctoniae* consistens e fibrillis vel funiculis et (plerumque) sclerotiis. Fructificatio plus minusve similis *Botryobasidio* sensu stricto natura et structura sed hyphae ascendentes basidiferentes saepe minus evolventes. Basidia brevia et compacta, subcylindrica ad obovoidea, paulum latiora hyphis sustinentibus; sterigmata relative magna, 2-4(-5). Sporae renovantes. Status imperfectus conidiferus ignotus."

The genus was characterized by its loosely attached resupinate basidiocarps, hyphae branching at right angles, clavate basidia arrayed in a palisade and the production of spore secondaries by proliferation.

The genus *Thanatephorus* includes currently 11 species (Roberts 1999b, Kirk & al. 2001) with *T. cucumeris* (A.B. Frank) Donk (anamorph *Rhizoctonia solani* J.G. Kühn) as type species. *T. cucumeris* is a parasite of various herbaceous plants and produces important agriculture damage depending on the strain virulence (Carling & al. 2002).

In the present paper, we describe *Thanatephorus ochraceus*, an endomycorrhizal species of the family *Orchidaceae*, collected on Mediterranean vegetation in the Natural Park of Cabañeros (Ciudad Real, Spain). Plants within

the well-conserved forest include *Quercus ilex* subsp. *ballota* (Desf.) Samp., *Q. faginea* subsp. *broteroi* (Coutinho) A. Camus, *Q. suber* L., *Q. pyrenaica* Willd., *Alnus glutinosa* (L.) Gaertn., *Pinus pinaster* Aiton with *Cistus ladanifer* L., *Phillyrea angustifolia* L., *Arbutus unedo* L., *Erica arborea* L. and *E. australis* L.

Material and methods

The material of *Thanatephorus ochraceus* was collected during one of several forays during the autumn of 2003. The type material of *Coniophora ochracea* is lost (Roberts 1999a,b); therefore we compared our Spanish specimens with two collections from Italy and Germany deposited in K (M) and with the Spanish specimens cited previously as *Uthatobasidium ochraceum* (Dueñas 1991, 1993) and deposited in MA Fungi and BIO-Fungi. Our research determined that the latter specimens represent *Ceratobasidium cornigerum* (Bourdot) D.P. Rogers, as a result of our revision.

We also compared our specimens to the type of *Botryobasidium globosisporum* deposited in LY, a rare species that is microscopically similar to *T. ochraceus* and which has been collected only once in Gabon (Africa).

The collections were studied with a binocular microscope after mounting in KOH 5%, Melzer's reagent and ammoniacal Congo red 5% solution. Spore measurements were made using the oil immersion objective. The micrographs have been made with a Nikon (Eclipse 80i) microscope and a digital camera Nikon (DS-5M).

Taxonomy

Thanatephorus ochraceus (Massee) P. Roberts, Sydowia 50(2): 252 (1998)

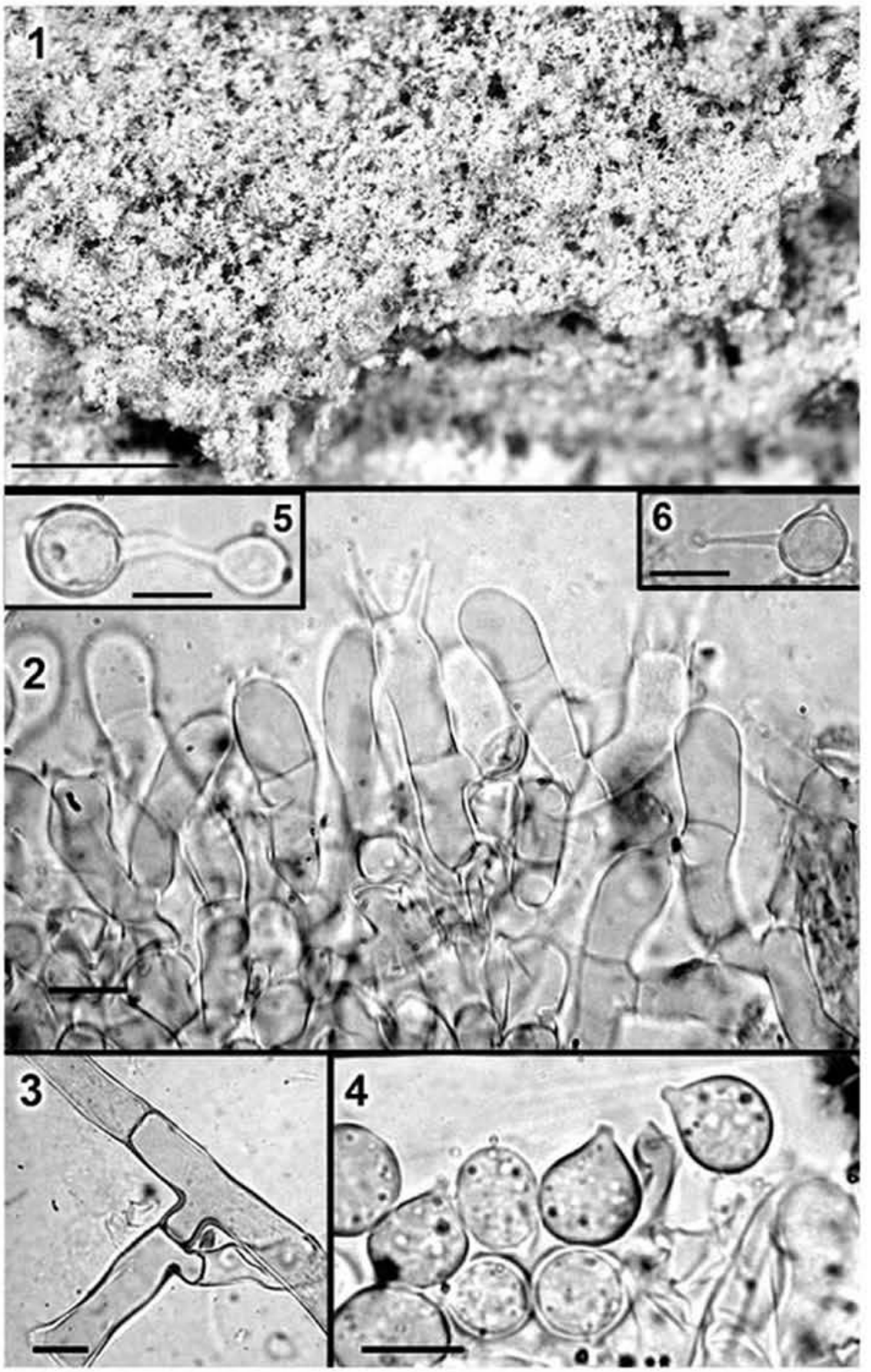
FIGURES 1-6

≡ *Coniophora ochracea* Massee, J. Linn. Soc., Bot. 25: 137 (1889)
≡ *Botryobasidium ochraceum* (Massee) Donk, Univ. Iowa Stud. Nat. Hist. 17(1): 16 (1935)
≡ *Uthatobasidium ochraceum* (Massee) Donk, Fungus, Wageningen 28: 23 (1958)
= *Corticium frustulosum* Bres., Annls mycol. 1(2): 98 (1903)
= *Thanatephorus orchidicola* Warcup & P.H.B. Talbot, Trans. Br. mycol. Soc. 49(3): 432 (1966)
= *Thanatephorus pennatus* Currah, Can. J. Bot. 65: 1958 (1987)

Basidiome arachnoid to hypochnoid, white greyish to light grey. The material from Cabañeros is abundant and very well sporulated. Found growing on five samples of woody debris.

Hyphal system monomitic, without clamps, **subicular hyphae** yellowish, thick-walled, 9-13(-15) µm diam., branching at right angles, **subhymenial hyphae**

FIGURES 1-6. *Thanatephorus ochraceus* (*AH 31816*). 1 - Basidiome. 2 - Hymenium. 3 - Subicular hyphae. 4 - Spores. 5-6- Secondary spores by repetition. Scale bars. 1= 1 mm. 2-6 = 10 µm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thin-walled, 6-9 µm diam. **Basidia** short cylindrical (10-)14-25 x (7-) 9-10 µm, 4-sterigmata 10-13(-20) µm long. **Spores** 7-10 x 6-9 µm, subglobose, hyaline to light yellowish, thick-walled, non-amyloid, non-dextrinoid, cyanophilous, producing secondary spores by repetition. **Cystidia** lacking.

SPECIMENS EXAMINED— SPAIN: **Ciudad Real,** NATIONAL PARK OF CABAÑEROS, ARROYO BREZOSO, 30S 0383-4357 leg. M.N. Blanco, J. Checa & G. Moreno, 8.XI.2003, on debris wood of *Quercus pyrenaica, AH 31816.* **Toledo,** LA IGLESUELA, 30TUK5256, leg. M. Dueñas, 20.X.1987, *MA-FUNGI 23000* (not *MA-Fungi 24351*, as it appears in Dueñas 1991) [det. M. Dueñas as *Uthatobasidium ochraceum* is *Ceratobasidium cornigerum*]. (in Dueñas 1991, 1993). **Alava,** RIBERA ALTA, from 2 Km to Subijana, slope W-SW of the Mountain Otero 30TWN0942, 750m, on *Juniperus communis*, leg. Isabel Salcedo & grupo 111, 17.V.1987, 3555IS in *31523 BIO-Fungi* [det. I. Salcedo as *Uthatobasidium ochraceum* is *Ceratobasidium cornigerum*]. **Madrid,** VALDELATAS, 30TVK4287, leg. M. Dueñas, 22.X.1993, on *Pinus halepensis, MA-FUNGI 41417,* [det. M. Dueñas as *Uthatobasidium ochraceum* is *Ceratobasidium cornigerum*]. ARGANDA, DEHESA DE ARGANDA, 30TVK6360, leg. M. Dueñas, 19.X.1993, on *Pinus halepensis, MA-FUNGI 41422, 41416* [det. M. Dueñas as *Uthatobasidium ochraceum* is *Ceratobasidium cornigerum*]. ITALY: **Puglia,** APULIA, on *Cistus monspeliensis* L. (as *C. monspesulensis*), leg. R.W.G. Dennis, 31.X.1981, *K (M) 15658.* GERMANY: **Westphalia,** WESTFALEN, , on *Quercus* sp., leg. W. Brinkmann, Aut 1907, *K(M) 30008.*

Comments — *Thanatephorus ochraceus* is characterized by its loosely attached resupinate basidiocarps, yellowish subicular hyphae that branch at right angles, the subglobose spores (7-10 x 6-9 µm), and the production of secondary spores by repetition. The fact that this secondary spore proliferation is sometimes difficult to see sometimes can cause confusion in the determination.

The genus *Uthatobasidium* Donk was described the same year, journal and page as *Thanatephorus* (Donk 1956) and later was synonymized under *Thanatephorus* (Jülich 1984). Roberts (1999a), who studied the type collections of *Thanatephorus orchidicola* (Warcup & Talbot 1966) and *Thanatephorus pennatus* (Currah 1987), synonymized them with *Coniophora ochracea*. Roberts proposed the combination *Thanatephorus ochraceus,* which is accepted here.

The anamorph of *Thanatephorus ochraceus* corresponds to the genus *Rhizoctonia*, which has occasionally been isolated from the roots of orchids, *Orchis mascula* (L.) L., *Coeloglossum viride* (L.) Hartm. (Warcup & Talbot 1966) and *Calypso bulbosa* (L.) Oakes (Currah 1987), forming endomycorrhizal structures. The peculiarity of this substrate should be considered for inclusion of *T. ochraceus* to the European Red Checklist., The teleomorph also grows as a saprophyte on various woody substrates (*Alnus, Cistus, Hippophae, Picea, Populus, Quercus, Ulmus*).

The specimen from the National Park of Cabañeros (*AH 31816*) was first cited as *Botryobasidium ochraceum* (Blanco & al. 2006). Once subsequent studies revealed the existence of proliferating secondary spores, the collection was

redetermined as belonging to *Thanatephorus*. However, the presence of such spores is not easy to observe in some collections, and even Hjortstam & al. (1988) did not mention them from Swedish material studied by Eriksson (1958). If proliferating spores are not seen, the specimen may be mis-determined. In this case, the specimen was incorrectly placed in *Botryobasidium*.

Thanatephorus ochraceus generally has a yellowish to brownish basidiome. Consequently, it can be misidentified as *Corticium flavescens* sensu auct., now known as *Thanatephorus fusisporus* (J. Schröt.) Hauerslev & P. Roberts (Langer 1994). The latter can be differentiated by the fusiform to citriform basidiospores (14-17 x 5.5-10 µm).

The yellowish colour of the basidiome is not always present in *T. ochraceus*, so *Thanatephorus orchidicola* has also been described with "albidus vel cervinus" colouration (Warcup & Talbot 1966) and *T. pennatus*, with mycelium "cervineo" in PDA and "cremeum" in CMA (Currah 1987), both species being synonyms of *T. ochraceus*.

The basidiocarps of the material from the National Park of Cabañeros have a white greyish to light grey colour, but the microscopic characteristics agree with the other studied collections.

Botryobasidium globosisporum (Boidin & Gilles) G. Langer [as *'globosporum'*], Bibl. Mycol. 158: 144 (1994) FIGURES 7-11

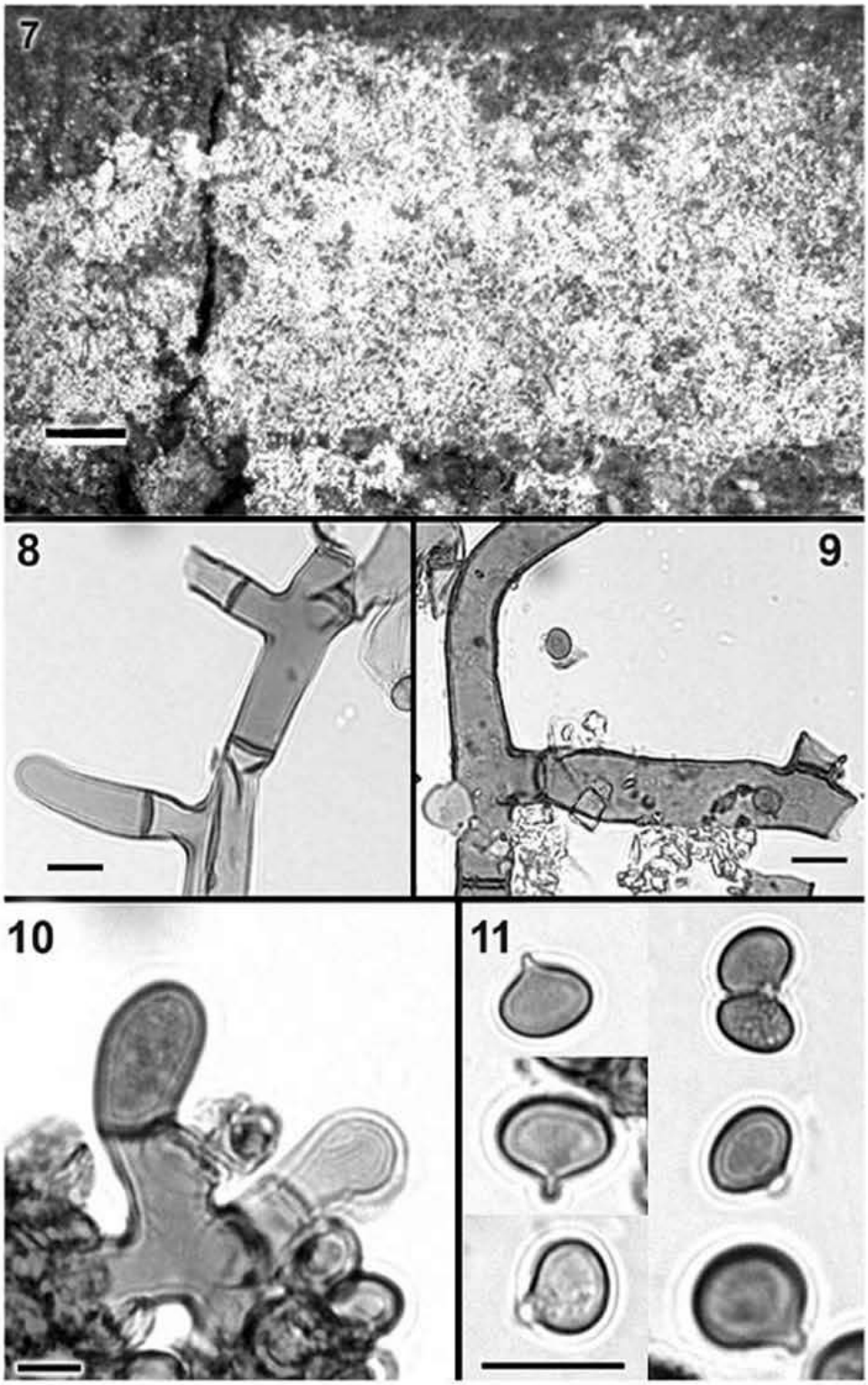
■ *Cejpomyces globosisporus* Boidin & Gilles [as *'globososporus'*], Mycotaxon 14(1): 289 (1982).

Basidiome arachnoid to hypochnoid, fragile, light yellow to light cream and easily separable from the substrate.

Hyphal system monomitic, hyphae without clamps, subicular hyphae well-developed, thick-walled, light yellowish and branched at right angles, 6-10 µm diam., without crystals; **basidia** with 4 sterigmata, difficult to observe and to measure due to the presence of spores; **basidioles** are smaller than the basidia; **spores** 5-7 x 5-6 µm, subglobose to globose in frontal view, with the apex flattened to very obtuse, so their aspect is ellipsoid in side view, hyaline to light yellowish, with thickened walls, non-amyloid, cyanophilous, apiculus very prominent up to 1 µm long; **cystidia** lacking.

SPECIMENS EXAMINED — GABON, Libreville km. 13 N, littoral bush vegetation, dead wood, 5.XI.1978, leg. G. Gilles 1264, *LY 8964* (**HOLOTYPE**).

Comments. We have studied two envelopes labelled as "Holotypus" with the test cited above. One sample contains instructions on the "utilization of spore-print on plastic slides" written by J. Boidin, one spore-print with the numbers G1264 and 8964 and a wrapper with green paper inside bearing fragmented material. The other envelope contains a piece of wood with a well-developed fungus.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The genus *Cejpomyces* Svrček & Pouzar is typified by *C. terrigenus* (Bres.) Svrček & Pouzar, with smooth spores, 4-sterigmate large basidia arranged in a rather dense palisade and a dense subhymenium formed by short cells. This makes the genus intermediate between *Botryohypochnus*, with strongly ornamented spores and basidia with 4 sterigmata, and *Botryobasidium* with smooth or lightly ornamented spores and basidia with (4-) 6-8 sterigmata. None of the species in these genera produce secondary spores by repetition.

Boidin & Gilles (1982) described a second species, *Cejpomyces globosisporus*, characterized by its globose spores.

Langer (1994) combined the species of *Cejpomyces: C. globosisporus* in *Botryobasidium*, and the type species, *C. terrigenus*, in *Thanatephorus*, characterized by the presence of spores secondaries by repetition. This taxonomic treatment is accepted by Kirk & al. (2001) and here.

Discussion

Thanatephorus ochraceus can be confused with *Botryobasidium globosisporum* due to the arachnoid to hypochnoid basidiome. The two species are differentiated by the production of spores secondaries by repetition in *T. ochraceus* and by the following characteristics:

TABLE 1: Character comparisons between *Botryobasidium globosisporum* and *Thanatephorus ochraceus*.

Character	*Botryobasidium globosisporum*	*Thanatephorus ochraceus*
Sterigma length	7-8 µm (Boidin & Gilles 1982) 5-8 µm (Langer 1994)	10-13(-20) µm
Spore size	5-6 x 4.5-5.5 µm side view; 5-6 x 5.5-7 µm face view (Boidin & Gilles 1982); 5-6.5 x 4-5.5 µm (Langer 1994)	7-10 x 6-9 µm
Spore repetition	Absent	Present, sometimes difficult to observe
Spore morphology	Subsphaerical, very large flattened (Boidin & Gilles 1982). Subglobose (Langer 1994).	Subglobose
Distribution	Libreville, Gabon, Africa	Europe (several countries)

FIGURES 7-11. *Botryobasidium globosisporum* (*LY 8964* HOLOTYPE). 7 - Basidiome. 8-9 - Subicular hyphae. 10 - Hymenium. 11 - Spores. Scale bars. 7 = 1 mm. 8-11 = 10 µm

Two other genera closely related to *Thanatephorus* are *Ceratobasidium* D.P. Rogers and *Botryobasidium* Donk. *Ceratobasidium* is differentiated by rounded basidia and a hymenium that does not form a dense palisade. *Botryobasidium* does not have spores secondaries by repetition. The genera *Uthatobasidium*, *Ypsilonidium* Donk and *Cejpomyces* are now considered to be synonyms of *Thanatephorus* (Kirk & al. 2001).

Langer (1994) includes in *Botryobasidium* species with a smooth resupinate basidiome, a monomitic hyphal system with hyphae branching at right-angles; basidia arranged in clusters or a dense palisade with 4-8 sterigmata and non-amyloid spores and without spores secondaries by repetition.

Acknowledgements

We wish to express our gratitude to Dr. Javier Rejos, curator of AH, who assisted us in the search of the type collections and to Laura Yebes and David Mitchell for linguistic assistance of the manuscript. A special thanks to Dr. L. Ryvarden and M. Bondartseva for the revision of the manuscript and M.T. Telleria by her taxonomic comments. This research has been supported by the Spanish Project REN2002-01965 and Project 2004X802 "Flora Micológica de Castilla-La Mancha".

Literature cited

Blanco MN, Moreno G, Checa J. 2006. Adiciones al estudio de los *Polyporales* s. lato del Parque Nacional de Cabañeros. I. Bol. Soc. Micol. Madrid 30: 185-197.

Boidin J, Gilles G. 1982. *Basidiomycetes Botryohypochnoideae* du Gabon. Mycotaxon 14 (1): 280-304.

Carling DE, Baird R, Gitaitis RD, Brainard KA, Kunigaga S. 2002. Characterization of AG-13, a newly reported anastomosis group of *Rhizoctonia solani*. Phytopathology 92: 893-899.

Currah RS. 1987. *Thanatephorus pennatus* sp. nov. isolated from mycorrhizal roots of *Calypso bulbosa* (*Orchidaceae*) from Alberta. Can. J. Bot. 65: 1957-1960.

Donk MA. 1956. Notes on resupinate *Hymenomycetes* II. The tulasnelloid fungi. Reinwardtia 3: 363-379.

Eriksson J. 1958. Studies in the heterobasidiomycetes and homobasidiomycetes — *Aphyllophorales* of Muddus National Park in North Sweden. Symb. Bot. Upsal. 16: 1-172.

Eriksson J, Ryvarden L. 1973. The *Corticiaceae* of North Europe. Vol. 2. Fungiflora. Oslo.

Hjortstam H, Larsson KH, Ryvarden L. 1988. The *Corticiaceae* of North Europe. vol. 8: 1450-1631. Fungiflora. Oslo.

Jülich W. 1984. Die Nichtblätterpilze, Gallertpilze und Bauchpilze. In: Kleine Kryptogamenflora II b/1. Stuttgart. New York. 626 pp.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's. Dictionary of the Fungi ninth edit. CAB International. UK. 655 pp.

Langer G. 1994. Die Gattung *Botryobasidum* Donk (*Corticiaceae*, *Basidiomycetes*). Biblioth. Mycol. 158:1-459.

Moreno G, Galán R, Llarandi E, Raitvir A. 2004. Estudio de los hongos que fructifican en el Parque Nacional de Cabañeros (Ciudad Real). Bol. Soc. Micol. Madrid 28: 229-269.

Roberts P. 1999a. *Thanatephorus ochraceus*: a saprotrophic and orchid endomycorrhizal species. Sydowia 50: 252-256.

Roberts P. 1999b. *Rhizoctonia*-forming fungi. A taxonomic guide. The Herbarium. Royal Botanic Gardens. Kew. 239 pp.

Telleria MT, Melo I. 1995. *Aphyllophorales* resupinatae non poroides, I. *Acanthobasidium–Cystostereum*. Flora Mycologica Iberica. Vol. 1. Ed. Real Jardín Botánico de Madrid & J. Cramer. 223 pp

Warcup JH, Talbot PHB.1966. Perfect states of some *Rhizoctonia*. Trans. Brit. Mycol. Soc. 49: 427-435.

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Type studies on *Chamaeota* species described from China

ZHU L. YANG

fungi@mail.kib.ac.cn, fungiamanita@gmail.com
Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650204, Yunnan, China

Abstract—A critical restudy of the holotype of *Chamaeota dextrinoidespora*, and the holotype and paratypes of *Chamaeota sinica* showed that they belong to *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae* and should be placed in the genus *Leucoagaricus*. Thus, two new combinations, *Leucoagaricus dextrinoidesporus*, and *L. sinicus*, are made. Both species are redescribed and illustrated in detail.

Key words—*Pluteaceae*, *Basidiomycota*, taxonomy

Introduction

The genus *Chamaeota* (W.G. Sm.) Earle, typified by *C. xanthogramma* (Ces.) Earle, is classified in the family *Pluteaceae* Kotl. & Pouzar because of pink and non-dextrinoid basidiospores without a germ pore, free lamellae, a convergent lamellar trama and presence of annulus (Singer 1986). Recent study showed that *C. mammillata* (Longyear) Murrill is an annulate *Pluteus* Fr., and *Chamaeota* may be rendered obsolete (Minnis et al. 2006). During a study of collections of *Agaricaceae* from China, the author found that it is necessary to restudy the types of *C. dextrinoidespora* and *C. sinica*, and the additional materials cited by the authors (Bi & Li 1988, Ying 1995) because these two species might be lepiotaceous fungi. Reexamination of the collections revealed, surprisingly, that (with one exception) they are representatives of *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae*, and should best be placed in the genus *Leucoagaricus* in accordance with the recent taxonomy of this group of fungi.

Materials and methods

The macroscopical descriptions are based on the original descriptions and notes with the material. In the original descriptions colour notations were used by Ying (1995) but not by (Bi & Li 1988). Revived tissues were mounted in 5% aqueous KOH, Melzer's reagent, 1% aqueous Congo red, 1% aqueous Cresyl Blue or cotton blue for microscopic examination. The abbreviation [*n/m/p*]

shall mean *n* basidiospores measured from *m* basidiocarps of *p* collections. Dimensions of basidiospores excluding the apiculus are given using notation of the form *(a) b-c (d)*. The range *b-c* contains a minimum of 90% of the measured values. Extreme values *a* and *d* are given in parentheses. Q refers to the length/width ratio of basidiospores; **Q** refers to the average Q of all basidiospores ± sample standard deviation. Herbarium abbreviations follow Holmgren et al. (1990).

Taxonomy

Leucoagaricus dextrinoidesporus (Z.S. Bi) Zhu L. Yang, **comb. nov.** **Figs. 1-5**

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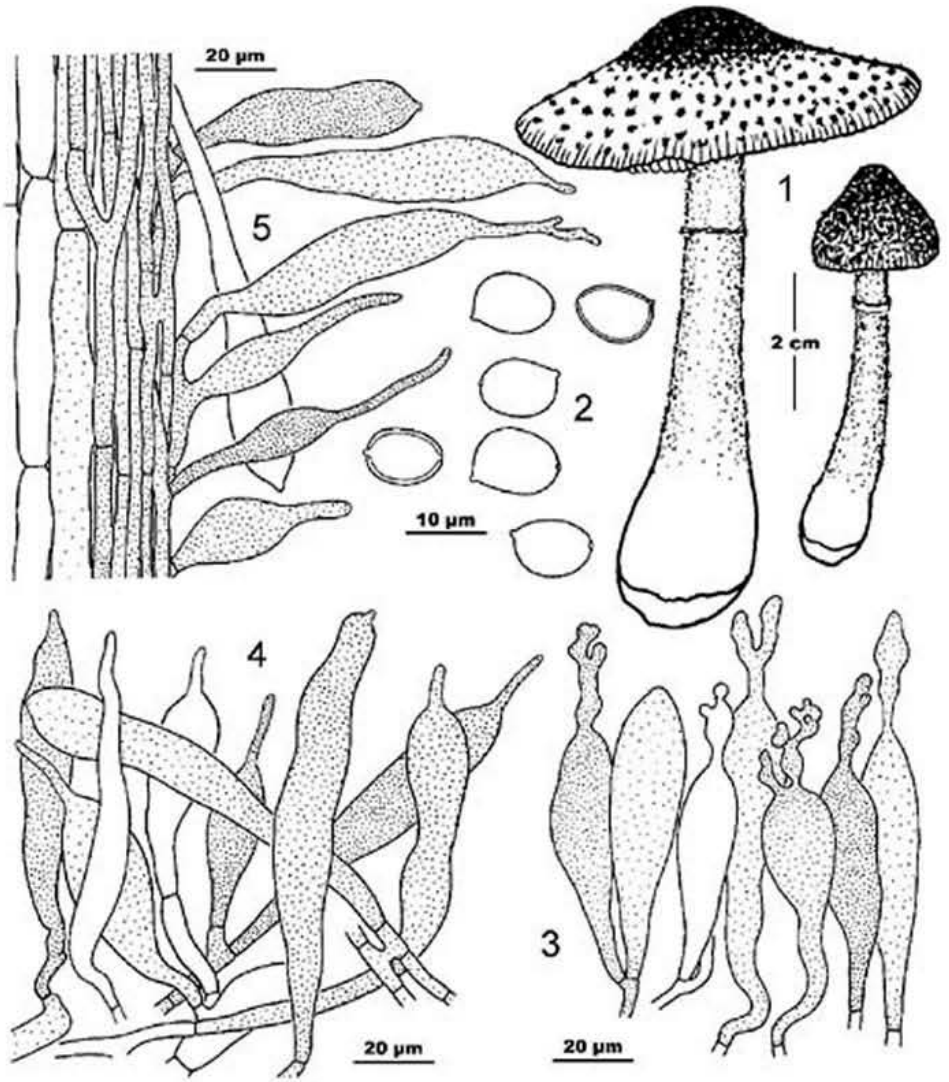
Basionym: *Chamaeota dextrinoidespora* Z.S. Bi, Bull. Bot. Res. 8 (1): 98, figs. 1-5 (1988).

Basidiomata (fig. 1) scattered. **Pileus** 2-6 cm diam., convex, umbonate, red-brown, becoming umbrinous over disc, covered with minute, brown squamules; margin of pileus finely striate (0.1-0.2R); context concolorous with pileal surface, 2-3 mm thick. **Lamellae** free, cream when young, purple red when mature, becoming dark brown with olivaceous tinge when dried, moderately crowded. **Stipe** 5-8 × 0.5-1.5 cm, attenuate upwards, becoming hollow when mature; surface brownish to pale red-brown, covered with squamules; base enlarged. **Annulus** superior, membranous, simple, concolorous with the pileus, persistent. Odor and taste none.

Basidiospores (fig. 2) [46/2/1] (8.0) 8.5-11.5 (12.0) × (6.0) 6.5-8.5 µm [Q = (1.25) 1.27-1.36 (1.41), **Q** = 1.32 ± 0.03], in side view broadly ellipsoid to ellipsoid, sometimes slightly amygdaliform, without suprahilar depression, in frontal view ellipsoid to broadly ellipsoid, hyaline, colorless or pale greenish yellow in 5% KOH, strongly dextrinoid, thick-walled (wall up to 1 µm thick), with germ pore, not or only slightly truncate, without a cap over the pore, cyanophilous, with pink inner wall and pink plug in germ pore in Cresyl Blue (metachromatic). **Basidia** 21-30 × 9-12 µm, subclavate, hyaline, thin-walled, 4-spored, not surrounded by pseudoparaphyses; sterigmata 3-4 µm long; basal clamp connections absent. **Pleurocystidia** absent. **Cheilocystidia** (fig. 3) crowded, often forming a sterile band along the lamellar edge, clavate to fusiform (60-120 × 13-18 µm), occasionally broadly clavate (50-70 × 11-18 µm), often with a single or a few abrupt, apical, often branched, sinuous to moniliform, appendix up to 30 µm long and 2-8 µm in diam, thin-walled, often with a brownish to brownish yellow intracellular pigment in KOH. **Lamellar trama** difficult to rehydrate, probably trabecular, made up of filamentous hyphae 3-12 µm in diam. **Squamules on pileus** (fig. 4) a disrupted trichodermium composed of loose fascicles of more or less erect, narrowly clavate to subfusiform, sometimes lanceolate, 60-140 × (8) 13-20 µm, slightly thick-walled (wall up to 0.5 µm thick) terminal elements often with yellowish



Figs. 1-5: *Leucoagaricus dextrinoidesporus* (holotype). 1. Basidiomata (based on dry material); 2. Basidiospores; 3. Cheilocystidia; 4. Squamules on pileus; 5. Caulocystidia and surface of stipe.

to brownish intracellular pigment in KOH, sometimes subhyaline and nearly colorless; terminal elements often with abrupt subcylindrical apical appendix up to 10 (30) µm long and 2-5 µm in diam. **Caulocystidia** (fig. 5) densely covering the surface of the stipe except the apical part, clavate to fusiform (55-140 × 10-20 µm), often with yellowish to brownish, intracellular pigment, slightly thick-walled (wall ≤0.5µm thick), often with abrupt subcylindrical apical appendix up to 20 (45) µm long. **Clamp connections** not observed.

Habit, habitat, distribution and season—Scattered, on soil among grass; so far only known from the type locality in Guangdong Province of China; August.

COLLECTION EXAMINED—**China, Guangdong Province**, Shixing ("Shizing") County, Zhangdong, 20.VIII.1985, Z.S. Bi & Y.F. Liu *s.n.* (GDGM *9701*, holotype).

Comments—In the above description the color and size of the basidiomata are mainly based on the data of Bi & Li (1988) and notes with the holotype. Other data are from personal observations on the dried holotype material. Bi & Li (1988) stated that the basidiospores of the present species were pale purple-red and without a germ pore, and clamp connections were present. This does not seem to be the case. The color changes of the basidioma on bruising or cutting and the reaction of the lamellae and the context to ammonia vapor are unknown, and need to be studied in the future when fresh material becomes available.

Due to the trichodermial elements in the squamules on the pileus and the hyaline, colorless, dextrinoid and metachromatic basidiospores with a germ pore, this taxon is not a species of *Chamaeota* but belongs to the *Leucoagaricus*/*Leucocoprinus* clade in the *Agaricaceae* (fide Vellinga 2004). It should be placed in *Leucoagaricus* Singer (fide Vellinga 2000, 2001, 2004, Vellinga & Davis 2007), and is very close to *L. americanus* (Peck) Vellinga (= *L. bresadolae* (Schulzer) Bon), *L. holospilotus* (Berk. & Broome) Bon and *L. meleagris* (Sowerby) Singer. However, *L. americanus* usually has larger basidiomata with all parts becoming yellow or saffron and finally red-brown on bruising, and slender, tapering elements in the squamules on the pileus [Smith & Weber 1987 under *Lepiota americana* (Peck) Sacc., Reid 1999, Vellinga 2000, 2001]. *Leucoagaricus holospilotus*, originally described from Sri Lanka, differs from *L. dextrinoidesporus* by its somewhat smaller basidiospores, shorter appendix of cheilocystidia and smaller terminal elements in the squamules on the pileus (Reid 1990 under *Leucocoprinus holospilotus* (Berk. & Broome) D.A. Reid, Pegler 1972, 1986 under *Lepiota holospilota* (Berk. & Broome) Sacc.). *Leucoagaricus meleagris* has a pileus with dark brown to blackish squamules, a context becoming yellow and then red on exposure, cheilocystidia with shorter apical appendix, and clavate fusoid to lanceolate elements in the squamules on the pileus often without an abrupt subcylindrical apical appendix (Reid 1990, Vellinga 2000, 2001). According to Vellinga (2000), the North American species *Lepiota sanguiflua* Murrill is very close to *L. meleagris* and may well be identical. *Leucoagaricus caldariorum* (D.A. Reid) Bon (≡ *Leucocoprinus caldariorum* D.A. Reid) (nom. inval., Art. 37.5, herbarium mentioned neither by Reid 1990 nor by Bon 1993) originally described from the UK, is also somewhat similar to *L. dextrinoidesporus* but has a stipe becoming red when scratched, a hymeniform lower layer in the squamules on the pileus (Reid 1990).

Bi & Li (1988) stated that the present species is similar to *Chamaeota tropica* Pegler, but differs from the latter by the color of the pileus and the dextrinoid spores. However, *C. tropica* has a much smaller, buff-yellow pileus with a narrowly plicate striate margin, whitish lamellae with a faint pink tinge, a white stipe, smaller subglobose to lacrymoid basidiospores without a germ pore, and pyriform cheilocystidia. Moreover, the pileipellis is an epithelium of isodiametric elements 8-15 µm in diam. (Pegler 1983).

Bi & Li (1988) cited another collection, GDGM 9175, besides the holotype under the name of *Chamaeota dextrinoidespora*. Reexamination revealed that it is *Chlorophyllum hortense* (Murrill) Vellinga (Ge & Yang 2006).

Leucoagaricus sinicus (J.Z. Ying) Zhu L. Yang, **comb. nov.** **Figs. 6-10**

MycoBank MB 510605

Basionym: *Chamaeota sinica* J.Z. Ying, Mycotaxon 54: 303, figs.1-8, 1995.

Basidiomata (fig. 6) caespitose to gregarious. **Pileus** 2.5-6 cm diam., convex, distinctly umbonate, vinaceous-cinnamon, darker over disc, densely covered with minute, dark brown squamules; margin finely striate (0.1-0.3R) or barely striate; context flesh-colored, vinaceous buff on drying. **Lamellae** free, pinkish, becoming dirty white to brownish when dried, moderately crowded to crowded; lamellulae in 2-3 tiers. **Stipe** 4-9 × 0.3-0.6 cm, subcylindrical or slightly attenuate upwards, hollow; surface concolorous with the pileus, covered with squamules; basal mycelium white to dirty white when dried. **Annulus** superior, membranous, often persistent.

Basidiospores (fig. 7) [60/3/3] 9.0-11.5 (13.0) × 6.5-8.0 (8.5) µm [Q = (1.27) 1.35-1.57 (1.71), **Q** = 1.45 ± 0.08], in side view ellipsoid, occasionally slightly amygdaliform, without suprahilar depression, in frontal view ellipsoid to subovoid, hyaline, colorless or pale greenish yellow in 5% KOH, rarely with yellow-brown pigment, thick-walled (wall up to 1 µm thick), with germ pore, not or only slightly truncate, without a cap over the pore, strongly dextrinoid, cyanophilous, with pink inner wall and pink plug in germ pore in Cresyl Blue (metachromatic). **Basidia** 23-35 × 9-11 µm, subclavate, hyaline, thin-walled, 4-spored, rarely intermixed with 2- or 3-spored basidia, not surrounded by pseudoparaphyses; sterigmata 3-4 µm long; basal clamp connections absent. **Pleurocystidia** absent. **Cheilocystidia** (fig. 8) scattered to crowded, often in fascicles, irregularly cylindrical and sinuous [50-120 (150) × 3-10 (13) µm], occasionally clavate (40-60 × 10-13 µm), sometimes with apical part slightly enlarged and irregularly branched, colorless, hyaline or with yellow-brown to ochreous intracellular pigment in KOH, thin-walled, occasionally slightly thick-walled (wall ≤ 0.5 µm thick). **Lamellar trama** difficult to rehydrate, probably trabecular, made up of filamentous hyphae 3-10 µm in diam.,

branching, interwoven, sometimes anastomosing. **Squamules on pileus** (fig. 9) a disrupted trichodermium composed of loose fascicles of long, more or less erect, subcylindrical, occasionally narrowly fusiform or lanceolate elements, 70-170 × 7-10 (14) μm, thin to slightly thick-walled (wall <0.5μm thick), often with a dark brown to dark yellowish brown intracellular pigment. **Caulocystidia** (fig. 10) densely covering the whole surface of the stipe except the apical part, subcylindrical to lanceolate [50-150 (200) × 5-16 (20) μm], sometimes broadly clavate (30-70 × 10-15 μm), colorless, hyaline or with a yellow-brown, intracellular pigment, thin- to slightly thick-walled (wall ≤0.5μm thick). **Clamp connections** not observed.

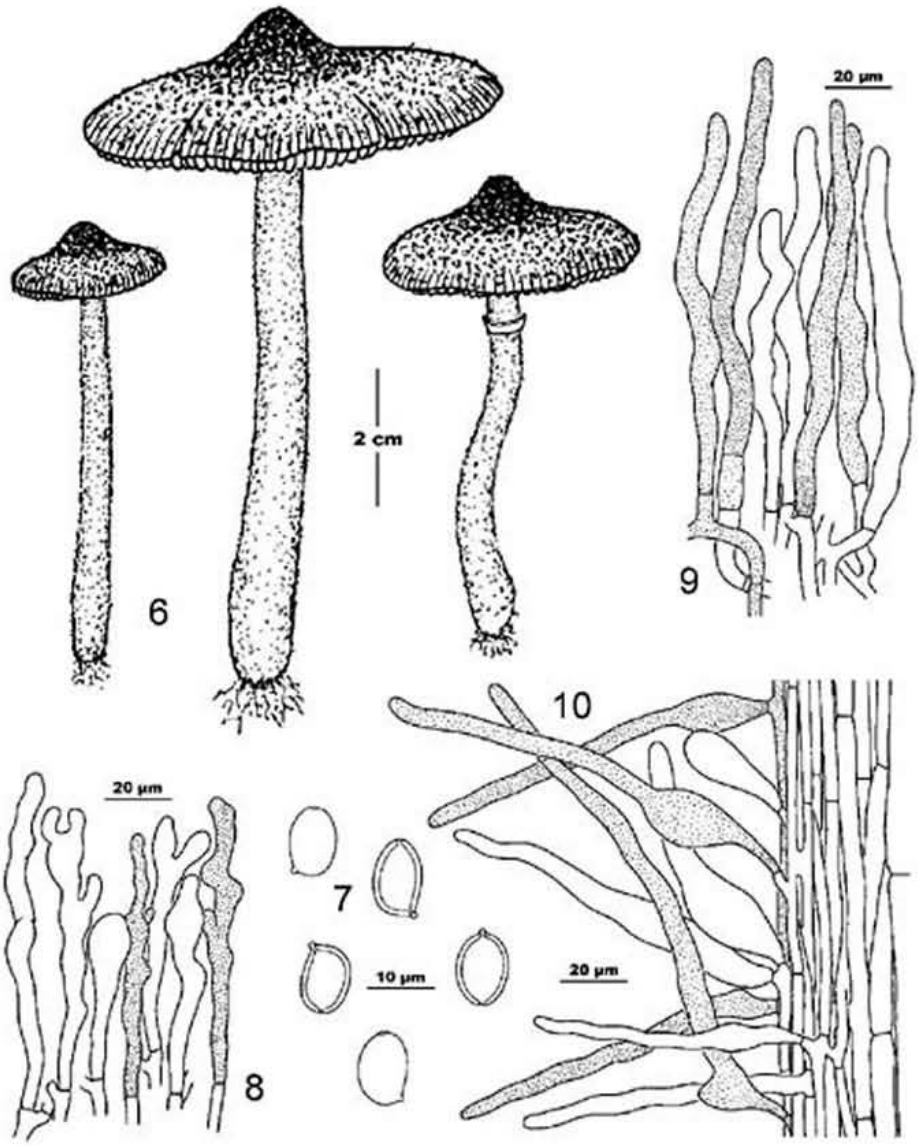
Habit, habitat, distribution and season — Caespitose to gregarious, on soil under bushes of *Rhododendron*; so far only known from the type locality in Zhejiang Province of China; May.

COLLECTIONS EXAMINED—China, Zhejiang Province, Hangzhou City, Jiulisong (30°.16′N, 120°.10′E), 14.V.1990, J.F. Wen *904* (HMAS *59909*, paratype); the same location, 15.V.1990, J.F. Wen *905* (HMAS *60647*, holotype); the same location, 16.V.1990, J.F. Wen *906* (HMAS *62975*, paratype).

Comments—In the above description the color and size of the basidiomata are mainly based on the data of Ying (1995) and notes with the materials. Other data are from personal observations on the dried material cited above. In the protologue, the spore mass, and mycelium at the base of the stipe were described as between Buff-Pink and Japan Rose, and Pale Vinaceous respectively (Ying 1995), which, together with the color changes on bruising or cutting and the reaction of the lamellae and the context to ammonia vapor, need to be studied in the future when fresh material becomes available. Ying (1995) described that the basidia were 2-spored, rarely 4-spored, and cheilocystidia were composed of long, septate cells. The present observations on the specimens cited above differ from those in Ying's report.

Due to the trichodermial elements composing the squamules on the pileus and the hyaline, colorless, dextrinoid and metachromatic basidiospores with a germ pore, this species is not a member of *Chamaeota* but belongs to the *Leucoagaricus/Leucocoprinus* clade in the *Agaricaceae* (fide Vellinga 2004). It should be placed in *Leucoagaricus* (fide Vellinga 2000, 2001, 2004, Vellinga & Davis 2007). This species is well characterized by its subcylindrical stipe, irregularly cylindrical to sinuous cheilocystidia with apical part slightly enlarged and irregularly branched, and subcylindrical to narrowly fusiform trichodermial elements in the squamules on the pileus.

Leucoagaricus sinicus is similar to *L. americanus*, and *L. meleagris*. However, *L. sinicus* differs from the latter two by its subcylindrical stipe, the more or less irregularly cylindrical cheilocystidia often with apical branches, and the



Figs. 6-10: *Leucoagaricus sinicus* (holotype). 6. Basidiomata (based on dry material); 7. Basidiospores; 8. Cheilocystidia; 9. Squamules on pileus; 10. Caulocystidia and surface of stipe.

subcylindrical to narrowly fusiform or lanceolate elements without a tapering apex in the squamules on the pileus. Moreover, *L. americanus* usually has larger basidiomata and *L. meleagris* has fibrillose squamules on the pileus and an inconspicuous germ pore on the spore wall (Vellinga 2001). According to Ying (1995), the pileus context of *L. sinicus* is flesh-colored, while that of *L. americanus* and *L. meleagris* is usually white to whitish but changes to yellow, and

then reddish to red after cutting (Vellinga 2000, 2001). Molecular phylogenetic analysis based on ITS and nLSU-rDNA nucleotide sequences of the holotype of *L. sinicus* and other members of the *Leucoagaricus/ Leucocoprinus* clade also showed that *L. sinicus* clustered with the *L. americanus* group, but differs from *L. americanus* and *L. meleagris* (unpublished data of Z.W. Ge).

Leucoagaricus sinicus is also somewhat similar to *L. holospilotus* and *L. caldariorum*. However, *L. holospilotus* has smaller basidiospores, clavate to lanceolate cheilocystidia often with an appendix and much wider trichodermial elements in the squamules on the pileus. *Leucoagaricus caldariorum* has broadly amygdaliform, somewhat smaller basidiospores, ovate, clavate to lanceolate cheilocystidia often with a short apical appendix and much wider clavate to lanceolate elements in the squamules on the pileus with a hymeniform lower layer (Reid 1990).

With regard to the more or less cylindrical stipe and elements in the squamules on the pileus, *L. sinicus* is similar to *Leucocoprinus lacrymans* T.K.A. Kumar & Manim. However, the latter differs from *L. sinicus* by its white to whitish pileus and stipe beaded with golden yellow to reddish brown watery exudates, the white to pale orange context, and the somewhat narrower cheilocystidia and caulocystidia (Kumar & Manimohan 2004).

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Literature cited

Bi ZS, Li TH. 1988. Two new species of agarics from North Guangdong Province of China. Bulletin of Botanical Research 8 (1): 97-102.

Bon M. 1993. Novitates lepiotarum. Documents Mycologiques 23 (91): 33.

Ge ZW, Yang ZL. 2006. The genus *Chlorophyllum* (Basidiomycetes) in China. Mycotaxon 96: 181-191.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I: herbaria of the world. 8th edition. New York Botanical Garden: New York (USA). 693 pp.

Kumar TKA, Manimohan P. 2004. A new species of *Leucocoprinus* from India. Mycotaxon 90: 393-397.

Minnis AM, Sundberg WJ, Methven AS, Sipes SD, Nickrent DL. 2006. Annulate *Pluteus* species, a study of the genus *Chamaeota* in the United States. Mycotaxon 96: 31-39.

Pegler DN. 1972. A revision of the genus *Lepiota* from Ceylon. Kew Bulletin 27: 155-202.

Pegler DN. 1983. Agaric Flora of the Lesser Antilles. Kew Bulletin Additional Series 9: 1-668.

Pegler DN. 1986. Agaric Flora of Sri Lanka. Kew Bulletin Additional Series 12: 1-519.

Reid DA. 1990. The *Leucocoprinus badhamii* complex in Europe: species which redden on bruising or become green in ammonia fumes. Mycological Research 94: 641-670.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th edit. Koeltz Scientific Books: Koenigstein (Germany). 981 pp.

Smith HV, Weber NS. 1987. Observations on *Lepiota americana* and some related species. Contributions from the University of Michigan Herbarium 16: 211-221.

Vellinga EC. 2000. Notes on *Lepiota* and *Leucoagaricus*. Type studies on *Lepiota magnispora*, *Lepiota barssii*, and *Agaricus americanus*. Mycotaxon 76: 429-438.

Vellinga EC. 2001. *Leucoagaricus* (Locq.: ex) Sing. In: Noordeloos ME, Kuyper ThW, Vellinga EC. (eds). Flora Agaricina Neerlandica 5: 85-108. - A. A. Balkema Publishers: Lisse, Abingdon, Exton (PA) and Tokyo.

Vellinga EC. 2004. Genera in the family *Agaricaceae*: evidence from nrITS and nrLSU sequences. Mycological Research 108: 354-377.

Vellinga EC, Davis RM. 2007. Lepiotaceous fungi in California, U.S.A.–1. *Leucoagaricus amanitoides* sp. nov. Mycotaxon 98:197-204.

Ying JZ. 1995. New and noteworthy agarics from China I. New species of *Chamaeota*. Mycotaxon 54: 303-307.

MYCOTAXON

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Mayamontana coccolobae (Basidiomycota), a new sequestrate taxon from Belize

MICHAEL A. CASTELLANO[1*], JAMES M. TRAPPE[2] & D. JEAN LODGE[3*]

mcastellano@fs.fed.us
[1]U. S. Department of Agriculture, Forest Service,
Pacific Northwest Research Station, Forestry Sciences Laboratory
3200 Jefferson Way, Corvallis, Oregon 97331, USA

trappej@onid.orst.edu
[2]Department of Forest Science, Oregon State University
Corvallis, Oregon 97331-5752, USA

dlodge@fs.fed.us
[3]U. S. Department of Agriculture, Forest Service,
International Institute of Tropical Forestry
PO Box 1377, Luquillo, Puerto Rico 00773-1377

Abstract–A new semi-hypogeous, sequestrate genus and species in the *Basidiomycota* is described from the Maya Mountains of Belize, where it was fruiting in association with *Coccoloba belizensis*. *Mayamontana coccolobae* is characterized by small, bright orange basidiomata with a friable, loculate, red-orange to red gleba and bilaterally asymmetric, ellipsoid to subglobose, hyaline to pale green or yellow spores with a slightly wrinkled utricle and thick walls.

Keywords: taxonomy, distribution

Introduction

While collecting basidiomycetes in the Maya Mountains of Belize as part of a US National Science Foundation funded project, one of us (DJL) encountered bright orange, semi-hypogeous, sequestrate basidiomes under *Coccoloba belizensis* Standl. (*Polygonaceae*) and other regionally endemic ectomycorrhizal hosts. The red-orange, loculate gleba bore hyaline, asymmetrical ballistospores with a wrinkled utricle, unlike other genera of sequestrate fungi. A new genus and species, *Mayamontana coccolobae*, is described from these collections.

Belize is on the southwestern corner of the Yucatan Peninsula, adjacent to México, Guatemala and Honduras and is part of the old terrain of Central America. The upper parts of the Maya Mountains, located in Belize and adjacent parts of Guatemala and Chiapas, México, have remained above sea level as isolated islands during interglacial periods and may have served as refugia for ancestral lineages of various taxa. The basidiomes of the new taxon were primarily associated with the ectomycorrhizal tree, *Coccoloba belizensis* in the Mountain Pine Ridge and Vaca Plateau regions, but also with species of *Neea* (*Nyctaginaceae*) at lower elevations in Blue Hole National Park. The Mountain Pine Ridge near the Five Sisters Falls is granitic, whereas the Vaca Plateau at the Rio Frio Cave Park and the Maya Mountain foothills at Blue Hole National Park are on limestone.

Materials and methods

Methods of collecting and macroscopic and microscopic study were generally those of Castellano et al. (1989). Colors of fresh specimens are in general terms. Hand-cut sections of both fresh and dried material were mounted in water, 5% KOH, Melzer's reagent, or cotton blue for standard light microscopy. Measurements of structures are from mature specimens and, when two dimensions are given, the length precedes the width. Photomicrographs are from material mounted in 5% KOH. Herbaria are abbreviated according to Holmgren et al. (1990). All specimens are deposited in the Mycological Herbarium of Oregon State University (OSC) and also in Forest Department Herbarium, Belize (BRH).

DNA was extracted from basidiome tissue using the CTAB/chloroform method described by Gardes & Bruns (1993), except that the source tissue was not lyophilized. The DNA extract was purified with the Q-Biogene Geneclean II glassmilk kit, and the ITS region of the nrDNA was amplified with primers ITS-1F and ITS-4 using the following PCR protocol: 1) 5 m at 95 C; 2) 1 m at 95 C; 3) 1 m at 52 C; 4) 2 m at 72 C; 5) repeat from step two 34 times. Success of the amplification was checked by electrophoresis on a 2.5% agarose gel.

Successfully amplified PCR product was again cleaned using the Q-Biogene Geneclean II glassmilk kit. Concentration of DNA in the PCR product was estimated by electrophoresing the product on a 2.5% agarose gel with a calibrated marker in an adjacent lane. The purified PCR product was diluted to an approximate molecular weight of 50 ng in 7 µl of dH2O. To this dilution was added 0.6 µl of primer ITS-4, 1 µl of sequencing buffer, and 2 µl of ABI Prism Big Dye Terminator 3.1. This cocktail was subjected to the following PCR protocol: 1) 5 m at 96 C; 2) 30 s at 96 C; 3) 15 s at 50 C; 4) 4 m at 60 C; 5) repeat from step two 25 times.

Sequencing was performed by the Oregon State University Center for Genome Research and Biocomputing on an Applied Biosystems capillary 3730 Genetic Analyzer. The sequences were submitted to the BLAST search engine for matching at the National Center or Biotechnology Information.

The large subunit of nrDNA of one specimen was also amplified and sequenced. Methods were as above except primers LR0R and LR3 were used for initial PCR amplification and LR0R was used for sequencing. BLAST results (below) were consistent with those for the ITS region.

Taxonomic description

Mayamontana Castellano, Trappe & Lodge, **gen. nov.**
MycoBank MB510440

A Stephanosporaceis altris gleba pallide rubroaurantia vel rubra et sporis bilateraliter asymmetricis, laevibus, utriculo rugoso, pariete crasso, singulatim hyalinis vel pallide viridibus vel luteis, in massa pallide viridiluteis, pedicellatis.

Etymology: *Mayamontana* honors the Mayan people and refers to the Maya Mountains.

Type species: *Mayamontana coccolobae* sp. nov.

Mayamontana coccolobae Castellano, Trappe & Lodge, **sp. nov.** Fig. 1
MycoBank MB510441

Basidiomata 6-8 mm lata, vivide aurantia. Gleba loculata, friabilis, pallide rubroaurantia vel rubra. Sporae (-9) 10-12 (-14) x (5-) 6.5-7 (-8) µm, bilateraliter asymmetricae, laeves, utriculo parum rugoso, pariete plus minusve 2 µm crasso, singulatim hyalinae vel pallide virides vel luteae, in massa pallide viridilutea, pedicello 3 x 2 µm. Holotypus BZ-1943.

Etymology: *coccolobae refers to the association of this species with the plant, Coccoloba belizensis.*

Basidiomata beneath loose litter or exposed, attached to the surface of mineral soil, attachment point evident at base where the peridium does not enclose the gleba, when fresh 6-8 mm in diameter, ovoid, bright orange, slightly felty, as dried 2-3 x 2-5 mm, irregularly flattened, subglobose to globose, pale orange-tan to orange to bright orange, slightly felty, very wrinkled; **gleba** when dried friable, pale red-orange to red, when rehydrated in 5% KOH the mediostratum of the trama is often bright red; spores and hyphae partially filling the irregularly rounded locules, 0.1-0.2 mm broad, red-orange leachate apparent when mounted in 5% KOH; **columella** lacking; **odor** none; **taste** not recorded.

Peridium 100-125 µm thick, of pale orange, thin-walled, inflated cells and irregularly interwoven to subparallel hyphae (5-10 µm in diam); the tissue near the outer surface encrusted with debris; the tissue near the gleba tends

to have more interwoven hyphae than inflated cells, but no clear demarcation of peridial layer boundaries; **trama** similar in structure to the peridium but more pale to nearly hyaline, of thin-walled cells irregularly inflated, up to 17 x 39 µm, mostly about 15 x 20 mm; **subhymenium** of hyaline, thin-walled, cells irregularly inflated up to 5mm diam; **hymenium** a palisade of basidia and basidioles, collapsing soon after spore development and obscured by the mass of spores; **cystidia** absent; **basidia** hyaline, thin-walled, subclavate, 25-37 x 7-10 µm, 4-spored; **sterigmata** 2-6 µm tall, 1-2 µm wide at base, hyaline; **clamp connections** absent; **spores** (9-) 10-12 (-14) x (5-) 6.5-7 (-8) µm, asymmetrical, broadly ellipsoid to subglobose, slightly flattened on one side, smooth; utricle uneven, slightly wrinkled, not inflated, giving the spore a roughened to warty appearance, thick walled, up to ±2 µm thick; inner surface of the spore wall appearing uneven, in KOH mostly hyaline but sometimes slightly pale green or yellow singly, in mass pale green-yellow, in Melzer's reagent no reaction; spore walls 0.5 µm thick; **pedicel** distinct, up to 3 µm long and 2 µm wide; the end appearing ragged.

Ecology, range, and distribution—Semi-hypogeous, scattered, on soil under loose leaf litter, beneath *Coccoloba belizensis* and *Neea* sp. at 70-370 m elevation in the Maya Mountains of Belize; August and October.

REPRESENTATIVE SPECIMENS EXAMINED—BELIZE: Maya Mountains, Mountain Pine Ridge, Forest Reserve, Five Sisters Lodge, lower nature trail (88° 59' 8" W 17° 2' 16"N), D.J. Lodge, *BZ-3052*, 5.X.2003 (HOLOTYPE-BRH; ISOTYPE-OSC). **BELIZE:** same locality as holotype except, upper nature trail (88° 59' 8" 17° 2' 19.4"N), D.J. Lodge, *BZ-74*, 10.VIII.2001 (BRH; OSC); Blue Hole National Park, Maya Mountains, Northern Foothills, Caves Branch, along Hummingbird Loop trail (88° 41' 1.5"W 17° 9' 29.5"N), D.J. Lodge, *BZ-1943*, 30.X.2002 (BRH; OSC).

Comments—*Mayamontana* is characterized by the small, hyaline, asymmetrical, smooth spores with a roughened utricle and a distinct pedicel, unusual in sequestrate taxa. The spores are similar to those of *Sclerogaster* in overall appearance but are significantly larger in size and lack the distinct warts of *Sclerogaster* spores. Basidiome characters are reminiscent of *Stephanospora* in peridial color, size, texture of the peridium and fruiting habit. We extracted DNA material from *M. coccolobae* and upon performing a BLAST search using GENCOM it is placed in the *Stephanosporaceae* (Martin et al. 2004) near *Stephanospora caroticolor* (Berk.) Pat. (GenBank Accession AJ419224). The characteristics of the basidiome are somewhat similar to species of

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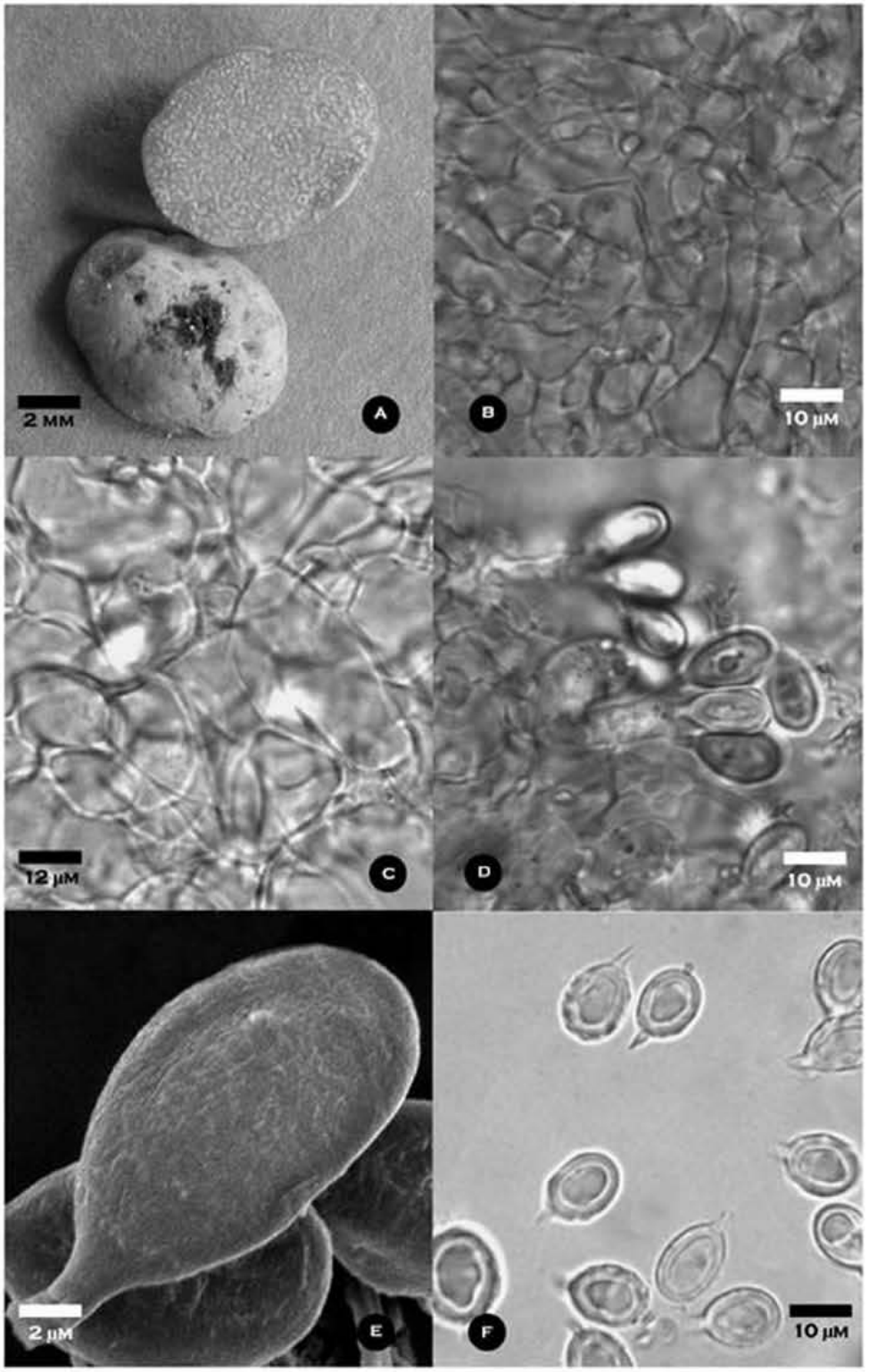
Fig. 1. *Mayamontana coccolobae* (holotype). A. Basidioma. B. Peridial hyphae in radial section; C. Tramal cells in radial section; D. Basidia and spores attached to sterigmata; E. SEM of basidiospore with distinct pedicel; F. Light photomicrograph of basidiospores showing the ragged end of the pedicel.


2 MM
A
B
10 µM
12 µM
C
D
10 µM
2 µM
E
F
10 µM

Stephanospora but basidiomes of *Stephanospora* species have a yellow peridium and a gray-olive gleba. *Mayamontana* also differs markedly from all described *Stephanospora* taxa by the lack of a basal ornamental collar or "corona" surrounding the spore base and prominent, wedge-shaped ridges.

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We thank Matthew Trappe of the Department of Forest Science, Oregon State University, for extracting, amplifying and blasting various DNA components to elucidate genus placement. We thank Drs. Efren Cázares, Roy Halling and Brad Kropp for reviewing the manuscript. This research was supported by a grant from the National Science Foundation, Biodiversity Surveys and Inventories Program to the State University of New York, College at Cortland (DEB-0103621), in collaboration with the Center for Forest Mycology Research, USDA-Forest Service, Forest Products Laboratory. The International Institute of Tropical Forestry, USDA-Forest Service, provided facilities in Puerto Rico for specimen analysis and processing. Ms. Beatriz Ortiz-Santana helped collect specimens. We are especially grateful to Dr. Sharon Matola, Director of the Belize Zoo and Mr. Tony Garel, the former Station Manager of the Tropical Education Center, for assisting with lodging, logistics, and equipment storage. We also thank Carlos Popper and the staff at Five-Sisters Lodge for permission to collect on their property and providing an ideal work environment in the Mountain Pine Ridge. Mrs. Melita Pratt and Mr. Nigel Bouloy of Jabiru Auto Rental assisted with logistics of arrivals and departures in Belize. Mr. Hector Mai assisted in plant identification. Several individuals with government and non-governmental agencies in Belize are acknowledged for their kind help with permits and guidance: Dr. Lizandro Quiroz, Ms. Natalie Rosado, Mr. Hector Mai, Mr. Marcelo Windsor, and Mr. John Pinelo of the Conservation Division, Belize Forestry Department in Belmopan and the Programme for Belize in Belize City.

Literature cited

Castellano MA, Trappe JM, Maser Z, Maser C. 1989. Keys to Spores of the Genera of Hypogeous Fungi of North Temperate Forests with Special Reference to Animal Mycophagy. Mad River Press, Eureka, California (USA). 186 pp.

Gardes M, Bruns T. 1993. ITS primers with enhanced specificity for basidiomycetes: applications to the identification of mycorrhizae and rusts. Molecular Ecology 2:113-118.

Holmgren PK, Holmgren NH, Barnett LC. (1990). Index herbariorum. Part I: Herbaria of the World. 8th ed. Bronx, The New York Botanical Garden, Bronx, 693 pp.

Martín MP, Raidl S, Telleria NT. 2004. Molecular analyses confirm the relationship between *Stephanospora caroticolor* and *Lindtneria trachyspora*. Mycotaxon 90:133-140.

MYCOTAXON

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Vittalia indica gen. & sp. nov. and *Helicoma indicum* sp. nov. from the forests of northeastern India

PUJA GAWAS [1] & D.J. BHAT [2]

[1] *pujabg@yahoo.co.in* & [2] *bhatdj@rediffmail.com*
Department of Botany, Goa University
Goa-403 206, India

Abstract — Two newly discovered hyphomycetous fungi isolated from forest litter of northeastern India are described in this paper. *Vittalia*, typified by *V. indica*, has solitary, verrucose, euseptate conidia produced on monotretic conidiogenous cells borne on smooth, branched conidiophores. The new species, *Helicoma indicum*, is distinguished from other known species in the genus by its uniseptate conidia.

Key words — *Bharatheeya*, *Diplococcium*, fungal diversity, *Spadicoides*, taxonomy

Introduction

Arunachal Pradesh, Assam, Mizoram and Nagaland, the northeastern Indian States, exhibit a rich and luxuriant floristic diversity (Borges 2005). Owing to steep altitudinal variations, the region possesses a temperate to sub-tropical climate (Ao & Bordoloi 2004). While some data on lichen and macrofungal diversity is available (Sati et al. 1997), not much is known on microfungal diversity of the northeastern region.

During a recent field trip to a few localities in the region, as part of an All-India Coordinated Project on Taxonomy of Fungi, samples of dead and decaying twigs and leaves were gathered. Of the several fungi isolated from these litter substrates, two new hyphomycetous taxa are described here.

Taxonomic description

Vittalia Gawas & Bhat **anam. gen. nov.**

MYCOBANK MB510706

Ad fungos conidiales, hyphomycetes. Coloniae effusae, pallide brunneae vel brunneae, pappim. Mycelium partim substrato immersum, partim superficiale. Stroma absentia. Setae et hyphopodia absentia. Conidiophora macronematica, mononematica, longa, angusta, mycelioida, curvata vel flexuosa, pallide brunnea vel brunnea, laevia vel

verrucosa, septata, ramosa vel non-ramosa. Cellulae conidiogenae monotreticae, nunquam cicatricem, integratae, terminales vel intercalare. Conidia sicca, solitaria, hyalina vel pallide brunnea, laevia vel verrucosa, cylindrica, rotundata ad duo extrimitas, recta vel allantoidea, euseptata.

Etymology: In honor of Prof. B.P.R. Vittal, University of Madras, India, a distinguished mycologist, who made enormous contributions to his discipline.

Conidial fungus, hyphomycete. *Colonies* effuse, pale to olivaceous brown, woolly. *Mycelium* partly immersed, partly superficial. *Stroma* none. *Setae* and *hyphopodia* absent. *Conidiophores* distinct, single, long, narrow, mycelioid, curved to flexuous, pale to olivaceous brown, smooth to verrucose, septate, branched or unbranched. *Conidiogenous cells* monotretic, non-cicatrized, integrated, terminal or intercalary. *Conidia* dry, solitary, hyaline to pale brown, smooth to verrucose, cylindrical, rounded at both ends, straight to allantoid, euseptate. Conidial secession rhexolytic.

Type species: *V. indica*

Vittalia indica Gawas & Bhat **sp. nov.** Fig. 1, 3-9

MycoBank MB510707

Ad fungos conidiales, hyphomycetes. Coloniae effusae, pallide brunnea vel brunnea, pappim. Mycelium partim substrato immersum, partim superficiale, ex hyphis septatis, ramosis, hyalinis vel pallide brunneis, 2-3.5 µm lat. Conidiophora macronematica, mononematica, longa, angusta, mycelioida, curvata vel flexuosa, pallide brunnea vel brunnea, laevia, septata, ramosa, ramus aucto longa, 2-3 µm lat. Cellulae conidiogenae monotreticae, nunquam cicatricem, integratae, terminales ad intercalare, cylindricae, 16-30 (-50) x 2-3 µm. Conidia sicca, solitaria, hyalina, verrucosa, cylindrica, rotundata ad duo extrimitas, allantoidea, 3-septata, 11-14 (-19) x 3-4.5 µm.

HOLOTYPE — On dead leaf of unidentified tree, Tezu, Arunachal Pradesh, India, coll. D.J. Bhat, 13.07.2006, Herb. No. HCIO 46950

Conidial fungus, hyphomycete. *Colonies* effuse, pale to olivaceous brown, wooly. *Mycelium* partly immersed, partly superficial, composed of septate, branched, hyaline to pale brown, 2-3.5 µm wide hyphae. *Conidiophores* distinct, single, long, narrow, mycelioid, curved to flexuous, pale to olivaceous brown, smooth, septate, branched, branches often very long, 2-3 µm wide. *Conidiogenous cells* monotretic, non-cicatrized, integrated, terminal or intercalary, cylindrical, 16-30 (-50) x 2-3 µm. *Conidia* dry, solitary, hyaline, verrucose, cylindrical, rounded at both ends, allantoid, 3-septate, 11-14 (-19) x 3-4.5 µm.

With darkly pigmented, smooth conidiophores, integrated, non-cicatrized, cylindrical, tretic conidiogenous cells and verrucose, euseptate conidia, *Vittalia* resembles three other hyphomycetous genera: *Bharatheeya* D'Souza & Bhat, *Diplococcium* Grove and *Spadicoides* S. Hughes (Ellis 1971, Eicker et al. 1985, D'Souza & Bhat 2002). These differ from each other in combinations of several distinct features as detailed in Table 1. The genus *Vittalia* is closer to

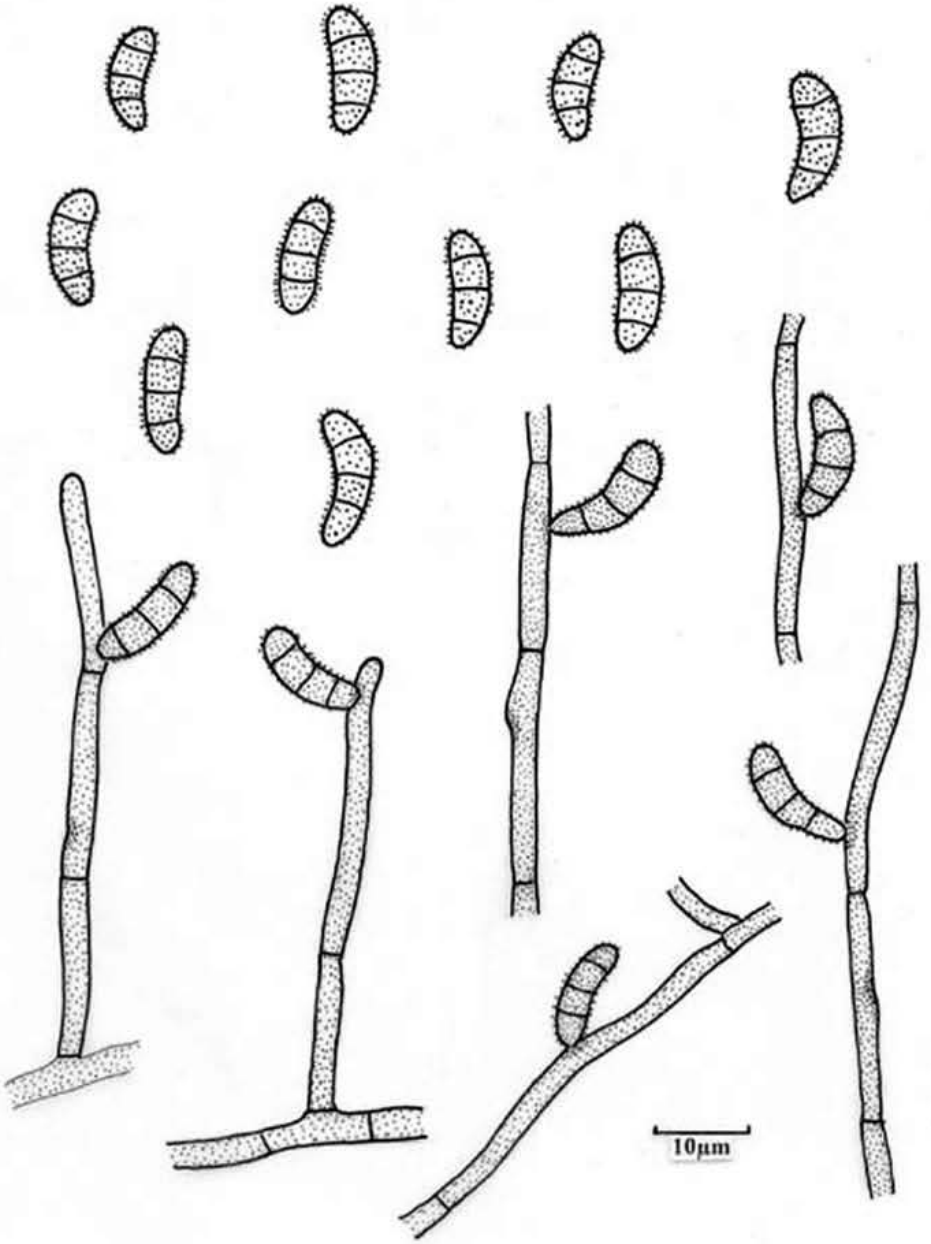


Fig. 1. *Vittalia indica*. Conidiophores, conidiogenous cells and conidia.

Bharatheeya in having long, slender, conidiophores and dry, solitary conidia. It is similar to *Diplococcium* in having terminal and intercalary conidiogenous cells and solitary, dry, euseptate conidia. It resembles *Spadicoides* in having branched conidiophores, terminal and intercalary conidiogenous cells and euseptate conidia. However, *Vittalia* is distinct from all these by monotretic

Table 1: Comparison of characters that distinguish *Vittalia* from other similar genera

Fungal genera	Conidiophores	Conidiogenous cells	Conidia	Reference
Bharatheeya	Erect, unbranched, septate, verrucose, inflated at the base	Polytretic	Solitary, distoseptate, smooth	D'souza and Bhat, 2002
Diplococcium	Erect, unbranched, septate, smooth	Polytretic	Catenate, smooth, euseptate	Ellis, 1971
Spadicoides	Erect, branched, septate, smooth	Polytretic	Solitary, smooth, euseptate	Ellis, 1971
Vittalia	Flexuous, septate branched, smooth	Monotretic	Solitary, verrucose, euseptate	Present observations

conidiogenous cells. A combination of characters such as branching of conidiophores and solitary, euseptate, verrucose nature of conidia supports the disposition of the fungus in the new genus, *Vittalia*, as *V. indica* sp. nov.

Helicoma indicum Gawas & Bhat **sp. nov.** Fig. 2, 10- 15

MycoBank MB510703

Ad fungos conidiales, hyphomycetes. Coloniae effusae, pallide brunnea, velutinae. Mycelium substrato immersum. Conidiophora macronematica, mononematica, fasciculata vel synnematica, 4-13 (mean 9) coalesco, erecta, divergentibus, pallide brunnea ad apicem, darker ad basim, laevia, 2-6 (- 15) septata, non-ramosa vel ramosa, up to 200 µm longa, 2-3 µm lat. Cellulae conidiogenae polyblasticae, denticulis, integratae, terminales, cylindricae, 14-40 x 1.5-2.5 µm. Conidia sicca, solitaria, laevia, hyalina, helicoidea, uniseptata, in 0.5-0.75 spiris convoluta, 5.5- 7.5 µm diam; filum 3-3.5 µm lat.

HOLOTYPE — On dead twig of unidentified tree, Mokokchung, Nagaland, India, coll. D.J. Bhat, 09.07.2006, Herb. No. HCIO 46952.

Conidial fungus, hyphomycete. *Colonies* effuse, pale brown, velvety. *Mycelium* immersed. *Conidiophores* distinct, fasciculate to synnematous, 4-13 (mean 9) conidiophores held together, erect, divergent, pale brown towards apex, darker at base, smooth, 2-6 (-15) septate, unbranched to branched, up to 200 µm long, 2-3 µm wide. *Conidiogenous cells* polyblastic, sympodial, denticulate, integrated, terminal, cylindrical, 14-40 x 1.5-2.5 µm. *Conidia* dry, solitary, smooth, hyaline, uniseptate, coiled 0.5-0.75 times, 5.5- 7.5 µm diam; conidial filament 3-3.5 µm wide.

Moore (1955) provided a generic key to the helicosporous fungi. Our fungus is a saprobe with conidiophores aggregated to form fascicles or loose synnemata and simple, solitary, non-hygroscopic, two-dimensionally coiled, transversely

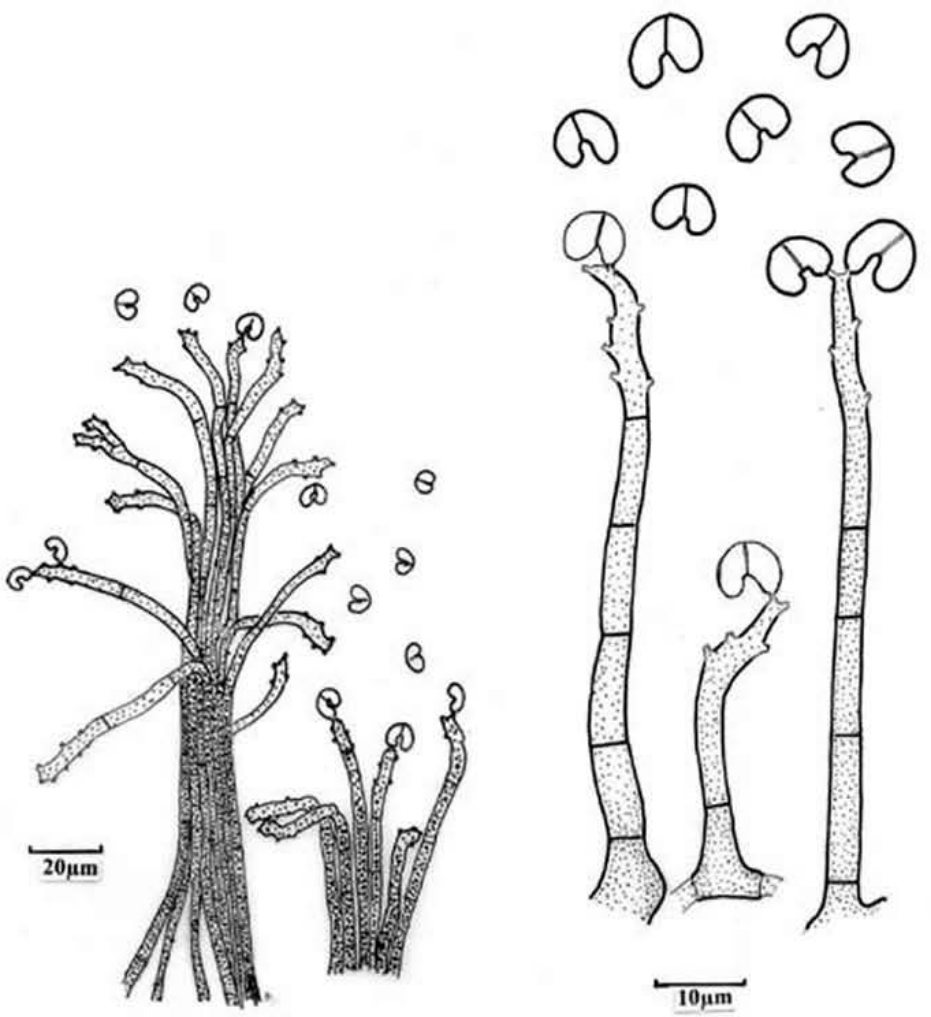


Fig. 2. *Helicoma indicum*. Conidiophores, conidiogenous cells and conidia.

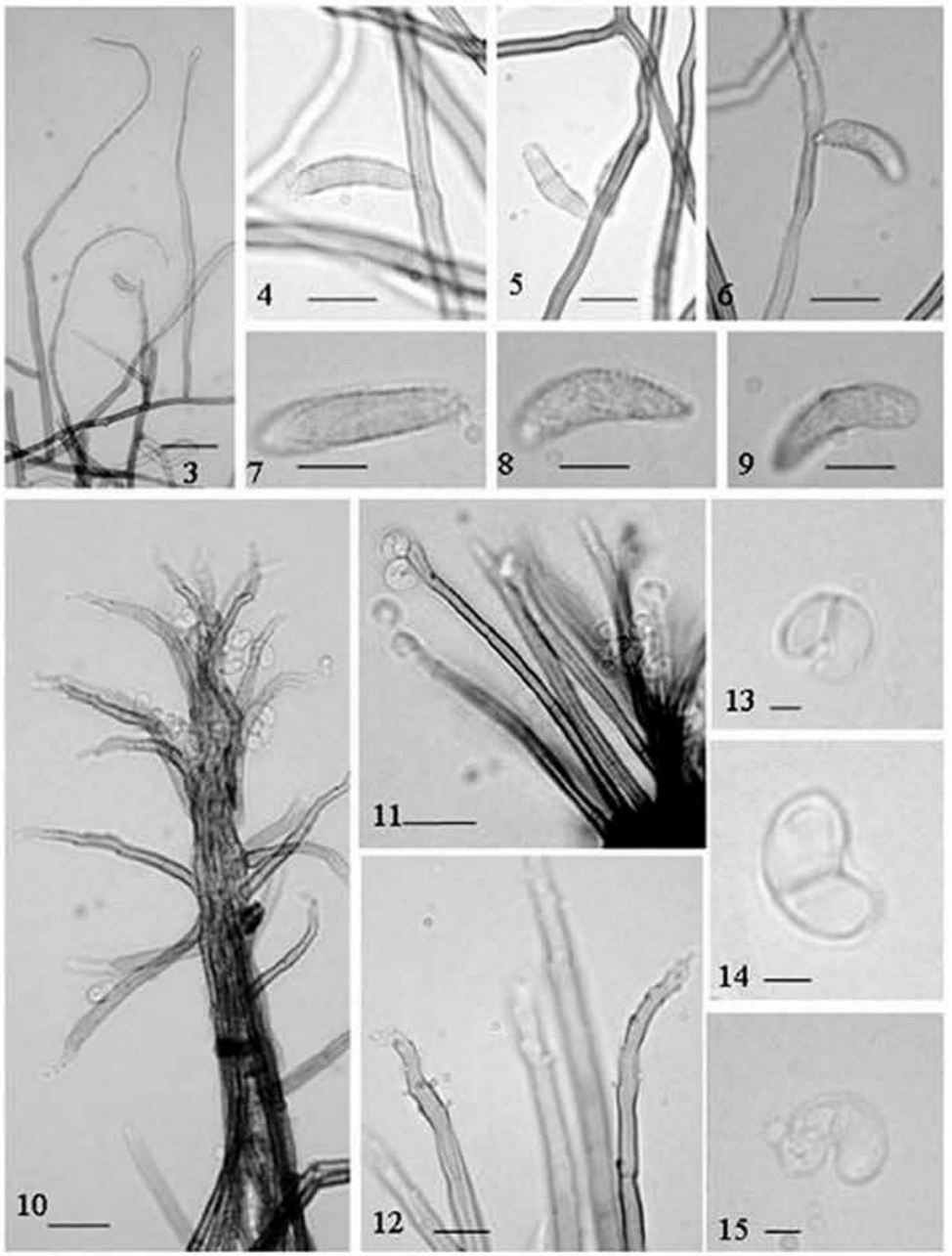
septate conidia. These characters support its placement in the genus *Helicoma* Corda, typified by *H. muelleri* Corda (Corda 1837), which presently accommodates about 50 species (Index Fungorum 2006). Pirozynski (1972) proposed to accommodate the species of *Helicoma* into two groups based on their mode of conidiogenesis. He included those with acrogenous conidia produced on sympodial, denticulate conidiogenous cells in the first group while species that produced hyaline, multiseptate, pleurogenous conidia on tooth-like conidiogenous cells borne on setiform conidiophores in the second (Pirozynski 1972). Following his scheme, we propose to place our fungus in the second group.

Goos (1986) reviewed 32 of the then known 40 species, segregated them into four Sections, viz. *Helicoma*, *Atroseptatum*, *Violaceum* and *Monilipes* and provided a useful key to each of the sections in the genus. With conidia borne acropleurogenously on conspicuous denticles, *H. indicum* fits well in the Sect. *Helicoma*. On comparison, the fungus was found to be quite different from any of the earlier known species, the distinct features being its uniseptate conidia and overall dimensions (Table 2).

Table 2: Comparison of species of *Helicoma* belonging to Section *Helicoma*

Species	Conidiophore length (µm)	Conidial diameter (µm)	Number of septa per conidium	Number of coils per conidium
H. ambiens Morgan	up to 600	18-20	6-8	1.5-1.75
H. asperothecum Linder	55-250	15-25	8-10	1.5-1.75
H. conicodentatum Linder	20-125	14-20	5-7	1.25-1.75
H. dennisii Ellis	up to 470	19-22	7-8	1.25-1.5
H. indicum Gawas & Bhat	up to 200	5.5-7.5	1	0.5-0.75
H. inflatum Linder	18-120	13-18	5-6	1.25-1.75
H. muelleri Corda	up to 200	14-21	5-8	1.5-1.75
H. narsapurense Rao & Rao	145-335	20-27	3-8	1.25-1.5
H. recurvum (Petch) Linder	125-300	15-20	6-8	1-1.75
H. taenia Moore	up to 600	15-20	7-16	1.5-1.75
H. taiwanensis Matsushima	100-400	7-15	3-5	1-1.5

Helicoma indicum resembles the genera *Trochophora* R.T. Moore and *Helicomyces* Link in having two dimensionally coiled, simple, solitary transversely septate conidia. *H. indicum* however differs from the former in having fasciculate to loosely aggregated synnemata, hyaline conidia and unthickened conidial septa.



Figs. 3-9. *Vittalia indica*. 3. Myceleoid conidiophores (bars= 20µm) 4-6. Monotretic conidiogenous cells (bars= 10µm). 7-9. Allantoid 3-septate conidia (bars= 5 µm). 10-15. *Helicoma indicum*. 10,11. Conidiophores in fascicles with attached conidia (bars= 20 µm), 12. Polyblastic denticulate conidiogenous cells (bar= 10 µm). 13-15. Helicoid unisepate conidia (bar= 5 µm).

Helicoma indicum differs from the other morphologically similar genus *Helicomyces* in its non-hygroscopic nature of conidia and in being thicker in proportion to the length of the conidial filament.

Using rDNA sequence analysis of helicosporous fungi, Tsui & Barbee (2006) and Tsui et al. (2006) inferred that this group of anamorphic fungi is polyphyletic and that the lack of monophyly is due to the inefficiency of the traditionally used morphological characters to delimit the genera. They said that, though no single morphological character perfectly correlates with the clades of the phylogenetic tree obtained during the study, a combination of characters such as conidiophore color, conidial color and conidial ontogeny are phylogenetically informative. They further suggested that characters such as prominence of conidiophores, thickness of conidial filaments and hygroscopic nature of conidia are more useful for species delimitation than for predicting higher level relationships. This has challenged the existing taxonomic and nomenclatural status of helicosporous fungi. In any case, until a thorough revision of the group is made, the existing genera are considered valid. In the present setup, we would like to accommodate our fungus as a new species in the genus *Helicoma* following the morphological characters as mentioned in the generic description. To quote Seifert & Gams (2001): 'Identification of most of the fungi is made using morphological characters, although the age of molecular biology provides us with molecular diagnostics. Using morphological characters, anamorph genera can be delimited that are practical for identification purposes, and are often (but not always) phylogenetically natural'.

Acknowledgments

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Literature cited

Ao M, Bordoloi S. 2004. The Amphibian Fauna of Nagaland, India: Species and Habitats. Froglog 62: 3.

Borges RM. 2005. The Frontiers of India's Biological Diversity. Tropinet 16(3): 1-3.

Corda ACL. 1837. Icones Fungorum hucusque cognitorum. Vol 1.

D'Souza M, Bhat DJ. 2002. *Bharatheeya*, a new hyphomycete genus from India. Mycotaxon 83: 397-403.

Eicker E, Sinclair R, Bhat DJ. 1985. Branching in *Spadicoides*. Trans. Br. Mycol. Soc. 85: 736-738.

Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, England. 608p.

Goos RD. 1986. A review of the anamorph genus *Helicoma*. Mycologia 78(5): 744-761.

Index Fungorum. 2006. www.indexfungorum.org

Linder DH. 1929. A Monograph of the Helicosporous Fungi Imperfecti. Annals Missouri Bot. Gard. 16(3): 227-348, 350-388.

Moore RT. 1955. Index to the *Helicosporae*. Mycologia 47(1): 90-103.

Pirozynski KA. 1972. Microfungi of Tanzania Part 1: Miscellaneous fungi on oil palm. Mycol. Pap. 129: 1-39.

Sati SC, Saxena J, Dubey RC. 1997. Himalayan Microbial Diversity. 2nd Vol. Today & Tomorrow Publishers, New Delhi. 517p.

Seifert KA, Gams W. 2001. The taxonomy of anamorphic fungi. In: The Mycota VII Part A. Systematics and Evolution (Eds. McLaughlin, McLaughlin, Lemke) Springer-Verlag Berlin Heidelberg. pp 307-347.

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Anomoloma, a new genus separated from *Anomoporia* on the basis of decay type and nuclear rDNA sequence data

TUOMO NIEMELÄ[1], KARL-HENRIK LARSSON[2], YU-CHENG DAI[3] & ELLEN LARSSON[2]

[1] *Finnish Museum of Natural History, Botanical Museum P.O.Box 7, FI–00014 University of Helsinki, Finland*

[2] *Göteborg University, Department of Plant and Environmental Sciences P.O. Box 461, SE–40530 Göteborg, Sweden*

[3] *Institute of Applied Ecology, Chinese Academy of Sciences Wenhua Road 72, Shenyang 110016, China*

Abstract—Five species of *Anomoporia*, and related but deviating material from South China, were studied microscopically and sequenced. Bayesian and maximum parsimony analyses were conducted using nuclear ribosomal ITS and large-subunit DNA regions. The species belong to a subclade within or close to the euagarics clade. The brown-rot-causing species *A. bombycina* (type of the genus *Anomoporia*), *A. vesiculosa*, and *A. kamtschatica* belong to a genus complex together with *Ceraceomyces*, *Hypochniciellum*, *Irpicodon* and *Plicaturopsis*, but their inner hierarchy needs further study before conclusions on genus limits can be made. Four strongly rhizomorphic species of *Anomoporia* are associated with white-rot, and they were found to form a well-supported clade. Consequently, a new genus *Anomoloma* is described. The following new combinations are made: *Anomoloma albolutescens* (type of the genus), *A. myceliosum*, *A. flavissimum*, and a new species is described from the South Chinese material: *A. rhizosum*. Numerous new records of *A. flavissimum* expand considerably its known range in China.

Key words—*Basidiomycota*, phylogeny, polypore, taxonomy

Introduction

The genus *Anomoporia* Pouzar was established for a small group of resupinate polypore species with monomitic hyphal structure and amyloid spores (Pouzar 1966). The type of the genus, *A. bombycina* (Fr.) Pouzar, causes intensive brown-rot on coniferous trees. Similarly brown-rot-causing are the closely related *A. vesiculosa* Y.C. Dai & Niemelä, described from China and later also found in Japan (Dai & Niemelä 1994, Dai 1996), and *A. kamtschatica* (Parmasto) Bondartseva, which is more widespread throughout northern Asia and Europe.

Pouzar (1966) also included some other species of resupinate polypores in *Anomoporia*, viz. *A. albolutescens* (Romell) Pouzar and *A. myceliosa* (Peck) Pouzar. Later Niemelä (1994) described *A. flavissima* from material collected by Erast Parmasto and others from the Russian Far East.

When studying the genus, Niemelä (1994) pointed out that while *A. bombycina* and *A. kamtschatica* have basidiocarps with cottony margins and cause brown-rot, *A. albolutescens*, *A. myceliosa* and *A. flavissima* are strongly rhizomorphic and grow on white-rotted wood. The type of rot is usually regarded as an important character for the classification of wood decay fungi, and recent molecular phylogenetic investigations seem to support that conclusion (e.g. Hibbett & Donoghue 2001, Hibbett & Thorn 2001). In order to test whether the different decay characteristics present in *Anomoporia* suggest that the genus is composed of phylogenetically disparate elements, a sequence dataset was compiled and analysed. Larsson et al. (2004) who studied the evolution of homobasidiomycetes with an emphasis on species with effused basidiomata included two species of *Anomoporia* in their analyses: the type species, and *A. kamtschatica*. These taxa formed, together with *Amylocorticium cebennense* (Bourdot) Pouzar, *A. subincarnatum* (Peck) Pouzar, *Ceraceomyces tessulatus* (Cooke) Jülich, and *Hypochniciellum subillaqueatum* (Litsch.) Hjortstam, a subclade within or close to the euagarics clade. There are no other *Anomoporia* sequences available in GenBank.

When designing the present dataset we expanded on the results by Larsson et al. (2004) and on the observation that *Anomoporia*, *Amylocorticium*, and *Hypochniciellum* all have amyloid spores. We also took into consideration suggestions from the literature that *Anomoporia myceliosa* might be related to *Porpomyces* (Bondartseva 1998) or *Ceriporiopsis* (Ryvarden & Gilbertson 1993) and added the type species from these two genera to our dataset. Larsson (2001) showed that *Porpomyces* is related to *Trechispora*, and that these genera belong to a well delimited lineage, the trechisporoid clade (Larsson et al. 2004, Binder et al. 2005). *Ceriporiopsis gilvescens* (Bres.) Domański has to our knowledge not been included in any molecular phylogenetic analyses before.

New Chinese finds of *Anomoporia flavissima* expand its known range considerably, and a related but undescribed species was collected twice in South China. These observations are also reported here.

Materials and methods

Data on the material used for phylogenetic analyses are listed in Table 1 together with GenBank accession numbers.

Ten sequences from the nuclear ribosomal ITS and large-subunit DNA regions were generated for this study. Ten additional sequences were downloaded from GenBank. *Meruliopsis taxicola* (Pers.) Bondartsev, *Basidioradulum radula* (Fr.)

Nobles and *Sistotrema brinkmannii* (Bres.) J. Erikss. representing the phlebioid, hymenochaetoid, and cantharelloid clades (Larsson et al. 2004), respectively, are included to aid in the polarisation of molecular characters. In analyses *Sistotrema brinkmannii* is used as outgroup in order to root the tree.

DNA was isolated from herbarium material using DNeasy plant mini kit (QIAGEN, Valencia), following manufacturer's recommendations. PCR reactions were carried out using Ready-To-Go™ PCR beads (Amersham Pharmacia Biotech). Primers used to amplify the complete ITS region were ITS1F and ITS4B (Gardes & Bruns 1993) and for the partial LSU region LR0R and Lr7 (Vilgalys & Hester 1990).

Amplified products were purified using Qiaqick spin columns (QIAGEN). Primers used for sequencing were ITS1, ITS3, ITS4 (White et al. 1990), Ctb6 (http://mendel.berkeley.edu/boletus.html), Lr5, and LR3R (Vilgalys & Hester 1990). 50–75 ng of PCR product were used in each sequencing reaction using DTCS Quick Start Kit (Beckman Coulter, Fullerton). Sequences were obtained using CEQ 8000 DNA analysis system (Beckman Coulter). Sequences

Table 1. Specimens used for phylogenetic analyses. Herbarium acronyms follow Holmgren et al. (1990).

Taxon	Voucher	Herbarium	GenBank number
Amyloathelia crassiuscula	K 169/796	GB	DQ144610
Amylocorticium cebennense	JS 24813	O	AY463376/AY586627
Amylocorticium subincarnatum	Å. Strid	GB	AY463377/AY586628
Amylocorticium subsulphureum	M. Ryberg	GB	DQ144611
Anomoloma albolutescens	RP 3549	H	DQ144612
Anomoloma flavissimum	TN 6397	H	DQ144613
Anomoloma myceliosum	TN 5911	H	DQ144614
Anomoloma rhizosum	YCD 4031	H	DQ144616
Anomoporia bombycina	GG 612-92	O	AY463378/AY586629
Anomoporia kamtschatica	KHL 11072	GB	AY463379/AY586630
Anomoporia kamtschatica	K 426	GB	DQ144615
Anomoporia vesiculosa	MN 934	O	DQ144617
Basidioradulum radula	NH 9453	GB	AF347105
Ceraceomyces tessulatus	KHL 8474	GB	AY463391/AY586642
Ceriporiopsis gilvescens	Haussknecht	O	DQ144618
Hypochniciellum subillaqueatum	KHL 8493	GB	AY463431/AY586679
Irpicodon pendulus	B. Nordén	GB	DQ144619
Meruliopsis taxicola	KHL 8541	GB	AY463408/AY586656
Plicaturopsis crispa	KHL 8615	GB	DQ144620
Porpomyces mucidus	KHL 11062	GB	AF347091
Sistotrema brinkmannii	NH 11412	GB	AF506473

were edited and assembled using Sequencer 3.1 (Gene Codes, Ann Arbor). Sequences were aligned using the data editor in PAUP* (Swofford 2003). Gaps for insertion-deletion events were manually introduced in the alignment.

The total aligned dataset included most of the 5.8 gene, ITS2, and the 5′ end of 28S (LSU) and consisted of 1837 positions including gaps. Complete sequences were obtained for all the specimens except for *Anomoporia flavissima*, which has a short LSU sequence, and *Anomoporia kamtschatica* K426, which lacks the ITS region. The ITS2 region was deemed too variable to allow unambiguous alignment and was excluded from the final analyses. The analyzed dataset had 1412 characters of which 191 were variable but parsimony uninformative and 189 were parsimony informative.

Heuristic searches for the most parsimonious trees were performed using PAUP*. All the transformations were considered unordered and equally weighted. Gaps were treated as missing data. Bootstrapping was performed using 1000 heuristic search replicates with 10 random taxon addition sequence and TBR swapping.

For a Bayesian inference of phylogeny, MrModeltest 2.2 (Nylander 2004) was used to estimate separate best-fit models of evolution for 5.8S and nLSU. A heterogeneous Bayesian inference run was set up in MrBayes 3.0B4 (Ronquist & Huelsenbeck 2003) with model parameters estimated separately for 5.8S and nLSU. Eight Metropolis-Coupled Markov Chain Monte Carlo (MCMCMC) chains with default temperatures were initiated; these were run for 5 million generations with tree and parameter sampling every 4 000 generations (1 250 trees). The burn-in was set to 20% (250 trees).

Microscopic study was done, spores were measured, and illustrations were drawn from sections mounted in Cotton Blue (abbreviated CB): 0.1 mg aniline blue (Merck 1275) dissolved in 60 g pure lactic acid; CB+ means cyanophily, CB(+) weak but distinct cyanophilous reaction, CB– acyanophily. Amyloid and dextrinoid reactions were tested in Melzer's reagent (IKI): 0.5 g crystalline iodine (I), 1.5 g potassium iodide (KI), 22 g chloral hydrate, aq. dest. 20 ml; IKI– means neither amyloid nor dextrinoid reaction. Occasionally also 5% KOH was used as mountant.

30 spores were measured from each specimen for spore dimensions using ×1250 magnification, phase contrast, and oil immersion. Microscope eyepiece scale bar with 1-µm-grid was used for measuring, and dimensions were estimated subjectively with an accuracy of 0.1 µm. This procedure was discussed more thoroughly in Miettinen et al. (2006). In presenting the variation of spore size, 5% of the measurements out of each end of the range are given in parentheses (if applicable). L = mean length (arithmetical mean of all the spores), W = mean width, Q = extreme values of length/width ratios among the studied specimens, n = number of spores measured from given number of specimens.

Results of phylogenetic analyses

Maximum parsimony (MP) analysis gave 18 MP trees in three islands with a consistency index of 0.6583 including uninformative changes. Fig. 1 shows one of the MP trees as a phylogram.

The ingroup, which includes all the selected representatives of *Anomoporia, Amyloathelia, Amylocorticium, Hypochniciellum, Ceraceomyces, Irpicodon*, and *Plicaturopsis*, form a moderately supported clade (86% bootstrap). Within the ingroup, basal nodes collapse to a polytomy with eight branches representing the white-rot *Anomoporia* species (100% bootstrap), *Amylocorticium* (86%), *Anomoporia bombycina/vesiculosa* (100%), *Anomoporia kamtschatica, Ceraceomyces tessulatus, Amyloathelia crassiuscula* Hjortstam & Ryvarden, *Hypochniciellum subillaqueatum*, and *Irpicodon/Plicaturopsis* (100%).

For the 5.8S and nLSU loci, MrModeltest suggested the SYM and GTR+I+G models respectively. Plotting the cold-chain likelihood values against the generation number revealed that stationarity was reached at approximately generation 10 000, well in advance of the burn-in threshold. Chain mixing was found to be satisfactory, with ≥ 971 cold-chain switches during the search.

In the Bayesian tree (Fig. 2) the position for *Amyloathelia crassiuscula, Ceraceomyces tessulatus*, and *Hypochniciellum subillaqueatum* is different compared to the MP tree. This is not unexpected and is in accordance with the lack of bootstrap support for the nodes leading to these taxa. In general, support for the topology appears better in the Bayesian tree with posterior probability values of 1.0 at nine nodes compared to four nodes with 100% bootstrap support in the MP tree. The most notable differences are the high support for the ingroup and for *Amylocorticium* as a monophyletic genus. The *Anomoporia* clade receives a posterior probability value of 0.85 that is clearly below what should be regarded as a reliable value for node support in Bayesian analyses (Ronquist 2004, Zander 2004). Thus, the result of the Bayesian analysis is more or less in congruence with the MP analysis for the residual *Anomoporia* clade.

Discussion

In the molecular phylogenetic analyses (Figs. 1, 2) four specimens of *Anomoporia* associated with a white-rot decay of the substrate were found to form a well-supported clade that we name the *Anomoloma* clade. The rest of the tested *Anomoporia* species become separated in two groups, one with *A. bombycina* and *A. vesiculosa*, and the other with *A. kamtschatica*. The topology for *Anomoporia* can be interpreted in three ways. The first possibility is to divide *Anomoporia* in three genera with *Anomoporia* restricted to *A. bombycina* and *A. vesiculosa*, and two new genera for the *Anomoloma* clade and for *A. kamtschatica*. This solution has full statistical support from the phylogenetic analyses. The second

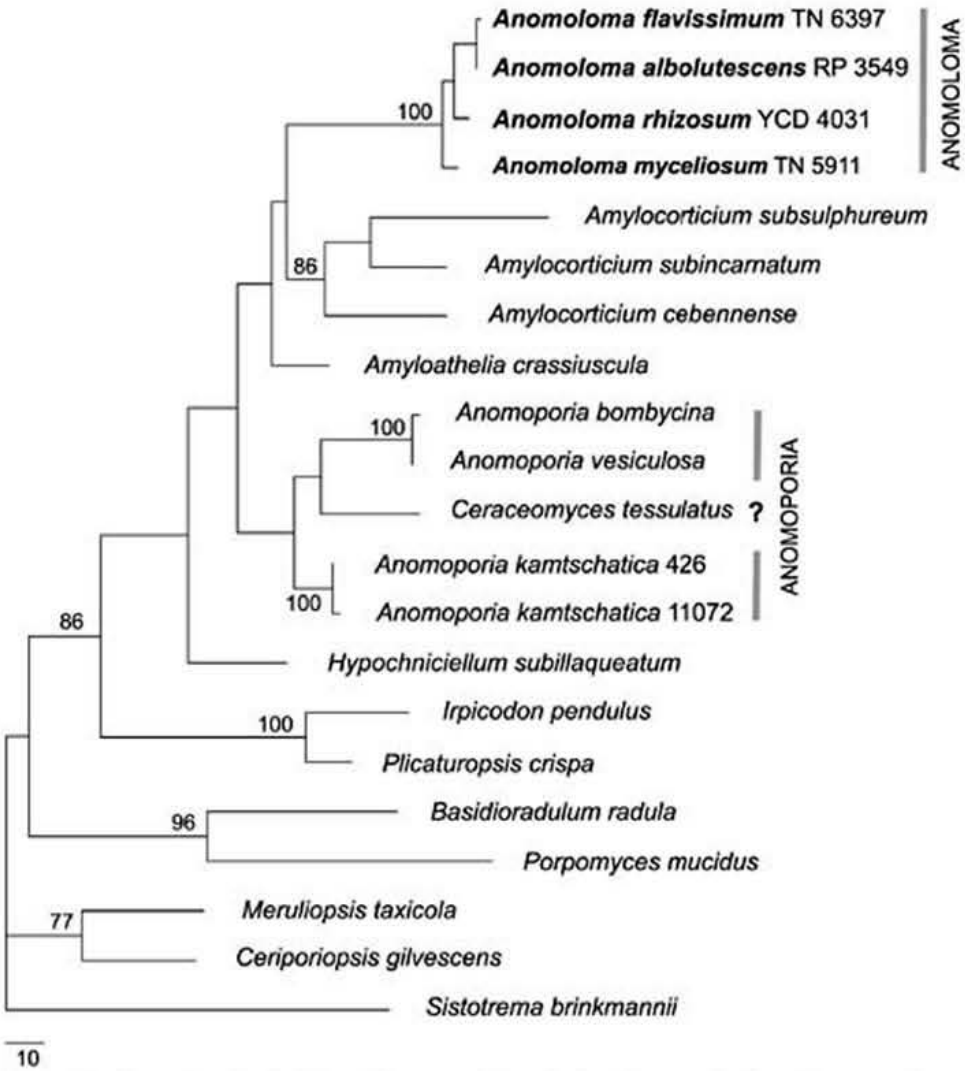

Fig. 1. Phylogenetic relationships of *Anomoporia* and related genera inferred from maximum parsimony analysis. One of 18 most parsimonious trees showing branch lengths proportional to the number of changes along the branch. Numbers indicate bootstrap proportions ≥ 50%.

possibility is to restrict *Anomoporia* to brown-rotting taxa (*A. bombycina, A. vesiculosa*, and *A. kamtschatica*) and create a new genus for the white-rot group. There is no support for such a circumscription of *Anomoporia* and it does not take into account the close relation to *Ceraceomyces tessulatus* implied by the phylogram. The third solution would be to keep *Anomoporia* together and accept the ingroup as one large genus, a solution that has statistical support but breaks radically with the present classification. *Anomoporia* would then include also *Amylocorticium, Irpicodon*, and *Plicaturopsis* and portions of *Ceraceomyces* and *Hypochniciellum*.

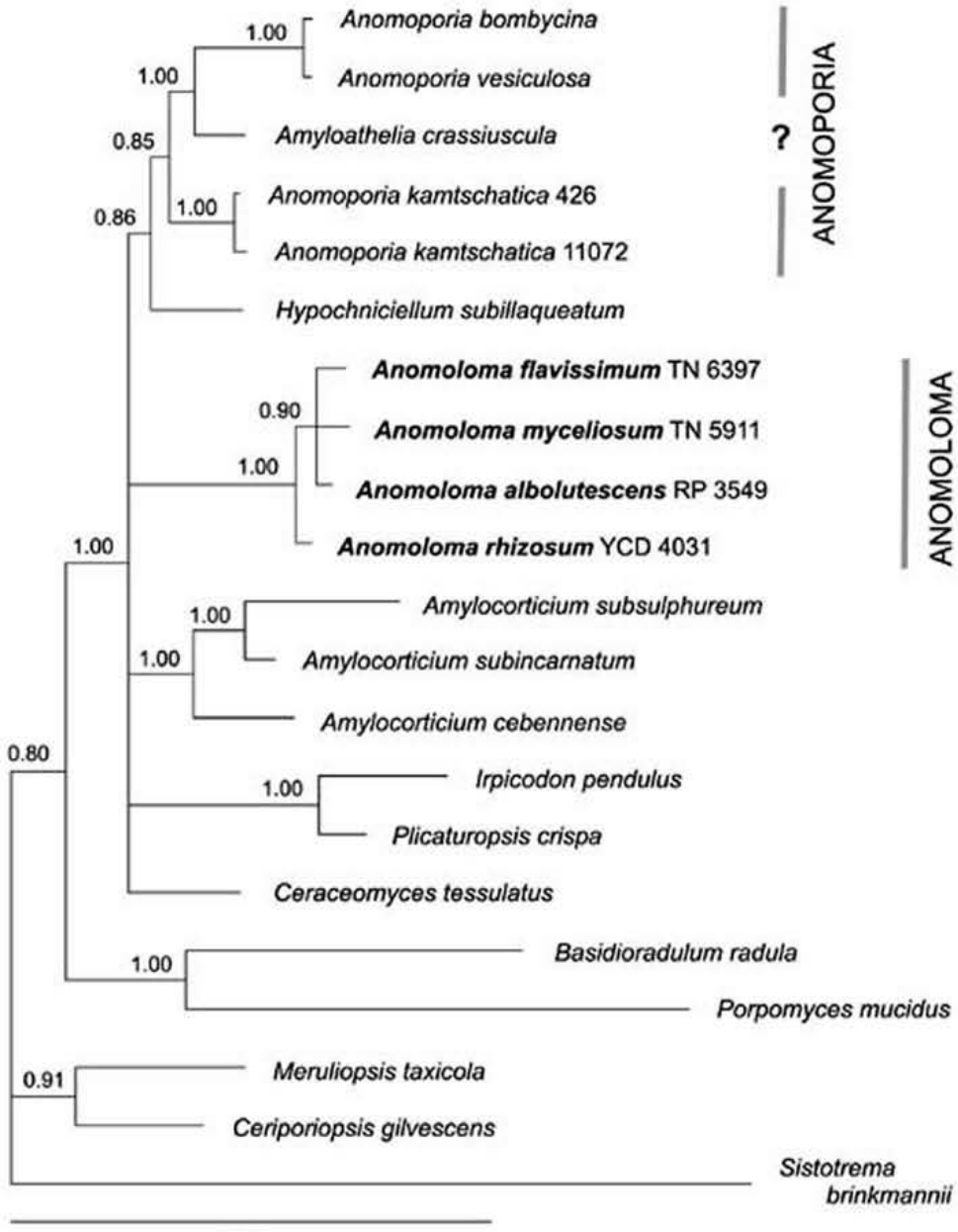

Fig. 2. Phylogenetic relationships of *Anomoporia* and related genera inferred from Bayesian analysis of combined nuclear 5.8S and ribosomal LSU gene regions (50% majority rule consensus tree) showing branch lengths. Numbers represent posterior probability values ≥ 0.80.

To broaden the concept of *Anomoporia* to cover the whole ingroup is unacceptable because the genus thus created can not be morphologically defined and would make a number of name changes necessary. Also, too many species are still not sequenced, and therefore drastic changes in classifications based on

incomplete taxon sampling should be avoided. Instead, we prefer to regard the ingroup as representing a suprageneric taxon. We conclude that *Anomoporia* must be split but the data presented here only supports segregation of the white rot taxa. We propose to keep the rest of *Anomoporia* as it is, until further species are studied and the general picture becomes clearer.

For the white-rot associated species now placed in *Anomoporia* we propose the new genus *Anomoloma*. At present it contains four closely related species. The genus does not seem to have a closer connection with any of the species of corticioid fungi included in the analysis, or otherwise known to us.

Anomoporia myceliosa is morphologically fairly similar to *Porpomyces mucidus* (Pers.) Jülich, although the latter lacks the amyloid reaction in the spore wall. Some authors have merged *P. mucidus* and *A. myceliosa* in the same genus, e.g. Bondartseva (1998) in *Fibuloporia*. This link, however, is not supported in our study or in earlier published molecular analyses: *Porpomyces mucidus* is in fact related to *Trechispora*, and belongs to a quite different clade (Larsson 2001, Larsson et al. 2004).

Ryvarden and Gilbertson (1993) noted that *Anomoporia myceliosa* has decay characteristics that differ from the type of *Anomoporia*, and they placed *A. myceliosa* in *Ceriporiopsis*. This genus is typified by *C. gilvescens*. In our analyses *C. gilvescens* falls outside the ingroup and is most close to *Meruliopsis taxicola*. The result implies that *C. gilvescens* belongs in the phlebioid clade sensu Larsson et al. (2004), which effectively rules out any relationship with *Anomoporia myceliosa*.

Taxonomy

Anomoloma Niemelä & K.H. Larss., **gen. nov.**
MycoBank MB 504173

Generis Anomoporiae similis, sed cariete alba protrudens et cum basidiomatibus margine rhizomorphosis.

Type species: *Polyporus albolutescens* Romell.

Etymology: *anomos* (Gr.) lawless, i.e. irregular, deviating from the common habit, referring to the rhizomorphic outline; *loma* (Gr., neuter) margin, edge.

Species in the genus *Anomoloma* are characterized by resupinate, strongly rhizomorphic basidiocarps and white, cream or yellow colours. Hyphal structure is monomitic, hyphae slightly cyanophilous and with clamp connections; spores are ellipsoid with slightly thickened wall, amyloid, approximately 3–5×2–4 µm, Q=1.2–1.4. The species cause white-rot mostly on woody debris of angiosperm and gymnosperm trees.

The following species are included in the new genus:

Anomoloma albolutescens (Romell) Niemelä & K.H. Larss., **comb. nov.**
MycoBank MB 504174

Basionym: *Polyporus albolutescens* Romell, Arkiv Botanik 11:11, 1911.
Lectotype: Sweden, Lapland, comm. Romell (Bresadola Herbarium, BPI *237956*, studied), selected by Lowe (1966).

Anomoloma myceliosum (Peck) Niemelä & K.H. Larss., **comb. nov.**
MycoBank MB 504175
Basionym: *Poria myceliosa* Peck, N.Y. State Mus. Bull. 54:952, 1902.
Lectotype: U.S.A., New York, Franklin, Floodwood, *Tsuga*, 31.VIII.1900 C.H. Peck *53* (NYS, studied), selected by Niemelä (1994).

Anomoloma flavissimum (Niemelä) Niemelä, K.H. Larss. & Y.C. Dai, **comb. nov.**
MycoBank MB 504176
Basionym: *Anomoporia flavissima* Niemelä, Ann. Bot. Fennici 31:102, 1994.
Holotype: Russia, Khabarovsk, Selikhino, Kabansopka, *Tilia amurensis*, 17.VIII.1961 Raitviir (TAA *42267*; isotype in H, both studied).

Anomoloma rhizosum Y.C. Dai & Niemelä, **spec. nov.** **Figure 3**
MycoBank MB 504177

Species Anomolomatis flavissimi similis, sed colore cremeo-lutescens et sporis magnioribus, 4.1–5.3×3–4 µm.

Holotype: China, Sichuan Prov., Aba Auto. State, Jiuzhaigou, on rotten *Tsuga chinensis*, 14.X.2002 Y.C. Dai *4160* (H; isotype in HMAS).

Notes on the species

Anomoloma rhizosum

Basidiocarp resupinate, ca. 5×10 cm wide, 1–2 mm thick, felty or very soft corky. Sterile margin irregular, 1–4 mm wide, swollen or thinning out, pale yellow or ochraceous; thread-like, straw-coloured rhizomorphs arising from margin and penetrating in decayed wood. Pore area yellowish: buff, pinkish buff, buff-yellow or luteous, oldest centre with a brownish tint; pores angular, regular, (3–)4–5 per mm. Section: subiculum felty, up to 1 mm thick, the ochraceous-yellow colour being strongest at basal layer next to substrate, tubes in section straw-coloured or buff-yellow.

Hyphal system monomitic (Fig. 3), hyphae with clamp connections. Subiculum with interwoven hyphae, (2.6–)3.3–4.2 µm in diam., walls mostly thick (frequently up to 1 µm), CB+, IKI–, KOH–, yellow especially close to the attachment, rarely covered with minute hyaline crystals. Tube trama with interwoven but longitudinally oriented hyphae, (2.4–)2.9–3.3(–3.8) µm in diam., walls fairly thin, CB(+), yellow in IKI, KOH–. Hymenium with rather loosely arranged palisade of clavate basidioles and 4-sterigmate, clavate basidia 14–18.5×5–5.8 µm; no cystidia; at tube bottoms hymenium mostly replaced by tufts of erect hyphidia. Hyphal tips at dissepiment edge smooth, regular, frequently containing bead-like oil globules. Basidiospores ellipsoid and often with truncated ends, slightly thick-walled, amyloid, CB(+), (3.9–)4.1–5.3

(–5.5)×(2.9–)3–4(–4.1) µm, L=4.82 µm, W=3.57 µm, Q=1.34–1.37 (n=60/2); often guttulate.

The species greatly resembles *A. flavissimum*, but spores are distinctly larger—in *A. flavissimum* they are (2.9–)3.2–4.1(–4.4)×(2.1–)2.4–3.1(–3.3) µm, L=3.66 µm, W=2.79 µm, Q=1.26–1.36 (Niemelä 1993). In the hymenium of *A. flavissimum* there are thin-walled vesicular cystidia, but such were not seen in the new species. The layered structure of the subiculum in *A. flavissimum* contrasts to the fairly uniform hyphal arrangement in *A. rhizosum*. Host characteristics may be unimportant among these fungi at the final successional stage of wood decomposition.

Specimens Examined—**China.** Sichuan: Aba Auto. State (see type). Jiuzhai Co., Jiuzhaigou Nat. Res., on rotten *Tsuga chinensis* in mixed forest, alt. 2800 m, 12.X.2002 Dai *4031* (H, HMAS).

Anomoloma flavissimum

The description of the species (Niemelä 1994) was based on ample herbarium materials collected from the Russian Far East by Erast Parmasto (Tartu, Estonia) and others. These collections exhibited a bright yellow colour and large basidiocarps with strongly developed rhizomorphs at their margins. Later the species was found in China (Dai 1996), and in 1998 Y.C.D. and T.N. could study it in the virgin forest of Changbai in Northeast China close to the type locality in the Russian Far East. Later on Y.C.D. together with his doctoral students have collected the species in several other Chinese localities (see Specimens Examined below), and *A. flavissimum* is now a fairly well-known species.

Fresh basidiocarps and rhizomorphs of *A. flavissimum* are bright sulphur yellow. The fungus grows in old natural forests with temperate vegetation at the altitude around 800–1200 metres in Changbai, but up to 3000 m in Tibet. The most common tree genera in the forests are *Abies, Pinus, Acer, Populus*, and *Quercus*. Characteristic of the species is that fructifications seem to arise from the ground, patchwise over areas of tens of square metres. In such areas yellow rhizomorphs are seen among soil debris, and small and large basidiocarps emerge on old stumps and rotten fallen trunks of any tree species. Often the basidiocarps cover areas of 20–50 cm or more along the lower side of tree trunks. This way of growing strongly implies that the species is mycorrhizal. However, wood under the basidiocarps was intensively white-rotted.

Y.C.D. from our team has collected and observed polypores in Chinese forest areas for over ten years. It seems that *Anomoloma flavissimum* is a very rare species, found in old-growth forests only. Evidently it is sensitive to changes in forest ecology, and threatened throughout its range.

Specimens Examined—**China.** Jilin: Antu Co., Changbaishan Nat. Res., *Populus davidiana*, 15.IX.1998 Niemelä *6362* (H); *Betula*, 17.IX.1998 Niemelä *6397* (H); *Populus*,

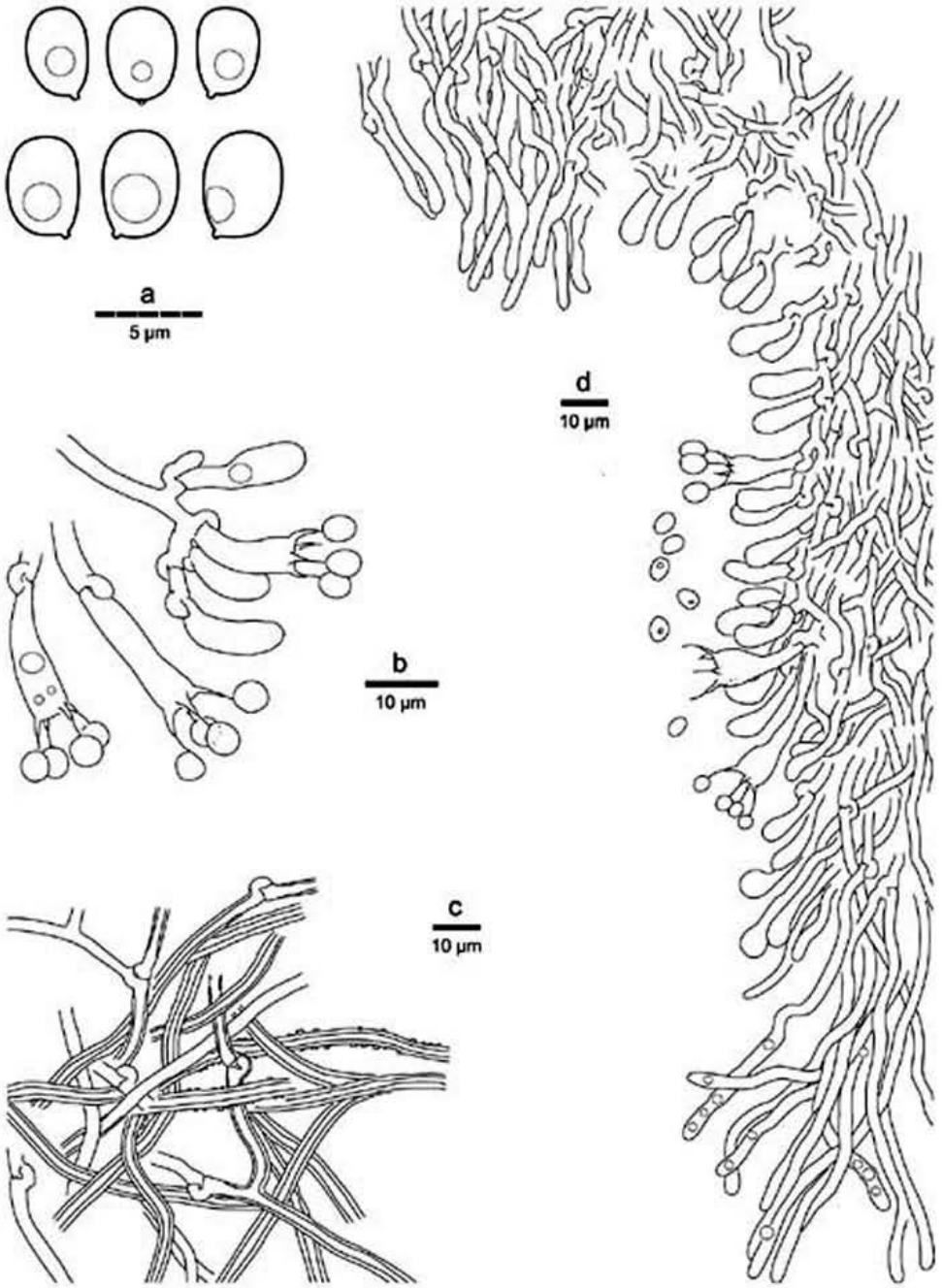

Fig. 3. Microscopy of *Anomoloma rhizosum*, drawn from holotype, mounted in Cotton Blue. a) Spores, b) basidia and basidioles, c) hyphae from subiculum, d) vertical section through tube dissepiment, showing a tuft of hyphidia at tube bottom, hymenium, tube trama, and hyphal tips at tube orifice.

21.IX.2002 Dai *3903*. Heilongjiang: Yichun, Fenglin Nat. Res., on gymnosperm wood, 9.IX.2002 Dai *3741*. Ning'an Co., "Underground Forest Park", *Abies*, 14.IX.2004 Yuan *595*; *Pinus*, 15.IX.2004 Yuan *665*, *732*. Xizang Auto. Reg.: Linzhi Co., Bayi, *Pinus densata*, 2.VIII.2004 Dai *5568*; *Quercus aquifolioides*, 1.VIII.2004 Dai *5533*. Zhejiang Prov.: Lin'an Co., Tianmushan Nat. Res., on angiosperm wood, 17.X.2004 Dai *6474*; *Pinus*, 17.X.2004 Dai *6475*.

—All preserved in HMAS, unless otherwise indicated. Collections listed by Niemelä (1994) are not repeated here.

Anomoloma albolutescens and *A. myceliosum*

These species were described and illustrated in Niemelä (1994). In North Europe they grow in rich, spruce-dominated mixed forests abundant with coarse woody debris and preferably old-growth or near-virgin. Both are rare and considered to be threatened (Rassi et al. 2001).

Acknowledgements

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References

Binder M, Hibbett DS, Larsson KH, Larsson E, Langer E, Langer G. 2005. The phylogenetic distribution of resupinate forms across the major clades of mushroom-forming fungi *(Homobasidiomycetes)*. Syst. Biodivers. 3: 113–157.

Bondartseva MA. 1998. Definitorium fungorum Rossicae, ordo *Aphyllophorales* 2. Nauka: Sankt-Peterburg.

Dai YC. 1996. Changbai wood-rotting fungi 7, a checklist of the polypores. Fungal Science 11: 79–105.

Dai YC, Niemelä T. 1994. Changbai wood-rotting fungi 1, a new species of *Anomoporia (Basidiomycetes)*. Ann. Bot. Fennici 31: 65–69.

Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes, application to the identification of mycorrhizas and rusts. Molec. Ecol. 2: 113–118.

Hibbett DS, Donoghue MJ. 2001. Analysis of character correlations among wood decay mechanisms, mating systems, and substrate ranges in *Homobasidiomycetes*. Syst. Biol. 50: 215–242.

Hibbett DS, Thorn RG. 2001. *Basidiomycota: Homobasidiomycetes*. In: McLaughlin DJ, McLaughlin EG, Lemke PA (eds.), The *Mycota* 7B, systematics and evolution: 121–167. Springer: Berlin & Heidelberg.

Holmgren PK, Holmgren NK, Barnett LC. 1990. Index Herbariorum. New York Botanical Garden: New York.

Larsson KH. 2001. The position of *Poria mucida* inferred from nuclear ribosomal DNA sequences. Harvard Pap. Bot. 6: 131–138.

Larsson KH, Larsson E, Kõljalg U. 2004. High phylogenetic diversity among corticioid homobasidiomycetes. Mycol. Res. 198: 983–1002.

Lowe JL. 1966. *Polyporaceae* of North America, the genus *Poria*. State Univ. Coll. Forestry Techn. Publ. 90: 1–183.

Miettinen O, Niemelä T, Spirin W. 2006. Northern *Antrodiella* species, the identity of *A. semisupina*, and type studies of related taxa. Mycotaxon 96: 211–239.

Niemelä T. 1994. Five species of *Anomoporia*, rare polypores of old forests. Ann. Bot. Fennici 31: 93–115.

Nylander JA. 2004. MrModeltest v2.2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.

Pouzar Z. 1966. Studies in the taxonomy of the polypores 1. Česká Mykologie 20: 171–177.

Rassi P, Alanen A, Kanerva T, Mannerkoski I (eds.). 2001. The 2000 Red List of Finnish species. Ministry of Environment & Finnish Environment Institute: Helsinki.

Ronquist F. 2004. Bayesian inference of character evolution. Trends Ecol. Evol. 19: 475–481.

Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 2003 19: 1572–1574.

Ryvarden L, Gilbertson RL. 1993. European polypores 1, *Abortiporus* to *Lindtneria*. Synopsis Fungorum 6: 1–387.

Swofford DL. 2003. PAUP* — phylogenetic analysis using parsimony (* and other methods). Version 4. Sinauer Associates: Sunderland, MA.

Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. J. Bacteriol. 172: 4238–4246.

White TJ, Bruns TD, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sininsky JJ, White TJ (eds.), PCR protocols, a guide to methods and applications: 315–322. Academic Press: New York.

Zander RH. 2004. Minimal values for reliability of bootstrap and jackknife proportions, decay index, and Bayesian posterior probability. PhyloInformatics 2: 1–13.

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New data and localities for *Navisporus* in America

MABEL GISELA TORRES-TORRES[1,2*], LAURA GUZMÁN-DÁVALOS[2]

** magitoto@yahoo.com, lguzman@cucba.udg.mx*
[1] Universidad Tecnológica del Chocó, Ciudadela Medrano
Quibdó, Chocó, Colombia

[2] Departamento de Botánica y Zoología, Universidad de Guadalajara
Apartado postal 1-139, Zapopan, Jal., 45101, Mexico

LEIF RYVARDEN[3]

leifry@ulrik.uio.no
[3] Botany Department, University of Oslo
P.O. Box 1045, Blindern, N-0316 Oslo, Norway

Abstract – The genus *Navisporus* is recorded for first time from Mexico, and the species *N. floccosus* is recorded for the first time from Mexico and Cuba. Based on study of the type specimen of *Ganoderma areolatum*, this species is synonymized under *N. floccosus*. Furthermore, *Navisporus sulcatus* is recorded from northern Brazil.

Key words – *Polyporaceae*, *Basidiomycota*, taxonomy

Introduction

Navisporus Ryvarden (*Polyporaceae*) (Ryvarden & Johansen 1980) is characterized by its dextrinoid skeletal hyphae and navicular basidiospores. It is a relatively small genus, with six species described, and mainly with a pantropical distribution (Ryvarden 1991). The majority of the species are poorly known, with a very restricted distribution. Four species have been described from the Neotropics: *Navisporus floccosus*, *N. sulcatus*, *N. perennis* Ryvarden & Iturr. and *N. terrestris* Gibertoni & Ryvarden, and two from the Paleotropics: *N. africanus* Ryvarden and *N. ortizii* S. Herrera & Bondartseva (Ryvarden & Iturriaga 2003, Gibertoni et al. 2004). Of these species, two are recently described and known only from their type localities: *N. perennis* from Venezuela (Ryvarden & Iturriaga 2003) and *N. terrestris* from Brazil (Gibertoni et al. 2004). *Navisporus floccosus* has been recorded from North America, Africa and Asia (Ryvarden & Johansen 1980) and *N. sulcatus* was cited from Florida (Gilbertson & Ryvarden

1986) and southern Brazil (Rajchenberg & Meijer 1990). The genus has not previously been recorded from Mexico.

In the course of *Ganodermataceae* studies from tropical America, the type specimen of *Ganoderma areolatum*, deposited at NY, was checked. This material has morphological features different from *Ganoderma*. Currently, *Ganoderma* is divided in two subgenera: *Ganoderma* and *Elfvingia*. Subgenus *Ganoderma* is characterized by having a glossy cuticle formed by cuticle cells; in contrast, in subgenus *Elfvingia* the crust is opaque, and does not present differentiated cells. *Ganoderma areolatum* was placed in the subgenus *Ganoderma* (Moncalvo & Ryvarden 1997) and was treated as a synonym of *G. resinaceum* Boud. (Ryvarden 1985), also in subgenus *Ganoderma*.

Materials and methods

The material studied was requested to ENCB, NY and O herbaria; the new collection made in Mexico was deposited in IBUG. Descriptions of the basidiomata were made according to the following macro features: basidioma size, substrate adhesion, pileus color, consistency; tubes stratification, length, color, pores per mm, pore surface color; context stratification, width, color. The color was described using the key colors of Kornerup & Wanscher (1978). Micromorphological observations were made from material mounted in 5% KOH and Melzer's reagent; measures were made in 5% KOH. Basidiospore shape was determined according to Q coefficient (length-width, Bas 1969) of 20 randomly selected basidiospores. Herbarium abbreviations follow Holmgren et al. (1990).

Taxonomy

The genus *Navisporus* is reported for the first time from Mexico. *Navisporus floccosus* is recorded from Mexico and Cuba. *Navisporus sulcatus*, an apparently rare species, is recorded from northern Brazil. The type specimen of *Ganoderma areolatum* has morphological features different from *Ganoderma*; here it is synonymized under *Navisporus floccosus*.

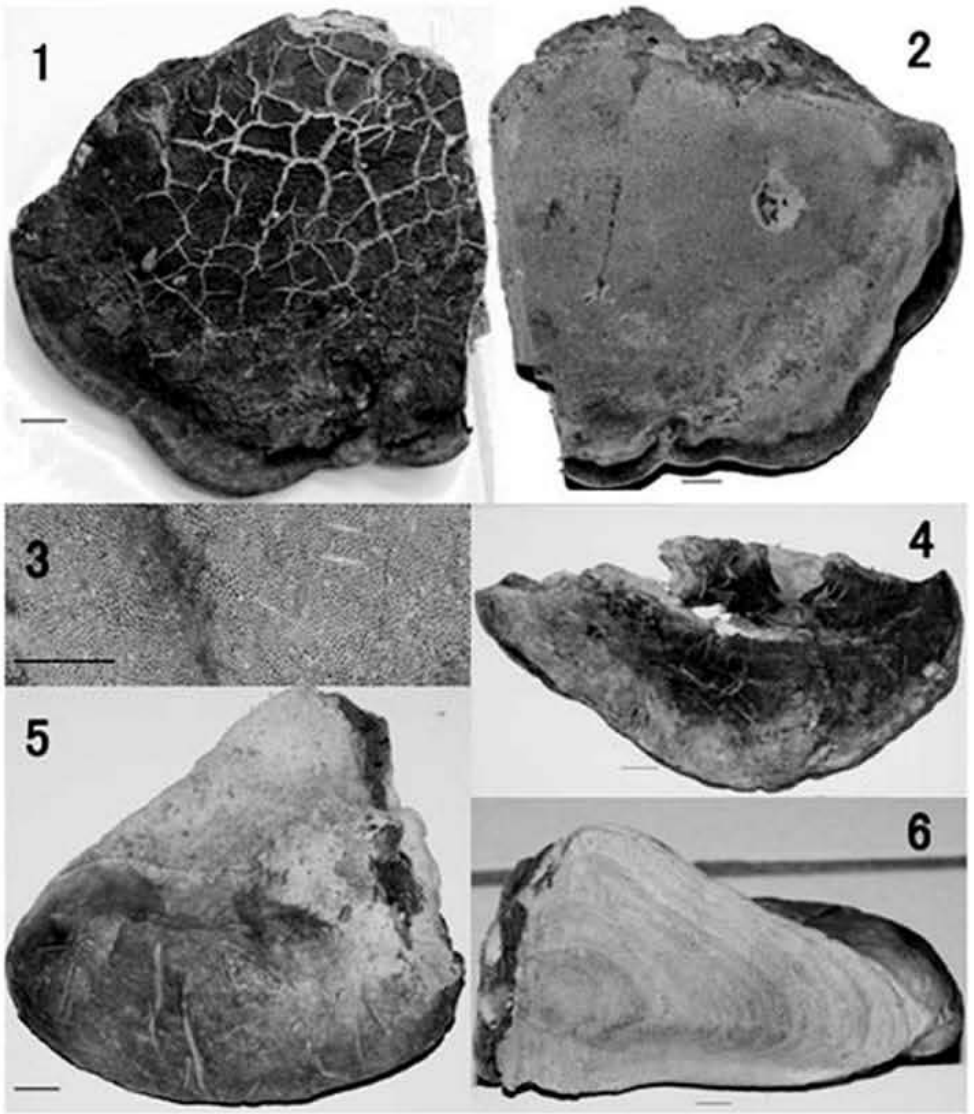
From the two species considered, only *Navisporus floccosus* is described in detailed, both macro and micromorphologically, while *N. sulcatus* is described only micromorphologically.

Navisporus floccosus (Bres.) Ryvarden Figs. 1-10, 13-16

in Ryvarden & Johansen, Prelim. Polyp. Fl. E. Afr. (Oslo): 443, 1980.

■ *Trametes floccosa* Bres., Ann. Roy. Inst. Bot. Roma 6: 179, 1896.

= *Ganoderma areolatum* Murrill, Bull. New York Bot. Gard. 8: 149, 1912.



Figs. 1-6. *Navisporus floccosus*. 1-2: Basidiomata of *Ganoderma areolatum* (holotype), 1: pileus, 2: pore surface, 3-4: basidiomata (L. Guzmán-Dávalos 9904), 3: pore surface, 4: pileus, 5-6: basidiomata (J. Pérez-Ortiz 1016), 5: pileus, 6: context. Scale bar = 1 cm, except 3 = 3 cm.

Basidiomata 20-35 x 13-20 x 5.5-7 cm, annual, sessile, broadly attached, single, soft-corky, light weighted, context thinner than tubes. **Pileus** rounded flabelliform, convex; surface glabrous, smooth, dull, without zonation; with a distinctive crust in old specimens, wrinkled, up to 0.5 mm thick; first cream (4A3) darkening to mandarin-orange (6B8) when bruised, grayish-brown (13F) to almost black in adult or old specimens; margin thin to thick, at times rounded, even, cream to grayish-brown. **Context** averaging 2-4 cm thick, up to

7 cm thick at the base, soft, zonate, orange-white (5A2) to pale orange (5A3), darker near the tubes, dark chestnut (6F7), without resinous substance. **Pores** 2-3 per mm, generally irregular; pore surface pale yellow (4A3), darker when bruising or aging; tubes 2.5-4 cm long, concolorous with pore surface. KOH: pileus black; context, tubes and pore surface blackish-brown.

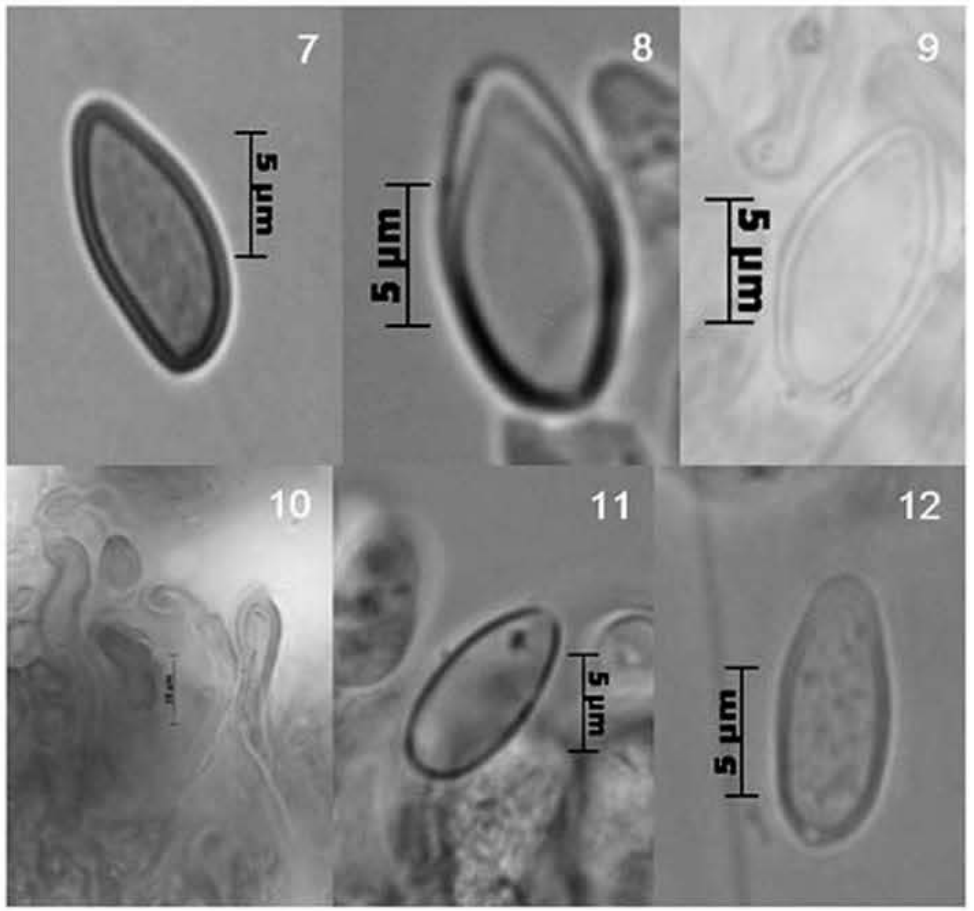
Contextual trama with dimitic hyphal system; generative hyphae scarce and collapsed, thin-walled, with conspicuous clamps, yellowish, difficult to observe; skeletal hyphae 1.6-14.4 µm diam., thick-walled (0.4-2.4 µm), non-septate, generally unbranched to moderately branched, yellowish to yellow, dextrinoid. **Hymenophoral trama with dimitic hyphal system**; generative hyphae 2.4-2.8 µm diam., thin-walled, with conspicuous clamps, yellowish, scarce, difficult to observe; skeletal hyphae up to 6.4 µm diam., thick-walled, non-septate, sometimes branched, yellowish to yellow, slightly dextrinoid to dextrinoid. **Pileus crust** when present formed by erect and rounded apex hyphae as a palisoderm; generative hyphae 3.2-6.4 µm diam., thin-walled to sclerified, with conspicuous clamps, single or multiple, generally branched, hyaline to yellowish, abundant, forming a compact network; skeletal hyphae 4.5-9.6 µm diam., thick-walled (0.8-4 µm), unbranched to branched, yellow to brown-amber, with granulose content, some septate toward apex and constricted; sclerids present. **Basidiospores** 11.2-13.6 x 5.6-7.2 µm, Q = 1.76-2.29, oblong to cylindrical, amygdaliform to subcylindrical, with the apical side acute to subacute, without germ pore, smooth, with conspicuous lateral apicule, yellowish to golden-yellow; thick-walled (up to 1 µm), negative in Melzer's reagent. **Basidia** approximately 18.4 x 5.6 µm, clavate, hyaline to yellowish, tetrasporated, scarce. **Cystidia** or other sterile hymenial elements not observed.

Substrata - On a dead trunk of a silk-cotton tree, on a living trunk of *Ficus*, and on an unidentified stump, according to the specimens examined.

Habitat - Secondary tropical forests.

Specimens studied - CUBA, Province of La Habana, Escaleras de Jaruca, 16 June 2001, C. Decock s.n. (O). MEXICO, Colima, near Colima, January 1910, W.A. Murrill & E.L. Murrill 588 (NY, Holotype of *Ganoderma areolatum*); Jalisco, Municipality of Puerto Vallarta, Hotel NH-Kristal, alt. 5 m, 28 October 2005, L. Guzmán-Dávalos 9904 (IBUG); Veracruz, Municipality of Minatitlán, El Remolino, Río Coachapa, 7 August 1977, J. Pérez-Ortiz 1016 (ENCB).

Remarks - The studied specimens coincide with Ryvarden (2004), except that this author described basidiospores slightly different (12-15 x 4.5-6.5 µm) and hyaline; in our case only the immature basidiospores were hyaline. The material L. Guzmán-Dávalos 9904 developed a very thick and black crust over some parts of the pileus; while in the type specimen of *Ganoderma areolatum*



Figs. 7-12. 7-10: Microscopic features of *Navisporus floccosus*. 7-9: basidiospores; 7: holotype of *Ganoderma areolatum*, 8: specimen J. Pérez-Ortiz 1016, 9: specimen L. Guzmán-Dávalos 9904; 10: elements from the crust of *Ganoderma areolatum* (holotype), sclerified generative hyphae. 11-12. *Navisporus sulcatus*, basidiospores (G.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos s.n.).

the cuticle is almost uniform over all the pileus. The specimen J. Pérez-Ortiz 1016 does not present this cuticle; moreover it has a very thick margin. Our guess is that the old materials might develop a thick and black cuticle, similar to *Ganoderma* and *Fomes*. In all cases, the Mexican materials studied here were confused with *Ganoderma*. Nevertheless, the macromorphological features that make them different from *Ganoderma* are the irregular, thinner walled and bigger sized pores in *N. floccosus*. Although, *N. floccosus* has black cuticle, pale context and spongy basidiomata as do some of the temperate species of *Ganoderma* (i.e. *G. carnosum* Pat., *G. oregonense* Murrill, *G. tsugae* Murrill and *G. valesiacum* Boud.), these have a peculiar shiny basidiomata and a more fragile cuticle.

The type material of *Ganoderma areolatum* presents remarkable features different from subgenus *Ganoderma*. First of all, *Ganoderma* has basidiospores double-walled, with inter-walled pillars and apical germ pore. The crust in *G. areolatum* is not formed by cuticle cells, but by skeletal hyphae as in subgenus *Elfvingia*. However, in *Elfvingia* the skeletal hyphae are arboriform. After a bibliographical review (Murrill 1912, Corner 1983, Gilbertson & Ryvarden 1986, Núñez & Ryvarden 2000, Ryvarden 2000) and the study of specimens of *Navisporus*, we concluded that the type specimen corresponds with *N. floccosus*, meaning *G. areolatum* is a synonym of *N. floccosus*.

Ryvarden & Johansen (1980) and Gilbertson & Ryvarden (1986) described the basidiospores as fusoid or navicular. In the studied materials, we observed that the basidiospores have only the apical side subacute or acute; this was also observed in the specimen of *N. sulcatus*.

Navisporus sulcatus (Lloyd) Ryvarden, Figs. 11-12, 17-19
Nordic Jl Bot. 3(3): 412, 1983.
≡ *Trametes sulcata* Lloyd, Mycol. Writ. 7: 1146, 1922.

The macroscopic features of *Navisporus sulcatus* are as described by Gilbertson & Ryvarden (1986).

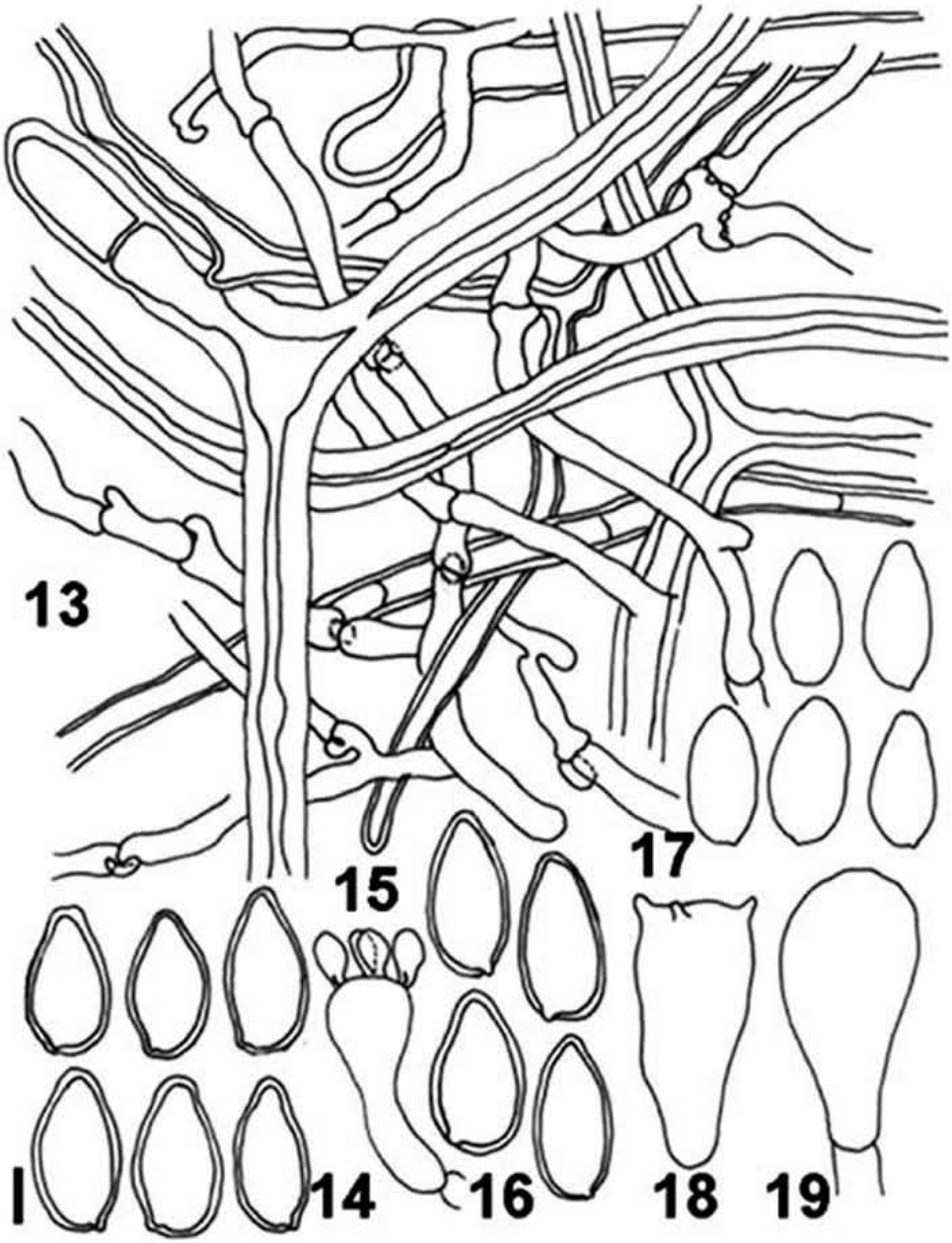
Contextual trama with dimitic hyphal system; generative hyphae scarce and collapsed, thin-walled, with conspicuous clamps, yellowish, difficult to observe; skeletal hyphae 2.4-5 µm diam., thick-walled (0.4-2.4 µm), non-septate, generally unbranched to moderately branched, yellowish to yellow, dextrinoid. **Hymenophoral trama with dimitic hyphal system**; generative hyphae 2.4-2.8 µm diam., thin-walled, with conspicuous clamps, yellowish, scarce, difficult to observe; skeletal hyphae up to 4 µm diam., thick-walled, non-septate, sometimes branched, yellowish to yellow, dextrinoid. **Basidiospores** 9-11.6 x 4.4-6.2 µm, Q = 1.82-2.82, oblong to cylindrical, amygdaliform to subcylindrical, with the apical side acute to subacute, without germ pore, smooth, with conspicuous apicule, yellowish to golden-yellow; thick-walled (up to 1 µm), negative in Melzer's reagent. **Basidia** 20-20.6 x 8.8-9 µm, clavate, hyaline to yellowish, tetrasporated, abundant. **Cystidia** or other sterile hymenial elements not observed.

Substrata - On *Manihot*.

Habitat - Tropical forest.

Specimen studied. Brazil, State of Roraima, Municipality of Boa Vista, Territorio do Roraima, vicinity of Auaris, 800 m, 31 July 1974, G.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos s.n. (O).

Remarks - The studied specimen coincides with Gilbertson & Ryvarden (1986) and with Gibertoni et al. (2004), except that in this material the duplex context



Figs. 13-19. 13-16: Microscopic features of *Navisporus floccosus*. 13-15: holotype of *Ganoderma areolatum*; 13: elements from the crust, 14: basidiospores, 15: basidium. 16: basidiospores (J. Pérez-Ortiz 1016). 17-19. Microscopic features of *Navisporus sulcatus* (G.T. Prance, O. Fidalgo, B.W. Nelson & J.F. Ramos s.n.); 17: basidiospores, 18: basidium, 19: basidiolum. Scale bar = 4 µm.

is not very evident. The species was recorded from south Brazil, State of Paraná (Rajchenberg & Meijer 1990), but no details about its morphological features and ecology were provided. Because of its morphological features the species may be confused with *Coriolopsis*, *Fomes* or *Trametes*, among many others; maybe this confusion is one of the reasons of its rarity.

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Literature cited

Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. Persoonia 5: 285-579.

Corner EJH. 1983. Ad Polyporaceas I, *Amauroderma* and *Ganoderma*. Beih. Nova Hedwigia 75: 1-182.

Gibertoni TB, Ryvarden L, Cavalcanti MAQ. 2004. Studies in neotropical polypores 18. New species from Brazil. Synopsis Fungorum 18, Fungiflora, Oslo.

Gilbertson RL, Ryvarden L. 1986. North American Polypores. Vol 1. Fungiflora, Oslo.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part I. The herbaria of the world. 8th edition. New York Botanical Garden, New York. 663 pp.

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. 3rd ed. Eyre Methuen, London.

Moncalvo JM, Ryvarden L. 1997. A nomenclatural study of *Ganodermataceae* Donk. Synopsis Fungorum 11, Fungiflora, Oslo.

Murrill WA. 1912. *Polyporaceae* of Mexico. Bull. New York Bot. Gard. 8: 137-153.

Núñez M, Ryvarden L. 2000. East Asian Polypores. Vol 1 *Ganodermataceae* and *Hymenochaetaceae*. Fungiflora, Oslo.

Rajchenberg M, Meijer AAR de. 1990. New and noteworthy polypores from Paraná and São Paulo States, Brazil. Mycotaxon 38: 173-185.

Ryvarden L. 1985. Type-studies in *Polyporaceae* 17. Species described by W.A. Murrill. Mycotaxon 23: 169-198.

Ryvarden L. 1991. Genera Polypores. Nomenclature and taxonomy. Synopsis Fungorum 5. Fungiflora, Oslo.

Ryvarden L. 2000. Studies in Neotropical polypores 2: a preliminary to Neotropical species of *Ganoderma* with a laccate pileus. Mycologia 92: 180-191.

Ryvarden L. 2004. Neotropical polypores part 1. Synopsis Fungorum 19, Fungiflora, Oslo.

Ryvarden L, Iturriaga T. 2003. Studies in neotropical polypores 10. New polypores from Venezuela. Mycologia 95: 1066-1077.

Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora, Oslo.

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Anamorphic fungi from submerged plant material: *Phaeomonilia pleiomorpha*, *P. corticola* and *Cacumisporium pleuroconidiophorum*

Rafael F. Castañeda Ruiz

rfcastaneda@inifat.co.cu
Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt", Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200

Gabriela Heredia Abarca

gabriela.heredia@inecol.edu.mx
Instituto de Ecología, A.P. 63, Km 2.5, Antigua carretera a Coatepec, Xalapa, Veracruz, México

Rosa Maria Arias

rosa.arias@inecol.edu.mx
Instituto de Ecología, A.P. 63, Km 2.5, Antigua carretera a Coatepec, Xalapa, Veracruz, México

Masatoshi Saikawa

saikawa@u-gakugei.ac.jp
Department of Biology, Tokyo Gakugei University, Nukuikita-machi, Koganei-shi, Tokyo 184-8501, Japan

David W. Minter

d.minter@cabi.org
CABI, Bakeham Lane, Egham, Surrey, TW20 9TY, United Kingdom

Marc Stadler

marc.stadler@t-online.de
University of Bayreuth, Dept. Mycology Universitätstr. 30, D-95544 Bayreuth, Germany

Abstract — *Phaeomonilia pleiomorpha* anam. gen. et sp. nov. found on a decaying petiole submerged in a stream in the "Los Tuxtlas" rainforest, Veracruz, Mexico is described and illustrated. It is distinguished by globose, unicellular, colorless conidia formed by "thallic" disarticulations of fertile branches on macronematous conidiophores and by a *Stylaspergillus* synanamorph which arises from the same vegetative hyphae. Following re-assessment of type material, *Phaeomonilia corticola* comb. nov. and *Cacumisporium*

pleuroconidiophorum comb. nov. are proposed. The *Antipodium* anamorph of *Ophionectria tricospora* is reported from submerged wood in Mexico.

Key words — freshwater fungi, systematics, tropical fungi, hyphomycetes

Introduction

During several expeditions in 2002 and 2006 through the "Los Tuxtlas" rainforest, Veracruz, Mexico and the "El Avila", Caracas, Venezuela some anamorphic fungi were collected from plant material submerged in streams. One of these fungi showed remarkable differences from previously described hyphomycetes and is therefore described as a new genus and species. Other two species are recorded from fresh water for the first time.

Materials and methods

Samples of submerged plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dishes, in moist chambers at 25° C, in plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Aeration was supplied with a fan (Daytron) for 5 to 10 minutes at 45 minutes intervals. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000.

Taxonomy

Phaeomonilia R.F. Castañeda, Heredia & R. M. Arias anam. gen. nov.
MycoBank MB 510699.

Fungus anamorphicus pertinens. ***Coloniae*** *effusae, brunneae usque ad nigrae.* ***Conidiophora*** *mononematosa, conspicua, plus minusve dichotome ad apicem ramosa, septata, brunnea usque ad atrobrunnea.* ***Secessio conidiorum*** *schizolytica.* ***Ramoconidia et conidia*** *"thallica-arthrica", catenulata, fertilium per disarticulationem ramorum moniliformium producta, globosa, ellipsoidea, doliiformia usque ad irregularia, unicellularia, hyalina.* ***Synanamorpha*** *ad genus Stylaspergillus similis, nonnumquam ipsis ex hyphis exoriens, conidiophoris cum macronematosis, mononematosis, ad apicem ramosis, brunneis et cellulis conidiogenis enterogenicis, uniloculosis, determinatis, introrsum curvatis, lageniformibus usque ad subulatis indutis quae conidia producunt acicularia, curvata, unicellularia, hyalina. Teleomorphosis ignota.*

Etymology: Greek, *phaeo-*, meaning dark-colored; Latin, *-monilia*, referring to a hyphomycete genus (*Monilia*).

Species typica: *Phaeomonilia pleiomorpha* sp. nov.

Anamorphic fungi — **Colonies** effuse, brown to black. **Conidiophores** mononematous, differentiated, septate, mostly dichotomously branched towards the apex, brown to dark brown. **Conidial secession** schizolytic. **Ramoconidia** and **conidia** "thallic-arthric", catenate, globose, ellipsoid, doliiform to irregular,

unicellular, colorless, formed by disarticulation of the conidiogenous branches. **Synanamorph** *Stylaspergillus*-like sometimes arising from the same vegetative hyphae, with macronematous, mononematous, brown conidiophores branched towards the apex. **Conidiogenous cells** enterogenous, unilocular, determinate, inwardly curved, lageniform, to subulate. **Conidia** acicular, curved, unicellular, colorless. **Teleomorph** unknown.

Comments: *Phaeomonilia* is somewhat similar to *Botryomonilia* Goos & Piroz. (Goos & Pirozynski 1975) in its dichotomous branching system narrowing progressively towards the apex before the maturation and fragmentation or disarticulation process that produces the "thallic-arthric" conidia, as described by Kendrick (2003). *Botryomonilia*, however, has conidia connected by an isthmus. The two other similar genera are *Stalheliella* Emden (Emden 1974) and *Oidiodendron* Robak (Ellis & Ellis 1997, Hambleton et al., 1998). In the former, the apical branching system is "narrower from inception and the initial branching is a cluster, although subsequent branching of the fertile hyphae is dichotomous" (Kendrick 2003), while the latter has an alternately penicillate to irregularly branching hyphal system. The new genus is distinct from both.

Phaeomonilia pleiomorpha R.F. Castañeda, Heredia & R. M. Arias, **anam. sp. nov.** **Figs 1-10**

MycoBank MB 510700

Coloniae effusae, funiculosae, brunneae. Mycelium plerumque superficiale et partim in substrato inmersum, ex hyphis septatis, ramosis, 2.5–5.5 µm, brunneis vel atrobrunneis, laevibus compositum. ***Conidiophora*** *mononematosa, usque ad 250 µm alta, 7–10 µm crassa ad basim, ad apicem dichotome ramosa, 2- ad 6-septata, ad basim brunnea, ad apicem pallidiora, levia.* ***Ramoconidia et conidia*** *"thallica-arthrica", catenulata, per disarticulationem ramorum moniliformium fertilium producta, globosa vel in forma plus minusve litterae Graecae upsilon, 4.0–5.8 × 3.9–4.4 µm, unicellularia, hyaline, levia, sicca.* ***Synanamorpha*** *cum conidiophoris macronematis, mononematis, 2- ad 3-septatis, compactis ramosis, 45–110 × 4–7 µm, brunneis, laevibus.* ***Cellulae conidiogenae*** *enterogenae, uniloculosae, determinatae, introrsum curvatae, lageniformes usque subulatae, 11.0–12.7 × 4–5 µm.* ***Conidia*** *acicularia, curvata, 5.8–9.0 × 1.0–1.5 µm, unicellularia, hyalina.* ***Teleomorphosis*** *ignota.*

Etymology: Greek, *pleio-*, meaning more than usual; *-morpha*, referring to existing forms of conidium ontogeny.

Colonies on the natural substratum effuse, funiculose, brown. **Mycelium** mostly superficial and partial immersed. **Hyphae** septate, branched, 2.5–5.5 µm, brown to dark brown, smooth. **Conidiophores** macronematous, mononematous, 2- to 6-septate, erect, straight or flexuous, more or less dichotomously branched towards the apex, up to 250 µm tall, 7–10 µm wide at the base, brown at the base, almost colorless towards the apex, smooth. **Ramoconidia** and **conidia** "thallic-arthric", catenulate, globose, broadly Y-shaped, 4.0–5.8 × 3.9–4.4 µm, aseptate, colorless, dry, smooth, forming by disarticulation of the conidiogenous

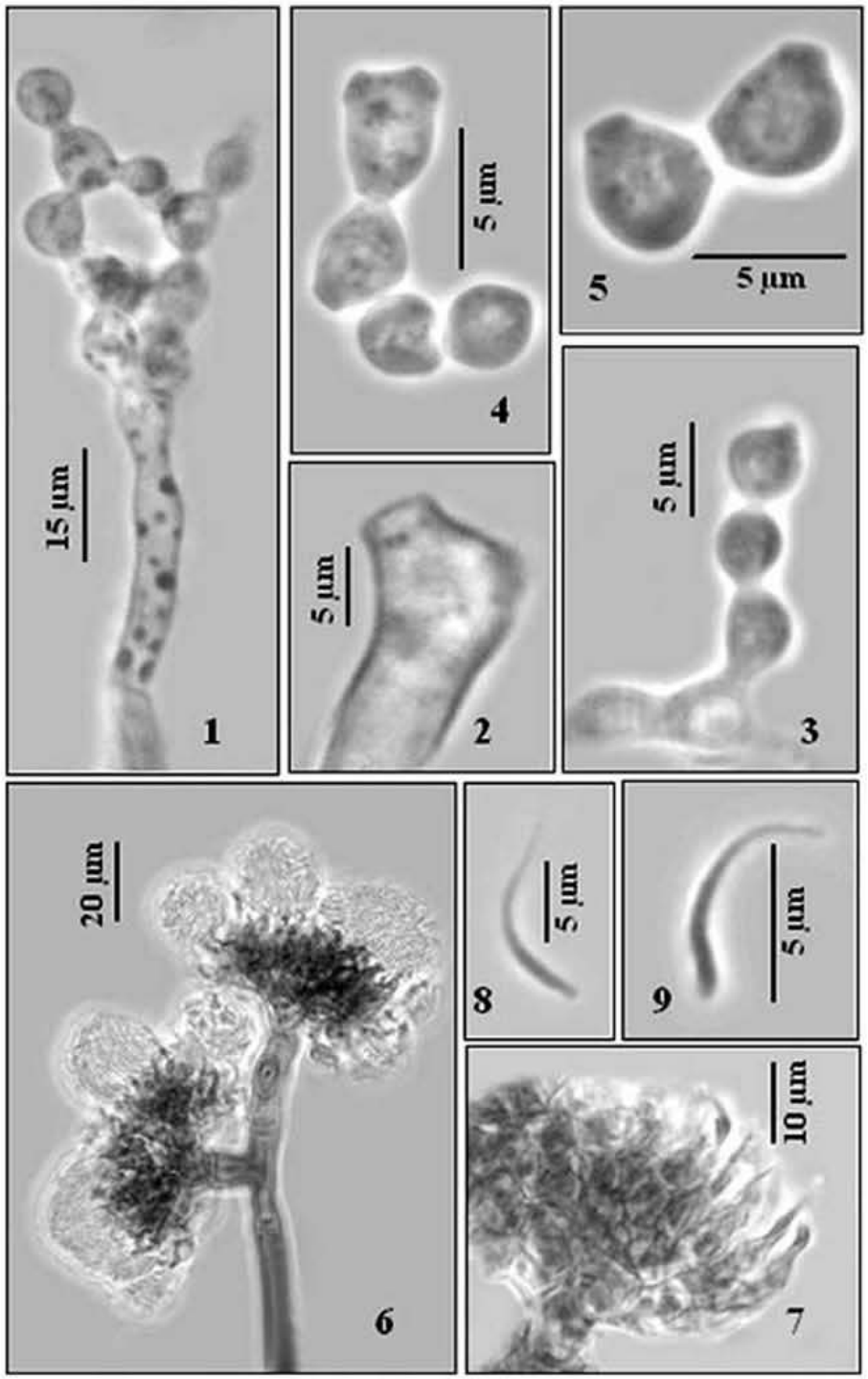

Fig. 1-9 *Phaeomonilia pleiomorpha*, from holotype (XAL CB746). **Fig. 1-3.** Conidiophore, conidiogenous branches and catenulate thallic-arthric conidia. **Fig.4,5.** Conidia. **Fig. 6-9.** Synanamorph (*Stylaspergillus*-like).

branches. **Synnamorph** *Stylaspergillus*-like, arising from the same vegetative hyphae.

Conidiophores macronematous, mononematous, erect, straight, 45–110 × 4–7 µm, compactly multi-branched at the apex, brown, smooth. **Metulae** turbinate to doliiform, 5.5–6.5 µm wide. **Conidiogenous cells** enterogenous, unilocal, determinate, inwardly curved, lageniform, to subulate, 11.0–12.7 × 4–5 µm. **Conidia** acicular, curved, 5.8–9.0 × 1.0–1.5 µm, aseptate, colorless, smooth, accumulating in a white mass. **Teleomorph** unknown.

TYPUS: Mexico. Veracruz: "Los Tuxtlas", on the petiole of an unidentified palm tree submerged in a stream, 24.V.2002, coll. R.M. Arias and J.Y.C. Elizondo. **Holotype:** XAL CB746. **Isotype:** MUCL 45628

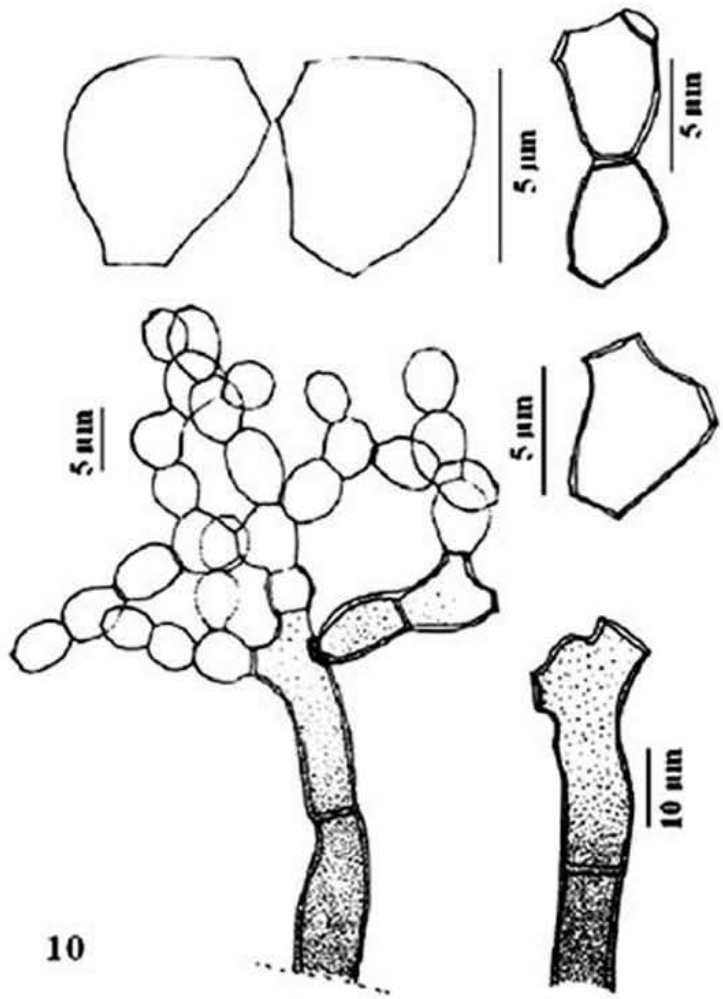

Fig.10. *Phaeomonilia pleiomorpha*, from holotype (XAL CB746).. Drawings of conidiophore, conidiogenous branches and conidia. Scale is indicated by bars.

Re-examination of material of *Monilia corticola* showed that it has aseptate, colorless, "arthric-thallic", doliiform, ellipsoid or Y-shaped conidia, 5.5–16.0 × 4–5 µm, formed by disarticulation of the apical fertile branches. All these characteristics are compatible with the new genus described above. A new combination is therefore proposed.

Phaeomonilia corticola (R.F. Castañeda) R.F. Castañeda, Saikawa & M. Stadler, **comb. nov.**

MycoBank MB 510701.

Basionym: *Monilia corticola* R.F. Castañeda, in Deuteromycotina de Cuba. Hyphomycetes II. p. 11 (1985), Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt", Cuba.

Specimen examined: INIFAT C84/146, on twig of *Bursera simaruba*, Sierra de Cubitas, Camagüey, Cuba, 29-XI-1984. Coll. R.F. Castañeda.

It was possible to identify several samples from decaying wood submerged in streams as *Pyriculariopsis pleuroconidiophora*. Ellis (1971) described the genus *Pyriculariopsis*, based on *P. parasitica* (Sacc. & Berl.) M.B. Ellis, and characterized by polyblastic, integrated, sympodial conidiogenous cells. This pattern of ontogeny was classified as conidial development type 10 (holoblastic, regularly alternating with sympodial proliferation, maturation by diffuse wall-building and secession schizolytic) in Hawksworth *et al.* (1995). Study of our samples of *P. pleuroconidiophora* showed that this fungus has conidiogenous cell development incompatible with the type of the genus.

Goos (1969) studied the conidiogenous cell development of *Cacumisporium capitulatum* (Corda) S. Hughes and found an unusual pattern of conidiogenesis with a combination of enteroblastic percurrent proliferation and sympodial holoblastic proliferation (development type 21, described as combination of events 10 and 19 in Hawksworth et al. 1995). The development observable in our samples of *P. pleuroconidiophora* is closely analogous to that described for *C. capitulatum*. The following new combination is therefore proposed.

Cacumisporium pleuroconidiophorum (Davydkina & Melnik) R.F. Castañeda, Heredia & Iturr., comb. nov. Figs. (11-19)

MycoBank # MB 510702.

Basionym: *Pyriculariopsis pleuroconidiophora* Davydkina & Melnik, Mikologiya i Fitopatologiya 23 (2): 112 (1989).

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

Specimens examined: XAL CB754-1 and XAL CB754-2, Mexico, Veracruz, on wood, 29.VII.2001, coll. G. Heredia, R.M. Arias, M. Reyes. INIFAT C06/36, Venezuela, Caracas, "El Ávila", ex wood submerged in a stream, 17.V.2006, coll. R. Fernández.

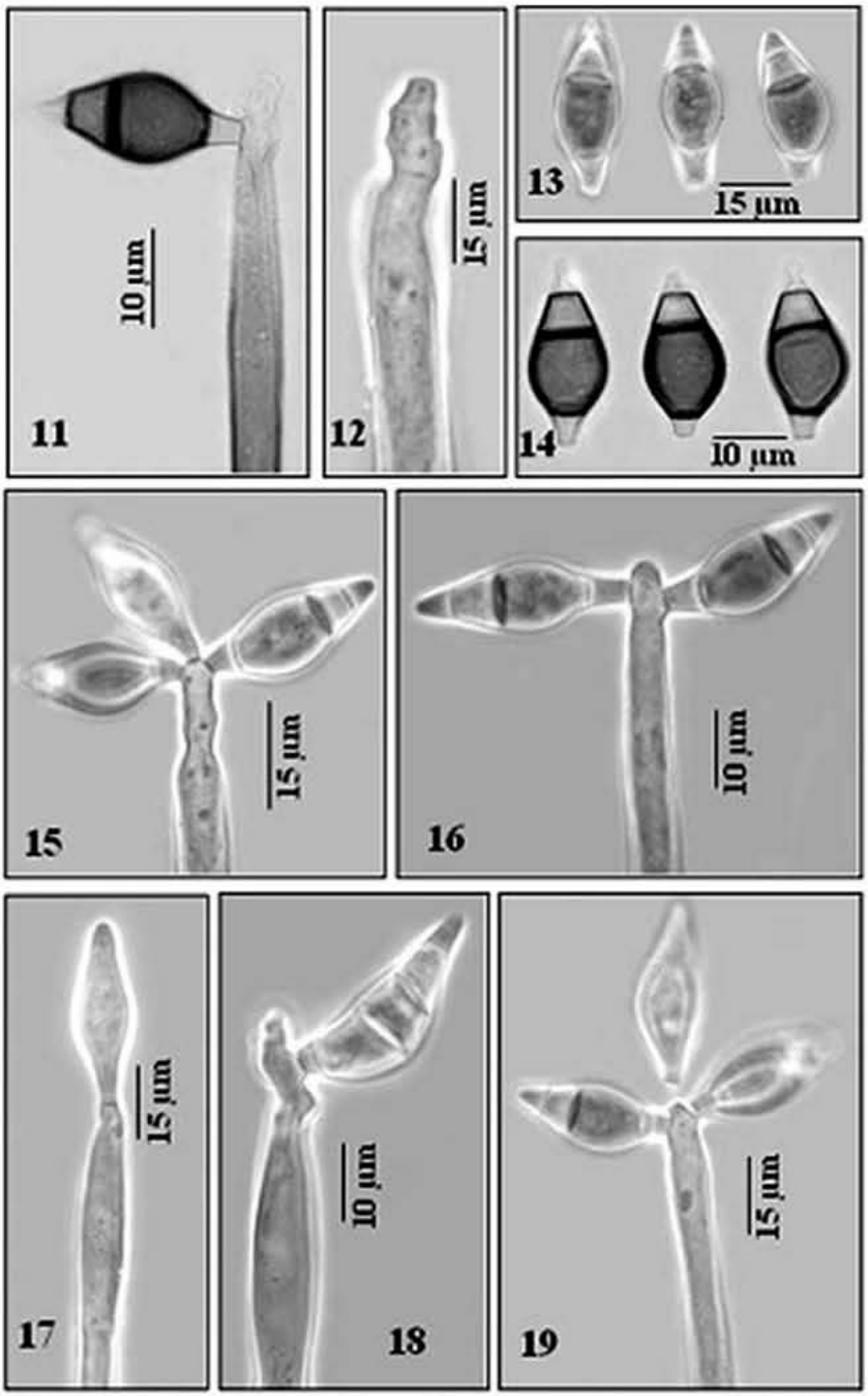

Fig.11-19. *Cacumisporium pleuroconidiophorum*, from nature (XAL CB754-1 and INIFAT C06/36), **Fig. 11, 12, 15-19** Details of conidiogenous cell proliferation and conidia. **Fig.13, 14.** Conidia. Scale is indicated by bars.

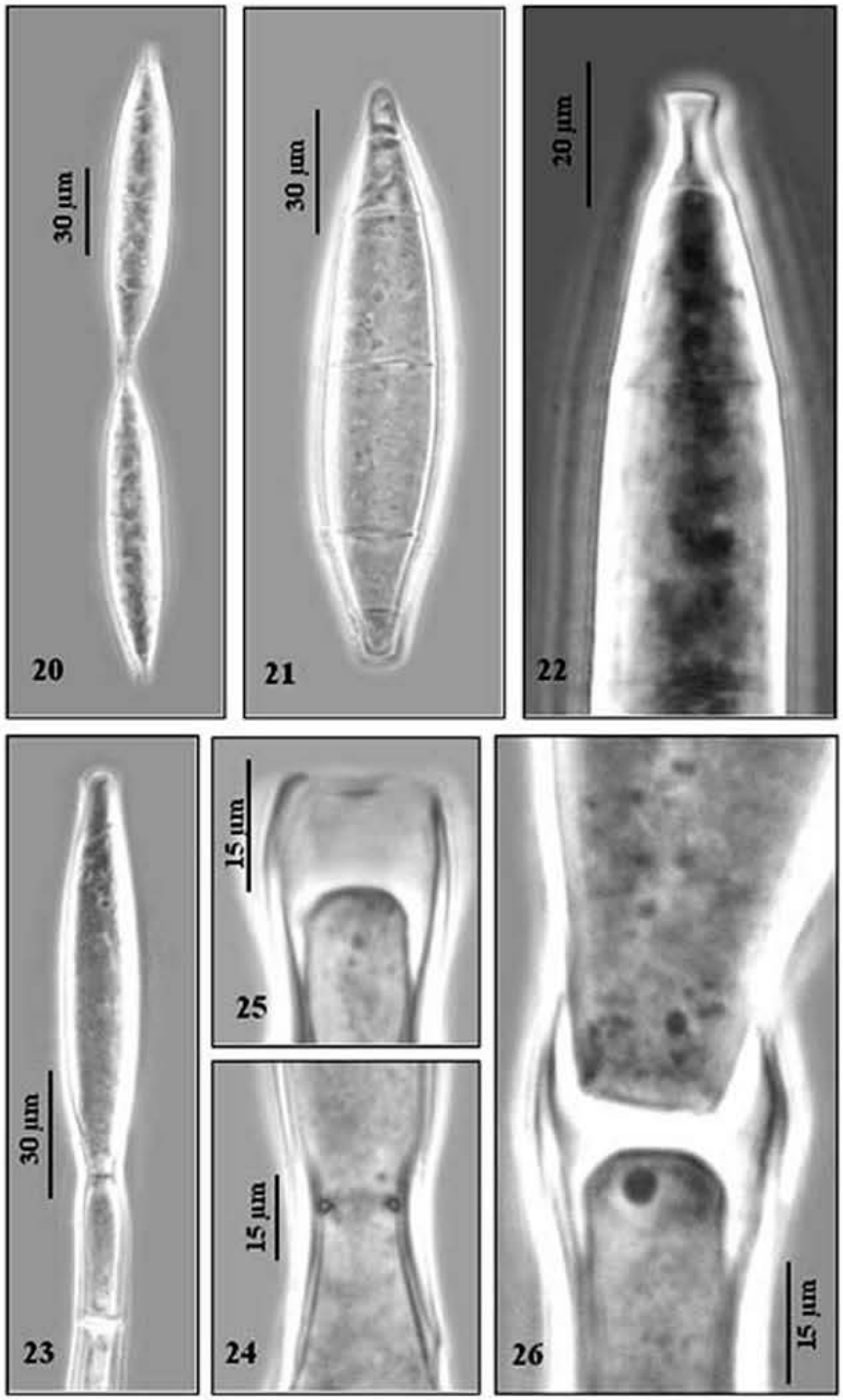

Fig. 20-26. *Antipodium spectabile*, from nature (XAL CB744). **Fig. 20-22.** Conidia. **Fig. 23.** Conidiogenous cell and conidia. **Fig.24-26.** Conidiogenous loci showing delimitation, conidial secession and collarette. Scale is indicated by bars.

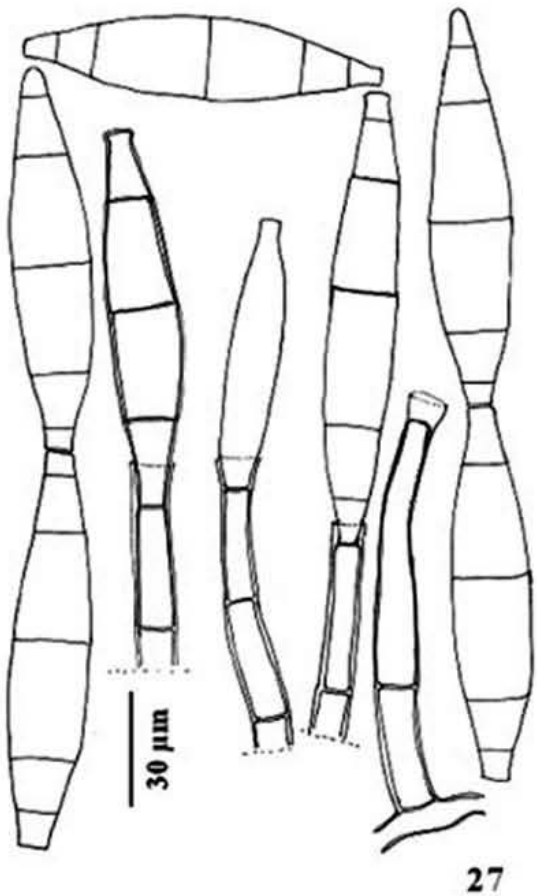

Fig. 27 *Antipodium spectabile*, from nature (XAL CB744). Drawings of conidiophores, conidiogenous cells and conidia. Scale is indicated by bars.

Antipodium spectabile Piroz., Can. J. Bot. 52:1143 (1974). **Figs. (20–27)**

Colonies on natural substratum hairy, effuse, white. **Mycelium** mostly immersed, composed of septate, branched, smooth, colorless hyphae, 2.0–4.5 µm diam. **Conidiophores** macronematous, mononematous, erect, straight or flexuous, 100–160 µm tall, 9–12 wide at the base, 3- to 6-septate, simple, smooth-walled, colorless. **Conidiogenous cells** enterogenous, unilocal, terminal, integrated, determinate, up to 40 µm long, 6.5–9.5 µm wide, colorless, with a conspicuous collarette at each conidiogenous locus, 7–9 µm wide, 5–6 µm deep. **Conidial secession** schizolytic. **Conidia** fusiform, 3- to 5-septate, (mostly 5-septate), basocatenate, truncate at the ends, or papillate to slightly obtuse at the apex, 95–128 × 21–29 µm, smooth, colourless.

Teleomorph: *Ophionectria trichospora* (Berk & Broome) Sacc., Michelia 1: 323 (1878).

Specimen examined: XAL CB744, Mexico, Veracruz, on wood submerged in a stream, 19.V.2002, coll. R.M. Arias and J. Y. C.Elizondo.

The above description, based on a specimen collected in nature, shows some differences in conidial morphology from the protologue of *Antipodium spectabile*, which was based on a pure culture derived from a single ascospore cultivated on PDA. Conidia in pure culture each have an apical cellular appendage or "foot-cell" (Pirozynski, 1974; Rossman et al., 1999), but only truncate or apically papillate conidia were observed by Subramanian & Bhat (1978) and in the specimen studied during the present work.

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Literature cited

Castañeda Ruiz RF. 1985. Deuteromycotina de Cuba. Hyphomycetes II. Instituto de Investigaciones Fundamentales en Agricultura tropical "Alejandro de Humboldt", Havana, Cuba, 23 pp.

Davydkina TA, Mel'nik VA. 1989. Two new hyphomycetes from the genera *Cordana* and *Pyryculariopsis*. Mikol. Fitop. 23 (2): 110-113. [in Russian]

Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, 608 pp.

Ellis MB, Ellis JP. 1997. Microfungi on Land Plants. An Identification Handbook. Enlarged Edn, 868 pp., Slough: Richmond Publishing.

Emden van JH. 1974. *Staheliella*, a new genus of *Hyphomycetes* from tropical soil. Acta Bot. Neerl. 23: 251-256.

Goos RD. 1969. Conidium ontogeny in *Cacumisporium capitulatum*. Mycologia 61: 52-56.

Goos RD. Pirozynski KA. 1975. Fungi of Barro Colorado Island: new and interesting hyphomycetes. Can. J. Bot. 53: 2927-293

Hambleton S, Egger KN, Currah RS. 1998. The genus *Oidiodendron*: species delimitation and phylogenetic relationships based on nuclear ribosomal DNA analysis. Mycologia 90 (5): 854-869.

Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Ainsworth & Bisby's, Dictionary of the fungi, eighth edition. International Mycological Institute, Kew, Surrey, 616 pp.

Kendrick WB. 2003. Analysis of morphogenesis in hyphomycetes: new characters derived from considering some conidiophores and conidia as condensed hyphal systems. Can. J. Bot. 81: 75-100.

Pirozynski KA. 1974. *Antipodium*, a new genus of Hyphomycetes. Can. J. Bot. 52: 1143-1146.

Rossman AY, Samuels GJ, Rogerson CT, Lowen R. 1999. *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). Stud. Mycol. 42: 248 pp.

Subramanian CV, Bhat DJ. 1978. Conidium ontogeny and ascus development in *Ophionectria trichospora*. Kavaka 6: 55-63.

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Endococcus variabilis, a new species on *Staurothele areolata*

MEHMET GÖKHAN HALICI[1], JANA KOCOURKOVÁ[2], PAUL DIEDERICH[3] & AHMET AKSOY[4]

[1]*mghalici@erciyes.edu.tr* [4]*aksoy@erciyes.edu.tr*
Erciyes University, Fen Edebiyat Fakültesi, Biyoloji Bölümü
38039 Kayseri, Turkey

[2]*jana_kocourkova@nm.cz*
National Museum, Václavské nám. 68
115 79 Praha, Czech Republic

[3]*paul.diederich@education.lu*
Musée national d'histoire naturelle
25 rue Munster, L-2160 Luxembourg

Abstract—*Endococcus variabilis* is described as a new species from the thallus of *Staurothele areolata* in Turkey and Austria. It differs from most other species of the genus in the 4–6(–8) spored asci and verrucose ascospores, from *E. zahlbrucknerellae* in ascomatal and ascospore size, and from all known species by the host selection.

Key words—lichenicolous fungi, *Dothideales*, *Ascomycota*

Introduction

The genus *Endococcus* comprises at least 37 species occurring on a wide range of crustose, foliose, and fruticose lichens. The species have been revised by Hawksworth (1979) and Triebel (1989, only lecideicolous species), but many others have been recognized since those works. Recent collections from Turkey and Austria of a species on *Staurothele areolata* differ significantly from previously described taxa and are described here as a new species.

Material and methods

The type specimen of the new species is deposited in ANES. It was examined by standard microscopic techniques, and drawings were made using a drawing tube. Sections were prepared by hand and examined in Congo red (1% solution in water, mixed 1:1 with 10% KOH), I (Lugol's iodine: I 0.5 g, KI 1.5 g, water

100 ml), 10% KOH, and water. Amyloid reactions were tested using Lugol's iodine solution (I) without and with pre-treatment by KOH (K/I). Ascus structures were examined and drawn in Congo red after pre-treatment with KOH. Ascospore measurements were made in water; extreme values are given in parentheses. Ascospore measurements are indicated as (minimum-) $\bar{x}-\sigma_x$ – $\bar{x}+\sigma_x$ (-maximum), followed by the number of measurements (n); the length/breadth ratio of ascospore is indicated as l/b and given in the same way.

The species

Endococcus variabilis Halici, Kocourk. & Diederich, sp. nov. FIGURES 1-2

MycoBank MB 510682

Fungus lichenicola in thallis lichenis Staurothele areolata vigens. Endococcus species insignis ascomatibus immersis vel semi-immersis, subsphaericis ad subpyriformibus, atris, 230–260 µm altis, 190–250 µm latis, pariete pallide brunneo sed apicaliter atrobrunneo, K+ viridulo, 20–25 µm crasso, apicaliter 40 µm crasso, hamathecio sine paraphysibus, periphysibus 30–36 µm longis, 3.5–5.5 µm latis, centro I+ dextrinoideo, K/I+ coeruleo, ascis clavatis ad subcylindricis, 4–6(–8)-sporis, 47–60 × 13.5–18.5 µm, parietate apicaliter incrassato, ascosporis auratobrunneis, 1-septatis, verruculosis, cum perisporo 0.5 µm crasso, (11.0–)13.0–16.0(–18) × (5.5–)6.5–7.5(–8.5) µm.

Typus: Turkey, Kayseri, Yahyalı, Aladağlar Milli Parkı, Karaboyunlar Mevkii, 37°52'N, 35°15'E, alt. 2795 m, on thallus of *Staurothele areolata* on exposed limestone rocks, 25 August 2006, *M.G.Halıcı* 0.2290 (ANES–holotypus).

Etymology: The epithet "*variabilis*" refers to the variable number of ascospores, usually 4 to 6, developing in the asci.

Description: Lichenicolous fungus growing on the areoles of the host thallus *Staurothele areolata*, suppressing host ascomatal production in infected areoles. **Ascomata** perithecioid, arising singly, sometimes aggregated in loose groups, immersed to erumpent, subglobose to obpyriform, upper part more or less applanate, with a broad ostiolar part up to 25 µm, black, somewhat shiny, 230–260 µm tall, 190–250 µm wide; wall mainly 25–35 µm thick, pseudoparenchymatous, formed of radially compressed polyhedral cells, dark brown near ostiole, basally to subapically subhyaline to pale brown, K+ greenish, c. (5–)7–9 cells thick, cells thin-walled, 6–10 × 2.5–4 µm in vertical section. **Hamathecium** of periphysoids, lining the ostiolar canal and spreading down to upper 1/5 of the ascoma, around the ostiolar part pale brown, beneath hyaline, simple or branched near the base, of 4–5 thin-walled cylindrical to broadly cylindrical cells 7–10(–15) × 3.5–5.5 µm diam, 30–36 µm long; central cavity formed of gelatinized tissue and the remains of discharged asci, hymenial gel hemiamyloid, I+ orange, K/I+ blue. **Asci** arising from the basal and side parts of the ascomatal cavity, lining a substantial part of the inner wall of ascomatal cavity, clavate to subcylindrical, sessile to shortly stalked, mostly without distinct

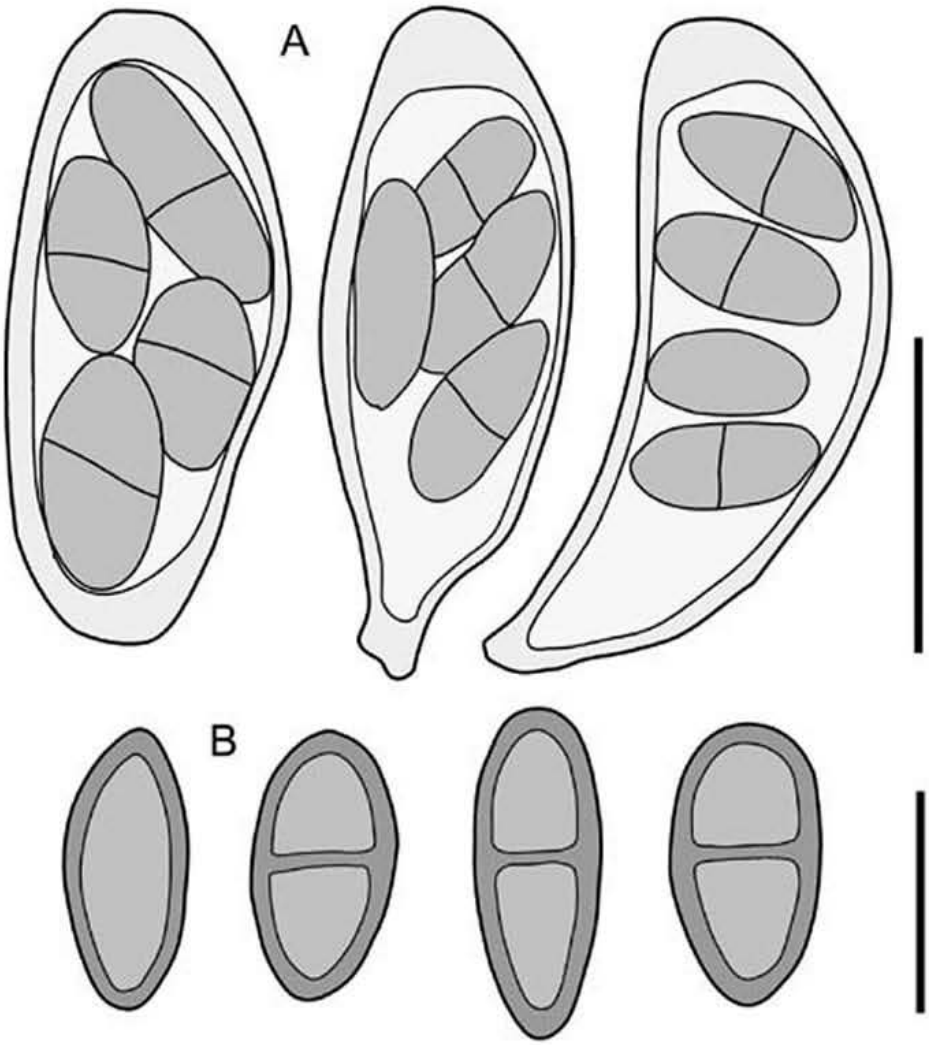

Fig. 1. *Endococcus variabilis* (holotype). A, asci in Congo red after pre-treatment with KOH. B, ascospores. Scales A = 20 µm, B = 10 µm.

internal apical beak, 4–6(–8)-spored, 47–60 × 13.5–18.5 µm, fissitunicate, K/I+ blue. **Ascospores** uniseriate or distichously arranged in the asci, ellipsoid to slightly fusiform, golden brown, simple when young, becoming 1-septate when mature, not or slightly constricted at the septum, some with one or two big oil droplets, golden brown, pigment somewhat concentrated at the slightly thickened apices and septum, the outermost layer faintly verruculose, 0.5–1 µm thick, the septum of the same thickness (0.5–1 µm), the gelatinous, thin, perispore 0.5 µm thick, (11.0–)13.0–16.0(–18) × (5.5–)6.5–7.5(–8.5) µm (n=40), length/breadth ratio (1.6–)1.8–2.4(–2.1) µm. **Conidiomata** not observed.

Additional specimen examined: Austria, Steiermark, Ostalpen, Niedere Tauren, Schladminger Tauern, WSW of Schladming, eastern overhangs of mountain range between Gasselhöhe and Rippetegg, path to Mittersee, MTB 8647/2, alt. 1820 m, on mineral rich calcareous mica schist, on thallus of *Staurothele areolata*, 26 August 2001, *J. Kocourková* (PRM 895949).

Discussion

Following Triebel (1989), *Endococcus* specimens with ascospores similar in size to our new species belong to *E. rugulosus* Nyl. 1855. However, this author used a very broad species concept, including under that name material from a wide variety of hosts belonging to at least seven genera. Recent studies (Brand, unpubl.; Sérusiaux et al. 1999, Kocourková 2000) suggest that *Endococcus* species are generally host-specific, and the name *E. rugulosus* should probably be restricted to specimens growing on *Verrucaria*. As the host of the new species, *Staurothele areolata*, is closely related to *Verrucaria*, both *Endococcus* species were carefully compared. Moreover, recently two additional *Endococcus* species were described from related host genera. *Endococcus incrassatus* Etayo & Breuss (Etayo & Breuss 2001) from *Placidiopsis cinerascens* and *E. karlstadtensis* Kocourk. & Brackel (Brackel & Kocourková 2006) from *Endocarpon pusillum*.

Apart from the different hosts, the new *Endococcus variabilis* differs from *E. rugulosus*, *E. incrassatus* and *E. karlstadtensis* in having 4–6(–8)-spored asci (versus constantly 8-spored), and substantially larger ascomata, mainly 230–260 × 190–250 µm, versus 90–220 µm diam in *E. rugulosus* and 100–120 µm in *E. incrassatus*. The ascospores of *E. variabilis* are (11.0–)13.0–16.0(–18) × (5.5–)6.5–7.5(–8.5) µm, distinctly verruculose and thick walled (wall c. 1 µm), larger then in *E. karlstadtensis* (8.5–)9.5–11.6(–12.7) × (4.9–)5.9–6.9(–7.5) µm, in which ascospores are pale brown for a long time and verruculose only when fully mature. The material on *Verrucaria* called *E. rugulosus* by Sérusiaux et al. (1999) has dark brown, also small and verruculose ascospores, 10–12(–12.5) × 5.5–7.5 µm that are thin walled (wall c. 0.5 µm); the material of *E. rugulosus* used for comparison in this study has also small ascospores, (8.5–)9.5–13.0(–15.5) × (5.0–)6.0–7.0(–8.0) µm. However, none of these authors studied the type specimen of *E. rugulosus*, and thus it is not entirely certain if they were dealing with the genuine *E. rugulosus*, or with a similar, undescribed species. Triebel (1989) gave the ascospores of *E. rugulosus* s. l. as smooth and (12–)13–16(–16.5) × (5.5–)6–7.5(–8) µm. In the holotype they are smooth and 12–15 × 6–9 µm (D. L. Hawksworth, pers. comm.).

With our current knowledge, *E. zahlbrucknerellae* (Henssen) D.Hawksw. 1979 is the only other known *Endococcus* species with 4-spored asci. That species differs in having much smaller ascomata (up to 100 µm diam), smaller ascospores (10.5–13.5 × 5.5–6 µm, fide Hawksworth 1979; 12–15 × 5–6 µm, fide

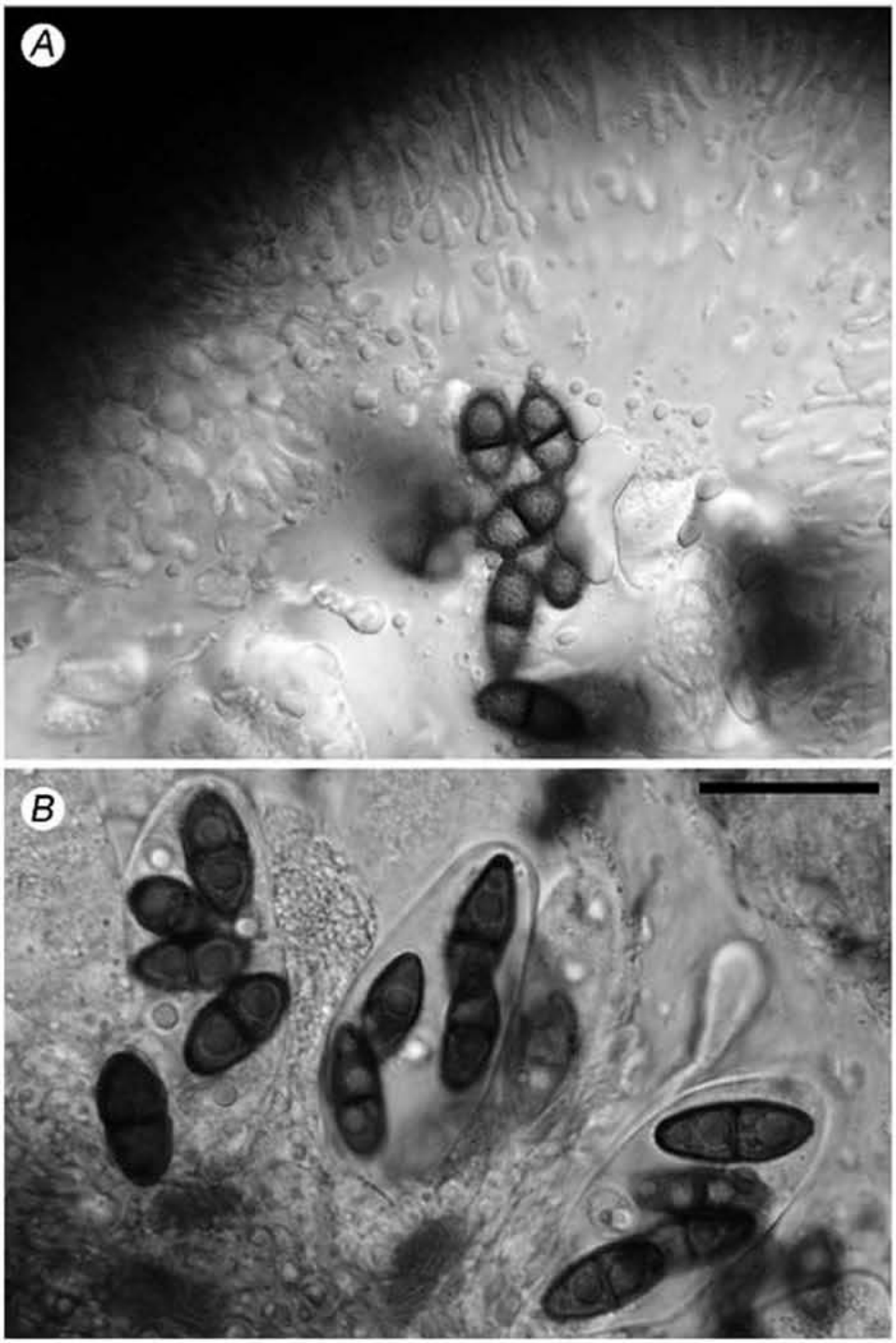

Fig. 2. ***Endococcus variabilis***. A, section through a perithecium showing verruculose ascospores from one ascus and periphysoids (*J. Kocourková*, PRM 895949). B, 4-spored asci (holotype). Scale = 20 µm.

Henssen 1977), and the induction of distinct galls on a different host lichen, *Zahlbruckneriella calcarea*.

Hafellner (2002) reported the discovery of a specimen from the Canary Islands on *Acarospora* with 4-spored asci that he provisionally included in *Endococcus stigma*, a species with soleiform and apically often strongly attenuated ascospores.

***Endococcus rugulosus* specimens examined** (All on *Verrucaria nigrescens*): Czech Republic: Central Bohemia, Praha, between Velká Chuchle and Slivenec, 290 m, MTB 5952, Homolka calcareous rocks, 4 January 1994, *J. Horáková* (PRM 889662). - Praha, Nová Ves, 290 m, MTB 5952, Hemrovy skály diabasic rocks, 15 April 1999, *J. Kocourková* (PRM 758701). - Praha, near Nová Ves settlement in Prokopské valley, MTB 5952, 310 m, Bílé skály calcareous rocks, 24 September 1999, *J. Kocourková* (PRM 758700). - Praha, Prokopské údolí valley, 280 m, MTB 5952, calcareous rocks above old swimming pool Holyňské koupaliště, 10 April 1988, *J. Horáková* (PRM 758688).

Slovakia: Carpathians, Spišské Podhradie, Sivá Brada hill, on calcareous sinter, 500 m, 21 May 1958, *A. Vězda* (PRM 515663; Vězda, Lich. Bohemosl. exs. no. 235, sub *Caloplaca lactea*).

Acknowledgements

David L. Hawksworth and Alan Orange are thanked for critically reviewing this paper. This study was supported by TUBITAK (105T175 coded project) and part of this study (J. Kocourková) was financially supported by the grant MK00002327201 from the Ministry of Culture of the Czech Republic. This study was finished when MGH was in the Facultad de Farmacia, Universidad Complutense de Madrid under the direction of David L. Hawksworth with a grant from TUBITAK.

Literature cited

Brackel W von, Kocourková J. 2006. *Endococcus karlstadtensis* sp. nov. und weitere Funde von flechtenbewohnenden Pilzen in Bayern - Beitrag zu einer Checkliste II. Berichte Bayerische Botanische Gesellschaft 76: 5-32.

Etayo J, Breuss O. 2001. *Endococcus incrassatus*, a new lichenicolous fungus (*Dothideales*). Österreichische Zeitschrift für Pilzkunde 10: 315–317.

Hafellner J. 2002. Bemerkenswerte Funde von Flechten und lichenicolen Pilzen auf makaronesischen Inseln VI. Über einige Neufunde. Fritschiana 36: 11-17.

Hawksworth DL. 1979. Studies in the genus *Endococcus* (*Ascomycotina, Dothideales*). Bot. Notiser 132: 283-290.

Henssen A. 1977. The genus *Zahlbruckneriella*. Lichenologist 9: 17-46.

Kocourková J. 2000 [“1999”]. Lichenicolous fungi of the Czech Republic. (The first commented checklist). Acta Musei Nationalis Pragae, Ser. B., Hist. Nat., 55[(3-4): 59-169.

Sérusiaux E, Diederich P, Brand AM, van den Boom P. 1999. New or interesting lichens and lichenicolous fungi from Belgium and Luxembourg. VIII. Lejeunia NS 162: 1-95.

Triebel D. 1989. Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. Bibliotheca Lichenologica 35: 1-278.

MYCOTAXON

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Fibricium gloeocystidiatum (Polyporales, Basidiomycetes), new to Europe

LUIGI ARRAS[1], ANDREA PIGA[2], ANNAROSA BERNICCHIA[3] & SERGIO PÉREZ GORJÓN[4]

[1]*luigi.arras@alice.it* [3]*annarosa.bernicchia@unibo.it* [4]*spgorjon@usal.es*

[1]*Viale Europa 28, 08045 Lanusei (Nuoro), Italy*

[2]*Viale Marconi 47, 0845 Lanusei (Nuoro), Italy*

[3]*Dipartimento di Scienze e Tecnologie Agroambientali Università degli Studi di Bologna, Via Fanin 42, 40127 Bologna, Italy*

[4]*Departamento de Botánica y Centro Hispano-Luso de Investigaciones Agrarias Universidad de Salamanca, Ldo. Méndez Nieto s/n. 37007, Salamanca, Spain*

Abstract — A collection of *Fibricium gloeocystidiatum* from Sardinia, Italy, is reported. Previously, this species was only known from Patagonia, Argentina on *Austrocedrus chilensis*. The European specimens were found on the fern *Osmunda regalis* and show some distinguishing characters from the Argentinian specimens. A key to the European species of *Fibricium* is provided.

Keyword — *Steccherinaceae*, wood-inhabiting fungi

Introduction

During the research on distribution and ecology of Aphyllophorales in Mediterranean areas particular care and attention have been devoted to the forests of Sardinia where some new corticioid and polyporoid species have been collected: *Aleurodiscus ilicicola* Bernicchia & Ryvarden, *Phellinus juniperinus* Bernicchia & Curreli, *Neolentiporus squamosellus* Bernicchia & Ryvarden, *Echinodontium ryvardenii* Bernicchia & Piga, *Antrodia sandaliae* Bernicchia & Ryvarden, *Antrodiella ichnusana* Bernicchia et. al. The record of *Piloporia sajanensis* (Parmasto) Niemelä is also worth mentioning. (Bernicchia 1990, 2005, Bernicchia & Piga 1998, Bernicchia & Ryvarden 1988, 1996, 1997, 1998, 2001).

We investigated all kind of substrata, from ferns to cork oak and strawberry tree to hawthorn. Further at the side of a country road (S.S 389 Lanusei- Nuoro),

we became aware of a stand of the beautiful fern *Osmunda regalis* L., which at the base had, partially immersed in the soil, some old and dead leaves covered with small round, whitish patches of corticioid fungi including (among others) *Fibricium gloeocystidiatum*, which we describe below.

Description

Fibricium gloeocystidiatum Rajchenb., Mycotaxon 81: 218, 2002. Fig. 1

Basidiomata resupinate, effused and easily detachable in very small pieces, hymenial surface smooth and continuous, whitish to cream, very thin, 100-150 µm thick, waxy in the mature parts, farinaceous and pulverulent when young; margin narrow, indeterminate, white, with very thin and numerous rhizomorphs spreading from the margin and invading the substrate; subiculum very thin.

Hyphal system dimitic: generative hyphae thin to slightly thick-walled, with hemispheric clamps at all septa, 1.5-4 µm wide, sometimes slightly wider close to the septa, with a yellowish and refractive content, predominant in subhymenium and subiculum, rare in the rhizomorphs; skeletal hyphae hyaline, thick-walled, unbranched, 1.5-2 µm wide, rare to numerous in the different parts of the basidiomata, abundant in the rhizomorphs and in the invaded wood, very scanty or partially absent in the subiculum. Hyphae gloeopleurous variable in number, sinuous, yellowish, with a dense and refractive content, and giving rise to gloeocystidia. In the material observed crystals are abundant.

Cystidia of two types: 1) gloeocystidia few, sometimes difficult to find, sinuous, rarely fusoid, very often clavate, embedded in the hymenium and with a refractive content, negative in sulfobenzaldehyde, (25) 30-55 (62) × (4) 5-6.6 (7) µm (mean: 37.1 × 5.7 µm); 2) cystidia numerous, fusoid to lanceolate, with a blunt apex, wider at the base, thin or slightly thick-walled, with one or two simple septa, basally clamped, (57) 70-85 (105) × 6.5-8 (10) (mean: 76.6 × 7.4 µm). All the specimens have some cystidia with clamped septa, but their frequency is very variable and sometimes very scanty. Some intermediate forms between these two types of cystidia have been seen.

Basidia clavate, with four sterigmata and a basal clamp, 17-23 (26) × 4.5-5.5 (6.5) µm.

Basidiospores hyaline, thin-walled, smooth, IKI-, cyanophile, with a heterogeneous and granular content, often glued together in groups of 2 or 4, variable but with cylindrical shape in general, more rarely ellipsoid, 5-6.5 (7) × 3 µm (mean: 5.76 × 3.01; Q= 1.91) (Figure 1).

Remarks: Gloeocystidia are particularly numerous, larger, and with a yellow colour in coll. 8078. In the same specimen, basidiospores are mostly ellipsoid

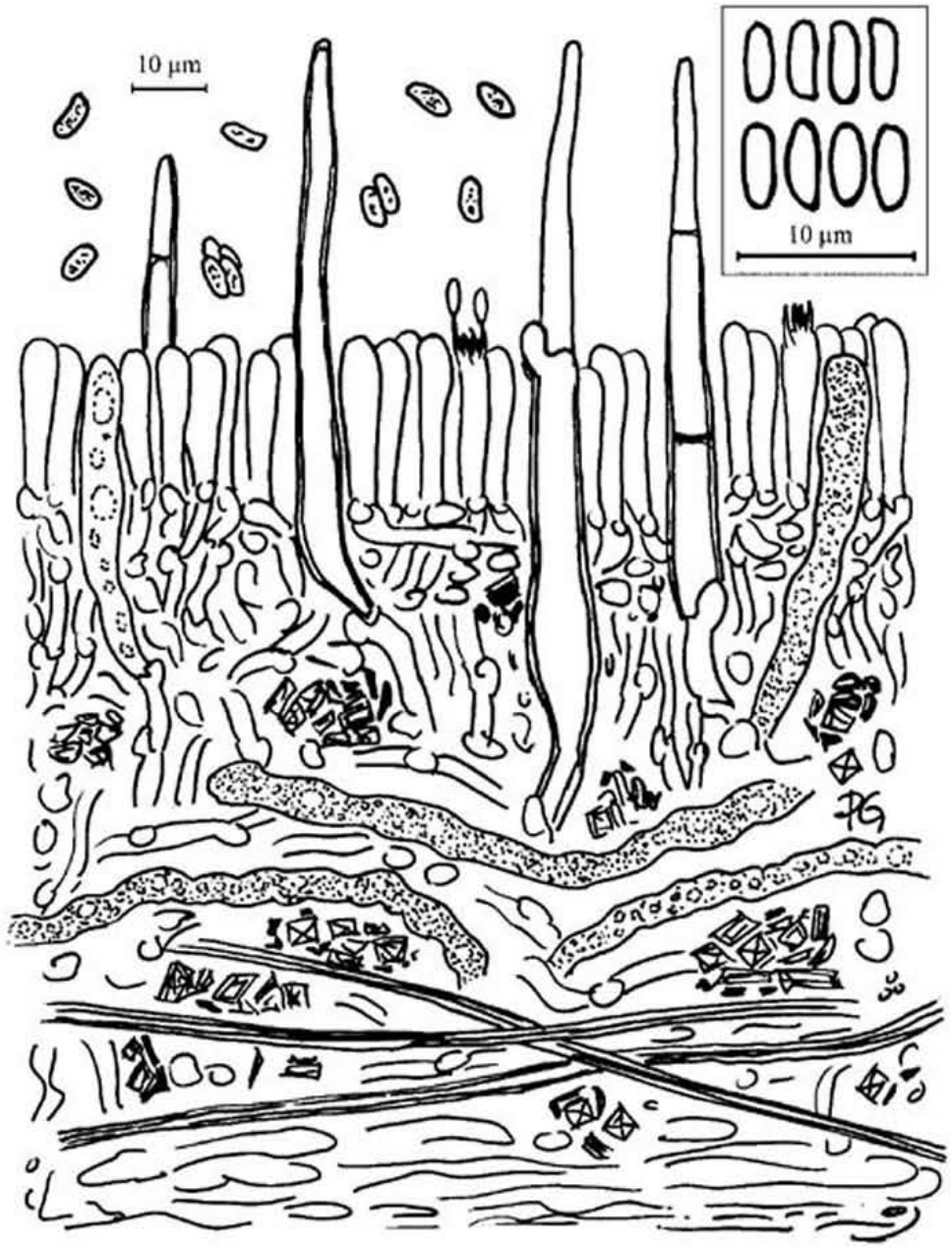

Figure 1. Microscopic elements of *Fibricium gloeocystidiatum*

and also somewhat larger (6.5-7 (7.2) × 3-3.3 µm), while basidiospores of coll. 8080 are cylindrical and not wider than 2.5 µm.

Habitat: in Italy collected on *Fraxinus* (?) and at the basal part of the fern *Osmunda regalis,* late in the autumn, growing sometimes with *Trechispora*

laevis K.H. Larss. and *Hypochnicium detriticum* (Bourdot & Galzin) J. Erikss. & Ryvarden.

KNOWN COLLECTIONS: **Argentina** — Chubut, Futaleufú, Los Cipreses, Estancia Pehuén, leg. M. Rajchenberg, coll. 11216; Los Cipreses, Trevelín, Estación Agroforestal INTA, leg M. Rajchenberg, coll. 11201, 11202, 11208, 11211, on fallen trunks of *Austrocedrus chilensis* (Rajchenberg 2002). **Italy** — Sardinia, Longhifresu, Lanusei (Nuoro) 20.V.2002, on angiosperm wood (*Fraxinus*?), HUBO coll. 4665, leg. A. Arras; S.S. 389 Lanusei-Nuoro country road close to St. Barbara Forest, (Nuoro), 07.XI. 2005, on *Osmunda regalis*, HUBO coll. 5487, 5490, leg. A. Piga and L. Arras; 19.XI.2005, on *Osmunda regalis*, HUBO coll. 5583, 7088, leg. A. Piga and A. Bernicchia; 20.XII.2006 on *Osmunda regalis*, HUBO coll. 8078, leg. L. Arras; 10.II.2007 on *Osmunda regalis*, HUBO coll. 8080, leg. L. Arras.

Discussion

The species may remind one of *Fibricium rude* (P. Karst.) Jülich (Eriksson & Ryvarden 1975), which, however, lacks gloeocystidia and gloeopleurous hyphae. Although M. Rajchenberg confirmed our collections as *F. gloeocystidiatum*, we note the following differences that distinguish the Sardinian specimens from Argentinean collections 11211 and 11216:

a) Basidiospore shape is more variable and generally cylindrical.
b) The tissues contain many crystals when inspected microscopically.
c) Skeletal hyphae appear concentrated in the rhizomorphs but very sparse in the subiculum.
d) Basidia are larger.
e) Cystidia with at least some clamped septa occur in all the Italian specimens. (No clamped cystidia were found in the Argentinean specimens.)
f) Almost all specimens have smaller and difficult to find gloeocystidia that are less visible in phloxine.
g) Sardinian host substrata include angiosperms and ferns [*Fraxinus* (?) and *Osmunda regalis*] whereas Argentinean substrates are restricted to the gymnosperm, *Austrocedrus chilensis*.

Key to the European species of *Fibricium* J. Erikss.

1. Hymenial cystidia present 2
1. Hymenial cystidia absent ..... ***Fibricium subceraceum*** (Hallenb.) Bernicchia

2. Without gloeocystidia 3
2. With gloeocystidia and gloeopleurous hyphae .. ***Fibricium gloeocystidiatum*** Rajchenb.

3. Cystidia not encrusted ..... ***Fibricium rude*** (P. Karst.) Jülich
3. Cystidia encrusted ..... ***Fibricium lapponicum*** J. Erikss.

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Prof. Leif Ryvarden (Norway) and Prof. Nils Hallenberg (Sweden) acted as pre-submission reviewers of the article. The last author is supported by a research grant co-financed by the European Social Fund and the Junta de Castilla y León (Spain). Many thanks to Prof. Mario Rajchenberg (Argentina) who examined our specimens and confirmed the diagnosis.

Literature cited

Bernicchia A. 1990. *Polyporaceae* s.l. in Italia. Instituto Patologia Vegetale, Università degli Studi di Bologna, 596 pp.

Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europaei 10. Ed. Candusso, Italia, 808 pp.

Bernicchia A, Piga A. 1998. A new species of *Echinodontium* from Italy. Mycotaxon 68: 483-491.

Bernicchia A, Ryvarden L. 1988. *Aleurodiscus ilexicola* Bern. & Ryv., sp. nov. from Sardinia. Mycol. Helvetica 3(1): 83-88.

Bernicchia A, Ryvarden L. 1996. Two new brown rot polypores from Italy. Mycol. Helvetica 8(2): 3-10.

Bernicchia A, Ryvarden L. 1997. *Piloporia sajanensis* (Parmasto) Niemelä, a rare, boreal polypore new to Italy. Mycol. Helvetica 9(1): 85-89.

Bernicchia A, Ryvarden L. 1998. *Neolentiporus* (*Basidiomycetes, Polyporales*) in Europe. Cryptogamie, Mycol. 19(4). 281-283.

Bernicchia A, Ryvarden L. 2001. A new *Antrodia* species (*Coriolaceae, Basidiomycetes*) from Italy. Mycotaxon 79: 57-66.

Eriksson J, Ryvarden L. 1975. The *Corticiaceae* of North Europe vol. 3. Fungiflora, Oslo.

Rajchenberg M. 2002. Corticioid and polyporoid fungi (*Basidiomycota*) that decay *Austrocedrus chilensis* in Patagonia, Argentina. Mycotaxon 81: 215-227.

MYCOTAXON

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Taxonomic revision of the myxomycetes from Cuba deposited in three reference collections: U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK)

M. Camino [1], G. Moreno [2] & A. Castillo [2]

hajb@ceniai.inf.cu, gabriel.moreno@uah.es, aurelio.castillo@uah.es

[1] *Jardín Botánico Nacional de Cuba, Universidad de la Habana*
Carretera El Rocío, Km 3½, Calabazar, Boyeros
C.P. 19230, Ciudad Habana, Cuba.

[2] *Dpto. de Biología Vegetal (Botánica), Universidad de Alcalá*
E-28871 Alcalá de Henares, Madrid, Spain.

Abstract — A revision was made of myxomycetes from Cuba deposited in three reference collections at the U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). These specimens were gathered mainly during the 19th century by Charles Wright during expeditions made to this island. All species are discussed and annotated. Identifications are supported by critical point SEM studies of spore ornamentation. Micrographs of spore ornamentation for species little studied by SEM or of particular interest for the island biota are included.

Key words — chorology, *Myxomycota*, taxonomy, Neotropical myxobiota, SEM

Introduction

This paper is a part of a review of historic material of myxomycetes collected in Cuba and deposited in several reference collections. It presents up to date information on this group in Cuba and is a precursor for a revised checklist of Cuban myxomycetes which we are preparing.

A first study (Camino et al. 2005) provided a critical review of specimens deposited in the Farlow Reference Collection (FH-USA). In the present work, we review specimens deposited in the U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). *Arcyria cinerea*, *A. denudata*, *Diachea bulbillosa*, *Diderma effusum*, *Hemitrichia calyculata*, *Physarum compressum*, *P. polycephalum*, *Stemonitis splendens* and *Trichia affinis* are cited, and photographs of some specimens are presented.

Materials and methods

The Cuban material studied came from three reference collections: the U.S. National Fungus Collections (BPI-USA), British Museum (BM-UK) and Kew (K-UK). Depending on their conservation state, they were studied macro- and microscopically.

Samples for light microscopy were mounted in Hoyer's medium and PVA according to Schnittler & Novozhilov (1996) and Koske & Tessier (1983). Spore measurements were made with an oil immersion objective and included surface structures such as spines or warts.

Scanning electron microscopy (SEM) images were prepared using the critical point method (Castillo & al. 1997) and micrographs were taken at the University of Alcalá using a Zeiss DSM-950. This technique uses very little material (one sporocarp, a part of it or only a small portion of spores).

In some cases, where the sample was scarce or not well conserved, it was compared with the same collection from the Farlow Collection (FH-USA) and reference was made to Camino et al. (2005).

In the list below, "FCW" indicates Fungi Cubenses Wrightiani and "W" indicates Charles Wright. Abbreviations for author citations follow Kirk & Ansell (1992) and those for reference collection citations follow Holmgren & Holmgren (1998).

Taxonomy

Arcyria cinerea (Bull.) Pers., Syn. Meth. Fung.: 184. 1801

= *Trichia cinerea Bull., Herb. France pl. 477, f.3. 1790*

= *Arcyria albida* Pers., Neues Mag. Bot. 1: 90. 1794

= *Arcyria bicolor* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc., Bot. 10: 239. 1868

= *Arcyria cinerea* var. *digitata* (Schwein.) G. Lister., Monogr. Mycetozoa, ed. 3: 232. 1925

Specimens examined — CUBA: *leg.* C. Wright, BM 716 (FCW 542. *Arcyria bicolor*, with an additional label bearing an identification noted by G. Lister as *Arcyria cinerea* var. *digitata*).

Comments — We confirm *Arcyria cinerea* as the correct identification, although the sample comprises only a few sporothecae joined to a single stipe.

Lister (1894) referred to this specimen as *Arcyria albida*. On the label, however, it is identified, possibly later, by G. Lister as *A. cinerea* var. *digitata*. FH maintains a duplicate of this material (Camino & al. 2005).

Arcyria denudata (L.) Wettst., Verh. Zool.-Bot. Ges. Wien 35: Abh. 535. 1886

= *Clathrus denudatus L., Sp. Pl.: 1179. 1753*

= *Arcyria punicea* Pers., Neues Mag. Bot. 1: 90. 1794

Specimens examined — CUBA: K 950 as *Arcyria punicea*.

Comments — Study of the specimen confirms that it corresponds to *Arcyria denudata* because of the typical capillitium of this species and the hyaline and almost smooth spores 7-8 µm diam.

This specimen was identified and cited by Lister (1894, 1911) as *Arcyria punicea*.

Diachea bulbillosa (Berk. & Broome) Lister, in Penzig, Myxomyc. Fl. Buitenzorg: 45. 1898

= *Didymium bulbillosum* Berk. & Broome, J. Linn. Soc. Bot. 14: 84. 1873

Specimens examined — CUBA: K s/n (W- 495 as *Diachea elegans*). K 436 (Cuba, as *Diachea elegans*. Inside the collection box is the stamp of Herbarium Hookerianum 1867).

Comments — In the specimens studied we observed globose sporothecae (squashed as a result of the way in which the material had been conserved) with a white columella and strongly spinose spores 9-10 µm diam.

This specimen (W- 495) is cited also with FCW 537 by Berkeley (1868) as *Diachea elegans*.

Diderma effusum (Schwein.) Morgan, J. Cincinnati Soc. Nat. Hist. 16: 155. 1894

= *Diderma cubense* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10: 347. 1868

Specimens examined — CUBA: BM 518 (FCW 526 as *Diderma cubense* and, on another label, an identification by Lister as *Diderma testaceum*). CUBA: BM 1297 (L: B.M. 55, Cuba, *leg.* C. Wright).

Comments — The sample BM 518 appeared originally as *Diderma cubense*, although Lister identified it as *Diderma testaceum* (Schrad.) Pers. This material is a duplicate of the specimen cited by Berkeley (1868) as *Diderma cubense* (FH-FCW 526), also studied by us. We conclude that it corresponds with *Diderma effusum* (Camino & al. 2005).

The sample BM 1297 was cited by Lister (1894) with the reference L: B.M. 55 as *Chondrioderma testaceum*.

We agree with Farr (1976) that this is a synonym of *Diderma effusum* and not of *Diderma testaceum*, as indicated by Martin & Alexopoulos (1969).

Hemitrichia calyculata (Speg.) M. L. Farr, Mycologia 66 (5): 887. 1974

= *Hemiarcyria calyculata Speg., Anales Soc. Ci. Argent. 10: 152. 1880*

= *Hemitrichia stipitata* (Massee) T. Macbr., N. Amer. Slime-Moulds: 207. 1899

Specimens examined — CUBA: *leg.* C. Wright, K s/n (W- 259 as *Hemitrichia clavata*. The interior of the collection box reads: 259 *Trichia clavata* Pers.). **CUBA**: San Juan Mt. Guantánamo, on rotten trunk of a palm tree, July, 1929, *leg.* B. Hioram, *det.* V.K. Charles, ex Herbario Collage of Sacred Heart, Guantánamo, BPI 838006 as *H. clavata* and later as *H. stipitata*.

Comments — For this species, we follow the concept of Farr (1974). She studied Spegazzini's type material of *Hemiarcyria calyculata*.

The specimen K s/n was studied by us and corresponds with *Hemitrichia calyculata* in the length of the stipe, form of the calyculus and in having spores 6-7 µm. diam. This specimen was also cited by Berkeley (1868) as *Trichia clavata* (FCW 547, W- 259).

The sample K 1765A cited by Lister (1894) as *Hemitrichia clavata* was not encountered.

Study of the specimen BPI 838006 confirmed that it corresponds with *Hemitrichia calyculata*. Plasmodiocarps of *H. serpula* are present in the same sample.

This species is very frequent in Cuba and was cited recently by Camino (1993, 1998), Pérez & Camino (2000), Camino & Pérez (2001) and Camino & al. (2005).

Physarum compressum Alb. & Schwein., Consp. Fung. Lusat.: 97. 1805

Specimens examined — **CUBA:** K 1350 (the label also bears additional identifications as *Physarum affine* and W- 907 *Didymium furfuraceum*).

Comments — The same sample was cited by Lister (1894). The material is very sparse and in poor condition; we studied a duplicate of W- 907 deposited in FH which has abundant sporocarps. We confirm the identification by Farr and Lister as *Physarum compressum* (Camino & al. 2005).

Physarum polycephalum Schwein., Schriften Naturf. Ges. Leipzig 1: 63. 1822

= *Didymium obrusseum* Berk. & M.A. Curtis, in Berkeley, J. Linn. Soc. Bot. 10: 348. 1868

= *Physarum polycephalum* var. *obrusseum* (Berk. & M.A. Curtis) Lister, Monogr. Mycetozoa: 48. 1894

= *Physarum polymorphum* (Mont.) Rostaf., Sluzowce Monogr.: 107. 1874

Specimens examined — **CUBA:** *leg.* C. Wright, BM 440 (FCW 532) as *Physarum polycephalum* var. *obrusseum*.

Comments — The sample consists of a slide in poor condition which is a duplicate of FCW-532 deposited of FH (possibly type material of *Didymium obrusseum*) and cited and described by Berkeley (1868) as *Didymium obrusseum*. As examination of this slide was not possible, we studied the original material deposited in FH. As result of this review, and following Alexopoulos (1969), we can confirm that the sample corresponds to *Physarum polycephalum* (Camino & al. 2005).

Lister (1894) cited this specimen (BM 440) as *Physarum polymorphum* and later as *P. polymorphum* var. *obrusseum* (Lister 1911).

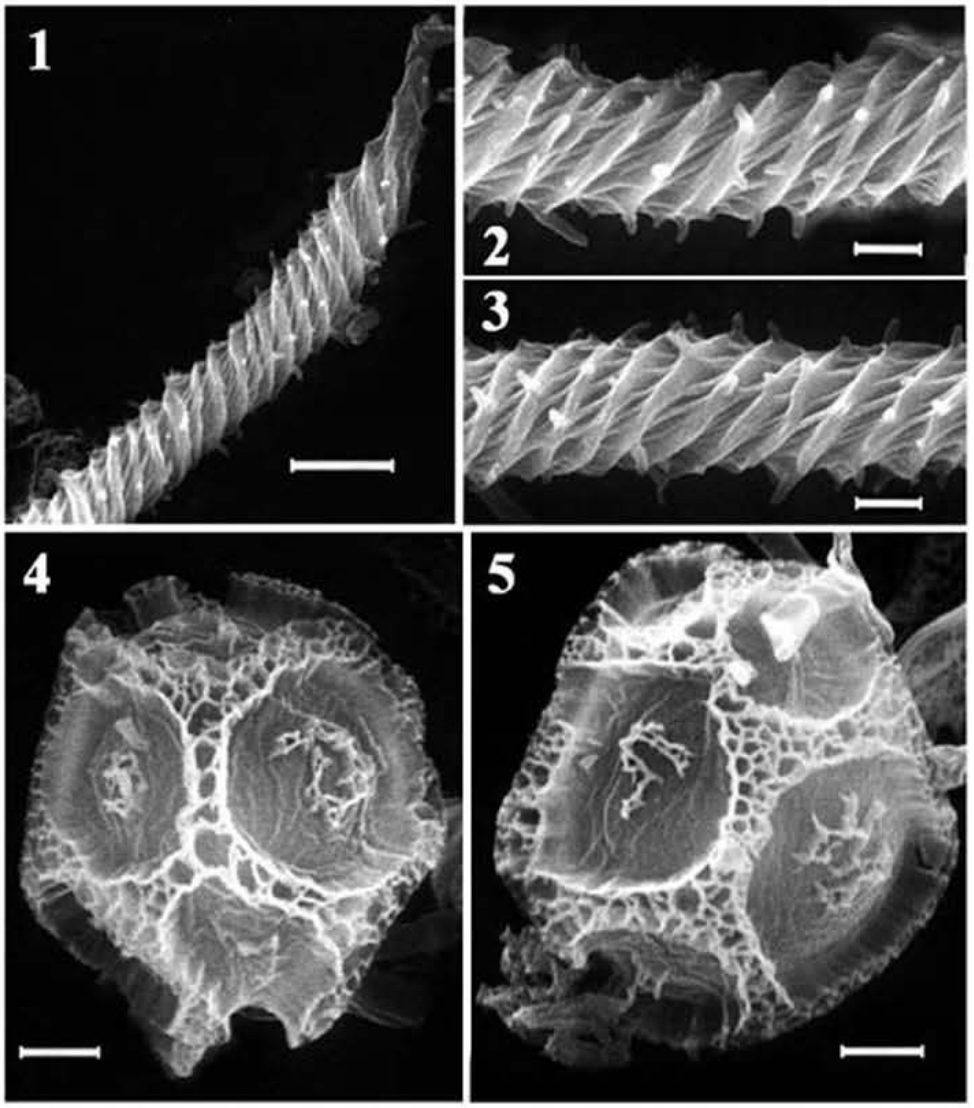
Stemonitis splendens Rostaf., Sluzowce Monogr.: 195. 1874

Specimens examined — **CUBA:** *leg.* C. Wright, BM 630 (FCW 538, as *Stemonitis fusca*, with another label bearing an identification by G. Lister as *Stemonitis splendens*). **CUBA:** K 1603 (W- 261 as *Comatricha longa*, with another label which reads: "*Stemonitis fusca* Roth Cuba, C. Wright").

Comments — Following review of the specimen BM 630, we agree with G. Lister's identification as *Stemonitis splendens* (Lister 1894, 1925).

The specimen K 1603 (W - 261) was cited by Lister (1894, 1911) as *Comatricha longa* (Camino & al. 2005).

The specimens BM 630 and K 1603 correspond with FCW 538 and were cited by Berkeley (1868) as *Stemonitis fusca* (Camino & al. 2005).



Figs. 1-5 *Trichia affinis* BPI 836624. 1. Detail of capillitium (bar = 5 µm). 2-3. Detail of spines in the capillitium (bar = 2 µm). 4-5. Detail of spore ornamentation (bar = 2 µm).

Trichia affinis de Bary, FIGURES 1-5
in Fuckel, Jahrb. Nassauischen Vereins Naturk. 23-24: 336. 1870

Specimens examined — CUBA: El Yunque, Mt. Baracoa, on *Nephrolepis* sp. in sink hole, March, 1903, *leg.* L.M. Underwood & F.S. Earle 968, *det.* Illegible, possibly G.W.M. ex N.Y.B.G., BPI 836624 as *Trichia affinis* but with an alternative identification as *T. persimilis*. CUBA: La Prenda, January, 1923, *leg.* Br. Hioram 5436, *det.* W.W. Diehl, BPI 836152 as *T. affinis*.

Comments — Some authors, such as as Farr (1958) and Martin & Alexopoulos (1969) treat this species together with *Trichia affinis* as synonyms of *T. favoginea*,

but we prefer to consider them as independent taxa following Nannenga-Bremekamp (1991). *Trichia favoginea* differs from *T. affinis* and *T. persimilis* in capillitium thickness (8-10 µm diam.), whereas *T. affinis* and *T. persimilis* have thinner capillitium tubes (4-6 µm diam.). It is difficult to separate the last two species; spore ornamentation is the principal character to differentiate them. *Trichia affinis* has reticulate spores with peaks in the ornamentation up to 1 µm high and discontinuous, whereas *T. persimilis* presents a broken reticulation of small meshes, with very incomplete peaks and with smooth areas without reticulation. The presence of small spines in the capillitium is a variable character and is sometimes present in both species.

The most recent identification of the sample BPI 836624 appears to be *Trichia affinis* because this name appears on the original label in another colour. The first identification was as *T. persimilis*.

The specimen BPI 836152 has capillitium tubes with spiny spiral bands up to 6 µm wide; spores with a well-developed reticulum, 10-12 µm. The specimen BPI 836624 has capillitium tubes with very small spines and spores of 11-13 µm with a complete and well-developed reticulum. Both correspond with *Trichia affinis*.

Doubtful material

- **BM 92,** CUBA: FCW 537 as *Diachea elegans* (Trentep.) Fr., another note "*Diachea leucopodia* Rost."

Comments — We saw only one slide in very bad condition. Identification was impossible and the original identification has therefore been followed here.

Although *Diachea elegans* is a synonym of *D. leucopodia* (Lado 2001) it would be incorrect to identify the specimen BM 92 (FCW 537) as *D. leucopodia* because Berkeley (1868) cited four specimens with FCW 537 as the reference number, and some correspond to *Diachea bulbillosa* while others correspond to *D. leucopodia* (Camino & al. 2005). Clearly BM 92 is a duplicate of one of the items cited by Berkeley (1868).

- **K 1501,** CUBA: *leg.* C. Wright, W- 483, on old bark, as *Didymium farinaceum* Fr.
- **K 1500,** CUBA: *leg.* C. Wright, W- 455 as *Didymium farinaceum* Fr.

Comments — It was impossible to study the specimens K 1500 and 1501 because only remnants of stipes remain.

We examined the specimens W- 483 and 455 deposited in FH (cited by Berkeley 1868, as *Didymium farinaceum*), but both samples were in a condition making any study impossible (Camino & al. 2005).

- **BPI 821255,** CUBA: La Prenda, Jan. 1923, *leg.* Br. Hioram 6759, *det.* W. W. Diehl, as *Comatricha elegans*, the collection box lid bears the handwritten note "only *Physarum* seen".

Comments — The material was in a bad condition. It was possible only to confirm that it corresponds to *Physarum*, as indicated in the box. Identification to species level was not possible.

Acknowledgements

This investigation was partly financed by research project REN2002-01965 of the Ministerio de Asuntos Exteriores and Ministerio de Ciencia y Tecnología, Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica. Another part was financed by a Miguel de Cervantes Scholarship of the University Alcalá de Henares for the first author, and her visit to the BM and K reference collections was supported by the UK Darwin Initiative Project Biodiversity Conservation in Cuba. We express our gratitude to Dr Javier Rejos, curator of the AH reference collection, and the curators and staff of BPI, BH and K collections. Also to J.A. Pérez and A. Priego, Service of Electronic Microscopy, University of Alcalá de Henares, for their invaluable help with the SEM, and wish to thank Dr D.W Minter and Mr D.W. Mitchell for the revision of the manuscript.

References

Alexopoulos CJ. 1969. The experimental approach to the taxonomy of the myxomycetes. Mycologia 61(2): 219-239.

Berkeley MJ. 1868. On a collection of fungi from Cuba. Part II. J. Linn. Soc. Bot. 10: 341-392.

Camino M. 1993 ["1991"]. Myxomycetes de Cuba. I. Revista Jard. Bot. Nac. Univ. Habana 12: 127-131.

Camino M. 1998. Los Myxomycetes del Hoyo de Bonet, Sierra de Cubitas, Camagüey. Revista Jard. Bot. Nac. Univ. Habana 19: 161-162.

Camino M, Pérez JM. 2001. Los Myxomycetes de la Reserva Ecológica "Alturas de Banao" (El Naranjal), Sancti Spiritus. Revista Jard. Bot. Nac. Univ. Habana 22: 109-117.

Camino M, Moreno G, Castillo A. 2005. Taxonomic revision of the myxomycetes from Cuba deposited in the Farlow Herbarium (USA). Mycotaxon 93: 379-400.

Castillo A, Moreno G, Illana C, Lago J. 1997. A critical study of some *Stemonitales*. Mycol. Res. 101: 1329-1340.

Farr ML. 1958. Taxomomic studies in the myxomycetes I. The *Trichia favoginea* complex. Mycologia 50: 357-369.

Farr ML. 1974. Earlier names for *Hemitrichia stipitata* (*Myxomycetes*). Mycologia 66: 887-888.

Farr ML. 1976. Flora Neotropica Monograph No. 16. *Myxomycetes*. New York Botanical Garden. 304 pp.

Holmgren, PK, Holmgren NH. 1998ff. (continuously updated). Index Herbariorum. New York Botanical Garden. New York. http://sciweb.nybg.org/science2/IndexHerbariorum.asp

Kirk PM, Ansell AE. 1992. Author of fungal names. A list of authors of scientific names of fungi, with recommended standard forms of their names, including abbreviations. Index of fungi supplement. CAB International, 95 pp.

Koske RE. Tessier B. 1983. A convenient permanent slide mounting medium. Mycol. Soc. Amer. Newsletter 34: 59.

Lado C. 2001. Nomenmyx, a nomenclatural taxabase of Myxomycetes. Cuadernos de trabajo de Flora Micológica Ibérica 16: 1-221.

Lister A. 1894. A Monograph of the *Mycetozoa*, being a descriptive catalogue of the species in the Herbarium of the British Museum. British Museum (Nat. Hist.) Cromwell road, London 224 pp, 78 pls.

Lister A. 1911. A Monograph of the *Mycetozoa* (ed. 2. rev. G. Lister). British Museum (Nat. Hist.). London. 302 pp, 200 pls.

Lister A. 1925. A Monograph of the *Mycetozoa* (ed. 3. rev. G. Lister). British Museum (Nat. Hist.). London. 296 pp, 200 pls.

Martin GW, Alexopoulos CJ. 1969. The *Myxomycetes*. Univ. Iowa Press. Iowa. 561 pp.

Nannenga-Bremekamp NE. 1991. A guide to temperate *Myxomycetes*. Biopress Limited. Bristol. 409 pp.

Pérez JM, Camino M. 2000. Riqueza micológica en un sitio natural del Jardín Botánico Nacional. Revista Jard. Bot. Nac. Univ. Habana 21: 133-137.

Schnittler M, Novozhilov Y. 1996. The myxomycetes of boreal woodlands in Russian northern Karelia: a preliminary report. Karstenia 36: 19-40

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The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

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p.258, line 17	*for:* Saber et al. 2000	*read:* Saber & Minassian 2000
p.265, line 6	*for:* species especially	*read:* especially
p.265, line 12	for: *adspersum,*	read: *adspersum*)
p.268, line 32	*ADD:* Saber M. 2002. New records of wood-inhabiting fungi (*Basidiomycetes*) from Iran. 15th Iranian Plant Protection Congress, Kermanshah, Iran.	
p.375, 3rd from bottom	*for:* period wood decay	*read:* poroid wood decay
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From the *Editor-in-Chief*

Mycotaxon 100

It is with great pleasure that the Editors and Editorial Board of Mycotaxon dedicate our century volume to one of its founding co-Editors, Grégoire L. Hennebert. To make this volume special, we include an opening dedication written by our other founder (100: 1–4). Richard P. Korf reminisces over what motivated Grégoire and him to design a mycological journal to expedite the publication of taxonomic papers and briefly traces the history of Mycotaxon from its first 64-page issue, Volume 1(1), published on September 16, 1974 through the current 370-page volume scheduled for a May 2007 release. I have been pleased to direct its transition from a journal prepared exclusively from author-produced hard copy to one now completely digitally prepared. Proud that the current volume contains 48 new names proposed in 45 papers co-written by 121 authors representing 32 different countries, I wonder with Prof. Korf what other changes may be in store for this truly international journal on fungal taxonomy and nomenclature.

Mycotaxon 100 also introduces another visual change. Its front cover bears an illustration taken from Grégoire's thoughtful 1991 paper on the problems with the nomenclature of pleoanamorphic fungi as governed by the frequently controversial Article 59 in the International Code of Botanical Nomenclature. Future volumes will continue to display line drawings on front covers, but each illustration will be chosen from among original figures by authors of papers included within each current volume. Mycotaxon subscription information has been moved to the inside front cover to make room for the Table of Contents that will now begin on the back cover. We hope you are as pleased with these changes are we are.

We are also happy to report that Mycotaxon has — finally — returned to its prompt publication schedule. This Friday afternoon, all editorial correspondence is current and only three manuscripts await final editorial review, all of which will certainly appear in the July–September volume, Mycotaxon 101. Baring unforeseen circumstances, we now anticipate that manuscript turn-around time should rarely exceed 90-days from receipt of the final submission in the Editor-in-Chief's office to publication date, with most manuscript turn-arounds averaging considerably less!

Shaun Pennycook (*Nomenclature Editor*), Cony Decock (*French Language Review Editor*), David Hawksworth (*Book Review Editor*), Karen Gettelman (*Index Editor*), Noni Korf (*Webmaster*), and the *Editorial Advisory Board* (Wen-Ying Zhuang, Don Pfister, Carol Shearer, Shaun Pennycook, Seppo Huhtinen, and Gary Samuels) join Dick and me in wishing Grégoire well and in looking forward to Mycotaxon's next 100 volumes.

Lorelei L. Norvell,
Editor-in-Chief

11 May 2007

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