MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

Volume 96 *April–June 2006*

CONTENTS

[Content continues inside front cover]

ISSN 0093-4666 MYXNAE 96: 1–364 (2006)
For subscription details, availability on microform, and availability of articles as photocopies or tear sheets, see back cover

[Content continued from front cover]

Indices & Information

RECENT BOOKS FROM MYCOTAXON

Prices include surface mail shipment (*for more books see* www.mycotaxon.com/books.html)
Mycotaxon, Ltd., P. O. Box 264, Ithaca, NY 14851-0264, U.S.A.

Fungi of China, by S. C. Teng.

Mycotaxon, Ltd. 1996. Hardbound, xiv + 586 pp., 426 illustrations, map, portrait, index, 8–1/2x11 inches. $79.00.
Airmail price varies by country: enquire. ISBN 0-930845-05-6.
Edited by Richard P. Korf, with a foreword by Teng's daughter, Rosaline Z. Deng.
Proceeds from sales go to the Teng family.

Special for *Mycotaxon* subscribers: deduct $20 from regular price!

What reviewers say about Teng's Fungi of China:

"... one of the most valuable books on the fungi of China ever published in English." —*Mycologia* 90: 1091-1092, 1998.

"... a great big blue uncompromising brick of a book ... an instant classic. Anyone interested in identification of fungi, particularly in Asia, should get this book immediately. Mycology owes another debt to Dick Korf for his sympathetic and intelligent editing of this superb work." —*Bibliography of Systematic Mycology* 10(6): xlviii-xlix. 1998.

"The book is important for any researcher interested in the systematic relationships, diversity, and distribution of fungi on a global scale." - *New Zealand Journal of Botany* 35: 265-266. 1977.

Fungi of Northwestern China, edited by Wen-Ying Zhuang.

Mycotaxon, Ltd. 2005. Hardbound, 430 pp., 26 x 18.5 cm. US$40.00 plus postage. ISBN 0-930845-14-5.
(Please ***order direct*** from Wen-Ying Zhuang, PO Box 2714, Beijing 100080, China; zhuangwy@sun.im.ac.cn).

Some 3887 named species belonging to 759 genera of fungi (slime molds, plasmodiophoromycetes, chytrid, oomycetes, zygomycetes, lichens, non-lichenized ascomycetes, anamorphic fungi, rusts, smuts, and the basidiomycetous macrofungi) hitherto known from Gansu, Ningxia, Qinghai, Shaanxi and Xinjiang, China are listed. Useful references, detailed tropical distribution, and hosts or substrates are provided for each species. *Contributing authors:* Shuang-Lin Chen, Lin Guo, Shou-Yu Guo, Ying-Lan Guo, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Xiao-Qing Zhang,Jian-Yun Zhuang, and Wen-Ying Zhuang.

Higher Fungi of Tropical China, edited by Wen-Ying Zhuang.

Mycotaxon, Ltd. 2001. Cloth bound, 485 pp., 26 x 18.5 cm. US$50.00 plus postage. ISBN 0-930845-13-7.
(Please ***order direct*** from Wen-Ying Zhuang, PO Box 2714, Beijing 100080, China; zhuangwy@sun.im.ac.cn).

Some 5056 named species belonging to 1192 genera of higher fungi hitherto known from tropical China are listed. Useful references, detailed tropical distribution, and hosts or substrates are provided for each species. *Contributing authors:* Lin Gou, Shou-Yu Guo, Ying-Lan Guo, Xiao-Lan Mao, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Zhi-He Yu, Xiao-Qing Zhang, Jian-Yun Zhuang, and Wen-Ying Zhuang.

A Monograph of the Fungus Genus *Cercospora*, by Charles Chupp

Published by the author, Ithaca. 1953. Hardbound, 667 pp. 222 illustrations, octavo, $25.00. Airmail, $45.00
Proceeds from sales go to the Chupp family.
Still a classic after a half century.

Mycotaxon Cumulative Index for Volumes XLI-LX (1991-1996)

Karen D. Gettelman, Richard P. Korf, Susan C. Gruff & Ian F. Korf
Mycotaxon, Ltd. 1998. Softbound, 296 pp., 6x9 inches. $35.00. Airmail, $55.00. ISBN 0-930845-07-2.

Mycotaxon Cumulative Index for Volumes XXI-XL (1984-1991)

Richard P. Korf & Susan C. Gruff
Mycotaxon, Ltd. 1991. Softbound, 352 pp., 6x9 inches. $30.00. Airmail, $50.00. ISBN 0-930845-01-3.

Mycotaxon Cumulative Index for Volumes I-XX (1974-1984)

Richard P. Korf & Susan C. Gruff
Mycotaxon, Ltd. 1984. Softbound, 232 pp., 6x9 inches. $17.50. Airmail, $37.50.
ISBN 0-930845-00-5.

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

Volume 96, 2006

COMPLETE IN ONE VOLUME
CONSISTING OF IV + 364 PAGES INCLUDING FIGURES

EDITOR-IN-CHIEF

ASSOCIATE EDITORS

NOMENCLATURE EDITOR

BOOK REVIEW EDITOR

FRENCH LANGUAGE EDITOR

INDEX EDITOR

EDITORIAL ADVISORY BOARD

Published by
MYCOTAXON, LTD, P. O. BOX 264
Ithaca, NY 14581-0264, USA

www.mycotaxon.com
Printed in the United States of America

MYCOTAXON

VOLUME NINETY-SIX TABLE OF CONTENTS

Indices & Information

PUBLICATION DATE FOR VOLUME NINETY-FIVE

MYCOTAXON *for* JANUARY-MARCH, VOLUME 95 (1–350 + I–VI)
was issued on June 16, 2006

MYCOTAXON

Volume 96, pp. 1–8 *April–June 2006*

The genera *Inocutis* and *Inonotus* (*Hymenochaetales*) in Uruguay

SEBASTIÁN MARTÍNEZ

sebamart@fing.edu.uy
Laboratorio de Micología
Facultad de Ingeniería/ Ciencias, J. Herrera y Reissig 565
11300 Montevideo, Uruguay

Abstract—Species of *Inocutis* and *Inonotus* from Uruguay were studied. *Inocutis texana* comb. nov. and *Inonotus ochroporus* are recorded for the first time from Uruguay and compared with type and representative material. A complete description and illustration of both species are provided. Two species of *Inocutis* and three of *Inonotus* are known from Uruguay. A key for the five species is presented. The homogeneity and validity of the genus *Inocutis* is discussed. Sclerified hyphae from the rudimentary granular core of *Inocutis jamaicensis* is described for the first time.

Key Words—Basidiomycetes, *Inonotus venezuelicus*, polypores, taxonomy, wood-rot

Introduction

The genus *Inonotus* P. Karsten was proposed in 1879 to accommodate species of polypores with a pileate habit and pigmented basidiospores. Later, Donk (1933), emended the genus to encompass all the species with pigmented basidiospores and a brown context, characters present in *I. cuticularis* (Bull.) P. Karst., the type species (Ryvarden 1991). However, the concept of this genus was enlarged to include species with a great variation with regard to habit of the basidiocarp, shape of the basidiospores, type and pigmentation of the spore wall and presence or absence of setae. Characters that remained constant to the expanded species concept include the presence of a brown fibrous context, xanthochroic reaction of the basidiocarp when exposed to KOH or another alkali solution, and a monomitic hyphal system with simple septate hyphae.

Some characters are of limited value for delimiting polypore genera (Ryvarden 1991) and others intergrade with the closely related genus *Phellinus* Quélet. The distinction between the genera was reduced to the mitism of the hyphal system and the consistency and durability of the basidiocarps—dimitic (hard and perennial in *Phellinus*) versus monomitic, (soft and annual) in *Inonotus*. However, intermediate forms exist side by side in both genera (Corner 1991; Fiasson & Niemelä 1984; Gilbertson & Ryvarden 1986, 1987; Larsen & Cobb-Poulle 1990).

There is growing morphological and molecular evidence to indicate that *Inonotus* is not a monophyletic genus. Some authors have divided *Inonotus* s.l. into more natural and smaller genera (Murrill 1904, Fiasson & Niemelä 1984). Fiasson & Niemelä (1984) created *Inocutis* to accommodate the European species of the *Inonotus rheades* group, or *Inonotus* sect. *Phymatopilus* (Donk 1974, Fiasson & Niemelä 1984). Based on the absence of setae and the presence of a marmorate core in the basidiocarps, Fiasson & Niemelä (1984) transferred three European species of this group—*I. dryophilus* (Berk.) Murrill, *I. rheades* (Pers.) P. Karst. and *I. tamaricis* (Pat.) Maire—to *Inocutis*. In addition, these species of *Inocutis* have a unique pattern of pigments and sclerified hyphae in the marmorate core (Fiasson 1982, Gilbertson & Ryvarden 1986, Ryvarden & Gilbertson 1993). Recently, Wagner & Fischer (2001, 2002) showed that *Inocutis* is a well-supported monophyletic genus in the *Hymenochaetales* that encompasses the European *I. rheades* group along with *Inonotus jamaicensis* and *Xanthochrous ludovicianus* Pat., two American species. Gottlieb et al. (2002) arrived at the same conclusion working with internal transcribed spacer sequences.

Inonotus s. l. is poorly studied in Uruguay. Only two species are historically well known—*Inonotus rickii* (Pat.) D. A. Reid, found mainly on *Acer* and *Platanus* in Southern Uruguay (Bettucci & Guerrero 1971), and *I. patouillardii* (Rick) Imazeki, recorded on *Celtis* and *Platanus* (Gazzano 1998). Recently, *Inocutis jamaicensis* was identified as the causal agent of wood-rot and deformation of *Eucalyptus* stems in southeastern and northwestern Uruguay (Martínez 2005); it was misidentified as *I. splitgerberi* (Mont.) Ryvarden earlier (Martínez et al. 2002).

The main objective of the present work is to record for the first time from Uruguay two species of *Inonotus* s.l. recently collected, describe both species, to survey the genus for the country, and to contribute additional data to help circumscribe the genus *Inocutis*.

Materials and Methods

Uruguay specimens were compared with type and representative specimens from four herbaria–BAFC, BPI, MVHC and NY (Holmgren et al. 1990). Microscopic examinations were made from freehand sections mounted in 5% KOH solution and 1% phloxine, in Melzer reagent (IKI), and in 0.5% cotton blue (CB) in 25% lactophenol (Kirk et al. 2001). Species were identified and compared using keys and descriptions from Pegler (1964), Urcelay & Rajchenberg (1999), Gottlieb et al. (2002) and Ryvarden (2004, 2005). Authors of fungal names are according to Kirk and Ansell (1992).

Results

Inocutis jamaicensis (Murrill) A. M. Gottlieb, J. E. Wright & Moncalvo, Myc. Prog. 1: 308. 2002. **Fig. 1.**

Basionym: *Inonotus jamaicensis* Murrill, Bull. Torr. Bot. Club 31: 597. 1904. (NY!)

Descriptions: Gilbertson & Ryvarden (1987), Gottlieb et al. (2002), Martínez (2005), Pegler (1964) and Rajchenberg & Wright (1998).

Remarks: For specimens studied see Martínez (2005). *Inocutis jamaicensis* is widely distributed in the Americas, and is reported to cause stem decay in *Eucalyptus* spp. in Uruguay (Martínez 2005). A character previously unreported is sclerified hyphae that are present in some sections of the context (Figure 1). Although sclerified hyphae are characteristic of the genus *Inocutis*, they are present only in some specimens and are easily

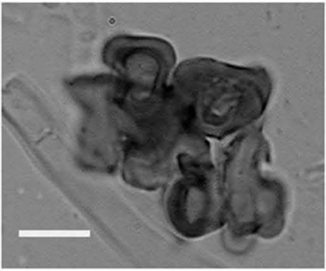


FIGURE1. Microscopical photograph of sclerified hyphae from granular core of *Inocutis jamaicensis*. Scale bar = 10 µm.

broken in squash mounts. Gottlieb et al. (2002) reported the presence of a rudimentary granular core and black lines in the context. These black lines in the context can be easily verified in many specimens studied from Uruguay, but a rudimentary granular core was not observed previously (Martínez 2005). Both characters are correlated with age, habit of the basidiocarp and the way in which the specimens were collected. Most of the Uruguayan specimens come from standing eucalypt trees where the basidiocarps develop in a pileate fashion (Martínez 2005). In older specimens collected with bark, a thin zone of granulose context was observed at the basidiocarp-substrate interface. Sclerified hyphae were observed in the granular core. Thus the habit and age of the specimen has a direct bearing on whether a granular core is present and if sclerified hyphae are observed.

Inocutis texana (Murrill) Seb. Martínez, **comb. nov.** **Fig. 2a-d.**

Basionym: *Inonotus texanus* Murrill, Bull. Torr. Bot. Club 31: 597. 1904. (NY!)

Basidiocarp annual, sessile, nodulose to ungulate, 40–70 x 25–45 x 15–50 mm. Pileus circular, glabrous, concentrically cracking in age, dark brown to almost black in old specimens. Hymenial surface creamish brown to dark yellowish brown. Context corky to fibrous, very thin, up to 5 mm thick, golden brown. Rudimentary granular core present in some specimens. When present, granular core containing sclerified hyphae, with short branches. Tubes brittle, ferruginous brown, up to 45 mm long. Pores irregular, smaller at margin, lacerate, 1-4/mm. Hyphal system monomitic, generative hyphae thin to thick walled, hyaline to reddish brown, 4–9 µm diam., occasionally branched. Contextual hyphae mostly thick walled, yellowish to reddish brown, 4–10 µm diam., ocasionally branched. Tramal and hymenial setae absent. Spores abundant, yellowish to golden reddish, subglobose, smooth, thick-walled, 8,0–9,0 x 6,0–7,0 µm.

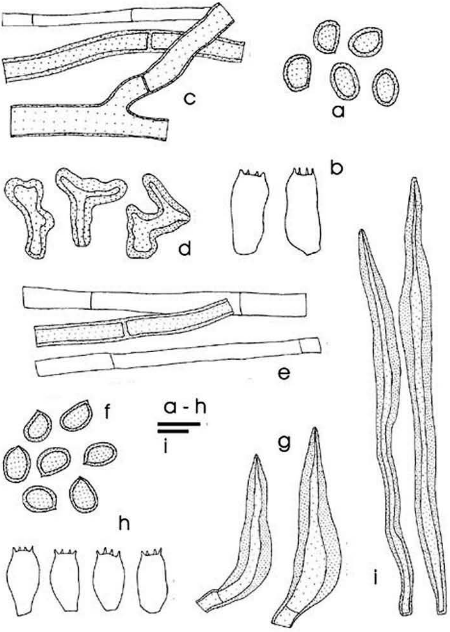


FIGURE 2. Microscopical characters of *Inocutis texana* (a-d) and *Inonotus ochroporus* (e-i). a. basidiospores; b. basidia; c. contextual and tramal hyphae; d. sclerified hyphae (a.-c. from MVHC 5259, d. from Holotype). e. tramal hyphae; f. basidiospores; g. hymenial setae; h. basidia; i. tramal setae. (All from MVHC 5302). Scale bars = 10 µm.

Distribution: Argentina (Urcelay & Rajchenberg 1999, Gottlieb et al. 2002), U.S.A. (Pegler 1964, Gilbertson & Ryvarden 1986), Uruguay.

Substrates: *Acacia, Diostea, Morus, Prosopis, Salix, Schinopsis* (Gottlieb et al. 2002, Gilbertson & Ryvarden 1986, Pegler 1964, Urcelay & Rajchenberg 1999), *Lithraea*.

> **SPECIMENS EXAMINED:** ARGENTINA. La Rioja Río La Carpintería, 1 km antes de Los Molinos, desde el S, on *Acacia furcatispina*, leg. O. Di Iorio, I-2001 (BAFC50971). Catamarca: San Pablo, Dpto. de Capayán, leg. V. Suárez & A. Gottlieb #53, 22-III-1995 (BAFC33667). Santiago del Estero: Dpto. Copo, Reserva de Copo, leg. J. Protomastro, III-1986 (BAFC30686). San Luis, Carpintería, on *Prosopis* sp., leg. O. Herrera, IV-1971 (BAFC50287).- **URUGUAY. Dpto. Lavalleja:** Minas, Paraje Campanero, on *Lithraea* sp., leg. G. Pérez, 18-IV-2003. (MVHC5259).- **USA. Texas:** Austin. on mesquite?, leg. Underwood, 24-XI-1891 (*Inonotus texanus*, Holotype NY!).

Remarks: This is the first report of *I. texana* for Uruguay. This species is well known from southwestern U.S.A. on *Acacia* sp. and *Prosopis* sp. (*Fabaceae*) (Gilbertson & Ryvarden 1986). Recently, Urcelay & Rajchenberg (1999) recorded this species from Argentina on *Acacia* sp., *Prosopis* sp. and *Schinopsis* sp. (*Anacardiaceae*) and Gottlieb et al. (2002) added *Diostea* sp. (*Verbenaceae*) to the host species. The Uruguayan collection is on *Lithraea* sp. (*Anacardiaceae*), and thus is able to collect this species on other substrata.

Gilbertson & Ryvarden (1986) observed a well developed granular core in this species, although Urcelay & Rajchenberg (1999) and Gottlieb et al. (2002) recorded only a rudimentary granular core in specimens from Argentina. A granular core was not observed in the Uruguayan specimen studied for it is composed of small fragments of a very young basidiocarp. The holotype is composed of small and blackened fragments with segments of different texture in the context. Under the microscope, sclerified hyphae were seen that were identical to those described by Gilbertson & Ryvarden (1986) (Figure 2d.). Sclerified hyphae were observed in some of the Argentinean specimens, but were absent in the Uruguayan specimen. Because *I. texana* shares with *I. jamaicensis* a similar hyphal system, granular core with sclerified hyphae, lack of setae, and spore type, its transfer to *Inocutis* is justified.

Inonotus ochroporus (Van der Byl) Pegler, Trans. Brit. Mycol. Soc. 47(2): 183. 1964.

Fig. 2e-i.

Basionym: *Polyporus ochroporus* Van der Byl., S. Afr. J. Sci. 18: 269. 1922.

Basidiocarp annual, dimidiate, sessile, 55–140 x 35–80 x 15–50 mm. Pileus circular, applanate to ungulate, single, glabrous, azonate, rusty brown to dark brown. Hymenial surface ochraceus to dark brown, blackish and radially cracked in old specimens. Context fibrous, soft, dark golden brown to chocolate brown, up to 30 mm thick. Tubes darker, up to 45 mm long. Pores irregular to angular, lacerated, 4-6/mm. Margin rounded to blunt. Hyphal system monomitic, generative hyphae thin-walled to thick-walled, hyaline to yellowish brown, 4–7 µm in diameter. Contextual hyphae thick-walled, dark reddish brown, 8–10 µm in diameter. Tramal setae brown, straight, lanceolate, mostly parallel to the tubes, 100–180 x 8–15 µm. Hymenial setae rare, ventricose, 20–50 x 8–12 µm. Basidia subglobose to clavate, 12–18 x 6–8 µm. Spores ellipsoid, thick-walled, yellowish, 7,5–9 x 5,5–7 µm.

Distribution: Argentina (Gottlieb et al., 2002), Eastern Africa: Kenya, Tanzania, Uganda (Ryvarden & Johansen 1980), South Africa, West Pakistan (Pegler 1964), Uruguay.

Substrates: *Casuarina, Ficus, Lithraea, Salix* (Gottlieb et al., 2002, Pegler 1964).

> **SPECIMENS EXAMINED:** ARGENTINA. CORRIENTES: Dpto. Capital, Riachuelo, leg. Schinini & Cristóbal 12169, 27-VI-1974 (BAFC 50291). CHACO: San Bernardo, on *Casuarina cunninghamiana*, leg. Di Iorio (det. J. Wright & E. Blanchet), V-1995 (BAFC 33722). SAN LUIS: Merlo, on *Lithraea ternifolia*, leg. C. Urcelay, XI-1998 (BAFC ex CORD). URUGUAY: DPTO. LAVALLEJA: Establecimiento "Santa Clara", on living *Lithraea* sp., leg. S. Simeto & S. Martínez, 5-XI-2003 (MVHC 5302, 5303).

Remarks: This is the first record of *I. ochroporus* for Uruguay. *I. ochroporus* is similar to *I. patouillardii*, also present in Uruguay, but this last species has smaller spores measuring 5,0-7,0 x 3,5-5,0 µm (Gilbertson & Ryvarden 1987). *I. ochroporus* is also reminiscent of *I. quercustris* M Blackw. & Gilb. The holotype of *I. quercustris* (M. Blackwell 1511 from BPI) differs in having slightly larger spores, absence of hymenial setae, and presence of conspicuous contextual hyphae with irregular wall thickening (see also Blackwell & Gilbertson 1985).

Inonotus venezuelicus Ryvarden, Mycotaxon 28: 529. 1987.

> **SPECIMEN EXAMINED:** VENEZUELA. EDO. MÉRIDA: Laguna Negra, E. of Laguna Mucubaji, Parq. Nac. Sierra Nevada, near Apartaderos, on *Polylepis* sp., leg. K.P. Dumont, J.H. Haines, G.J. Samuels & A. Revas (Dumont-VE 2300), det. L. Ryvarden, 18-VII-1971 (isotype NY).

Remarks: A complete description of this species is available in Ryvarden (1987, 2004). *Inonotus venezuelicus* was treated as a synonym of *I. jamaicensis* by Gottlieb et al. (2002). The isotype is a resupinate specimen, and although Ryvarden (1987, 2004) indicated the spore dimensions as 5,0-6,0 x 4,5-5,0 µm, my measurements (n=30) are 5,8-7,5 x 4,6-5,8 µm, slightly larger than those of *I. jamaicensis*. Thus, I believe this is a distinct species in the complex. Since only the type material is known, additional collections are needed to better characterize this species.

Key to the known species of *Inocutis* and *Inonotus* in Uruguay

1a. Setae present in context and hymenium, granular core and sclerified hyphae absent .... (***Inonotus***) 2

1b. Setae lacking in context and hymenium, rudimentary granular core with sclerified hyphae present .... (***Inocutis***) 4

2a. (1a) Chlamydospores present, basidiospores 6–8 x 4,5–7 µm ...... ***Inonotus rickii***

2b. (1a) Chlamydospores absent 3

3a. (2b) Basidiospores ovoid 7,5–9,0 x 5,5–7,0 µm .... ***Inonotus ochroporus***

3b. (2b) Basidiospores ellipsoid 5,0–7,0 x 3,5–5,0 µm .... ***Inonotus patouillardii***

4a. (1b) Basidiocarps effusse-reflexed to triquetrous, basidiospores 5,5–7,0 x 4–5 µm .... ***Inocutis jamaicensis***

4b. (1b) Basidiocarps dimidiate to ungulate, basidiospores 8,0–9,0 x 6,0–7,0 µm .... ***Inocutis texana***

Discussion

The genus *Inonotus* s.l. is poorly known in Uruguay with only two common species—*I. rickii* and *I. patouillardii*—reported for the country until recently/now. The genus has gained importance due to the great economic losses suffered by commercial *Eucalyptus* forests recently shown to be caused by *Inocutis jamaicensis* (Martínez 2005). The current intensive search to identify other species of *Inonotus* s.l. producing stem or wood rot of native or introduced trees of economic importance resulted in two new records for Uruguay: *Inonotus ochroporus* and *Inocutis texana*.

The genus *Inocutis* is well supported in molecular phylogenetic studies (Wagner & Fischer 2002, Gottlieb et al. 2002). Morphologically, the genus is characterized by sclerified hyphae in the context and a contextual granular core (although these structures were not observed in all the specimens studied) (Wagner & Fischer 2002). The genus also has a characteristic pigment pattern (Fiasson 1982).

This work reports for the first time the presence of sclerified hyphae in *I. jamaicensis*. Gilbertson & Ryvarden (1986) previously reported sclerified hyphae in *I. texana*. Because of its similarity to *I. jamaicensis* and the *Inocutis rheades* group, including the absence of setae, presence of a rudimentary granular core, presence of sclerified hyphae in the granular core and type of basidiospores, *I. texanus* is here transferred to *Inocutis*.

Acknowledgements

Dr. Karen Nakasone (Forest Products Laboratory, Madison, U.S.A.) and Dr. Mario Rajchenberg (CIEFAP, Chubut, Argentina) served as pre-submission reviewers. Specimens and information used in this study were loaned or put at my disposal by the curators of the following herbaria: BAFC, BPI and NY. Dra. Lina Bettucci (Montevideo, Uruguay) has suggested many improvements in a previous draft. Eufores SA and Proyecto PDT SC/OP/07/01 financially supported this work.

Literature cited

Bettucci L, Guerrero RT. 1971. Hongos xilófagos: Estudio de cultivos. Boletín de la Facultad de Agronomía (Montevideo) 118: 1-40.

Blackwell M, Gilbertson RL. 1985. A new species of *Inonotus* (*Aphyllophorales*, *Hymenochaetaceae*) on oak in Louisiana. Mycotaxon 23: 285-290.

Corner EJH. 1991. Ad Polyporaceas VII. The xanthochroic polypores. Nova Hedwigia. Heft 101. J Cramer: Berlin, Stuttgart (Germany). 175 pp

Donk MA. 1933. Revision der niederländischen Homobasidiomycetae - *Aphyllophoraceae* II. Mededeelingen van het Botanisch Museum en Herbarium van de Rijks universiteit te Utrecht, 277p.

Donk MA. 1974. Check list of European Polypores. North Holland Publ. Co. Amsterdam, London, 469p.

Fiasson JL. 1982. Distribution of styrylpyrones in the basidiocarps of various *Hymenochaetaceae*. Biochemical Systematics and Ecology 10(4): 289-296.

Fiasson JL, Niemelä T. 1984. The *Hymenochaetales*: a revision of the European poroid taxa. Karstenia 24: 14-28.

Gazzano S. 1998. Notas sobre Basidiomycetes xilófilos del Uruguay. VIII. Registro de *Aphyllophorales* y sus sustratos arbóreos. Comunicaciones Botánicas del Museo de Historia Natural de Montevideo VI(109): 1-12.

Gilbertson RL, Ryvarden L. 1986. North American Polypores Vol. I. Fungiflora: Oslo (Norway). 433 pp

Gilbertson RL, Ryvarden L. 1987. North American Polypores Vol. II. Fungiflora: Oslo (Norway). 452 pp

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

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum part I. Herbaria of the world. 8th. edn. Regnum Vegetabile 120. New York Botanical Garden, New York. (http://www.nybg.org/bsci/ih/)

Kirk PM, Ansell AE. 1992. Authors of Fungal Names. Index of Fungi Supplement. CAB International: Wallingford (United Kingdom).

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi 9th Ed.. CAB International: Oxon (United Kingdom). 655 pp

Larsen MJ, Cobb-Poulle LA. 1990. *Phellinus* (*Hymenochaetaceae*). A survey of the world taxa. Synopsis Fungorum 3. Fungiflora: Oslo (Norway). 206 pp

Martínez S. 2005. *Inocutis jamaicensis*, the causal agent of eucalypt stem rot in Uruguay. Mycotaxon 91: 165-171.

Martínez S, Lupo S, Bettucci L. 2002. *Inonotus splitbergeri* (Mont.) Ryv. a stem pathogen of *Eucalyptus globulus* in Uruguay. Revista Brasileira de Fitopatologia 27: 420.

Murrill WA. 1904. The *Polyporaceae* of North America-IX. *Inonotus*, *Sesia* and monotypic genera. Bulletin of the Torrey Botanical Club 31: 593-610.

Overholts LO. 1953. The *Polyporaceae* of the United States, Alaska and Canada. Univ. Michigan Press: Ann Arbor (USA). 466 pp

Pegler DN. 1964. A survey of the genus *Inonotus* (*Polyporaceae*). Transactions of the British Mycological Society 47(2): 175-195.

Rajchenberg M, Wright JE. 1998. Two interesting polypore species *(Hymenochaetales)* from Argentina. Folia Cryptogamica Estonica 33: 119-122.

Ryvarden L. 1987. New and noteworthy Polypores from tropical America. Mycotaxon 28(2): 525-541.

Ryvarden L. 1991. Genera of Polypores. Nomenclature and Taxonomy. Synopsis Fungorum 5. Fungiflora: Oslo (Norway). 363 pp

Ryvarden L. 2004. Neotropical Polypores part 1. Synopsis Fungorum 19. Fungiflora: Oslo (Norway). 229 pp

Ryvarden L. 2005. The genus *Inonotus*, a synopsis. Synopsis Fungorum 21. Fungiflora: Oslo (Norway). 149 pp

Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora: Oslo (Norway). 636 pp

Ryvarden L, Gilbertson RL. 1993. European Polypores. Part 1. Synopsis Fungorum 6. Fungiflora: Oslo (Norway). 387 pp

Urcelay C, Rajchenberg M. 1999. Two North American *Inonotus* (*Hymenochaetaceae*, *Aphyllophorales*) found in Argentina. Mycotaxon 72: 417-422.

Wagner T, Fischer M. 2001. Natural groups and a revised system for the European poroid *Hymenochaetales* (Basidiomycota) supported by nLSU rDNA sequence data. Mycological Research 105: 773-782.

Wagner T, Fischer M. 2002. Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetic relationships of allied genera. Mycologia 94: 998-1016.

MYCOTAXON

Volume 96, pp. 9–12 April–June 2006

A new species and a new record of smut fungi from Northwestern China

SHENGRONG WANG[1] & CUIYUN ZENG[2]

[1] *wangsr@gsau.edu.cn* & [2] *zengcy@st.gsau.edu.cn*
Department of Plant Pathology, College of Grassland
Gansu Agricultural University, Lanzhou 730070, China

Abstract—A new species, *Thecaphora oxytropis* on *Oxytropis ochrocephala*, and a new record, *Urocystis irregularis* on a new host plant, *Aconitum carmichaelii*, are reported from Northwestern China.

Key words—*Ustilaginales*, taxonomy

During a mycological expedition to Tianzhu County of Gansu Province in Northwestern China in 2005, several interesting smut fungi were collected. Among them the authors identified a previously unknown species of *Thecaphora* on *Oxytropis ochrocephala*. According to Vánky (1991), eleven species of *Thecaphora* have been reported on *Leguminosae* world wide. None of them is on *Oxytropis*.

The authors compared the spore balls of the unknown *Thecaphora* sp. with those of other known species of *Thecaphora* on *Leguminosae*. Because no smut fungus known on Leguminosae has spore balls similar to those found on *Oxytropis ochrocephala*, we conclude that *Thecaphora* sp. on *Oxytropis* is a new species, and describe it as follows:

Thecaphora oxytropis S.R. Wang, sp. nov. **Figs. 1-3**

> *Sori in seminibus transformatis, in locum massa glomerulorum sporarum colore pallide brunnea, granuloso-pulverea substituens. Glomeruli sporarum globosi, ellipsoidei vel leviter irregulares, 32.5-47.5 × 38.0-54.5 µm, e sporis 4-21(-31) sat laxe connectis compositi. Sporae subpolyhedraliter irregulares, cuneiformis usque ellipsoidei, 16.5-22.0 × 14.0-17.0µm, pallide brunneas, pariete in locis contactus levi, in locis liberibus superficiei rotundato et verrucoso.*

Sori in seeds filling the pods with a light-brown, granular-powdery mass of spore balls. Spore balls globose, subglobose, ovoid, ellipsoidal or slightly irregular, 32.5-47.5 × 38.0-54.5 µm, composed of 4-21(-31) easily separating ustilospores. Ustilospores subpolyhedral, cuneiform, ovoid, ellipsoidal, polyhedral or slightly irregular, 16.5-22.0 × 14.0-17.0µm, yellowish to light yellowish-brown, wall smooth on the contact surfaces, coarsely and irregularly verrucose on the free surface. Germination unknown.

> On *Oxytropis ochrocephala* Bunge (*Leguminosae*), China, Gansu: Tianzhu County, Zhuaxi, alt. ca. 3100 m, 20 VIII 2005, coll. S.R. Wang & C.Y. Zeng, GAU 05011 (holotypus), HUV 21285 (isotypus). Known only from the type collection.

Thecaphora oxytropis and *T. hedysari* Vánky have loose spore balls, but they differ in that the former has smaller spore balls and fewer spores in a ball.

A species of *Urocystis* on *Aconitum carmichaelii* was also collected by the authors. After examination it turned out to be *Urocystis irregularis*. According to Vánky (1994), on *Aconitum* only one species of *Urocystis* is known, *U. irregularis*, occurring in Europe, Asia, and North America. It has not yet been reported from China nor anywhere previously on *A. carmichaelii* (Ling 1953, Guo 2000a,b, 2003, Guo & Zhang 2004, Guo & Wang 2005, Wang & Piepenbring 2002, Wang & Guo 2002, Vánky & Guo 1985, Kakishima et al. 2000). Thus, the collection represents a new record for China on a new host plant:

Urocystis irregularis (G. Winter) Săvul. Bul. Şti. Acad. Rep. Populare Române 3:220, 1951. Figs.4-6

= *U. sorosporioides* f. *irregularis* G. Winter, Hedwigia 19:2, 1880.

Sori on the abaxial side of leaves, on petioles and stems forming pustules, sometimes confluent, or in the veins as long swellings, at first covered by the epidermis subsequently rupturing to expose the black, powdery mass of spore balls. Spore balls subglobose to irregular, 26.0-37.5 × 21.0-28.5 µm in diam., composed of 1-6 ustilospores, surrounded by an incomplete layer of peripheral sterile cells. Spores subglobose, elongated, irregular to slightly polyhedral, 13.5-18.0 × 9.5-13.0 µm in diam., olive-brown to yellowish-brown, smooth or slightly granular, with irregular small thickenings on the free surface. Sterile cells globose, subglobose, ovoid to irregular, 8.5-12.0 × 4.0-8.5 µm, light yellowish-brown, smooth, hyaline.

On *Aconitum carmichaelii* Debeaux (*Ranunculaceae*), China, Gansu: Tianzhu County, Tanshanling, alt. ca. 2890 m, 18 VIII 2005, coll. S.R. Wang & C.Y. Zeng. GAU 05015.

Acknowledgements

The authors would like to express their deep thanks to Dr. K. Turkington and Dr. D.J. Bing from Agriculture and Agri-Food Canada (Lacombe, Canada) for reading the manuscript and improving the English, to Dr. K. Vánky (Tübingen, Germany) and Prof. M. Piepenbring (Frankfurt/M, Germany) for reading the manuscript and serving as pre-submission reviewers, to Fang Qiangen for identifying the host plants, to Xu Changlin for assistance in the field collection, and to Xu Bing and He Dongyun for assistance in the laboratory experiments. This research was partly supported by the Gansu Natural Science Foundation (No. ZR-97-041; No. 4RS045-A65-038).

Literature Cited

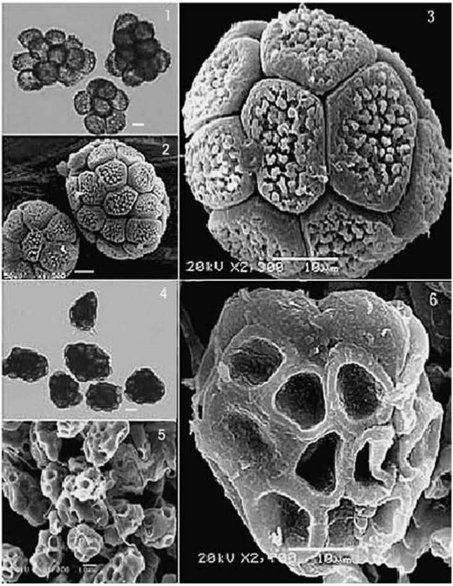
Guo L. 2000a. Flora Fungorum Sinicorum, *Ustilaginaceae* Vol. 12, Science Press, Beijing. 1-124.

Guo L. 2000b. *Sporisorium pollinianum*, a smut species new to China. Mycosystema 19(3): 420-421.

Guo L. 2003. Smut fungi in Qinghai. Mycosystema 22 (Suppl): 112-116.

Guo L, Zhang HC. 2004. A new species and two new records of Ustilaginomycetes from China. Mycotaxon 90: 387-390.

Guo L, Wang SR. 2005. A new species and a new record of *Anthracoidea* (*Ustilaginales*) from China. Mycotaxon 93: 159-162



Figs. 1-3. *Thecaphora oxytropis* on *Oxytropis ochrocephala* (holotypus). Fig. 1. Spore balls as seen by LM (light microscopy;). Fig. 2. Spore balls as seen by SEM (scanning electron microscopy). Fig. 3. Spore ball as seen by SEM. Figs. 4-6. *Urocystis irregularis* on *Aconitum carmichaelii* (GAU 05015). Fig. 4. Spore balls as seen by LM. Fig. 5. Spore balls as seen by SEM. Fig. 6. A spore ball as seen by SEM Bars = 10 µm

Kakishima M, Denchev CM, Zhou X, Zang M. 2000. Smut fungi from Yunnan province, China, collected in 1998. Bull. Nat. Sci. Mus., Tokyo, Ser. B, 26: 23-34.

Ling L. 1953. The *Ustilaginales* of China. Farlowia 4: 305-351.

Săvulescu T.1951. Noutăti din micoflora R.P. Române. Bul.Şti.Acad. Rep. Populare Române 3:211-227

Vánky K. 1991. *Thecaphora* (*Ustilaginales*) on *Leguminosae*. Trans. Mycol. Soc. Japan 32: 145-159.

Vánky K. 1994. European Smut Fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York. 1-570.

Vánky K, Guo L. 1985. *Ustilaginales* from China. Acta Mycologica Sinica 5(Suppl): 234-235.

Wang SR, Piepenbring M. 2002. New species and new records of smut fungi from China. Mycological Progress 1(4): 399-418.

Wang SR, Guo L. 2002. A new record of smut fungi from China. Mycosystema 21(3): 452-453.

Winter G. 1880. Mycologische Notizen. Hedwigia 19:1-4.

MYCOTAXON

Volume 96, pp. 13–19 *April–June 2006*

Additional and interesting lichenized and lichenicolous fungi from Turkey

MEHMET GÖKHAN HALICI*

mghalici@erciyes.edu.tr
Biology Department, Faculty of Science & Art, Erciyes University
Kayseri, Turkey

MUSTAFA KOCAKAYA

kocakaya38@mynet.com
Ahmet Gazi Ayhan Bulvarı, Kazımkarabekir Mah
Silvan Geçidi No:24 Kayseri,Turkey

AHMET AKSOY

aksoy@erciyes.edu.tr
Biology Department, Faculty of Science & Art, Erciyes University
Kayseri, Turkey

Abstract—14 species of lichenized and lichenicolous fungi are reported from the Turkish provinces of Kayseri, Niğde, Adana, Yozgat and Muğla. Nine taxa, *Anisomeridium viridescens*, *Cercidospora epicarphinea*, *Lichenodiplis lecanorae*, *Lichenothelia convexa*, *Pilophorus cereolus*, *Porpidia superba*, *Sagediopsis campsteriana*, *Toninia verrucarioides* and *Zwackhiomyces sphinctrinoides* are new for Turkey. Comments on habitat and substrata and a short description are provided for each taxon.

Key words—Ascomycota, conidial fungi, lichens

Introduction

Serious lichenology in Turkey started in last two decades. A total of 360 papers actually refer to lichens from Turkey (John 2004). If floristic, these mostly focus on the lichens of the Black Sea region (e.g. John & Breuss 2004, Yıldız et al. 2002, Yazıcı 1999, Özdemir Türk 1997) and the Mediterranean region (e.g. John 2003, John & Nimis 1998, Nimis & John 1998, John, 1996), but there have been few lichenological studies in Central Anatolia (e.g. Halıcı et al. 2005, Karabulut & Türk 1998, Özdemir 1991). This contribution reports further species as first records for Turkey or the province of Kayseri, Muğla or Yozgat.

Materials and Methods

The specimens on which this paper is based are all preserved in the herbarium of Erciyes University, Biology Department, Science & Art Faculty, Kayseri, Turkey. The accession numbers of the collections are given in parentheses after the locality details.

The specimens were first examined with a dissecting microscope, and then with an Olympus BH2 microscope fitted with Nomarski differential interference contrast. Specimens were examined in water, 10% KOH, Lugols iodine solution or lactofuchsin. Spore measurements were generally made in KOH, but in the case of thin walled spores these were also checked in water.

Species recorded

Anisomeridium viridescens (Coppins) R.C. Harris

A detailed description is provided by Purvis et al. (1992: 92, as *Arthopyrenia viridescens*).

The Turkish specimen was collected from bark of *Cedrus libani* associated with *Caloplaca cerina* var. *cerina* and *C. flavorubescens* in ancient woodland. The thallus is lichenized with *Trentopohlia*. Ascomata are perithecia, involucrellum brown, K + green. Asci 8-spored. Ascospores colourless, 1-septate, the cells usually biguttulate, 12.5-14.5 x 4-5 µm.

New record for Turkey. Known also from the British Isles on smooth bark of *Corylus* in old woodlands (Purvis et al. 1992).

> KAYSERI: Yahyalı, Aladağlar Milli Parkı, Hacer Ormanları, 37°48.152' N, 35° 16.870' E, alt. 1690 m, on bark of *Cedrus libani*, 20 Sep.2004, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth (MGH 0.2275).

Bacidia laurocerasi (Delise ex Duby) Zahlbr.

A detailed description is provided by Purvis et al. (1992: 107).

The Turkish specimen was collected from the bark of *Pinus nigra* growing with macrolichens such as *Anaptychia ciliaris*, *Bryoria fuscescens* and *Parmeliopsis ambigua* in ancient woodland. Thallus very thin. Apothecia ~ 1 mm; numerous, blackish. Asci 8-spored. Ascospores 30-38 x 3-4 µm, 8- to 13-septate at maturity, acicular.

In Turkey, previously recorded from Muğla (John 1996, Nimis & John 1998) and Sakarya (Szatala 1927 as *B. endoleuca*). New record for Kayseri province.

Known also from the British Isles, Europe, North America, Australia and New Zealand on ± basic or nutrient rich bark of trunks and branches of trees and shrubs, usually in open situations or secondary woodland (Purvis et al. 1992).

> KAYSERI: Yahyalı, Aladağlar Milli Parkı, Hacer Ormanları, 37° 47.935' N, 35° 18.136' E, alt. 1648 m, on bark of *Pinus nigra*, 20 Sep.2004, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth (MGH 0.2276).

Buellia erubescens Arnold

A detailed description is provided by Purvis et al. (1992: 113).

The Turkish specimen, collected from ± smooth bark of *Abies* in ancient woodland, was associated with *Parmelina pastillifera*, *Anaptychia ciliaris* and *Lecidella elaeochroma*. Thallus thin; whitish, K + red, PD + orange, C -. Apothecia ~ 1 mm, heavily pruinose when young. Asci 8-spored. Ascospores first colourless, then brown, 2-celled; 12.5-15 x 5.6-7.5 µm.

Previously recorded from six provinces in Turkey (John & Nimis 1998, Huneck et al. 1992, Yıldız & John 2002, John & Breuss 2004, Steiner 1909, Özdemir 1990), sometimes as *B. zahlbruckneri*. New record for Kayseri province.

Known also from the British Isles, western and central Europe, the Azores and North America, on ± smooth bark (Purvis et al. 1992).

> KAYSERI: Yahyalı, Aladağlar Milli Parkı, Hacer Ormanları, 37° 47.935' N, 35° 18.136' E, alt. 1648 m, on bark of *Abies*, 20 Sep.2004, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth (MGH 0.2277).

Cercidospora epicarphinea (Nyl.) Grube & Hafellner

A detailed description is provided by Grube & Hafellner (1990).

The Turkish specimen grows on the apothecia of an unidentified *Caloplaca* sp. and appears to suppress ascospore production in the host. Interascal tissues (hamathecium) present. Perithecia immersed, 150-180 µm diam, peridial wall blue-green. Asci 8-spored. Ascospores 16.5-20 x 4.5-6 µm, 1-septate, colourless.

New record for Turkey. Known also from Spain and Canary Islands on *Caloplaca carphinea* and *C. scoriophila* (Grube & Hafellner 1990).

> KAYSERI: Erciyes Mountain, Exit of Hisarcık, Western part of the highway, 38°36' N, 35° 30' E, alt. 1540 m, on the apothecia of *Caloplaca* sp. on siliceous rocks, 25 Aug.2002, leg. M. G. Halıcı & M. Kocakaya, det. D. L. Hawksworth (MGH 0.2278).

Leptorhaphis atomaria (Ach.) Szatala

A detailed description is provided by Aguirre-Hudson (1991: 99).

The Turkish specimen, collected from the bark of *Populus nigra*, was associated with *Lecanora albella*. Thallus smooth, very thin; weakly lichenized with *Trentopohlia*. Asci 8-spored; ascospores arranged in two bundles in the asci, colourless, 1-septate, filiform, crescent shaped, 20-22 x 2.5-4 µm.

Previously recorded from İstanbul by Steiner (1889). New record for Kayseri province.

Widespread in temperate regions of Europe on bark of *Fraxinus excelsior* and also particularly on species of *Populus*, growing on the trunk, often mixed with lichens such as *Xanthoria parietina* and species of *Caloplaca* and *Lecanora*; perhaps facultatively lichenized with trentepohlioid algae or not, it has also been mentioned from Northern America (Aguirre-Hudson 1991).

> KAYSERI: Yahyalı, Aladağlar Milli Parkı, Hacer Ormanları, 37° 47.935' N, 35° 18.136' E, alt. 1648 m, on bark of *Populus nigra*, 20 Sep.2004, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth (MGH 0.2279).

Lichenodiplis lecanorae (Vouaux) Dyko & D. Hawksw.

A detailed description is provided by Hawksworth (1981).

The Turkish specimen, on the apothecia of *Caloplaca holocarpa*, was collected from the bark of *Populus nigra*; it seems to be commensalistic as there was no damage to the thallus, and ascospore production was not suppressed. Conidia pale brown to dark brown, arising singly, 1-septate, 4.5-5 x 2-2.5 µm diam.

Commensalistic to parasitic on the apothecia, and more rarely the thalli, of *Caloplaca*, *Lecanora* and *Pertusaria* species, also on thalli of *Evernia prunastri*, *Lecidea erratica* and *Schismatomma decolorans*.

New record for Turkey. Widespread in Europe, the former U.S.S.R, and also known from Morocco (Hawksworth 1981).

> KAYSERI: Yahyalı, Aladağlar Milli Parkı, Hacer Ormanları, 37° 47.906' N, 35° 17.889' E, alt. 1595 m, on the apothecia of *Caloplaca holocarpa* on bark of *Populus nigra*, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth, (MGH 0.2280).

Lichenostigma maureri Hafellner

A detailed description is provided by Hafellner (1982).

The Turkish specimens, on *Usnea subfloridana* and *Pseudevernia furfuracea*, were collected from *Pinus sylvestris*. Commensalistic, since no damage observed in the host thallus. Ascomata internal structure paraplectenchymatic stromatic, non-aggregated. Ascospores brown, echinulate, upper cell wider; 10 x 5 µm.

Previously recorded from Turkey by Hafellner (1982). New record for Muğla and Yozgat provinces.

Known also from Spain, the Canary Islands and Great Britain on *Usnea* species and *Pseudevernia furfuracea* (Hafellner 1982, Hawksworth 1982).

> MUĞLA: Yaraş Village, Picnic Area of Yaraş Forest (20 km to the city center), 37° 09.128' N, 28° 29.918' E, alt. 750 m, on *Pseudevernia furfuracea* on *Pinus sylvestris*, 23 Aug.2004, leg. M. G. Halıcı & M. Kocakaya, det. D. L. Hawksworth, (MGH 0.2289).
>
> YOZGAT: Akdağmaden District, Between Büyük Nalbant Mountain and Kızılkoca Village, Çat Ormanları, 39° 30' N, 35° 59' E, alt. 1780 m, on *Usnea subfloridana* on *Pinus sylvestris*, leg. M. G. Halıcı & M. Kocakaya, det. D. L. Hawksworth, (MGH 0.2281).

Lichenothelia convexa Henssen

A detailed description is provided by Purvis et al. (1992: 359-360).

The Turkish specimen was collected from bare rock and sometimes on *Aspicilia caesiocinerea*. This material lacked ascospores, but has macroconidia, 10-20 µm diam., agreeing with those illustrated and described by Hennsen (1987).

New record for Turkey. Known also from the British Isles, Germany, Sweden and North America on slate, intermixed with *Rhizocarpon geographicum* thalli, and on sarsens (Purvis et al., 1992).

> ADANA: Aladağlar Milli Parkı, Turhasan Mountain, 37° 45.280' N, 35° 18.028' E, alt. 2000 m, on bare siliceous rocks and *Aspicilia caesiocinerea*, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth, (MGH 0.2282).

Pilophorus cereolus (Ach.) Th.Fr.

Detailed descriptions are provided by Jahns (1981) and Brodo et al. (2001).

The Turkish specimen was collected on calcareous soil. Primary thallus greyish, sorediate. No apothecia. Thallus and soralia K + yellow, PD -.

New record for Turkey. Known also from many localities in Europe and North America on weathered rocks or soil (Jahns, 1981, Brodo et al. 2001).

> Niğde: Çamardı, Aladağlar Milli Parkı, Entrance of Demirkazık, 37° 51.050' N, 35° 07.100' E, alt. 1900 m, on calcareous soil, 29 Aug.2005, leg. M. G. Halıcı & M. Kocakaya, det. D. L. Hawksworth, (MGH 0.2283).

Porpidia superba (Körb.) Hertel & Knoph

A detailed description is provided by Gowan & Ahti (1993: 69).

The Turkish specimen was collected from calcareous rocks. Thallus cream-white, thick, forming knob-like bullae, K-, C-. Apothecial disks brown, concave, heavily pruinose. True exciple well developed, black. Asci 8-spored. Ascospores colourless, simple; 15-22 x 9-10 µm.

New record for Turkey. Known also from Finland, Great Britain and Russia on calcareous and also on siliceous rocks, particularly schists (Gowan & Ahti 1993).

> Kayseri: Yahyalı, Aladağlar Milli Parkı, Delikkaya, 37° 54.948' N, 35° 15.506' E, alt. 2910 m, on calcareous rock, 3 Oct.2004, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth, (MGH 0.2284).

Rhizocarpon simillimum (Anzi) Lettau

A detailed description is provided by Purvis et al. (1992: 541).

The Turkish specimen was collected from siliceous rocks. Thallus dark grey, areolate; areoles bullate. Asci 8-spored, ascospores brown, 1-septate; 12-13 x 6-7 µm.

In Turkey, previously recorded from Mudanya (Verseghy 1982). New record for Kayseri province.

Known also from the British Isles and Norway on sunny, acid, ± vertical outcrops (Purvis et al. 1992).

> Kayseri: Erciyes Mountain, North of Perikartın (Northern slope of Erciyes Mountain), 38° 35' N, 35° 27' E, alt. 2300 m, on siliceous rock, 3 Oct.2004, leg. M. G. Halıcı & M. Kocakaya, det. D. L. Hawksworth, (MGH 0.2285).

Sagediopsis campsteriana (Linds.) D. Hawksw. & R. Sant.

A detailed description is provided by Triebel (1993).

The Turkish specimen, on *Aspicilia desertorum*, was collected from calcareous rocks. Ascomata perithecia, arising singly, immersed at the base and appearing largely superficial, black, not shiny, 100-250 µm diam; ostiolate, the ostiole not papilliform or raised in any way. Asci elongate-clavate, bitunicate in structure, discharge not seen, thickened at the apex, about 65-70 x 11-13 µm, 8-spored. Ascospores overlapping and distichously arranged in the ascus, broadly fusiform, apices generally somewhat attenuated towards the apices but occasionally more rounded, colourless, (1-)3-septate, not constricted at the septum, the cells often with conspicuous rounded vacuoles, smooth walled, lacking a defined gelatinous sheath, 12-21 x 4.5-7 µm, l/b ratio 2-3.5.

New record for Turkey. Known also from Europe and North America on several *Ochrolechia* species and *Lecanora hagenii* (Triebel 1993).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Gökoluk Mevkii, Dedegediği geçidi, 37°55.392' N, 35° 17.376' E, alt. 2430 m, on *Aspicilia desertorum* on calcareous rocks, 2 Aug.2005, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth, (MGH 0.2286).

Toninia verrucarioides (Nyl.) Timdal

A detailed description is provided by Timdal (1991: 117).

The Turkish specimen was collected from calcareous rocks in a shaded habitat in a forest. Thallus squamulose. Asci 8-spored. Ascospores colourless, ellipsoid to bacilliform, 1- to 3-septate; 9.5-15 x 4-5 µm.

New record for Turkey. Known from temperate and arctic parts of Europe and North America on calciferous rocks, usually in fissures but also on smooth faces or on soil-covered rock (Timdal 1991).

MUĞLA: Yaraş Village, Picnic Area of Yaraş Forest (20 km to the city center), 37°09.128' N, 28° 29.918' E, alt. 750 m, on calcareous rock, 23 Aug.2004, leg. M. G. Halıcı & M. Kocakaya, det. D. L. Hawksworth, (MGH 0.2287).

Zwackhiomyces sphinctrinoides (Zwackh) Grube & Hafellner

A detailed description is provided by Grube & Hafellner (1990).

The Turkish specimen, on *Xanthoria elegans*, was collected from calcareous rocks. Ascomata perithecia; pyriform, 150-250(-270) µm diam; peridial wall brown with basal cells paler than the upper ones. Asci 8- spored. Ascospores colourless, 1-septate, verruculose, 18-20 x 6.5-9 µm.

New record for Turkey. Widespread in Great Britain and Spain on *Collema* species, *Clauzadea metzleri, Leptogium turgidum, Caloplaca variabilis, Solenopsora olivacea* and other calcicolous lichens (Grube & Hafellner 1990).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Gökoluk Mevkii, Dedegediği geçidi, 37°55.392' N, 35° 17.376' E, alt. 2430 m, on *Xanthoria elegans* on calcareous rocks, leg. M. G. Halıcı & A. Aksoy, det. D. L. Hawksworth, (MGH 0.2286).

Acknowledgements

We are grateful to Prof. David L. Hawksworth for the identification of the specimens, reviewing a draft of this paper, and for opening his laboratory, files and library to the first author. Dr Volker John and Prof. Mark R.D. Seaward are thanked for critically reviewing the paper and for most helpful suggestions for its improvement. This study was partly supported by TÜBİTAK.

Literature Cited

Aguirre-Hudson B. 1991. A taxonomic study of the species referred to the ascomycete genus *Leptorhaphis*, Bull. Br. Mus. Nat. Hist. (Bot.) 21(2): 85-192.

Brodo M, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. New Haven, Yale University Press.

Gowan SP, Ahti T. 1993. Status of the lichen genus Porpidia in eastern Fennoscandia. Ann. Bot. Fennici 30: 53-75.

Grube M, Hafellner J. 1990. Studien an flechtenbewohnenden Pilzen der Sammelgattung *Didymella* (Ascomycetes, *Dothideales*). Nova Hedwigia 51: 283-360.

Hafellner J. 1982. Studien über lichenicole Pilze und Flechten II. *Lichenostigma maureri* gen. et spec. nov. ein in der Ostalpen haufiger lichenicoler Pilz (Ascomycetes, Arthoniales). Herzogia 6: 299-308.

Halıcı MG, John V, Aksoy A. 2005. Lichens of Erciyes Mountain (Kayseri, Turkey). Fl. Medit. 15: 567-580.

Hawksworth DL. 1981. The lichenicolous coelomycetes. Bull. Br. Mus. nat. Hist., Bot. 9: 1-98.

Hawksworth DL. 1982. Notes on British lichenicolous fungi IV. Notes R. bot. Gdn Edinb. 40: 375-397.

Huneck S, John V, Jakupovic J, Elix JA. 1992. Zur Chemie einiger Strauch- und Krustenflechten aus der Türkei. Herzogia 9: 489-492.

Jahns HM. 1981. The genus *Pilophorus*. Mycotaxon 13: 289-330.

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

John V, Nimis PL. 1998. Lichen flora of Amanos Mountain and the province of Hatay. Tr. J. of Botany 22: 257-267.

John V. 2003. Flechten aus der Türkei, von G.Ernst gesammelt, Herzogia 16: 167-171.

John V. 2004. Lichenological studies in Turkey and their relevance to environmental interpretation.- Abstract book, XI OPTIMA meeting, 5.-11.9.2004 Belgrad: 45.

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

Karabulut F, Özdemir Türk A. 1998. Lichens of the Akşehir District (Konya), Tr. J. of Botany 22: 191-198.

Nimis PL, John V. 1998. A Contribution to the Lichen Flora of Mediterranean Turkey. Cryptogamie, Bryol. Lichénol. 19(1): 35-58.

Özdemir A. 1991. Eskişehir İli Likenleri. Tr. J. of Botany 15: 189-196.

Özdemir Türk A. 1997. A study on the lichen flora of Sinop and Kastamonu provinces. J. Fac. of Sci. Ege Univ. 20: 221-229.

Steiner J. 1899. Flechten. In: Fritisch C., Beitrag zur Flora von Konstantinopel. I. Kryptogamen, Denkschr.k. Akad. Wiss.,math-naturw.Cl. Wien 48: 222-238.

Steiner J. 1909. Lichenes. In: Handel-Mazetti DHF von.: Ergebnisse einer bott. Reise in d. Pontische Randgebirge im Sandschak Trapezunt, etc.- Annal. Naturhist. Hofmus. Wien 23: 107-123.

Szatala Ö. 1927. Lichenes Turcicae asiaticae a patre Prof. Stefano selinka in insula Burgas Adassi (Antigoni) lecti. Magy. Bot Lapok 26: 18-22.

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

Timdal E. 1991. A monograph of the genus *Toninia* (Lecideaceae, Ascomycetes). Opera Botanica 110: 1-137.

Triebel D. 1993. Notes on the genus Sagediopsis (Verrucariales, Adelococcaceae). Sendtnera 1: 273-280.

Verseghy KP. 1982. Beitrage zur Kenntnis der türkischen Flechtenflora. Studia Botanica Hungarica 16: 53-65.

Yazıcı K. 1999. Lichen flora of Trabzon. Tr. J. of Botany 23: 97-112.

Yıldız A, John V, Yurdakulol E. 2002. Lichens from the Çangal Mountains (Sinop, Turkey). Cryptogamie, Mycologie 23(1): 81-88.

MYCOTAXON

Volume 96, pp. 21–29 April–June 2006

Four species of *Exobasidium* from Korea

JI-HYUN PARK[1], KYUNG-HEE KIM[2]*,
KYUNG-JOON LEE[1] & SEUNG-KYU LEE[2]

[1]*Department of Forest Sciences, Seoul National University*
Seoul 151-921, Korea

**kyung624@foa.go.kr*
[2]*Department of Forest Environment, Korea Forest Research Institute*
Seoul 130-712, Korea

Abstract—Four species of *Exobasidium* collected in Korea are reported with descriptions and host plants. They are *E. dubium, E. yoshinagai, E. japonicum* and *E. cylindrosporum*. Of these, *E. dubium, E. yoshinagai* and *E. cylindrosporum* are newly added to the fungus flora of Korea.

Key words—Exobasidium diseases, *Rhododendron*

Introduction

The genus *Exobasidium* belongs to Basidiomycota and contains more than 100 described taxa (Alexopoulos et al. 1996, Nagao et al. 2004a). They are all plant pathogens causing leaf galls, blight, blisters, witches' broom, dwarfing or abnormal bud proliferation in field trees and ornamentals (Coyier & Roane 1986; Ing 1998, 1999). The fungus flora in Korea is still very poorly known and has not been investigated in many regions of the country. In some phytopathological papers (cf. Korean Society of Plant Pathology 2004), two *Exobasidium* species parasitic on three host plants were listed and additional one unidentified species was recorded to be associated with leaf galls on *Rhododendron schlippenbachii*. Therefore, mycological studies for the Korean *Exobasidium* spp. are urgently needed for diagnosis of the diseases and precise identification of the fungus. In the present paper we described morphological characteristics and host plants of four *Exobasidium* species based on specimens collected in Korea.

Materials and Methods

The materials listed in the present paper were collected from May to June, 2004 and were deposited in KFRI (Korea Forest Research Institute). Identification of each fungus was based on microscopic as well as cultural characteristics. Leaves with newly sporulating lesions were cut into small pieces and fixed to the inside of the lid of a

---

*Corresponding author.

sterile Petri dish, poured with potato dextrose agar (PDA) acidified with 10% (v/v) lactic acid. The dish was kept at 23°C in the dark. The lid of the Petri dish was turned at two hours intervals. Basidiospores then fell down from the hymenium onto the agar surface. After microscopic examination, basidiospore was isolated from the dish, and 18 isolates were transferred to new PDA dishes for further growth. The cultures were incubated in an unlighted room at 23°C. Slides were prepared on Shear's mounting fluid for morphological observation under light microscope. JSM-5410LV SEM was used for the observation of basidia and sterigmata. Additional anatomical observations using paraffin infiltration method were conducted to study the comparative anatomy of infected areas by *Exobasidium* species. Ezuka (1974a, b, 1990a, b, 1991a, b, 1992a, b, c), Ito (1955), Karatygin (2000), Karatygin & Huseyin (2002), Nannfeldt (1981), Nagao et al. (2001, 2003a, b, 2004a, b), Otani (1976), Sundström (1964) and Zhang et al. (1995) were consulted to aid in species identification.

Descriptions

1. *Exobasidium dubium* Racib., Kosmos 34: 1172 (1909). Fig. 1

Description: Germ tubes of the basidiospores emergent from both end cells at first then from each septal regions; conidia produced at the tip of germ tubes or laterally, budding to produce daughter cells polarly, developing into hyphae; colonies on PDA growing gradually, to a maximum 7 mm diam. in 21-day incubations, gelatinous, fixed on the agar surface, composed of branching and intricate hyphae, pseudohyphae and conidia; surface yellowish white to pale yellow, corrugate in center, not farinose by conidial formation; dark pigmentation absent.

Basidia 17-31 x 5.5-10.0 µm, clavate to cylindrical, apices obtuse, (2-)3-4(-5)-spored, directly emergent from the host surface or through stomata, not fasciculate; sterigmata 3-7 µm long, 1.5-2.0 µm diam. at the base, outwardly emergent, tapering toward the tip; basidiospores 13-23 x 3.3-8.0 µm, subcylindric to musiform, straight to slightly curved, becoming slender in center and septal regions, hyaline, smooth, unicellular when formed, becoming 1-4(-5)-septate when germinating; conidia 5-15 x 1.3-3.6 µm, linear, acicular, sometimes 1-septate.

Symptomatic Characteristics: Flat lesions on leaves, up to 15 mm across, usually 1 to 5 lesions on one leaf, circular to irregular in outline, sometimes confluent to develop larger, pale yellow to yellow above, becoming reddish or brownish in center, sometimes with conspicuous red margin above; the lower leaf surface of the infected area eventually with a thin white layer of hymenium; mycelial mat localized between the lower epidermis and the first layer of spongy mesophyll; infected parts not thickened; hypertrophy and hyperplasia absent.

Habitat: On living leaves of *Rhododendron yedoense* f. *poukhanense* (H. Lév.) M. Sugim. and *R. yedoense* Maxim. f. *yedoense*.

> Specimens Examined: On *R. y.* f. *poukhanense*, KFRI2237, 2238, 2239, 2240, 2241, 2242 (3 June, 2004, Seoul), KFRI2243, 2244, 2245, 2246 (5 June, 2004, Pocheon-si), KFRI2247 (24 June, 2004, Seoul); On *R. y.* f. *yedoense*, KFRI2248 (3 June, 2004, Seoul), KFRI2249 (24 June, 2004, Seoul).

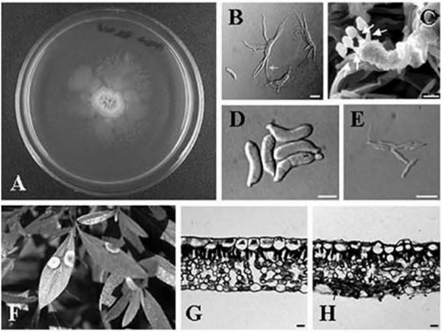


Fig. 1. *Exobasidium dubium*. A. A colony on PDA, 16 weeks, KFRI2244. B. Germination of basidiospores on PDA, Arrow shows a long germ tube, KFRI2237. C. A basidium with four immature basidiospores, Arrows show sterigmata, KFRI 2243. D. Three basidiospores before septation and two spores becoming 3-septate, KFRI2249. E. Conidia, KFRI2249. F. Flat lesions with conspicuous red margin on adaxial leaf surface in a naturally infected host. G. A cross section of healthy part of infected leaf, KFRI2249. H. A cross section of infected part, Arrows show mycelial mats in abaxial side, KFRI2249. Scale bars: B = 10 µm, C = 5 µm, D–E = 10 µm, G–H = 20 µm.

Notes: This is the first record on this species in Korea. This fungus was recorded on *R. luteum* from Europe and on *Rhododendron* sp. from Turkey (Nannfeldt 1981, Karatygin & Huseyin 2002). Recently, Nagao et al. (2003a) discussed this fungus on leaves of *R. y.* f. *yedoense* in Japan. The present study adds *R. y.* f. *poukhanense* and *R. y.* f. *yedoense* as new host records to Korea. Although the Korean specimens did not show colonies with pale pink described by Nagao et al. (2003a), the other taxonomic characteristics of this species are in close agreement with the previous records.

2. ***Exobasidium yoshinagai*** Henn., Bot. Jahrb. 31: 736 (1902). Fig. 2

Description: Germ tubes of the basidiospores emergent from each cell, developing into long and branched hyphae; conidia produced at the tip of germ tubes or laterally, budding to produce daughter cells polarly, developing into hyphae; colonies on PDA growing gradually, to a maximum 4 mm diam. in 21-day incubations, gelatinous, fixed on the agar surface, composed of branching and intricate hyphae, pseudohyphae and conidia; surface yellowish white, slightly corrugate in center, not farinose by conidial formation; dark pigmentation absent.

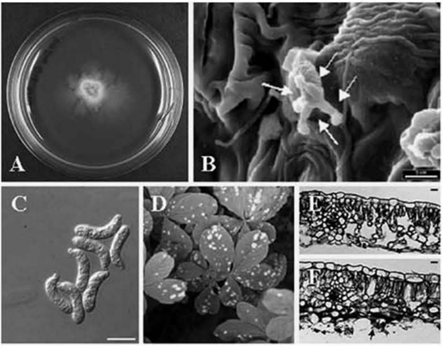


Fig. 2. *Exobasidium yoshinagai*. A. A colony on PDA, 16 weeks, KFRI2250. B. A basidium with four immature basidiospores, Arrows show sterigmata, KFRI2252. C. Strongly geniculate basidiospores towards the hilum before septation, KFRI2252. D. Flat lesions without conspicuous red margin on adaxial leaf surface in a naturally infected host. E. A cross section of healthy part of infected leaf, KFRI2250. F. A cross section of infected part, Arrows show mycelial mats in abaxial side, KFRI2250. Scale bars: B = 5 µm, C = 10 µm, E–F = 20 µm.

Basidia 20-34 x 5.4-9.1 µm, clavate to cylindrical, apices obtuse, 2-4-spored, directly emergent from the host surface or through stomata, not fasciculate; sterigmata 3-8 µm long, 1.5-2.1 µm diam. at the base, outwardly emergent, tapering toward the tip; basidiospores 13-22 x 4.2-6.5 µm, cylindrical, slightly curved, strongly geniculate towards the hilum, hyaline, smooth, unicellular when formed, becoming (1-)3-septate when germinating; conidia 5-10 x 1.4-2.9 µm, linear to acicular.

SYMPTOMATIC CHARACTERISTICS: Flat lesions on leaves, up to 49 lesions under 5 mm across on one leaf, sometimes 1 to 4 lesions ranging from 7 to 14 mm across on one leaf, circular in outline, sometimes confluent to develop larger, pale yellow to yellow above, without conspicuous margin above; the lower leaf surface of the infected area eventually with a thin white layer of hymenium; mycelial mats localized in the abaxial side of the lesions; infected parts not thickened; hypertrophy and hyperplasia absent.

HABITAT: On living leaves of *Rhododendron schlippenbachii* Maxim.

SPECIMENS EXAMINED: On *R. schlippenbachii*, KFRI2250, 2251 (3 June, 2004, Seoul), KFRI2252 (5 June, 2004, Pocheon-si).

Notes: Earlier literature (Ezuka 1991a) gave relatively long measurements of basidia, in the range of 50-70 µm. In the Korean materials, they are much shorter (20-34 µm). It may be due to the different criteria for measurement of the length of basidia that develop from mycelium beneath the epidermis. In addition, Ezuka (1991a) commented that the number of leaf lesions by this fungus was under ten on one leaf, but *E. yoshinagai* was occasionally found to form abundant small lesions (under 5 mm) on one leaf of *R. schlippenbachii* in this study. The other characteristics of taxonomic value match well each other. This is the first record on the fungus in Korea. Ezuka (1974a, 1991a) reported this species as a causal agent of the leaf blisters of *R. dilatatum*, *R. kiyosumense*, *R. reticulatum*, *R. wadanum*, *R. viscistylum* var. *glaucum* and *R. weyrichii* from Japan. *Rhododendron schlippenbachii* was recognized as a new host record to Korea.

3. *Exobasidium japonicum* Shirai, Bot. Mag. Tokyo 10: 52-53 (1896). Fig. 3

Description: Germ tubes of the basidiospores emergent from both polar cells, sometimes from septal regions; conidia produced at the tip of germ tubes or laterally, budding to produce daughter cells polarly, developing into hyphae; colonies on PDA growing gradually, to a maximum 8 mm diam. in 21-day incubations, sometimes heaping up to form a mound, gelatinous, fixed on the agar surface, composed of branching and intricate hyphae, pseudohyphae and conidia; surface pastel yellow to pale yellow but sometimes pale orange or pale red to greyish red, slightly corrugate around the center, sometimes farinose by conidial formation; sometimes dark pigmentation present.

Basidia 29-50 x 3.5-8.5 µm, clavate to cylindrical, apices obtuse, 2-4-spored, directly emergent from the host surface or through stomata; sterigmata 3-7 µm long, 1.5-3.0 µm diam. at the base, outwardly emergent, tapering toward the tip; basidiospores 10-19 x 3.0-5.9 µm, musiform, straight to slightly curved, hyaline, smooth, unicellular when formed, becoming 1(-2)-septate when germinating; conidia 6-15 x 1.2-2.0 µm, linear.

Symptomatic Characteristics: Pocket like depressions in leaves, concave above and convex below, 1 to 5 galls on one leaf, sometimes covering the entire leaf, light green above, sometimes becoming reddish; both adaxial surface and abaxial surface of the infected area eventually covered with white powdery hymenium; mycelial mats located under both epidermal layers; infected parts 2-9 times thicker than healthy parts; hypertrophy and hyperplasia occurred; cell differentiation absent in the infected tissues except for the epidermis and vascular bundle; cell contents lost in the infected parts.

Habitat: On living leaves of *Rhododendron yedoense* f. *poukhanense* and *R. yedoense* f. *yedoense*.

> Specimens Examined: On *R. y.* f. *poukhanense*, KFRI2253, 2254, 2255 (3 June, 2004, Seoul), KFRI2256 (5 June, 2004, Pocheon-si); On *R. y.* f. *yedoense*, KFRI2257, 2258 (3 June, 2004, Seoul), KFRI2259 (5 June, 2004, Pocheon-si), KFRI2260 (24 June, 2004, Seoul).

Notes: Chung et al. (1977) and Korean Society of Plant Protection (1986) listed this fungus in Korea without morphological description on *R. schlippenbachii* and *R. mucronulatum*, respectively. However, *R. schlippenbachii* and *R. mucronulatum* have wrongly been identified as hosts of *E. japonicum* instead of *R. y.* f. *poukhanense* in Korea. There is no *Exobasidium* species causing such pocket-like leaf galls on those species and

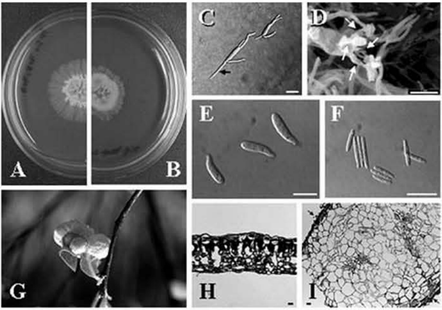


Fig. 3. *Exobasidium japonicum*. A. A colony on PDA, 16 weeks, KFRI2256. B. A colony on PDA exuding dark pigment, 16 weeks, KFRI2260. C. Basidiospore germination of mycelial type on PDA, Arrow shows a long germ tube, KFRI2255. D. A Basidium with four immature basidiospores, Arrows show sterigmata, KFRI2260. E. Musiform basidiospores before septation, KFRI2256. F. Conidia, KFRI2256. G. Pocket-like depressions on a naturally infected host. H. A cross section of healthy part of infected leaf, KFRI2260. I. A cross section of infected part with hypertrophy and hyperplasia, Arrows show mycelial mats in both adaxial and abaxial sides, KFRI2260.

Scale bars: C = 10 µm, D = 5 µm, E–F = 10 µm, H = 20 µm, I = 40 µm.

related sections, *Sciadorhodion* and *Rhodorastum*. Therefore, this fungus is considered as a new record in Korea. The Korean materials have shorter basidia than those of previous records (Ito 1955, Nannfeldt 1981, Ezuka 1990b). Nannfeldt (1981) commented that infected parts were eventually hymenium-clad and chalky white on the morphological underside. However, white hymenium-clad occurred on both sides of leaf galls in Ezuka's study and present study. The other characteristics of taxonomic value for this species are generally in agreement with the previous records. *R. indicum*, *R. kaempferi*, *R. lateritium*, *R. linearifolium*, *R. mucronatum*, *R. obtusum*, *R. pulchrum*, and *R. simsii* were reported from Japan and Europe (Ito 1955, Nannfeldt 1981, Ezuka 1990b). *R. y.* f. *poukhanense* and *R. y.* f. *yedoense* were recognized as new hosts to Korea.

4. *Exobasidium cylindrosporum* Ezuka, Trans. Mycol. Soc. Japan 31: 451 (1990). Fig. 4

DESCRIPTION: Germ tubes of the basidiospores emergent from each cell, small and short; conidia produced at the tip of germ tubes, budding to produce daughter cells polarly; colonies on PDA growing gradually, to a maximum 11 mm diam. in 21-day incubations, gelatinous, fixed on the agar surface, composed of hyphae and conidia; surface white to orange white, corrugate narrowly around the center; dark pigmentation absent.

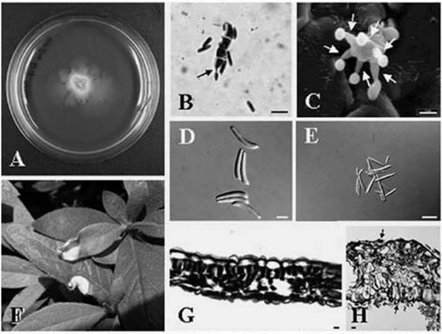


Fig. 4. *Exobasidium cylindrosporum,* KFRI2261. A. A colony on PDA, 16 weeks. B. Basidiospore germination of conidial type on PDA, Arrow shows a short germ tube. C. A basidium with six immature basidiospores, Arrows show sterigmata. D. Long and slenderly musiform basidiospores before septation. E. Conidia. F. Shallow leaf depressions on a naturally infected host. G. A cross section of healthy part of infected leaf. H. A cross section of infected part in which hypertrophy without hyperplasia occurred, Arrows show mycelial mats in both adaxial and abaxial sides.

Scale bars: B = 10 μm, C = 3 μm, D = 10 μm, E = 10 μm, G–H = 20 μm.

Basidia 20-36 x 5.0-6.9 μm, clavate to cylindrical, apices obtuse, 4-6-spored, directly emergent from the host surface or through stomata; sterigmata 4-6 μm long, 1.7-2.7 μm diam. at the base, outwardly emergent, tapering toward the tip; basidiospores 19-24 x 2.9-4.8 μm, slenderly and long cylindrical, slightly curved, hyaline, smooth, unicellular when formed, becoming 1-3-septate when germinating; conidia 7-21 x 1.7-2.6 μm, linear.

Symptomatic Characteristics: Shallow depressions on leaves, 4 to 11 mm diam. across, with red margin above, usually concave above and convex below, mostly circular in outline, sometimes confluent to develop larger and irregular distortion; 1 to 3 shallow depressions on one leaf; both adaxial and abaxial sides of leaf galls eventually covered with white powdery hymenium; mycelial mats concentrated under both epidermal layers; infected parts 3-7 times thicker than healthy parts; hypertrophy occurred without hyperplasia; cell differentiation absent in the infected tissues except for the epidermis and vascular bundle; cell contents lost in the infected parts.

Habitat: On living leaves of *Rhododendron tashiroi* Maxim.

Specimens Examined: On *R. tashiroi*, KFRI2261 (16 June, 2004, Suwon-si).

NOTES: This is the first record on the fungus in Korea. The Korean collection is in general in accordance with the description by Ezuka (1990b) except for the basidia that were measured longer in the literature. This fungus was recorded from Japan on leaves of *R. hortense, R. macrosepalum, R. mucronatum* and *R. oomurasaki* (Ezuka 1974b, 1990b). The present study adds *Rhododendron tashiroi* as a new host in Korea.

Acknowledgements

The authors express sincere thanks to Dr. Makoto Kakishima at University of Tsukuba, Japan, and Dr. Igor V. Karatygin at Komarov Botanical Institute of Russian Academy Sciences, for critical comments on the manuscript and for acting as pre-submission reviewers.

Literature cited

Alexopoulos CJ, Mims CW, Blackwell M. 1996. Introductory Mycology. 4th edition. John Wiley & Sons, Inc.: New York (USA). 869 pp.

Chung BJ, Lee YH, Lee EK. 1977. Survey on the occurrence of plant diseases in some important agricultural crops. Res. Rep. Plant Prot. Res. and Train. 7: 21. (in Korean).

Coyier DL, Roane MK. 1986. Compendium of rhododendron and azalea diseases. APS press: St. Paul, MN (USA). 88 pp.

Ezuka A. 1974a. A taxonomic examination of *Exobasidium* in Japan. Ann. Phytopath. Soc. Japan 40(2): 147.

Ezuka A. 1974b. A taxonomic examination of *Exobasidium* in Japan. Ann. Phytopath. Soc. Japan 40(3): 185-186.

Ezuka A. 1990a. Notes on some species of *Exobasidium* in Japan (I). Trans. Mycol. Soc. Japan 31: 375-388.

Ezuka A. 1990b. Notes on some species of *Exobasidium* in Japan (II). Trans. Mycol. Soc. Japan 31: 439-455.

Ezuka A. 1991a. Notes on some species of *Exobasidium* in Japan (III). Trans. Mycol. Soc. Japan 32: 71-86.

Ezuka A. 1991b. Notes on some species of *Exobasidium* in Japan (IV). Trans. Mycol. Soc. Japan 32: 169-185.

Ezuka A. 1992a. *Exobasidium* species in Japan (1). Forest Pests 41(1): 3-9.

Ezuka A. 1992b. *Exobasidium* species in Japan (2). Forest Pests 41(2): 2-9.

Ezuka A. 1992c. *Exobasidium* species in Japan (3). Forest Pests 41(3): 2-9.

Ing B. 1998. *Exobasidium* in the British Isles. The Mycologist 12(2): 80-82.

Ing B. 1999. *Exobasidium* in Scotland. Bot. J. Scotl. 51(2): 221-225.

Ito S. 1955. Mycological flora of Japan. Vol II. Yokendo: Tokyo (Japan). 450 pp.

Karatygin IV. 2000. Order *Exobasidiales*: position in class Ustilaginomycetes and key for the identification of species from genus *Exobasidium*. Mikologiia I Fitopathologiia 34(6): 23-31.

Karatygin IV, Huseyin E. 2002. A rare species from the genus *Exobasidium* on *Rhododendron*. Mikologiia I Fitopathologiia 36(4): 13-15.

Korean Society of Plant Pathology. 2004. List of plant diseases in Korea. 4th edition. Jeong-haeng Pub. Co.: Seoul (Korea). 779 pp.

Korean Society of Plant Protection. 1986. A list of plant diseases, insect pests, and weeds in Korea. 2nd edition. Korean Society of Plant Protection: Seoul (Korea). 633 pp. (in Korean).

Nagao H, Ezuka A, Ohkubo H, Kakishima M. 2001. A new species of *Exobasidium* causing witches' broom on *Rhododendron wadanum*. Mycoscience 42: 549-554.

Nagao H, Akimoto M, Kishi K, Ezuka A, Kakishima M. 2003a. *Exobasidium dubium* and *E. miyabei* sp. nov. causing Exobasidium leaf blisters on *Rhododendron* spp. in Japan. Mycoscience 44: 1-9.

Nagao H, Ogawa S, Sato T, Kakishima M. 2003b. *Exobasidium symploci-japonicae* var. *carpogenum* var. nov. causing Exobasidium fruit deformation on *Symplocos lucida* in Japan. Mycoscience 44: 369-375.

Nagao H, Sato T, Kakishima M. 2004a. Three species of *Exobasidium* causing Exobasidium leaf blight on subgenus *Hymenanthes*, *Rhododendron* spp., in Japan. Mycoscience 45: 85-95.

Nagao H, Kurogi S, Sato T, Kakishima M. 2004b. Taxonomy of *Exobasidium otanianum* causing Exobasidium leaf blight on *Rhododendron* species in Japan. Mycoscience 45: 245-250.

Nannfeldt JA. 1981. *Exobasidium*, a taxonomic reassessment applied to the European species. Symb. Bot. Upsal. 23(2): 1–72.

Otani Y. 1976. A new species of *Exobasidium* collected in Iriomote-island, Okinawa. Trans. Mycol. Soc. Japan 17: 355-357.

Sundström KR. 1964. Studies of the physiology, morphology and serology of *Exobasidium*. Symb. Bot. Upsal. 18: 1-89.

Zhang X, Arai K, Sakoda T, Iwai H. 1995. A new variety of *Exobasidium otanianum* isolated from *Rhododendron dilatatum* var. *satsumense*. Trans. Mycol. Soc. Japan 36: 97–102.

MYCOTAXON

Volume 96, pp. 31–39 *April–June 2006*

Annulate *Pluteus* species, a study of the genus *Chamaeota* in the United States

ANDREW M. MINNIS[1*], WALTER J. SUNDBERG[1], ANDREW S. METHVEN[2], SEDONIA D. SIPES[1], & DANIEL L. NICKRENT[1]

[*]drew3@siu.edu

[1]Department of Plant Biology, Southern Illinois University at Carbondale
Carbondale, IL USA 62901-6509

[2]Department of Biological Sciences, Eastern Illinois University
Charleston IL 61920-3099

Abstract—*Chamaeota* is a rare agaric genus traditionally classified in the *Pluteaceae*. The present work offers a treatment of the two species described from the United States. Historical records, morphological and anatomical examinations of type and other collections, and molecular data from nuclear LSU rDNA sequences were studied. Typifications of *Annularia mammillata* and *A. sphaerospora* are offered for nomenclatural stability. *Chamaeota sphaerospora* is synonymized with *C. mammillata* and the new combination *Pluteus mammillatus* is proposed.

Key words—*Agaricales*, taxonomy, *Hispidoderma*, lectotype, epitype

Introduction

The genus *Chamaeota* (W.G. Sm.) Earle, typified by *C. xanthogramma* (Ces.) Earle, a poorly known fungus, is typically classified in the *Pluteaceae* Kotl. & Pouzar (Singer 1986) because the better known species have pink basidiospores, free lamellae, a convergent lamellar trama, and an annulus. The genus shares the first three characters with *Pluteus* Fr. and *Volvariella* Speg., the other members of the family, but differs in the last (Singer 1986). Recent molecular evidence, however, suggests that *Pluteus* and *Volvariella* together do not form a clade (Moncalvo et al. 2002). The relationship of *Chamaeota* to other agarics and its potential use as an outgroup for *Pluteus* was unknown.

Chamaeota is a small genus consisting of approximately ten species worldwide. Species of *Chamaeota* have been infrequently reported in the United States from a limited number of sites (Longyear 1902, Peck 1906, Murrill 1917, Murrill 1943, Kauffman 1918, Beardslee 1939). Species delineation remains unclear and several authors (Kauffman 1918, Beardslee 1939, Murrill 1943, Singer 1978) have commented on the need to clarify the range of variation and boundaries of individual species. Two species, *Chamaeota sphaerospora* and *Chamaeota mammillata* are the only species originally described from the United States. Their interpretation is made difficult by the lack of explicitly designated type specimens. The present paper is offered to address these problems in the United States.

Materials and methods

Molecular Study

Genomic DNA was isolated from the *ASM 7916* collection identified by classical morphology and anatomy as *C. sphaerospora* using a version of the method described by Nickrent (1994) scaled down to use less material. Universal primers routinely used in Vilgalys' laboratory at Duke University (http://www.biology.duke.edu/fungi/mycolab/primers.htm) were employed to amplify (5.8SR, LR7) and to obtain (LR5, LR16, LROR, LR3R) a partial nuclear LSU rDNA sequence using standard protocols. The resulting sequence was subsequently aligned manually to the LSU sequence alignment used in the analysis of Moncalvo et al. (2002). A heuristic parsimony analysis similar to that of Moncalvo et al. (2002) was performed to place the sequence on a fungal tree (results not shown). The above analysis placed the sequence within a *Pluteus* clade. A reduced dataset containing 21 taxa was constructed to demonstrate the position of *Chamaeota* within the *Pluteus* clade. *Limacella illinita* (Fr.) Maire, *Volvariella volvacea* (Bull.) Singer, and *Auricularia polytricha* (Mont.) Sacc. were chosen as outgroup taxa because of their positions outside of the *Pluteus* clade. A branch-and-bound analysis was performed with the following parameters: gaps treated as missing data, multistate taxa interpreted as uncertainty, addition sequence furthest, branches collapsed if maximum branch length is zero, MulTrees option in effect, characters weighted using the Moncalvo et al. (2002) stepmatrix. Branch robustness was evaluated with 1000 bootstrap replications using identical search parameters.

Morphological & anatomical study

Fresh collections identified as *Chamaeota sphaerospora* were made, documented, and preserved with standard methods (Smith 1949). Color terms are from Kornerup and Wanscher (1978). Standard techniques were used to prepare material for anatomical study (Smith 1949, Largent et al. 1977). Dried material was wetted with 95% ethanol for 1 min, soaked in water for 1 min, blotted to remove excess water, and sectioned by hand. Material was mounted and viewed in 3% KOH or Melzer's reagent. Basidiospore dimensions of the newly designated lectotype of *Annularia sphaerospora* are based on observation of 30 basidiospores. All other microscopic dimensions are based on observation of at least 10 structures. Length to width ratios are reported as Q. Mean values for length, width, and Q are designated as L^m, W^m, and Q^m respectively. Anatomical data for the lectotype of *A. sphaerospora* are presented separately in the species description because of the importance of this collection. Data from other specimens are presented as a composite description under "**additional data**" where they add to or differ from the type material and original circumscription. Herbarium acronyms are from Holmgren and Holmgren (1998 onwards).

Results

The nuclear LSU rDNA dataset analyzed included 781 characters. Of these, 74 were parsimony-informative. The maximum parsimony analysis produced one shortest tree of 990.3 steps (Fig. 1). The consistency (CI), homoplasy (HI), retention (RI), and rescaled consistency (RC) indices were 0.7157, 0.2843, 0.7698, and 0.5509, respectively.

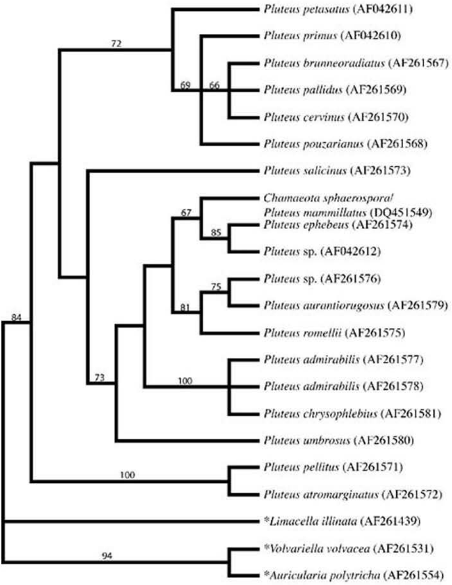


Fig. 1. The single most parsimonious tree based on partial nuclear LSU rDNA sequences. Bootstrap values greater than 50% are indicated above branches. Genbank accession numbers for each sample are shown. All sequences originated in the Moncalvo et al. (2002) study except *Pluteus* sp. (AF042612) from Moncalvo et al. (2000) and *Chamaeota sphaerospora*/*Pluteus mammillatus* from this work. Asterisks denote outgroup taxa.

Pluteus forms a clade (84% BS) with the sequence of the *ASM 7916* collection of *C. sphaerospora* embedded within it. There is moderate bootstrap support (67% BS) for a sister relationship of the *ASM 7916* sequence to the *P. ephebeus* clade.

Typification

Chamaeota mammillata (Longyear) Murrill, N. Amer. Fl. 10: 139. 1917.

≡ *Annularia mammillata* Longyear, Rep. Mich. Acad. Sci. 3: 59. 1902. Type: Pl. I, Fig. 4 in Longyear, Rep. Mich. Acad. Sci. 3: 58. 1902—***Lectotype [icon.] designated here.*** Type: *Annularia mammillata* Longyear, *Pluteus mammillatus* Minnis et al., *ASM 7916* (EIU)—***Epitype designated here.***

When Longyear (1902) named the species, he based it on a single basidiocarp collected from Greeneville, Michigan on a decaying log in woods and did not explicitly designate a type. The original material mentioned in the protologue was not found at Michigan State University, formerly the Michigan Agricultural College (Heather Hallen and Alan Fryday, pers. comm.). Likewise, it is not present at the New York Botanical Garden (NY) (Barbara Thiers, pers. comm.) or the University of Michigan Herbarium (MICH).It is apparently lost. No other authentic material or other specimens are available for study. Since it is allowable to select an illustration as a lectotype, we chose the figure from Longyear's original circumscription. See Fig. 2 for a reproduction of this image.In order to facilitate a more precise taxonomic interpretation, a collection used in this study was chosen as the epitype. All of the specimen data on the herbarium box are given above.

Chamaeota sphaerospora (Peck) Kauffman, The *Agaricaceae* of Michigan 534. 1918.

≡ *Annularia sphaerospora* Peck, Bull. Torrey Bot. Club 33: 216. 1906. Type: *Annularia sphaerospora* Peck, Loc. Detroit, Mich, Leg. O.E. Fischer, Aug. '05 (NYS)—***Lectotype designated here.***

In the protologue, Peck gave O.E. Fischer, a physician, credit for collecting the material used to circumscribe the species. However, unpublished correspondence between Peck and Fischer indicate that a Mr. Burrows of 50 Hazelwood Ave. (Detroit?) was the collector. Fischer sent one of the two collections given to him by Mr. Burrows to Peck. This material mentioned in the protologue was apparently used by Peck to write the circumscription, but he did not clearly designate a type. All of the type specimen data present on the specimen label are given above. An isolectotype not mentioned in the original species description is located in the University of Michigan Herbarium (MICH). According to the herbarium collection manager, Patricia Rogers (pers. comm.), Dr. Pierre-Arthur Moreau noticed some *Hebeloma* material mixed in with this collection. We have not examined this collection.

Taxonomy

Pluteus mammillatus (Longyear) Minnis, Sundb., & Methven, **comb. nov.** **Figs. 2-7.**

≡ *Annularia mammillata* Longyear, Rep. Mich. Acad. Sci. 3: 59. 1902 (basionym).

≡ *Chamaeota mammillata* (Longyear) Murrill, N. Amer. Fl. 10: 139. 1917.

= *Annularia sphaerospora* Peck, Bull. Torrey Bot. Club 33: 216. 1906.

≡*Chamaeota sphaerospora* (Peck) Kauffman, The *Agaricaceae* of Michigan 534. 1918.

Data based on study of the lectotype of *Annularia sphaerospora*:

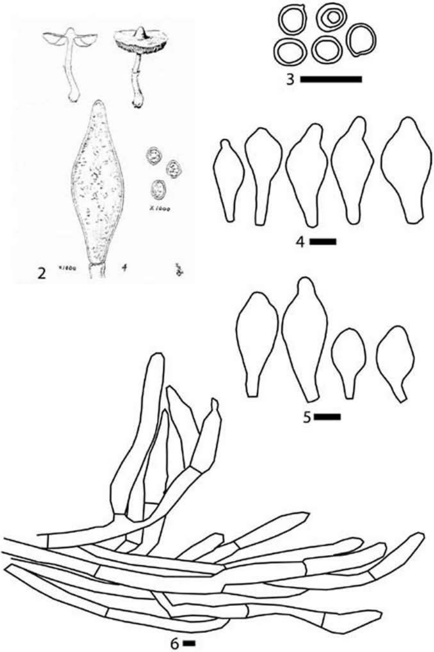
Basidiospores globose to subglobose to short-ellipsoid to slightly ovate in face and profile views, circular in end-view, 5.3–7.0 × 4.8–6.6 µm, Q = 1.0–1.18 (L^m = 6.1 µm, W^m = 5.5 µm, Q^m = 1.11), apiculate, smooth, walls slightly thickened, subhyaline to pale yellow in KOH, with a single large oil drop inside or several smaller drops resulting in a granular appearance. Basidia clavate, tetrasterigmate, 20–23 × 7–9 µm without sterigmata, walls thin and hyaline in KOH. Pleurocystidia abundant, broadly to narrowly fusoid-ventricose with pedicels and short necks with obtuse apices, 37–61 × 14–24 µm, walls thin and hyaline in KOH, no apparent contents. Cheilocystidia abundant, vesiculate to clavate to fusoid-ventricose, 31–58 × 11–22 µm, walls thin and hyaline in KOH, no apparent contents. Lamellar trama convergent. Subhymenium cellular. Pileipellis more or less a cutis with bundles of erect to appressed hyphae that are more abundant towards the disc, hyphae thin-walled occasionally containing light brown intracellular pigment. Context composed of 3–15 µm wide hyphae, thin-walled, hyaline in KOH, no apparent contents. Stipitipellis a cutis of cylindrical hyphae, 3–8 µm wide, thin-walled, hyaline in KOH, no apparent contents. Clamp connections absent. All anatomical features inamyloid in Melzer's reagent.

Additional data:

Pileus 0.9-7 cm in diameter, initially conic-campanulate becoming convex-plane, low narrow to broad umbo present or not; margin entire, slightly striate, occasionally appendiculate, initially incurved then becoming decurved; surface dry, radially fibrillose with fibrillose scales on disc, fibrils becoming smaller and more separated towards the margin, fibrils light brown to brown (6D7-D6, 6E8-E6); ground color deep yellow to orange yellow (4A-8-A6 to 4B8-B7). Lamellae free, close, thin, broad, not marginate, white becoming grayish red (7B3) in age. Lamellulae in two tiers. Stipe 0.2–8 cm × 1–14 mm, equal or narrowly clavate, terete, whitish to pale yellow (3A3), surface dry, longitudinally fibrillose or streaked, fibrils concolorous with those on pileus, basal tomentum white. Annulus found on lower 1/2 to 1/3 of stipe, white to yellowish white (4A2,3A2), thin, membranous, sheathing with flaring apex, occasionally evanescent. Flesh of pileus and stipe solid, white. Odor and taste not distinctive.

Basidiospores brownish pink in mass, 4.8–7.0 × 3.1–6.6 µm, Q = 1.08–1.88 (L^m = 6.1 µm, W^m = 5.3 µm, Q^m = 1.17). Basidia 17–29 × 6–11 µm, usually with granular contents. Pleurocystidia rarely broadly clavate, 39–99 × 8–30 µm. Cheilocystidia 30–86 × 8–24 µm. Pileipellis hyphae often containing brown intracellular pigment, 5–13 µm wide. Stipitipellis hyphae 4–18 µm wide, with or without brown intracellular pigment. Caulocystidia consist of cylindrical hyphae with obtuse apices, 5–9 µm wide, thin-walled, with brown intracellular pigment. Annulus composed of filamentous hyphae, 3–10 µm wide, thin-walled, hyaline in KOH, no apparent contents.

Specimens examined—**UNITED STATES. FLORIDA: Seminole Co.**, Oviedo, 22.XII.1935, coll. HC Beardslee Jr. (*35135*, MICH as *Chamaeota pusilla*); 9.XI.1936, coll. HC Beardslee Jr. (*35135*, MICH as *Chamaeota fenzlii*); Highlands Hammock State Park near Sebring, 1942, coll. R Singer, F244a (F). **MICHIGAN: Wayne Co.**, Detroit, VIII.1904, coll. RH Stevens (F as *Annularia fenzlii*). **MISSOURI: Wayne Co.**, Mingo National Wildlife Refuge near Puxico, scattered on lignicolous substrates, 20.IX.2003, coll. AM Minnis, *Minnis 3-09-20-1* (SIU) & *Minnis 3-09-20-2* (SIU); 17.IX.1994, coll. AS Methven, *ASM*



Figs. 2-6. *Pluteus mammillatus.* Fig. 2. Lectotype illustration of *Annularia mammillata* from Longyear (1906). Fig. 3. Basidiospores (*A. sphaerospora* lectotype). Fig. 4. Pleurocystida (*A. sphaerospora* lectotype). Fig. 5. Cheilocystidia (*A. sphaerospora* lectotype). Fig. 6. Pileipellis (*Minnis 5-09-20-1*). Scale bars for Figs. 3-6 = 10 µm.

Fig. 7. *Pluteus mammillatus*. Basidiocarps of two collections, *Minnis 3-09-20-1* and *Minnis 3-09-20-2*.

7916, DQ451549 (designated epitype of *A. mammiliata*, EIU); 20.IX.2005 coll. AM Minnis, *Minnis 5-09-20-1* (SIU).

Comments—This species is easily recognized in the field by its yellowish pileus, free, dirty-pink lamellae, annulus, and occurrence on decaying deciduous substrates. Microscopically, there is considerable variation in pleurocystidial shape. This variation around the fusoid-ventricose type is present within and among individual basidiocarps. In our experience, this variation is not unusual in *Pluteus*. Kauffman (1918) did not note the presence of pleurocystidia in *Chamaeota sphaerospora*. However, they are present in all of the collections we have examined. Hesler noted the presence of pleurocystidia on an annotation label for the lectotype of *A. sphaerospora*. Despite the misleading species epithet of *C. sphaerospora*, the spores are not always globose.

Murrill (1917) considered *C. mammillata* to be a synonym of *C. sphaerospora*. Kauffman (1918) and Singer (1978) recognized the two as distinct species. Considering the range of variation we have seen in *C. sphaerospora*, Longyear's description (1902) is a match and the two species are synonyms. See discussion for justification of the transfer to *Pluteus*.

Pluteus mammillatus (designated above) is rarely collected in the United States. Even so, it appears to be widespread in the Eastern United States. It has also been reported from Argentina (Moreno and Albertó 1996). Wright and Albertó (2002) included a photograph with their description of an Argentinean collection that appears to be *P. mammillatus*. We have not examined any of the South American collections.

Chamaeota fenzlii (Schulzer) Singer, a European species, is similar. According to Singer's description, it differs from *C. sphaerospora* by possessing yellow-marginate lamellae (1978).

Discussion

Singer (1986) discussed the similarities of *Chamaeota* to *Pluteus* section *Hispidoderma* Fayod. This section is characterized by a pileipellis consisting entirely of elongated elements and thin-walled cystidia. The species of *Chamaeota* noted by Singer differ primarily by the presence of a partial veil. For convenience in matters of identification, Singer (1986) felt that it was acceptable to maintain the genus as separate at that time despite the number of other agarics where the presence or absence of a veil does not warrant genus level distinction. In contrast, in his seminal work on *Pluteus* in South America, Singer (1958) noted the presence of a rudimentary volva in *Pluteus stephanobasis* Singer and stated that it was acceptable to maintain this species in the genus instead of placing it in *Volvariella*. Characters that are not found in *Volvariella* including metuloid pleurocystidia and the lack of a natural transition from a rudimentary volva to the more complex volvas found in *Volvariella* supported his view (Singer 1958).

Based on the molecular evidence presented in this study, *Chamaeota* is not a good outgroup for *Pluteus* because it is in the *Pluteus* clade. The partial veil of *C. mammillata* is a derived character within this *Pluteus* lineage. Of the taxa examined, *C. mammillata* is most closely related to *Pluteus ephebeus* (Fr.) Gillet, a member of *Pluteus* section *Hispidoderma*. We feel that the partial veil does not warrant exclusion of *C. mammillata* from the genus *Pluteus*. Future descriptions of the genus should be modified to potentially include the presence of a partial veil.

Interestingly, *Chamaeota tropica* Pegler and *Chamaeota subolivascens* Courtec. are described as having cellular pileipelli (Pegler 1983, Courtecuisse 1991). This feature is also found in *Pluteus* section *Celluloderma* Fayod. It would be interesting to know if these species are also derived from within the *Pluteus* lineage. If so, a partial veil is likely to have been derived more than one time in the genus. Future studies on the other species of *Chamaeota* including the type of the genus, *C. xanthogramma*, should be performed. It is our belief that the genus will be rendered obsolete.

Acknowledgements

We thank Dr. Else C. Vellinga and Dr. Scott A. Redhead of the University of California, Berkeley and the Eastern Cereal and Oilseed Research Centre, respectively, for their presubmission reviews of the manuscript. We also acknowlege the New York State Museum (NYS), the University of Michigan Herbarium (MICH) and the Field Museum of Natural History (F) for the loans of collections used in this study. Dr. Raymond Stotler and Dr. Dale H. Vitt are credited for advice on nomenclature. Finally, our gratitude is extended to the Missouri Mycological Society for their support and comraderie.Financial support for this work was provided by the Alexander H. and Helen V. Smith Research Fund.

Literature cited

Beardslee HC. 1939. New and interesting fungi. Mycologia 26: 253-260.

Courtecuisse R. 1991. Eléments pour un inventaire mycologique des environs du saut Pararé (Arataye) et l'inselberg des Nouragues (Guyane française). V. *Pluteaceae*. (*Pluteales*, Basidiomycota). Crypt. Bot. 2:136-152.

Holmgren PK, Holmgren NH. 1998 onwards (continuously updated). Index Herbariorum. New York Botanical Garden. http://sciweb.nybg.org/science2/IndexHerbariorum.asp

Kauffman CH. 1918. The *Agaricaceae* of Michigan. Vol. 1. Wynkoop Hallenback Crawford Co., State Printers, Lansing, Michigan. 924 p.

Kornerup A, Wanscher JH. 1978. Methuen Handbook of Color. 3rd ed. Eyre Methuen, London. 252 p.

Largent D, Johnson D, Watling R. 1977. How to Identify Mushrooms to Genus III: Microscopic Features. Mad River Press, Eureka, California. 148 p.

Longyear BO. 1902. New species of Michigan fungi. Rep. Mich. Acad. Sci. 3: 57-60.

Moncalvo JM, Lutzoni F, Rehner SA, Johnson J, Vilgalys R. 2000. Phylogenetic relationships of agaric fungi based on nuclear large subunit ribosomal DNA sequences. Syst. Biol. 49: 278-305.

Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clémencon H, Miller Jr. OK. 2002. One hundred and seventeen clades of Euagarics. Mol. Phyl. Evol. 23: 357-400.

Moreno G, Albertó E. 1996. *Agaricales sensu lato* de Argentina. I. Cryptogamie, Mycol. 17: 61-84.

Murrill WA. 1917. (*Agaricales*), *Agaricaceae* (pars), *Agariceae* (pars). N. Amer. Fl. 10: 77-144.

Murrill WA. 1943. Some Southern novelties. Mycologia 35: 422-433.

Nickrent DL. 1994. From field to film: Rapid sequencing methods for field collected plant species. BioTechniques 16: 470-475.

Peck CH. 1906. New species of fungi. Bull. Torrey Bot. Club 33: 213-221.

Pegler DN. 1983. Agaric Flora of the Lesser Antilles. Her Majesty's Stationary Office, London. 668 p. 27 pl.

Singer R. 1958. Contribution toward a monograph of the genus *Pluteus*, especially those of the east slope of the Andes and Brazil. Lloydia 21: 195-299.

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 ed. Koeltz Scientific Books, Koenigstein. 981 p.

Smith AH. 1949. Mushrooms in Their Natural Habitats. Sawyers, Portland. 626 p.

Wright JE, Albertó E. 2002. Hongos. Guía de la Región Pampeana. 1. Hongos con Laminillas. L.O.L.A., Buenos Aires. 279 p.

MYCOTAXON

Volume 96, pp. 41–46 April–June 2006

Tylopilus microsporus, a new species from Southwest China

S.-Z. Fu[1,3], Q.-B. Wang[1] & Y.-J. Yao[1,2*]

yaoyj@sun.im.ac.cn

[1]Key Laboratory of Systematic Mycology and Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

[2]Mycology Section, Royal Botanic Gardens, Kew
Richmond, Surrey TW9 3AB, UK

[3]Graduate School of Chinese Academy of Sciences, China

Abstract—A new species, *Tylopilus microsporus*, collected from Sichuan and Yunnan, China, is described and illustrated. The new species is characterized by pale violet to violet pileus, paler purple to purplish brown stipe, flesh color to pale purplish red hymenophore and small spores. The differences between this species and its related taxa, such as *T. plumbeoviolaceus*, *T. rubrobrunneus*, *T. plumbeoviolaceoides* and *T. violatinctus*, are discussed.

Key words—*Boletaceae*, boletes, taxonomy

Introduction

Tylopilus P. Karst. is a cosmopolitan genus in *Boletales* with about 75 species worldwide (Kirk et al. 2001). Some species in the genus are edible but others are considered mildly poisonous (Singer 1986). Singer et al. (1991) considered tropical Asia and Central America as the distribution centres of *Tylopilus*, but its species are widespread, e.g. North America (Smith & Thiers 1971, Bessette et al. 2000), Asia (Corner 1972, Nagasawa 1997, Li & Song 2000), Mexico and Central America (Singer et al. 1991) and Australasia (Pegler & Young 1981, Li & Watling 1999, Watling 2001). Some uncertainties remain as to the taxonomic position of the genus largely owing to poor generic definitions. The genus was originally limited to *T. felleus* (Bull.) P. Karst., and defined as being gymnocarpic, ectomycorrhizal and producing pinkish, light greyish brown or pinkish orange-brown basidiospores not exceeding 15 μm in length by Pegler & Young (1981), who also placed the genus within *Strobilomycetaceae* E.-J. Gilbert. This taxonomic treatment was accepted by Hawksworth et al. (1995). However, the genus is also characterized by having pinkish, pinkish orange, reddish brown, to purplish brown, amber brown or rusty brown basidiospores, lacking a veil and generally having pallid tubes when

---

[*] Author for correspondence.

young (Smith & Thiers 1971, Wolfe, 1979, Bessette et al. 2000), and placed in *Boletaceae* Chevall. (Watling 1970, Smith & Thiers 1971, Singer 1986, Kirk et al. 2001).

There is no major molecular study on the relationships within *Tylopilus* and between *Tylopilus* and *Strobilomyces* Berk. *Tylopilus* s. l. may not be monophyletic, but a clade of *Tylopilus* spp. including *T. felleus* is the sister-group to *Leccinum*, while *Strobilomyces* spp. are at the base of the *Boletaceae* (Binder 1999). The narrow generic concept proposed by Pegler & Young (1981) may be better to maintain the monophyletic position for *Tylopilus*, but it is difficult to define *Tylopilus* and to justify it as a natural genus in *Boletaceae* or in *Strobilomycetaceae* because of the simplicity and plasticity of morphological and anatomical characters and the lack of molecular data.

In China, species of the genus have been reported from various areas but mainly from the South and the South-west (Chiu 1948, Zang 1986, Ying & Zang 1994, Li & Song 2000), especially in Guangdong, Sichuan and Yunnan provinces. The early Chinese records of *Tylopilus* were mostly given as *Boletus* L. A total of some 30 taxa, including species and varieties, has so far been reported (Tai 1979, Zang 1986, Ying & Zang 1994, Yuan & Sun 1995, Shao & Xiang 1997, Chen & Peng 1998, Mao 1998, 2000, Zhang 1999, Li & Song 2000, Li et al. 2002, Wang et al. 2004) and a check-list of the genus in China with a review of all taxa reported is currently underway (Wang et al., in preparation).

In this paper, a new species of *Tylopilus* is proposed and illustrated, based on several collections made from Yunnan and Sichuan during an investigation into the diversity of macrofungi in the South-west of China.

Materials and Methods

All the specimens used in this study were collected from Yunnan and Sichuan, China, and are deposited in the Herbarium Mycologicum, Academia Sinica (HMAS). The macro-characters described here were based on fresh collections. The collections were dried by using an electric air-ventilation drier. Micro-characters were examined in a 5% KOH solution in laboratory from dried specimens. The line drawings of basidiospores and pleurocystidia were made with the assistance of a camera lucida. The sizes of basidiospores are based on at least 30 measurement of each mature specimen.

Taxonomy

Tylopilus microsporus S.Z. Fu, Q.B. Wang & Y.J. Yao **sp. nov.** Figs 1 & 2

Etymology: The epithet refers to the comparatively small basidiospores found in this species.

Pileus hemisphericus, convexus vel subconvexus, 6.0–12.0 cm latus, subamethystinus, amethystinus vel brunneo-amethystinus, subtomentosus vel pruinosus. Contextus 1.0–2.0 cm crassus ad centrum, cretaceus, constans; odor indistinctus, sapor amarus. Tubuli ad 5.0–10.0 mm longi, depressi ad stipitem, juvenes albi, maturi constanter albi vel parum subrosei; pori subangulares vel rotundi, 3–4 per mm, cretacei primum, deinde carnei vel pallide purpureo-coccinei, maturitate parum brunnei. Stipes cylindricus, 5.0–14.0 cm longus, 1.0–3.5 cm crassus ad centrum, subaequalis vel saepe leniter amplificatus deorsum, non reticulatus, leniter striatus, cretaceus vel brunneus, apice parum amethystinus, juventute deorsum pallide brunneo-amethystinus, amethystinus vel brunneo-amethystinus, maturitate pallide brunneus vel brunneus, basi albus, solidus. Basidiosporae (6.5–)7.0–

9.0(–10.0) × 3.0–4.0(–5.0) µm, subfusoideae, glabrae, pallide subroseo-brunneae. Basidia 22–24 × 8.0–9.0 µm, clavata. Cystidia 37–58 × 8.0–12.0 µm, clavata vel fusoidea infra inflata, in solutione KOH intus pallide aurantiaca. Trama hymenophori divergens. Hyphae hyalinae, fibulis destitutis.

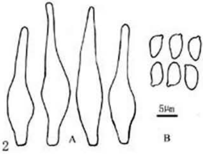
Pileus 6.0–12.0 cm in diam., at first hemispherical, becoming convex, subconvex to nearly applanate at maturity; margin incurved at first, becoming decurved with a narrow band of sterile tissue; surface dry, subtomentose or more or less pruinose, pale violet to violet when young, becoming pale violet, purple pink, with brown tints when mature, then pale brownish with greyish violet tints when old, often pale yellow brown at centre and with pale violet tints at margin; unchanging or slightly deeper on bruising. *Context* 1.0–2.0 cm thick at centre, white, unchanging when bruised, odour not distinctive, taste very bitter. *Tubes* 5.0–10.0 mm long, white when young, and remaining so when mature or slightly pinkish, unchanging when bruised, adnate to slightly depressed around the stipe; pores nearly round, 3–4 pores per mm, white at first, becoming flesh-coloured to purplish pink to pale violet with slightly brown tints when mature, unchanging when bruised. *Stipe* 5.0–14.0 cm long, 1.0–3.5 cm thick, sub-cylindric, always enlarging downward, non-reticulate, slightly striate or subglabrous, white or brownish with pale purple to violet tints at the apex, pale brownish lilac to lilac or brownish lilac downwards when young, becoming brownish to brown, with white mycelium at the base, solid; context white, unchanging when bruised. *Basidiospores* (6.5–)7.0–9.0(–10.0) × 3.0–4.0(–5.0) µm, subfusoid, distally expanding, smooth, thin-walled, pale pinkish brown containing one or two oil-droplets. *Basidia* 22–24 × 8.0–9.0 µm, clavate, 2- or 4-spored. *Pleurocystidia* 37–58 × 8.0–12.0 µm, copious, clavate to fusoid, inflated below, with pale golden yellow contents in KOH. *Hymenophoral trama* of *Boletus*-type, typically divergent from a central strand, hyphae hyaline in KOH, thin-walled. *Pileipellis* an interwoven trichodermium, slightly brown in KOH. *Stipitipellis* a trichodermium, with some short, narrowly ventricose dermatocystidia 35–60 × 6.5–12.0 µm. *Clamp-connections* absent.

Specimens examined: China: **Yunnan**, Kunming, Heping Village Market, 31 Aug. 2002, Q. B. Wang No. 85, HMAS 79720; Simao, Simao Market, 10 Aug. 2003, Q. B. Wang No. 190, HMAS 84730 (**HOLOTYPE**). **Sichuan**, Dechang County, Badong Town, Gaofeng, 1900 m alt., solitary to gregarious on the ground, in mixed woods, 16 Aug. 2003, Q. B. Wang & S. Z. Fu No. 234, HMAS 84743; Dechang County, Badong Town, Yinjiashan, 2200 m alt., solitary on the ground, in mixed woods, 14 Aug. 2003, S. Z. Fu No. 12, HMAS 79471; Dechang County, Nanshan Town, Datianwan Village, 1700 m alt., solitary on the ground, under the mixed woods of *Quercus* sp. and *Pinus* sp., 15 Aug. 2003, S. Z. Fu No. 32, HMAS 79468; same locality and same date, solitary to gregarious on the ground, S. Z. Fu No. 33, HMAS 84745; same locality and same date, gregarious, S. Z. Fu No. 34, HMAS 79458.

Habit and habitat: Solitary to gregarious on the ground in mixed woods with *Quercus* sp. and *Pinus* sp.

Distribution: China: Yunnan and Sichuan.

This species is mainly characterized by the pale violet to violet pileus, pale purple hymenophore, brownish stipe and small spores, (6.5–)7.0–9.0(–10.0) × 3.0–4.0(–5.0) µm. These characters, together with the very bitter context, may be confused with other closely related species in the field, such as *T. plumbeoviolaceoides* T.H. Li et al., *T.*



Figs 1 & 2. *Tylopilus microsporus* (HMAS 84730, Holotype). Fig. 1. Photograph of basidiomata. Fig. 2. Line drawing of microscopic characters. A. Pleurocystidia; B. Basidiospores.

plumbeoviolaceus (Snell & E.A. Dick) Singer, *T. rubrobrunneus* Mazzer & A.H. Sm. and *T. violatinctus* T.J. Baroni & Both, which have a vinaceous or purple brown pileus and very bitter context.

Tylopilus microsporus differs from *T. rubrobrunneus* and *T. plumbeoviolaceus* in having smaller spores. The spores of *T. rubrobrunneus* are 10–14 × 3.5–4.5 µm (Smith & Thiers 1971, Bessette et al. 2000) or 12–14 × 4–5 µm (Grund & Harrison 1976), larger than those of *T. microsporus*. Furthermore, the pileus of *T. rubrobrunneus* is purple-brown, dark reddish brown, dull brown or cinnamon in age (Bessette et al. 2000), while the pileus of *T. microsporus* is pale violet, purple pink, with brown tints. Although spores of *T. plumbeoviolaceus* were measured as 7–9 × 2.8–4 µm (mostly 8–9 × 3 µm) by Snell & Dick (1941), Singer (1947) considered the spore size of 9.5–14 × 3–3.8 µm (most frequently 10.2–12 × 3.3–3.5 µm) was reasonably constant because of slow maturing of the spores in this species. Singer et al. (1991) gave the same size of spores for collections from Mexico. The spore size of 10–13 × 3–4 µm was also provided for *T. plumbeoviolaceus* by both Smith & Thiers (1971) and Bessette et al. (2000), and 11–14 × 4–5 µm by Grund & Harrison (1976). All these spore measurements are larger than those in *T. microsporus*. Further, the pileus of *T. plumbeoviolaceus* is quite violaceous when young (Snell & Dick, 1941), contrasting pale violet to violet when young in *T. microsporus*.

Tylopilus plumbeoviolaceoides was described from Guandong, China, by Li et al. (2002). It has a dark violaceous, brown-vinaceous to purple-chestnut pileus, which is subviscid to viscid, and the pileipellis is an ixotrichodermium or a trichodermium with some gelatinized material; whilst the pileus of *T. microsporus* is dry, pale violet to violet when young and becoming pale violet, purple pink, with brown tints in age, and the pileipellis is an interwoven trichodermium without gelatinized material. The stipe of *T. plumbeoviolaceoides* is concolorous with the pileus to more pinkish chestnut, compared with the brownish stipe of *T. microsporus*. Further, the spores of *T. plumbeoviolaceoides*, (7.5–)8.5–10.5(–12) × (2.5–)3–3.8(–4.2) µm (Li et al. 2002), are longer than those of *T. microsporus*. The fungus illustrated for *T. plumbeoviolaceoides* by Wang et al. (2004) from Yunnan is the same as *T. microsporus* described here (Wang, pers. comm.).

Tylopilus violatinctus, hitherto known only from North America, is another similar species, but its pileus becomes rusty violet to dark violet and stipe turns typically to dull yellow to yellow brown when bruised, and its hymenophore becomes pinkish flesh-color and finally deep cocoa-brown when mature (Bessette et al. 2000); contrasting to the unchanging, or just deeper, pileus and the unchanging stipe when bruised, and the pale violet, purple pink, with brown tints hymenophore when mature in *T. microsporus*.

The complex of *Tylopilus* species with purplish-tinted basidiomata is difficult to determine by macro-characters alone. There might be many species involved in this complex. Further studies, especially DNA sequence analyses, are needed in order to understand the complex.

Acknowledgements

The authors are grateful to Drs H. Knudsen and T.-H. Li for serving as pre-submission reviewers and for their valuable comments and suggestions, and to Prof. J.-Y. Zhuang for assistance with the Latin diagnosis. We are thankful to Ms. X. H. Wang, Profs P.-G. Liu and Zhu-L. Yang, and Mr. F.-Q. Yu for their kind help in the field work. This study is supported by the Programme for Key International Science and Technology Cooperation Project of P. R. China (2001CB711103) from Ministry of Science and Technology, the National Science Fund for Distinguished Young Scholars (30025002) from National Natural Science Foundation of China, the Key Research Direction of Innovation Programme (KSCX2-SW-101C) and the scheme of Introduction of Overseas Outstanding Talents, operated by the Chinese Academy of Sciences.

Literature Cited

Bessette AE, Roody WC, Bessette AR. 2000. North American Boletes, a Color Guide to the Fleshy Pored Mushrooms. Syracuse University Press, Syracuse, USA.

Binder M. 1999. Zur Molekularen Systematik der *Boletales*: *Boletineae* und *Sclerodermatineae* subordo nov. PH.D. thesis. University of Regensburg, Germany.

Chen C-M, Peng J-J. 1998. Four *Tylopilus* new to Taiwan. Fung. Sci. 13: 11–16.

Chiu W-F. 1948. The boletes of Yunnan. Mycologia 40: 199–231.

Corner EJH. 1972. *Boletus* in Malaysia. Government Printer, Singapore.

Grund DW, Harrison KA. 1976. Nova Scotian Boletes. J. Cramer, Vaduz, Liechtenstein, Germany.

Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Ainsworth & Bisby's Dictionary of the Fungi. 8th ed. CAB International, Wallingford, UK.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th ed. CAB International, Wallingford, UK.

Li T-H, Song B. 2000. Chinese boletes: a comparison of boreal and tropical elements. In Whalley AJS. Tropical Mycology 2000, the Millennium Meeting on Tropical Mycology (Main Meeting 2000). 1–9p. British Mycological Society & Liverpool John Moores University, Liverpool, UK.

Li T-H, Watling R. 1999. New taxa and combinations of Australian Boletes. Edinb. J. Bot. 56: 143–148.

Li T-H, Song B, Shen Y-H. 2002. A new species of *Tylopilus* from Guandong. Mycosystema 21: 3–5.

Mao X-L. 1998. The Economic Fungi in China. Science Press, Beijing, China (in Chinese).

Mao X-L. 2000. The Macrofungi of China. Henan Science and Technology Press, Zhengzhou, China. (in Chinese).

Nagasawa E. 1997. A preliminary checklist of the Japanese *Agaricales*. I. the *Boletineae*. Rep. Tottori Mycol. Inst. 35: 39–78.

Pegler DN, Young TWK. 1981. A natural arrangement of the *Boletales*, with reference to spore morphology. Trans. Br. Mycol. Soc. 76: 103–146.

Shao L-P, Xiang C-T. 1997. Forest Mushrooms of China. Northeast Forestry University Press, Haerbin, China. (in Chinese).

Singer R. 1947. The *Boletoideae* of Florida. The *Boletineae* of Florida with notes on extralimital species III. Amer. Midl. Nat. 37: 1–135.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein, Germany.

Singer R, Garcia J, Gomez LD. 1991. The *Boletineae* of Mexico and Central America. III. Beihefte zur Nova Hedwigia Heft 102: 1–99.

Smith AH, Thiers HD. 1971. The Boletes of Michigan. The University of Michigan Press, Ann Arbor, USA.

Snell WH, Dick EA. 1941. Notes on boletes. VI. Mycologia 33: 23–37.

Tai F-L. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing, China. (in Chinese).

Teng S-C. 1936. Additional fungi from China. III. Sinensia 8: 529–569.

Teng S-C. 1963. Fungi of China. Sciences Press, Beijing, China. (in Chinese).

Wang X-H, Liu P-G, Yu F-Q. 2004. Color Altas of Wild Commercial Mushrooms in Yunnan. Yunnan Science and Technology Press, Kunming, China. (in Chinese).

Watling R. 1970. British Fungus Flora – Agarics and Boleti. I. *Boletaceae, Gomphidiaceae, Paxillaceae*. Her Majesty's Stationery Office, Edinburgh, UK.

Watling R. 2001. Australian boletes: their diversity and possible origins. Aust. Syst. Bot. 14: 407–416.

Wolfe JRCB. 1979. *Austroboletus* and *Tylopilus* Subgenus *Porphyrellus* with Emphasis on the North American Taxa. J. Cramer, Vaduz, Germany.

Ying J-Z, Zang M (eds). 1994. Economic Macrofungi from Southwestern China. Science Press, Beijing, China. (in Chinese).

Yuan M-S, Shun P-Q. 1995. Sichuan Mushrooms. Sichuan Science and Technology Press, Chengdu, China. (in Chinese).

Zang M. 1986. Notes on the *Boletales* from Eastern Himalayas and adjacent areas of China. Acta Bot. Yunnan. 8: 1–22. (in Chinese).

Zhang G-Y. 1999. Illustrations of China Popular Edible Mushrooms. Yunnan Science & Technology Press, Kunming, China. (in Chinese).

MYCOTAXON

Volume 96, pp. 47–50 *April–June 2006*

An annotated checklist of *Leccinum* in China

S.-Z. FU[1,2], Q.-B. WANG[1] & Y.-J. YAO[1*]

yaoyj@sun.im.ac.cn

[1]*Key Laboratory of Systematic Mycology and Lichenology*
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

[2]*Graduate School of Chinese Academy of Sciences*
Beijing 100049, China

Abstract—Species of the genus *Leccinum* reported from China are reviewed and annotated with a summary of their current research status. A total of 32 names have been included from an extensive literature research. Among these names, two are regarded as synonyms of other species of the genus and another one transferred to *Tylopilus*. The taxonomic status of three names, the generic placement of two names and the application of one name to Chinese material are controversial. Among the remaining 23 names, seven were reported without specimen support and 16 with specimen citation. It is also found that the descriptions of six of these taxa from China differ from those from Europe and elsewhere. Specimen citation, morphology description and species identification of the Chinese records are also discussed. The full checklist is posted at http://www.mycotaxon.com/resources/weblists.html.

Key words—boletes, distribution, nomenclature

Leccinum Gray is a bolete genus with about 75 accepted species (Kirk et al. 2001) among some 282 proposed names (http://www.indexfungorum.org/Names/Names.asp, March 2006). The genus is worldwide, but distributed mainly in the northern temperate zone (Kirk et al. 2001). Species of *Leccinum* are ectomycorrhizal (Singer 1975) and play important roles in both ecology and economy. Ectomycorrhizal basidiomycetes, including the boletes, constitute an important component of forest fungal communities (Dahlberg et al. 1997, Baxter & Dighton 2001, Yan & Yao 2003) and forest ecosystems. It has been shown that ectomycorrhizal fungal diversity can determine plant productivity (Jonsson et al. 2001) and that ectomycorrhizal fungi benefit their hosts by enhancing mineral uptake, thus contributing to the recycling of nutrients in the ecosystem (Dames et al. 1999). Furthermore, all the known species of *Leccinum* seem to be edible; some are used for food and sold in markets as fresh, dried, salted or pickled products (Singer 1975). *Leccinum extremiorientale*, for example, is often found in the wild mushroom market in Kunming, Yunnan, China.

Species of *Leccinum* in China have been the subject of modern scientific studies since the early 20th century but such studies were infrequent until the 1980s. Baccarini

---

[*] Author for correspondence

(1905) reported *L. scabrum* from Qinling Mountains, Shanxi, and the same species was subsequently reported some 30 years later as *Boletus scaber* from Jiangsu (Teng 1936). Subsequently, two more *Leccinum* species were reported from Yunnan (Keissler & Lohwag 1937). Chiu (1948) recorded three *Leccinum* species in *Boletus* L. in his comprehensive study of boletes in the south-west of China, mainly Yunnan province. A further species was added by Teng (1963). In a summary of all known Chinese fungi, Tai (1979) included six species of *Leccinum*. Zang carried out further research on boletes in the south-west of China from the 1980s and reported six *Leccinum* species, including one new to science (Zang 1986). Subsequently, 15 species were reported from the same region by Ying & Zang (1994). Some additional species of *Leccinum* were also included in local lists of fungi. In total, 32 names of *Leccinum* have been reported from China. They are listed in Table 1, with references and notes on their current status.

Among the 32 names in Table 1, two are regarded as synonyms of other species of the genus (*L. nigrescens* and *L. rufum*) and one (*L. eximium*) is transferred to *Tylopilus*. The taxonomic status of three (*L. crocipodium*, *L. holopus* and *L. versipelle*), the generic placement of two (*L. chromapes* and *L. subglabripes*), and the name application to Chinese material of one (*L. rugosiceps*) are controversial because of the simplicity and plasticity of morphological and anatomical characters.

Among the remaining 23 names, seven were reported without specimen support, i.e. *L. duriusculum*, *L. intusrubens*, *L. oxydabile*, *L. quercinum*, *L. subleucophaeum*, *L. subradicatum* and *L. variicolor*, and 16 with specimen citation, i.e. *L. albellum*, *L. ambiguum*, *L. atrostipitatum*, *L. aurantiacum*, *L. extremiorientale*, *L. griseum*, *L. hortonii*, *L. insigne*, *L. olivaceopallidum*, *L. potteri*, *L. roseofractum*, *L. rubropunctum*, *L. rubrum*, *L. scabrum*, *L. subgranulosum* and *L. subleucophaeum* var. *minimum*. The descriptions of some of these taxa from China are different from those of the same taxa from Europe and elsewhere, i.e. *L. olivaceopallidum*, *L. oxydabile*, *L. quercinum*, *L. rugosiceps*, *L. roseofractum* and *L. rubropunctum*. A revision of these taxa is required to verify their occurrence in China.

Acknowledgements

The authors are grateful to Drs P. Roberts and T.-H. Li for serving as pre-submission reviewers and for their valuable comments and suggestions. This study is supported by the Programme for Key International Science and Technology Cooperation Project of P. R. China (2001CB711103) from Ministry of Science and Technology, the National Science Fund for Distinguished Young Scholars (30025002) from National Natural Science Foundation of China, the Key Research Direction of Innovation Programme (KSCX2-SW-101C) and the scheme of Introduction of Overseas Outstanding Talents, operated by the Chinese Academy of Sciences.

Literature Cited

AS [Mycological and Lichenological Expedition to Shennongjia, Academia Sinica] 1989. Fungi and Lichens of Shennongjia. World Publishing Corp., Beijing, China. (in Chinese).

Baccarini P. 1905. Funghi dello Schensi septentrionale raccolti dal Padre Giuseppe Giraldi. Appunti Annali Nuovo Giorno Botanica Italiana 22 (nuova serie): 689–698.

Baxter JW, Dighton J. 2001. Ectomycorrhizal diversity alters growth and nutrient acquisition of grey birch (*Betula populifolia*) seedlings in host-symbiont culture conditions. New Phytologist 152: 139–149.

Table 1. Species of *Leccinum* in China

Name	Place of publication	Report from China	Note
L. albellum (Peck) Singer	Mycologia 37: 799 (1945)	Yeh & Chen(1982)	√
L. ambiguum A.H. Sm. & Thiers	Boletes of Michigan: 138 (1971)	Dai & Li (1994)	√
L.atrostipitatum A.H. Sm.et al.	Michigan Bot. 5: 155 (1966)	Dai & Li (1994)	√
L. aurantiacum (Bull.) Gray	Nat. Arr. Brit. Pl. 1: 646 (1821)	Keissler & Lohwag (1937)	√
L. chromapes (Frost) Singer	Amer. Midl. Nat. 37: 124 (1947)	Keissler & Lohwag (1937)	†
L. crocipodium (Letell.) Watling	Trans. & Proc. Bot. Soc. Edinburgh 39: 200 (1961)	Chiu (1948)	†
L. duriusculum (Schulzer ex Fr.) Singer	Amer. Midl. Nat. 37: 122 (1947)	Mao et al. (1993)	*
L. eximium (Peck) Singer	Persoonia 7: 319 (1973)	Chiu (1948)	= *Tylopilus eximius* (Peck) Singer
L. extremiorientale (Lar.N. Vassiljeva) Singer	Agar. Mod. Tax. 2nd Ed.: 744 (1962)	AS (1989)	√
L. griseum (Quél.) Singer	Die Röhrlinge II: 89 (1967)	Yeh & Chen (1981)	√
L. holopus (Rostk.) Watling	Trans. Br. Mycol. Soc. 43: 692 (1960)	Yeh & Chen (1980)	†
L. hortonii (A.H. Sm. & Thiers) Hongo & Nagas.	Rep. Tottori mycol. Inst. 16: 50 (1978).	Ying & Zang (1994)	√
L. insigne A.H. Sm.et al.	Michigan Bot. 5: 160 (1966)	Yeh & Chen (1981)	√
L. intusrubens (Corner) Høil.	Nordic Jl Bot. 2: 270 (1982)	Wu et al. (1997)	*
L. nigrescens (Richon & Roze) Singer	Amer. Midl. Nat. 37: 116 (1947)	Chiu (1957)	= *L. crocipodium*
L. olivaceopallidum A.H.Sm. et al.	Michigan Bot. 6: 125 (1967)	Bi et al. (1997)	#
L. oxydabile (Singer) Singer	Amer. Midl. Nat. 37: 116 (1947)	Mao (2000)	#, *
L. potteri A.H. Sm. et al.	Michigan Bot. 5: 138 (1966)	Dai & Li (1994)	√
L. quercinum E.E. Green & Watling	Notes R. bot. Gdn. Edinb. 29: 151 (1968)	Mao (2000)	#, *
L. roseofractum Watling	Notes. R. bot. Gdn. Edinb. 28: 313 (1968)	Bi et al. (1997)	#
L. rubropunctum (Peck) Singer	Amer. Midl. Nat. 37: 117 (1947)	Chiu (1948)	#
L. rubrum M. Zang	Acta bot. Yunnanica 8: 11 (1986)	Zang (1986)	√
L. rufum (Schaeff.) Kreisel	*Boletus* Schr Reihe 1: 30 (1984)	Mao (2000)	=*L. aurantiacum*
L. rugosiceps (Peck) Singer	Mycologia 37: 799 (1945)	Yeh & Chen (1980)	†
L. scabrum (Bull.) Gray	Nat. Arr. Brit. Pl. (London) 1: 646 (1821)	Baccarini (1905)	√
L. subglabripes (Peck) Singer	Mycologia 37: 799 (1945)	Tai (1936-1937)	†
L. subgranulosum A.H. Sm. & Thiers	Boletes of Michigan: 210 (1971)	Ying & Zang (1994)	√
L. subleucophaeum E.A. Dick & Snell	Mycologia 52: 453 (1960)	Li & Song (2000)	*
L. subleucophaeum var. *minimum* C.S. Bi	Acta Mycol. Sin. 3: 201 (1984)	Bi et al. (1984)	√
L. subradicatum Hongo	Mem. Shiga Univ. 23: 41 (1973)	Mao (2000)	*
L. variicolor Watling	Notes R. Bot. Gdn. Edinb. 24: 268 (1969)	Mao et al. (1993)	*
L. versipelle (Fr.) Snell	Lloydia 7: 58 (1944)	Liu (1991)	†

√Recognizable species. †Controversial in taxonomic status, generic placement and application of name to Chinese material. #To be confirmed; records different in description from the western literature. *To be confirmed; records lacking specimen support.

Bi Z-S, Li T-H, Zheng G-Y, Li C. 1984. Basidiomycetes from Dinghu Mountain of China. III. Some species of *Boletaceae* (2). Acta Mycologica Sinica 3: 199–206. (in Chinese).

Bi Z-S, Li T-H, Zhang W-M, Song B. 1997. A Preliminary Agaric Flora of Hainan Province. Guangdong Higher Education Press, Guangzhou, China. (in Chinese).

Chiu W-F. 1948. The boletes of Yunnan. Mycologia 40: 199–231.

Chiu W-F. 1957. Atlas of the Yunnan Boletes. Science Press, Beijing, China. (in Chinese).

Dahlberg A, Jonsson L, Nylund JE. 1997. Species diversity and distribution of biomass above and below ground among ectomycorrhizal fungi in an old-growth Norway spruce forest in south Sweden. Canadian Journal of Botany 75: 1323–1335.

Dai X-C, Li T-H. 1994. Macrofungus Flora of Ganzi, Sichuan Province. Sichuan Technology and Science Press, Chengdu, China. (in Chinese).

Dames JF, Straker CJ, Scholes MC. 1999. Ecological and anatomical characterization of some *Pinus patula* ectomycorrhizas from Mpumalanga, South Africa. Mycorrhiza 9: 9–24.

Jonsson L, Nilsson MC, Wardle DA, Zackrisson O. 2001. Context dependent effects of ectomycorrhizal species richness on tree seedling productivity. Oikos 93: 353–364.

Keissler K, Lohwag H. 1937. Fungi in Handel-Mazzetti. Symbolae Sinicae 2: 1–79.

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

Li T-H, Song B. 2000. Chinese boletes: a comparison of boreal and tropical elements. In Whalley AJS. Tropical Mycology 2000, the Millennium Meeting on Tropical Mycology (Main Meeting 2000). British Mycological Society & Liverpool John Moores University, Liverpool, UK.

Liu B. 1991. The Edible Macrofungi in Shanxi. Shanxi University Union Press, Taiyuan, China. (in Chinese).

Mao X-L, Jiang C-P, Ouzhuciwang. 1993. Economic Macrofungi of Tibet. Beijing Science and Technology Press, Beijing, China. (in Chinese).

Mao X-L. 2000. The Macrofungi of China. Henan Science and Technology Press, Zhengzhou, China. (in Chinese).

Singer R. 1975. The *Agaricales* in Modern Taxonomy. 3rd ed. J. Cramer, Vaduz, Liechtenstein.

Tai F-L. 1936–1937. A list of fungi hitherto known from China. Science Report of National Tsing Hua University Series B 2:137–165, 191–639.

Tai F-L. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing, China. (in Chinese).

Teng S-C. 1936. Additional fungi from China. III. Sinensia 7: 529–569.

Teng S-C. 1963. Fungi of China. Sciences Press, Beijing, China. (in Chinese).

Wu X-L, Zang M, Xia T-Y. 1997. Coloured Illustrations of the *Ganodermataceae* and other Fungi. Guizhou Science & Technology Press, Guiyang, China. (in Chinese).

Yan D-H, Yao Y-J. 2003. Recent advance of research on fungi in forest ecosystem. Acta Phytoecologica Sinica 27: 143–150. (in Chinese).

Yeh K-W, Chen Z-C. 1980. The boletes of Taiwan I. Taiwania 25: 166–184.

Yeh K-W, Chen Z-C. 1981. The boletes of Taiwan II. Taiwania 26: 100–115.

Yeh K-W, Chen Z-C. 1982. The boletes of Taiwan III. Taiwania 27: 52–63.

Ying J-Z, Zang M (eds). 1994. Economic Macrofungi from Southwestern China. Science Press, Beijing, China. (in Chinese).

Zang M. 1986. Notes on the *Boletales* from Eastern Himalayas and adjacent areas of China. Acta Botanica Yunnanica. 8: 1–22. (in Chinese).

MYCOTAXON

Volume 96, pp. 51–60 April–June 2006

New species and new records of *Graphis* from India: transseptate species with completely carbonized exciples and norstictic acid

BHARATI ADAWADKAR & URMILA MAKHIJA

UV_Makhija@hotmail.com
Agharkar Research Institute
G.G. Agarkar Road, Pune - 411004, India

Abstract—The present paper gives an account of ten species of the genus *Graphis*. *G. albidofarinacea*, *G. cinnamomea*, *G. colliculoides*, *G. kollaimalaiensis*, *G. nigrocarpa*, *G. nilgiriensis*, and *G. verruciformis* are described as new to science. *Graphis flavens*, *G. induta*, and *G. marginata* are recorded for the first time from India. The two species *G. flavens* and *G. nilgiriensis* without norstictic acid are described in an appendix.

Keywords—lichenized fungi, ascomycetes, taxonomy, *Graphidaceae*

Introduction

The *Graphidaceae* is a large and widely distributed group of mainly tropical lichens with about 918 species worldwide (Kirk et al. 2001). The clear concepts of the genera (and several species) are available in the recent treatment of *Graphidaceae* (Staiger 2002).

Awasthi (1965), in his "Catalogue of lichens from India, Nepal, Pakistan and Ceylon," enumerated 36 species of *Graphis* Adans., which were recorded in the nineteenth and the early twentieth centuries by various lichenologists—viz. Bélanger (1838), Leighton (1869), Stirton (1879), Nylander (1867, 1891, 1900), Jatta (1905) and Räsänen (1952)—based on the collections of European botanists or naturalists from India.

Lichenological studies in India were resumed beginning in the early 1940s by Dr. D.D. Awasthi, Dr. P.G. Patwardhan, and their associates. Subsequently 33 new species were recorded and published in various scattered publications by Indian lichenologists [Awasthi & Singh (1975) Awasthi & Singh (1977), Patwardhan & Kulkarni (1976, 1979), Kulkarni (1977), Nagarkar & Patwardhan (1982), Singh & Sinha (1994) and Makhija et al. (1992)].

Awasthi (2000) lists 74 species of *Graphis* so far known from India in his "Lichenology in Indian subcontinent". We are currently undertaking a detailed survey of this family, which is particularly well represented in India.

As a result of a major revision of the spore genus *Graphis* and studies of recent collections of this genus from India we have discovered approximately 145 species that can be transferred to different genera following the new system set forth by Staiger (2002). Consequently, the transseptate species in the genera —namely, *Acanthothecis*, *Dyplolabia, Fissurina, Graphis, Hemithecium, Platythecium* and *Thalloloma* — are described elsewhere (Makhija & Adawadkar 2003, 2005a,b; Makhija et al. 2005; Adawadkar & Makhija 2004, 2005).

In the present account we describe ten species in the genus *Graphis* with completely carbonized exciple and colourless, transseptate ascospores from India. *Graphis flavens, G. induta, G. marginata* are recorded for the first time from India, and *G. albidofarinacea, G. cinnamomea, G. colliculoides, G. kollaimalaiensis, G. nigrocarpa, G. nilgiriensis,* and *G. verruciformis* are new to science. The two species *G. flavens* and *G. nilgiriensis* without norstictic acid are described in an appendix but are not included in the key.

Materials and Methods

In the present work chemical data has been obtained by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970, Culberson 1972, White & James 1985). All specimens were examined under UV light (365 nm).

We have also consulted morphological and chemical data obtained from the re-examination of type or authentic material of several taxa in the *Graphidaceae* together with photographs of type specimens from the late Dr. Mason Hale, who provided materials for our studies during his several visits to our laboratory at ARI.

Key to the Indian *Graphis* species with norstictic acid, completely carbonized exciples and transseptate ascospores

1a. Ascomata concolorous with the thallus 2

1b. Ascomata dark or black 4

2a. Ascomata short, up to 5 mm long.
Thallus pale grayish brown to brownish gray, thick, warty; ascomata 1–5 mm long, concolorous, simple to branched, immersed; disc narrow; ascospores hyaline, 8–11-transseptate, 33–63 x 4–8 µm; norstictic acid present............ ***G. induta***

2b. Ascomata long, more than 5 mm long.......................................3

3a. Thallus pale grayish white, rough, warty; ascomata 4–8 mm long, simple to branched, immersed to semi-immersed, terminally acute to subacute; disc white pruinose; ascospores hyaline, 12–14-transseptate, 55–71 x 6–8 µm; norstictic acid present .... ***G. albidofarinacea***

3b. Ascomata concolorous with the thallus.
Thallus greenish gray, glossy, uneven; ascomata 1–8 mm long, concolorous, simple to rarely branched; disc white pruinose; ascospores hyaline, 18–21-transseptate, 96–105 x 10–12 µm; norstictic and con-norstictic acids present ... ***G. marginata***

4a. Salazinic acid present.
Thallus greenishyellowto yellowish brown, finely cracked; ascomata 0.3–8 mm long, black, simple to rarely branched, immersed, terminally acute to subacute; disc cinnamon coloured in wet condition; ascospores 7–15-transseptate, 21–42 x 5–8 µm; norstictic and salazinic acids present .... ***G. cinnamomea***

4b. Salazinic acid absent 5

5a. Ascospores upto 50 µm long 6

5b. Ascospores more than 50 µm long 7

6a. Thallus dull greenish gray, warty; ascomata 1–4 mm long, black; ascospores 6–12-transseptate, 37–50 x 4–6 µm; norstictic acid present .... ***G. verruciformis***

6b. Thallus grayish, evanescent; ascomata 0.5–2 mm long, black, simple to branched, semi-emergent, ends round; ascospores 5–9-transseptate, 21–27 x 4–6 µm; norstictic acid present .... ***G. colliculoides***

7a. Thallus green, flaking; ascomata 1–5 mm long, black, simple, triradiately to sparsely and irregularly branched; ascospores 9–13-transseptate, 50–71 x 8–12 µm; norstictic acid present .... ***G. kollaimalaiensis***

7b. Thallus greenish to yellowish buff; ascomata 1–10 mm long, black; exciple present below; ascospores 8–14-transseptate, 33–63 x 4–6 µm; norstictic acid present .... ***G. nigrocarpa***

Taxonomic descriptions

Graphis albidofarinacea **Adaw. & Makhija sp. nov.** **Figure 1**

> *Similis* Graphis immersa *Fink sed thallo farinaceo, ascomata albo pruinoso et ascosporis majoribus differt.*
>
> *Etymology:* from the Latin *albidus*, whitish and *farinosus*, mealy; a reference to whitish, effuse thallus.
>
> **Holotype**–India, Tamil Nadu, Kodaikanal, 24.9.1973, *P.G. Patwardhan & M.B. Nagarkar, 73.2254*; holotype: AMH.

Thallus whitish grayish-green, rough, unevenly thickened, warty, somewhat effuse to granular. **Ascomata** lirelline, 4–8 mm long, 0.2–0.3 mm broad, simple to branched, irregularly spread, immersed to slightly emergent, terminally acute to obtuse. Disc black when exposed, white pruinose. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, not striate, laterally to completely carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not inspersed, 138–232 µm high and 168–315 µm broad, I-, KI-. **Hypothecium** orange yellow, thick, 42–63 µm high. **Paraphyses** simple, long, thin. **Asci** 6–8 sporate. **Ascospores** hyaline, 12–14-transseptate, ellipsoidal, 55–71 x 6–8 µm, I + blue.

Chemistry– Norstictic acid present.

> **Specimens examined**–**Tamil Nadu:** Kodaikanal, Munnar road, *P.G. Patwardhan & M.B. Nagarkar*, 73.2248, 73.2253; Kodaikanal, *C.R. Kulkarni & P.D. Badhe*, 73.2247, 73.2249; *P.G. Patwardhan & C.R. Kulkarni*, 73.2251 (AMH).

Remarks–The new species *Graphis albidofarinacea* is comparable to *G. immersa* in the nature of the exciple, but differs from the latter species in having white mealy thallus, ascomata covered with white pruina and large ascospores. Ascospores are 38–45 µm long in *G. immersa*.

Graphis albidofarinacea closely resembles an Australian species *G. stenospora* var. *deficiens* A.W. Archer and *G. catherinae* A.W. Archer but they have no lichen substances in their thalli.

Graphis cinnamomea Adaw. & Makhija sp nov. Figure 2

> *Similis* Graphis adpressa *Vain. sed acida norsticticum et salazincium continens differt.*
>
> *Etymology:* from the Latin *cinnamomeus*, mixed with yellowish and red; a reference to disc colour.
>
> Holotype–India, Tamil Nadu, Kodaikanal, near Golf Club, 24.1.1975, *P.G. Patwardhan & A.V. Prabhu, 75.184*; holotype:AMH.

Thallus greenish yellow to yellowish brown, thick, delimited by thin, black hypothallus. **Ascomata** lirelline, black, 0.3–8 mm long and 0.1–0.2 mm broad, simple to branched, immersed, terminally obtuse. **Disc** narrow, black, cinnamon coloured when wet, pruinose. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, not striate, laterally to completely carbonized. **Epithecium** hyaline to light brown, thin, K-. **Hymenium** hyaline, not inspersed, 52–87 µm high and 105–157 µm broad, I-, KI-. **Hypothecium** hyaline to light orange, 17–21 µm thick. **Asci** 8 sporate. **Ascospores** hyaline, 7–15-transseptate, ellipsoidal, 21– 42 x 5–8 µm, I+ blue.

Chemistry– Norstictic and salazinic acids present.

> **Specimens examined**–**Tamil Nadu:** Sim's Park, Coonoor, *P.D. Badhe & C.R. Kulkarni*, 73.814; Niligiri hills, Korakundha, *P.G. Patwardhan* 73.1473 (AMH).

Remarks–*Graphis cinnamomea* is characterized by mostly simple ascomata with cinnamon coloured disc covered by white pruina, the not striate, laterally to completely carbonized exciple and the presence of norstictic and salazinic acids. The new species is distinguished from the externally similar *G. adpressa* by the absence of lichen substances and larger ascospores of 46–58 x 12–5 µm in that species. The combination of norstictic and salazinic acids is rather rare in *Graphis*.

The most closely related *Graphis emersa* Müll. Arg., a species from Queensland, differs from the new species in having only norstictic acid, while the new species has salazinic acid in addition to the norstictic acid in its thallus.

Graphis colliculoides Adaw. & Makhija **sp. nov.** Figure 3

> *Similis* Platythecium colliculosum *(Mont.) Staiger sed excipulo omnino carbonaceo et acidum norsticticum continens differt.*
>
> *Etymology:* from the species name *colliculosum*.
>
> Holotype–India, Tamil Nadu, Devicolam, 25.1.1976, *P.G. Patwardhan, 76.701*; holotype: AMH.

Thallus grayish green, thin, mostly evanescent, sparsely cracked with age, delimited by thin, black hypothallus. **Ascomata** lirelline, 0.5–2 mm long, 0.1–0.2 mm broad, black, simple to branched, semiemergent, terminally round. **Disc** black, narrow to moderately broad, epruinose. **Exciple** convergent, covered by a crystal studded thalline margin up to the top, not striate, completely carbonized. **Epithecium** hyaline to light brown, K-. thin. **Hymenium** hyaline, not inspersed, 96–105 µm high and 147–155 µm broad, I-, KI-. **Hypothecium** hyaline to pale, thin. **Asci** 8 sporate. **Ascospores** hyaline, 5–9-transseptate, ellipsoidal, 21–27 x 4–6 µm, I + blue.

Chemistry– Norstictic acid present.

Remarks–The present new species resembles *Platythecium colliculosum* in its appearance.

However, *Platythecium colliculosum* has non carbonized exciple and has salazinic and protocetraric acids in its thallus.

It is somewhat similar to *Graphis centrifuga* Räsänen and *G. semiaperta* Müll. Arg. with respect to the characters of ascospores and the chemistry but *G. centrifuga* has the hymenium inspersed and has large lirellae arranged in well defined stellate clusters, where as *G. semiaperta* has mostly simple lirellae and a black epithecium.

Graphis induta Müll. Arg., Hedwigia 30: 185, 1891. **Figure 9**

Thallus buff with pinkish tinge, pale grayish brown to brownish gray, thick, distinctly warty, cracked. **Ascomata** lirelline, 1–5 mm long, 0.1 mm broad, concolorous with the thallus, simple to branched, immersed, crowded, terminally acute to obtuse. **Disc** blackish, covered by white pruina. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, not striate, completely carbonized. **Epithecium** hyaline, thin, K-. **Hymenium** hyaline, not inspersed, 120–150 µm high and 170–200 µm broad, I-, KI-. **Hypothecium** hyaline, thin. **Asci** 4–6 sporate. **Ascospores** hyaline, (4-) 8–11-transseptate, ellipsoidal, 33–63 x 4–8 µm, I + blue.

Chemistry– Norstictic acid present.

> **Specimens examined**– **Tamil Nadu:** Kollaimalai, *M.B. Nagarkar & P.G. Patwardhan* 85.1625, 85.1626 (AMH).

Remarks–*Graphis induta* can easily be distinguished by its distinctly warty, buff coloured thallus with pinkish tinge; concolorous, crowded ascomata; disc black, white pruinose; not striate, completely carbonized exciple; (4-) 8–11 -transseptate ascospores of 33–63 x 4–8 µm.

The species resembles *Graphis anguilliformis* Taylor but that is distinguished from the present species by the tall, heavily carbonized, robust exciple, larger (75–110 µm long) ascospores and absence of lichen substances in *G. anguilliformis*.

Graphis kollaimalaiensis Adaw. & Makhija **sp. nov.** **Figure 6**

> *Similis* Graphis turgidula *var.* norstictica *A.W. Archer sed lirellis longiorobus et ascosporis locularibus minores differt.*
>
> *Etymology:* from the Latin *ensis*, a place of origin, and Kollaimalai, the type locality.
>
> **Holotype**–India, Tamil Nadu, Kollaimalai, 15.10.1985, *M.B. Nagarkar & P.G. Patwardhan, 85.1526*; holotype:AMH.

Thallus green, flaking, cracked, thick. **Ascomata** lirelline, 1–5 mm long, 0.1 mm broad, black, simple to sparsely branched, straight to curved, flat to slightly raised above, scattered, terminally obtuse. **Disc** narrow to slightly broad, dark blackish brown. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, not striate, completely carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not inspersed, 150–160 µm high and 200–210 µm broad, I-, KI-. **Hypothecium** hyaline, thin. **Asci** 8 sporate. **Ascospores** hyaline, 9–13-transseptate, ellipsoidal, 50–71 x 8–12 µm, I + blue.

Chemistry– Norstictic acid present.

> **Specimens examined**–**Tamil Nadu:** Kollaimalai, *P.G. Patwardhan & M.B. Nagarkar* 85.1525, 85.1636, 85.1637 (AMH).

Remarks–The present new species seems to be similar to *Graphis tenuescens* Nyl. from which it differs in having 8 sporate asci. In *G. tenuescens* the asci are 1–2 sporate.

It can easily be distinguished from the somewhat similar species *Graphis leucoparypha* Kremp. by its thick, flaking thallus, much conspicuous lirellae and with only 9–13-transseptate ascospores. *Graphis leucoparypha* has (15-) 16–18 (-20) locular ascospores and has only 0.5–2(-3) mm long lirellae.

Graphis marginata Raddi, Memor. Soc. Ital. Sc. 18: 344, 1820. Figure 5

Thallus greenish gray, thick, uneven, cracked, glossy. **Ascomata** lirelline, 1–8 mm long, 0.1–0.2 mm broad, concolorous, simple to rarely branched, immersed to slightly raised, scattered, terminally round. **Disc** very narrow, black, covered by white pruina. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, not striate, slightly irregular outline, thick, completely carbonized. **Epithecium** brownish, thin. **Hymenium** light orange yellowish tinged, 176–189 µm high and 163–168 µm broad, not inspersed, I-, KI-. **Hypothecium** pale yellowish, 6–8 µm high. **Asci** 6–8 sporate. **Ascospores** hyaline, 18-21-transseptate, ellipsoidal, 96–105 x 10–12 µm, I + blue.

Chemistry– Norstictic and con-norstictic acids present.

> **Specimens examined–Tamil Nadu:** Anamalai hills, Topslip, *M.B. Nagarkar & U.V. Makhija*, 82.142, 82.173 (AMH).

Remarks–*Graphis marginata* resembles *G. congesta* in respect of external morphology and exciple nature. However, *G. congesta* has much smaller ascospores of 50–75 x 9–15 µm in size and only norstictic acid in its thallus. *G. marginata* was previously reported from Brazil and is here reported for the first time from India. In India this species has been collected in semi-evergreen forest at higher elevation.

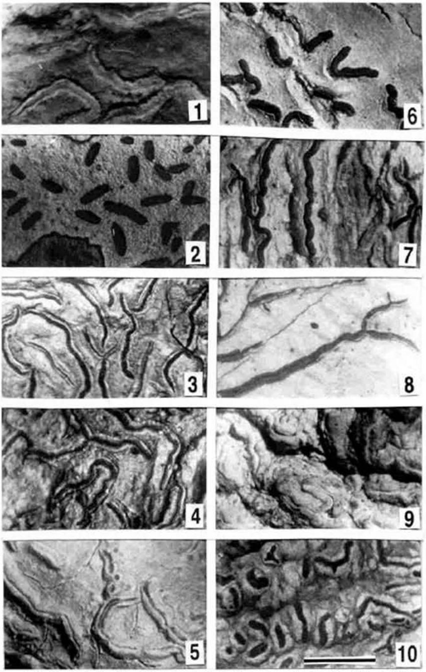
Graphis nigrocarpa Adaw. & Makhija **sp. nov.** Figure 7

> *Similis* Graphis kollaimalaiensis *sp. nov. sed lirellis longioribus et ascosporis angustibus differt.*
>
> *Etymology:* from the Latin *niger*, black and from Greek *karpos*, fruit, a reference to black lirellae.
>
> Holotype–India, Tamil Nadu, Munnar to Kodai, 24.1.1976, *M.B. Nagarkar & K.D. Gole*, *76.623*; holotype: AMH.

Thallus dull yellow, yellowish buff, unevenly thickned, delimited by thin black hypothallus. **Ascomata** lirelline, 1–10 mm long and 0.1–0.2 mm broad, black, simple to irregularly branched, flexuose, immersed to slightly raised, terminally acute to subacute. **Disc** narrow, indistinct. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, crystals studded, not striate, completely carbonized. **Epithecium** hyaline, thin, K-. **Hymenium** hyaline, clear to sometimes inspersed with crystals, 126–168 µm high and 84–168 µm broad, I-, KI-. **Hypothecium** hyaline, 6–8 µm high. **Asci** 4–6 sporate. **Ascospores** hyaline, 8–14-transseptate, ellipsoidal, 33–63 x 4–6 µm, I + blue.

Chemistry– Norstictic acid present.

> **Specimens examined–Tamil Nadu:** Munnar to Kodai, *M.B. Nagarakar & K.D. Gole*, 76.586, 76.587, 76.113 (AMH).



Figures1-10. Habit. 1. *Graphis albidofarinacea*, 2. *G. cinnamomea*, 3. *G. colliculoides*, 4. *G. flavens*, 5. *G. marginata*, 6. *G. kollaimalaiensis*, 7. *G. nigrocarpa*, 8. *G. nilgiriensis*, 9. *G. induta*, 10. *G. verruciformis*. Bar = 2mm

Remarks–*Graphis nigrocarpa* differs from *G. kollaimalaiensis* in having much larger (up to 10 mm long) irregularly branched ascomata and has narrower ascospores. This species has been collected in montane forest.

Graphis nigrocarpa can easily be separated from *G. rustica* Kremp. by the presence of stictic acid, slightly larger ascospores (66–76 x 9–10 µm) and more number of locules (16–18 locules) of the ascospores in *G. rustica*.

The new species seems to be very similar to *Graphis catherinae* but that species lacks lichen substances.

Graphis verruciformis Adaw. & Makhija sp. nov. Figure 10

Similis Graphis congesta *(Fée) Müll. Arg. sed ascosporis minoribus differt.*

Etymology: from the Latin *verruca*, wart; a reference to warty thallus.

Holotype–India, Kerala, near Chinnar, Munnar to Udumalpet, 19.10.1985, *P.G. Patwardhan & M.B. Nagarkar, 85.1756*; holotype:AMH.

Thallus dull grayish green, smooth to thick, finely and distinctly cracked, rough, distinctly warty. **Ascomata** lirelline, 1–4 mm long, 0.1 mm broad, black, simple, semi-emergent, scattered, terminally acute to obtuse. **Disc** narrow to moderately broad, dark blackish brown, pruinose. **Exciple** present at the base, convergent, covered by a thalline margin up to the top, not striate, completely carbonized. **Epithecium** hyaline, thin, K-. **Hymenium** hyaline, not inspersed, 110–130 µm high and 150–190 µm broad, I-, KI-. **Hypothecium** hyaline, thin. **Asci** 8 sporate. **Ascospores** hyaline, 6–12-transseptate, ellipsoidal, 37–50 µm x 4–6 µm, I + blue.

Chemistry– Norstictic acid present.

Remarks–*Graphis verruciformis* differs from the closely related *G. congesta* in having smaller ascospores of 37–50 µm x 4–6 µm. In *Graphis congesta* ascospores are rather larger of 50–75 µm long.

Appendix

Graphis flavens Müll. Arg., Flora 85: 334, 1882. Figure 4

Thallus yellowish green, uneven, cracked, delimited by thin, black hypothallus. **Ascomata** lirelline, 1–2.5 mm long, narrow, mostly simple to occasionally branched, concolorous with the thallus, scattered, immersed to semiemergent, irregularly curved, flexuose, terminally obtuse. **Disc** narrow, black, epruinose. **Exciple** present at the base, convergent, covered by a thalline margin upto the top, crystal studded, not striate, completely carbonized. **Epithecium** brownish, thin, K-. **Hymenium** hyaline, not inspersed, 97–105 µm high and 100–105 µm broad, I-, KI-. **Hypothecium** hyaline, 8–12 µm thick. **Asci** 8 sporate. **Ascospores** hyaline, 14–18-transseptate, ellipsoidal, 29–63 x 8–12 µm, I+ blue.

Chemistry– No lichen substances present.

Specimens examined–**Tamil Nadu:** Agasthi hills, Upper Kodayar, on road side tree, on Kakachi road, elev. approx. 1400 m., *P.G. Patwardhan & P.K. Sethy*, 84.76, near Chinnar, Munnar-Udumalpet, *M.B. Nagarkar & P.G. Patwardhan*, 85.1751 (AMH).

Remarks–*Graphis flavens*, a species previously reported from Java, is reported for the first time from India. This species has been collected in undisturbed forest at higher elevation, in montane forest.

Graphis nilgiriensis Adaw. & Makhija **sp. nov.** Figure 8

> *Similis* Graphis proserpens *Vain. sed excipulo omnino carbonaceo differt et acidum sticticum continens.*
>
> *Etymology:* from the Latin *ensis*, a place of origin, and Nilgiri, the type locality.
>
> **Holotype**–India, Tamil Nadu, Nilgiri hills, Naduvattam, in Shola forest, app. 5000 ft., 25.2.1978, *P.G. Patwardhan, 78.109*; holotype:AMH.

Thallus yellowish green, thick, smooth, glossy, delimited by thin, black hypothallus. **Ascomata** lirelline, 1–5(-7) mm long and 0.1 mm broad, simple to branched, black, raised, scattered, narrow, terminally acute to subacute. Disc narrow to somewhat broader. **Exciple** convergent, covered by a thick thalline margin till the top, striate, 5–6 striae on each side, striae fused, much expanded at the apical region, completely carbonized. **Epithecium** hyaline, thin. **Hymenium** hyaline, not inspersed, 60–70 µm high and 120–149 µm broad, I-, KI-. **Hypothecium** indistinct. **Asci** 8 sporate. **Ascospores** hyaline, 9–13-transseptate, ellipsoidal, 38–42 x 4–6 µm, I+ blue.

Chemistry– Stictic acid present.

Remarks–*Graphis nilgiriensis* is characterized by its stramineous thallus; conspicuous, black, narrow, semi-emergent ascomata; striate, completely carbonized exciple; 38–42 µm long ascospores and presence of stictic acid. It resembles to *Graphis proserpens* in gross morphology, but differs from the latter in having completely carbonized exciple and fewer striae. *G. proserpens* has partially carbonized and multistraite exciple. *G. persulcata* Stirt., which resembles closely to the present species, however, lacks lichen substances. This lichen has been collected from evergreen montane forest.

Literature Cited

Adawadkar B, Makhija U. 2004. A new isidiate species of lichen genus *Graphis* from India. *Lichenologist* **36(6)**: 361-363

Adawadkar B, & Makhija U. 2005. Some transseptate species of the genera *Hemithecium* and *Platythecium* from India. Mycotaxon **92**: 387-394.

Awasthi DD. 1965. Catalogue of the Lichens from India (Nepal, Pakistan and Ceylon). Beih. Nova Hedwigia **17**: 1-137.

Awasthi DD. 2000. Lichenology in Indian Subcontinent. Publ. By Bishen Singh Mahendra Pal Singh, Dehradun, Pp. 1-124.

Awasthi DD, Singh KP. 1975. Observation on some Graphidaceous lichen taxa. Phyta **1**: 34-40.

Awasthi DD, Singh SR. 1977. Five new taxa of saxicolous lichens from Meghalaya, India. Norw. J. Bot. **24**: 1-8.

Bélanger MV. 1838. Voyage aux Indes Orientales. Années 1825-29 Botanique, II. Partie, Cryptogamie par ch. Bélander et Bory de St. Vincent. Paris, 1834-38. (Lichens, pp. 113-144) 192 pp.

Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. J. Chromatogr. **72**: 113-125.

Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. J. Chromatogr. **46**: 85-93.

Jatta A. 1905. Licheni esotici dell Erbario Levier, raccolti nell' Asia Meridionale e nell'Oceania. Malpighia **17:** 3-15

Kirk PM, Canon PF, David JC, Stalpers JA (eds.) 2001. Dictionary of the fungi 9th edition. Publ. By Commenwealth Agricultural Bureau.International (CABI), UK. Pp. 1-655.

Kulkarni CR. 1977. A new species of *Graphis* from Western Ghats, South Western India. Biovigyanam **3:** 115-116.

Leighton WA. 1869. The lichens of Ceylon collected by G.H.K. Thwaites. Trans. Linn. Soc. London **27:** 161-186.

Makhija U, Adawadkar B. 2003. A new species of *Acanthothecis* from India. Mycotaxon **88:** 139-141.

Makhija U, Adawadkar B. 2005a. Some additions to the *Graphidaceae* in the Andaman islands, India. Mycotaxon **91:** 347-352.

Makhija U, Adawadkar B. 2005b. Some new species of *Graphis* (Lichenised Ascomycota) from the Andaman and Nicobar Islands of India. Mycotaxon **91:** 369-379.

Makhija U, Dube A, Adawadkar B, Chitale GC. 2005. Some species of Lichen genera *Dyplolabia* and *Graphis* from Maharashtra, India. Geophytology (in press).

Makhija U, Kekare S, Patwardhan PG. 1992. Materials for a lichen flora of the Andaman Islands: VII-The family *Graphidaceae*. Biovigyanam **18(1):** 12-20.

Nagarakar MB, Patwardhan PG. 1982. Notes on some lichens from North East India IV: Genus *Graphis*. Biovigyanam **8:** 125-131.

Nylander WL. 1867. Lichenes Kurziani e Calcutta. Flora **50:** 3-9.

Nylander WL. 1891. Sertum Lichenaeae tropicae e Labuan et Singapore. Paris, 48 pp

Nylander WL. 1900. Lichenes Ceylonenses. Acta Soc. Sci. Fenn. **26(10):** 1-16.

Patwardhan PG, Kulkarni CR. 1976. Some additions to the lichen flora of India IV: *Graphis* and *Graphina* (Family *Graphidaceae*). Biovigyanam **2:** 123-132.

Patwardhan PG, Kulkarni CR. 1979. Some new taxa of the family *Graphidaceae* from Western Ghats, Southwestern India. Norw. J. Bot. **26:** 45-52.

Räsänen V. 1952. Lichenes Novi, VII, Arch. Soc. Zool. Bot. Fenn. "Vanamo". **5(1):** 25-32.

Singh KP, Sinha GP. 1994. Flora of Nagaland. Publ. By Bishen Singh Mahindra Pal Singh, Dehradun, Pp. 1-498.

Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. Biblio Lichenol. **85:** 1-526.

Stirton J. 1879. New and rare lichens from India and the Himalaya. Proc. Phil. Soc. Glasgow **11:** 306-322.

White FJ, James PW 1985. A new guide to microchemical techniques for the identification of lichen substances. Bull. British Lichen Soc. **57:** 1-41 (Suppl.)

MYCOTAXON

Volume 96, pp. 61–71 *April–June 2006*

Four species of *Caloplaca* (*Teloschistaceae*, lichenized Ascomycota) new to Poland

KARINA WILK[1] & ADAM FLAKUS[2]

[1]palka@ib-pan.krakow.pl [2]flakus@ib-pan.krakow.pl
Laboratory of Lichenology, W. Szafer Institute of Botany
Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland

Abstract — The species *Caloplaca conciliascens*, *C. obliterans*, *C. percrocata* and *C. vitellinaria* are reported as new to the lichen biota of Poland. All of them were collected in the Polish Carpathians, mainly in the Tatra mountains. Detailed taxonomic descriptions and comments are provided.

Key words — lichenized fungi, taxonomy, geographical distribution

Introduction

The lichen genus *Caloplaca* Th. Fr. has been the subject of taxonomic surveys by many authors. Most recently European species of the genus were studied in detail by Giralt et al. (1992), Laundon (1992a), Nimis (1992), Roux & Navarro-Rosinés (1992), Søchting (1994), Navarro-Rosinés & Roux (1995), Navarro-Rosinés & Hladun (1996), Søchting & Stordeur (2001) and Khodosovtsev (2001, 2002), Arup (2006). North American *Caloplaca* species have been investigated by Arup (1992ab, 1993ab, 1994, 1995ab), Wetmore (1994, 1996a, 2001, 2003, 2004) and Wetmore & Kärnefelt (1998, 1999). Antarctic species are also fairly well known (e.g., Søchting & Øvstedal 1992; Olech & Søchting 1993; Søchting & Olech 1995, 2000). Polish species of the genus have not been investigated in detail, however, and are in need of taxonomic revision. Currently 67 taxa have been reported from Poland (Nowak & Tobolewski 1975, Fałtynowicz 2003), approximately 50 of which occur in the Polish Carpathians (Bielczyk 2003). New records of *Caloplaca* for Poland have recently been supplied by Kossowska (1999), Zalewska (2000), Bielczyk (2003), Sparrius (2003), and Ceynowa-Giełdon & Adamska (2005).

The paper is based mainly on collections made by the second author during fieldwork in the Polish Tatra Mts. in 2002-2004. The study area plays an important role for the preservation of biological diversity including lichens, not only in Poland but also on a European scale. Despite the long tradition of lichenological research in the Polish Tatra Mts., many species are still being discovered from the area (e.g., Bielczyk 2003, Czarnota 2004, Flakus 2004, Krzewicka 2004, Kukwa 2004, Flakus & Bielczyk 2006, Śliwa 2006).

The present paper contributes to the study of the genus *Caloplaca* in Poland and expands the knowledge of lichen diversity in the Polish Carpathians. Detailed taxonomic descriptions and comments are presented below.

Taxonomic Descriptions

Caloplaca conciliascens (Nyl.) Zahlbr. FIGURE 1a
Catal. Lich. Univ. 7, p. 109 (1931)

Thallus small, indistinct, areolate, greyish white. Apothecia sessile, clustered, angular, 0.5–1.0 mm diam. Disc flat to slightly convex, brownish red. Margin persistent, thin, slightly flexuose, black. Parathecium without algae, inside colourless, outside blackish green. Epihymenium brownish golden; hymenium hyaline, 60–75 µm; hypothecium hyaline, with oil drops, ca. 80 µm; paraphyses simple or with some branches in upper parts, tips with 1–2 slightly swollen cells. Spores 8 per ascus, 10–14 × 5–7 µm, isthmus 3–4(–5) µm.

Spot test reactions: thallus K–, cN+ weakly violet (lecidea green); apothecial margin K+ violet red, cN+ distinctly violet (lecidea green), H+ intensifying green; epihymenium K+ violet red; upper parts of paraphyses H+ weakly greenish.

Ecology — At the collection site, *C. conciliascens* grew on mylonitized granite rock in shady place in the subnival belt of Tatra Mts. It was accompanied by *Lecanora cenisia* Ach.

Geographical distribution — The species is known from Austria (Wunder 1974, Hafellner & Türk 2001), Italy (Nimis 1993) and Turkey (John 1996).

Comments — *Caloplaca conciliascens* is characterized by a reddish black apothecial disc and brownish black margin. Wunder (1974) treated this taxon in the study on saxicolous species of *Caloplaca* with black coloured apothecia. The group of lichens is not homogeneous and this particular species has been considered as a member of *C. ferruginea* group (Wunder 1974, Kärnefelt 1989). Wetmore (1996a) discussed C. conciliascens in his taxonomic treatment of *C. siderites* group in North and Central America. He concluded that *C. conciliascens*, *C. exsecuta* (Nyl.) Dalla Torre & Sarnth., *C. concilians* (Nyl.) H. Olivier, *C. litoricola* Brodo and *C. britzelmayri* (Hue) Zahlbr. are probably closely related and form one distinct group characterized by presence of "dark apothecial margin and lecidea green instead of thalloidima green" (Wetmore 1996a).

Caloplaca conciliascens is very similar to *C. exsecuta*, which is a fairly common species distinguished by a very thin, sometimes almost disappearing thallus, flat to strongly convex apothecia, higher hymenium (65–135 µm) and a hypothecium (50–125 µm), which is always brownish coloured with numerous oil drops and wider spores (5.5–8.0 µm) (Wunder 1974).

Other related species are: *C. concilians* that differs from *C. conciliascens* in having abundant algae in the apothecial margin, *C. britzelmayri* with dirty yellowish apothecium disc, larger spores that occupies calcareous rocks, and *C. litoricola*, which besides distinctive characters of the apothecia is a maritime species known from western coast of North America (Wetmore 1996a,b). Clauzade & Roux (1985) regarded the taxon as closely related to *C. conversa* (Kremp.) Jatta. *Caloplaca conversa* in comparison with *C. conciliascens* produces smaller apothecia of different anatomy – margins usually lecanorine, with distinct oval cells, never black or greenish coloured (Wunder 1974). The two species differ also due to their chemistry (see Wetmore 1996a).

SPECIMEN EXAMINED — POLAND, WESTERN CARPATHIANS, Tatry Wysokie Mts., Ciemnosmreczyńska Przełączka pass, N aspect, slope 30°, mylonite area, subnival belt, alt. 2115 m, 49°11'21"N, 20°02'59"E, on mylonite rock, 7 August 2004, *A. Flakus 3046* (KRAM).

Caloplaca obliterans (Nyl.) Blomb. & Forssell FIGURE 1b

Points-Förteckning, p. 69 (1880)

Thallus small, more or less irregularly shaped in outline, areolate, pale to dark orange. Areoles irregularly shaped, often minutely lobed, plane to convex, scattered or huddled in groups. Hypothallus thin, concolorous with thallus, characterized by dendritic extensions to rock cracks. Soralia in the centre of thallus, concave and eroded, yellowish orange. Apothecia numerous in the centre of thallus, partially innate or adnate, small, up to 0.5 mm diam. Disc flat to slightly convex, orange, surrounded by thin, concolorous or slightly lighter margin. Amphithecium with algae. Epihymenium brownish golden; hymenium hyaline, 50–65 μm; hypothecium hyaline, 40–50 μm; paraphyses with some branches, tips with 1–2 swollen cells, up to 5 μm diam. Spores 10–11.5 × 4 μm, isthmus 2–3 μm.

Spot test reactions: thallus K+ violet red; apothecial margin cN–; epihymenium K+ violet red.

Ecology — At the collection site the species occupied a typical niche, viz.: an overhanging granite wall, in moist and shady place. It was accompanied by *Buellia alboatra* (Hoffm.) Th. Fr., *Lecanora dispersa* (Pers.) Sommerf., *Pseudosagedia chlorotica* (Ach.) Hafellner & Kalb and *Xanthoria elegans* (Link.) Th. Fr. The species is characteristic for the silicate community *Caloplacetum obliterantis* Wirth 1972 (see Wirth 1972, Obermayer 1993).

Geographical distribution — According to Wirth (1995) the species occurs in Europe in boreal to montane and high montane zones of temperate zone. It was reported from Iceland (Orange 1990), Norway, Sweden, Finland, Russian Fennoscandia (Nordin 1972), United Kingdom (Wade 1965, Laundon 1992b, Coppins 2002), Denmark (Søchting & Alstrup 2002), Czech Republic (Vězda & Liška 1999), Slovakia (Pišút 1995, Pišút et al. 1996, Lisická 2005), Ukraine (Kopachevskaya 1986, Oksner 1993), Germany (Wirth 1995), Austria (Obermayer 1993), Romania (Kondratyuk et al. 2003), Hungary (Verseghy 1971), Bulgaria (Mayrhofer et al. 2005), Italy (Nimis 1993), France (Harmand 1913, Ozenda & Clauzade 1970), Portugal (Llimona & Hladum 2001) and Spain (Etayo 1990). Besides Europe it occurs in Southwest Asia in Israel (Alon & Galun 1971) and Jordan (El-Oqlah 1992), in North America (Esslinger 1997, Fryday et al. 2001) and in Australia (Kalb 1996).

Comments — *Caloplaca obliterans*, as a minutely lobate species containing anthraquinones, was included by Nordin (1972) in the *Caloplaca* subgen. *Gasparrinia*. More recently, Wetmore & Kärnefelt (1998) carried out a revision of the lobate and subfruticose species of *Caloplaca* in North and Central America. The authors discussed the species in the paper but did not find any specimens of that taxon in the studied material.

According to Wetmore & Kärnefelt (1998), *C. obliterans* should not be included in subgen. *Gasparrinia* as it does not develop distinct elongated lobes.

Caloplaca obliterans resembles *C. cirrochroa* (Ach.) Th. Fr., *C. proteus* Poelt and *C. decipiens* (Arnold) Blomb. & Forssell, but those species occur on calcareous substrate. There are also some morphological differences between the taxa: *C. cirrochroa* and *C. proteus*, have a thallus consisting of more convex and longer lobes in comparison with *C. obliterans* and *C. decipiens* has rather lip-shaped or capitate soralia.

Moreover, Arup (1993a, 1995a) compared *C. obliterans* with two other sorediate species, i.e. *C. flavogranulosa* Arup and *C. citrina* (Hoffm.) Th. Fr. However, *C. obliterans* is well distinguishable due to the dark orange colour of thallus, concave and eroded soralia as well as distinct, dendritic hypothallus (Arup 1993a, 1995a).

Caloplaca obliterans has been reported from many European countries where it is usually collected in sterile form. The apothecia, which develop very rarely, are small, only up to 0.5 mm diam. Our collection of *C. obliterans* has a lower hymenium and hypothecium when compared to those provided by Alon & Galun (1971) – 70–90 µm and ca. 90 µm, respectively. Moreover, it is worth noting that our specimen is partly fertile and so has more aggregated areoles lacking soralia and a poorly developed hypothallus.

SPECIMEN EXAMINED — POLAND, WESTERN CARPATHIANS, Tatry Wysokie Mts., Dolina Rybiego Potoku valley, Mokra Wanta, in moist and shaded place, WWN aspect, alt. 1750 m, on overhanging granite wall, 17 August 2002, *A. Flakus 83* (KRAM).

REFERENCE MATERIAL EXAMINED — J. J. Havaas, Lich. Norv. Occid. 218 (KRAM).

Caloplaca percrocata (Arnold) J. Steiner FIGURE 1c

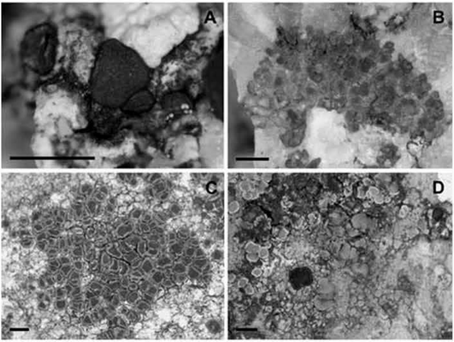
Halácsy in Denkschrift. Math.-naturw. Classe Kais. Akad. Wiss. Wien, vol. LXI, p. 523 (1894)

Thallus thick or thin, areolate, whitish grey, sometimes with a tinge of bluish or brownish. Areoles irregular, with uneven surface, subfarinose, plane to convex, up to 3 mm diam. Hypothallus thin, dark grey and rather rarely visible. Apothecia numerous in the centre of thallus, aggregated in groups, 0.4 to 1.3 mm diam, often angular to flexuose, sessile from the beginning. Disc flat, dark, brownish orange to brownish red, contrasting with pale, yellowish orange, thick margin. Thalline margin pale yellow, soon excluded (only sometimes good visible). Parathecium with radiating hyphae; amphithecium with numerous algae. Epihymenium brownish golden; hymenium hyaline, up to 100 µm; hypothecium hyaline, with oil droplets, ca. 60 µm; paraphyses with some branches. Spores 15–18(–20) × 8–10(–12.5) µm, isthmus 3–4(–5) µm.

Spot test reactions: thallus K–, C–, cN+ weakly violet (thalloidima green); epihymenium K+ violet red. The thallus contains the anthraquinone 7-chloroemodin (detected by U. Søchting).

Ecology — At the collection site the lichen occurred on base-rich siliceous shale on steep slopes in exposed places in the alpine belt. It was accompanied by *Aspicilia* sp., *Eiglera flavida* (Hepp) Hafellner, *Polyblastia cupularis* A. Massal. and *Thelidium* sp.

Geographical distribution — The species was reported from Norway (Santesson et al. 2004), Austria (Poelt 1960, Hoffmann et al. 1998, Türk & Berger 1999), Hungary (Verseghy 1994), Bulgaria (Mayrhofer et al. 2005), Ukraine (Kopachevskaya 1986,



Figs. 1 A-D. Species of *Caloplaca*. A: *C. conciliascens* (*A. Flakus 3046* KRAM); B: *C. obliterans* (*A. Flakus 83* KRAM); C: *C. percrocata* (*A. Flakus 151* KRAM). D: *C. vitellinaria* (*A. Flakus 5120* KRAM). Scale bar = 1 mm.

Oksner 1993), Croatia (Kušan 1953), Italy (Nimis 1993), France (Ozenda & Clauzade 1970, Roux 1976, Houmeau & Roux 1991), Spain (Egea 1984) and Portugal (Llimona & Hladun 2001). Additionally, the species was reported by Kondryatuk et al. (2004) from France, Byelorussia, Turkey and North Africa.

Comments — According to Magnusson (1944a) *C. percrocata* belongs to the *C. ferruginea* group which consists of taxa closely related to *C. ferruginea* (Huds.) Th. Fr. and united by ferrugineous coloured apothecia. Moreover, the species of the *C. ferruginea* group are characterized by containing the chemosyndromes based on 7-chloroemodin (see Søchting & Tønsberg 1997, Elix et al. 2000). This group is rather large and includes species representing all ecological groups of lichens, for example corticolous, lignicolous, muscicolous and saxicolous (Magnusson 1944a,b, Clauzade & Roux 1985, Roux & Navarro-Rosinés 1992).

More recently Wetmore (1996a) established a more restricted *C. siderites* group in which *C. percrocata* was included. This group consists of exclusively saxicolous species characterized by grey, whitish or brown thalli that lack anthraquinones with apothecia that are red or orange and do contain anthraquinones. Furthermore, Wetmore (1996a) reported the non-crystallizing pigment thalloidima green in most of the treated species, including *C. percrocata*. This pigment reacts with K, cN, 10% N, C and concentrated HCl giving a violet colour.

Caloplaca percrocata is a rather characteristic taxon due to the prominent apothecia and the usually distinct areolate thallus. It could be confused with *C. teicholyta* (Ach.) J. Steiner, which has a scurfy-granular to sorediate surface of thallus (not at all or weakly areolate), uniformly red coloured apothecia with usually well visible white thalline margin.

Caloplaca erythrocarpa (Pers.) Zwackh differs in producing smaller and also uniformly red apothecia.

The species *C. atroflava* (Turner) Mong. and *C. submergenda* (Nyl.) H. Olivier may also be considered similar to *C. percrocata* but they differ in ecological preferences (both are acidophilous and hygrophilous) and some morphological details. *Caloplaca atroflava* forms dark grey thallus and apothecia without any thalline margin while *C. submergenda* has apothecia with persistent, greyish thalline margins and produces considerably smaller spores (Clauzade & Roux 1987).

Another acidophilous species, *C. limitosa* (Nyl.) H. Olivier, was also considered as possible to be mistaken with *C. percrocata* (see Nimis 1993). A detailed description of *C. percrocata* is available in several papers, e.g. Magnusson (1944a), Oksner (1993), Wetmore (1996a) and Kondryatuk et al. (2004).

SPECIMENS EXAMINED — POLAND, Western Carpathians, Tatry Zachodnie Mts., Twardy Upłaz, N slope below Ciemniak Mt., alt. 1900 m, 49°14'12"N 19°54'12"E, on siliceous shale contains calcium, 30 August 2002, *A. Flakus 151* (C, KRAM, MIN); and 9 July 2004, *A. Flakus 2251* with *K. Palka* & *B. Cykowska* (KRAM; the duplicates of the specimen will be distributed by Wetmore in Telosch. Exs. Fasc. 4).

REFERENCE MATERIAL EXAMINED — Poelt, Lich. Alp. no. 50 (KRAM).

Caloplaca vitellinaria Szatala FIGURE 1d

Ann. Hist.-Nat. Mus. Natl. Hungarici, ser. nov. 7, p. 276 (1956)

Thallus absent or very scanty, pale orange, over the thallus or apothecia of the host *Candelariella vitellina* (Hoffm.) Müll. Arg. Apothecia numerous, usually grouped and then angular, up to 1 mm diam. Disc flat to slightly convex, orange. Margin thin, paler than disc, flush and only in young apothecia slightly raised. Parathecium with radiating hyphae; amphithecium with numerous algae. Epihymenium brownish golden; hymenium hyaline, 60–70 µm; hypothecium hyaline, ca. 30 µm; paraphyses with branches, tips with 1–2 swollen cells, up to 5 µm diam.; spores 9–14 × 5–8 µm, isthmus (3–)4–5 µm.

Spot test reactions: thallus K+ violet red; epihymenium K+ violet red; hymenium I+ blue; hypothecium, parathecium and amphithecium I–.

Ecology — At the collection site the lichen colonized the thallus of *Candelariella vitellina* on sandstone and shale containing calcium in lower montane and alpine belts of Polish West Carpathians. It was accompanied by *Acarospora* sp., *Lecanora dispersa* and *Lecidella stigmatea* (Ach.) Hertel & Leuckert.

Geographical distribution — The species is known from Slovakia (Pišút et al. 1996, Lisická 2005), Austria (Hafellner & Türk 2001), Hungary (Szatala 1956), the Iberian Peninsula (Llimona & Hladun 2001) and Turkey (John 1996).

Comments — *Caloplaca vitellinaria* is a parasitic species occurring on the thallus of *Candelariella* spp., e.g. *C. vitellina*, *C. coralliza* (Nyl.) H. Magn. (Szatala 1956, Poelt

1969, Wirth 1995, Hafellner 2001). *Caloplaca grimmiae* (Nyl.) H. Olivier is another taxon colonising *Candelariella* spp., but it differs significantly by the colour of apothecia, which have reddish brown discs with blackish brown margins.

Caloplaca vitellinaria was treated by Clauzade & Roux (1985) in connection with the *C. ferruginea* group and was accepted by the authors at variety level of *C. holocarpa* (Hoffm.) A.E. Wade. The primary differences between *C. vitellinaria* and *C. holocarpa* apparently are their ecology, although there are some other distinguishing characters such as size and arrangement of apothecia (bigger and aggregated in case of *C. vitellinaria*).

Caloplaca vitellinaria is similar to *C. insularis* Poelt but the latter taxon has better developed thallus and smaller apothecia (up to 0.8 mm diam.) with medulla reacting distinctly I+ violet. Moreover, *C. insularis* is parasitic on the *Aspicilia* spp., i.e. *A. candida* (L.) Körb. (Poelt 1960), *A. polychroma* Anzi (Clauzade & Roux 1985).

It is worth noting that in the specimens of *C. vitellinaria* examined, both collected by us and A. Vězda, a considerably low hymenium (ca. 80 µm) was observed compared to the original description where it reaches ca. 100–125 µm (Szatala 1956).

SPECIMENS EXAMINED — POLAND, Western Carpathians: Beskid Śląski Mts., Pasmo Baraniej Góry range, Pietraszyna village, Koczy Zamek Mt., in open, sunny place, alt. 847 m, 49°32'54"N 18°58'32"E, on calcareous sandstone, 9 September 2005, *K. Wilk 3838* (KRAM); Tatry Zachodnie Mts., Twardy Upłaz, N slope below Ciemniak Mt., alt. 1900 m, 49°14'14"N 19°54'13"E, on siliceous shale contains calcium, 30 July 2005, *A. Flakus 5120* (KRAM).

REFERENCE MATERIAL EXAMINED — HUNGARY, VESPREM: supra balneas Tihany prope lacum Balaton, alt. 220 m, 17 August 1964, *A. Vězda* (KRAM-L-28050).

Acknowledgements

We sincerely thank C. Roux (Mirabeau, France) and U. Søchting (Copenhagen, Denmark) for peer reviewing the manuscript. We are grateful to L. Śliwa (Kraków, Poland) for valuable comments on the text and to C. Roux for important information on France bibliography. U. Søchting and C. Wetmore (Minnesota, U.S.A.) are acknowledged for confirming *C. percrocata*. Financial support for the study was provided to the second author by Polish Ministry of Education and Sciences for the years 2005-2007 (MEiN, grant no. 2 P04G 078 29).

Literature cited

Alon G, Galun M. 1971. The genus *Caloplaca* in Israel. Israel Jour. Bot. 20: 273-292.

Arup U. 1992a. *Caloplaca stantonii* sp. nov. and its relationship to *Caloplaca bolacina* and other lobate to squamulose species in North America. Bryologist 95(4): 449-457.

Arup U. 1992b. *Caloplaca marina* and *C. rosei*, two difficult species in North America. Bryologist 95(2): 148-160.

Arup U. 1993a. *Caloplaca flavogranulosa* sp. nov. and *C. citrina*, two sorediate species on seashore rocks in western North America. Bryologist 96(4): 598-603.

Arup U. 1993b. *Caloplaca luteominia* and *C. bolanderi* in western North America. Bryologist 96(3): 463-470.

Arup U. 1994. The genus *Caloplaca* on seashore rocks in eastern North America. Bryologist 97(4): 377-392.

Arup U. 1995a. Littoral species of *Caloplaca* in North America: a summary and key. Bryologist 98(1): 129-140.

Arup U. 1995b. Eight species of *Caloplaca* in coastal western North America. Bryologist 98(1): 92-111.

Arup U. 2006. A new taxonomy of the *Caloplaca citrina* group in the Nordic countries, except Iceland. Lichenologist 38(1): 1-20.

Bielczyk U. (ed.). 2003. The Lichens and Allied Fungi of the Polish Carpathians - An Annotated Checklist. Biodiversity of the Polish Carpathians, Vol. 1, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków. 342 pp.

Ceynowa-Giełdon M, Adamska E. 2005. *Caloplaca ruderum*, a lichen species new to Poland. Polish Bot. J. 50(1): 75-76.

Clauzade G, Roux C. 1985. Likenoj de Okcidenta Eŭropo. Ilustrita Determinlibro. Bull. Soc. Bot. Centre-Ouest, Numero Special 7. Royan, France. 893 pp.

Clauzade G, Roux C. 1987. Likenoj de Okcidenta Eŭropo. Suplemento 2a. Bull. Soc. Bot. Centre-Ouest, nov. sér., 18: 177-214.

Coppins BJ. 2002. Checklist of Lichens of Great Britain and Ireland. British Lichen Society. 87 pp.

Czarnota P. 2004. New and rare species of the genus *Micarea* (Micareaceae) in the lichen flora of Poland. Polish Bot. J. 49(2): 135-143.

Egea JM. 1984. Contribución al conocimiento del genero *Caloplaca* Th. Fr. en España: especies saxicolas. Coll. Bot. (Barcelona) 15: 173-204.

Elix JA, Wardlaw JH, Søchting U. 2000. Two new anthraquinones from the lichen *Caloplaca spitsbergensis*. Herzogia 14: 27-30.

El-Oqlah AA. 1992. The lichen flora of Jordan. A catalogue of species and ecological notes. Dirasat 19B: 109-121 [http://www.biologie.uni-amburg.de/checklists/middleeast/jordan_l. htm (viewed online on January 23 2005)].

Esslinger TL. 1997. 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 (viewed online on January 23 2005)].

Etayo J. 1990. Algunos líquenes saxícolas del Pirineo Aragonés. Lucas Mallada 2: 81-102.

Faltynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland. An annotated checklist. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków. 435 pp.

Flakus A. 2004. New and rare lichen species of the Polish Tatra Mountains. Polish Bot. J. 49(1): 79-91.

Flakus A, Bielczyk U. 2006. New and interesting records of lichens from the Tatry Mountains. In: Lackovičová A, Guttová A, Lisická E, Lizoň P. (eds.), Central European lichens – diversity and threat. Mycotaxon, Ithaca (in press).

Fryday AM, Fair JB, Googe MS, Johnson AJ, Bunting EA, Prather LA. 2001. Checklist of lichens and allied fungi of Michigan. Contributions to the University of Michigan Herbarium 23: 145-223.

Giralt M, Nimis PL, Poelt J. 1992. Studien über den Formenkreis von *Caloplaca flavorubescens* in Europa. Cryptogamie, Bryol., Lichénol., 13(3): 261-273.

Hafellner J. 2001. Bemerkenswerte Flechtenfunde in Österreich. Fritschiana 28: 1-30.

Hafellner J, Türk R. 2001. Die lichenisierten Pilze Österreichs - Eine Checkliste der bisher nachgewiesenen Arten mit verbreitungsangaben. Stapfia 76: 1-167.

Harmand J. (abbé) 1913. Lichenes de France. Catalogue systématique et descriptif. Crustacés. Pannariés, heppiés, lécanorés, pertusariés, thélotremés. Léon Lhomme, Paris. 761-1185 pp.

Hoffmann P, Berger F, Obermayer W, Wittmann H, Breuss O, Sipman H. 1998. Ergänzungen zur Flechtenflora der Ötztaler Alpen (Tirol, Österreich). Ergebnisse der BLAM-Exkursion 1993. Herzogia 13: 155-164.

Houmeau J-M, Roux C. 1991. Contribution à l'étude des lichens et des champignons lichénicoles des Pyrénées. Bull. Soc. Bot. Centre-Ouest, nov. sér., 22: 545-556.

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

Kalb K. 1996. Additional lichen records from Australia. 29. Australasian Lichenological Newsletter 39: 28-34.

Kärnefelt I. 1989. Morphology and Phylogeny in the Teloschistales. Crypt. Bot. 1: 147-203.

Khodosovtsev OYe. 2001. A new for Ukraine species of the genus *Caloplaca* Th. Fr. (*Teloschistaceae*). Ukr. Botan. Journ. 58(4): 460-465.

Khodosovtsev OYe. 2002. A new for Ukraine and rare species of the genus *Caloplaca* Th. Fr. (*Teloschistaceae*) from southern Ukraine. Ukr. Botan. Journ. 59(3): 321-329.

Kondryatuk SYa, Khodosovtsev AYe, Oksner AN. 2004. *Caloplaca*. In: Khodosovtsev AYe, Kondratyuk SYa, Makarova II, Oksner AN. Handbook of the lichens of Russia. 9. *Fuscideaceae, Teloschistaceae*. Russian Academy of Sciences, St. Petersburg. 340 pp.

Kondratyuk SYa, Popova LP, Lackovičová A, Pišút I. 2003. A catalogue of Eastern Carpathian lichens. Kiev-Bratislava, M.H. Kholodny Institute of Botany. 264 pp.

Kopachevskaya YeG. 1986. Likhenoflora Kryma i yeyo analiz. Izdatel'stvo „Naukova Dumka", Kiev.

Kossowska M. 1999. *Caloplaca crenulatella* (Teloschistaceae) – a lichen species new to Poland. Fragm. Flor. Geobot. Ann. 44(2): 531-532.

Krzewicka B. 2004. Porosty Hali Gąsienicowej w Tatrach Wysokich. Część I. Fragm. Flor. Geobot. Polonica 11(2): 365-370.

Kukwa M. 2004. Porosty z rodzaju *Lepraria* w Tatrzańskim Parku Narodowym. Parki Nar. Rez. Przyr. 23: 3-12.

Kušan F. 1953. Prodromus flore lišaja Jugoslavije. Posebna izdanja odjela za prirodne nauke, Knjiga II. Jugoslavenska Akademija Znanosti i i Umjetnosti, Zagreb.

Laundon JR. 1992a. New British species of *Caloplaca*. Lichenologist 24(1): 1-5.

Laundon JR. 1992b. *Caloplaca* Th. Fr. (1860). In: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. (eds.), The lichen flora of Great Britain and Ireland. Natural History Museum Publications, London. 401-404 pp.

Lisická E. 2005. The lichens of the Tatry Mountains. Veda, the Publishing House of the Slovak Academy of Sciences, Bratislava. 439 pp.

Llimona X, Hladun NL. 2001. Checklist of the lichens and lichenicolous fungi of the Iberian Peninsula and Balearic Islands. Bocconea 14: 5-581.

Magnusson AH. 1944a. Studies in the *ferruginea*-group of the genus *Caloplaca*. Göteborgs Kungl. Vetenskapsoch Vitterhets Samhälles Handlingar, Sjätte Följden, Ser. B. 3(1): 1-71.

Magnusson AH. 1944b. Some species of *Caloplaca* from North America. Bot. Not. 1944: 63-79.

Mayrhofer H, Denchev CM, Stoykov DY, Nikolova SO. 2005. Catalogue of the lichenized and lichenicolous fungi in Bulgaria. Mycol. Balcanica 2: 3-61.

Navarro-Rosinés P, Hladun NL. 1996. Les especies saxicolo-calcícolas del grupo de *Caloplaca lactea* (Teloschistacceae, líquenes), en las regiones mediterranea y medioeuropea. Bull. Soc. Linn. Provence 47: 139-166.

Navarro-Rosinés P, Roux C. 1995. *Caloplaca navasiana* Nav.-Ros. et Roux sp. nov., espèce nouvelle de lichen du littoral méditerranéen. Cryptogamie, Bryol., Lichénol., 16(2): 89-97.

Nimis PL. 1992. Chiavi analitiche del genere *Caloplaca* Th. Fr. in Italia (Lichenes, Teloschistaceae). Not. Soc. Lich. Ital. 5: 9-28.

Nimis PL. 1993. The lichens of Italy. An annotated catalogue. Museo Regionale di Scienze Naturali, Torino, Monogr. 12: 1-897.

Nordin I. 1972. *Caloplaca*, sect. *Gasparrinia* i Nordeuropa. Taxonomiska och ekologiska studier. Skriv Service AB, Uppsala. 184 pp.

Nowak J, Tobolewski Z. 1975. Porosty polskie. Opisy i klucze do oznaczania porostów w Polsce dotychczas stwierdzonych lub prawdopodobnych. Państwowe Wydawnictwo Naukowe, Warszawa – Kraków. 1177 pp.

Obermayer W. 1993. Die Flechten der Seetaler Alpen (Steiermark, Österreich). Mitt. Naturwiss. Vereins Steiermark 123: 91-166.

Olech M, Søchting U. 1993. Four new species of *Caloplaca* from Antarctica. Lichenologist 25(3): 261-269.

Orange A. 1990. New or interesting lichens and lichenicolous fungi from Iceland. Acta Bot. Islandica 10: 37-44.

Oksner AM. 1993. Flora lishaynikiv Ukraini. Vol. 2(2). Naukova Dumka, Kiiv. 541 pp.

Ozenda P, Clauzade G. 1970. Les lichenes. Étude biologique et flore illustrée. Masson édit., Paris. 801 pp.

Pišút I. 1995. Interessante Flechtenfunde aus Mittel-, Süd und Südosteuropa 2. In: Farkas EE, Lücking R, Wirth V. (eds.), Scripta Lichenologica - Lichenological Papers Dedicated to Antonín Vězda. Bibliotheca Lichenologica, J. Cramer, Berlin, Stuttgart. 281-287 pp.

Pišút I, Lackovičová A, Lisická E. 1996. A second checklist and bibliography of Slovak lichens. Biologia, Bratislavia, 51/Supplement 3: 1-79.

Poelt J. 1960. Mitteleuropaische Flechten VI. Mitt. Bot. Staatssamml. München 3: 568-584.

Poelt J. 1969. Bestimmungsschlüssel Europäischer Flechten. Verlag von J. Cramer, Lehre. 757 pp.

Roux C, Navarro-Rosinés P. 1992. *Caloplaca egeana* Roux et Nav.-Ros. sp. nov. kaj *Caloplaca veneris* Roux et Nav.-Ros. sp. nov., du novaj likenspecioj de la mediteranea marbordo. Bull. Soc. Linn. Provence 43: 97-103.

Roux C. 1976. Champignons lichénisés ou lichénicoles intéressants pour la flore française méridionale. Bull. Mus. Hist. Nat. Marseille, 36: 19-27.

Santesson R, Moberg R, Nordin A, Tønsberg T, Vitikainen O. 2004. Lichen-forming and Lichenicolous Fungi of Fennoscandia. Museum of Evolution, Uppsala University, Uppsala, Sweden. 359 pp.

Søchting U. 1994. *Caloplaca ahtii* Søchting spec. nova and other *Caloplaca* species with greenish-bluish soredia from the northern hemisphere. Acta Bot. Fennica 150: 173-178.

Søchting U, Alstrup V. 2002. Danish Lichen Checklist. Version 1. 2002. [http://www.bi.ku.dk/lichens/dkchecklist/ (viewed online on January 23 2005)].

Søchting U, Olech M. 1995. The lichen genus *Caloplaca* in polar regions. Lichenologist 27(6): 463-471.

Søchting U, Olech M. 2000. *Caloplaca scolecomarginata* spec. nova and *C. frigida* spec. nova, two new lichen species from Antarctica. In: Schroeter B, Schlensog M, Green TGA. (eds.), New Aspects in Cryptogamic Research. Contributions in Honour of Ludger Kappen. Biblioth. Lichenol., J. Cramer, Berlin, Stuttgart. 19-26 pp.

Søchting U, Øvstedal DO. 1992. Contributions to the *Caloplaca* flora of the western Antarctic region. Nord. J. Bot. 12(1): 121-134.

Søchting U, Tønsberg T. 1997. *Caloplaca xanthostigmoidea* (Räs.) Zahlbr., a common lichen in cool regions of the northern hemisphere. In: Tibell L, Hedberg I. (eds.), Lichen Studies Dedicated to Rolf Santesson. Symbolae Botanicae Upsalienses, Acta Universitatis Upsaliensis, Uppsala. 247-253 pp.

Søchting U, Stordeur R. 2001. *Caloplaca thuringiaca* sp. nov., a species from the *Caloplaca holocarpa* complex. Lichenologist 33(6): 467-472.

Sparrius L. 2003. Contribution to the lichen flora of the Białowieża Forest and the Biebrza valley (Eastern Poland). Herzogia 15: 155-160.

Szatala Ö. 1956. Neue Flechten. V. Ann. Hist.-Nat. Mus. Natl. Hung., ser. nov. 7: 271-282.

Śliwa L. 2006. Additions to the lichen flora of the Tatry National Park and its surroundings (Polish Carpathians). In: Lackovičová A, Guttová A, Lisická E, Lizoň P. (eds.), Central European lichens – diversity and threat. Mycotaxon, Ithaca (in press).

Türk R, Berger F. 1999. Neue und seltene Flechten sowie lichenicole Pilze aus den Ostalpen III. Linzer Biol. Beitr. 31(2): 929-953.

Wade AE. 1965. The genus *Caloplaca* Th. Fr. in the British Isles. Lichenologist 3(1): 1-28.

Wetmore CM. 1994. The lichen genus *Caloplaca* in North and Central America with brown or black apothecia. Mycologia 86(6): 813-838.

Wetmore CM. 1996a. The *Caloplaca sideritis* group in North and Central America. Bryologist 99(3): 292-314.

Wetmore CM. 1996b. http://www.tc.umn.edu/--wetmore/

Wetmore CM. 2001. The *Caloplaca citrina* group in North and Central America. Bryologist 104(1): 1-11.

Wetmore CM. 2003. The *Caloplaca squamosa* group in North and Central America. Bryologist 106(1): 147-156.

Wetmore CM. 2004. The sorediate corticolous species of *Caloplaca* in North and Central America. Bryologist 107(4): 505-520.

Wetmore CM, Kärnefelt EI. 1998. The lobate and subfruticose species of *Caloplaca* in north and central America. Bryologist 101(2): 230-255.

Wetmore CM, Kärnefelt EI. 1999. What is *Caloplaca cinnabarina*?. Bryologist 102(4): 683-691.

Wirth V. 1972. Die Silikatflechten-Gemeinschaften im ausseralpinen Zentraleuropa. Dissert. Bot. 17: 1-306.

Wirth V. 1995. Die Flechten Baden-Württembergs, Teil 1 & 2. Eugen Ulmer GmbH & Co., Stuttgart. 1006 pp.

Wunder H. 1974. Schwartzfruchtige, saxicole Sippen der Gattung *Caloplaca* (Lichenes, Teloschistaceae) in Mitteleuropa, dem Mittelmeergebiet und Vorderasien. Biblioth. Lichenol. No. 3, J. Cramer, Lehre. 186 pp.

Verseghy K. 1971. Hazai *Gasparrinia* fajok. II. Rendszertani resz. [*Gasparrinia*-Arten in Ungarn. II. Systematischer Tiel (Erste Helfte).]. Bot. Közlem. 58(1): 21-28.

Verseghy K. 1994. Magyarország Zuzmóflórájának Kézikönyve. Studia Naturalia, 5, Magyar Természettudományi Múzeum, Budapest. 415 pp.

Vězda A, Liška J. 1999. Katalog Lisejníku Ceské Republiky [A Catalogue of Lichens of the Czech Republic]. Institute of Botany, Academy of Sciences of the Czech Republic, Pruhonice. 283 pp.

Zalewska A. 2000. Ekologia porostów Puszczy Boreckiej i jej obrzeży. Praca doktorska, Olsztyn.

MYCOTAXON

Volume 96, pp. 73–76 April–June 2006

The status of *Psilocybe floridana* (*Strophariaceae*) in *Callistosporium* (*Tricholomataceae*)

ETELVINA GÁNDARA
& GASTÓN GUZMÁN

gandara@ecologia.edu.mx
guzmang@ecologia.edu.mx
Instituto de Ecología
Apartado Postal 63, Xalapa 91000, Veracruz, Mexico

Abstract— Evidence is presented indicating that the type specimen of *Psilocybe floridana* is the same type of *Callistosporium psilocybe* and that both names are synonyms of *C. luteoolivaceum*.

Keywords— synonymy, intracellular pigment

Introduction

During the study of type specimens of *Psilocybe* (Fr.) P. Kumm. for a second edition of the monograph on the genus *Psilocybe* (Guzmán 1983), we found that the type of *P. floridana* (Murrill 1945) does not belong to *Psilocybe*, as Guzmán (1983) previously stated. Guzmán had previously considered that Murrill's fungus was a *Psathyrella* sp. However, the intracellular pigment in the spores, basidia and hyphae, lack of clamp connections, and lack of a germ pore on the spores for *P. floridana* indicates this species is actually a *Callistosporium* Singer (1944). Notwithstanding, Singer (1944) had not considered Murrill's species when he, together with Murrill (Singer 1944), described *C. psilocybe*. Singer (1946, 1970) maintained this position in subsequent papers. Interestingly, the specimens used for the description of *C. psilocybe* are the same ones that were used for the description of *Psilocybe floridana*. Singer (1946) considered *C. psilocybe* as a synonym of *C. luteoolivaceum*. In this paper we discuss the synonymy of *Psilocybe floridana* with *Callistosporium luteoolivaceum*.

Materials and methods

Available specimens of *Psilocybe floridana* and *Callistosporium luteoolivaceum* from FH, FLAS and MICH were studied. Microscopical study was made with sections of each basidioma mounted in 5% KOH, 3% NH_4OH and 1% Congo red (previously treated with 96% alcohol for rehydration). Spore shape was based on the quotient (Q), obtained from the length : width ratio following Bas (1969).

Both *Psilocybe floridana* and *Callistosporium psilocybe* have the same holotype and synonyms of *C. luteoolivaceum*

Callistosporium luteoolivaceum (Berk. & M.A. Curtis) Singer, Lloydia 9: 117, 1946.
Figs. 1-6

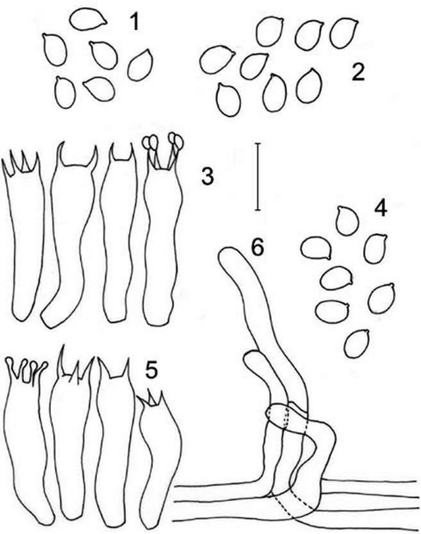
≡ *Agaricus luteoolivaceum* Berk. & M.A. Curtis, Ann. Mag. Nat. Hist. III 4: 286, 1859.
≡ *Collybia luteoolivaceum* (Berk. & M.A. Curtis) Sacc., Syll. Fung. *5*: 215, 1887.
= *Callistosporium psilocybe* Murrill & Singer, in Singer, Mycologia *36*: 363, 1944.
= *Psilocybe floridana* Murrill, Proc. Fl. Acad. Sci. *7*: 126, 1945.
Non *Stropharia floridana* Murrill, Mycologia 35: 536, 1943, according to the study of the type in FLAS: *Murrill 8738* (FLAS-10170).
For other synonyms, see Redhead (1982)

For a complete description, see Singer (1970). However, as the basidiomata show a wide variation in form and color, we present here some additional morphological features of the pileus, based on a study of the type of *Psilocybe floridana*, which includes a color drawing by Murrill at FLAS. The pileus is subcampanulate or convex to plane-convex, finally subumbilicate or umbilicate. All the basidiomata are yellowish-melleous to dark vinaceous brown as dried. The following microscopic features were observed: *spores* (4-) 4.5-5.5 (-6) x 3-4.5 µm, Q = (1.1-) 1.2-1.6, broadly ellipsoid to ellipsoid, occasionally subglobose, **without germ pore**, thin-walled, smooth, hyaline or with a brownish vinaceous content, inamyloid. *Basidia* 20-28 (-30) x 4.5-7 µm, 4-spored, cylindric-clavate, flexuous, thin-walled, hyaline or with same pigment as the spores. *Pleurocystidia* absent. *Cheilocystidia* absent. *Subhymenium* not differentiated or composed of parallel hyphae, 1.5-2 (-3) µm wide, thin-walled, hyaline or brownish vinaceous from intracellular pigment. *Hymenophoral trama* regular, hyphae 3-7 µm wide, thin-walled, hyaline or with brownish vinaceous intracellular pigment. *Pileipellis* with hyphae radially arranged, repent, (3.5-) 5-7 (-10) µm wide, thin-walled, hyaline or with brownish vinaceous intracellular pigment. *Stipitipellis* a cutis, occasionally disrupted by small clusters of ascending hyphae, 3-7 µm wide, thin-walled, hyaline. *Clamp connections* absent.

Habitat and Distribution– According to Singer (1944, 1946, 1970), Murrill (1945), Dennis (1951), Redhead (1982), Pegler (1983), Moser (1984) and Hongo (1989), this fungus is reported from North America, South America, the Caribbean, Europe and Asia. However, it seems that the concept of *C. luteoolivaceum* accepted by those authors encompasses several species, both temperate and tropical. A critical revision of some synonyms is necessary.

This fungus is reported on wood (logs, trunks and stumps) or rotting wood, frequently covered by mosses, rarely in soil, in temperate, subtropical and tropical forests. Pulido & Boekhout (1989) cited *P.* aff. *floridana* from Colombia, in high mountains.

Discussion—This collybioid fungus was considered as a *Collybia* by Saccardo (1987) and also by Murrill in the herbarium in the holotype of *Psilocybe floridana*. The basidiomata are also similar to a *Psilocybe* or *Psathyrella*. However, the intracellular pigment in spores, basidia and hyphae is the main feature to consider the species as *Callistosporium*, following Singer (1944, 1946, 1970), and as discussed by Redhead (1982). The thin-walled, ellipsoid and hyaline to pigmented spores and the absence of



Figs. 1-6. *Callistosporium luteoolivaceum*. 1, 2, 4: spores. 3, 5: basidia, 6: stipitipellis (1: holotype; 2, 3: holotype of both *C. psilocybe* and *Psilocybe floridana*; 4, 5, 6: Singer F-2651). Scale bar 10 µm.

a germ pore are important features. However, Singer (1970) described the spores of *Callistosporium luteoolivaceum* having a germ pore. Material from the Czech Republic in F (Singer & Pouzar C-5546, F-1018787) was identified by Singer as *Psilocybe floridana* but it is in fact *P. laetissima* Hauskn. & Singer (!). The confusion on the holotypes of both *Psilocybe floridana* and *Callistosporium psilocybe*, was because both Murrill (1944) and Singer (1944) published descriptions at the same time, based on the same herbarium material from Juniper Springs, in Marion Co., Florida, gathered by Murrill on October 13, 1940 and recorded in FLAS as 19323. Halling (1986) listed the type of *P. floridana*: "Marion Co., Juniper Springs, 13 Oct 1940, Murrill, F-19323" and for *C. psilocybe*: "Juniper Springs, Oct, Murrill (Holotype: FH!; isotype: FLAS)" based on the protologues for both species together with data attached to specimens. In both descriptions of *P. floridana* and *C. psilocybe* it is noted that the fungus grows on an oak log in October, although Singer did not mention the year.

Studied Material. UNITED STATES, Florida: Marion Co., Juniper Springs, Oct. 13, 1940, *Murrill* s.n. (FLAS-19323, **HOLOTYPE** of *Psilocybe floridana* and **ISOTYPE** of *Callistosporium psilocybe*; FH, **HOLOTYPE** of *C. psilocybe*; MICH-12136, **ISOTYPE** of *Psilocybe floridana*); Gainesville, Jun. 8, 1943, *Singer F-2651* (FH, as *C. psilocybe*).

Additional Material Examined. North Carolina: Curtis Herb., 1856, *Sprague 962* (FH-5728, **HOLOTYPE** of *Agaricus luteoolivaceum*).

Acknowledgments

We are grateful to Dr. Roy Halling (New York Botanic Garden) and Dr. Timothy J. Baroni (State University of New York) for their critical review. Dr. Dennis E. Desjardin (San Francisco State University) and Dr. Laura Guzmán-Dávalos (Universidad de Guadalajara, Mexico) gave useful comments to a preliminary version. Also we express our thanks to Curators of F, FH, FLAS and MICH for loaned important specimens and to Virginia Ramirez-Cruz for her help in some microscopic observations. Guzmán acknowledgments the support of his institution to his research. We also thank Lorelei Norvell and Shaun Pennycook their editorial support.

Literature cited

Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. Persoonia 5: 285-579.

Dennis RWG. 1951. *Agaricaceae* of Trinidad and Venezuela. Leucosporae I. Trans. Brit. Mycol. Soc. 34: 411-480.

Guzmán G. 1983. The Genus *Psilocybe*. Beih. Nova Hedwigia 74, Cramer, Vaduz.

Halling RE. 1986. An Annotated Index to Species and Infraspecific Taxa of *Agaricales* and *Boletales* Described by William A. Murrill. Mem. New York Botanical Garden 40, New York.

Hongo T. 1989. Notulae Mycologicae 17. IN: Selected Mycological Papers of Dr. T. Hongo. Shiga Univ., Otsu.

Moser M. 1984. Notes on the genus *Callistosporium*. *In*: La Famiglia delle *Tricholomataceae*. Centro Studi per la Flora Mediterranea, Borgo val di Taro.

Murrill WA. 1945 ('1944'). New Florida Fungi. Procc. Florida Acad. Sc. 7: 107-127.

Pegler DN. 1983. Agaric flora of the Lesser Antilles. Kew Bull. Addit. Ser. 9, Her Majestys's Stationery Office, London.

Pulido M, Boekhout T. 1989. Distribution of macrofungi along the Parque Los Nevados transect. IN: Van der Hammen, T., S. Díaz-Piedrahita and V.J. Álvarez (Eds.), La Cordillera Central Colombiana. Transecto Parque Los Nevados II, Cramer, Berlin.

Redhead SA. 1982. The systematics of *Callistosporium luteoolivaceum*. Sydowia 35: 223-235.

Saccardo PA. 1987. Sylloge Fungorum 5, Patavia (ed. 1944, Brothers, Ann Arbor).

Singer R. 1944. New genera of fungi. Mycologia 36: 358-368.

Singer R. 1946. Type Studies in *Agaricales* II. Lloydia 9: 114-131.

Singer R. 1970. A monograph of the subtribe *Omphalinae*. IN: *Omphalinae* (*Clitocybeae*, *Tricholomataceae*, Basidiomycetes). Flora Neotropica 3: 1-84.

MYCOTAXON

Volume 96, pp. 77–81 *April–June 2006*

Three new species of *Stemphylium* from China

Yong Wang & Xiu-Guo Zhang*

zhxg@sdau.edu.cn
Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract—Three new species of *Stemphylium* from China are described and illustrated: *S. pruni*, *S. plantaginis* and *S. capsici*. The type specimens are deposited in the Herbarium of the Department of Plant Pathology of Shandong Agricultural University (HSAUP).

Key words—hyphomycetes, dematiaceous

Introduction

Until now, about 150 *Stemphylium* taxa have been reported in the world, but only four new species have previously been described from China (Zhang & Zhang 2003). During the past few years, we have obtained numerous isolates of *Stemphylium* spp. from a large number of leaf spots derived from different plants. However, most isolates belonged to a few well-known species of *Stemphylium* such as *S. botryosum*, *S. solani* and *S. lycopersici*. This study presents a survey of *Stemphylium* species isolated from necrotic leafspots on *Prunus persica*, *Plantago major*, and *Capsicum annuum* in China.

Materials and Methods

Specimens of leaves with leafspots were collected from various zones in China during 2002-2005. All specimens were examined in the laboratory and then deposited in the herbarium of the Department of Plant Pathology, Shandong Agricultural University (HSAUP). Morphological comparisons of sporulation elements of *Stemphylium* spp. were based on cultures that developed under standardized conditions (Simmons 2001): potato-carrot agar (PCA) in plastic petri dishes, at ambient room temperatures 28°, and examined within 3-4 weeks. Microscope slides of superficial colony growth were prepared in a lactophenol and glycerin solution. The slides were examined and camera lucida drawings were prepared to show the most diagnostic characters. The taxonomic determinations were made from descriptions in the literature.

---

*Corresponding author

Taxonomic Description

Stemphylium pruni **Yong Wang bis & X.G. Zhang, sp. nov.** FIGURE 1

Ex culturis in agaro 'potato-carrot' descripta. Coloniae effusae, pallide brunneae vel medio-brunneae. Mycelium superficiale, hyphae ramosae, septatae, pallide brunneae, laeves, 3.5-4.5 μm latae. Conidiophora solitaria, laevia, recta vel curvata, nonramosa vel raro ramosa, pallide brunnea, cylindrica, 4-7-septata, 87-134×3.5-4.5 μm, ad apicem in saepissime 1 proliferationis usque 6.0-7.5 μm, laevi. Conidia singularia in apice conidiophori et dein proliferationis cujusque successivae oriunda, pallide brunneae, oblonga-ellipsoidea vel oblonga, ad apicem subtruncata, ad basim rotundata vel subtruncata, recta, laevia, 1-3-transverse septata, 0-1 longitudinaliter septata, ad 1-2 distincte constricta, 17-44×11.5-24 μm.

Holotype: on leaves of *Prunus persica* (L.) Batsch, Arboretum of Guiyang, Guizhou Province, China. Aug. 16. 2003, Y. Wang, HSAUP III$_0$0159.

Etymology: in reference to the host, *Prunus persica*

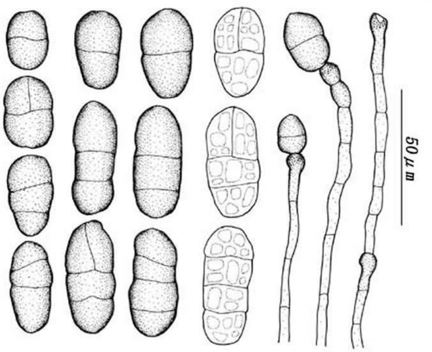


Fig. 1 Conidia and conidiophores of *S. pruni*

Colonies on PCA effuse, pale brown to medium brown. Mycelium superficial, hyphae branched, septate, pale brown, smooth, 3.5-4.5 μm wide. Conidiophores solitary, unbranched or occasionally branched, straight or slightly curved, light brown, cylindrical, swollen at the apex 6.0-7.5 μm diam and distinctly flared, 4-7-septate, 87-134×3.5-4.5 μm, smooth or occasionally echinulate near the proliferation pore. Conidia develop singly through a wide pore at the apex of each conidiophore, pale brown, oblong-elliposoid or oblong, subtruncate at the apex, rounded or subtruncate at the base, straight, smooth-walled, with 1-3 transverse septa and 0-1 longitudinal septum, and always with 1-2 distinct constrictions at the transverse septa, 17-44×11.5-24 μm (av. 34.5×18 μm), L/W ratio is 1.5-2.4 (av. 1.9).

The conidia of this species are similar to those of *S. nabarii* (Sarwar & Srinath 1966). However, the conidial size range and L/W ratio (av. 35×18 μm, L/W=1.5-2.4) are smaller than those of *S. nabarii* (av. 44×14 μm, L/W=2.8-3.3). Some conidia of the new taxon have a longitudinal septum, while those of *S. nabarii* have no longitudinal septa. In addition, the conidiophores of the new taxon (87-134 μm) are longer than those of *S. nabarii* (48-77 μm).

Stemphylium plantaginis Yong Wang bis & X.G. Zhang, **sp. nov.** FIGURE 2

Ex culturis in agaro 'potato-carrot' descripta. Coloniae effusae, pallide brunneae vel brunneae. Mycelium superficiale ex hyphis ramosis, septatis, pallide brunneis, laevibus, 3.5-4.5 μm crassis compositum. Conidiophora singula, recta vel curvata, nonramosa vel raro ramosa, pallide brunneae, cylindrica, 7-9-septata, 48-108×4.0-6.5 μm, ad apicem in saepissime 2 proliferationis usque 6.5-12.0 μm, laevibus. Conidia singularia in apice conidiophori et dein proliferationis cujusque successivae oriunda, brunneae, ovoidea, late ellipsoidea vel oblonga-ellipsoidea, ad apicem vel basim subtruncata, recta vel curvata, laevia, 1-2-transverse septata, 0-1 longitudinaliter septata, 26-54×16-26 μm.

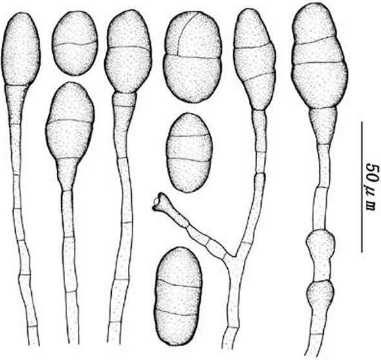


Fig. 2 Conidia and conidiophores of *S. plantaginis*

Holotype: on leaves of *Plantago major* L., Arboretum of Moutain Tai, Shandong Province, China. Oct. 5. 2003, Y. Wang, HSAUP III$_0$0532.

Etymology: in reference to the host, *Plantago major*

Colonies on PCA effuse, light brown to brown. Mycelium superficial, composed of branched, septate, pale brown, smooth, hyphae 3.5-4.5 µm wide. Conidiophores solitary, simple or occasionally branched, straight or slightly curved, light brown, cylindrical, 7-9-septate, 48-108×6.5-4.0 µm, swollen at the apex 6.5-12.0 µm diam and distinctly flared, smooth. Conidia develop singly through a wide pore at the apex of each conidiophore, pale brown, ovoid, broadly-ellipsoid or oblong-ellipsoid, subtruncate at the apex and at the base, straight or slightly curved, smooth-walled, with 1-2 transverse septa, and 0-1 longitudinal septum, 26-54×16-26 µm (av. 37.5×21.5 µm), L/W ratio is 1.3-2.5 (av. 1.9).

The conidia of *S. plantaginis* are similar in shape to those of *S. vesicarium* (Simmons 1969), but the two species can be separated by conidia septation and wall ornamentation. The conidia in the new taxon generally have 1-2 transverse septa while those of *S. vesicarium* have 1-5 septa. In addition, the conidia of the new taxon are also smooth-walled with 0-1 longitudinal septum, as opposed to those of *S. vesicarium* that are conspicuously and densely verrucose at all ages and have 1-2 (-3) longitudinal septa.

Stemphylium capsici Yong Wang bis & X.G. Zhang, sp. nov. FIGURE 3

Ex culturis in agaro 'potato-carrot' descripta. Coloniae effusae, medio-brunneae vel brunneae. Mycelium superficiale ex hyphis ramosis, septatis, medio-brunneis, laevibus, 4.0-5.0 µm crassis compositum. Conidiophora singula, recta vel curvata, simplicia vel raro ramosa, medio-brunneae vel brunneae, cylindrica, 1-7-septata, 22-58×4.5-8.5 µm, ad apicem in saepissime 1 proliferationis usque 7.0-9.0 µm, inflato, laevis. Conidia singula in apice conidiophori et in proliferationis cujusque successivae oriunda, medio-brunneae vel brunneae, ovoidea, oblonga-ellipsoidea, ad apice rotundata vel subtruncata, ad basim subtruncata, recta vel curvata, 1-3 transverse septata, 0-2 longitudinaliter vel 2-5 oblique septata, distincte constricta ad septa transversa, 14-33×9.0-10.5 µm, laevia.

Holotype: on leaves of *Capsicum annuum* L., Arboretum of Dali, Yunnan Province, China. Aug. 5. 2002, X.G. Zhang, HSAUP III$_0$1012

Etymology: in reference to the host, *Capsicum annuum*

Colonies on PCA spreading flatly, medium brown to brown. Mycelium supercial, composed of branched, septate, medium brown, smooth, hyphae 4.0-5.0 µm wide. Conidiophores simple or occasionally branched, straight or curved, medium brown to brown, cylindrical except at the apical proliferations which are swollen or distinctly flared, 1-7-septate, 22-58×4.5-8.5 µm, flared apically up to 7.0-9.0 µm, smooth. Conidia developing singly through a wide pore at the apex of each conidiophore, medium brown to brown, ovoid or oblong-ellipsoid, rounded or subtruncate at the apex, and subtruncate at the base, straight or slightly curved, smooth-walled, with 1-3 transverse septa, and 0-2 longitudinal or 2-5 oblique septa, 14-33×7.5-12.5 µm (av. 20.0×11.5 µm), L/W ratio is 1.3-2.5 (av. 1.9).

The new species differs from *S. allii-cepae* and *S. lactucae* (Zhang & Zhang 2003) in the smaller size range of its conidia (14-33×7.5-12.5 µm). In addition, the mature conidia

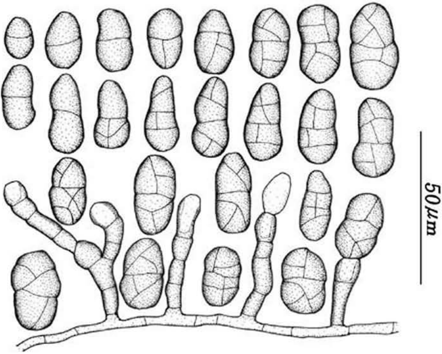


Fig. 3 Conidia and conidiophores of *S. capsici*

of *S. allii-cepae* and *S. lactucae* have 1-3 and 1 distinctly consticted transverse septa respectively, while conidia of the new taxon are not distinctly constricted transverse septa. On the other hand, the conidia of the new taxon have 2-5 oblique septa, more than either *S. allii-cepae* or *S. lactucae*. The apical conidium cell of the new taxon is also less acute than that of both well-known species.

Acknowledgments

The authors are indebted to W.B. Kendrick, N.R. O'Neill and G. Okada for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Science Foundation of China (no.30570006).

Literature Cited

Sarwar M, Srinath KV. 1966. A new species of *Stemphylium* on *Chrysanthemum cinerariaefolium* Vis. Mycopath. et Mycologia Applicata 29 (3-4): 320-322.

Simmons EG. 1969. Perfect states of *Stemphylium*. Mycologia 61:1-26.

Simmons EG. 2001. Perfect states of *Stemphylium* IV. Harvard Papers in Botany 6 (1): 199-208.

Zhang XG, Zhang TY. 2003. Taxonomic studies of *Stemphylium* from China. Mycotaxon 85: 247-252.

MYCOTAXON

Volume 96, pp. 83–107 *April–June 2006*

Caribbean heterobasidiomycetes: 2. Jamaica

PETER ROBERTS

p.roberts@rbgkew.org.uk
Mycology Section, Royal Botanic Gardens
Kew, Surrey TW9 3AB, UK

Abstract – Fifty-five species of heterobasidioid fungi belonging to the orders *Atractiellales*, *Auriculariales*, *Ceratobasidiales*, *Dacrymycetales*, *Exidiales*, *Platygloeales*, *Septobasidiales*, *Tremellales*, and *Tulasnellales* are described or reported from Jamaica. The new species *Exidia aeruginosa* and *Achroomyces dennisii* are described and the new combination *Exidiopsis scutelliformis* proposed, with *E. fuliginea* as a synonym. *Heterochaete verruculosa* sensu Bodman (et auct. seq.) is considered a mix of *H. verruculosa* sensu stricto and *Exidia japonica*. Twenty-six of the 55 species (47%) are newly recorded from Jamaica; 19 of them (34%) are also new records for the Caribbean islands.

Key words – cloud forest, endoparasites, *Basidiomycetes*, *Urediniomycetes*

The majority of species recorded in this paper were collected by the author and colleagues in June 1999 as part of the US National Science Foundation, Biotic Surveys and Inventories Program for the Greater Antilles.

The sites surveyed were almost all within the Holywell Park area of the Blue Mountains at an altitude of around 1000 m. The park is in the county of Surrey, mostly in St Andrew parish, but with one trail (Oatley Mountain) extending into Portland parish. Vegetation is mainly secondary cloud forest, with a mix of deciduous trees, *Podocarpus*, and a few planted *Pinus caribaea*. The nearby gardens at Cinchona (c. 1000 m) and upland valley woodland at Clydesdale (c. 800 m), both with some planted *Eucalyptus*, were also visited. Most of the heterobasidiomycete collections are held in the mycological herbarium [K(M)] of the Royal Botanic Gardens, Kew, but some additional collections, forwarded by Dr Karen Nakasone, are held at the Center for Forest Mycology Research (CFMR), Wisconsin, USA. Duplicate specimens are deposited in the herbarium of the Institute of Jamaica (IJ).

Previous collections from Jamaica held at Kew are also recorded. These include specimens of *Septobasidium* species from the Blue Mountains collected in 1926 by J.N. Couch (Professor of Botany at the University of North Carolina), specimens from the American botanist and collector Charles Orcutt (who moved to Jamaica in the 1920s), material sent to Kew by E.B. Martyn (plant pathologist in Jamaica from 1940 - 1950), and specimens collected by R.W.G. Dennis (Royal Botanic Gardens, Kew) in 1949-50. Also included are references to Jamaican heterobasidiomycetes in other publications, notably the paper on Jamaican *Septobasidiales* by Couch (1929), the booklet on neotropical heterobasidiomycetes by Lowy (1971), and the checklist of Caribbean fungi by Minter et al. (2001).

A previous paper on Caribbean heterobasidiomycetes (Roberts 2003b) dealt with species from the Dominican Republic.

Atractiellales

Hobsonia mirabilis (Peck) Linder, Ann. Missouri Bot. Gard. 16: 340 (1929)

SPECIMENS EXAMINED - Surrey: St Andrew: Castleton Botanical Gardens, on dead palm leaf, 16 Dec. 1949, Dennis *250B*, *K(M) 85760*; Holywell Park (path to cabins), on dead *Hedychium coronarium* stems, 10 June 1999, Roberts *GA541*, *K(M) 63247*; Morce's Gap, on dead *H. coronarium* stems, 25 Dec. 1949, Dennis *250C*, *K(M) 85759*.

Hobsonia mirabilis produces viscid-gelatinous, hyaline to whitish fruitbodies on a variety of woody or herbaceous substrata. It has long been classed as an anamorphic ascomycete, but recent molecular research (Sikaroodi et al. 2001) has suggested that *Hobsonia* is related to the genus *Helicogloea*. The species was illustrated from Venezuela by Roberts (2003a) and recorded from the Dominican Republic by Roberts (2003b). It has not previously been reported from Jamaica.

Auriculariales

Auricularia cornea Ehrenb., in Nees von Esenbeck, Horae Phys. Berol.: 91 (1820)

Auricularia polytricha (Mont.) Sacc., in Berlese & Saccardo, Atti. R. Inst. Veneto VI. 3: 722 (1885)

SPECIMENS EXAMINED - Surrey: Portland: Hog Hole to Cart Falls View, on dead trunk, 22 Dec. 1973, B.D. Morley & C. Whitefoord *772* (as *A. polytricha*), *K(M) 61992*; Holywell Park, Oatley Mountain Trail, on log, 10 June 1999, Roberts *GA561*, *K(M) 63248*; Nanny Town, on wood, 22 Dec. 1973, B.D. Morley & C. Whitefoord *716* (as *A. polytricha*), *K(M) 61991*; Port Antonio (8 mi from), Winnifred Guest House, on log, 16 Mar. 1946, A.M. Barry *F54*, *K(M) 61990*; **St Andrew:** Clydesdale, on wood, 16 June 1999, D.J. Lodge (Roberts *GA717*), *K(M) 63295*; Kingston, on wood, June 1999, comm. Roberts, *K(M) 121795*; **St Thomas:** Arntully, Apr. 1928, Orcutt *5595* (as *A. auricula*), *K(M) 85308*.

Auricularia cornea is a common and conspicuous pantropical species, distinguished by its smooth hymenium and hirsute, but unzoned pileus. The species was recorded from the Dominican Republic by Roberts (2003b) and has previously been reported from Jamaica (parishes of Manchester, Portland, St Andrew, St Ann, St Thomas, and Trelawny) in Minter et al. (2001).

Auricularia delicata (Fr.) Henn., in Bresadola et al., Bot. Jahrb. Syst. 17: 492 (1893)

SPECIMEN EXAMINED – Jamaica. Unlocalized, Mr Poore (as *Tremella auricula*; det. M.J. Berkeley as *Exidia fuscosuccinea*), *K(M) 51755*.

Auricularia delicata is a common pantropical species characterized by its distinctly reticulate hymenium. The species was recorded from the Dominican Republic by

Roberts (2003b) and has previously been reported from Jamaica (Portland, St Andrew, St Catherine, St Elizabeth, St Thomas, and Westmorland) in Minter et al. (2001).

Auricularia fuscosuccinea (Mont.) Henn., Bot. Jahrb. Syst. 17: 19 (1893)

> **SPECIMENS EXAMINED - JAMAICA.** Unlocalized, on tree, 1928, Orcutt *4231* (as *A. tenuis*), *K(M) 44591*; **Surrey: Portland:** Corn Puss Gap (between Portland and St Thomas), on wood, 21 Feb. 1946, C.B. Lewis *F44, K(M) 51767.*

Auricularia fuscosuccinea is a common tropical species, distinguished by its smooth, purplish brown basidiomes, without a macroscopically hirsute pileus. The species was recorded from the Dominican Republic by Roberts (2003b) and previously reported from Jamaica (Portland, St Andrew, and St Catherine) by Lowy (1971).

Auricularia mesenterica (Dicks.) Pers., Myc. Eur. 1: 97 (1822)

Auricularia mesenterica is a cosmopolitan species, distinguished by its effuso-reflexed basidiomes, with distinctly zoned and hirsute pilei and smooth to reticulate hymenia. The species was reported from Jamaica (Manchester, St Andrew, and Trelawny) by Lowy (1971).

Ceratobasidiales

Ceratobasidium noxium (Donk) P. Roberts, Rhizoctonia-forming fungi: 48 (1999)
Koleroga noxia Donk, Fungus 28: 35 (1958)
Pellicularia koleroga Cooke, Grevillea 4: 116 (1876), p.p. [nom. conf.]

> **SPECIMENS EXAMINED - JAMAICA.** Unlocalized, on living *Citrus maxima* leaves, July 1948, Martyn *P/P 340, K(M) 52849*; **Middlesex: Manchester:** near Mandeville, on living *Coffea* leaf, Oct. 1892, anon. (as *Pellicularia koleroga*), *K(M) 29392;* **St Catherine:** Linstead, on living *Mangifera indica* leaves, 27 Sep. 1967, F. Thompson *CB 1120, K(M) 52933.*

Ceratobasidium noxium is a widespread tropical species, originally described from India, but with few recent records. It forms web-blights on living leaves of trees and shrubs, causing the disease variously called 'black rot', 'koleroga', or 'candelillo' in coffee. The species was previously reported from Jamaica in Minter et al. (2001) as *Pellicularia koleroga*, a nomen confusum. *Ceratobasidium noxium* was redescribed and illustrated in Roberts (1999).

Thanatephorus cucumeris (A.B. Frank) Donk, Reinwardtia 3: 376 (1956)
[anamorph] *Rhizoctonia solani* J.G. Kühn, in Die Krankheiten der Kulturgewächse: 224 (1858)

Thanatephorus cucumeris, mostly found in its anamorphic (mycelial) state, is a cosmopolitan plant pathogen on an extremely wide range of hosts. It was reported in Minter et al. (2001) from the parishes of St Andrew, St Catherine, and St Thomas in Jamaica, and was previously recorded from the Dominican Republic by Roberts (2003b). The species was redescribed and illustrated, with synonyms listed, in Roberts (1999).

Dacrymycetales

Calocera cornea (Batsch) Fr., Stirp. Agri. Fems. 5: 67 (1827)

Originally described from Germany, *Calocera cornea* is a cosmopolitan species distinguished by its gregarious, yellowish, subulate-cylindrical, gelatinous basidiomes up to 10 mm high, its unclamped hyphae, and its comparatively small, single-septate basidiospores. It was reported by Lowy (1971) from St Andrew and St Thomas parishes.

Cerinomyces crustulinus (Bourdot & Galzin) G.W. Martin, Mycologia 41: 85 (1949)
Fig. 1

Basidiomes discoid at first, c. 1 mm across, then coalescing and becoming smooth, effused, gelatinous, 20 mm or more across, translucent tawny when fresh, drying similar. The whitish, fimbriate subiculum is visible at margins.

Hyphae hyaline, 4 - 6 µm wide in context, walls thickly gelatinized in KOH, with clamp-connexions; **hyphidia** conspicuous, branched; **basidia** dacrymycetoid, c. 30 µm long; **basidiospores** cylindrical (Q = 3.0 - 3.7), 14 - 15.5 x 3.5 - 5 µm, allantoid, aseptate.

> **SPECIMEN EXAMINED - SURREY: St Andrew:** HOLYWELL PARK, FAIRY GLADE TRAIL, on wood, 13 June 1999, Roberts *GA649, K(M) 116646.*

Following McNabb (1964) and subsequent authors, this effused species accords quite well with *Cerinomyces crustulinus* as originally described from France and recorded from North America. The presence of branched hyphidia is a distinguishing feature of the species. The Jamaican collection differs, if at all, from McNabb's description in having larger spores (McNabb gave 9 - 11 (- 12) x 3 - 4 µm as the spore measurement) and context hyphae with gelatinized walls. *Cerinomyces crustulinus* has not previously been recorded from the Caribbean.

Dacrymyces capitatus Schwein., Trans. Am. Phil. Soc. II, 4: 186 (1832)

> **SPECIMEN EXAMINED - SURREY: St Andrew:** HOLYWELL PARK, WATERFALL TRAIL, on wood, 8 June 1999, K. Nakasone (Roberts *GA521), K(M) 98265.*

The Jamaican collection falls within a rather difficult group of unclamped *Dacrymyces* species with 1-3-septate basidiospores. It is distinguished mainly by its distinctly discoid basidiomes attached to the substratum at a point. The species was originally described from North America and is cosmopolitan, though not previously recorded from the Caribbean.

Dacrymyces chrysospermus Berk. & M.A. Curtis, in Berkeley, Grevillea 2: 20 (1873)

> **SPECIMEN EXAMINED - SURREY: St Andrew:** CLYDESDALE, on decorticated log, 16 June 1999, Roberts *GA716, K(M) 98264.*

Dacrymyces chrysospermus is distinguished by its coalescing, cerebriform basidiomes, its unclamped hyphae, and its 7-septate basidiospores. The species was originally described from North America and appears to be cosmopolitan. It has not, however, previously been reported from the Caribbean.

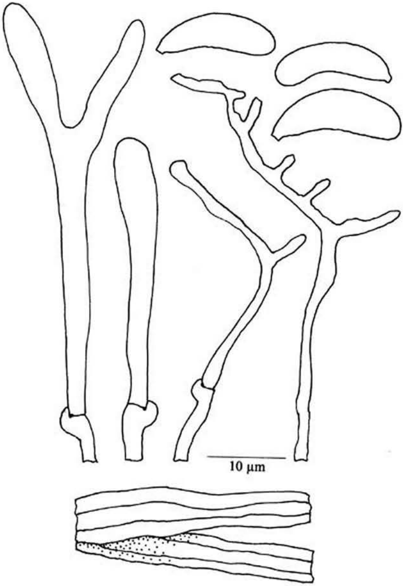


Fig. 1. ***Cerinomyces crustulinus*** (Jamaica, K(M) 116646). Mature and immature basidia with basal clamp-connexions; aseptate basidiospores; branched hyphidia; thick-walled context hyphae.

Dacrymyces falcatus Brasf., Lloydia 1: 154 (1938)

Originally described from Panama, the species is distinguished by its clampless hyphae and basidiospores with 15 or more septa. It was reported by Lowy (1971) for Portland parish.

Dacrymyces minor Peck, Rep. New York Mus. Nat. Hist. 30: 49 (1878)

> **SPECIMEN EXAMINED** - **SURREY: St Andrew:** HOLYWELL PARK, WATERFALL TRAIL, on fallen decorticated stick, 14 June 1999, Roberts *GA668, K(M) 98261.*

The collection comprises a swarm of small, discoid, dull orange basidiomes having unclamped hyphae and 1 – 3-septate basidiospores, the septa slightly thickened. As such, it seems best referred to *Dacrymyces minor*, originally described from North America and reported from the Dominican Republic by Roberts (2003b). The species has not previously been recorded from Jamaica.

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

Dacryopinax elegans is a spathulate species with 3-septate basidiospores, originally described from the southern United States. It was reported by Lowy (1971) for Clarendon parish.

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

> **SPECIMENS EXAMINED** - **MIDDLESEX: St Mary:** ORANGE RIVER EXPERIMENTAL STATION, Jan. 1948, Martyn *P/P 290, K(M) 52664*; **SURREY: St Andrew:** CLYDESDALE, on fallen wood, 16 June 1999, D.J. Lodge (Roberts *GA718*), *K(M) 114754*; **St Thomas:** BATH, on wooden gate, Mar. 1946, A.M. Barry *F36, K(M) 52663.*

This is a ubiquitous warm temperate and tropical species, producing conspicuous, spathulate basidiomes. It was originally described from North America and has previously been reported from the parishes of Portland, St Andrew, and St Thomas in Minter et al. (2001). It was reported from the Dominican Republic in Roberts (2003b).

Guepiniopsis buccina (Pers.) L.L. Kenn., Mycologia 50: 888 (1958)

> **SPECIMENS EXAMINED** - **SURREY: St Andrew:** MORCE'S GAP, on wood, 10 June 1888, W. Fawcett (as *Guepinia pezizaeformis*), *K(M) 8698*; ST HELEN GAP TO MONKEY HILL, on wood, 1 Sep. 1957, A.L. Welden *878, K(M) 8699.*

Guepiniopsis buccina is a cosmopolitan species producing trumpet-like basidiomes (cup-shaped with a long stipe). The collections cited above were previously reported by McNabb (1965).

Exidiales

Basidiodendron cinereum (Bres.) Luck-Allen, Can. J. Bot. 41: 1043 (1963)

> **SPECIMENS EXAMINED** - **SURREY: St Andrew:** HOLYWELL PARK, WAG WATER RIVER TRAIL, on dead *Hedychium coronarium* stem, 11 June 1999, Roberts *GA600, K(M) 63274*; same location and date, on *Pinus caribaea* stick, Roberts *GA610, K(M) 114690*;

Holywell Park, Waterfall Trail, on fallen wood, 14 June 1999, Roberts *GA675, K(M) 63320.*

Basidiodendron cinereum is a cosmopolitan species or species complex, originally described from Italy. Like all *Basidiodendron* species, the basidiomes are normally thin, effused, greyish and farinaceous-ceraceous, often drying ochraceous and finely reticulate. The specimen K(M) 63274 is typical, having a thin farinaceous basidiome with abundant gloeocystidia under the microscope and basidiospores measuring 9.5 - 11 x 5.5 - 7 µm. The specimens K(M) 63274 and K(M) 114690 are microscopically similar, but have thicker, ceraceous basidiomes, possibly representing more mature specimens.

An additional collection (**Surrey: St Andrew:** Holywell Park, Waterfall Trail, on twig, 14 June 1999, Roberts *GA689, K(M) 116886*) has a thin, pale greyish, farinaceous basidiome and appears similar to a *Basidiodendron* species, but lacks gloeocystidia. The basidiospores are close to those of *B. cinereum*, measuring 11.5 - 13.5 x 6.5 - 7.5 µm. The specimen is tentatively referred to *B. cinereum*, but may well represent a distinct species.

Basidiodendron cinereum has not previously been reported from the Caribbean.

Basidiodendron eyrei (Wakef.) Luck-Allen, Can. J. Bot. 41: 1034 (1963)

SPECIMENS EXAMINED - Surrey: St Andrew: Holywell Park, Fairy Glade Trail, on fallen wood, 13 June 1999, Roberts *GA652, K(M) 63324*; same location, on hardwood twigs, 15 June 1999, Nakasone *150383, CFMR*; Holywell Park, Waterfall Trail, on dead tree fern stems, 8 June 1999, Roberts *GA505, K(M) 63398*; same location, on fallen wood, 14 June 1999, Roberts *GA664, K(M) 63319.*

Basidiodendron eyrei is a common, cosmopolitan species, originally described from England. It is distinguished by its comparatively small subglobose to globose basidiospores (with Q frequently <1.0, hence with the apiculus on one of the wider sides) and the formation of conspicuous 'acropetal basidial stalks' in mature specimens. Basidiospores are typically 3.5 - 5 µm across, but in some of the collections cited above they are slightly larger, up to 5.5 - 6 µm across. The species has not previously been reported from Jamaica.

Basidiodendron fulvum (Massee) Ginns, Opera Botanica 61: 54 (1982)

SPECIMENS EXAMINED - Surrey: St Andrew: Holywell Park, Oatley Mountain Trail, on fallen wood, 15 June 1999, Roberts *GA694, K(M) 63321*; Cinchona, Trail to Morce's Gap, on decayed hardwood, 12 June 1999, Nakasone *150309, CFMR* and *K(M) 116728*; **USA. New Jersey.** Newfield, on *Magnolia* sp., undated, J.B. Ellis *3399*, holotype, *K(M) 28713.*

Basidiodendron fulvum, described from the USA (type cited above), is similar to *B. eyrei* but is distinguished by its smaller basidia and basidiospores. It was recorded from Venezuela in Roberts (2003a), but has not previously been reported from the Caribbean.

Basidiodendron radians (Rick) P. Roberts, Kew Bull. 56: 170 (2001)

Basidiodendron nodosum Luck-Allen, Can. J. Bot. 41: 1045 (1963)

> **SPECIMENS EXAMINED – BRAZIL. Rio Grande do Sul:** São Leopoldo, on wood, 1930, J. Rick *47*, holotype, *K(M) 56863*; **CANADA. Ontario: Algoma Dist.:** Little White River, on decayed *Pinus* wood, 14 Sep. 1956, R.F. Cain, holotype of *Basidiodendron nodosum*, *TRTC 33408*; **JAMAICA. SURREY: Portland:** Holywell Park, Oatley Mountain Trail, on rotten fallen wood, 10 June 1999, Roberts *GA574*, *K(M) 116642*; **St Andrew:** Cinchona, on rotten *Podocarpus* wood, 9 June 1999, Roberts *GA538*, *K(M) 113669*; Holywell Park, Fairy Glade Trail, on decorticated hardwood, 15 June 1999, Nakasone *150380*, *CFMR*.

Basidiodendron radians is similar to *B. cinereum* (above), but differs in its subglobose to ellipsoid basidiospores (Q = 1.1 - 1.4). The species was originally described from Brazil (the synonym *B. nodosum* from Canada) but appears to be cosmopolitan. Type specimens have been examined and are cited above. It was redescribed and illustrated from the Balearic Islands by Roberts (1996, as *B. nodosum*). Though apparently common, the species has not previously been reported from the Caribbean.

The specimen K(M) 116642 is extremely thin and unusual in having swollen elements, some with yellowish contents, which are branched and appear intermediate between hyphidia and gloeocystidia.

Basidiodendron spinosum (L.S. Olive) Wojewoda, Mała Flora Grzybów II: 91 (1981)

> **SPECIMEN EXAMINED - Surrey: St Andrew:** Holywell Park, Waterfall Trail, on fallen wood, 8 June 1999, Roberts *GA513*, *K(M) 63259*.

Basidiodendron spinosum is a cosmopolitan species, recognized microscopically by its distinctly warted basidiospores. It was originally described from Tahiti and has been redescribed and illustrated from Costa Rica by Kisimova-Horovitz et al. (1997) and noted from Venezuela by Roberts (2003a). It has not previously been reported from the Caribbean.

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

Originally described from Brazil, *Ductifera sucina* was redescribed and reported from Jamaica by Wells (1957) and Lowy (1971), based on a collection from Morce's Gap (St Andrew). The species forms pallid, pustular to cerebriform basidiomes with gloeocystidia.

Eichleriella alliciens (Berk. & Cooke) Burt, Ann. Missouri Bot. Gard. 2: 746 (1915)

Exidiopsis alliciens (Berk. & Cooke) K. Wells, Mycologia 53: 354 (1962 ['1961'])

Originally described from Brazil, *Eichleriella alliciens* was reported from Jamaica by Wells (1961, as *Exidiopsis alliciens*). The species forms ochraceous, effused, stereoid basidiomes and appears to be cosmopolitan.

Eichleriella leveilleanum (Berk. & M.A. Curtis) Burt, Ann. Missouri Bot. Gard. 2: 744 (1915)

Originally described from the United States, *Eichleriella leveilleanum* was reported from Jamaica by Wells (1961). The species forms reddish, effused, stereoid basidiomes and appears to be restricted to the Americas.

Exidia aeruginosa P. Roberts **sp. nov.** **Fig. 2**

Basidiomata gelatinosa, pustulata vel lobata, stipitata, usque ad 10 mm lata, areolata, non setulosa, grisea vel brunnea, subter aeruginosa; hyphae 1 – 2.5 µm latae, fibulatae; hyphidia ramosa; basidia tremelloidea, quadricellularia, oblongea, 23 – 25 x 12 - 13 µm; basidiosporae cylindraceae, suballantoideae, 16 - 22 x 7.5 – 9.5 µm.

Holotype: **JAMAICA. Surrey: St Andrew:** Holywell Park, Waterfall Trail, on dead attached deciduous twigs, 14 June 1999, Roberts *GA670, K(M) 116842.*

Basidiomes small, gelatinous, pustular to lobate, stipitate, up to 10 mm across, strongly areolate and appearing (overall) dull grey to brown in the field. Under lens, areolate to reticulate with distinct, rather roughened ridges, hymenial surface between ridges smooth (without hyphal pegs), brown to rusty brown at surface, bluish green below. When dried, pustular, dark greyish brown.

Hymenium comprising a surface layer of basidia and hyphidia in a brown gelatinous matrix, arising from a loosely gelatinized (not agglutinated), bluish-green context; **hyphae** hyaline, narrow, 1 - 2.5 µm wide, highly branched and irregular, thin-walled, with conspicuous clamp-connexions; **hyphidia** finely branched; **cystidia** absent; **basidia** tremelloid, 4-celled, oblong (Q = 1.7 - 1.9), 23 - 25 x 12 - 13 µm, immature basidia narrow and often fusiform; **sterigmata** elongated and sinuous; **basidiospores** (not clearly seen) apparently cylindrical (Q = 2.0 - 2.5), weakly allantoid, 16 - 22 x 7.5 - 9.5 µm.

Exidia aeruginosa is distinguished by its unusual bluish green basidiomes with a rusty to brownish hymenial layer. This striking colouration is not only visible under a lens, but microscopically when mounts are made in water, the brownish gelatinized matrix of the hymenium contrasting with the equally gelatinized blue-green context. In addition, the species is unusual in having a smooth but alveolate hymenium, lacking hyphal pegs. Microscopically, the hyphae are exceptionally narrow and the basidia comparatively large (often fusiform when young). Despite the presence of abundant mature basidia, very few basidiospores were seen and their true range and size remains uncertain.

The keys to Caribbean and Latin American *Exidia* species published by Lowy (1971, 1980) suggest no close match to this species, all but one of the taxa treated being 'papillate' (i.e. with hyphal pegs). Nonetheless, the type and only collection of *Exidia antiguae* Lowy (GUATEMALA. Finca San Mayor, on fallen *Quercus* branches, 25 June 1963, Lowy *G216, LSUM*) was re-examined, since it was described as having 'distinctly greenish tints when fresh'. From this re-examination, it appears that *Exidia antiguae* differs from *E. aeruginosa* not only in having hyphal pegs on the hymenial surface, but also in its much smaller basidia (13 - 17 x 8 - 9 µm) and basidiospores (9.5 - 13 x 4.5 - 5 µm). The greenish tints are no longer apparent in the type collection and may have been algal in origin, since superficial algal cells are present in mounts. Morphologically *Exidia*

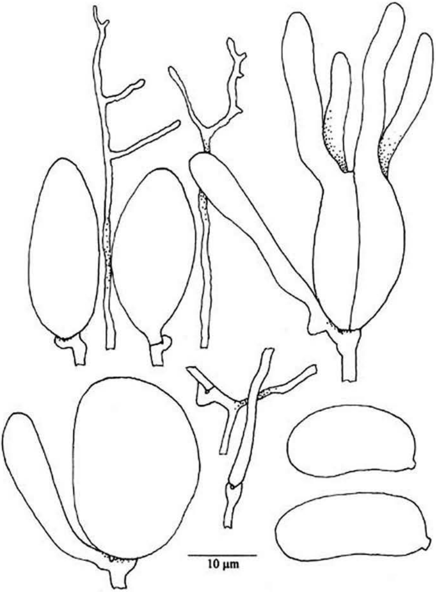


Fig. 2. ***Exidia aeruginosa*** (Jamaica, holotype, K(M) 116842). Immature and mature basidia, with branched hyphidia; clamped hyphae; basidiospores.

antiguae appears close to and possibly conspecific with *E. plana* (F.H. Wigg.) Donk sensu Donk (1966).

A second possible species, not treated by Lowy (1971, 1980), is *Exidia alveolata* Pat., which was said to be alveolate (like *E. aeruginosa*), pale smoky-brown, and smooth. However a re-examination of the type and only collection (**ECUADOR.** Cotocollao, on dead wood, Feb. 1892, Lagerheim, *FH*) showed that *E. alveolata* differs from *E. aeruginosa* in having sparse but distinct hyphal pegs on the hymenial surface (not mentioned in the type description), as well as in its smaller basidia (14 - 17 x 10 - 12.5 µm) and basidiospores (10.5 - 16 x 4 - 6 µm).

Exidia japonica Lloyd, Mycol. Not. 5: 599 (1916)

> **SPECIMENS EXAMINED – COLOMBIA. Magdalena:** Sierra Nevada de Santa Marta, Hacienda Cincinnati, on palm, 22 Aug. 1935, G.W. Martin *3626*, (as *Heterochaete verruculosa*) *IA 398729*; **JAMAICA. Surrey: St Andrew:** Hermitage Reservoir, on bark of decaying log, 30 May 1954, R.P. Bengry *F1024* (as *Exidia* sp.), *K(M) 44819*; Holywell Park, Shelter Trail, on branch, 17 June 1999, Roberts *GA729, K(M) 116889*; **PANAMA.** Chiriqui, Valley of Upper Rio Chiriqui Viejo, on wood, 4 July 1935, G.W. Martin *2502*, (as *H. verruculosa*) *IA 379886*.

The more recent Jamaican collection (Roberts GA729) comprises several small, shallowly pustulate basidiomes which are partly coalesced and lobate to effused. Rehydrated, they are watery greyish, highly gelatinous, and covered in small but easily visible, whitish hyphal pegs, 60 - 75 µm high. The basidiomes are immature, but developing basidia are present, as are brown, gloeoplerous hyphidia (contrasting with the hyaline hyphae and context), and clusters of mineral matter, particularly in the pegs. The earlier collection (Bengry F1024) looks similar but is extensively effused, highly gelatinized, 'greyish-white, somewhat convolute' (according to accompanying notes), the pegs with clustered mineral matter and the basidiospores measuring 9.5 - 12 x 4 - 4.5 µm.

These features agree well with the redescription and illustration of *Exidia japonica* in Spooner & Roberts (1998), based on collections from Brunei and Australasia, and further redescriptions based on material from Cameroon (Roberts 2001) and Venezuela (Roberts 2003a). *Exidia japonica* has not previously been recorded from the Caribbean.

Heterochaete verruculosa (Möller) Bodman, originally described from Brazil, was said to have very thin, effused, gelatinized, whitish basidiomes with small hyphal pegs (up to 70 µm high), small basidia, and basidiospores measuring 9 - 10 x 4 µm (Möller 1895). The type no longer survives, but recent material matching this description (**BRAZIL. São Paulo: Cananeia Mun.:** Ilha Cardoso, on branch, 5 Feb. 1987, K. Hjortstam *16819, K(M) 116892*) has been examined. The species has some features in common with *Exidia japonica* (e.g. spore size, size of hyphal pegs, gelatinized context), but differs inter alia in being entirely effused, closely attached, and very thin (tissue-paper thin, according to Möller).

As re-interpreted by Bodman (1952), however, '*Heterochaete verruculosa*' appears to be a mix of Möller's original species description and *Exidia japonica*. A specimen from Colombia, examined by Bodman and cited above, consists of discrete, shallowly pustular patches together with larger, thickly gelatinous, effused areas. Basidia are c. 11–12 x 7 - 8 µm, the basidiospores 8 - 10 x 3.5 - 4.5 µm, the hyphidia mainly collapsed but gloeoplerous. A second specimen from Panama, also examined by Bodman and cited above, is effused but thickly gelatinous and has similar microscopic features, including brown gloeoplerous hyphidia. Both collections seem better referred to *Exidia japonica*.

Exidia nucleata (Schwein.) Burt, Ann. Missouri Bot. Gard. 8: 371 (1921)
Tremella nucleata Schwein., Naturf. Ges. Leipzig Schr. 1: 115 (1822)
Myxarium nucleatum Wallr. , Flora Crypt. Germaniae: 26 (1833)

> **SPECIMEN EXAMINED** - JAMAICA. Surrey: St Andrew. Holywell Park, Shelter Trail, on fallen twigs, 17 June 1999, Roberts *GA724, K(M) 63346.*

Originally described from the United States, this is a cosmopolitan species recognized inter alia by its pustulate, hyaline basidiomes, conspicuous mineral inclusions, and myxarioid (stalked) basidia. The species was extensively redescribed and illustrated by Reid (1970) as *Myxarium nucleatum*. It has not previously been recorded from Jamaica.

Exidiopsis galzinii (Bres.) Killerm., in Engler & Prantl, Die natürlichen Planzenfamilien (2nd ed.) 6: 113 (1928)
Bourdotia petiolata (D.P. Rogers) K. Wells, Lloydia 20: 54 (1957)

This effused species with conspicuous gloeocystidia was reported from Jamaica by Wells (1959, as *Bourdotia petiolata*). It was redescribed and illustrated from the Dominican Republic by Roberts (2003b).

Exidiopsis scutelliformis (Berk. & M.A. Curtis) P. Roberts **comb. nov.** **Fig. 3**
Hirneola scutelliformis Berk. & M.A. Curtis, in Berkeley, Grevillea 2: 19 (1873)
Exidiopsis fuliginea Rick, Broteria 5: 8 (1906)

Basidiomes effused, margins indistinct, smooth, ceraceous to subgelatinous, hyaline to pale brown, drying to a thin, grey, vernicose film.

Hymenium comprising a layer of clustered basidia, cystidia, and hyphidia arising from a loosely gelatinized (not agglutinated) context intermixed with amorphous accretions of mineral matter; **hyphae** hyaline, 1.5 - 2.5 µm wide, thin-walled, with clamp-connexions; **hyphidia** nodulose to branched, often with dark brown granular contents contrasting against the hyaline context and hyphae. Narrow, disconnected lines of granules form a loose network at the hymenial surface; **cystidia** frequent in the hymenium, hyaline, thin-walled, most clavate to fusiform, 25 - 40 x 8 - 10 µm, but many irregular; **basidia** tremelloid, 4-celled, globose to subglobose (Q = 1.0 - 1.2), 10 - 12 x 9 - 10 µm, typically in clusters; **sterigmata** four, becoming sinuous and elongated; **basidiospores** cylindrical (Q = 3.0 - 3.3), 12 - 13.5 x 4 - 4.5 µm, weakly allantoid.

> **SPECIMENS EXAMINED** – BRAZIL. Rio Grande do Sul: São Leopoldo, on stick, 1905, J. Rick, lectotype of *Exidiopsis fuliginea, FH;* JAMAICA. Surrey: St Andrew. Holywell Park, Waterfall Trail, on twig, 14 June 1999, Roberts *GA667, K(M) 98281;* USA. ALABAMA: unlocalized on *Asimina* branch, undated, Peters *6343* (ex herb. M.J. Berkeley), holotype, *K(M) 8208.*

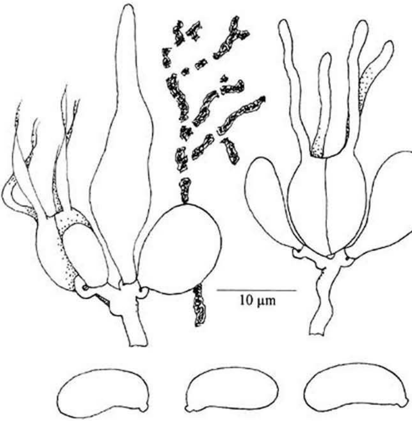


Fig. 3. ***Exidiopsis scutelliformis*** (Jamaica, K(M) 98281). Cystidium in cluster of old and immature basidia; granular, browning, branched hyphidium; cluster of mature and immature basidia; basidiospores.

Exidiopsis scutelliformis was originally described from Alabama 'looking like a flat *Peziza*...hymenium brown. Sometimes laterally confluent, and forming a continuous mass' (Berkeley 1873). The type specimen (cited above) consists of two pieces of bark, one showing disc-shaped fruitbodies a few millimetres across, occasionally coalescing, the other a more effused fruitbody. Microscopically they appear identical. All other specimens seen are effused. The type specimen was originally identified as '*Exidia scutelliformis*' (in pencil) with '*Hirneola*' (in ink) overwriting '*Exidia*'. An accompanying letter from De Seynes (dated 1876) notes that *Hirneola scutelliformis* is an *Exidia*, but this redisposition seems never to have been published. There are additional specimens at K from South Carolina. The species is distinguished by its normally effused, subgelatinous basidiomes, its cylindrical to suballantoid basidiospores, the clustered basidia in a loosely gelatinized context, the irregular presence of cystidia-like elements, accretions of mineral matter in the hymenium, and the granular, browning hyphidia.

Exidiopsis fuliginea appears indistinguishable from and hence synonymous with *E. scutelliformis*. The species was originally described from Brazil and was re-examined by Wells (1957) and Roberts (2001), who illustrated the type collection (cited above) and noted its occurrence in Africa. The species has been reported from the southern USA under both names (Wells 1957), but has not previously been recorded from Jamaica.

Heterochaete crassa Bodman, Mycologia 41: 531 (1949) Fig. 4

Basidiomes effused, pale pinkish brown, +/- athelioid, dry (not gelatinous), with 5 - 6 erect, narrow, tubular, hyphal pegs per mm.

Hyphal system dimitic; **hyphae** (generative) collapsing and not easily seen, hyaline, c. 2 µm wide, thin-walled, with clamp-connexions; skeletal hyphae pale yellowish to ochre-brown, 2.5 - 4.5 µm wide, thick-walled. Hyphal pegs mainly composed of brown skeletal hyphae, the whole peg encrusted with amorphous clots of mineral matter; **hyphidia** not evident, but simple obtuse or subacute elements in the hymenium; **cystidia** absent; **basidia** tremelloid, 4-celled, clavate to oblong, c. 26 x 10 µm; **basidiospores** cylindrical (Q = (1.6 -) 2.0 – 2.4), (10 -), 13 - 15.5 x 6 - 6.5 µm, some ventrally depressed.

> **SPECIMENS EXAMINED** - **JAMAICA. CORNWALL: Trelawny.** QUICKSTEP (COCKPIT COUNTRY), on rotten wood, 30 Dec. 1949, Dennis *J132, K(M) 44824;* **USA. FLORIDA: Dade Co.** MIAMI, SIMPSON PARK, on *Nectandra coriacea*, 17 Nov. 1942, R. Singer *F1494*, **TYPE**, *FH 380016*.

The description above is based on the Jamaican collection, which is notable for its dimitic hyphal system with skeletal hyphae predominating, for its narrow, clavate basidia, and for its comparatively small, cylindrical (not or barely allantoid) basidiospores.

Following Bodman (1952), the collection keys closest to *Heterochaete brasiliensis* Bodman. But re-examination of the type specimen (**BRAZIL. RIO GRANDE DO SUL:** SÃO SALVADOR, May 1942, J. Rick, *IA 380012*), shows that, though macroscopically similar, *H. brasiliensis* differs from the Jamaican material in having smaller basidia (most just 20 µm or so long) and shorter, more allantoid spores, as well as having many individually encrusted hyphae in the hyphal pegs. A more recent Brazilian collection in the Kew herbarium, closely resembling the type, has also been examined.

The North American type of *H. crassa* (cited above) has a macroscopically similar basidiome, though deeper coloured, and is very similar microscopically. Basidia (erroneously given as 'oval or globose, rarely exceeding 20 µm in length' in Bodman 1952) are clavate to oblong in the type collection, averaging 26 - 28 x 10 - 12 µm. Hyphae are similar and basidiospores are not (or barely) allantoid, c. 12 - 16 x 6 - 7 µm. This agrees well with the Jamaican collection cited above.

Heterochaete crassa is a little-known species, first described from Florida and also reported from Brazil. It is not impossible that *H. brasiliensis*, which is equally little-known, is just part of the variation within a single species, but if so *H. crassa* is the earlier name. Neither species has previously been recorded from the Caribbean.

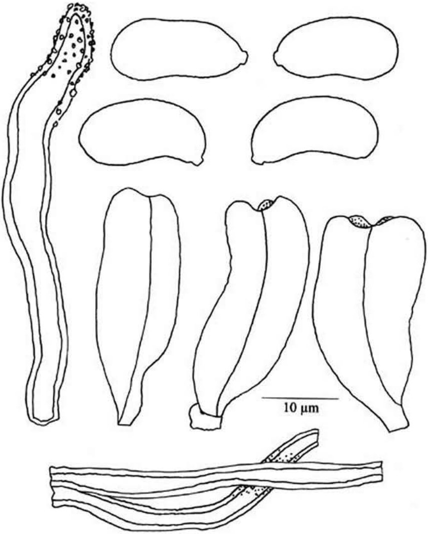


Fig. 4. ***Heterochaete crassa*** (USA, holotype, FH 380016). Simple, thick-walled hyphidium; basidiospores; immature basidia; thick-walled context hyphae.

Heterochaete minuta Pat., Bull. Soc. Mycol. France 9: 139 (1893) **Fig. 5**

Basidiomes effused, off-white with pale brownish tints, thin, farinaceous to athelioid, dry (not gelatinous), closely attached, forming patches up to 40 x 8 mm, with c. 8 narrow, tubular, hyphal pegs per mm.

Hyphal system monomitic; **hyphae** hyaline, torulose, not easily seen, 1.5 – 2.5 µm wide, thin-walled, with clamp-connexions; hyphal pegs narrow, tubular, c. 200 x 40 – 50 µm; **hyphidia** conspicuous, branched, coated as if iced with a mineral exudate;

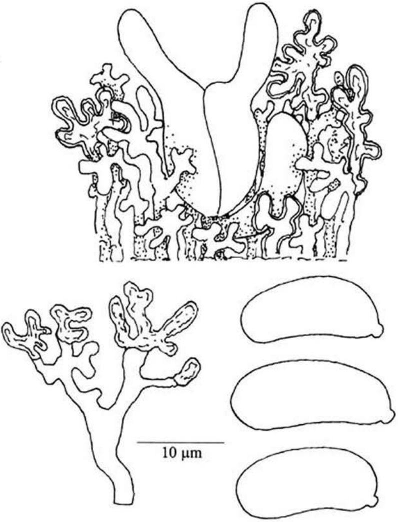


Fig. 5. ***Heterochaete minuta*** (Jamaica, K(M) 121868). Section from hymenium showing basidium and partly encrusted, branched hyphidia; partly encrusted, branched hyphidium; basidiospores.

cystidia absent; **basidia** (few seen) tremelloid, 2 - 4-celled, ellipsoid to oblong, c. 16 x 11 µm; **basidiospores** cylindrical (Q = 2.2 – 2.7), 13 - 19 x 6.5 – 7 µm, some ventrally depressed.

> **SPECIMENS EXAMINED** – ECUADOR. Pululahua, on fallen twigs, Mar. 1892, G. de Lagerheim, holotype, *FH*; JAMAICA. Surrey: St Andrew. Holywell Park, Shelter Trail, on dead twig, 12 June 1999, Roberts *GA616, K(M) 121868.*

Macroscopically, *Heterochaete minuta* is distinguished by its thin, off-white basidiomes densely covered in long, narrow hyphal pegs. Microscopically, the hyphidia are distinctive, being covered by a thin, continuous layer of mineral matter (as if iced-over) and hence prominent and conspicuous.

The type specimen (cited above) consists of several small, barely visible, streak-like patches (hence presumably the epithet) which under a lens appear very similar to the Jamaican collection. Microscopically, the same prominent, coated hyphidia are evident. Patouillard & de Lagerheim (1893) gave basidiospore dimensions as 16 – 18 x 5 – 6 µm.

The species is little-known, but said by Bodman (1952) to occur in Guyana and Panama as well as Ecuador. There is also a collection at K from Colombia. It has not previously been reported from the Caribbean.

Heterochaete shearii (Burt) Burt, Ann. Missouri Bot. Gard. 8: 377 (1921)

> **SPECIMENS EXAMINED** - JAMAICA. Middlesex: St Catherine. Worthy Park, on *Piper* stick, 10 Feb. 1959, D.A. Powell *701, K(M) 85788*; Surrey: St Andrew. Holywell Park, Oatley Mountain Trail, on decorticated branch, 14 June 1999, Nakasone *150446, CFMR* and *K(M) 116879*; Holywell Park, Shelter Trail, on dead twigs, 10 June 1999, Nakasone *150299, CFMR*; same location, on dead standing wood, 12 June 1999, Roberts *GA630, K(M) 63323*; Holywell Park, Waterfall Trail, on dead branches, 13 June 1999, Nakasone *150356, CFMR.*

Heterochaete shearii can be distinguished macroscopically by its effused, greyish-brown basidiomes, bruising brown, with abundant but irregular, tubular hyphal pegs, and microscopically by its brown subicular hyphae, frequent cystidia-like elements in the hymenium, and consistently bisterigmate basidia (illustrated in Roberts 2001). The species, originally described from North America, is common and widespread, but has not previously been reported from Jamaica.

Oliveonia fibrillosa (Burt) Donk, Fungus 28: 20 (1958)

> **SPECIMENS EXAMINED** - JAMAICA. Surrey: Portland. Holywell Park, Oatley Mountain Trail, on fallen wood of *Podocarpus* (?) sp., 10 June 1999, Roberts *GA571, K(M) 113671*; St Andrew. Holywell Park, Trail to Cabins, on dead stem of *Heydichium coronarium*, 17 June 1999, Roberts *GA727, K(M) 114698.*

Oliveonia fibrillosa typically produces thin, effused basidiomes on dead wood or herbaceous stems. Microscopically, it is recognised by its asepate basidia, clamped hyphae, hyaline cystidia, and ventrally depressed to suballantoid basidiopores. The species was redescribed and illustrated in Roberts (1999). It appears to be cosmopolitan, though infrequently collected. *Oliveonia fibrillosa* was originally described from Mexico and has been reported from Venezuela (Roberts 2003a), but has not previously been recorded from the Caribbean.

Stypella dubia (Bourdot & Galzin) P. Roberts, Mycotaxon 69: 216 (1998)

> SPECIMENS EXAMINED - JAMAICA. SURREY: St Andrew. CLYDESDALE, on decayed conifer wood, 16 June 1999, Roberts *GA714, K(M) 63260;* HOLYWELL PARK, SHELTER TRAIL, on decayed wood, 12 June 1999, Roberts *GA632, K(M) 116649.*

Stypella dubia is a cosmopolitan species, originally described from France and redescribed and illustrated in Roberts (1998). It is distinguished inter alia by its fascicles of thick-walled cystidia. The species has not previously been reported from the Caribbean.

Stypella grilletii (Boud.) P. Roberts, Mycotaxon 69: 223 (1998)

> SPECIMENS EXAMINED - JAMAICA. SURREY: St Andrew. HOLYWELL PARK, WATERFALL TRAIL, on decayed wood, 8 June 1999, Roberts *GA502, K(M) 114683;* same location, on fallen stick, 15 June 1999, Roberts *GA702, K(M) 114684.*

Stypella grilletii is a cosmopolitan species, originally described from France and redescribed and illustrated in Roberts (1998). It is distinguished inter alia by producing abundant, tiny, gelatinous-crystalline basidiomes which coalesce to form an effused, tuberculate, and ultimately smooth, compound basidiome. The species has not previously been reported from the Caribbean.

Tremellodendron tenue Burt, Ann. Missouri Bot. Gard. 2: 740 (1915)

This little-known clavarioid species, described from Jamaica, has sparsely branched basidiomes and fusiform basidiospores, 14 – 16 x 6 – 7 µm. It was redescribed by Lowy (1971).

Tremelloscypha gelatinosa (Murrill) Oberw. & K. Wells, in Wells & Oberwinkler, Mycologia 74: 325 (1982)

This is a sebacinoid species, growing on decayed wood and resembling a stipitate stereoid fungus. The species was described from Trelawny parish in Jamaica and is otherwise only known from Florida, USA. It was extensively reviewed and illustrated by Wells & Oberwinkler (1982).

Platygloeales

Achroomyces dennisii P. Roberts **sp. nov.** Fig. 6

> *Basidiomata nulla, in hymeniis parasitica. Hyphae 2 - 3 µm latae, fibulatae. Conidia elongata, fusiformia, 8.5 - 16 x 2 - 3 µm. Basidia cylindracea, ter transeptata, 25 - 30 x 4 - 5 µm, e probasidiis exorientia. Basidiosporae ovoideae, 7.5 - 8.5 x 2.5 - 3.5 µm.*
>
> ***Holotype:*** JAMAICA. SURREY: St Andrew. KINGSTON, MONA, in hymenium of *Hyphodontia sambuci* (Pers.) J. Erikss. on dead grass stems, 2 Jan. 1950, Dennis *J165/b, K(M) 121772.*

Basidiomes intrahymenial in host; not macroscopically visible.

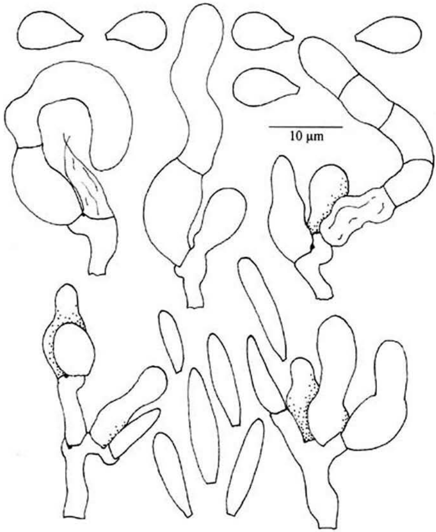


Fig. 6. ***Achroomyces dennisii*** (Jamaica, holotype, K(M) 121772). Basidiospores; basidia arising from swollen probasidia; immature basidia alongside attached conidia; detached conidia.

Hyphae hyaline, 2 - 3 µm wide, thin-walled, with clamp-connexions; **haustorial cells** none seen; **conidiophores** not distinct; **conidia** elongated fusiform to narrowly clavate, 8.5 - 16 x 2 - 3 µm, arising from clamps alongside probasidia; **cystidia** absent; **basidia** auricularioid, 4-celled, tubular, 25 - 30 x 4 – 5 µm, arising from swollen, thin-walled probasidia 6 - 8 µm wide; **sterigmata** not clearly seen; **basidiospores** ovoid (Q = 1.6 – 1.7), 7.5 – 8.5 x 2.5 – 3.5 µm, often ventrally flattened or depressed, germination not seen.

Achroomyces dennisii is distinguished by its corticioid host, its triseptate basidia arising from swollen probasidia, its narrow, elongated conidia, and its ovoid basidiospores. The conidia appear to arise from clamp-connexions alongside immature probasidia, and no distinct conidiophores were seen. As basidia mature, the contents of the probasidia are evacuated and the probasidial walls collapse. Something similar may happen to the basidia at the point of spore release, since no spore-bearing basidia could be found in mounts.

Three additional auricularioid parasites are known from *Hyphodontia sambuci* in Europe: *Achroomyces lumbricifer* P. Roberts, which differs inter alia in its distinctly coiled basidia lacking probasidia; *Achroomyces lunaticonidiatus* Van de Put, which has small, lunate conidia; and *Spiculogloea occulta* P. Roberts, which has spiculate basidia, haustorial cells, and conidia under 5 µm long. *Achroomyces robertsii* Trichies, known from *Hyphodontia nespori* (Bres.) J. Erikss. & Hjortstam, lacks probasidia and has subglobose basidiospores.

Achroomyces Bonord. contains a mixture of mycoparasitic auricularioid species not assigned elsewhere. As such, it is the appropriate genus for this new Jamaican species, pending further research into its septal pore ultrastructure and interaction with its host.

Platycarpa polypodii (Couch) Couch, Mycologia 41: 428 (1949)

Septobasidium polypodii Couch, J. Elisha Mitchell Sci. Soc. 44: 255 (1929)

Platycarpa polypodii is an auricularioid parasite of ferns (*Polypodium* spp), described from Jamaica and originally placed in *Septobasidium*, a genus now restricted to parasites of scale insects (see below). The species was redescribed and illustrated in Oberwinkler & Bandoni (1984).

Septobasidiales

Septobasidium species are effused, possess auricularioid basidia, and are associated with scale insects on living plants. Collections from Jamaica were described and illustrated by Couch (1929) and included in his world monograph (Couch 1938). He appears to have used different systems for numbering specimens in his two publications, which make the identification of isotypes unclear. All his 1926 collections of newly described species are at least paratypes, however, and are so marked below.

Septobasidium alveolatum Couch, J. Elisha Mitchell Sci. Soc. 44: 253 (1929)

> **SPECIMENS EXAMINED** - JAMAICA. SURREY: Portland. MOSSMAN'S PEAK, on living deciduous tree, 30 June 1926, Couch *8543*, PARATYPE, *K(M) 116616*; BLUE MOUNTAINS, unlocalized, Sum. 1926, Couch *160*, PARATYPE, *K(M) 116617*.

The species is distinguished by its 4-celled basidia with persistent probasidia and by its alveolate (honeycomb-like) middle layer. Type material (two collections cited above) is from the Blue Mountains.

Septobasidium arboreum (Couch) Boedijn & B.A. Steinm., Bull. Jard. Bot. Buitenzorg III, 11: 168 (1931)

> **SPECIMENS EXAMINED** - JAMAICA. Surrey: Blue Mountains, unlocalized, on living *Psychotria* sp., 1926, Couch *113*, paratype, *K(M) 116625*; same details, July 1926, Couch *8550*, paratype, *K(M) 116626*.

The basidia of this species are four-celled, lacking a probasidial cell. The basidiomes are thin and granular. Couch (1929, 1938) only mentioned a single collection of this species dated June 1926, but the specimens cited above are both marked as 'types'.

Septobasidium areolatum Couch, J. Elisha Mitchell Soc. 44: 248 (1929)

> **SPECIMENS EXAMINED** - JAMAICA. Surrey: **Portland.** Mossman's Peak, on living deciduous tree, 2 July 1926, Couch *8537*, isotype, *K(M) 116614*; same details, Couch *123*, paratype, *K(M) 116615*.

The species is distinguished by its areolate basidiomes and two-celled basidia, rather similar to those of *S. jamaicaense* (below), but distinctly smaller. Type material (two collections cited above) is from the Blue Mountains.

Septobasidium atropunctum Couch, J. Elisha Mitchell Soc. 44: 251 (1929)

> **SPECIMENS EXAMINED** - JAMAICA. Surrey: **St Andrew.** Cinchona (near) on living deciduous tree, July 1926, Couch *144*, paratype, *K(M) 116623*; same details, Sum. 1926, Couch *8548*, paratype, *K(M) 116624*.

Septobasidium atropunctum has four-celled basidia and develops individual oval compartments or 'houses' for its insect hosts (see Couch 1938). Type material (two collections cited above) is from the Blue Mountains.

Septobasidium fragile Couch, The genus *Septobasidium*: 196 (1938)

This thin species has four-celled basidia and a persistent probasidium. It was originally described from the Blue Mountains (Couch 1938).

Septobasidium jamaicaense Burt, Ann. Missouri Bot. Gard.3: 333 (1916)

> **SPECIMENS EXAMINED** - JAMAICA. Surrey: **Portland.** Portland Gap, on living *Solanum punctulatum*, July 1926, Couch *8525*, *K(M) 116618*; Blue Mountains, unlocalized, on living *S. punctulatum*, July 1926, Couch *136*, *K(M) 116619*; Blue Mountains, unlocalized, on living trunk of *Eupatorium critoniforme*, 31 Aug. 1986, comm. B. Ing, *K(M) 116613*.

Septobasidium jamaicaense is distinguished by its extensive, greyish-purplish, distinctly chambered basidiomes and by its comparatively large, two-celled basidia. The species was originally described from the Blue Mountains and Couch (1938) noted a further 25 collections from the area, mostly on *Solanum punctulatum*. A note with the specimen on *Eupatorium critoniforme* (cited above) states that the same fungus was also seen on *Solanum*.

Septobasidium purpureum Couch, J. Elisha Mitchell Soc. 44: 255 (1929)

> **SPECIMEN EXAMINED** - JAMAICA. Surrey: **St Andrew.** Cinchona, on branch of living deciduous tree, *July 1926, Couch 146*, SYNTYPE, *K(M) 116621.*

The species is distinguished primarily by its unusual, aseptate, monosporic basidia and was originally described from the Blue Mountains (type cited above).

Septobasidium rhabarbarinum (Mont.) Bres., Ann. Mycol. 14: 240 (1916)
Septobasidium frustulosum (Berk. & M.A. Curtis) Pat., Bull. Soc. Mycol. France 10: 79 (1894)

> **SPECIMENS EXAMINED** - JAMAICA. Surrey: **St Andrew.** Cinchona (NEAR), on branch of living deciduous tree, July 1926, Couch *8551* (as *S. frustulosum*), *K(M) 116735*; same details, Couch *157* (as *S. frustulosum*), *K(M) 116736.*

This is a cosmopolitan species distinguished by its yellowish basidiome and four-celled basidia lacking probasidia. It was first reported from Jamaica by Couch (1929) under the name *Septobasidium frustulosum*, later (Couch 1938) synonymized with *S. rhabarbarinum*.

Septobasidium septobasidioides (Henn.) Höhn. & Litsch., Sb. Akad. Wiss. Wien Math.-Nat. Kl. I, 116: 757 (1907)
Septobasidium papyraceum Couch, J. Elisha Mitchell Sci. Soc. 44: 249 (1929)

> **SPECIMENS EXAMINED** - JAMAICA. Cornwall: **Trelawny.** Crowlands, on dead wood, 10 June 1999, L. Ryvarden *41585*, *K(M) 82502*; Surrey: Blue Mountains, unlocalized, on *Psychotria* wood, July 1926, Couch *8501*, PARATYPE of *Septobasidium papyraceum*, *K(M) 85320*; same details, Couch *8505*, PARATYPE of *S. papyraceum*, *K(M) 85321*; **Portland.** Portland Gap, on *Psychotria* wood, 10 July 1926, Couch *131*, PARATYPE of *S. papyraceum*, *K(M) 85319.*

Septobasidium septobasidioides was originally described from Brazil and reported from Jamaica by Couch (1929) under the synonym *S. papyraceum*. It is distinguished by its four-celled basidia lacking probasidia and by the unusual 'winged' margins of the basidiomes.

Tremellales

Tremella coffeicolor (Berk.) P. Roberts, Kew Bull. 59: 99 (2004)
Tremella auricularia Möller, Protobasid.: 113 (1895)

Basidiome gelatinous, foliaceous, c. 15 mm across, tawny to rusty brown.

Hyphae easily seen, in a fairly soft, gelatinous matrix, hyaline or with gold-yellowish contents, 1 - 3 µm wide, thin-walled, with clamp-connexions; **haustorial cells** not seen; **conidiophores** occasionally present in hymenium, branched, giving rise to botryose clusters of conidia; **conidia** arising from conidiophores and basidiospores, mostly ovoid, 3 - 5 x 2 - 3 µm; **basidia** tremelloid, 4-celled, globose to ellipsoid, 15 - 17 x 14 - 15 µm; **sterigmata** long, narrow, and sinuous; **basidiospores** mostly ellipsoid (Q = 1.4 - 1.7 (- 1.9)), (8 -) 9.5 - 12 (- 14) x 6 - 8 (- 9) µm, germination by germ tube or the production of yeast cells (conidia).

SPECIMEN EXAMINED - JAMAICA. SURREY: St Andrew. CLYDESDALE, on wood, 16 June 1999, D.J. Lodge (Roberts *GA719*), *K(M) 116850*.

Tremella coffeicolor is macroscopically similar to smaller specimens of the common, European *T. foliacea* Pers. Microscopically, it differs in its substantially larger basidia and basidiospores. The species, originally described from Bermuda, was illustrated and described from Brazil (as *T. auricularia*) in Roberts & de Meijer (1997) and from the Azores in Roberts & Spooner (2004).

The Jamaican specimen is more orange-brown than noted for the Azores collections, but well within the variation seen in Brazilian material.

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

Tremella fuciformis is a common, pantropical species, distinguished by its delicate, white, fuciform basidiomes, small basidia and basidiospores (illustrated in Roberts & de Meijer 1997). It is parasitic on or associated with species of the ascomycetous genus, *Hypoxylon* Bull. (fide Chen, 1998) and was reported from Jamaica (St Ann) by Lowy (1971).

Tremella mesenterica Retz., Kongl. Vet. Acad. Handl. 30: 249 (1769)

Tremella mesenterica is a cosmopolitan species, bright yellow and lobate, associated with mycelia of species in the corticioid genus *Peniophora* Cooke. It was reported from Jamaica (St Thomas) in Minter et al. (2001) and recorded from the Dominican Republic by Roberts (2003b). The species was described and illustrated from England in Roberts (1995).

Tremella olens Berk., in Hooker, Fl. Tasm. II: 262 (1859 ['1860'])

Tremella fibulifera Möller, Protobas. 119 (1895)

SPECIMEN EXAMINED - JAMAICA. SURREY: Portland. HOLYWELL PARK, OATLEY MOUNTAIN TRAIL, on fallen wood, 10 June 1999, Roberts *GA562*, *K(M) 113744*.

Tremella olens is widespread in tropical and subtropical areas. It is distinguished by its pustular to lobed, whitish-hyaline basidiomes, thin- to thick-walled, gelatinized hyphae, and ellipsoid basidiospores. The species was reviewed and illustrated in Roberts (2001) based on African and Asian material together with the Australian type collection. Collections from Venezuela were described in Roberts (2003a). *Tremella fibulifera*, originally from Brazil, was redescribed and illustrated from that country by Roberts & de Meijer (1997). The type has thinner-walled hyphae than the type of *T. olens*, but otherwise the two taxa appear to be conspecific. *Tremella olens* has not previously been reported from the Caribbean.

Tulasnellales

Tulasnella cystidiophora Höhn. & Litsch., Sb. Akad. Wiss. Wien Math.-Nat. Kl. I, 115: 1557 (1906)

SPECIMEN EXAMINED - JAMAICA. SURREY: St Andrew HOLYWELL PARK, OATLEY MOUNTAIN TRAIL, on partly fallen branch, 15 June 1999, Roberts *GA693*, *K(M) 63257*.

Tulasnella cystidiophora is distinguished inter alia by its conspicuous gloeocystidia. Originally described from Finland, the species was redescribed and illustrated by Roberts (1994). It has not previously been recorded from the Caribbean.

Tulasnella eichleriana Bres., Ann. Mycol. 1: 113 (1903)

SPECIMEN EXAMINED - JAMAICA. SURREY: St Andrew. HOLYWELL PARK, WATERFALL TRAIL, on fallen wood, 8 June 1999, Roberts *GA518, K(M) 63179.*

Originally described from Poland, *Tulasnella eichleriana* is a cosmopolitan species or species complex, redescribed and illustrated by Roberts (1994). The species can be recognized by its effused, ceraceous, grey-violaceous basidiomes, clampless hyphae, and small, subglobose to ellipsoid basidiospores. *Tulasnella eichleriana* was reported from the Dominican Republic by Roberts (2003b), but has not previously been recorded from Jamaica.

Tulasnella tomaculum P. Roberts, Mycol. Res. 97: 215 (1993)

SPECIMEN EXAMINED - JAMAICA. SURREY: St Andrew. HOLYWELL PARK, WATERFALL TRAIL, on fallen wood, 8 June 1999, Roberts *GA516, K(M) 63272.*

Tulasnella tomaculum is a cosmopolitan species, originally described from England in Roberts (1993), but not previously reported from the Caribbean. The species is similar to *T. eichleriana* (above), but differs in its weakly allantoid basidiospores.

Acknowledgments

Thanks to Prof. Leif Ryvarden, University of Oslo, and Dr D. Jean Lodge, Center for Forest Mycology Research, Puerto Rico, for refereeing the manuscript. Fieldwork in Jamaica was made possible by grant DEB-95-25902 to the State University of New York College at Cortland from the USA National Science Foundation, Biotic Surveys and Inventories Program, and was facilitated by the USDA - Forest Service's Center for Forest Mycology Research - Forest Products Laboratory and International Institute of Tropical Forestry. Travel was partly funded by the Royal Botanic Gardens, Kew. Thanks go to Prof. Timothy J. Baroni, State University of New York, College at Cortland, to Dr D. Jean Lodge, Center for Forest Mycology Research, Puerto Rico, and to Dr Sharon Cantrell, now at Universidad Turabo, Gurabo, Puerto Rico, for helping organize the visit. Many thanks to local biologists and cooperators, especially Ms Tracey Commock, Institute of Jamaica, as well as Dr D. Smith and M. Mundle of the Jamaica Conservation Development Trust, Ms A. Donaldson and the Natural Resources Conservation Authority, Mr R. Williams and Mr C. Battick of the Scientific Research Council, and the Forestry Department of Jamaica. Thanks also to the herbaria at Harvard University (FH), Iowa State University (IA), Louisiana State University (LSUM), and the University of Toronto (TRTC) for the loan of type specimens.

References

Berkeley MJ. 1873. Notices of North American fungi. Grevillea 14: 17 - 20.

Bodman MC. 1952. A taxonomic study of the genus *Heterochaete*. Lloydia 15: 193 - 233.

Chen C-J. 1998. Morphological and molecular studies in the genus *Tremella*. Bibl. Mycol. 174: 1 - 225.

Couch JN. 1929. A monograph of *Septobasidium*. Part I. Jamaican species. J. Elisha Mitchell Sci. Soc. 44: 242 - 260 + 25 pl.

Couch JN. 1938. The genus *Septobasidium*. Univ. North Carolina Press.

Donk MA. 1966 Check list of European hymenomycetous heterobasidiae. Persoonia 4: 145 – 335.

Kisimova-Horovitz L, Oberwinkler F, Gómez LD. 1997. Basidiomicetos resupinados de Costa Rica. *Exidiaceae* (*Tremellales*). Rev. Biol. Trop. 45: 1325 – 1347.

Lowy B. 1971. *Tremellales*. Flora Neotropica 6: 1 - 153.

Lowy B. 1980. *Tremellales*. Flora Neotropica 6 (supplement): 1 - 18.

McNabb RFR. 1964. Taxonomic studies in the *Dacrymycetaceae* I: *Cerinomyces*. New Zealand J. Bot. 2: 415 - 424.

McNabb RFR. 1965. Taxonomic studies in the *Dacrymycetaceae* IV: *Guepiniopsis*. New Zealand J. Bot. 3: 159 - 169.

Minter DW, Rodríguez Hernández M, & Mena Portales J. 2001. Fungi of the Caribbean: an annotated checklist. Middlesex, PDMS.

Möller A. 1895. Protobas. Jena, Gustav Fischer.

Oberwinkler F, Bandoni R. 1984. *Herpobasidium* and allied genera. Trans. Brit. Mycol. Soc. 83: 639 – 658.

Patouillard N, de Lagerheim G. 1893. Champignons de l'Equateur. Bull. Soc. Mycol. France 9: 124 – 165.

Reid DA. 1970. New or interesting records of British hymenomycetes IV. Trans. Brit. Mycol. Soc. 55: 413 – 441.

Roberts P. 1993. Allantoid-spored *Tulasnella* species from Devon. Mycol. Res. 97: 213 - 220.

Roberts P. 1994. Globose and ellipsoid-spored *Tulasnella* species from Devon and Surrey, with a key to the genus in Europe. Mycol. Res. 98: 1431 - 1452.

Roberts P. 1995. British *Tremella* species I: *Tremella aurantia* & *T. mesenterica*. Mycologist 9: 110 - 114.

Roberts P. 1996. Heterobasidiomycetes from Majorca & Cabrera. *Mycotaxon* 60: 111 – 123.

Roberts P. 1998. A revision of the genera *Heterochaetella, Myxarium, Protodontia, & Stypella* (Heterobasidiomycetes). Mycotaxon 69: 209 – 248.

Roberts P. 1999. Rhizoctonia-forming fungi. Kew, RBG.

Roberts P. 2001. Heterobasidiomycetes from Korup National Park, Cameroon. Kew Bulletin 56: 163 – 187.

Roberts P. 2003a. Heterobasidiomycetes from Rancho Grande, Venezuela. Mycotaxon 87: 25 – 41.

Roberts P. 2003b. Caribbean heterobasiomycetes. 1. Dominican Republic. Mycotaxon 87: 187 – 201.

Roberts P, de Meijer AAR. 1997. Macromycetes from the state of Paraná, Brazil 6: *Sirobasidiaceae* & *Tremellaceae*. Mycotaxon 64: 261 – 283.

Roberts P, Spooner BM. 2004. Heterobasidiomycetes from the Azores. Kew Bulletin 59: 95 – 101.

Sikaroodi M, Lawrey JD, Hawksworth DL, DePriest PT. 2001. The phylogenetic position of selected lichenicolous fungi: *Hobsonia, Illosporium*, and *Marchandiomyces*. Mycol. Res. 105: 453 – 460.

Spooner BM, Roberts P. 1998. Heterobasidiomycetes from Brunei Darussalam. Kew Bulletin 53: 631 – 650.

Wells K. 1957. Studes of some *Tremellaceae*. Lloydia 20: 43 - 65.

Wells K. 1959. Studies of some *Tremellaceae*. III. The genus *Bourdotia*. Mycologia 51: 541 - 563.

Wells K. 1961. Studies of some *Tremellaceae*. IV. *Exidiopsis*. Mycologia 53: 317 - 370.

Wells K, Oberwinkler F. 1982. *Tremelloscypha gelatinosa*, a species of a new family *Sebacinaceae*. Mycologia 74: 325 - 331.

MYCOTAXON

Volume 96, pp. 109–121 *April–June 2006*

New taxa of the lichen genus *Pertusaria* (Ascomycota) from Thailand

SUREEPORN JARIANGPRASERT

s_vipoosunti@yahoo.com
Department of Biology, Faculty of Science, Maejo University
Chiang Mai 50290, Thailand

Abstract—*Pertusaria alboaspera* var. *disflavens, P. kansriae* var. *stictica, P. methylstenosporica, P. microstoma* var. *isidiata, P. neoknightiana, P. orientalis, P. parameeana, P. phulhuangensis, P. pilosula* var. *abditiva, P. platycarpa P. subcopelandii* and *P. subplanaica* var. *stictica* from Thailand, are reported as new to science.

Key words—lichens, taxonomy

Introduction

Thailand is a tropical country with a high biodiversity in vascular plants and animals as well as lichens. As an example, Homchantara & Coppins (2002) recently described more than thirty new species of *Thelotremataceae* from Thailand. The twelve taxa in the lichen genus *Pertusaria* described below were found to be new to science. These taxa were described and illustrated as species 1-12 in the keys to the 113 species of *Pertusaria* found in Thailand (Jariangprasert 2005). The techniques used for identification of lichen compounds, thin layer chromatography (TLC) and high performance liquid chromatography (HPLC), were as described previously (Jariangprasert & Archer 2002-2004).

Taxonomic Descriptions

Pertusaria alboaspera var. *disflavens* Jariangprasert var. nov. Figure 1

Sicut Pertusaria alboaspera *sed lichexanthone deficiens.*

Etymology: the epithet *disflavens* is from the Latin *dis*, not, and *flavens*, yellowing, a reference to the absence of the yellow fluorescence due to the lichexanthone present in *var. alboaspera*.

Holotype: THAILAND. Chiang Mai Province: Mueang District, Doi Suthep-Pui National Park, in woodpile of hill tribe, 1340 m, on bark of *Litchi chinensis, S. Jariangprasert 1663*, 16.vii.2001; holotype: QSBG.

KEY CHARACTERS—**Thallus** corticolous, greyish green, surface dull, slightly cracked, isidia and soredia absent. **Apothecia** verruciform, conspicuous, numerous and scattered, sometimes confluent, 0.5-0.8 mm diam. **Ostioles** hyaline to grey, inconspicuous, 1-4 per apothecium. **Ascospores** (6-)8 per ascus, basally biseriate, subfusiform-ellipsoid, 65-85 µm long, 27-35 µm wide; smooth, outer ascospore wall 5-10 µm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV-; 2,2'-di-*O*-methylstenosporic acid (major), stictic acid (major) and constictic acid (minor).

Substrate and Distribution—*Pertusaria alboaspera* var. *disflavens* is a rare corticolous taxa known only from a specimen collected in Doi Suthep Pui National Park, Chiang Mai Province, northern Thailand. It grows on *Litchi* at an altitude of 1340 m.

COMMENTS—*Pertusaria alboaspera* var. *disflavens* is characterised by asci with eight ascospores and the presence of 2,2'-di-*O*-methylstenosporic and stictic acids. The new species differs from *P. alboaspera* A.W. Archer & Elix var. *alboaspera* in lacking lichexanthone (Archer & Elix 1993).

***Pertusaria kansriae* var. *stictica* Jariangprasert var. nov.** Figure 2

Similis Pertusaria kansriae sed *acidum sticticum continens differt.*

Etymology: from the presence of stictic acid.

Holotype: THAILAND. Phitsanulok Province: Nakhon Thai District, Phu Hin Rong Kla National Park, behind Ban Pha Chu Thong guest house, 1100 m, on bark of *Artocarpus heterophyllus*, *S. Jariangprasert 2132*, 20.i.2002; holotype: QSBG.

KEY CHARACTERS—**Thallus** corticolous, buff or off-white to ivory, surface smooth and shiny, areolate, isidia and soredia absent. **Apothecia** verruciform, conspicuous, flattened hemispherical, not confluent, not constricted at base. **Ostioles** hyaline, inconspicuous, or rarely pale brown conspicuous, 1 per apothecium. **Ascospores** sometimes 4-5 per ascus, uniseriate, or 8 per ascus, irregularly basally biseriate, subfusiform to ellipsoid, (50-)80-94 µm long, 25-44 µm wide, outer ascospore wall 4-10 µm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ red orange, UV+ salmon orange to orange; 4,5-dichlorolichexanthone (minor), 2'-*O*-methylstenosporic acid (major), stictic acid (minor) and constictic acid (minor).

Substrate and Distribution—*Pertusaria kansriae* var. *stictica* occurs in Phu Hin Rongkla National Park, Phitsanulok Province in northern Thailand and is uncommon in Chiang Mai and Loei Provinces. It grows on *Peltophorum*, *Phyllanthus* and *Schima* at altitudes between 600 and 1100 m.

COMMENTS—*Pertusaria kansriae* var. *stictica* is characterised by asci with eight uniseriate ascospores and the presence of 4,5-dichlorolichexanthone, 2'-*O*-methylstenosporic and stictic acids. The species resembles *P. kansriae* Jariangprasert (Jariangprasert & Anusarnsunthorn 2005) but is differentiated from that species by the presence of stictic acid and the number of ascospores per ascus.

ADDITIONAL SPECIMENS EXAMINED—THAILAND. **Chiang Mai Province:** Mae Rim District, The Queen Sirikit Botanic Garden, on slope next to fern plot, 640 m, on bark of *Peltophorum pterocarpum* in evergreen forest, *K. Boonpragob s.n.*, 25.i.1994, RU 273 (RAMK). **Phitsanulok Province:** Nakhon Thai District, Phu Hin Rong Kla National Park, opposite the headquarters, 1100 m, on bark of *Phyllanthus emblica* in pine plantation, *S. Jariangprasert 1923, 1925, 1932, 1943*, 19.i.2002 (QSBG). **Loei Province:** Nahaeo District, Nahaeo National Park, at a bridge to Na Po, 720-750 m, on bark of *Schima wallichii* in dry evergreen forest, *N. Homchantara s.n.*, 4.iv.1995, RU 7622 (RAMK).

Pertusaria methylstenosporica Jariangprasert **sp. nov.** Figure 3

Similis Pertusaria novaeguineae *sed acidium 2'-O-methylperlatolicum deficiens.*

Etymology: the epithet *methylstenosporica* refers to the presence of methyl 2'-O-methylstenosporate in the new species.

Holotype: THAILAND. Chiang Mai Province: Jom Thong District, Doi Inthanon National Park, gateway to Ban Pha Mhon, 1040 m, on tree trunk, in pine forest, *S. Jariangprasert 2459*, 13.iii.2002; holotype: QSBG.

Key characters—**Thallus** corticolous, olive green to green, surface smooth and shiny, isidia and soredia absent. **Apothecia** verruciform, conspicuous, flattened hemispherical, constricted at base, rarely confluent, sometimes cracked, 1-2 apothecia per verruca, 0.5-1.0 mm diam. **Ostioles** grey-black, conspicuous, fused in a central depression, 1-4 per apothecium, 1-8 per verruca. **Ascospores** 2-3 per ascus, subfusiform to ellipsoid-cylindrical, (100-)118-150 µm long, 35-50 µm wide; smooth, outer ascospore wall 6-12 µm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV-; methyl 2'-O-methylstenosporate (major), planaic acid (minor), 2-O-methylperlatolic acid (minor), methyl 2-O-methylperlatolate (minor), methyl planaiate (minor), stictic acid (major) and constictic acid (trace).

Substrate and Distribution—*Pertusaria methylstenosporica* is a rare, endemic, corticolous species, known only the type specimen from Doi Inthanon National Park, Chiang Mai, in the north of Thailand. It grows in pine forest at an altitude of 1040 m.

Comments—*Pertusaria methylstenosporica* is distinguished from other *Pertusaria* species with two smooth ascospores per ascus by the presence of methyl 2'-O-methylstenosporate. This substance is rarely found as a major compound but occurs in *P. alboaspera* var. *tetraspora* Jariangprasert (Jariangprasert & Anusarnsunthorn 2005). The species is morphologically similar to *P. novaeguineae* A.W. Archer & Elix but has a different chemistry; *Pertusaria novaeguineae* contains 2'-O-methylperlatolic acid (Archer & Elix 1998a).

Pertusaria microstoma var. ***isidiata*** Jariangprasert **var. nov.** Figure 4

Similis Pertusaria microstoma *sed isidiis differt.*

Etymology: the epithet *isidiata*, refers to the isidiate thallus.

Holotype: THAILAND. Tak Province: Mueang District, Tambon Mae To, Lan Sang National Park, trail to Musoe Dam-Musoe Lhueang Agricultural Station, Pha Daeng unit, 970 m, on bark of *Knema linifolia* in evergreen forest, *S. Jariangprasert 3918*, 20.xi.2002; holotype: QSBG; topotype: *S. Jariangprasert* 3919: RAMK.

Key characters—**Thallus** corticolous, greyish green, surface smooth, dull, isidiate, soredia absent. **Isidia** simple to coralloid, numerous, dense, concolourous with the thallus, 0.2-0.8 mm long, 0.1 mm diam. **Apothecia** verruciform, conspicuous, subglobular to hemispherical, numerous, crowded, constricted at the base, 0.3-0.8 mm diam. **Ostioles** black, conspicuous, slightly depressed, 1-2(-4) per apothecia. **Ascospores** (1-)2-3 per ascus, ellipsoid, (80-)82-92(-106) µm long, (32-)36-44 µm wide; rough, outer ascospore wall 6-10 µm thick.

Chemistry—K+ pale yellow, KC-, C-, Pd+ orange, UV+ orange red; 4,5-dichlorolichexanthone (minor), 2'-O-methylperlatolic acid (major), stictic acid (minor) and constictic acid (minor-trace).

Substrate and Distribution—*Pertusaria microstoma* var. *isidiata* is an uncommon corticolous species. Three of the four specimens were found in Tak Province in northern Thailand whereas the remaining specimen was collected in Phetchaburi Province in southwest Thailand. It grows on *Knema* at altitudes between 600 and 1000 m.

Comments—*Pertusaria microstoma* var. *isidiata* is characterised by the isidiate thallus, two rough ascospores per ascus and the presence of 4,5-dichlorolichexanthone, 2'-O-methylperlatolic and stictic acids. The new variety is chemically identical to *P. microstoma* Müll. Arg. (Archer 1997) but that species lacks isidia, and to *P. bundiensis* A.W. Archer & Elix (Archer & Elix 1998b) but that species has larger ascospores, 150-170 µm long.

> Additional specimens examined—**THAILAND. Tak Province:** type locality, *S. Jariangprasert 3759*, 20.xi.2002. **Phetchaburi Province:** Kaeng Krachan National Park, by side of road beyond 28 km marker, 600 m, on fallen log, in moist evergreen forest, *S. Jariangprasert 2521*, 12.vi.2002 (QSBG).

Pertusaria neoknightiana Jariangprasert **sp. nov.** Figure 5

> *Sicut* Pertusaria knightiana *sed ascosporis minoribus et parietibus interioribus laevis differt.*
>
> *Etymology*: from the Latin, *neo*, new, and a reference to *Pertusaria knightiana*.
>
> *Holotype*: THAILAND. Phitsanulok Province: Nakhon Thai District, Phu Hin Rong Kla National Park, behind Ban Pha Chu Thong guest house, 1100 m, on bark of *Mangifera indica* in pine plantation, *S. Jariangprasert 2118*, 20.i.2002; holotype: QSBG.

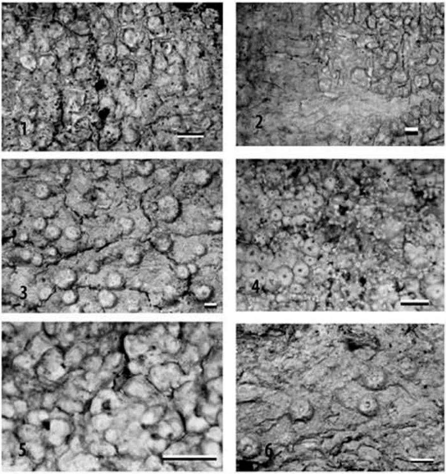
Key characters—**Thallus** corticolous, pale greyish green, surface subtuberculate, glossy, with crystals below the cortex, lacking isidia and soredia. **Apothecia** verruciform, inconspicuous, rarely confluent, 0.4-0.9 mm diam. **Ostioles** conspicuous, grey-black, immersed in a central depression, 1 per apothecium. **Ascospores** 2 per ascus, ellipsoid, (54-)86-122 µm long, (24-)36-46µm wide; smooth, outer ascospore wall 6-10 µm thick.

Chemistry—K+ yellow then red, KC-, C-, Pd +yellow, UV+ strong yellow orange; 4,5-dichlorolichexanthone (minor), norstictic acid (major) and connorstictic acid (minor).

Substrate and Distribution—*Pertusaria neoknightiana* is a corticolous species, sparsely distributed in two provinces of northern Thailand. It grows on *Dalbergia*, *Mangifera* and *Prunus* at altitudes between 100 and 1300 m.

Comments—*Pertusaria neoknightiana* is characterised by asci with two smooth ascospores and the presence of 4,5-dichlorolichexanthone and norstictic acid. The new species is chemically similar to *P. knightiana* Müll. Arg., a saxicolous species from New Zealand and Australia, but that species has rough ascospores.

> Additional specimens examined—**THAILAND. Chiang Mai Province:** Chiang Dao District, Huai Nam Dang National Park, Noen Phee Lhok, 1300 m, on Fagaceae, *S. Jariangprasert 4518.2*, 24.xii.2002 (QSBG); *ibid.*, on *Dalbergia*, in evergreen forest, *S. Jariangprasert 4486.2*, 24.xii.2002 (QSBG). **Phitsanulok Province:** Nakhon Thai District, Phu Hin Rong Kla National Park, 1030 m, on *Prunus cerasoides* in evergreen forest, *N. Homchantara NH 42.8(1)*, 2.v.2003 (RAMK).



Figures 1-6. New taxa of *Pertusaria*. **1.** *P. alboaspera* var. *disflavens*, holotype (QSBG); **2.** *P. kansriae* var. *stictica*, holotype (QSBG); **3.** *P. methylstenosporica*, holotype (QSBG); **4.** *P. microstoma* var. *isidiata*, holotype (QSBG); **5.** *P. neoknightiana*, holotype (QSBG); **6.** *P. orientalis*, holotype (QSBG). Scale bar = 1 mm.

Pertusaria orientalis Jariangprasert **sp. nov.** **Figure 6**

Similis Pertusaria malvinae *sed corticola et ascosporis minoribus differt.*

Etymology: from the Latin, *orientalis*, eastern, a reference to the occurrence of the species in Asia.

Holotype: THAILAND. Chiang Mai Province: Mueang District, Doi Suthep-Pui National Park, trail to top of Doi Pui Mountain, 1600 m, in moist evergreen forest, *S. Jariangprasert 1672*, 16.vii.2001; holotype: QSBG.

KEY CHARACTERS—**Thallus** corticolous, greyish green, surface subtuberculate, rarely wrinkled, cracked and areolate, isidia and soredia absent. **Apothecia** verruciform, conspicuous, flattened hemispherical to irregular, rarely confluent, 0.5-1.3 mm diam.

Ostioles hyaline and inconspicuous to black and conspicuous, surrounded with translucent tissue, some sunken and fused to become pseudolecanorine or slightly raised, 1-3 per apothecia. **Ascospores** 2-3(-4) per ascus, broad ellipsoid-cylindrical, 72-134 µm long, 40-80 µm wide; smooth, outer ascospore wall 6-14 µm thick.

Chemistry—K- or + yellow, KC-, C-, Pd-, UV-; confluentic acid (major) and 2'-*O*-methylmicrophyllinic acid (minor-trace).

Substrate and Distribution—*Pertusaria orientalis* is a common corticolous species in Chiang Mai Province in the north but uncommon in Loei and Tak Provinces in the northeast Thailand. It grows on *Anacolosa*, *Artocarpus*, *Cinnamomum*, *Docynia*, *Eurya*, *Phyllanthus*, *Prunus* and *Senna* at altitudes between 100 and 1700.

COMMENTS—*Pertusaria orientalis* is characterised by asci with two predominantly smooth ascospores and the presence of confluentic acid. The Thai specimens are chemically similar to the saxicolous species *P. malvinae* Messuti & A. W. Archer from the Falkland Islands (Messuti & Archer 1999) but differ from that species by substrate preference and number of ascospores. In *P. orientalis* there are two to three, rarely four (immature) ascospores per ascus in contrast to the four-spored asci in *P. malvinae*.

ADDITIONAL SPECIMENS EXAMINED—THAILAND. **Chiang Rai Province:** Phan District, Tambon Pa Hung, Doi Lhuang National Park, Pang Pa Gluay and Pang Ma Kham Pom, 1210 m, on Fagaceae, in evergreen forest, *S. Jariangprasert 3568*, 14.xi.2002 (QSBG). **Chiang Mai Province:** Mueang District, Doi Suthep-Pui National Park, behind headquarters, 1100 m, on *Artocarpus heterophyllus* in evergreen forest, *S. Jariangprasert 2667.2*, 17.ix.2002 (QSBG); *ibid.*, a trail to Ban Maeo Community, 1450 m, on bark of Fagaceae, in evergreen forest, *S. Jariangprasert 1680*, 16.vii.2001 (QSBG); *ibid.*, 1300 m, a trail behind Ban Mong Doi Pui, Moo 4 Ban Khun Chang Khian, *S. Jariangprasert 2591.2*, 16.ix.2002 (QSBG); *ibid.*, trail behind Ban Maeo Community, 1340 m, on *Senna floribunda* in evergreen forest, *S. Jariangprasert 1664, 1672*, 16.vii.2001 (QSBG); Fhang District, Angkhang, opposite crossroad to Mae Phoe Headwaters catchment, 1520 m, on *Docynia indica*, *S. Jariangprasert 2849*, 29.ix.2002 (QSBG); Chiang Dao District, Huai Nam Dang National Park, around welfare restaurant, 1540-1680 m, on *Eurya acuminata* var. *wallichiana*, *S. Jariangprasert 4583, 4588, 4589, 4590, 4659, 4702.1, 4735, 4736, 4739*, 25.xii.2002 (QSBG); *ibid.*, behind welfare restaurant, 1580 m, on unidentified tree, *S. Jariangprasert 4717*, 25.xii.2002 (QSBG); behind welfare shop, 1600 m, on *Cinnamomum*, *S. Jariangprasert 4572, 4579.2*, 25.xii.2002 (QSBG); *ibid.*, on Euphorbiaceae, *S. Jariangprasert 4613, 4617.2*, 25.xii.2002 (QSBG); roadside to Sone Doi, 1600 m, on *Eurya acuminata* var. *wallichiana*, *S. Jariangprasert 4743*, 25.xii.2002 (QSBG); *ibid.*, Sone Doi, tent area, 1680 m, on *Prunus cerasoides* in evergreen forest with pines, *S. Jariangprasert 4633*, 25.xii.2002 (QSBG); *ibid.*, view point, 1440 m, on Euphorbiaceae, *S. Jariangprasert 4640*, 25.xii.2002 (QSBG); *ibid.*, roadside to the new palace, 1540 m, *S. Jariangprasert 4660*, 25.xii.2002 (QSBG); *ibid.*, 62-63 km, Noen Phee Lhok, 1300 m, on Fagaceae, in evergreen forest, *S. Jariangprasert 4427*, 24.xii.2002 (QSBG); Jom Thong District, Doi Inthanon National Park, at twenty-seventh kilometre stone, 1060 m, in deciduous/pine forest, *S. Jariangprasert 2468*, 13.iii.2002 (QSBG); *ibid.*, left hand side of gateway to Ban Lung Daeng, 1300 m, on *Phyllanthus emblica*, *S. Jariangprasert 4804*, 25.xii.2002 (QSBG); Omkoi District, Tambon Mon Jong, Ban Mae Toen, Omkoi Wildlife Sanctuary, in front of Musoe unit, 1340 m, on cultivated *Senna floribunda* in evergreen forest with pines, *S. Jariangprasert 4215*, 17.xii.2002 (QSBG); *ibid.*, on unidentified tree, *S. Jariangprasert 4228.2*, 17.xii.2002 (QSBG); *ibid.*, Mae La Meed Lhuang, 1440 m, on *Carallia brachiata*, *S. Jariangprasert 4346, 4363, 4368.1, 4382*, *4394.1*, 19.xii.2002 (QSBG); *ibid.*, on vine, *S. Jariangprasert 4391.1*, 19.xii.2002 (QSBG); *ibid.*, on *Anacolosa ilicoides*, *S. Jariangprasert 4388*, 19.xii.2002 (QSBG). **Tak Province:** Mueang District, Tambon Mae To, Lan Sang National Park, between Tak Province and Mae Sod District, on the way to Musoe Dam and Musoe Lhueang Agricultural Station, trail to Pha Daeng unit, 1020 m, on Fagaceae, in evergreen forest, *S. Jariangprasert 3803*, 20.xi.2002 (QSBG). **Loei Province:** Phu Lhuang Wildlife Sanctuary, in front of Song Phra Jaroen placard, 1460 m, on bark of *Lithocarpus truncatus* in oak/chestnut forest, *S. Jariangprasert 2298*, 3.ii.2002 (QSBG).

Pertusaria parameeana Jariangprasert sp. nov. Figure 7

Sicut Pertusaria meeana *sed ostiolis nigris et acida perlatolicum et dihydropicrolichenicum continens differt.*

Etymology: from the Greek *para*, near, a reference to the similarity of the new species to *Pertusaria meeana*.

Holotype: THAILAND. Chiang Mai Province: Mae Rim District, The Queen Sirikit Botanic Garden, opposite the headquarters building, 650-730 m, on bark of *Semecarpus albescens* in dry dipterocarp forest, *K. Boonpragob s.n.*, 17.i.1995; holotype: RU 3817 (RAMK); topotype: RU 3824 (RAMK).

KEY CHARACTERS—**Thallus** corticolous, dark green, surface rough, subtuberculate, isidia and soredia absent. **Apothecia** verruciform, conspicuous, flattened hemispherical, constricted at base, confluent, 1-3 apothecia per verruca, 0.5-0.8 mm diam. **Ostioles** black, conspicuous, sunken, sometimes fused, 1-5 per apothecia. **Ascospores** (1-)2(-3) per ascus, rarely 4 (then immature), ellipsoid, (80-)105-137(-140) µm long, (35-)40-60 µm wide; smooth, outer ascospore wall 10-17 µm thick.

Chemistry—K-, KC-, C-, Pd-, UV+ salmon orange; atranorin (trace), 4,5-dichlorolichexanthone (minor), 2-*O*-methylperlatolic acid (major), perlatolic acid (trace), dihydropicrolichenic acid (trace) and ±2-*O*-methylstenosporic acid (trace).

Substrate and Distribution—*Pertusaria parameeana* is a corticolous species, found in several northern provinces and rarely in the southwest. It grows on *Dipterocarpus*, *Semecarpus* and *Shorea* at altitudes between 370 and 1300 m.

COMMENTS—*Pertusaria parameeana* is characterised by asci with two smooth ascospores and the presence of 2-*O*-methylperlatolic acid and 4,5-dichlorolichexanthone. The species is chemically similar to the Australian species *P. meeana* A.W. Archer & Elix but differs in morphology and trace compounds. *Pertusaria meeana* has inconspicuous, punctiform, translucent ostioles and flattened hemispherical verruciform apothecia, and contains the trace compounds 2-*O*-methyhyperlatolic and 2-*O*-methyisohyperlatolic acids (Archer 1997) whereas the new species has sunken, conspicuous black ostioles and constricted apothecia, and contains perlatolic, dihydropicrolichenic and 2-*O*-methylstenosporic acids as trace lichen compounds.

ADDITIONAL SPECIMENS EXAMINED—THAILAND. **Chiang Rai Province:** Phan District, Tambon Pa Hung, Doi Lhuang National Park, Ban Pang Pu Lo, 1180 m, on Fagaceae, from dry dipterocarp to deciduous forest, *S. Jariangprasert 3460*, 13.xi.2002 (QSBG). **Chiang Mai Province:** Mueang District, Doi Suthep Pui National Park, 18°48′N, 99°56′E, 650 m, in dry dipterocarp forest, *P. W. James & P. A. Wolseley* 2632, 30.i.1993, (BM); Mae Rim District, The Queen Sirikit Botanic Garden, opposite of the headquarters building, 900-1100 m, on bark of *Dipterocarpus obtusifolius* in dry dipterocarp forest, *K. Boonpragob s.n.*, 15.i.1995, RU 3615 (RAMK); Huai Nam Dang National Park, Noen Phee Lhok, between the sixty-second and sixty-third kilometres, 1300 m, on Fagaceae, in hill evergreen forest, *S. Jariangprasert 4415, 4527*, 24.xii.2002 (QSBG). **Lampang Province:** Phan District, Tambon Jae Sawn, Jae Sawn National Park, nature study track round waterfall, 660 m, on *Semecarpus albescens* in evergreen forest, *S. Jariangprasert 3067, 3068*, 5.xi.2002 (QSBG); *ibid.*, behind the youth camp, opposite waterfall, 740 m, on *Shorea siamensis* in dry dipterocarp forest, *S. Jariangprasert 3265*, 6.xi.2002 (QSBG). **Uttaradit Province:** Nam Pad District, Ban Huai Mun, Phu Soi Dao National Park, Huai Tao, Ban Coke, 490 m, on *Dipterocarpus obtusifolius* in dry dipterocarp forest, *S. Jariangprasert 4009.1*, 27.xi.2002 (QSBG). **Tak Province:** Mueang District, Tambon Mae To, Lansang National Park, near waterfall, 480-540 m, on *Shorea*, in dry dipterocarp forest, *S. Jariangprasert 3668, 3677*, 19.xi.2002 (QSBG). **Uthai Thani Province:** Huai Kha Khaeng Wildlife Sanctuary, 15°35'N, 99°20'E, 500 m, in dry dipterocarp forest, *P. A. Wolseley, 1024.1*, 10.i.1991, (BM); *ibid.*, Khao Nang Rum, 15°29'N, 99°18'E, 400 m, on *Dipterocarpus*, in dry dipterocarp forest, *P. A. Wolseley 5262, 5263*, 20.i.1992, (BM); *ibid.*, Valley plot, 370 m, *Aguirre, James & Wolseley 3061.1*, 12.ii.1993, (BM).

Pertusaria phulhuangensis Jariangprasert sp. nov. Figure 8

Sicut Pertusaria minor *sed ascosporis majoribus et ostiolis differt.*

Etymology: from the Latin, *ensis*, place of origin, and Phu Lhuang Wildlife Sanctuary.

Holotype: THAILAND. Loei Province: Phu Lhuang Wildlife Sanctuary, behind the Queen's palace, Pha Yueang Cliff, 1470 m, on tree trunk, in oak/chestnut forest, *S. Jariangprasert 2193*, 3.ii.2002; holotype: QSBG; *S. Jariangprasert 2192*, topotype: RAMK.

KEY CHARACTERS—**Thallus** corticolous, green, surface smooth, isidia and soredia absent **Apothecia** verruciform, conspicuous, broadly hemispherical, confluent, 1-4 apothecia per verruca, 0.7-2.3 mm diam. **Ostioles** hyaline to grey, conspicuous, most are poriform, surrounded with white tissue, 1-5 per apothecia. **Ascospores** (5-)6-8 per ascus, uniseriate, subfusiform-ellipsoid, 74-110 µm long, 30-44 µm wide; smooth, some with pores between outer and inner wall, outer ascospore wall 6-10 µm thick.

Chemistry—K- or + yellow, KC-, C-, Pd+ orange, UV-; 2'-*O*-methylperlatolic acid (major), stictic acid (minor) and peristictic acid (trace).

Substrate and Distribution—*Pertusaria phulhuangensis* is a rare, endemic corticolous species from Phu Lhuang Wildlife Sanctuary, Loei Province, in upper northeastern Thailand. It occurs in oak/chestnut forest at 1470 m.

COMMENTS—*Pertusaria phulhuangensis* is characterised by asci with eight ascospores and the presence of 2'-*O*-methylperlatolic and stictic acids. The new species differs from the chemically similar species *P. minor* Müll. Arg., from Indonesia, by the larger, uniseriate ascospores, 74-110 x 30-44 µm, compared to 60-80 x 22-32 µm in *P. minor* (Zahlbruckner; 1928). In addition, *Pertusaria minor* has black ostioles in contrast to the hyaline ostioles in *P. phulhuangensis*.

ADDITIONAL SPECIMENS EXAMINED—THAILAND. **Loei Province:** Phu Lhuang Wildlife Sanctuary, in front of the old palace, 1470 m, on tree trunk, in oak/chestnut forest, *S. Jariangprasert 2251*, 3.ii.2002 (QSBG); *ibid.*, behind the Queen's palace, Pha Yueang Cliff, 1470 m, on tree trunk, in oak/dipterocarp forest, *S. Jariangprasert 2192*, 3.ii.2002; topotype: RAMK.

Pertusaria pilosula var. ***abditiva*** Jariangprasert var. nov. Figure 9

Sicut Pertusaria pilosula *sed 4,5-dichlorolichexanthone deficiens.*

Etymology: from the Latin, *abditivus*, removed from, a reference to the absence of 4,5-dichlorolichexanthone, present in var. *pilosula*.

Holotype: THAILAND. Sukhothai Province: Ramkhamhaeng National Park, nature study trail, 450 m, in dry evergreen forest, *K. Vongshewarat*, 22.x.1997, RU 9509.3 (RAMK).

KEY CHARACTERS—**Thallus** corticolous, olive green, soredia absent, isidiate. **Isidia** initially simple, becoming branched, 0.15-1.0 mm long, 0.1-0.15 mm diam. **Apothecia** unknown.

Chemistry—K-, KC-, C-, Pd-, UV-; 2'-*O*-methylperlatolic acid (major), stictic acid (minor) and constictic acid (trace).

Substrate and Distribution—*Pertusaria pilosula* var. *abditiva* is an isidiate corticolous species, found predominantly in northern Thailand. It grows on *Ficus* and *Vatica* at altitudes between 140 and 1100 m.

COMMENTS—*Pertusaria pilosula* var. *abditiva* is characterised by an isidiate thallus and the presence of 2'-*O*-methylperlatolic and stictic acids. It resembles *P. pilosula* A.W. Archr & Elix but is distinguished from that species by the absence of 4,5-dichlorolichaxanthone (Archer 1997). The Thai specimens also resemble *P. buburana* Elix & A.W. Archer, an isidiate species from Papua New Guinea, but that species contains only 2'-*O*-methylperlatolic acid (Elix et al. 1997).

ADDITIONAL SPECIMENS EXAMINED—THAILAND. **Chiang Mai Province:** Mueang District, Doi Suthep-Pui National Park, 99°54'E, 18°48'N, 1100 m, in moist evergreen forest, *P. A. Wolseley & B. Aguirre-Hudson*, 24.xi.1991, L 5317 (CMU). **Lamphun-Lampang Provinces:** Doi Khun Tan National Park, 200 m, 1060 m, on *Ficus*, in evergreen forest, *S. Jariangprasert 2943*, 24.x.2002 (QSBG); *ibid.*, beyond a shelter between Yo 2 and Yo 3, 1100 m, in hill evergreen forest, *S. Jariangprasert 2954*, 24.x.2002 (QSBG). **Uttaradit Province:** Nam Pad District, Ban Huai Mun, Phu Soi Dao National Park, behind waterfall, 800-1000 m, on Fagaceae, in dry dipterocarp/evergreen forest, *S. Jariangprasert 4057, 4072*, 28.xi.2002 (QSBG); *ibid.*, Ban Coke to Ban Huai Tao, behind big rock, in dry dipterocarp forest, *S. Jariangprasert 3983*, 27.xi.2002 (QSBG); *ibid.*, 820-1100 m, on bark of unidentified vine, in dry dipterocarp/Fagaceae forest, *S. Jariangprasert 4062*, 28.xi.2002 (QSBG). **Uthai Thani Province:** Huai Kha Kaeng Wildlife Sanctuary, Khao Nang Rum, 99°18'E, 15°29'N, 370 m, on *Vatica cinerea* in dry evergreen forest, *P. A. Wolseley & B. Aguirre-Hudson*, 22.i.1992, L 5394 (CMU); *ibid.*, river to KNR, windy gap pass, 99°15'E, 15°28'N, 900 m, in dry evergreen forest, *P. A. Wolseley & B Aguirre-Hudson*, 27.i.1992, 5313 (BM); *ibid.*, 99°18'E, 15°29'N, 370 m, on Rutaceae, in dry evergreen forest, *B. Aguirre-Hudson & P. A. Wolseley*, 28.i.1992, 5303 (BM); *ibid.*, Khao Kiew, 99°20'E, 15°27'N, 500 m, in evergreen forest, *Aguirre, James & Wolseley*, 15.ii.1993, 2545 (BM). **Nakhon Ratchasima Province:** Khao Yai National Park, Nhong Phagshe, 14°27'71"N, 101°22'19"E, 800 m, on *Ficus* fallen log, in dry evergreen forest, *S. Jariangprasert 4876*, 16.viii.2003 (QSBG). **Chantaburi Province:** Khao Soi Dao Wildlife Sanctuary, in front of the head office, 280 m, on bark of vine, in dry evergreen forest, *S. Jariangprasert 2557*, 16.vi.2002 (QSBG). **Krabi Province:** Khao Panom Benja National Park, close to welfare restaurant, 140 m, on tree trunk, in evergreen forest, *S. Jariangprasert 2931*, 13.x.2002 (QSBG).

Pertusaria platycarpa Jariangprasert **sp. nov.** **Figure 10**

> *Sicut* Pertusaria praetermissa *sed lichexanthone continens vice 4,5-dichlorolichexanthone.*
>
> *Etymology*: the epithet *platycarpa* is from the Greek *platys*, broad and *karpos*, fruit, a reference to the flattened apothecia.
>
> *Holotype*: THAILAND. Loei Province: Phu Lhuang Wildlife Sanctuary, in front of the old palace, 1470 m, on bark of *Acronychia pedunculata* in oak/chestnut forest, *S. Jariangprasert 2161*, 3.ii.2002; holotype: QSBG.

Key characters—**Thallus** corticolous, greyish green, surface dull, slightly wrinkled and cracked, with crystals below the cortex, isidia and soredia absent. **Apothecia** verruciform, conspicuous, flattened hemispherical, constricted at the base, concolourous with the thallus, pale above, rarely confluent, 2-3 per verruca, 0.6-1.1 mm diam. **Ostioles** smooth, translucent, inconspicuous, 1-2 per apothecia. **Ascospores** 8 per ascus, basally irregularly biseriate, subfusiform, 70-110(-134) µm long, 36-46(-54) µm wide; smooth, outer ascospore wall 6-12 µm thick.

Chemistry—K+ yellow, KC-, C-, Pd+ orange, UV+ yellow; lichexanthone (minor), 2'-*O*-methylstenosporic acid (major), 2'-*O*-methyldivaricatic acid (trace), 2'-*O*-methylperlatolic acid (trace) and stictic acid (trace).

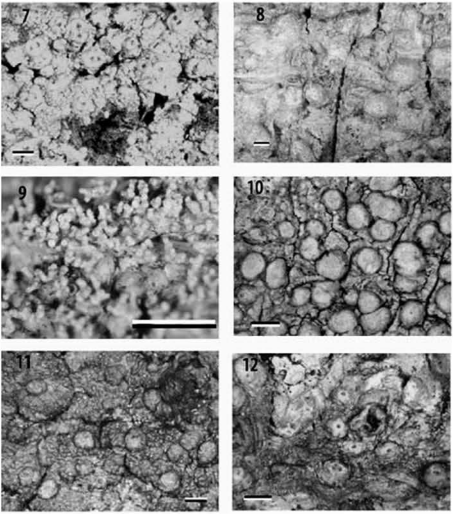
Substrate and Distribution—*Pertusaria platycarpa* is a rare, endemic corticolous species known only from the type specimen from Phu Lhuang Wildlife Sanctuary, Loei Province, in northeastern Thailand. It grows on *Acronychia* at 1470 m.

Comments—*Pertusaria platycarpa* is characterised by asci with eight ascospores and the presence of lichexanthone and 2'-*O*-methylstenosporic acid. The new species is morphologically similar to *P. alboaspera* but that species contains stictic and 2,2'-di-*O*-methylstenosporic acids as a major compounds. The species resembles *P. praetermissa* A.W. Archer & Elix and *P. boweniana* A.W. Archer & Elix but those species contains 4,5-dichlorolichexanthone and 2-chlorolichexanthone respectively (Archer 1997) in place of lichexanthone present in the new species. The new species is chemically identical to *P. elixii* Jariangprasert but that species has four ascospores per ascus (Jariangprasert & Anusarnsunthorn 2005).

Pertusaria subcopelandii Jariangprasert **sp. nov.** **Figure 11**

> *Similis* Pertusaria copelandii *sed verrucis et ascosporis minoribus et 4,5-dichlorolichexanthone deficiens.*
>
> *Etymology*: From the Latin *sub*, under or somewhat, a reference to the similarity with the species *Pertusaria copelandii*.
>
> *Holotype*: THAILAND. Chiang Mai Province: Mae Rim District, The Queen Sirikit Botanic Garden, Doi Pha Glong Mountain, 1430 m, on bark of *Castanopsis ferox* in evergreen pine forest, *K. Boonpragob s.n.*, 7.xi.1994; holotype: RU 3087 (RAMK).

Key characters—**Thallus** corticolous, dark olive green, surface wrinkled, cracked, lacking isidia and soredia. **Apothecia** verruciform, conspicuous, concolourous with the thallus, flattened to concave, hemispherical to pseudolecanorine, very constricted at base, not confluent, 0.7-1.5 mm diam. **Ostioles** inconspicuous, in yellowish tissue, centrally depressed. **Ascospores** 2 per ascus, subfusiform to cylindrical, 100-170 µm long, 30-50 µm wide; smooth, outer ascospore wall 6-14 µm thick.



Figures 7-12. New taxa of *Pertusaria* **7.** *P. parameeana*, holotype (RAMK); **8.** *P. phulhuangensis*, S. Jariangprasert 2192 (RAMK); **9.** *P. pilosula* var. *abditiva*, S. Jariangprasert 3828 (QSBG); **10.** *P. platycarpa*, holotype (QSBG); **11.** *P. subcopelandii*, holotype (RAMK); **12.** *P. subplanaica* var. *stictica*, S. Jariangprasert 2454 (RAMK). Scale bar = 1 mm.

Chemistry—K+ yellow, KC+ yellow, C-, Pd-, UV-; atranorin (minor), 2'-*O*-methylperlatolic acid (major), 2-*O*-methylperlatolic acid (minor), planaic acid (minor), methyl 2-*O*-methylperlatolate (minor), methyl planaiate (minor), stictic acid (major) and peristictic acid (trace).

Substrate and Distribution—*Pertusaria subcopelandii* is a rare, endemic corticolous species, known only from the type specimen from the Mae Rim District, Chiang Mai Province in northern Thailand. It grows on *Castanopsis* at 1430 m.

Comments—*Pertusaria subcopelandii* is characterised by asci with two smooth ascospores and the presence of 2'-*O*-methylperlatolic and stictic acids. The new species resembles *P. copelandii* Vain. but lacks 4,5-dichlorolichexanthone and possesses smaller ascospores, 100-170 µm long compared to 163-200 µm in *P. copelandii*. The new species is chemically similar to *P. novaeguineae* but the latter has distinct black ostioles and asci with 3-4 ascospores (Archer & Elix 1998a).

Pertusaria subplanaica var. *stictica* Jariangprasert var. nov. Figure 12

Similis Pertusaria subplanaica *sed acidum sticticum continens differt.*

Etymology: the name of the new variety refers to the presence of stictic acid.

Holotype: THAILAND. Phitsanulok Province: Nakhon Thai District, Phu Hin Rong Kla National Park, by road from Mhun Daeng Waterfall at thirty-seventh kilometre stone, 1560 m, on bark of *Prunus cerasoides* in evergreen forest, *S. Jariangprasert 2076*, 19.i.2002; holotype: QSBG.

Key characters—**Thallus** corticolous, yellow ivory to greyish green, surface smooth, rarely wrinkled, lacking isidia and soredia. **Apothecia** verruciform, conspicuous, hemispherical, constricted at the base, not confluent, (0.5-)1.6-3.0 mm diam. **Ostioles** variable, inconspicuous to black and conspicuous, some sunken, surrounded with translucent tissue, 1-4 per apothecium. **Ascospores** (4-6)7-8 per ascus, uniseriate, occasionally basally biseriate, subfusiform to ellipsoid, 64-102 µm long, (27-)38-50 µm wide; smooth, outer ascospore wall 6-20 µm thick.

Chemistry—K+ pale to yellow, KC-, C-, Pd+ orange, UV+ orange; 4,5-dichlorolichexanthone (minor), 2,2'-di-*O*-methylstenosporic acid (major), 2,2'-di-*O*-methyldivaricatic acid (major), 2'-*O*-methylstenosporic acid (minor), methyl 2'-*O*-methylstenosporate (minor), planaic acid (minor) and stictic acid (major).

Substrate and Distribution—*Pertusaria subplanaica* var. *stictica* is a corticolous species found in northern and upper northeastern Thailand. It grows on *Castanopsis*, *Persea*, *Phyllanthus*, *Prunus* and *Syzygium* at altitudes between 100 and 1600 m.

Comments—*Pertusaria subplanaica* var. *stictica* is characterised by asci with eight uniseriate ascospores and its chemistry. The new variety resembles *P. subplanaica* A.W. Archer & Elix var. *subplanaica* but is distinguished from that taxon by the presence of stictic acid (Archer 1997).

Additional specimens examined—THAILAND. Chiang Mai Province: Jom Thong District, Doi Inthanon National Park, gateway to Ban Mae Glang Lhuang, 1040 m, on bark of *Syzygium aqueum* in deciduous forest, *S. Jariangprasert 2394.1*, 13.ii.2002 (QSBG); *ibid.*, on bark of *Castanopsis*, in deciduous forest, *S. Jariangprasert 2454*, 13.ii.2002 (QSBG). **Phitsanulok Proviince**: Nakhon Thai District, Phu Hin Rongkla National Park, opposite the headquarters, 1100 m, on bark of *Phyllanthus emblica* in pine plantation, *S. Jariangprasert 1919.2*, 19.i.2002 (QSBG). **Loei Province**: Phu Lhuang Wildlife Sanctuary, in front of the old palace, 1470 m, on bark of *Persea kurzii* in oak/chestnut forest, *S. Jariangprasert 2171*, 3.ii.2002 (QSBG); *ibid.*, close to Pha Chang Phan Cliff, 1510 m on unidentified bark (fragrant of tree), next to the cliff, in oak/chestnut forest, *S. Jariangprasert 2249*, 3.ii.2002 (QSBG).

Acknowledgements

The author is grateful to the Curators of BM, CMU, PSU and RAMK for the loan of specimens, to Professor J.A. Elix (Australian National University) for the high performance liquid chromatography results and editorial assistance, to Dr. A.W. Archer (National of Herbarium of New South Wales) for correcting the manuscript and editorial assistance, and to the Department of Biology, Faculty of Science, Maejo University, for the use of the laboratories and equipment.

Literature Cited

Archer AW. 1991. New species and new reports of *Pertusaria* (Lichenised Ascomycotina) from Australia and New Zealand with a key to the species in Australia. Mycotaxon 41(1): 223-269.

Archer AW 1997. The lichen genus *Pertusaria* in Australia. Biblioth. Lichenol. 69: 1-249.

Archer AW, Elix JA. 1992. Further new species and new reports of *Pertusaria* (Lichenised Ascomycotina) from Australia. Mycotaxon 45: 417-431.

Archer AW, Elix JA. 1993. Additional new taxa and a new report of *Pertusaria (*Lichenised Ascomycotina) from Australia. Mycotaxon 49: 143-150.

Archer AW, Elix JA. 1998a. Additional new species and two new reports in the lichen genus *Pertusaria* (Lichenised Ascomycotina) from Papua New Guinea. Mycotaxon 67: 155-179.

Archer AW, Elix JA. 1998b. The lichen genus *Pertusaria* (Lichenised Ascomycotina) in Papua New Guinea: three new species and two new reports. Mycotaxon 69: 311-318.

Elix JA, Aptroot A, Archer AW. 1997. The lichen genus *Pertusaria* (Lichenised Ascomycotina) in Papua New Guinea and Australia: Twelve new species and thirteen new reports. Mycotaxon 64: 17-35.

Homchantara N, Coppins BJ. 2002. New species of the lichen family *Thelotremataceae* in SE Asia. Lichenologist 34: 113-140.

Jariangprasert S. 2005. Taxonomy and ecology of the lichen family *Pertusariaceae* in Thailand. Doctoral thesis, Chiang Mai University, Thailand.

Jariangprasert S, Archer AW, Elix JA, Anusarnsunthorn V. 2002. Two new species in the lichen genus *Pertusaria* (Ascomycotina) from Thailand. Mycotaxon 83: 353-356.

Jariangprasert S, Archer AW, Elix JA, Anusarnsunthorn V. 2003. New species in the lichen genus *Pertusaria* (lichenized Ascomycotina) from Thailand. Mycotaxon 85: 289-295.

Jariangprasert S, Archer AW, Anusarnsunthorn V. 2004. Further new taxa in the genus *Pertusaria* (Lichennized Ascomycota) from Thailand. Mycotaxon 89: 123-129.

Jariangprasert S, Anusarnsunthorn V. 2005. Additional new taxa in the lichen genus *Pertusaria* (Lichenized Ascomycota) from Thailand. Mycotaxon 91: 279-292.

Messuti MI, Archer AW. 1999. The lichen genus *Pertusaria* in the Falkland Islands (Islas Malvinas). The Bryologist 102(2): 208-214.

Zahlbruckner A. 1928. Neue und ungenügend beschriebene javanische Flechten. Ann. Cryptog. Exotique 1: 181-193.

MYCOTAXON

Volume 96, pp. 123–127 April–June 2006

Two new *Cystoderma* species from high Andean Ecuador

IRJA SAAR[1] & THOMAS LÆSSØE[2]

irja.saar@ut.ee
[1]Institute of Botany and Ecology, University of Tartu
40 Lai St., Tartu, 51005, Estonia

thomasl@bi.ku.dk
[2]Department of Microbiology, Biological Institute, University of Copenhagen
Øster Farimagsgade 2D, Copenhagen K, DK-1353, Denmark

Abstract—Two new agaric species, *Cystoderma andinum* and *C. papallactae* are described from high Andean Ecuador.

Key words—*Agaricales*, páramo

Introduction

The agaric genus *Cystoderma* Fayod (1889: 350-351) is known as widespread (Kirk et al. 2001). However, the majority of the approximately thirty known species are distributed in the temperate regions (Kirk et al. 2001, Smith & Singer 1945, Heinemann & Thoen 1973, Saar 2003). The tropical species described hitherto are *C. chocoanum* Franco-Mol., *C. cristalliferum* Thoen, *C. contusifolium* Pegler, *C. elegans* (Beeli) Thoen, *C. ferruginosum* (Bres.) Pegler, *C. luteohemisphaericum* Dennis and *C. siparianum* (Dennis) Thoen (Dennis 1961, Franco-Molano 1993, Pegler 1966, 1983, Thoen 1969). The majority of these species were described from lowland localities with a tropical climate, whilst *C. cristalliferum* and *C. elegans* both were collected from higher altitudes (1650 m) with a more temperate climate. Very few records of the genus *Cystoderma* have been published from South America and none from Ecuador. *Cystoderma siparianum* – a species described from Trinidad (Lesser Antilles), is possibly present in Ecuador since a specimen collected by Cronshaw, so named, is deposited in Kew. Dennis (1961, 1970) reported *C. amianthinum* (Scop.) Fayod and *C. luteohemisphaericum* from Andean and coastal Venezuela respectively. Pegler (1997) reported *C. amianthinum*, *C. contusifolium* and *C. siparianum* from São Paulo (Brazil), and described a new species *C. contusifolium* from Martinique, Lesser Antilles (Pegler 1983). Singer (1969) observed *C. amianthinum* from Argentina (Tierra del Fuego), Chile (Osorno, alt. 900 m) and Bolivia (La Paz, alt. 3000 m), and described a new species *C. austrofallax* Singer closely related to *C. fallax* A.H. Sm. & Singer from Chile (Valdivia, alt. 200 m). Franco-Molano (1993) described a new species *C. chocoanum* from Colombia (Chocó).

Three specimens of the genus *Cystoderma* collected by the second author and co-workers from high elevations in open páramo and *Polylepis* forest in Ecuador were studied and found to represent two undescribed species.

Methods

The colours of the basidiocarps were designated using the colour names by Kornerup & Wanscher (1974). Microscopic investigations were carried out using a Zeiss Axioskop 2 light microscope at magnification x1000 and measurements were made in 3% KOH solution. The pictures were adjusted with AxioVision 3.0 software (Carl Zeiss Vision GmbH). The spore measurements are based on 25 randomly taken basidiospores from each specimen. Colour photographs of the type specimens can be found at the homepage of the fungi of Ecuador (http://www.mycokey.com/Ecuador.html).

Description of new species

Cystoderma andinum I. Saar & Laessøe, sp. nov. FIGURES 1–4

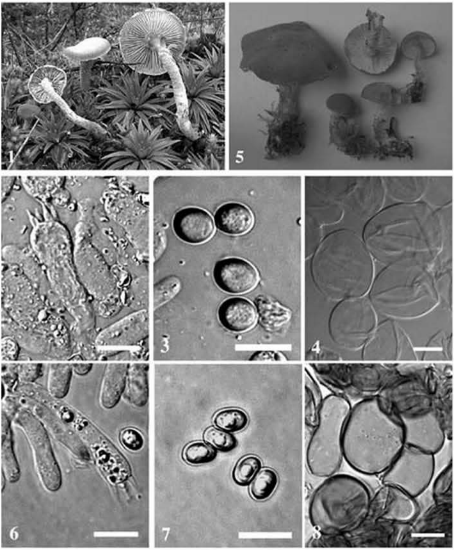
MYCOBANK NUMBER MB 510024

> *Pileus 25–43 mm latus, convexus vel umbonatus; superficies granuloso-squamulosa, primo testacea, deinde griseo-aurantiaca. Lamellae adnexae vel sinuate decurrente, integerrimae, albidae vel bubalinae. Stipes 55–65 × 4–7 (–14) mm, squamulosus; annulus evanescens. Sporae (5.0–) 6.0–7.5 (–8.5) × (4.0–) 4.5–5.5 (–6.0) µm, amyloideae, ellipsoideae. Basidia anguste clavata, 26–35 × 6–8 µm, 4-sterigmatibus. Cystidia desunt. Pileipellis catenis sphaerocystarum composita; arthrosporae desunt. Hyphae fibulatae.*
>
> *Holotypus: Ecuador, Napo, paramo El Virgen, ca. 3800 m alt., 7.IV. 2002, T. Læssøe (TL-9246) in herbarium QCA concervatus est.*
>
> Etymology: from the Andes

Pileus 25–43 mm, convex to slightly umbonate, dry, finely granulose-squamulose, margin appendiculate with white veil remnants, at first brick red (7D7 terra cotta, tile red) then fading greyish orange (5B5), retaining the darker colour at the margin for some time. **Lamellae** adnexed or sinuate with decurrent tooth, medium spaced, edge entire, whitish to cream (4A3) or somewhat darker. **Stipe** 55–65 × 4–7 (–14) mm, pale cream, turning a bit rusty brown in old specimens, densely squamulose below ring zone, with evanescent ring zone, base swollen or not, radicating in the plant cushion. **Context** white. **Odour** not distinctive or strongly of cyanide/unpleasantly earthy.

Basidiospores (5.0–) 6.0–7.5 (–8.5) × (4.0–) 4.5–5.5 (–6.0) µm, Q = (1.1–) 1.2–1.6 (–1.8), broadly ellipsoid to ellipsoid, rarely oblong, hyaline, amyloid. **Basidia** narrowly clavate, hyaline, inamyloid, 4-spored, 26–35 × 6–8 µm. **Pleuro-** and **cheilocystidia** absent. **Pileipellis** formed by chains of sphaerocysts, 14–36 × 14–30 µm, globose to oblong, faintly rugulose, hyaline to yellowish brown in H_2O, not darkening in KOH; arthrospores absent. **Stipitipellis** composed of hyphae up to 7 µm broad, cylindric to inflated, covered by sphaerocysts 10–27 × 8.5–19 µm, similar to those forming the pileipellis. **Clamp connections** present.

Habitat in dense fascicle, among unidentified cushion plants in open páramo, in wet, cushion plant community.



Figs 1–8. ***Cystoderma andinum*** (C 57998, isotype): **1.** Fruitbodies; **2.** Basidia; **3.** Spores; **4.** Sphaerocysts from pileipellis. ***Cystoderma papallactae*** (C 58002, isotype): **5.** Fruitbodies; **6.** Basidia; **7.** Spores; **8.** Sphaerocysts from pileipellis. Bars = 10 µm.

Collections examined – Ecuador, Prov. Napo, just below and E of the Papallacta pass, páramo El Virgen (00°19'66"S 78°12'06"W). Among unidentified cushion plants in open páramo. Alt.: ca. 3800 m, 7 April 2002, T. Læssøe TL-9246 (QCA, **holotype;** C 57998, **isotype**); Ibid.,Vólcan Antisana, scrub along road leading W from Laguna Mica. In open wet, cushion plant community. Alt.: 3700 m., 22 June 2002, J. Salazar TL-9752 (QCA, C 58476).

Comments. This species belonging to section *Cystoderma* Singer (1962) is characterized by its large, strongly amyloid basidiospores. The temperate species having similarly coloured pilei, *C. granulosum* (Batsch) Fayod (brick red) and *C. adnatifolium* (Peck) Harmaja (greyish orange), have smaller (4–5 × 2–3 µm) and inamyloid basidiospores. Several species possessing pilei with different shades of brown and with amyloid basidiospores, described from tropical regions, differ likewise in having smaller spores: *C. austrofallax* (4–5 × 3 µm), *C. chocoanum* (5.4–6.3 × 2.7–3.6 µm), *C. cristalliferum* (3.7–4.5 × 2–3.2 µm) and *C. ferruginosum* (4–5.2 × 2–3.2 µm). *Cystoderma cristalliferum* furthermore has cheilo- and pleurocystidia.

The two collections are from the same region of Ecuador and from very similar plant communities.

Cystoderma papallactae I. Saar & Laessøe, sp. nov. FIGURES 5–8

MYCOBANK NUMBER MB 510025

Pileus 23–45 mm latus, convexus vel umbonatus; superficies ruditer granuloso-squamulosa, testacea. Lamellae sinuate decurrente, integerrimae, albidae vel bubalinae. Stipes ad 45 × 6 mm, bulbosus, squamulosus; annulus evanescens. Sporae 5.0–5.5 (–6.0) × 3.0–3.5 (–4.0) µm, inamyloideae, ellipsoideae vel oblongae. Basidia clavata, 23–27 × 6 µm, 4-sterigmatibus. Cystidia desunt. Pileipellis catenis sphaerocystarum composita; arthrosporae desunt. Hyphae fibulatae.

Holotypus: Ecuador, Napo, paramo El Virgen, ca. 3800 m alt., 7.IV.2002, T. Læssøe (TL-9250) in herbarium QCA conservatus est,

Etymology: locality Papallacta, Ecuadorean Andes

Pileus 23–45 mm, convex to faintly umbonate, coarsely granulose-squamulose, margin hardly appendiculate, brownish orange (7C7) or brick red (terra cotta, tile red 7D7), fading in age. **Lamellae** sinuate, with decurrent tooth, medium spaced, edge entire, white to cream (4A3). **Stipe** up to 45 × 6 mm, at base 10 mm, orange brown, squamulose below ring zone, with evanescent ring zone, base white, bulbous. **Context** white to cream. **Odour** faint, slightly metallic when cut. Taste indistinct, like raw cucumber and astringent.

Basidiospores 5.0–5.5 (–6.0) × 3.0–3.5 (–4.0) µm, Q = (1.4–) 1.4–1.8, ellipsoid to oblong, hyaline, inamyloid. **Basidia** clavate to narrowly clavate, hyaline, inamyloid, 4-spored, 23–27 × 6 µm. **Pleuro- and cheilocystidia** absent. **Pileipellis** formed by chains of sphaerocysts, 18–37 × 15–27 µm, subglobose to oblong, faintly rugulose, pale yellowish brown to cinnamon in H_2O, not darkening in KOH; arthrospores absent. **Stipitipellis** composed of hyphae up to 8 µm broad, cylindric to inflated, covered by sphaerocysts 19–39 × 13.5–30 µm, similar to those forming the pileipellis. **Clamp connections** present.

Habitat in moss under *Polylepis* tree.

Collections examined – Ecuador, Prov. Napo, just below and E of the Papallacta pass, páramo El Virgen (00°19'66"S 78°12'06"W). In moss under big *Polylepis* tree. Alt.: ca. 3800 m, 7 April 2002, leg. T. Læssøe TL-9250 (QCA, **holotype**; C 58002, **isotype**).

Comments. This species belongs to section *Granulosa* (Fr.) Locq. emend Locq. (1951; see also Singer 1986), or if a narrow generic system is adopted in the genus *Cystodermella* Harmaja (2002). It is characterized by its large inamyloid basidiospores and brownish orange pileus. The temperate species, *C. granulosum* with similarly coloured pileus, has smaller (4-4.5 × 2.5-3 µm) basidiospores. The other species with brown-coloured pilei, discussed under *C. andinum*, have amyloid basidiospores.

Acknowledgements

We thank the curator of fungi, Botanical Museum, University of Copenhagen for a loan of specimens. The first author's work in Copenhagen was supported by a grant from the European Commission's (FP 6) Integrated Infrastructure Initiative program SYNTHESYS (DK-TAF 527). The second author was funded by a Danish government grant (RUF 91056). Javier Salazar is thanked for valuable help in the field and Dr. E. Parmasto for the revision of the Latin diagnoses. We are grateful to Drs. R. E. Halling and G. Gulden for presubmittal reviews of the manuscript.

Literature Cited

Dennis RWG. 1961. Fungi Venezuelani: IV. Kew Bull. 15: 67-156.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull., Addit. Ser. 3: 1-531, 15 col. pls., 9 b&w pls.

Fayod V. 1889. Prodrome d'une histoire naturelle des Agaricinés. Ann. Sci. Nat., Bot., sér. VII 9: 181-411.

Franco-Molano AE. 1993. Studies on *Cystoderma*: a new species and a new combination. Mycologia 85(4): 672-676.

Harmaja H. 2002. *Amylolepiota*, *Clavicybe* and *Cystodermella*, new genera of the *Agaricales*. Karstenia 42: 39-48.

Heinemann P, Thoen D. 1973. Observations sur le genre *Cystoderma*. Bull. Trimestriel Soc. Mycol. France 89: 5-34.

Kirk PM, Cannon PF, David JC, Stalpers JA. (Eds.). 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9 Ed. CAB International. 655 pp.

Kornerup A, Wanscher JH. 1974. Farver i farver. Politikens Forlag: København. 248 pp.

Locquin M. 1951. Le genre *Cystoderma* Fayod. Bull. Trimestriel Soc. Mycol. France 67: 65-80.

Pegler DN. 1966. Tropical African *Agaricales*. Persoonia 4(2): 73-124.

Pegler DN. 1983. Agaric flora of the Lesser Antilles. Kew Bull., Addit. Ser. 9: 409-412.

Pegler DN. 1997. The agarics of São Paulo. Royal Botanic Gardens: Kew. 68 pp.

Saar I. 2003. The genera *Cystoderma* and *Cystodermella* (*Tricholomataceae*) in Temperate Eurasia. Mycotaxon 86: 455-473.

Singer R. 1962. The *Agaricales* in modern taxonomy. J. Cramer: Vaduz. 912 pp.

Singer R. 1969. Mycoflora Australis. Beih. Nova Hedwigia 29: 1-405.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4 Ed. Koeltz Scientific Books: Koenigstein. 981 pp.

Smith AH, Singer R. 1945. A monograph on the genus *Cystoderma*. Pap. Michigan Acad. Sci. 30: 71-124.

Thoen D. 1969. Le genre *Cystoderma* (*Tricholomataceae*) en Afrique centrale. Bull. Jard. Bot. Belg. 39: 183-190.

MYCOTAXON

Volume 96, pp. 129–132 *April–June 2006*

Glomerospores: a new denomination for the spores of Glomeromycota, a group molecularly distinct from the Zygomycota

Bruno Tomio Goto & Leonor Costa Maia

brunogoto@hotmail.com leonorcmaia@yahoo.com.br
Programa de Pós-Graduação em Biologia de Fungos,
Departamento de Micologia, Universidade Federal de Pernambuco
Av. Prof. Nelson Chaves s/n, Cidade Universitária, 50670-420, Recife, PE, Brazil

Abstract—The arbuscular mycorrhizal fungi (AMF) are grouped into the Glomeromycota phylum. However, the names used for the spores formed by these fungi are not clear, being based on morphological characters, some of which can be shared by fungi in separate phyla (Glomeromycota and Zygomycota – *Endogonales*), due to adaptative convergence. Considering also that all other phyla of fungi have their own characteristic spore types, with unique names, we propose a denomination to be used only for the spores of Glomeromycota.

Key Words—Glomeromycetes, mycorrhiza, taxonomy, terminology

Taxonomy

The terminology used for the spores of arbuscular mycorrhizal fungi (AMF) has changed according to each author's view, and different names such as chlamydospores, conidia, sporophores, azygospores or even simply spores have been used to describe these propagative structures (Gerdemann & Trappe 1974, Gibson 1985, Walker & Sanders 1986, Walker 1987, Morton 1988, Schenck & Pérez 1990, Tommerup & Sivasithamparam 1990).

Nowadays the AMF, earlier included in *Glomales*, an order of Zygomycetes (Morton & Benny 1990), are separated from the Zygomycota based on molecular studies. Schüssler et al. (2001) proposed the phylum Glomeromycota and indicated that these fungi are more closely related to Ascomycota and Basidiomycota than to Zygomycetes. This proposal has been accepted (Tehler et al. 2003), although for some it is premature to recognize the glomalean fungi as a phylum (Tanabe et al. 2005). Anyway, each fungal phylum has an appropriate name for its spores: ascospore for Ascomycota, basidiospore for Basidiomycota, zygospore for Zygomycota (Gerdemann & Trappe 1974, Alexopoulos et al. 1996). All of these are formed by sexual reproduction, while in Glomeromycota there is no evidence of a sexual process. On the other hand, asexual spores have different denominations, based on formation and similarity with spores of other groups.

Considering that in Glomeromycota the reproductive structures are apparently of asexual origin, there is no agreement among authors in regard to the nature of these spores (Morton 1988). The term chlamydospore, for example, was designated for the resistant spores of other species (Gerdemann & Trappe 1974). In *Acaulospora*, *Entrophospora* and *Gigaspora* the spores have been named azygospores, due to the similarity of the vesicle in the first two genera and the suspensor in the third, with the azygospores formed parthenogenetically in some Zygomycetes, a group in which the AMF were included.

This terminology is confused because within a phyletic group (Morton & Benny 1990, Schüssler et al. 2001), with reproduction exclusively asexual, the spores present diverse nature. This is not uncommon among other groups of asexual fungi such as the "Deuteromycetes", that form chlamydospores, blastospores, arthrospores and conidia (Alexopoulos et al. 1996).

Endogone Link contains fungi morphologically similar to the Glomeromycota, but its spores (zygospores), produced in sporocarps, have sexual origin (Alexopoulos et al. 1996), while azygospores are rarely observed (Berch & Fortin 1983). During zygospore formation, two walls are distinguished: an outer wall, from the zygosporangium, and an inner wall, from the zygospore (O'Donnell et al. 1978a, b). In the AMF, the spore presents a single unique wall (Maia & Kimbrough 1993) formed by many layers of different appearance (Walker 1983).

Germination of spores in *Endogonales* is similar to that of Glomeromycetes (*Acaulospora*, *Entrophospora*, *Scutellospora* and *Pacispora*), with the germ tube emerging either from a germinal shield, directly through the spore wall or from the hyphal insertion point (O'Donnell 1978a, b).

The germinal shield of AMF is highly specialized, being helicoid (*Scutellospora projecturata* Kramad. & C. Walker) or rich in foldings (*Entrophospora colombiana* Spain & N.C. Schenck, *Acaulospora tuberculata* Janos & Trappe, *A. rehmii* Sieverd. & S. Toro, *S. gilmorei* (Trappe & Gerd.) C. Walker & F.E. Sanders, *S. scutata* C. Walker & Dieder., *S. cerradensis* Spain & J. Miranda). Spores of *Endogone pisiformis* Link have a germinal shield less elaborated than that of the AMF, formed between the endospore wall (zygospore) and the exospore wall (zygosporangium) and although each spore can have up to three germinal shields, only one will originate the germinal tube.

On the other hand, spores of AMF produce a germinal shield in various places in the outer or innermost layers of the so-called "germinal wall". Berch & Fortin (1983) mentioned that spores of AMF and *Endogone* present such characteristics by adaptative convergence, since in both cases the thick spore wall provides higher resistance to environmental stresses such as predation and action of soil microorganisms. Molecular data (Schüssler et al. 2001) seem to confirm this hypothesis of adaptative convergence, since the AMF form a homogeneous group separated from the Zygomycetes.

Chlamydospores are resistant spores, with a thick wall (Kirk et al. 2001). Based on molecular data (Schüssler et al. 2001) that show a monophyletic group, and also on the morphological diversity of the complex sub cellular structure of the AMF spore wall, unique in the Regnum Fungi, we propose the name glomerospores for the spores of Glomeromycota. This would distinguish these spores from those of other different taxa.

Glomerospores – Asexual reproductive structures formed at the end of a subtending hypha, or a bulbous sporogenous cell, or from a sporiferous saccule, in this case with lateral or intercalary position, with or without a germinative component, presenting or not a germinal shield or orb, typically formed by fungi that form an arbuscular mutualistic symbiosis with most terrestrial plants.

Etymology: "Glomero" = referring to the Glomeromycota phylum + "spore" = reproductive structure.

Acknowledgements

Thanks are due to Dr. R. Hanlin and J.W. Kimbrough for reviewing the manuscript and making helpful suggestions. The authors are in debt to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for providing PhD scholarship and research grant, respectively.

Literature cited

Alexopoulos CJ, Mims CW, Blackwell M. 1996. Introductory Mycology. 4th ed. John Wiley & Sons: New York.

Berch SM., Fortin JA. 1983. Germination of zygospores of *Endogone pisiformis*. Mycologia 75(2): 328 – 332.

Gerdemann JW, Trappe JM. 1974. The *Endogonaceae* of the Pacific Northwest. Mycologia Memoir 5: 1 – 76.

Gibson JL. 1985. Morphology, cytology, and ultrastructure of selected species of *Endogonaceae* (Endogonales) (Zygomycetes). PhD Dissertation. University of Florida. Gainesville, FL.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th ed. CABI: Wallinford, U.K.

Maia LC, Kimbrough JW. 1993. Ultrastructural studies of spore walls of *Acaulospora morrowiae* and *A. scrobiculata*. Mycol. Res. 97(10): 1183 – 1189.

Morton, J.B. 1988. Taxonomy of VA mycorrhizal fungi: Classification, nomenclature, and identification. Mycotaxon 32: 267-324.

Morton JB, Benny GL. 1990. Revised classification of arbuscular mycorrhizal fungi (Zygomycetes). A new order, *Glomales*, two new suborders, *Glomineae* and *Gigasporineae*, and two new families, *Acaulosporaceae* and *Gigasporaceae*, with an emendation of Glomaceae. Mycotaxon 37: 471 – 491.

O'Donnell KL, Flegler SL, Hooper GR. 1978a. Zygosporangium and zygospore formation in *Phycomyces nitens*. Can. J. Bot. 56: 91 – 100.

O'Donnell KL, Flegler SL, Ellis JJ, Hesseltine CW. 1978b. The *Zygorhynchus* zygosporangium and zygospore. Can. J. Bot. 56: 1061 – 1073.

Schenck NC, Pérez Y. 1990. Manual for the identification of VA Mycorrhizal fungi. 3° ed. Synergistic Publications: Gainesville. 241pp.

Schüssler A, Schwarzott D, Walker C. 2001. A new phylum, the Glomeromycota: Phylogeny and Evolution. Mycol. Res. 105: 1413 – 1421.

Tanabe Y, Watanabe MM, Sugiyama J. 2005. Evolutionary relationships among basal fungi (Chytridiomycota and Zygomycota): Insights from molecular phylogenetics. J.Gen. Appl. Microbiol. 51: 267 – 276.

Tehler A, Little DP, Farris JS. 2003. The full-length phylogenetic tree from 1551 ribosomal sequences of chitinous fungi, Fungi. Mycol. Res. 107: 901–916.

Tommerup IC, Sivasithamparam K. 1990. Zygospores and asexual spores of *Gigaspora decipiens*, an arbuscular mycorrhizal fungus. Mycol. Res. 94: 897 – 900.

Walker C. 1983. Taxonomic concepts in the *Endogonaceae:* Spore wall characteristics in species descriptions. Mycotaxon 18: 443 – 455.

Walker C. 1986. Taxonomic concepts in the *Endogonaceae:* II. A fifth morphological wall type in Endogonaceous spores. Mycotaxon 25: 95 – 97.

Walker C. 1987. Current concepts in the taxonomy of the *Endogonaceae.* Pp. 300 – 302. In: Mycorrhizae in the Next Decade, Practical Applications and Research Priorities, DM Sylvia, LL Hung, JH Graham (eds.). IFAS, University of Florida. Gainesville, FL.

Walker C, Sanders FE. 1986. Taxonomic concept in the *Endogonaceae:* III. The separation of *Scutellospora* gen. nov. from *Gigaspora* Gerd. & Trappe. Mycotaxon 27: 169 – 182.

MYCOTAXON

Volume 96, pp. 133–140 April–June 2006

The sequestrate genus *Rhodactina* (Basidiomycota, *Boletales*) in northern Thailand

Zhu L. Yang[1], James M. Trappe[2], Manfred Binder[3],
Rarunee Sanmee [4], Pipob Lumyong[5] & Saisamorn Lumyong[6]

fungi@mail.kib.ac.cn
[1]*Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany*
Chinese Academy of Sciences, Kunming 650204, Yunnan, China

trappej@onid.orst.edu
[2]*Department of Forest Science, Oregon State University*
Corvallis, Oregon 97331-5752, USA

mbinder@clarku.edu
[3]*Biology Department, Clark University, Lasry Building for Bioscience*
950 Main St., Worcester, Massachusetts 01610-1477, USA

rarunee_s@advanceagro.com
[4]*Department of Biology, Faculty of Science, Chiang Mai University*
Chiang Mai 50200, Thailand

agppi003@chiangmai.ac.th
[5]*Department of Plant Pathology, Faculty of Agriculture, Chiang Mai University*
Chiang Mai 50200, Thailand

scboi009@chiangmai.ac.th
[6]*Department of Biology, Faculty of Science, Chiang Mai University*
Chiang Mai 50200, Thailand

Abstract—The sequestrate *Rhodactina* was originally proposed as a monotypic genus to accommodate *R. himalayensis* and was suggested be a member of the *Gautieriaceae* because of similarities in spore ornamentation. Our results, based on *atp*6 sequences, however, place *Rhodactina* in the *Boletaceae*. In addition to the type species, a new species, *R. incarnata*, from northern Thailand is described and illustrated.

Key words—taxonomy, new taxon, phylogeny, mycorrhizae, distribution

Introduction

Fungi in northern Thailand have not been intensively studied, but many macrofungi have been collected from the region in recent years. Among them are two species of *Rhodactina* Pegler & T.W.K. Young (1989)—*R. himalayensis* and *R. incarnata*— which we describe here. The phylogenetic position of this unusual genus was inferred from a nucleotide tree based on *atp*6 sequences.

Materials and methods

Collecting and taxonomic procedures

Mature and developing basidiomata of *Rhodactina* were collected in forests dominated by *Dipterocarpaceae* in northern Thailand. The possible mycorrhizal hosts were recorded at the time of collecting. Specimens were annotated and/or photographed in the field. Colour standards used were Ridgway (1912), and Kornerup and Wanscher (1981). Colour names with first letters capitalized, e.g. "Light Corinthian Red", are from Ridgway (1912); colour codes of the form "8A2" indicate the plate, row, and colour block in Kornerup and Wanscher (1981). Specimens were dried in an electric drier, and then deposited in herbaria. Herbarium abbreviations follow Holmgren et al. (1990).

Tissues were mounted in 3% KOH, Melzer's reagent, and cotton blue for microscopic examination. Q refers to the length/width ratio of basidiospores; Q refers to the average Q of all basidiospores ± sample standard deviation.

Molecular procedures

The mitochondrial *atp6* gene, which codes for ATPase subunit 6, was amplified using the primer combination ATP6-1 and ATP6-2 (Kretzer and Bruns 1999). The reaction conditions and cycling protocols are described in detail by Kretzer and Bruns (1999). Dr. Martin Bidartondo (Royal Botanical Gardens Kew) kindly provided the *atp6* sequence for the holotype of *R. incarnata* CMU 25116 (GenBank accession DQ328982). Collections of *R. himalayensis* were largely infected by parasitic *Sepedonium* spp. and were not used for molecular studies. All PCR products were sequenced by use of BigDye terminator sequencing chemistry (Applied Biosystems, Foster City, California), purified with Pellet Paint (Novagen, EMB Biosciences, San Diego, California), and run on an Applied Biosystems 3730 capillary DNA sequencer. The newly generated sequencing data were aligned by codon in the editor of PAUP* 4.0b10 (Swofford, 2002). The final data set consisted of 49 species using 32 sequences drawn from the study of Kretzer and Bruns (1999), eight sequences downloaded from the AFTOL database (http://ocid.nacse.org/research/aftol/), four sequences from Binder & Hibbett (unpublished), and four unpublished sequences provided by Z. Wang.

The *atp6* nucleotide data set was analyzed by maximum likelihood approaches and Bayesian MCMC. The general time reversible model with distribution of rates at variable sites modeled on a discrete gamma distribution with four rate classes (GTR+G) was estimated with MODELTEST 3.06 (Posada and Crandall 2001) as best-fit likelihood model. Two parallel Bayesian analyses were performed with MrBayes v3.1.1 (Ronquist & Huelsenbeck, 2003) with four chains and 5×10^6 generations each, saving trees every 1000th generation. Posterior probabilities for the Bayesian approach were determined by calculating a 50% majority rule consensus tree with the proportion of trees gathered after convergence of likelihood scores was reached.

The *atp6* data were analyzed in PAUP* by maximum likelihood under the GTR+G model with nucleotide frequencies estimated (A=0.3450, C=0.1010, G=0.0839, T=0470), a rate matrix of substitutions (A-C=1.2850, A-G=3.4710, A-T=1.8277, C-G=4.1821, C-T=3.4710, G-T=1.0000), and $\alpha = 0.3771$. In addition, a likelihood bootstrap analysis was performed under the same settings using 1000 replicates with MAXTREES set to 1000. All analyses were run on a Linux Pro 9.2 Opteron AMD 246 cluster (Microway).

Taxonomy

1. *Rhodactina incarnata* Zhu L. Yang, Trappe & Lumyong, sp. nov.

Figs. 1-2

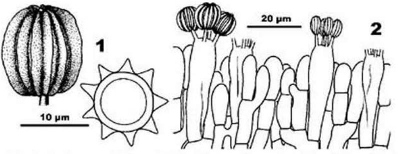
> *Basidiomata 1.5-3 cm lata. Peridiumque gleba incarnata. Basidiosporae pallide purpureae vel incarnatae, dextrinoideae, 10-13 × 10-12 µm ornamentum porcae 8-10 acutium longitudinalium includentes. Basidia 28-40 × 8-10 µm, 4-sporigera. Cystidia nulla. Fibulae absentes.*
>
> **Etymology:** Latin *incarnata*, "flesh coloured", referring to the colour of the basidioma.

Basidiomata 1.5-3 cm diam., subglobose to ovoid, with a rudimentary basal attachment. **Peridium** 0.5-1 mm thick, pale pink (Light Corinthian Red to Testaceous, 8A2-4), glabrous and smooth. **Gleba** completely enclosed, pink (Corinthian Red to Rose Doree, 10A4-6), viscid, irregularly to angularly loculate; loculi 0.5 to 1.5 mm broad. **Stipe-columella** absent.

Basidiospores including ornamentation 10-13 × 10-12 µm, Q = 1-1.1, **Q** = 1.03 ± 0.04, excluding ornamentation 9.5-12 × 7-8 µm, Q = 1.3-1.5, **Q** = 1.38 ± 0.07, statismosporic, orthotropic, broadly ellipsoid to subfusiform excluding ornamentation, purplish, purplish red to carneous, with a strongly dextrinoid wall ca. 1 µm thick; *ornamentation* of 8-10 solid ridges regularly and longitudinally arranged, up to 3 µm tall and 2-3 µm wide at the base, giving the spores a stellate appearance in polar-view; *sterigmal appendage* short, nearly truncate. **Basidia** 28-40 × 8-10 µm, clavate to subcylindric, (1-) 4-spored; sterigmata stout, straight, up to 5 µm long. **Cystidia** lacking.

Tramal plates 80-200 µm thick, with a narrow, central layer of subparallel to loosely interwoven hyphae 1.5-7 µm broad, hyaline, thin-walled, non-gelatinized to gelatinized. **Peridiopellis** poorly differentiated, of interwoven, thin-walled hyphae 2-8 µm broad that are covered with brown encrustations. **Clamp connections** lacking.

Habit, habitat, distribution and season—Subepigeal, on sandy soil under leaf litter in a dry forest dominated by *Dipterocarpaceae*; known only from the type locality in northern Thailand (Chiang Mai); July.



Figs. 1-2: *Rhodactina incarnata* (holotype). 1. Basidiospores in equatorial view (left) and in polar-view (right); 2. Hymenium with basidia at different stages of development.

COLLECTION EXAMINED—THAILAND, Chiang Mai, Sanpatong District, Mae Wang, Conservation Forest, Sanpatong-Ban Guard Rd., 24.VII.2002, S. Lumyong, P. Lumyong, R. Sanmee & Z. L. Yang *45209* (holotype CMU *25116*, isotype OSC).

Comments—*Rhodactina incarnata* is characterized by its broadly ellipsoid to subfusiform basidiospores 9.5-12 × 7-8 µm (excluding ornamentation) that are purplish, purplish red to carneous and ornamented with 8-10 longitudinal ridges, and basidia 28-40 × 8-10 µm. *R. himalayensis* differs in having fusiform to subfusiform basidiospores 12-16 × 7.5-9.5 µm (excluding ornamentation) with (5) 6-7 (8) ridges and basidia 40-68 × 12-15 µm (see below; Pegler and Young 1989; Table 1). The two species are easily differentiated: none of these characters overlap except spore color, which tends to be more red in *R. incarnata* than *R. himalayensis*.

Table 1. Distinguishing characteristics of *R. himalayensis* and *R. incarnata*

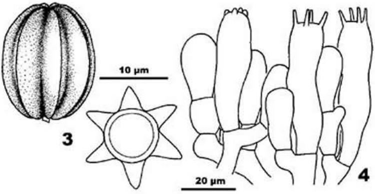
Character	*R. himalayensis*		*R. incarnata*
	Data of Yang et al.	Data of Pegler & Young	Data of Yang et al.
Size of spores with ornamentation	15-20 × 12.5-18 µm, Q = 1.1-1.2	16-20 × 13-17.5 µm, Q = 1-1.3	10-13 × 10-12 µm, Q = 1-1.1
Size of spores without ornamentation	12-16 × 7.5-9.5 µm, Q = 1.5-1.8	11-16 x 7-10 µm, Q = 1.5	9.5-12 × 7-8 µm, Q = 1.3-1.5
Number of ridges on spores	(5) 6-7 (8)	(5) 6-7 (8)	8-10
Height and width of ridges on spores	3-4 µm wide, up to 5 µm tall	2.5-4.5 µm wide	2-3 µm wide, up to 3 µm tall
Size of basidia	40-68 × 12-15 µm	30-50 × 9-12 µm	28-40 × 8-10 µm

2. *Rhodactina himalayensis* Pegler & T.K.W. Young, Opera Bot. 100: 201, 1989.

Figs. 3-4

Basidiomata 2-3 cm broad, subglobose to short-pyriform, with an indistinct basal attachment. **Peridium** 0.5-1 mm thick, pale purple to pale violaceous, becoming dirty white to grayish when dried, glabrous. **Gleba** completely enclosed, violet brown to purple-brown when mature, purplish dark brown when dried, irregularly to angularly loculate; locules up to 1.5 mm broad. **Stipe-columella** absent.

Basidiospores including ornamentation 15-20 × 12.5-18 µm, Q = 1.1-1.2, Q = 1.12 ± 0.04, excluding ornamentation 12-16 × 7.5-9.5 µm, Q = 1.5-1.8, Q = 1.62 ± 0.11, statismosporic, orthotropic, fusiform to subfusiform excluding ornamentation, purple to purplish, with a strongly dextrinoid wall up to 1 µm thick; *ornamentation* of (5) 6-7 (8) solid, regularly and longitudinally arranged ridges up to 5 µm tall and 3-4 µm wide, giving the spores a stellate appearance in polar-view; *sterigmatal appendage* short, nearly truncate. **Basidia** 40-68 × 12-15 µm, clavate to subcylindric, 4-spored; sterigmata straight, up to 5 µm long. **Cystidia** lacking.



Figs. 3-4: *Rhodactina himalayensis* (CMU 25117). 3. Basidiospores in equatorial view and polar-view; 4. Hymenium with basidia at different stages of development.

Tramal plates 70-250 µm thick, with a narrow, central layer of subparallel to loosely woven hyphae 1.5-10 µm broad, hyaline, thin-walled, non-gelatinized to gelatinized. **Peridiopellis** appressed, poorly differentiated, of interwoven, thin-walled hyphae 2-8 µm broad that are covered with brown encrustations. **Clamp connections** lacking.

Habit, habitat, distribution and season—subepigeal, associated with *Dipterocarpaceae*; known from northwestern India (Uttar Pradesh) and northern Thailand (Chiang Mai); January-November.

> **COLLECTION EXAMINED**—THAILAND, Chiang Mai, Doi Suthep-Pui National Park, forest behind Channel 9 TV Station, 4.VIII.2000, S. Lumyong, P. Lumyong, R. Sanmee & B. Dell *2254* (CMU *25117*, OSC).

Comments—Originally described from northwestern India, *Rhodactina himalayensis* is characterized by basidiospores with (5)6-7(8) longitudinally arranged ridges. Pegler and Young (1989) described its peridial surface "whitish with a pale drab grey tinge, soon bruising brownish grey to blackish brown." They did not examine fresh specimens, however, so those colors were likely noted by the original collector from faded specimens. The fresh peridial surface of our collections was pale purple to pale violaceous but became dirty white to grayish when dried.

Results of *atp6* analysis

The final alignment of the *atp6* data set included 705 positions. The optimal tree inferred under the maximum likelihood criterion (Fig. 5) had a likelihood of −9856.89. For comparison, the best states of the cold chain were −9880.67 and −9880.99 in the two parallel Bayesian runs, respectively. Bayesian runs converged to stable likelihood values after 150,000 generations, and 4850 trees from each individual run were combined to calculate posterior probabilities. The average standard deviation of split frequencies was 0.002836 at the end of the runs. Bayesian posterior probabilities (BPP) strongly support most internodes in the *Boletales* with values of 1.0, while bootstrap values (BS) are

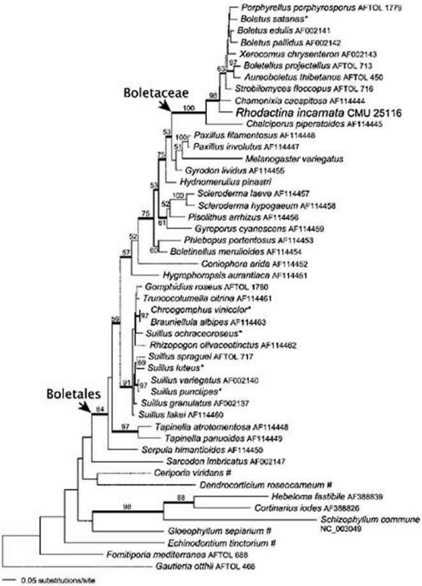


Fig. 5: Phylogenetic placement of *Rhodactina incarnata* inferred from *atp6* sequences. Branches in boldface indicate Bayesian posterior probabilities of 1.0, lower support values are not shown. Bootstrap support values (in %) are provided at internodes. Published sequences are either flagged with GenBank accession numbers or AFTOL numbers. Sequences marked with an asterisk are available from the Bruns laboratory web site (http://plantbio.berkeley.edu/~bruns/). Sequences that are highlighted with pound signs are by courtesy of Zheng Wang (University of Iowa).

generally lower (52 – 100%). The placement of *Rhodactina incarnata* in the *Boletaceae* is strongly supported by both methods (BPP = 1.0, BS = 100%).

Discussion

The study of origins of gasteromycetes and their diversity has been a subject of major interest to fungal taxonomists and molecular systematists. Convergent evolution of morphological characters becomes an increasingly emerging pattern when recent phylogenies are compared to classical concepts. Hosaka et al. (in press) have shown that a spore ornamentation of longitudinal ridges cuts across orders: the genus *Austrogautieria*, thought because of spore ornamentation to belong to the *Gomphales* along with *Gautieria*, turns out from molecular data instead to belong to the *Hysterangiales*. Pegler and Young (1989) originally placed *Rhodactina* in the *Gautieriaceae* because of the resemblance of its spore ornamentation to *Gautieria* and *Austrogautieria*. They did acknowledge that *Rhodactina* might be in the *Boletales*, because one of the paratypes of *R. himalayensis* was infected by *Sepedonium chrysospermum* (Bull.) Fr., a parasite of boletes. In addition, the ultrastructure of the ornamentation of *R. himalayensis* spores closely resembles that of *Chamonixia*, another gasteroid genus in the *Boletales* (Kretzer and Bruns 1999; Binder and Bresinsky 2002) that produces statismospores with longitudinal costae. Our results inferred from analyses of mitochondrial *atp6* gene sequences unambiguously place *R. incarnata* in the *Boletaceae*. Nevertheless, its closest relatives were not resolved in this study, mainly because of the limited availability *atp6* sequences for *Boletaceae*. Apparently, *R. incarnata* is not closely related to *Chamonixia*. Minute amounts of genomic DNA did not allow us to amplify additional loci, such as the nuclear ribosomal large subunit or the internal transcribed spacer region, which will be instrumental to place *Rhodactina* species more accurately in future studies.

Acknowledgments

Yang's participation was funded in part by the Chinese National Fund for Distinguished Young Scholars (No. 30525002). Trappe's participation was funded in part by US National Science Foundation Grant BRS 9401421 and the U.S. Forest Service Pacific Northwest Research Station, Corvallis, Oregon. The Thailand Research Fund (Royal Golden Jubilee PhD program) supported participation in the research by Sanmee, and Lumyong. Binder was supported by a National Science Foundation Grant (DEB 0444531 to MB and David Hibbett). Dr. Martin Bidartondo generously shared his conclusions from sequence data on *Rhodactina* in support of Binder's conclusions. The authors thank Drs. Annette Kretzer and Lisa Grubisha for reviewing the manuscript.

Literature cited

Binder M, Bresinsky A. 2002. Derivation of a polymorphic lineage of Gasteromycetes from boletoid ancestors. Mycologia 94: 85-98.

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.

Hosaka K, Bates ST, Beever RE, Castellano MA, Colgan III W, Dominguez LS, Geml J, Giachini AJ, Kenney SR, Nouhra EA, Simpson NB, Trappe JM. in press. Molecular phylogenetics of the gomphoid-phalloid fungi with an establishment of the new subclass Phallomycetidae and two new orders. Mycologia.

KornerupA, Wanscher JH. 1981. Taschenlexikon der Farben. 3. Aufl. Muster-Schmidt Verlag: Zürich (Switzerland). 242 pp.

Kretzer AM, Bruns DT. 1999. Use of *atp6* in fungal phylogenetics: an example from the Boletales. Molecular Phylogenetics and Evolution 13: 483-492

Pegler DN, Young TWK.1989. *Rhodactina himalayensis* gen. et sp. nov. (*Gautieriaceae*) from India. Opera Botanica 100: 201-206.

Posada D, Crandall KA. 2001. Selecting the best-fit model of nucleotide substitution. Syst. Biol. 50: 580-601.

Ridgway R. 1912. Color standards and color nomenclature. R. Ridgway: Washington, D.C. (USA). 43 pp.

Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19: 1572-1574.

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

MYCOTAXON

Volume 96, pp. 141–146 *April–June 2006*

The Skibotn area in North Norway – an example of very high lichen species richness far to the north

ARVE ELVEBAKK[1*] & JARLE W. BJERKE[2*]

*[1]arve.elvebakk@ib.uit.no, [2]jarle.bjerke@ib.uit.no**
Department of Biology, University of Tromsø
Tromsø N-9037, Norway

Abstract—During the 4-day excursion of the Nordic Lichen Society (NLF) in 2003, 653 lichen species were recorded from the Skibotn area in eastern Troms County, central North Norway, bringing the total of known lichen species from the area to 709. Of the 291 species considered rare, 250 were found during the excursion. Of the 115 species reported as new to Troms County, 29 are also new to North Norway and eight new to Norway. Two species, *Caloplaca spitsbergensis* and *Stereocaulon groenlandicum*, are new to Fennoscandia. The number of lichenicolous species increases to 803 for the region when 94 previously known species are added. We believe that only Sweden's Torneträsk region surpasses this diversity. The high species number—remarkable for such northern latitudes (68-69° N)—challenges the general concept that species richness decreases as latitude increases. A fully annotated checklist of the Skibotn species is now posted on http://www.mycotaxon.com/resources/weblists.html

Keywords—lichenology, local flora, new records, Arctic fringe, biodiversity

Introduction

The Skibotn area, North Norway, has been much used for excursions and field courses after the University of Tromsø established a field station there. The vascular plant and bryophyte floras of the area are very rich (Engelskjøn et al. 1995, Elvebakk unpubl.), and an international mycological congress reported 818 species from this and adjacent areas (Mathiassen et al. 1995). The NLF (Nordisk Lichenologisk Förening/Nordic Lichen Society) excursion in August 2003 represents the first recent professional study of the area's lichen mycota.

Skibotn/Ivgobahta is situated at the outlet of the Skibotndalen/Ivgovuovdi valley, which runs in a northwest to southeast direction from the Lyngen fjord almost to the Finnish border near Kilpisjärvi. The lower valley belongs to the middle boreal zone and has a continental climate with a mean July temperature of 13.5° C (for 1961-1990) and an annual precipitation of 475 mm (for 1984-1990 at the Skibotn meteorological station) (Aune 1993). The valley experiences a pronounced local rain-shadow effect as shown by the precipitation values for Kvesmenes/Vieksegieddi (630 mm) and Oteren/Čavkkus (970 mm), two villages lying only 15-20 km to the southwest. Three bedrock patterns occur in the valley: acidic arkosic schists near the fjord, calcareous schists and marble in the central valley, and acidic schists and other rock types toward the east. The mountain areas have strongly contrasting bedrock geology.

During the 2003 NLF meeting at Skibotn, 38 participants visited eight different localities within Storfjord and the county of Troms: sea shore rocks, south-facing rock walls, boulder slopes and forests in the warmer valley bottom, river gorge with well-developed rocky inundation zone, and diverse habitats in low (600 m) and middle (1150 m) alpine belts. Calcareous and non-calcareous substrates were present at all collecting sites except for the seashores. A annotated, complete list of all species recorded can be downloaded from http://www.mycotaxon.com/resources/weblists.html. Both Table 1 and the fully annotated checklist were compiled using specimen-based data supplied by the excursion participants from collections housed in home institutions or personal herbaria.

Results

Some findings from the excursion have already been published as species new to Troms by Jørgensen (2004), Westberg et al. (2004) and Santesson et al. (2004). We list another 115 species new to Troms county in Table 1. We follow the nomenclature set forth by Santesson et al. (2004) and cite author names only for those species not treated (or cited with another name) by those authors.

During the excursion, 653 lichen species were recorded from the Skibotndalen area. When this number is added to the 26 species previously reported from the area and another 30 species slightly further to the south, the total for the region of known lichen species comes to 709. Of the 291 species considered rare, 250 were found during the excursion. Rare species were found in all localities visited. Seashore rocks housed both rare northern (*Caloplaca fraudans, C. spitsbergensis, Lecanora atrosulphurea, Verrucaria halophiloides)* and rare southern species (*Lecanora andrewii, Verrucaria praetermissa*). Rocky valley slopes hosted known thermophilous lichen mycota (*Degelia plumbea, Pannaria conoplea, Melanelia subargentifera, Xanthoparmelia conspersa*) supplied by *Leptochidium albociliatum, Melanelia tominii, Psorula rufonigra, Spilonema revertens* and *Squamarina degelii*. The valley river gorge had a richly developed inundation zone with rocks with many rare species (*Aspicilia aquatica, A. supertegens, Caloplaca atrosulphurea, C. diphyodes, Ephebe hispidula, E. lanata, Hymenelia arctica, Miriquidica plumbeoatra, Placynthium flabellosum, P. rosulans, Porpidia ochrolemma, Rhizocarpon amphibium, Verrucaria latebrosa*).

Rare species of the mountains—*Carbonea atronivea, Calvitimela perlata, Lecania subfuscula, Lecanora flotowiana, Leciophysma furfurascens, Polysporina ferruginea, Stereocaulon arenarium, S. groenlandicum, Umbilicaria dendrophora* and *Vulpicida tubulosus*—include a placodioid species still not determined to genus level.

Discussion

Species richness and diversity

The general trend in biodiversity is that species richness decreases with increasing latitudes (e.g. Barthlott et al. 1996). Thus, it is remarkable that a local lichen mycota has more than 700 species as far north as 69° 20' N. This even more impressive when we include another 94 fully identified lichenicolous fungi (Alstrup et al., in prep.), bringing the total of known lichenized and lichenicolous fungal species to 807.

Measuring biodiversity according to region is not easy. One alternative is to use an existing database. By consulting the impressive internet-based Norwegian Lichen Database (NLD), we can generate a grid-based measurement of known lichen species diversity that closely reflects collecting activity. A February, 2005, NLD search of a few well-studied municipalities showed Oslo with 767 taxa, Granvin (the home municipality of J. J. Havaas) with 641, Storfjord (data processed until then) with 607, Trondheim and Oppdal both with 589, and Tromsø with 568.

Municipalities of course have different sizes, and the NLD database is still incomplete. For instance the NLD lists only 396 species for Vega. Yet, Degelius (1982) reported no fewer than 668 lichen species from this municipality, a number that in 1981 a large Norwegian newspaper cited as a world record among local lichen mycotas (!). Degelius (1982) himself described the lichen mycota in the region as "one of the richest in the world".

The NLF excursions provide interesting insights into lichen diversity. The potentially most interesting localities within each region were intensively studied during 4-5 days by 21 to 55 participants, always including very skilled field lichenologists. Species lists are available for the 1985-1997 excursions. The proportion of lichenicolous fungi has increased over the years and has never been as high as for 2003. If purely literature reports, lichenicolous fungi and uncertain lichen determinations are omitted, there is an interesting north-south gradient, with the southernmost 1987 Bornholm excursion (Hansen 1987) having the lowest species number (282) and the present northernmost one with the highest (657). The four central Scandinavian excursions— Åsele Lappmark in 1991 (Thor 1992), central Norway in 1985 (Øvstedal 1986), southern Finland in 1989 (Vitikainen 1991) and Nord-Trøndelag in 1993 (Holien et al. 1994) — are intermediate (with 549, 447, 428 and 398 species, respectively). When plotted against latitudes, these results give a very distinct trend line (see Fig. 1 in supplementary checklist), with increasing species diversity towards the north ($R^2 = 0.84$). The considerably lower species numbers (316 and 320) from the two oceanic excursions to the Faeroe Islands in 1995 (Alstrup et al. 1999) and eastern Iceland in 1997 (Kristinsson 1999) reduce the R^2 value to 0.49 when included. We suggest that the low value is linked to the lower habitat diversity related to rock types, forests, climate, altitude, and overall grazing rather than to oceanity itself.

We have found it difficult to find reports of areas with such high local lichen species diversity in the literature. Strikingly enough, the other 'competing' records known to us also occur within northern Fennoscandia. We have already mentioned the high diversity near Vega (Degelius 1982). In addition, Magnusson (1952) listed about 720 lichens and 34 lichenicolous fungi from the Torneträsk area in northernmost Sweden, Alstrup (1986) and Tibell (1988) reported 11 and 22 more species new to Torne Lappmark, respectively, and Alstrup (1991) reported another 117 lichens and 28 lichenicolous fungi for the region.

Comparisons are not straightforward in that the Torneträsk area is somewhat larger than Skibotn, several taxa listed by Magnusson (1952) would not be accepted today while some additional taxa may also be known. A new review of the local lichen mycota of the western Torneträsk area would be of great interest in a biodiversity context, as the above references suggest a species number near 900, possibly the most species-rich local lichen mycota known in the world. Torneträsk is even better explored, as is illustrated by several conspicuous omissions from the Skibotn list (e.g. *Protoparmeliopsis muralis* and *Pannaria hookeri*). In addition, some species (*Umbilicaria crustulosa*, *U. havaasii*, *U. nylanderiana*; cf. Hakulinen 1962 and *Bryoria lanestris*; cf. A. Elvebakk 00:085, TROM) have been reported or collected in Finland close to the Norwegian border. Comparisons between the Skibotn and Torneträsk areas should also consider that the latter includes only altitudes above c. 340 m.

Table 1—Species recorded as new to the county of Troms.
(***Bold italic*** denotes species new to North Norway; N* = new to Norway; F* = new to Fennoscandia.)

Ameliella grisea N*
Coppins & Fryday ined.
Anzina carneonivea
Aspicilia aquatica
Aspicilia caesiocinerea
Aspicilia mastrucata
Aspicilia montana
Bacidia igniarii
Baeomyces carneus
Bryophagus gloeocapsa
Buellia aethalea
Buellia ectolechioides
Buellia pulverulenta
Caloplaca approximata
Caloplaca atrocyanescens N*
Caloplaca cerinelloides
Caloplaca diphyodes
Caloplaca exsecuta
Caloplaca grimmiae
Caloplaca nivalis
Caloplaca spitsbergensis F*
Caloplaca tetraspora
Caloplaca tornoënsis
Calvitimela perlata
Candelariella coralliza
Carbonea atronivea
Carbonea intrusa
Catillaria contristans
Catolechia wahlenbergii
Cercidospora decolorella
Cladonia macrophyllodes
Cladonia stygia
Collemopsidium halodytes
Cystocoleus ebeneus
Endocarpon pulvinatum
Endocarpon pusillum
Ephebe hispidula
Helocarpon crassipes
Hymenelia arctica
Hymenelia cyanocarpa
Hymenelia melanocarpa
Lecania subfuscula
Lecanora actophila
Lecanora andrewii
Lecanora cavicola
Lecanora chloroleprosa
Lecanora chlorophaeodes
Lecanora flotowiana N*
Lecanora hypoptella
Lecanora perpruinosa N*
Lecanora rimicola
Lecanora subintricata
Lecidea confluens
Lecidea fuliginosa
Lecidella carpatica
Lecidella euphorea
Lecidella wulfenii
Leciophysma furfurascens
Lempholemma isidiodes
Lempholemma polyanthes
Lepraria borealis
Lepraria cacuminum
Lepraria diffusa var.
chrysodetoides
Lepraria rigidula
Leptogium tenuissimum
Lichinodium sirosiphoideum
Melanelia tominii
Micarea cinerea f. *tenuispora*
Micarea denigrata
Micarea incrassata
Micarea melaena
Micarea turfosa
Miriquidica complanata
Miriquidica intrudens
Miriquidica obnubila
Miriquidica plumbeoatra N*
Pertusaria coccodes
Placynthium dolichoterum
Placynthium rosulans
Polyblastia cruenta
Polyblastia hyperborea
Polyblastia peminosa
Polyblastia terrestris
Polysporina ferruginea
Porina mammillosa
Porpidia cinereoatra
Porpidia tuberculosa
Protoparmelia oleagina
Pseudosagedia chlorotica
Psorotichia schaereri
Pyrenopsis furfurea
Rhizocarpon amphibium
Rhizocarpon atroflavescens
Rimularia badioatra
Rimularia impavida
Rinodina parasitica
Scoliciosporum umbrinum
Squamarina degelii
Staurothele areolata
Stereocaulon arcticum
Stereocaulon groenlandicum F*
Stereocaulon leucophaeopsis
Stereocaulon saxatile
Stereocaulon tornense
Strigula muscicola N*
F. Berger, Coppins, Cl. Roux & Sérus. ined.
Thelidium incavatum
Thelidium pluvium
Thelocarpon impresellum
Trapeliopsis pseudogranulosa
Usnea hirta
Verrucaria halophila
Verrucaria halophiloides
Verrucaria latebrosa
Verrucaria praetermissa
Vulpicida tubulosus
Xanthomendoza borealis
(R. Sant. & Poelt) Søchting et al.

To conclude, the local lichen mycotas from the northern Fennoscandian sites Skibotn, Torneträsk and Vega show extraordinarily high species diversities, contradicting the general latitudinal trends in biodiversity. While no doubt a result of intensive studies by specialists, the high species richness can also be explained by a higher topographical and climatic diversity, higher diversity in substrate types, and also a higher degree of open rock surfaces, as compared to landscapes dominated by forests and agricultural activity further to the south. On a global scale, however, more efforts are needed to obtain knowledge on local lichen biodiversity. This is illustrated by the fact that Aptroot (2001) recorded an impressive 173 lichen species on a single tree in Papua New Guinea; only half of them determined with certainty to species level.

Proposed additions to the Norwegian red-list of threatened lichens

A revision of the Norwegian red-list of threatened species is under preparation (www.artsdatabanken.no). In keeping with the above results we suggest that the following species be included among threatened macrolichens in Norway: *Cladonia macroceras*, *Collema ceraniscum*, *Melanelia agnata*, *Stereocaulon arenarium*, *S. groenlandicum*, *Vulpicida tubulosus* and *Xanthomendoza borealis*, in addition to the small-fruticulose *Leciophysma* species.

Acknowledgements

Thanks to all Excursion participants for their contributions to the now vastly improved knowledge of the lichen mycota of the Skibotn area, and particularly to the many participants who submitted information on their own collections. This represented many additions to the species list, and improves much the documentation of the collections, now mostly housed in the participants' home herbaria. We are also grateful to the University of Tromsø, for a grant allowing us to combine the Excursion with a Symposium, for comments from peer reviewers Vagn Alstrup and Tor Tønsberg, to Virginie Ramasco for assistance in the manuscript preparation process, and to the Norwegian Water Resources and Energy Directorate (NVE), who allowed us to use their normally closed mountain road.

Literature Cited

Alstrup V. 1986. Lichens from Björkliden, Northern Sweden. Graphis Scripta 1: 3-6.

Alstrup V. 1991. Lichens and lichenicolous fungi from the Torneträsk area. Graphis Scripta 3: 54-67.

Alstrup V, Christensen, SN. 1999. The NLF-excursion to the Faeroe Islands 1995. Graphis Scripta 10: 21-28.

Aptroot A. 2001. Lichenized and saprobic fungal biodiversity of a single *Elaeocarpus* tree in Papua New Guinea, with the report of 200 species of ascomycetes associated with one tree. Fungal Diversity 6: 1-11.

Aune B. 1993. Temperaturnormaler, normalperiode 1961-1990. Det Norske Meteorologiske Institutt Klima Rapporter 02/93: 1-63.

Barthlott W, Lauer W, Placke A 1996. Global distribution of species diversity in vascular plants: towards a world map of phytodiversity. Erdkunde 50: 317-327.

Degelius G. 1982. The lichen flora of the Island of Vega in Nordland, Northern Norway. Acta Regiae Scientarum et Litterarum Gothoburgensis, Botanica 2: 1-127.

Engelskjøn T, Skifte O. 1995. The vascular plants of Troms, North Norway. Tromura Naturvitenskap 80: 1-277.

Hakulinen R. 1962. Die Flechtengattung *Umbilicaria* in Ostfennoskandien und angrenzenden Teilen Norwegens. Annales Botanici Societatis Zoologicae Botanicae Fennicae 'Vanamo' 32, 6: 1-87.

Hansen ES. 1987. Nordisk Lichenologisk Forenings ekskursion til Danmark 1987. Graphis Scripta 1: 95-102.

Haugan R, Timdal E 1994. *Tephromela perlata* and *T. talayana*, with notes on the *T. aglaea*-complex. Graphis Scripta 6: 17-26.

Holien H, Tønsberg T. 1994. The 10th meeting of the Nordic Lichen Society in Nord-Trøndelag, Norway, 1993. Graphis Scripta 6: 67-75.

Jørgensen PM. 2004. *Psoroma tenue* var. *boreale*, an overlooked, widespread, arctic-alpine lichen. Graphis Scripta 15: 60-64.

Kristinsson H. 1999. The 12th meeting of the Nordic Lichen Society in Eiðar, Iceland 1997. Graphis Scripta 11: 13-21.

Magnusson AH. 1944. Studies in the ferruginea-group of the genus *Caloplaca*. Göteborgs Kungliga Vetenskaps-Samhälles Handlingar. Sjätte Följden, Serie B: 3, 1: 1-71.

Magnusson AH. 1950. On some species of *Blastenia* and *Caloplaca* with black apothecia. Botaniska Notiser 1950 3: 369-386.

Magnusson AH. 1952. Lichens from Torne Lappmark. Arkiv för Botanik 2: 45-249.

Mathiassen G, Granmo A. 1995. The 11th Nordic Mycological Congress in Skibotn, North Norway 1992: Rapport Botanisk Serie (University of Trondheim) 1995-6, 1-77.

Mattsson JE, Lai MJ. 1993. *Vulpicida*, a new genus in *Parmeliaceae* (Lichenized Ascomycetes). Mycotaxon 46: 425-428.

Øvstedal DO. 1986. Nordisk lichenologisk forenings ekskursjon til Norge 1985. Graphis Scripta 1: 14-25.

Poelt J, Buschart A. 1978. Über einige bemerkenswerte Flechten aus Norwegen. Norwegian Journal of Botany 25: 123-135.

Purvis OL, James PW. 1985. Lichens of the Coniston copper mines. Lichenologist 17: 221-237.

Santesson R. 1993. The Lichens and Lichenicolous Fungi of Sweden and Norway. SBT-förlaget, Lund.

Santesson R, Moberg R., Nordin A., Tønsberg T, Vitikainen O. 2004. Lichen-formimg and lichenicolous fungi of Fennoscandia. Museum of Evolution, Uppsala, 359 pp.

Søchting U. 1989. Lignicolous species of the lichen genus *Caloplaca* from Svalbard. Opera Botanica 100: 241-257.

Thor G. 1992. The 9th meeting of the Nordic Lichen Society, Sweden 1991. Graphis Scripta 4: 19-29.

Tibell L. 1988. The lichen course in Abisko 1986. Graphis Scripta 2: 12-15.

Timdal E. 1983. The genus *Squamarina* in Scandinavia. Lichenologist 15: 169-179.

Tønsberg T, Gauslaa Y, Haugan R, Holien H, Timdal E. 1996. The threatened macrolichens of Norway 1995. Sommerfeltia 23: 1-258.

Vitikainen O. 1991. Lichens recorded during the 8th Nordic lichen excursion in archipelago of S.W. Finland, 1989. Graphis Scripta 3: 35-43.

Westberg M, Kärnefelt I, Thell A. 2004. *Melanelia agnata*, an overlooked species, new to Sweden. Graphis Scripta 15: 23-37.

Zhurbenko M, Søchting U. 1993. *Caloplaca tornoënsis* and *Caloplaca spitsbergensis* (Lichenes), the two lichen species from the Taimyr Peninsula new to Russia. Botanicheskij Zhurnal 78: 118-120.

MYCOTAXON

Volume 96, pp. 147–150 April–June 2006

A new species of *Didymium* (Myxomycetes) with reticulate spores

Yuri K. Novozhilov[1]* & Inna V. Zemlyanskaya[2]

yurinovozhilov@gmail.com
[1]V.L. Komarov Botanical Institute of the Russian Academy of Sciences
Prof. Popov St. 2, 197376 St. Petersburg, Russia

[2] Volgograd State Medicinal University
Pavshikh Boitzov Square 1, 400066 Volgograd, Russia

Abstract—An undescribed species of myxomycete characterized by distinct banded-reticulate spores and the absence of a capillitium was isolated in moist chamber culture from the litter of white sagebrush (*Artemisia lercheana*) collected in a steppe community in the Volgograd region of Russia. A description of this new species and scanning electron photographs are presented. Characters distinguishing this species from *D. atrichum*, *D. nullifilum* and *D. subreticulosporum* are outlined. The taxonomic limits of the species are discussed.

Key words—*Physarales*, *Didymiaceae*, steppe

Introduction

The genus *Didymium* was erected by Schrader (1797) for *Didymium farinaceum* Schrad. (= *D. melanospermum* (Pers.) T. Macbr.) based upon the crystalline structure of the lime on the peridium. The majority of species of *Didymium* have a well-developed capillitium, but some species appear to lack a capillitium. *Didymium atrichum* Henney & Alexop. (Henney et al. 1980) and *D. nullifilum* (Kowalski) M.L. Farr (Farr 1982) are good examples of species with a reduced capillitium. During a study of myxomycetes in desert and steppe regions of the Caspian Lowland (Russia), we observed what appeared to be a species of *Didymium* without a capillitium while examining moist chamber cultures of litter of white sagebrush (*Artemisia lercheana* Weber), collected from a study site in a steppe community near the city of Volgograd. The fruit bodies of this myxomycete consisted of snow-white or ash grey subglobose or pulvinate slightly flattened sporangia with peridium covered with polygonal minute lime crystals and scales. Based on the structure of the lime on the peridium and colour of the spore mass, it was suspected that these sporangia represented a species of *Didymium*. The eight specimens consisting of several hundred sporangia are in very good condition. More detailed observation of this material confirmed that it represented an undescribed species of *Didymium*, which is described herein.

---

* *Corresponding author*

Materials and methods

This study is based on material collected from moist chamber cultures. Samples of litter of *Artemisia lercheana* were placed on filter paper in Petri dishes. Cultures were moistened with distilled water adjusted to pH 7.0 and maintained up to 1 month under diffuse daylight at room temperature (22-23°C). After 10 days several hundred sporangia of a distinct and undescribed species of myxomycete developed in these moist chambers. Some sporangia were used in attempts to establish spore to spore cultures but these were unfortunately unsuccessful. Spores were preserved as permanent slides in polyvinyl lactophenol. Air-dried sporangia were studied with a JEOL 35c scanning electron microscope at St. Petersburg; the material was mounted on copper stubs using double-sided sticky film and sputter-coated with gold up to 200-500 Å thickness. Color descriptions of sporangia are given according to Petersen (1996).

Taxonomic Description

Didymium reticulosporum Novozh. & Zeml., **sp. nov.** Figure 1

> *Sporangia dispersa vel conferta, candida (60, Petersen 1996) vel cinerea (56, Petersen 1996), ad basin compressam suffulta, pulvinata, subapplanata vel subglobosa, 0.5-1.5 mm in diametro, interdum pro plasmodiocarpis ad 3 mm longis. Hypothallus tenuis, paleaceus, inconspicuus. Peridium unistratosum, tenue, paleaceum, crystallis albis, polygonalibus vel squamulis calcibus densiuscule obtectum, interdum haud calcificatum. Columella nulla. Capillitium nullum. Massa sporarum aquila. Sporae globosae vel subprotractae, 13-16 µm in diametro, incluso dimensio ornamentationis, atropurpureo-brunneae (3, Petersen 1996), ornamentatione reticulatis insigni, foveolis, magnis, planis in numero 3-4 in sectione opticae sporis hemisphaerae; cristae reticuli in sectione optice 1.5-2 µm altae. Sub SEM [microscopio scanico] intra reticulum basalis ornamentatio reticulata secundaria pro reticulis minute alveolatis conspicua et area episporii obtegentia.*
>
> ***Etymology:*** Refers to the distinctive ornamentation of spores.

Sporangia scattered or gregarious, snow-white (60, Petersen, 1996) or ash grey (56, Petersen, 1996) forming subglobose or pulvinate slightly flattened sporocarps, 0.5-1.5 mm diam., varying to short plasmodiocarps up to 3 mm long; **peridium** single, thin, membranous, sparsely to densely powdered with white lime polygonal minute crystals and scales, sometimes nearly limeless; **columella** absent; **capillitium** absent; **spore-mass** dark brown; **spores** globose or slightly elongated, 13-16 µm diam., including the ornamentation, very dark purplish brown, fuscous (3, Petersen 1996) to violet-brown (1, Petersen, 1996), prominently banded-reticulate with regular large 3-4 meshes across the hemisphere; the bands form a border ca. 1.5-2 µm high in optical section; in SEM the secondary reticulum with smaller meshes covering the epispore is visible inside the basic reticulum; **plasmodium** hyaline to yellowish-milky.

Ecology and distribution—On the dead twigs of Artemisia lercheana, bark of apple-tree and litter of pear-tree.

> **REPRESENTATIVE SPECIMENS EXAMINED—RUSSIA. Volgograd province,** THE WATERSHED OF THE VOLGA RIVER (44°21'04"E, 48°34'43"N), located at an elevation of 100 m above sea level, steppe community with *Artemisia lercheana*, within the steppe zone; isolated in moist chamber culture, on the dead twigs of *A. lercheana* collected 24.07.2001, I.V. Zemlyanskaya (HOLOTYPE-LE 204007). **Volgograd province:** **Kamyshinskiy**

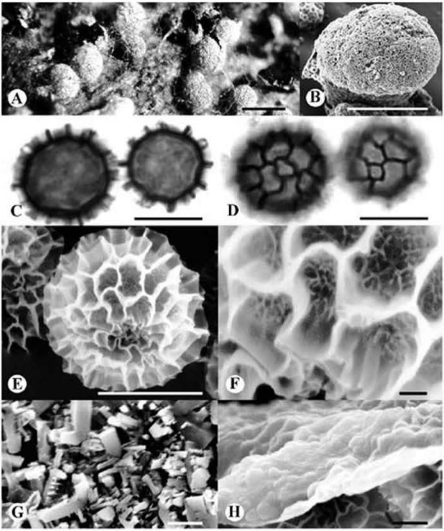


Fig. 1. Sporangia, peridium and spore morphology of *Didymium reticulosporum* (LE 204007). – A. Habit of sporangia. B. SEM micrograph of a closed sporangium. C. Polyvinyl lactophenol mount of spores in optical section. D. Polyvinyl lactophenol mount of spores in top view. E. Spore as viewed under SEM. F. Detail of spore ornamentation under SEM. G. SEM micrograph of lime polygonal minute crystals and scales on the peridium. H. SEM micrograph of membranous peridium.

Scale bars: A, B = 1 mm, C, D, E = 10 µm, F, G, H = 1 µm.

---

district, Shcherbatovskiy National Park, Shcherbatovka village (45°41'33"E, 50°29'36"N), on bark of apple tree and on litter of pear-tree, isolated in moist chamber culture 21.02.2005 (the private collection of Dr. I.V. Zemlyanskaya 614/1, 621/1, 621/4).

Note: An isotype has been sent to the National Fungus Collections (BPI) USA, the private collection of Dr. C. Lado (dwb, Lado), and the private collection of Dr. M. Schnittler (sc).

Comments—This species differs from species of *Diderma* in having the upper part of the peridium covered with rhomboid and polygonal crystals of lime (Fig. 1, H) and therefore belongs to the genus *Didymium*. No described species of *Didymium* with reduced capillitium appears to be closely related to this new species. *Didymium reticulosporum* differs from all other species in the genus by virtue of its unique spore ornamentation. *Didymium atrichum* has reticulate or spinulose spores, but its spores are much smaller (10-11 µm diam.) and only appear very faintly reticulate under oil immersion. *Didymium nullifilum*, another species with a reduced capillitium, has spores 8-10 µm diam. covered with widely scattered spines up to 1 µm high.

Other taxa with banded-reticulate spores have been described throughout many genera of myxomycetes, but this type of spore ornamentation is rare within *Didymium*. Only *D. subreticulosporum* Oltra, G. Moreno & Illana (Moreno et al. 1996; see also Lizárraga et al. 1998) has banded-reticulate spores; all other species of *Didymium* have spinulose, verrucose or faintly reticulate spores. However, *D. subreticulosporum* has stipitate sporocarps and its spores are much smaller (9-11 µm diam.). In contrast, *D. reticulosporum* has sessile sporocarps and large prominently banded-reticulate spores (13-16 µm) with the secondary reticulum covering the epispore, and this kind of spore ornamentation has never been observed among myxomycetes.

Acknowledgements

We wish to express our thanks to L.A. Karzeva, St. Petersburg, for technical assistance during the SEM-investigations and to Dr. A. Borodina for writing the Latin diagnosis. Prof. Harold W. Keller (Central Missouri State University) made valuable comments relating to the collection of *Didymium reticulosporum*. This work was supported by two grants (02-07-90439 and 02-04-49907) from the Russian Science Foundation [RFBR], the scientific project "Bioraznoobrazie" with additional funding provided by the Planetary Biodiversity Inventory project (Global Biodiversity of Eumycetozoans) supported by a grant (DEB-0316284) from the National Science Foundation. We are grateful to Dr. Gražina Adamonytė (Institute of Botany, Vilnius, Lithuania) and Dr. Steve L. Stephenson (Arkansas University, USA) for comments, discussion during manuscript preparation and language correction.

Literature cited

Farr ML. 1982. Notes on Myxomycetes. III. Mycologia 74: 339-343.

Henney MR., Alexopoulos CJ, Scheetz RW. 1980. *Didymium atrichum*, a new myxomycete from south-central Texas. Mycotaxon 11: 150-164.

Lizárraga M., Illana C., Moreno G. 1998. *Didymium subreticulosporum* (Myxomycetes), a new species for America. Mycotaxon 67:313-316.

Moreno G, Castillo AM, Illana C., Lizárraga M. 1996. Two new species of *Didymium* of Spain. - In: Abstracts of the second international congress on systematics and ecology of Myxomycetes. Real Jardin Botanico, CSIC: Madrid (Spain): 57.

Petersen JH. 1996. The Danish Mycological Society's Colour-chart. Low Budget Publishing: Greve (Denmark). 6 pp.

Schrader HA. 1797. Nova genera plantarum. Sigfried Lebrecht Crusium: Lipsiae (Germany). 32 pp.

MYCOTAXON

Volume 96, pp. 151–158 *April–June 2006*

Anamorphic fungi from submerged leaves in Cuba: *Brevicatenospora enteroproliferata* gen. et sp. nov. and *Beltraniopsis aquatica* sp. nov.

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

DAVID W. MINTER

d.minter@cabi.org
CABI Bioscience, Bakeham Lane
Egham, Surrey, TW20 9TY, United Kingdom

MARC STADLER

marc.stadler@t-online.de
InterMed Discovery GmbH, c/o Bayer Pharma Research Center, Bldg. 0452
P.O.B. 101709, D-42096 Wuppertal, Germany

MASATOSHI SAIKAWA

saikawa @u-gakugei.ac.jp
Department of Biology, Tokyo Gakugei University
Nukuikita-machi, Koganei-shi, Tokyo 184-8501, Japan

MAYRA CAMINO-VILARÓ

hajb@ceniai.inf.cu
Jardín Botánico Nacional, Carretera del Rocio, Km 3.5
C.P 19230, Calabazar, Boyeros, Ciudad de La Habana, Cuba

Abstract—*Brevicatenospora enteroproliferata* anam. gen. et sp. nov. and *Beltraniopsis aquatica* anam. sp. nov. are described and illustrated on decaying leaves of *Andira inermis* and an unidentified plant submerged in the 'Ancón' stream, Mil Cumbres, Pinar del Rio Province, Cuba. The former is distinguished by hologenous, unilocal, indeterminate conidiogenous cells with numerous enteroblastic percurrent proliferations and polymorphic unicellular, red-brown to dark brown conidia in short chains and the latter is characterized by unicellular, fusiform to navicular, brown conidia.

Key words—fresh water, systematics, tropical fungi, hyphomycetes

Introduction

In contrast to other habitats, freshwater biotopes have so far been widely neglected during inventories of tropical fungal biodiversity. In fact, submerged plant debris in tropical streams and lakes has recently turned out to harbor various undescribed taxa of conidial fungi (Castañeda et al. 2005a,b). During an expedition through the rainforest in the western mountains of Mil Cumbres, Pinar del Rio Province, Cuba, two interesting hyphomycetes were collected in 2004 on submerged decaying leaves of *Andira inermis* and an unidentified plant in a stream. They showed remarkable differences from previously described hyphomycetes and are therefore, described as a new genus and species. We report here their characteristics, based on microscopic studies that were carried out as described in Castañeda et al. (2005a)

Taxonomy

Brevicatenospora R.F. Castañeda, Minter & Saikawa **anam. gen. nov.**

> *Ad fungos conidiales, hyphomycetes pertinens. Coloniae effusae, brunneae usque rubro-brunneae vel nigrae. Conidiophora conspicua, septata, brunnea usque ad atrobrunnea. Cellulae conidiogenae uniloculosae, hologenosae, indeterminatae, cum multis proliferationibus enteroblasticis percurrentis. Loci conidiogeni apicales. Secessio conidiorum schizolytica. Conidia acrogena, unicellularia vel septata, catenulata, polymorpha, obovata, globosa, pyriformia, globosa, clavata, spathulata usque ad capitata, brunnea, rubro-brunnea usque ad nigra, levia vel verrucosa. Teleomorphosis ignota.*
>
> Etymology: Latin, *brevi*, meaning short; *catena*, meaning chain; *spora*, referring to the conidia.
>
> Typus: *Brevicatenospora enteroproliferata* sp. nov.

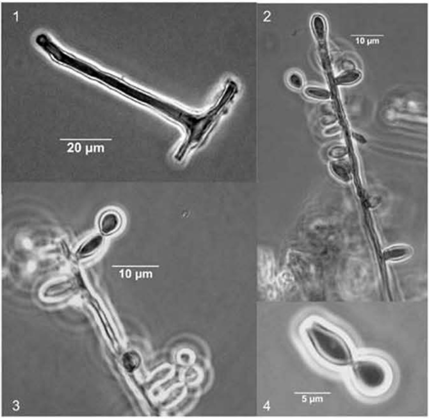
Conidial fungi, hyphomycetes. **Colonies** effuse, brown to red-brown or black. **Conidiophores** differentiated, septate, brown to dark brown. **Conidiogenous** cells unilocal, hologenous, indeterminate with numerous enteroblastic percurrent proliferations. **Conidiogenous loci** apical. **Conidial secession** schizolytic. **Conidia** acrogenous, unicellular or with one septum, polymorphic, ranging from obovate, globose, pyriform, clavate, spathulate to capitate, brown, red-brown to black, smooth-walled or verrucose, catenulate. Teleomorph: unknown.

COMMENTS— *Brevicatenospora* is somewhat similar to the genera *Annellophora* S. Hughes (Hughes 1951), *Acrogenospora* M.B. Ellis (Ellis 1971), *Belemnospora* P.M. Kirk (Kirk 1981), *Sporidesmiella* P.M. Kirk (Kirk 1982), and *Repetophragma* Subram. (Subramanian 1992) in having hologenous, unilocal conidiogenous cells with few to several enteroblastic percurrent proliferations and delicate annellations on the apical region of the conidiophores, but catenulate conidia are not formed in any of these genera. The genera *Endophragmiella* B. Sutton (Sutton 1973) and *Ityorhoptrum* P. M. Kirk (Kirk 1986) appear superficially similar to *Brevicatenospora*; both genera have hologenous, unilocal, percurrently proliferating conidiogenous cells and solitary conidia, but the rhexolytic conidial secession separate those genera from the new one. Also, the genera *Junewangia* W.A. Baker & Morgan-Jones (Baker et al. 2002), *Camposporidium* Nawawi & Kuthub. (Nawawi A, Kuthubutheen 1988) and *Digitoramispora* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1990) have analogous annellidic conidial ontogeny with several enteroblastic extensions of the conidiogenous cells, but the solitary conidia in *Junewangia* are dictyoseptate; *Camposporidium* has phragmoconidia with several cellular appendages, whereas, septate, branched, more or less digitate conidia are present in *Digitoramispora*.

Brevicatenospora enteroproliferata R.F. Castañeda, Minter & Saikawa

anam. sp. nov. FIGURES 1–7

Coloniae effusae, brunneae usque rubro-brunneae. Mycelium partim superficiale et partim in substrato inmersum. Conidiophora conspicua, mononemata, 3– ad 7–septata, simplicia, 80–110 µm alta, 5.2–7.8 µm crassa ad basim, levia, brunnea usque ad atrobrunnea. Cellulae conidiogenae uniloculosae, hologenosae, indeterminatae, annellatae, 3.9–6.4 µm crassa, brunneae usque pallide brunneae, cum 10–28-proliferationibus enteroblasticis percurrentibus. Loci conidiogeni apicales. Conidia acrogena, unicellularia, breviter catenulata, brunnea vel rubro-brunnea, levia, sicca, polymorpha; conidia primaria



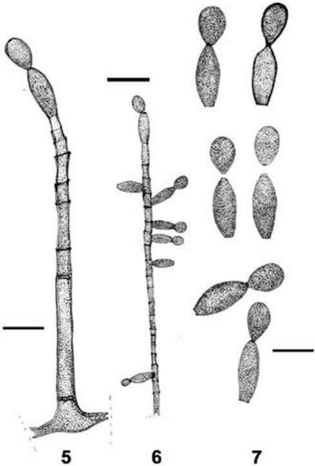
Figs. 1–4. Photomicrographs of *Brevicatenospora enteroproliferata*, from holotype (INIFAT C04/111). **Fig. 1.** Conidiophore and conidiogenous cell. **Fig. 2.** Conidiophore with conidiogenous cells and conidia. **Fig. 3.** Conidiogenous cells. **Fig. 4.** Conidiogenous cell detached with conidium. Scale is indicated by bars.

clavata, sub-clavata ad usque leviter spathulata, utrimque truncata, 6.5–8.5 × 3.2–6.5 µm, sed 2.6–3.0 µm crassa ad apicem; conidia secundaria late obovoidea, pyriformia usque ad subglobosa, 3.9–5.2 × 3.9–4.5 µm. Teleomorphosis ignota.

Holotype: INIFAT C04/111 on submerged decaying leaves of *Andira inermis* in "Ancon" stream, Mil Cumbres, Pinar del Rio Province, Cuba. Coll. D. W. Minter and M. Camino, November 13, 2004.

Etymology: Latin, *entero*, referring to the inner wall; *proliferata*, meaning extended.

Colonies on the natural substratum effuse, brown to red-brown. Mycelium superficial and immersed. **Conidiophores** macronematous, mononematous,,3– to 7–septate,



Figs. 5–7. Drawings of *Brevicatenospora enteroproliferata*, from holotype (INIFAT C04/111) . **Fig. 5.** Conidiophore and conidiogenous cell. **Fig. 6.** Conidiophore with conidiogenous cells and attached conidia. **Fig. 7.** Primary and secondary conidia partially detached. Scale is indicated by bars (10 µm).

simple, 80–110 µm tall, 5.2–7.8 µm wide at the base, smooth-walled, brown to dark brown. **Conidiogenous cells** unilocal, hologenous, 3.9–6.4 µm wide, indeterminate, annellidic with 10–28-enteroblastic percurrent proliferations. **Conidiogenous loci** apical. **Conidial secession** schizolytic. **Conidia** acrogenous, one-celled, brown to red-brown, smooth-walled, dry, forming short, simple chains, usually remaining adhering to the axis of the conidiophores, polymorphic; primary conidia clavate, subclavate, to slightly spathulate, truncated at the ends, 6.5–8.5 × 3.2–6.5 µm, 2.6–3.0 µm near the apex; secondary conidia obovoid, pyriform to subglobose. 3.9–5.2 × 3.9–4.5 µm. Teleomorph: unknown.

Beltraniopsis aquatica R.F. Castañeda & M. Stadler **anam. sp. nov.**

FIGURES 8–15

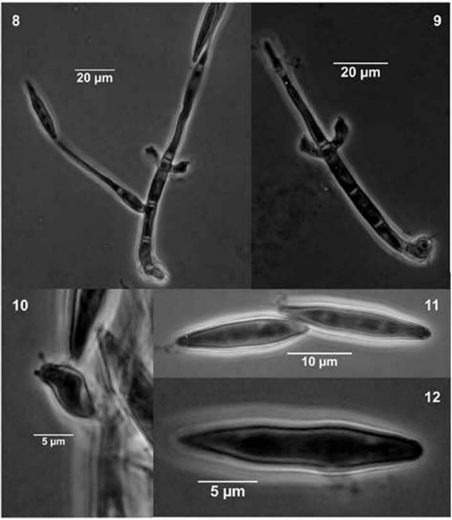
Ad omnibus speciebus Beltraniopsis differt ob conidia solitaria, acrogena, fusiformia ad usque navicularia, leviter constricta ad centrum, sicca vel leviter verruculosa, levia, brunnnea, 18.2–23.4 × 3.9–5.2 µm.

Holotype: INIFAT C04/101 on submerged decaying leaves of an unidentified plant in "Ancon" stream, Mil Cumbres, Pinar del Rio Province, Cuba. Coll. D. W. Minter and M. Camino, November 13, 2004.

Etymology: Latin, *aquatica*, refers to its growing in water.

Colonies on natural substratum effuse, brown. Mycelium mostly immersed, composed of septate, unbranched, 1.3–2.0 µm diam., pale brown to brown, smooth-walled hyphae. **Conidiophores** macronematous, mononematous, sometimes forming a fasciculate group, setiform, rounded or slightly clavate at the apex, inflated at the base, 68–90 µm long, 6.5–9.1 µm wide at the base, 3- to 7-septate, branched in the median part, smooth-walled, brown at the base, pale brown to subhyaline towards the apex. **Conidiogenous cells** multilocal, hologenous, 6.5–10.5 × 4.0–4.5 µm, sympodially proliferating, indeterminate, discrete. **Separating cells** absent. **Conidiogenous loci** denticulate; denticles 0.6–1.3 µm long. **Conidial secession** schizolytic. **Conidia** solitary, pleurogenous, fusiform to navicular, slightly constricted at the middle, brown, smooth-walled, sometimes minutely verruculose, obtuse to round at the apex and attenuated, truncated at the base, 18.2–23.4 × 3.9–5.2 µm, dry. Teleomorph unknown.

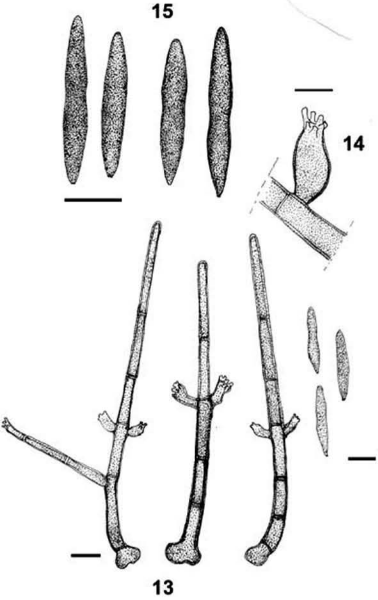
COMMENTS— Seven species have been described in the genus *Beltraniopsis* thus far: *B. esenbeckiae* Bat. & J.L. Bezerra, the type species (Batista & Bezerra 1960), *B. asperisetifer* Matsush. (Matsushima 1971), *B. tanzaniensis* Piroz. (Pirozynski 1972), *B. fabularis* Rambelli & C. Ciccar. (Rambelli & Ciccarone 1987), *B. ramosa* R.F. Castañeda (Castañeda & Arnold 1985), *B. rhombispora* Matsush. (Matsushima 1993) and *B. miconiae* Gusmão & Grandi (Gusmão et al. 2000). Among these taxa, *B. aquatica* is superficially similar to *B. rhombispora*, it has conidia 15–21 × 3–4 µm that are almost the same size of *B. aquatica*, but conidia in *B. rhombispora* are rhombic to biconic, smooth-walled, and pale olivaceous. Also both taxa lack the separating cells present in other previously described species.



Figs. 8–12. Photomicrographs of *Beltraniopsis aquatica*, from holotype (INIFAT C94/101).
Fig. 8. Branched conidiophore. Fig. 9. Simple conidiophore.
Fig. 10. Conidiogenous cells. Figs. 11-12. Conidia.
Scale is indicated by bars.

Acknowledgements

We are deeply indebted to Lori M. Carris (Washington State University) and Huzefa Raja (University of Illinois) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank the Cuban Ministry of Agriculture for facilities.



Figs. 13–15. Drawings of *Beltraniopsis aquatica*, from holotype (INIFAT C94/101)
Fig. 13. Conidiophores. **Fig. 14.** Conidiogenous cell. **Fig. 15.** Conidia.
Scale is indicated by bars (10 µm in Figs. 15 and 17; 5 µm in Fig. 16. e

Literature Cited

Baker WA, Partridge EC, Morgan-Jones G. 2000. Notes on Hyphomycetes. LXXXV. *Junewangia*, a genus in which to classify four *Acrodictys* species and a new taxon. Mycotaxon 81: 293–319.

Batista AC, Bezerra JL. 1960. *Beltraniopsis* – Novo gênero de fungos dematiaceae. Universidade de Recife. Publicação 296: 1-11.

Castañeda Ruiz RF, Arnold GRW. 1985. Deuteromycotina de Cuba. I. Hyphomycetes. Revista del Jardin Botanico Nacional 6: 47–67.

Castañeda Ruiz RF, Kendrick B. 1990. Conidial fungi from Cuba. II. University of Waterloo Biology Series 33: 1–61.

Castañeda Ruiz RF, Heredia G, Arias RM, Stadler M, Minter DW. 2005a. Two Hyphomycetes from submerged plant material of México. Mycotaxon 91: 333-337.

Castañeda Ruiz RF, Stadler M, Saikawa M, Iturriaga, T, Decock C, Heredia G. 2005b. Microfungi from submerged plant material: *Zelotriadelphia amoena* gen. et sp. nov. and *Vanakripa fasciata* sp. nov. Mycotaxon 91: 339-345

Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, 608 pp.

Gusmão LFP, Grandi RAP, Milanez AI. 2000. A new species of *Beltraniopsis* from Brazil, with a key to the known species. Mycological Research 104: 251–253.

Hughes SJ. 1951. *Annellophora* nom.nov. (= *Chaetotrichum* Syd. non Rabenh.). Transactions of the British Mycological Society 34: 544–550.

Kirk PM. 1981. New or interesting microfungi. II. Dematiaceous hyphomycetes from Esher Common, Surrey. Transactions of the British Mycological Society 77: 279–297.

Kirk PM. 1982. New or interesting microfungi. VI. *Sporidesmiella* gen.nov. Transactions of the British Mycological Society 79: 479–489.

Kirk PM. 1986. New or interesting microfungi. XV. Miscellaneous Hyphomycetes from the British Isles. Transactions of the British Mycological Society 86: 409–428.

Matsushima T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea 78 pp. Published by the author, Kobe.

Matsushima T. 1993. Matsushima Mycological Memoirs 7: 75 pp. Published by the author, Kobe.

Nawawi A, Kuthubutheen AJ. 1988. *Camposporidium*, a new phragmoconidial genus of hyphomycetes. Mycotaxon 32(1): 161–167.

Pirozynski KA. 1972. Microfungi of Tanzania. Mycological Papers 129: 1-64.

Rambelli A, Ciccarone C. 1987 ('1985'). Two new dematiaceous hyphomycetes from humid tropic forest litter. Giornale Botanico Italiano 119: 291-294.

Subramanian CV. 1992. A reassessment of *Sporidesmium* (Hyphomycetes) and some related taxa. Proceedings of the Indian National Science Academy Part B. Biological Sciences, 58(4): 179–189.

Sutton B.C. 1973. Hyphomycetes from Manitoba and Saskatchewan, Canada. Mycological Papers 132: 1–143.

MYCOTAXON

Volume 96, pp. 159–162 *April–June 2006*

Leptosphaeria raphani does not occur on *Draba aspera*

David L. Hawksworth

myconova@terra.es
MycoNova, The Yellow House, Calle Aguila 12, Colonia La Maliciosa
Mataelpino, ES-28492 Madrid, Spain

Abstract—The specimen on which the report of the occurrence of *Leptosphaeria raphani* on *Draba aspera* in Montenegro (Republic of Serbia and Montenegro) was based has been compared with the holotype of that name. The species on *Draba* differs from *L. raphani* in having more darkly pigmented ascospores which are elongate-ellipsoid not broadly fusiform, have all cells equal in length, and are shorter and wider, with a lower length/breadth ratio. The specimen from Montenegro is clearly a different species, and requires further study to determine if it is new. Canadian material reported on *Arabis alpina* and *Draba oblongata* could, on the basis of the published information, be conspecific with the Montenegran. *Leptosphaeria raphani* is currently only definitely known from *Raphanus maritimus* in the UK.

Key words—*Arabis, Dothideomycetes,* misidentifications, Mycotaxon policy, *Phaeosphaeriaceae, Raphanus*

Introduction

Leptosphaeria raphani D. Hawksw. & Sivan. 1975 was originally described from the base of dying stems of *Raphanus maritimus* (*Cruciferae*) on the shingle ridge of what is now the Slapton Ley National Nature Reserve in South Devon in the UK (Hawksworth & Sivanesan 1975). Subsequently, Shoemaker (1984) referred two collections on other crucifers, *Arabis alpina* and *Draba oblongata,* to *L. raphani* but did not examine the holotype or "authenticated material" and was careful to stress the disposition was provisional. The species was also illustrated in Ellis & Ellis (1985) whose drawings were prepared from the holotype.

In December 2004 I received a paper to referee for Mycotaxon reporting the species from *D. aspera* in Montenegro (Republic of Serbia and Montenegro). There were substantive differences in the description and photographs provided from the original account of *L. raphani,* and I recommended the paper not be submitted until the holotype and the Canadian specimens had been examined. My report was also copied to André Aptroot (then at the Centraalbureau voor Schimmelcultures, Utrecht) as he was thanked in the manuscript for 'verification of identification'. I was therefore surprised to see the paper published almost unchanged in Mycotaxon without my being acknowledged as one of the referees (Vukojević et al. 2005).

In order to clarify the matter, I borrowed the holotype of *L. raphani* from IMI (CABI Bioscience, Egham, UK) and the Montenegran collection from BEOU (Botanical Institute and Garden, University of Belgrade). This note reports the results of my side-by-side comparison of these two collections, which established that the Montenegran report was based on a misidentification.

Materials and Methods

The permanently preserved slides in both collections were examined using an Olympus BH2 microscope fitted with Nomarski Differential Interference Microscopy and a drawing tube. A selection of ascospores free of the asci were drawn to show the range in shape and size, and sizes and length/breadth ratios were noted.

SPECIMENS EXAMINED — SERBIA AND MONTENEGRO: Montenegro: Maja Kolata (Mt. Prokletije), 2530 m, on leaves of *Draba aspera*, 5 July 1995, *B. Stevanović* et al. (BEOU). — UNITED KINGDOM: England: South Devonshire: Slapton, Slapton Ley National Nature Reserve, *ca.* 10 m, on dead stems of *Raphanus maritimuus* on the shingle ridge, 15 Aug. 1973, *D. L. Hawksworth 3563* (IMI 178278 – holotype of *Leptosphaeria raphani*).

Results and Discussion

The suspicion that the two collections represented different species was confirmed. The ascospores differ in colour, shape, size, length/breadth ratio, constrictions, and the relative sizes of the cells (Table 1, Fig. 1). As these details match the pertinent published drawings and photographs, it is evident that they are not artefacts of preservation. The ascospore sizes given below are from the preserved slides, and somewhat larger ranges are given in the pertinent publications: 20-26 x 4-5 µm for IMI 178278 (Hawksworth & Sivanesan 1975) and 17.5-23.7 x 5-7.5 µm for that in BEOU (Vukojević et al. 2005), presumably because many more spores were measured. In addition, the sizes of the ascomata differ substantially and hardly overlap in width, measuring 275-325 x 200-259 µm in IMI 178278 (Hawksworth & Sivanesan 1975) and only 164-230 x 130-225

Table 1. A comparison of the ascospore characters in the two collections named as *Leptosphaeria raphani* examined.

Character	IMI 178278 (holotype)	BEOU
Colour	Yellow-brown	Red-brown
Shape	Broadly fusiform	Broadly ellipsoid
Apices	Attenuated	Rounded
Constrictions	Median septum only	All septa
Cell size	The two central cells the longest	All cells ± equal in size
Size	20.5-24 x 4.5-5.5 µm	17-17.5 x 5-6 µm
Length/breadth ratio	3.9-5.0	2.9-3.5

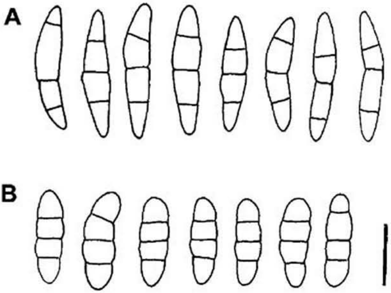


Fig. 1. Ascospore shape and septation in "*Leptosphaeria raphani*". (A) IMI 178278 (holotype) on *Raphanus maritimus*; and (B) BEOU on *Draba aspera*. Scale bar = 10 μm.

μm in the BEOU collection (Vukojević et al. 2005). While it might be true that the dimensions of the ascomata might be "a result of development on different hosts and in different environmental conditions" (Vukojević et al. 2005: 266), such factors could not explain the fundamental differences in the ascospores. Indeed, the features of ascospore colour, shape, and septation patterns are regularly used in species delimitation in this and allied genera (e.g. Leuchtman 1984; Shoemaker 1984); to allow such a range of variation within a single *Leptosphaeria* species would shake the foundations of the current taxonomy of the genus.

The detailed descriptions of the two Canadian collections on *Arabis alpina* and *Draba oblongata*, and especially the photograph of the ascospores, provided by Shoemaker (1984: 2726, fig. 145), suggest that he was also dealing with a different species. The ascomata were stated as being larger than in the Montenegran collection (200-280 x 200-280 μm) and the ascospores (15-20 x 4.5-5 μm) had shorter central cells and were more elongate than in the BEOU collection, and further not clearly constricted at septa apart from the median one.

In concluding that the UK collection is distinct and that the name *Leptosphaeria raphani* has been wrongly applied, what names should be used for the other specimens? It might be tempting to describe two additional new species, but as there are already at least 29 species names introduced for *Leptosphaeria*'s (s. lat.) on *Cruciferae* (Crane & Shearer 1991) I believe that it would be irresponsible to do that without an investigation of the application of all those names.

There are perhaps three main lessons for mycologists in general from this investigation. (1) If you are going to report a fungus on a new host, first compare the material with type or authentic specimens and do not rely on descriptions or identifications by others who have not made such a comparison[1]. (2) Do not ignore referees' comments because they might mean more work as to do so may cause you public embarrassment. And (3) MYCOTAXON's policy of now requesting all referees' reports to be copied separately to the Editor-in-Chief is in the interests of avoiding mistakes entering the scientific literature.

I might add that this is not the first time there have been instances of papers appearing in MYCOTAXON where my comments as a referee have been ignored, though in those cases I was acknowledged, thus implying I agreed with the conclusions when I certainly did not! I refrain from mentioning those here, until I can find time to write more notes in a similar vein – but they did not involve a species name I had introduced that I did not wish to see being misapplied.

Acknowledgements

I am grateful to Paul M. Kirk (CABI Bioscience, Egham) for arranging the loan of the holotype of *Leptosphaeria raphani,* and to Jelena Vukojević (University of Belgrade) for the loan of the Montenegran collection reported as *L. raphani.* J. Leland Crane (Illinois Natural History Survey, Champaign) and Rajesh Jeewon (University of Hong Kong) kindly acted as referees for this paper.

Literature Cited

Crane JL, Shearer CA. 1991. A nomenclator of *Leptosphaeria* V. Cesati & G. de Notaris (*Mycota-Ascomycotina-Loculoascomycetes*). Illinois Natural History Survey Bulletin 34: 195-355.

Ellis MB, Ellis JP. 1985. Microfungi on Land Plants. London: Croom Helm.

Hawksworth DL, Sivanesan A. 1975. New and interesting microfungi from Slapton, South Devonshire: *Ascomycotina.* Transactions of the British Mycological Society 64: 101-111.

Leuchtmann A. 1984. Über *Phaeosphaeria* Miyake und andere bitunicate Ascomyceten mit mehrfach querseptierten Ascosporen. Sydowia 37: 75-194.

Shoemaker RE. 1984. Canadian and some extralimital *Leptosphaeria* species. Canadian Journal of Botany 62: 2688-2729.

Vukojević J, Grbić ML, Stevanović B, Stevanović V. 2005. First record of *Leptosphaeria raphani* on *Draba aspera* found on the Balkan Peninsula. Mycotaxon 93: 265-268.

---

[1] If for any reason type or authentic material is not available, endeavour to collect material on the same host for comparison (ideally also from the same region as the holotype); where no original material remains or it no longer exhibits particular characters, a neotype or epiptye respectively can be designated to fix its application for the future.

MYCOTAXON

Volume 96, pp. 163–168 April–June 2006

Drechslerella brochopaga, the anamorph of *Orbilia (Hyalinia) orientalis*

ZEFEN YU[1], YING ZHANG[1], MIN QIAO[1], H.-O. BARAL[2],
E. WEBER[2] & KEQIN ZHANG[1*]

*Kqzhang111@yahoo.com.cn
[1]Laboratory for Conservation and Utilization of Bio-resource
Yunnan University, Kunming, Yunnan 650091, PR China
[2]Blaihofstrasse 42, D-72074 Tübingen, Germany

Abstract—Cultures derived from three collections of *Orbilia* (formerly *Hyalinia*) *orientalis* produced an anamorph, which could be identified as *Drechslerella brochopaga*. The cultures formed constricting rings when nematodes *Panagrellus redivivus* were added. Both teleomorph and anamorph are illustrated and described. In addition, the new combination *Orbilia tenebricosa* is proposed.

Keywords—*Orbilia orientalis*, anamorph-teleomorph connection

Introduction

The genus *Orbilia* Fr. is a globally distributed genus comprising more than 200 species (Baral et al., in prep.). Its history was simply reviewed by Liu et al. (2005a). *Orbilia* has not been a major focus of mycologists because of the perceived low economic importance of the genus and minute size of the apothecia (Alexopoulos et al. 1996). However, Pfister (1994) reported predacious capabilities for some species of *Orbilia* and their *Arthrobotrys* anamorphs, and further data on nematode trapping in *Orbiliaceae* were subsequently supplied by Liu et al. (2005a, b) and Mo et al. (2005a, b). These authors also summarized known anamorphs of *Orbilia* (Liu et al. 2005a, Mo et al. 2005a). However, *Helicoon* Morgan (Pfister 1997) was excluded because its teleomorph was separated from other *Orbilia* spp. in the analysis of ITS regions (Hagedorn & Scholler 1999), and an *Idriella*-like anamorph (Haines & Egger 1982) was excluded because its teleomorph was not referable to *Orbilia* (Baral et al., in prep.).

The genus concept of predacious hyphomycetes was emended by Scholler et al. (1999) on the basis of ITS and 18S rDNA sequence data (Hagedorn & Scholler 1999) and, according to the phylogenies inferred from sequence analyses of 28S rDNA, 5.8S rDNA and ß-tubulin genes, further emended by Li et al. (2006).

Pfister (1997) and Scholler et al. (1999) included the sequence data of one and two strains of *Drechslerella brochopaga* (at that time without known teleomorph connection) respectively in their phylogenetic study of *Orbiliaceae*. During study of *Orbilia* and their anamorphs, we found that *Orbilia orientalis* produced a nematode-trapping anamorph. After a detailed examination, the fungus was identified as *Drechslerella brochopaga*.

Material and methods

Fresh specimens of *Orbilia orientalis* were collected in China (on decaying bark of broad-leaved tree in a forest at 848 m altitude, located in Jinggangshan Park of Jian City, Jiangxi province, in October 2005, Y. Zhang. A dried voucher specimen was deposited in the Laboratory for Conservation and Utilization of Bio-resource, Yunnan Province, China. YMFT 1.01892) and in France (on rotten bark on lower face of *Corylus avellana* branch lying on ground, c. 20 m altitude, N of St. Gemme la Plaine, Dept. Vendée, 6.VI.2003, J. L. Surault, H.B. 7379; on rottten wood of *Carpinus betulus* branch lying on moist ground, c. 110 m altitude, Forêt d'Aulnay, dept. Deux-Sèvres, 28.VI.2006, P. Tanchaud, H.B. 8146a). To isolate its anamorph, several apothecia were fixed to the lid of a Petri dish with their hymenia upside down to shoot ascospores on the surface of CMA (20 g corn meal, 18g agar, 40 mg streptomycin, 30 mg ampicillin, 1000 ml distilled water).

Spore deposits from all apothecia produced the same anamorph. The Petri-dishes with apothecia were placed 4-6 days at room temperature until ascospore germination was seen on the CMA. The ascospores were transferred onto PDA plates and CMA plates respectively. After incubating 7-10 days at 25°, conidiophores and conidia were observed and measured with an Olympus B51 microscope with differential interference contrast and a Zeiss Standard 20 microscope. Trapping organs were induced by adding about 100 nematodes (*Panagrellus redivivus* Goodey) into a 1cm × 1cm square slot at the margins of the colony where the agar was removed.

In one of the two French collections (H.B. 7379), the anamorph (conidiophores and conidia) was only obtained around the apothecium on the lid of the Petri dish; a sterile transfer of mycelium and conidia in order to obtain a pure culture failed.

Taxonomic Description

Teleomorph:

Orbilia orientalis (Raitv.) Baral, FIGURE 1

in Krieglsteiner, Regensburger Mykologische Schriften 9(1): 271. 1999

≡ *Hyalinia orientalis* Raitv., in Azbukina, Plantae non vasculares, Fungi et Bryopsida Orientis extremis Sovietici, Fungi, Tomus 2, Ascomycetes, p. 362, 1991

Apothecia 0.8-1.2 mm in diam. (0.3-3 mm, France), superficial, with a distinct stalk up to 0.2-0.3 mm high, scattered to gregarious on decayed bark, white and translucent throughout when moist, pale brown when dry. Disc slightly concave to flat, margin even and smooth (distinctly crenulate-toothed in French specimens). Ectal excipulum of angular or globose cells, 8.0-13.8 µm in diam. (near base 18-42 × 12-38 µm, on flanks 15-30 × 12-20 µm, France), with thin or only slightly thickened walls, towards margin of t. prismatica-angularis oriented at a high angle, marginal cells tipped by glassy processes (only observed in French specimens) up to 30-40 × 3.5-4.5 µm, curved outwards, agglutinated to form rounded teeth. Medullary excipulum rather thick, of t. globulosa (-prismatica) with intermingled hyphae, subhymenium poorly developed.

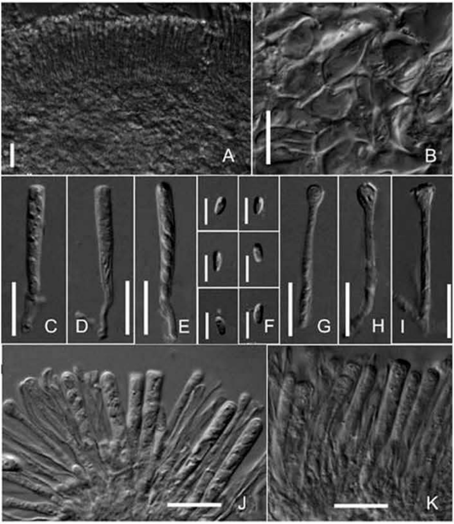


Fig. 1. *Orbilia orientalis* (YMFT 1. 01829) A. Hymenium B. Cells of ectal excipulum. C-E. Dead asci. F. Living ascospores with globose SBs. G-I. Dead paraphyses. J-K. Cluster of dead asci and paraphyses with living spores. Scale bar: A-E, G-K = 10 μm, F = 5 μm.

Asci 29.5-38 × 3.2-4(-4.5) μm (living state, France), 8-spored, lower (2-) 3-5(-6) spores inversely oriented (with spore body towards ascus base), cylindric, rounded or truncate at the apex (depending on side of view), tapered and often forked at the base (L, h- or H-shaped). Ascospores hyaline, non-septate, cylindric-ellipsoid, sometimes slightly tapered at lower end, 3.1-3.9×1.6-1.8 μm (living state, France: 2.7-3.7 × 1.3-1.6(-1.8) μm), with a refractive rod-shaped spore body (SB) at upper end in living mature ascospores, 1.2-1.4 × 0.3-0.5 μm in diam. (France: SB rod-shaped, attached to apex by a very fine

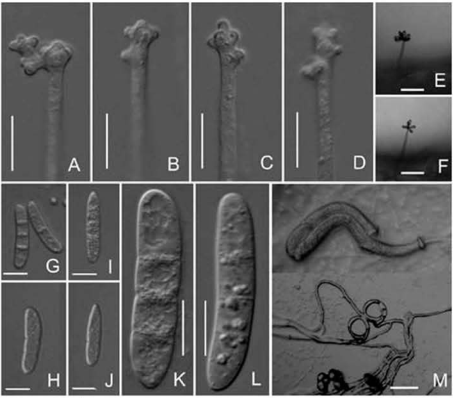


Fig. 2. *Drechslerella brochopaga* (YMF 1.01829) A-F. Conidiophores. G-L. Conidia. M. Constricting rings. Scale bars: A-D, G-L=10 µm; E-F, M=50 µm.

filum, total size 1.2-1.7 × 0.15-0.2(-0.3) µm, SB often situated at lateral wall of spore). Paraphyses 1.3-2.0 µm wide, enlarged to (2.3-)2.8-3.7(-4) µm in diam. at the medium to rather strongly clavate or capitate apex, terminal cell much longer than lower cells, apex covered by a rough thin layer of exudate.

Anamorph:

Drechslerella brochopaga (Drechsler) M. Scholler, Hagedorn & A. Rubner, Sydowia 51: 99, 1999 FIGURE 2

Basionym: Dactylella brochopaga Drechsler, Mycologia 29: 517, 1937

= *Dactylariopsis brochopaga* (Drechsler) Mekht., Mikol. Fitopatol. 1: 278, 1967

= *Arthrobotrys brochopaga* (Drechsler) S. Schenck, W.B. Kendr. & Pramer, Can. J. Bot. 55: 982, 1977

= *Candelabrella brochopaga* (Drechsler) Subram., Kavaka 5: 95, 1978 ("1977")

Colonies colorless, spreading on CMA, reaching 48 mm after 14 days at 25°. Vegetative hyphae hyaline, septate, 3.5-4 µm wide. Aerial mycelium sparse, hyaline, septate, branched, 2.5-4 µm wide. Conidiophores hyaline, erect, septate, mostly 380-430 µm high, 3.5-4.0 µm at the base, tapering upward to a width of 2-2.5 µm at the apex, there bearing short blunt denticles 2-10 μm in length, whereon bearing 3-10 conidia in radiating capitate arrangement, occasionally producing up to 13 conidia in more scattered, irregularly racemose arrangement. Conidia commonly cylindric-oblong, rounded at the distal end, shortly tapered at the somewhat truncate base, 20-36 × 5-7.5 μm (living state, France: (27.5-)31-39(-45) × 6.5-7(-9) μm), slightly to medium curved especially near distal end (straight in front view), with (1-)3 septa, predominantly 3-septate, then terminal cells often exceeding the length of the middle cells by a third or even a half (not so distinctly longer in French material). Many constricting rings with an outer diam. of 30-40 μm were observed on the CMA plates challenged with nematodes.

Discussion

Orbilia orientalis was described by Raitviir (1991) in the genus *Hyalinia* Boud., based on the presence of long glassy processes at the apothecial margin (described as "solid glassy hairs 40-60 × 3-5 μm"). Baral (1994) has shown that such hair characters frequently vary among closely related taxa or even within a species, and therefore have little taxonomic value at generic level. Hence, *Hyalinia* is here treated as a synonym of *Orbilia*.

O. orientalis is known to us from a few records from Europe and Asia. In our collections, the ascospores are more obtuse and the paraphyses more capitate than described in the protologue (spores pointed and paraphyses only slightly clavate). However, in a restudy of the holotype specimen (TAA) by one of us (H.B.) it was found that the ascospores were actually obtuse and the paraphyses distinctly capitate. We are therefore convinced that our collections from China and Europe are conspecific with the type collection from the Far East of Russia (region of Ussur, Primorsk, north of Vladivostok).

In the collection from China, the glassy processes were very short or perhaps even absent, the apothecial margin therefore smooth. Since the other characters including the anamorph were found to be very similar among our specimens, we conclude that the presence versus absence of such processes has little taxonomic value at species level in *O. orientalis*.

Orbilia orientalis is very close to ***Orbilia tenebricosa*** (Svrček) Baral **comb. nov.** (Basionym: *Patinella tenebricosa* Svrček, Česká Mykol. 31: 135, 1977), from which it differs in distinctly shorter and partly thicker ascospores, also in the absence of apothecial pigmentation. For *O. tenebricosa* (sub *Patinella*) Pfister (1997) reported *Drechslerella polybrocha* (Drechsler) M. Scholler et al. as anamorph. This was the first report of an anamorph with constricting rings in the *Orbiliaceae*. The present paper is the second report of such an anamorph-teleomorph connection.

Acknowledgements

We are very grateful to Prof. X.Z. Liu and Prof. Brian Spooner for critically reviewing the manuscript and providing precious suggestions on this paper. This work was funded by projects from the Department of Science and Technology of Yunnan Province (approved no. 2005NG05) and Ministry of Science and Technology of PR China (2003CB415102).

Literature Cited

Alexopoulos CJ, Mims CW, Blackwell M. 1996. Introductory Mycology. Fourth Edition. New York: John Wiley and Sons, Inc: 355.

Baral HO. 1994. Comments on "Outline of the ascomycetes – 1993". Systema Ascomycetum 13:113-128.

Baral HO, Marson G, Weber E. (in prep.). Monograph of Orbiliomycetes.

Haines JH, Egger, KN 1982. A new species of *Orbilia* from Canada. Mycotaxon 16: 107-113.

Hagedorn G, Scholler M. 1999. A reevaluation of predatory orbiliaceous fungi. I. Phylogenetic analysis using rDNA sequence data. Sydowia 51: 27-48.

Li Y, Hyde KD, Jeewon R, Cai L, Vijaykrishna D, Zhang KQ. 2006. Phylogenetics and evolution of nematode-trapping fungi estimated from nuclear & protein coding genes. Mycologia 97: 1034-1046.

Lin B, Liu XZ, Zhang WY. 2005a. *Orbilia querci* sp. nov. and its knob-forming nematophagous anamorph. FEMS Microbiol. Lett. 245: 99-105.

Liu B, Liu XZ, Zhang WY. 2005b. A new species of *Hyalorbilia* and its anamorph from China. Nova Hedwigia 81: 145-155.

Mo MH, Zhou W, Huang Y, Yu ZF, Zhang KQ. 2005a. A new species of *Dactylella* and its teleomorph. Mycotaxon 91: 185-192.

Mo MH, Huang XW, Zhou W, Huang Y, Hao YE, Zhang KQ. 2005b. *Arthrobotrys yunnanensis* sp. nov., the fourth ananmorph of *Orbilia auricolor*. Fungal Diversity 18: 107-115

Pfister DH. 1994. *Orbilia fimicola*, a nematophagous discomycetes and its *Arthrobotrys* anamorph. Mycologia 86 : 451-453.

Pfister DH. 1997. Castor, Pollux and life histories of fungi. Mycologia 89: 1-23.

Raitviir A. 1991. Order *Helotiales* Nannf. (in Russian), In: Z. M. Azbukina, Plantae non vasculares, Fungi et Bryopsida Orientis extremis Sovietici, Fungi, Tomus 2, Ascomycetes, *Erysiphales, Clavicipitales, Helotiales*. p. 254-363.

Scholler M, Hagedorn G, Rubner A. 1999. A reevaluation of predatory orbiliaceous fungi. II. A new generic concept. Sydowia 51: 89-113.

MYCOTAXON

Volume 96, pp. 169–172 *April–June 2006*

A new species of *Agyrium* from Yunnan, China

Wen-Ying Zhuang[1]* & Zhu-Liang Yang[2]

zhuangwy@sun.im.ac.cn
[1]Key Laboratory of Systematic Mycology & Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

fungi@mail.kib.ac.cn
[2]Kunming Institute of Botany, Chinese Academy of Sciences
Kunming 650204, China

Abstract — A collection of a gelatinized discomycete-like fungus associated with other fungi on decorticated wood of *Rhododendron* sp. from southwestern China is studied in detail. Morphological features indicate that it is a new species of the genus *Agyrium*. Distinctions between the Yunnan fungus and the currently accepted species of the genus, *Agyrium rufum*, are discussed.

Key words — morphology, taxonomy, *Agyrium aurantium*

Introduction

The genus *Agyrium* Fr. was established by Fries (1822), and later typified with *A. rufum* (Pers.) Fr. by Clements & Shear (1931). Thirty-two species names under the genus are currently listed in the CABI Index Fungorum website (http://www. indexfungorum. org/Names/Names.asp) and most of them are either synonyms of *A. rufum* or have been eliminated from the genus. Although two species were indicated in the Dictionary of the Fungi (Kirk et al. 2001), the genus seems to be monotypic (Ahti pers. comm., Kirk pers. comm.). Dennis (1978) provided a detailed description and illustration of *A. rufum* based on the British material.

A recent *Agyrium* collection on decorticated wood of *Rhododendron* sp. from southwestern China at a high elevation was examined and found to be distinct from the known species of *Agyrium*, and is described as a new taxon.

Methods by Zhuang (2005) were followed in this study.

Taxonomy

Agyrium aurantium **W.Y. Zhuang & Zhu L. Yang, sp. nov.** **Figs. 1–5**

> *Ab Agyrio rufo ascocarpis pulvinatis vel cupulatis, aurantiacis; ascis 4–8-sporis, 100–110 × 13–16 µm; ascosporis ellipsoideis, 14–16.8 × 8–10 µm differt.*

---

* Author for correspondence.

Etymology: The specific epithet refers to the fruitbody color of the fungus.

Apothecia circular, pulvinate with center depressed, broadly attached, strongly gelatinous, 0.3–0.7 mm diam when dry; hymenium and receptacle surface glabrous and orange when fresh, reddish brown when dry. Ectal excipulum of textura intricata, 20–40 µm thick, tissues strongly gelatinized, covered by a layer of gel; hyphae hyaline, 1.7–3.5 µm wide, walls somewhat glassy. Medullary excipulum of textura intricata, not clearly separated from ectal excipulum, distinct only at apothecial base, 40–50 µm thick. Hymenium ca 115 µm thick, not blue in iodine. Asci cylindrical-clavate, 100–110 × 13–16 µm, 4–8-spored, J– in Melzer's reagent, thick-walled, usually with an apical thickening, lateral walls 1–1.5 µm thick. Ascospores ellipsoid, 14–16.8 × 8–10 µm, sometimes with the lower end slightly narrower, occasionally subpyriform, non-septate, with a dark-stained area at one side in cotton blue lactophenol and a single, very large guttule, mostly uniseriate. Paraphyses immersed in gel, filiform, multiseptate, branched in the apical portion, 1.5–2 µm wide at apex and 1–1.5 µm below.

Holotype: CHINA. Yunnan. Lijiang County, Laojunshan, alt. 3700-3800 m, on decorticated wood of *Rhododendron* sp. associated with other fungi, 31 VII 2005, Z. L. Yang 4459, HKAS 48625; isotype HMAS 97510.

Notes: The new species is very similar to *Agyrium rufum* in gross morphology but differs obviously in the uniseriate ascospores 14–16.8 × 8–10 µm vs. 10–15 × 6–8 µm, 4–8-spored asci that are much larger 100–110 × 13–16 µm vs. 80 × 12 µm, and hymenium not reacting with iodine instead of blued by iodine as in *A. rufum* (Dennis 1978). We treat the above distinctions at the species level.

Acknowledgements

The authors would like to express their deep thanks to Dr. P. M. Kirk, Dr. T. Ahti and Dr. D.L. Hawksworth for consultations, Prof. R. P. Korf and Prof. D. L. Hawksworth for serving as pre-submission reviewers and valuable suggestions, and Ms. X. Song for making sections of fruitbodies. This work was supported by the National Natural Science Foundation of China (nos. 30230020, 30525002).

Literature cited

Clements FE, Shear CL. 1931. The Genera of Fungi. Wilson & Co. New York.

Dennis RWG. 1978. British Ascomycetes. Ed. 2. Cramer. Vaduz.

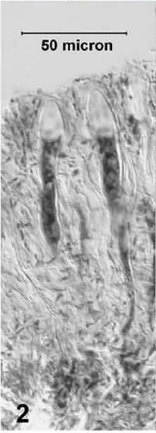
Fries E. 1822. Systema Mycologicum. Vol. 2, Sect. 1, pp. 1–274. Lundae.

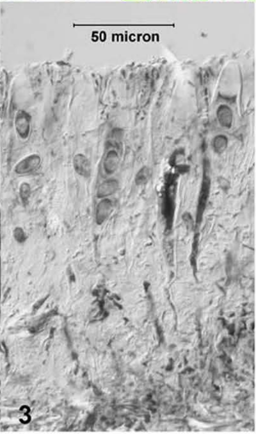
Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. CAB International. Wallingford.

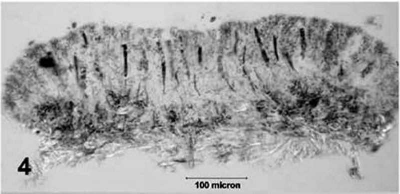
Zhuang W-Y. 2005. Re-disposition of specimens filed under *Lachnea* in HMAS. Fungal Diversity 18: 211-224.

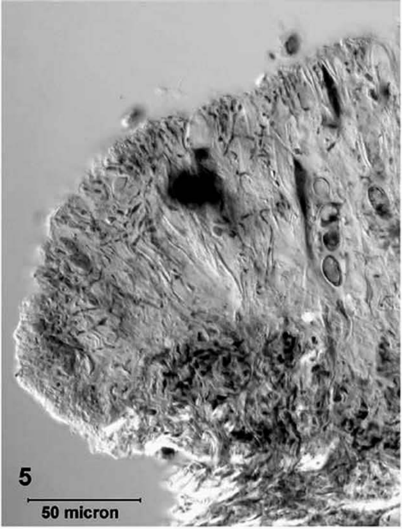
Figs. 1-5. Morphology of *Agyrium aurantium* (HMAS 97510). ***[Figs. 1–3 on facing page]:*** 1. Ascocarps associated with other fungi on nature substrate, scale bar = 10 mm. 2. Portion of hymenium showing asci with a very thick apex. 3. Portion of hymenium showing ascospores. ***[Figs. 4-5 on following page , p. 172]:*** 4. Longitudinal section of an ascocarp. 5. Structure at apothecial margin and branched paraphysis apices in gel matrix.


1


50 micron
2


50 micron
3


4
100 micron


5
50 micron

MYCOTAXON

Volume 96, pp. 173–180 April–June 2006

New species of *Kananascus* and its anamorph from Lithuania

Aušra Treigienė

ausra.t@botanika.lt
Institute of Botany, Laboratory of Mycology
Žaliųjų ežerų 49, LT-08406, Vilnius, Lithuania

Abstract—*Kananascus europaeus* sp. nov. (Sordariomycetes, *Trichosphaeriales*) and its anamorph *Koorchaloma europaea* sp. nov. were recorded on *Acorus calamus*, *Carex panicea*, *Equisetum* sp. and *Scirpus sylvaticus* in Lithuania. Both are described and illustrated.

Key words—Ascomycetes, taxonomy

Introduction

The genus *Kananascus* Nag Raj (Sordariomycetes, *Trichosphaeriales*) was established in 1984 to accommodate two species – *K. verrucisporus* Nag Raj (type species) and *K. koorchalomagnatus* Nag Raj. The genus is characterised by superficial perithecia bearing setae with swollen and often bulbous terminal cells. The anamorph genus *Koorchaloma* Subram. was described in 1953 with the type species *Koorchaloma madreeya* Subram. *Koorchaloma* is characterised by sporodochial to acervular setose conidiomata with fusiform conidia that bear mucoid appendages at both ends or only at the apex (Nag Raj 1984, 1993). Until now, nine species have been described for the genus: *Ko. bambusae* Nag Raj, *Ko. dimorpha* Matsush., *Ko. galateae* Kohlm. & Volkm.-Kohlm., *Ko. jamaicensis* Nag Raj, *Ko. madreeya* Subram., *Ko. occidentalis* Nag Raj, *Ko. okamurae* Hino & Katum., *Ko. novojournalis* Yanna et al., and *Ko. spartinicola* V.V. Sarma et al. (Hino 1961; Nag Raj 1984, 1993; Yanna et al. 1998; Kohlmeyer & Volkmann-Kohlmeyer 2001; Sarma et al. 2001; Matsushima 2003). All fungi have been reported from Asia (China – Hong Kong, India, Japan) and America (USA, Jamaica).

At the beginning of July, 2001, in eastern Lithuania (Širvintos district) abundant orange conidiomata were observed on dead leaves of *Scirpus sylvaticus*. The fungus was identified as belonging to the genus *Koorchaloma*. Approximately a month later an ascomycete belonging to the genus *Kananascus* was found in the same locality together with this coelomycete. The fungus was most abundant on *Scirpus sylvaticus*. Nearby growing *Acorus calamus* was also slightly colonized by this fungus, but only sparse conidiomata were observed on its leaves. While revisiting the same locality in September, we found neither conidiomata nor perithecia of this fungus on any plants. In 2002 we again failed to find this fungus, yet in early July 2003 the fungus was recorded in western Lithuania (Plungė district) on plants of *Carex panicea* and *Equisetum* sp.

Based on the morphological characters of ascomycetes and coelomycetes, we concluded that this material from Širvintos district refers to *Kananascus* and *Koorchaloma* respectively. Comparative morphological studies of our material with all known representatives of *Kananascus* and *Koorchaloma* revealed that fungi from Širvintos and Plungė districts do not respond to descriptions of other related fungi (Table 1, 2). Therefore, we describe these micromycetes as new species of *Kananascus* and *Koorchaloma*.

Colour of conidiomata was defined according to Kornerup & Wanscher (1978).

Descriptions

Kananascus europaeus Treigienė sp. nov. Figs. 1, 2

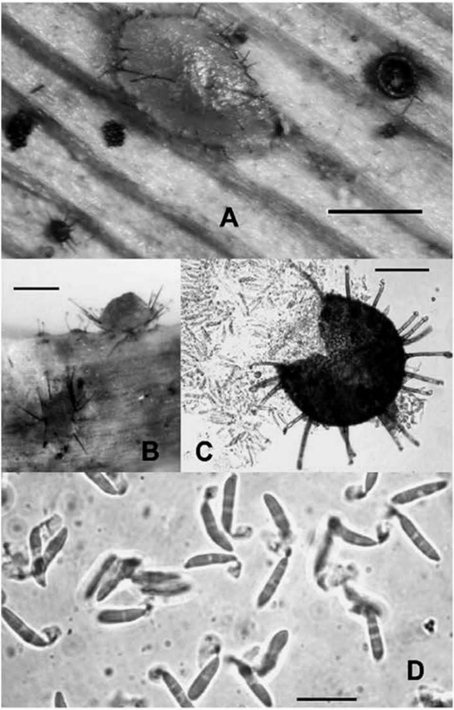
Perithecia discrete, superficialia, globosa, subglobosa vel pyriformia, diametros 90–200 µm, 150–250 µm alta, arida, collabentia, unilocularia, setosa, atrobrunnea, parvo papillatum, ostiolum circulare; canalis apicalis periphysatis; parietula 20–25 µm crassa, extrinsecus composita ex alituot stratis e cellulis pallescentibus et tenuitunicatis textura prismatica. Setae perithecii enatae circiter mediam partem parietulae, simplices, cylindreae, septatae, brunneae, ad apicem pallidiorae, leves, crassitunicatae 95–125 µm longae, 5–6 µm latae, 9–10 µm latae ad basim, cellula apicis dilatata, globosa vel subglobosa, tunica tenui, subhyalina vel hyalina, ut videtur mucosa, usque 7.5 µm lata, interdum percurrenter crescens. Asci fusiformi, 60–75 × 8–8.5 µm. Paraphyses nullae. Ascosporae anguste fusiformae, paulum sinuatae, basibus paulum extenuatis et rotundatis, 1-septatae, hyalinae, leves, crasse guttulatae, 21.5–25 × 2.5–3 µm.

HOLOTYPE—**LITHUANIA. ŠIRVINTOS DISTRICT, Petriškės village** (54°53'N, 25°07'E), on dead leaves of *Scirpus sylvaticus* L. collected 10.VII.2001, A. Treigienė (HOLOTYPE-BILAS 26107, ISOTYPE-LE 212486) (together with *Koorchaloma europaea*).

Etymology: first species of the genus recorded from Europe.

Perithecia discrete, superficial, globose, subglobose or pyriform, 90–200 µm diam., 150–250 µm high, collapsing when dry, unilocular, setose, brownish black, with small papilla, ostiole circular; apical canal periphysate; wall 20–25 µm thick, composed externally of few layers of textura angularis with brown, thick-walled cells and internally of textura prismatica with lighter coloured, thin-walled cells; perithecial setae arising all around the perithecial wall in the median part, simple, cylindrical, septate, dark brown, smooth, thick-walled, 95–125 µm long, 5–6 µm wide, 9–10 µm wide at the base, apex cell enlarged, globose to subglobose, thin-walled, subhyaline to hyaline, appearing mucoid, up to 7.5 µm wide, occasionally with percurrent growth. Asci clavate, 60–75 × 8–8.5 µm. Paraphyses absent. Ascospores narrow fusiform, slightly bent, ends rounded and slightly narrowing, 1-septate, hyaline, smooth-walled, guttulate, 21.5–25 × 2.5–3 µm.

Fig. 1. *Kananascus europaeus* (holotype in BILAS 26107). A. Association of teleomorph (at the upper right and the lover corner) and anamorph (in the centre; bar=400 µm); B. Conidiomata (bar=100 µm); C. Ruptured perithecium and asci (bar=50 µm); D. Conidia (bar=15 µm).


A
B
C
D

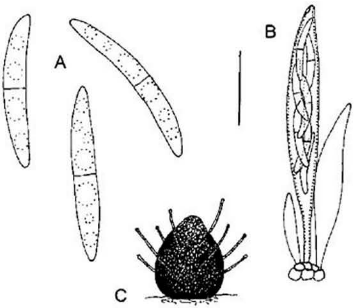


Fig. 2. *Kananascus europaeum* (holotype in BILAS 26107): A. Ascospores (bar=10 µm), B. asci (bar=40 µm), C. perithecium (bar=200 µm).

Table 1. A comparison of morphological characters of *Kananascus europaeus, K. verrucisporus* and *K. koorchalomagnatus*

	K. verrucisporus	*K. europaeus*	*K. koorchalomagnatus*
Perithecia			
Diam. (µm)	250–300	90–200	160–300
High (µm)	290–320	150–250	180–300
Wall thickness (µm)	20–30	20–25	20–25
Ascus size (µm)	40–65 × 5–10	60–75 × 8–8.5	(40)52–71 × 7–10
Ascospores			
Size (µm)	16–27 × 3–4	21.5–25 × 2.5–3	18–25 × 3.5–4.5
Shape	Fusiform	Narrow fusiform	Fusiform

Koorchaloma europaea Treigienė sp. nov. Figs. 1, 3

Mycelium superficiale vel in substrato immersum, ramosum, septatum, hyalinum, circa 1.5–2.5 µm latum. Conidiomata stromatica, discreta, dispersa, superficialia, parum crocata, gelatinosa, diameteros 100–1100 µm, 95–250 µm alta. Stromata tenue, album. Setae dispositae circum marginem conidiomatis, sterilae, solitariae, non-ramosae, plerumque erectae, leves, crassitunicatae, septatae, brunneae, apex pallidior et tenui tunica, rondosus sive tumidosus usque 10 µm latus interdum percurrenter crescens; nonnulli apices cum vagina muscilagina diam. circa 15 µm. Setae conidiomatis multiseptatae, circa 105–520 µm longae, 5–7.5 µm latae, ad basim 7.5–15 µm latae. Setae substratae tantum 2–4 septatae, plerumque breves, nonnullae usque 72 µm latae. Conidiophora macronematosa, in sporodochialibus composita, erecta, ramosa ad basim, tenuitunicata, levia, hyalina, usque 40 µm longae et 2.5 µm latae, interdum reducata ad cellulae conidiogenae. Cellulae conidiogenae monoblasticae, discretae, terminales, subcylindricae, saepe in apice tumidosae, cum parvo collario, leves, hyalinae, 15–35 × 1.8–3 µm. Conidia unicellulata, naviculata, rarius anguste fusiformia, in apice erecta sive paulum sinuata, hyalina, guttulatae, 10–17.5 × 2–2.5 µm, in apice cum adimento choanaformio gelatinosa, basi truncata.

HOLOTYPE—LITHUANIA. Širvintos district, Petriškės village (54°53'N, 25°07'E), on dead leaves of *Scirpus sylvaticus* L. collected 10.VII.2001, A. Treigienė (HOLOTYPE-BILAS 26107, ISOTYPE-LE 212486) (together with *Kananascus* europaeus).

Mycelium superficial or immersed in the substratum, composed of branched, septate, smooth, hyaline hyphae, 1.5–2.5 µm wide. Conidiomata stromatic, scattered, superficial, light orange, gelatinous, 100–1100 diam., 95–250 µm high. Stromata thin, white. Setae situated along the edges of conidiomata and dispersed on substrate (scattered or in short rows), sterile, unbranched, erect or variously bent, smooth, thick-walled, septate, brown, paler towards the apex, apex thin-walled, rounded or swollen up to 10 µm wide with occasional percurrent growth; some apices with yellow, up to 15 µm diam. gelatinous sheaths. Conidiomatal setae multiseptate, up to 105–520 µm long, 5–7.5 µm wide, swollen at the base which is 7.5–15 µm wide. Setae which are visible on the surface of substrate are developing on hyphae which are expanding in plant tissue from stroma in all directions around; they are 2-4-septate, up to 72 µm long. Conidiophores macronematous, compacted in the sporodochium, erect, branched at the base, thin-walled, smooth, hyaline, up to 40 µm long and up to 2.5 µm wide, some reduced to conidiogenous cells. Conidiogenous cells monoblastic, discrete, subcylindrical, often somewhat swollen at the apex, with flared collarettes, smooth, hyaline, 15–35 × 1.8–3 µm. Conidia 10–17.5 × 2–2.5 µm, unicellular, guttulate, naviculate, rarely narrow fusiform, apex straight or slightly bent, bearing a funnel-shaped, mucoid, apical appendage, base truncate.

OTHER SPECIMENS EXAMINED—On dead leaves of *Scirpus sylvaticus*, LITHUANIA, **Širvintos district**, Petriškės village (54°53'N, 25°07'E), 7.VII.2001, A. Treigienė, BILAS 26108; on dead leaves of *Acorus calamus* L., LITHUANIA, **Širvintos district**, Petriškės village (54°53'N, 25°07'E), 15.VIII.2001, A. Treigienė, BILAS 26109; on dead leaves of *Carex panicea* L., LITHUANIA, **Plungė district**, environs of Plateliai (56°02'N, 21°46'E), 2.VII.2003, A. Treigienė, BILAS 26963; on dead stem of *Equisetum* sp., LITHUANIA, **Plungė district**, environs of Plateliai (56°02'N, 21°46'E), 2.VII.2003, A. Treigienė, BILAS 26964.

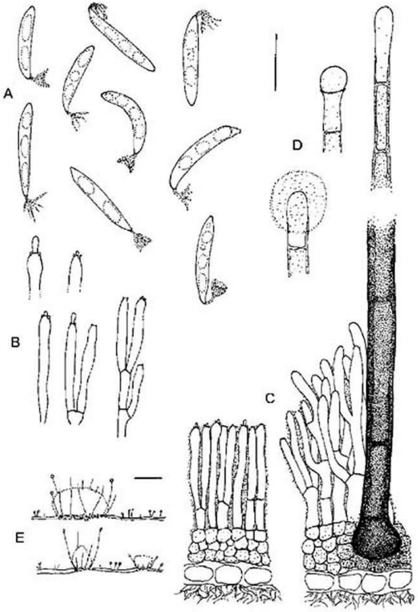


Fig. 3. *Koorchaloma europaea* (holotype BILAS 26107): A. Conidia and B. conidiophores (bar=10 µm); C. basal stroma, excipular elements and setae. D. apical cells of setae (one with an oil drop) (bar=20 µm); E. habit sketch showing approximate conidiomata and setae (bar=100 µm).

Comments––*Kananascus europaeus* differs from the known *K. koorchalomagnatus* (anamorph – *Koorchaloma madreeya*) and *K. verrucisporus* (anamorph – *Koorchaloma jamaicensis*) by ascospore shape and size. The synopsis of characteristics of these three similar species of *Kananascus* is given in Table 1. According to morphological characters, Lithuanian specimens of *Koorchaloma europaea* occupy an intermediate position between *Ko. jamaicensis* and *Ko. madreeya*. Naviculate conidia of *Ko. europaea* are similar to these of *Ko. jamaicensis* but conidia of the latter species bear mucoid appendages at both ends (at one end in *Ko. europaea*). Moreover, conidiophores of *Ko. jamaicensis* are reduced to conidiogenous cells. The new species is closest to *Ko. madreeya* in the structure of conidiomata, but mainly differs by the form of conidia (Table 2).

Table 2. A comparison of morphological characters of *Koorchaloma europaea, Ko. jamaicensis* and *Ko. madreeya*

	Ko. jamaicensis	*Ko. europaea*	*Ko. madreeya*
Conidiomata			
Diam. (µm)	120–320	100–1100	200–600
Colour	Salmon to flesh	Light orange	Salmon to orange
Setae			
Length (µm)	80–170	105–520	100–350
Width at base (µm)	13–15	7.5–15	8–12
Width at apex (µm)	3–7	5–10	4–6
Swollen at apex	–	+/–	+
Size of conidiogenous cells (µm)	6–11(12) × 2.5–3	15–35 × 1.8–3	11–20 × 3–4
Conidiophores reduced to conidiogenous cells	+	+/–	–
Conidia			
Size	12–19 × 2.5–3.5	10–17.5 × 2–2.5	11–17 × 3–4.5
Shape	Naviculate, fusiform	Naviculate, narrow fusiform	Fusiform
Appendages			
apical	+	+	+
basal	+	–	–

Acknowledgments

I am grateful to Dr. Vadim A. Mel'nik (Komarov Botanical Institute, Russia) and Dr. Ernestas Kutorga (Vilnius University, Lithuania) for comments, discussion during manuscript preparation and language correction and Dr. D. Staškevičienė for correcting the Latin diagnosis.

Literature cited

Hino I. 1961. Icones fungorum bambusicolorum Japonicorum. The Fuji Bamboo Garden town, Kobe, Japan. 335 p.

Kohlmeyer J, Volkmann-Kohlmeyer B. 2001. Fungi on *Juncus roemerianus*. 16. More new coelomycetes, including *Tetranacriella*, gen. nov. Botanica Marina 44: 147-156.

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. London. 252 pp.

Matsushima T. 2003. Matsushima Mycological Memoirs. No 10. Published by the author, Kobe, Japan. 214 p.

Nag Raj TR. 1984. *Koorchaloma*, *Koorchalomella* and *Kananascus* gen. nov. Mycotaxon 19: 167-212.

Nag Raj TR. 1993. Coelomycetous anamorphs with appendage-bearing conidia. University of Waterloo, Ontario. 1101 p.

Sarma VV, Newell SY, Hyde KD. 2001. *Koorchaloma spartinicola* sp. nov., a new marine sporodochial fungus from *Spartina alterniflora*. Botanica Marina 44: 321-326.

Subramanian CV. 1953. A new genus of the *Tuberculariaceae*. J. Ind. Bot. Soc. 32(3): 123-126.

Yanna, Hyde KD, Goh TK. 1998. *Koorchaloma novojournalis* sp. nov., a new sporodochial fungus from Hong Kong. Fungal Diversity 1: 193-197.

MYCOTAXON

Volume 96, pp. 181–191 April–June 2006

The genus *Chlorophyllum* (Basidiomycetes) in China

Z. W. Ge[1,2] & Zhu L. Yang[1,*]

zwge@mail.kib.ac.cn fungi@mail.kib.ac.cn

[1] *Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany*
Chinese Academy of Sciences, Heilongtan, Kunming 650204, Yunnan, P. R. China

[2] *Graduate School of the Chinese Academy of Sciences*
Beijing 100039, P. R. China

Abstract—Species of the genus *Chlorophyllum* (*Agaricaceae*) in China are described and illustrated with line drawings. Among them, *C. sphaerosporum* is new to science, and *C. hortense* is new to China. A key to the *Chlorophyllum* species in China is also provided.

Key words—*Agaricales*, new taxon, new record, taxonomy, distribution

Introduction

The genus *Chlorophyllum* Massee (*Agaricaceae, Agaricales*, Basidiomycetes) in its amended sense is characterized by a hymenidermal pileus covering, a smooth stipe, and basidiospores without a germ pore or with a germ pore but just caused by a depression in the episporium. A hyaline covering on the germ pore is absent. The basidiospores may be white, green, brownish or brown in deposit, and the habit varies from agaricoid to secotioid (Vellinga 2001, 2002, 2003a, b; Vellinga & de Kok 2002; Vellinga et al. 2003). During our survey of the lepiotoid fungi in China, several species were identified, and one new species of the genus was encountered and thus described below. Differences between similar species are provided and discussed.

Material and methods

All material examined collected in China, and deposited in three Herbaria. Herbarium codes used follow Holmgren et al. (1990) with one exception: HKAS = Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences, which is not listed in the index or relevant publications. The descriptions of species will appear in alphabetical order by species epithet. In the description, macro-morphology is based on the field notes and color slides of the material; micro-morphology is based on observation of the material under microscope. In the descriptions of basidiospores, the abbreviation [*n*/*m*/*p*] shall mean *n* basidiospores measured from *m* fruit bodies of *p* collections in 5% KOH solution; *Q* is used to mean "length/width ratio" of a spore in

---

[*] Corresponding author

side view; **Q** means average *Q* of all basidiospores ± sample standard deviation; *x* means range of basidiospore length × width.

Taxonomy

1. ***Chlorophyllum agaricoides*** (Czern.) Vellinga, Mycotaxon 83: 416, 2002 FIGURE 1

Endoptychum agaricoides Czern., Bull. Soc. Imp. nat. Moscou 18 (2): 148, 1845; *Secotium agaricoides* (Czern.) Hollós, Természetrajzi Füzetek 25: 93, 1902.

Fruit bodies (Fig. 1a) secotioid, 5-8 cm high, 3-7 cm across, cordate to obtusely conical, usually broader toward base; margin appressed to the stipe, usually lacerated when mature. **Peridium** 1-3 mm thick, fleshy and tender when young, becoming rather tough and fibrous upon drying; surface white, becoming straw colored on maturing and drying, covered with brownish to brown squamules. **Gleba** white when young, becoming yellow and finally brown; gleba chambers somewhat labyrinthiform, varying in width, up to 1 mm; tramal plates persisting in the mature and dried specimens, forming lamella-like folds; columella present, white, becoming reddish when bruised. **Stipe** short, 1-2 × 0.8-1.5 cm, sub-conical, tapering downward into a thick cord, whitish, becoming yellowish on maturing.

Basidia 7-11.5 µm in diam., clavate, 4-spored. **Basidiospores** (Fig. 1b) [45/3/3] 7.5-8.5 (9.5) × 6.0-7.0 (8.0) µm (x = 8.3 ± 0.41 × 7.0 ± 0.31 µm), Q = 1.13-1.21 (1.25) (**Q** = 1.18 ± 0.04), orthotropic, statismosporic, subglobose to broadly ellipsoid, rarely ovoid, yellowish brown to greenish brown, smooth, thick-walled, but becoming thinner towards the apex which is often slightly depressed; hilar appendix small but usually attached to a thin-walled sterigmal appendage; young basidiospores dextrinoid, metachromatic in cresyl blue, becoming reddish in Congo Red. Clamps not observed in all tissues.

Habitat and known distribution in China: Solitary; scattered, or in groups on lawns and pastures, sometimes also on the ground in forest. Terrestrial; distributed in Inner Mongolia.

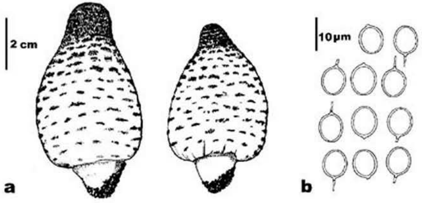


Fig. 1. *Chlorophyllum agaricoides* (HKAS 4408).
a. Fruit bodies. **b.** Basidiospores.

Material examined: China, Inner Mongolia, 15 Sept. 1978, Z. Y. Li & J. Z. Li 1465 (HKAS4408); Baotou City, 3 Aug. 1988, P. G. Liu 307 (HKAS 21432), alt. 1630 m; 31 Aug. 1988, P. G. Liu 260 (HKAS 21430a), P. G. Liu 571 (HKAS 21431), alt. 2100 m; Wumeng county, 2 Aug. 1990, P. G. Liu 627 (HKAS 23034), alt. 1590 m.

Note: *Chlorophyllum agaricoides* is characterized by its secotioid habit, labyrinthiform to sublamellate gleba, and yellowish brown to greenish brown, statismosporic, orthotropic, subglobose to broadly ellipsoid basidiospores with a slightly depressed apex. It has been formerly recorded as *Endoptychum agaricoides* from Inner Mongolia and Hebei Province of China by Liu (1984, 2005).

2. *Chlorophyllum hortense* (Murrill) Vellinga, Mycotaxon 83: 416, 2002 FIGURE 2

Lepiota hortensis Murrill, N. Amer. Fl. 10 (1): 59, 1914; *Leucoagaricus hortensis* (Murrill) Pegler, Kew Bull. Add. Ser. 9: 414, 1983.

Fruit bodies (Fig. 2a) agaricoid, small to medium. **Pileus** 4-7 cm in diam., convex, distinctly umbonate, white to cream-colored, covered with small patches of pale ochreous to yellowish brown squamules, margin of pileus finely short striate when dried. **Lamellae** free, crowded, whitish, becoming dirty white to pale ochreous, but never becoming darker when dried. **Stipe** 6-8 × 0.5-1 cm, subcylindrical, fibrillose, white to whitish, base not enlarged. **Annulus** present, persistent. **Context** white, becoming reddish when cut.

Basidia (Fig. 2e) 20-30 (32) × 7.5- 8.5(10.0) µm, clavate to narrowly clavate, hyaline, mostly 2-spored, occasionally 4-spored; sterigmata 3-5 µm long; clamps not observed on basal septa. **Basidiospores** (Fig. 2c) [85/5/2] (8.0) 8.5-10.0 (11.5) × (5.5) 6.0-7.0 (8.0) µm ($x = 9.0 \pm 0.61 \times 6.4 \pm 0.43$ µm), $Q = (1.23)\ 1.31\text{-}1.50\ (1.57)$ ($\mathbf{Q} = 1.42 \pm 0.06$), ellipsoid, sometimes broadly ellipsoid, thick walled, smooth, without germ pore, dextrinoid, metachromatic in cresyl blue, not or becoming reddish in Congo Red. **Pleurocystidia** absent. **Cheilocystidia** (Fig. 2d) (23) 30-40 (50) × (6) 8-10 (12) µm, crowded, forming a sterile edge, narrowly clavate to subcylindrical often with a round apex 6-8 µm, thin-walled, often with yellowish to brownish vacuolar pigments. **Pileipellis** (pileal squamules) (Fig. 2b) a hymeniderm made up of broadly clavate, sometimes subfusiform, colorless or nearly colorless, slightly thick walled (≤0.5 µm) terminal elements. **Stipitipellis** hardly differentiated, without caulocystidia, composed of filamentous hyphae with many anastomosing structures.

Habitat and known distribution in China: Solitary; Terrestrial; distributed in Guangdong and Yunnan Provinces. New to China.

Material examined: China, Guangdong Prov., Lianshan, 11 Sept. 1985, G. Y. Zheng 9175 (GDGM 9175, as *Chamaeota dextrinoidespora* by Bi & Li 1988), alt. 700-800 m. Yunnan Prov., Kunming, 21 Sept. 1991, Z. L. Yang 1709 (HKAS 23623), alt. 1900 m.

Note: The characters of the collections cited above agree well with the original and related descriptions (e.g. Akers & Sundberg 1997; Pegler 1983; Vellinga 2003a). Clamps in the Chinese collections were not observed, while Vellinga (2003a) stated that *C. hortense* is provided with clamps, and Akers & Sundberg (1997) found the clamps in the stipitipellis. Our observations show that there are many anastomosing structures on the hyphae of stipitipellis, which may be misinterpreted as clamps when they are on or near septa.

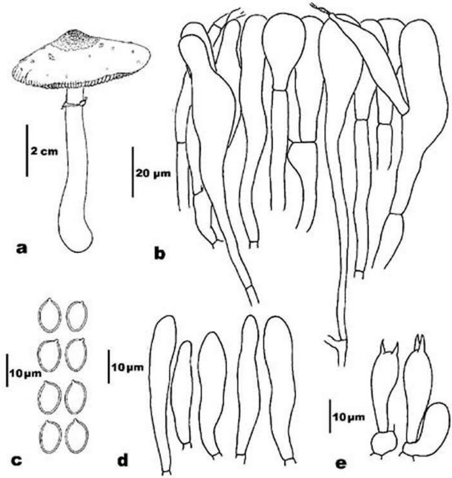


Fig. 2. *Chlorophyllum hortense* (GDGM 9175).
a. Fruit bodies. **b.** Pileipellis (squamules on pileus).
c. Basidiospores. **d.** Cheilocystidia. **e.** Basidia.

GDGM 9175 was previously regarded as *Chamaeota dextrinoidespora* Z.S. Bi (Bi & Li 1988). Reexamination of the type of *C. dextrinoidespora* shows that it bears basidiospores [(8.0) 8.5-11.5 (12) × (6.0) 6.5-8.5 µm] with a distinct germ pore, clavate to fusiform cheilocystidia (11-18 µm in diam.) often with a papilla or rostrate apical appendages; and a trichodermial pileipellis of narrowly clavate to subfusiform, sometimes lanceolate cells (13-20 µm in diam.) often with a rostrate apical appendage (data of authors unpublished).

3. *Chlorophyllum molybdites* (G. Mey.: Fr.) Massee, Kew Bull. 1898: 136, 1898

FIGURE 3

Agaricus molybdites G. Mey., Pr. Fl. Essequ.: 300, 1818: Fr., Syst. Mycol. 1: 308, 1821; *Mastocephalus molybdites* (G. Mey.: Fr.) Kuntze, Rev. Gen. Pl. 2: 860, 1891; *Lepiota molybdites* (G. Mey.: Fr.) Sacc., Syll. Fung. 5: 30, 1887; *Leucocoprinus molybdites* (G. Mey.: Fr.) Pat., Bull. Soc. Mycol. Fr. 29: 215, 1913; *Macrolepiota molybdites* (G. Mey.: Fr.) G. Moreno, Bañares & Heykoop, Mycotaxon 55: 467, 1995.

Fruit bodies (Fig. 3a) agaricoid, medium to large. **Pileus** 8-17 cm in width, nearly hemispherical when young, becoming convex to plano-convex with age, sometimes with a low umbo at disc, white to whitish, covered with brown squamules; disc smooth, brown. **Lamellae** free, crowded, whitish when young, then greenish to green when mature, bluish green to grayish green when dried. **Stipe** whitish, subcylindrical, 18 × 0.8-1.2 (1.5) cm, widening downwards, base enlarged. **Annulus** well developed, ascending, double crowned, upper surface whitish, lower surface brownish. **Context** whitish, becoming reddish brown when cut.

Basidiospores (Fig. 3c) [40/2/2] (8.5) 9.0-10.0 (10.5) × 6.5-8.0 µm ($x = 9.54 \pm 0.44 \times 7.18 \pm 0.37$ µm), $Q = (1.25)\ 1.27\text{-}1.43$ ($\mathbf{Q} = 1.33 \pm 0.06$), broadly amygdaliform, thick-walled, smooth, light olive-green, dextrinoid, with a germ pore caused by a depression in the episporium on the truncate apex. **Basidia** (Fig. 3c) 27-36 × (9.5) 11-14 (16) µm, clavate, hyaline, 4-spored; sterigmata 3-4.5 µm long. **Pleurocystidia** absent. **Cheilocystidia** (Fig. 3d) numerous, broadly clavate to sphaeropedunculate, 21-40 × (9) 13-21 µm, with brownish vacuolar pigment. **Pileipellis** (Fig. 3b) a palisade of hyphae with terminal elements clavate to subfusiform, 8-16 µm in diam., with brown to dark brown vacuolar pigment.

Habitat and known distribution in China: Terrestrial to saprotrophic; scattered to gregarious on the ground in broadleaf forest. Distributed in Guangdong, Hainan, Hunan, Sichuan and Yunnan.

Material examined: China, Guangdong Prov., Renhua, 1 Aug. 1985, A. H. Huang & G. Y. Zheng 9131 (GDGM 9131, as *Macrolepiota rachodes* by Bi et al. 1990, 1994); Baoting, 20 May 1988, T. H. Li 13868 (GDGM 13868, as *Macrolepiota rachodes* by Bi et al. 1997). Hainan Prov., Haikou, 20 Aug. 1994, X. L. Wu 7 (HKAS 29348); Qiongshang, 2 Jun. 1988, GDGM 14911 (as *Macrolepiota rachodes* by Bi et al. 1997). Hunan Prov., Hengyang, 21 Jun. 2004, Z. H. Chen 30237 (HKAS 45051). Sichuan Prov., Xichang, 30 Jun. 1978, L. W. Xu 8 (HMAS 42516, as *Lepiota rachodes* by Ying et al. 1994), E 102.16, N 27.54. Yunnan Prov., Yuanmou, 4 July 2005, L. S. Wang 05-24866 (HKAS 49418).

Note: The Chinese specimens match closely with other descriptions of *C. molybdites* (e.g. Reid & Eicker 1991, Vellinga 2001). This species, often causing gastro-intestinal problems (e.g. Reid & Eicker 1991), was previously misidentified as *Macrolepiota rachodes* in some Chinese mycological literature (e.g. Bi et al. 1990, 1994, 1997). But the bluish green lamellae, the well developed complex annulus, the whitish context becoming reddish brown when cut, the greenish, broadly amygdaliform basidiospores with a truncate apex, and the broadly clavate to sphaero-pedunculate cheilocystidia clearly characterize the species.

Chlorolepiota mahabaleshwarensis Sathe & S.D. Deshp. is similar to *C. molybdites* on account of the greenish basidiospores. However, the basidiospores of the former are not

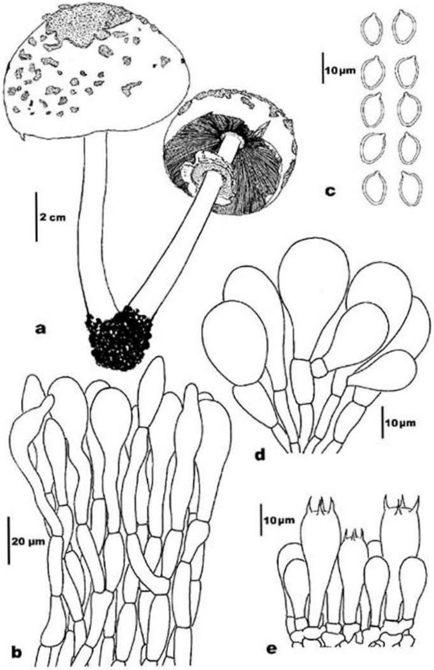


Fig. 3. *Chlorophyllum molybdites* (HKAS 45051).
a. Fruit bodies. b. Pileipellis. c. Basidiospores. d. Cheilocystidia. e. Basidia..

truncated, and bear a rudimentary germ pore with a poral plug (Sathe & Deshpande 1979).

4. *Chlorophyllum sphaerosporum* Z. W. Ge & Zhu L. Yang, sp. nov. FIGURE 4

> *Pileus 4.5-6.5 cm latus, convexus, albus vel albidus, squamulis luteo-brunneis vel rubeolis brunneis, obtusus umbonatus. Lamellae liberae, albae. Stipes 4.0-7.0 × 0.5-0.7 cm, subcylindricus, subeaqualis vel sursum attenuatus, albidus, non-discolorans, basis incrassatus. Annulus membranaceus, albidus. Caro alba. Basidia 24-32 × 9.5-12.5 µm, clavata, hyalina, 4-sporigera. Basidiosporae (8.0) 9.0-10.0 (11.0) × 7.0-9.0 (9.5) µm, subglobosae vel lato-ellipsoideae, hyalinae, aporae, dextrinoideae, congophilosae, metachromaticae. Pleurocystidia absentia. Cheilocystidia clavata vel latoclavata, hyalina, (18) 25-32 (40) × (9) 11-13.5 µm. Squamulae pilei hymenidermae, apicalis hyphis pallide brunneis clavatis. Fibulae praesentes. Habitatio: terrestris.*
>
> *Holotypus: "Mao Xiao-Lan M8040 (HMAS 66153), 15 August 1994, Inner Mongolia, China".*
>
> *Etymology:* the epithet refers to the shape of the basidiospores.

Fruit bodies (Fig. 3a) agaricoid, small to moderate. **Pileus** 4.5-6.5 cm in diam., convex, with a low umbo at the disc; surface white to whitish, covered with yellow brown to reddish brown squamules, continuous on disc, elsewhere disrupted; margin with faint short striations. **Lamellae** free, crowded, white, off-white to cream when dried. **Stipe** central, 4.0-7.0 × 0.5-0.7 cm, subcylindrical, slightly attenuate upward, surface whitish, not changing color when bruised, enlarged at the base. **Annulus** membranous, whitish, movable, compound. **Context** white, unchanging; taste mild.

Basidia (Fig. 4e) 24-32 × 9.5-12.5 µm, clavate, hyaline, thin-walled, 4-spored, occasionally 2-spored; sterigmata up to 4.5 µm long. **Basidiospores** (Fig. 4c) [105/6/2] (8.0) 9.0-10.0 (11.0) × 7.0-9.0 (9.5) µm ($x = 9.1 \pm 0.50 \times 8.0 \pm 0.51$ µm), $Q = (1.00)\ 1.12\text{-}1.21$ ($\boldsymbol{Q} = 1.14 \pm 0.04$), subglobose, sometimes broadly ellipsoid, smooth, hyaline, thick-walled (about 0.5 µm thick), without germ pore, dextrinoid, congophilous, metachromatic in cresyl blue; apiculus 1-1.5 µm long. **Pleurocystidia** absent. **Cheilocystidia** (Fig. 4d) (18) 25-32 (40) × (9) 11-13.5 µm, clavate to broadly clavate, hyaline to very pale yellowish, thin-walled. **Lamellar trama** subregular to irregular, composed of colorless hyphae (2.5) 5-10 (12) µm in width. **Pileipellis** (Fig. 4b) a hymenidermal layer composed of brownish, slightly thick-walled, clavate to broadly clavate terminal elements 38-53 (80) × 12-25 (31) µm. **Clamp connections** occasionally observed at the base of young basidia and cheilocystidia.

Habitat and known distribution: Terrestrial in forests dominated by *Keteleeria* and *Xanthoceras*, so far only known from Inner Mongolia, China.

> Additional material examined: China, Inner Mongolia, Qasuqi, 10 Aug. 1988, P. G. Liu 313b (HKAS 21185b), alt. 1200 m.

Note: *Chlorophyllum sphaerosporum* is characterized by its small, thick-walled, subglobose basidiospores without a germ pore, the unchanging context, and the hymenidermal pileipellis composed of brownish, slightly thick-walled clavate terminal elements. Based on these characters, especially the small subglobose basidiospores without a

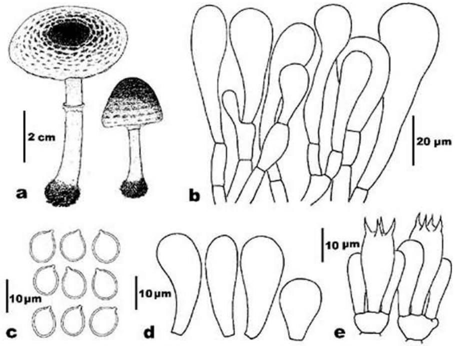


Fig. 4. *Chlorophyllum sphaerosporum* (from holotype).
a. Fruit bodies. b. Pileipellis (squamules on pileus).
c. Basidiospores. d. Cheilocystidia. e. Basidia.

germ pore, *C. sphaerosporum* can be easily keyed out in the genus *Chlorophyllum*. The present species is similar to *Chlorophyllum hortense*, in bearing basidiospores without a germ pore. However, *C. hortense* has 2-spored basidia, ellipsoid to broadly ellipsoid basidiospores, narrowly clavate to subcylindrical cheilocystidia, and the whitish context of the stipe becoming reddish when damaged (Akers & Sundberg 1997; Vellinga 2003a; see above).

Chlorophyllum sphaerosporum is also similar to *C. shimogaense* Sathe & S.M. Kulk. on account of the subglobose basidiospores. However, the latter, originally described from Shimoga, southwestern Indian, has much larger fruit bodies (pileus 8-10.5 cm in diam., stipe 13.5-15 × 0.7-7.1 cm) with a trichodermal palisade of much narrower hyphae (4.5-10.5 µm in diam.) in the pileal squamules, and possesses no clamp connections (Sathe et al. 1981). The basidiospores of *C. shimogaense* were described as having "indistinct germ pore or without germ pore". *Chlorophyllum sphaerosporum* seems to be also similar to *C. bharatense* Sathe & S.M. Kulk.. However, the latter, originally described from India, has a trichodermal palisade with much narrower terminal cells (43-108 × 11-13.5 µm) in the squamules on the pileus, and cream lamellae becoming reddish brown when dried, and no clamps. The basidiospores of *C. bharatense* were described as "without germ pore or with indistinct germ pore (Sathe et al. 1981). Type collections of the Indian species were requested twice on loan for comparison, but no response was received.

Taxon with uncertainty recorded from China

Chlorophyllum rachodes (Vittad.) Vellinga, Mycotaxon 83: 416, 2002

Agaricus rachodes Vittad., Descr. Funghi mang. Italia: 158, 1883 ('1835'); *Lepiota rachodes* (Vittad.) Quél., Mém. Soc. Émul. Montbéliard. Sér. II, 5: 70, 1872; *Leucocoprinus rachodes* (Vittad.) Pat., Ess. Tax. Hym.: 171, 1900; *Lepiotophyllum rachodes* (Vittad.) Locq., Bull. Mens. Soc. Linn. Lyon 11: 40, 1942 (as '*L. rhacodes*'); *Macrolepiota rachodes* (Vittad.) Singer, Lilloa 22: 417, 1951 ('1949').

Note: Macroscopically, *C. rachodes* is characterized by big fleshy fruit bodies, contrasting plate-like squamules on the pileus, a double-crowned annulus, and a bulbous stipe base. The stipe surface becomes orange-red first, then light brown when bruised. Microscopically, it is characterized by the ellipsoid spores with a germ pore caused by a depression in the episporium on the truncate to round apex, and the sphaeropedunculate to broadly clavate cheilocystidia (Candusso & Lanzoni 1990; Vellinga 2003b).

C. rachodes was previously recorded in China (as *Lepiota rachodes* or *Macrolepiota rachodes*) (Bi et al. 1990, 1994, 1997; Zang et al. 1996; Wang & Zang 1983; Mao, 1995; Ying & Zang 1994; Ying et al. 1994). However, according to our re-examination of the vouchers cited in the literature, some of the collections are *C. molybdites* (see above), while GDGM 11851 is *Macrolepiota procera* (Scop.: Fr.) Singer, and HKAS 5299, HMAS 30376 and 30499 are *Leucoagaricus nympharum* (Kalchbr.) Bon; HKAS 13214 is *Lepiota clypeolaria* (Bull.: Fr.) P. Kumm. HKAS 5630 consists of only one immature fruit-body, and looks like *M. procera*. HKAS 11749 can not be traced in the Herbarium. Thus, whether *C. rachodes* indeed occurs in China remains uncertain. For the convenience of use, this species is included in the following key.

Key to the *Chlorophyllum* species in China

1 Fruit bodies agaricoid, hymenophore lamellate, basidiospores heterotropic, ballistosporic, ellipsoid, subglobose to broadly amygdaliform, without sterigmal appendage 2

1 Fruit bodies secotioid, hymenophore (gleba) labyrinthiform to sub-lamellate, basidiospores orthotropic, statismosporic, broadly ellipsoid to subglobose, often with a short sterigmal appendage .... *C. agaricoides*

2 Fruit bodies small to large; lamellae white or brownish with age; spore print white or off -white, never green 3

2 Fruit bodies large; lamellae becoming greenish when mature; spore print green .... *C. molybdites*

3 Pileus and stipe discolored reddish or light brown when bruised or cut; basidiospores ellipsoid to broadly ellipsoid or broadly amygdaliform, with or without a germ pore 4

3 Pileus and stipe not changing color when bruised or cut; basidia 4-spored, basidiospores subglobose, without a germ pore .... *C. sphaerosporum*

4 Pileus with pale ochreous to yellowish brown patch-like squamules; stipe becoming reddish when bruised; annulus simple; stipe base without a bulb; basidia 2-spored, basidiospores without a germ pore, apex not truncate; cheilocystidia narrowly clavate to subcylindrical .... ***C. hortense***

4 Pileus with brown plate-like squamules; stipe becoming light brown when bruised; annulus double crowned; stipe base bulbous; basidiospores with a germ pore caused by a depression in the episporium on the truncate to round apex; cheilocystidia clavate, broadly clavate to sphaeropedunculate ...... ***C. rachodes***

Acknowledgements

The authors are very grateful to Drs. B.P. Akers and E.C. Vellinga for critically reviewing the manuscript. Thanks are also due to Dr. T. H. Li, Guangdong Institute of Microbiology (GDGM), and Dr. L. Guo, Institute of Microbiology, Chinese Academy of Sciences (HMAS) for allowing us access to the relevant specimens in their herbaria. This study was supported by China's National Fund for Distinguished Young Scholars (No. 30525002) and by the National Natural Science Foundation of China (Nos. 30270017 and 30420120049).

Literature Cited

Akers BP, Sundberg WJ. 1997. *Leucoagaricus hortensis*: some synonyms from Florida and taxonomic observations. Mycotaxon 62: 401-419.

Bi ZS, Li TH. 1988. Two new species of agarics from North Guangdong Province of China. Bull. Bot. Res. 8 (1): 97-102. (in Chinese).

Bi ZS, Li TH, Zhang WM, Song B. 1997. A preliminary agaric flora of Hainan Province. Guangzhou: Guangdong Higher Education Press. 388 pp. (in Chinese).

Bi ZS, Zheng GY, Li TH, Wang YZ. 1990. Macrofungus flora of the mountainous district of North Guangdong. Guangzhou: Guangdong Science and Technology Press. 450 pp. (in Chinese).

Bi ZS, Zheng GY, Li TH. 1994. Macrofungus flora of Guangdong Province. Guangzhou: Guangdong Science and Technology Press. 879 pp. (in Chinese).

Candusso M, Lanzoni G. 1990. *Lepiota s. l.* Fungi Europaei 4. Giovanna Biella, Saronno. 743 pp.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I: Herbaria of the World. 8th ed. New York: New York Botanical Garden. 693 pp.

Liu B. 1984. The Gasteromycetes of China. Nova Hedwigia Beih. 76: 1-235.

Liu B (ed.). 2005. Flora fungorum sinicorum. Vol. 23: *Sclerodermatales*, *Tulostomatales*, *Phallales* et *Podaxales*. Beijing: Science Press. 222 pp. (in Chinese).

Mao XL. 1995. Macrofungal flora of the Mt. Namjagbarwa Region. In Li BS (ed.) Biota of the Mt. Namjagbarwa Region. Beijing: Science Press. 118-192 (in Chinese).

Pegler DN 1983. Agaric flora of the Lesser Antilles. Kew Bull. Add. Ser. 9: 1-668.

Reid DA, Eicker A. 1991. A comprehensive account of *Chlorophyllum molybdites*. Bot. Bull. Acad. Sinica 32: 317-333.

Sathe AV, Deshpande DS. 1979. *Chlorolepiota* — A new genus of *Agaricales* (mushroom) from India. Current Science 48: 693-695.

Sathe AV, Deshpande SD, Kulkarni SM, Daniel J. 1981 ('1980'). *Agaricales* (mushrooms) of South-West India. MACS, Pune, India. Monograph No. 1. 114 pp.

Vellinga EC. 2001. *Chlorophyllum* Mass. In: Noordeloos ME, Kuyper ThW, Vellinga EC (eds.). Flora Agaricina Neerlandica. Lisse/Abingdon/Exon (PA)/Tokyo: A. A. Balkema Publishers. 169 pp.

Vellinga EC. 2002. New combinations in *Chlorophyllum*. Mycotaxon 83: 415-417.

Vellinga EC. 2003a. *Chlorophyllum* and *Macrolepiota* (*Agaricaceae*) in Australia. Austr. Syst. Bot. 16: 361-370.

Vellinga EC. 2003b. Type studies in *Agaricaceae* — *Chlorophyllum rachodes* and allies. Mycotaxon 85: 259-270.

Vellinga EC, De Kok RPJ. 2002. (1539) Proposal to conserve the name *Chlorophyllum* Massee against *Endoptychum* Czern. (*Agaricaceae*). Taxon 51: 563-564.

Vellinga EC., De Kok RPJ, Bruns TD. 2003. Phylogeny and taxonomy of *Macrolepiota* (*Agaricaceae*). Mycologia 95 (3): 442-456.

Wang YC, Zang M (eds.). 1983. Fungi of Xizang (Tibet). Beijing: Science Press. 226 pp. (in Chinese).

Ying JZ, Wen HA, Zong YC. 1994. The Economic macromycetes from western Sichuan. Beijing: Science Press. 137 pp. (in Chinese).

Ying JZ, Zang M (eds.). 1994. Economic macrofungi from southwestern China. Beijing: Science Press. 399 pp. (in Chinese).

Zang M., Li B, Xi JX. 1996. Fungi of Hengduan Mountains. Beijing: Science Press. 598 pp. (in Chinese).

MYCOTAXON

Volume 96, pp. 193–198 *April–June 2006*

Trechispora elongata species nova from North Europe

OTTO MIETTINEN[1] & KARL-HENRIK LARSSON[2]

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

[2] *Göteborg University, Botanical Institute*
P.O. Box 461, SE-40530 Göteborg, Sweden
karl-henrik.larsson@botany.gu.se

Abstract—*Trechispora elongata* (corticioid fungi, Basidiomycota) is described as new. It is reported from Finland, Norway, Poland and Sweden. Morphologically it belongs to the corticioid *Trechispora farinacea* group and is characterised by elongated spores and an anamorph.

Key words—*Corticiaceae*, taxonomy

Introduction

The genus *Trechispora* P. Karst. (Basidiomycetes) with corticioid and poroid species has received attention from several authors in the latest decades. A thorough revision was made by Liberta (1973) and more recently by Larsson (1992, 1995). Still, new species can be encountered even in the relatively well-studied area of Northern Europe. The new species described here belongs to the taxonomically difficult group of species close to *T. farinacea* (Pers. : Fr.) Liberta. The earliest specimen was first collected by John Eriksson 50 years ago and other mycologists have since collected it. After recent collections and Larsson's (1995) revision of the *T. farinacea* group, it has become possible to describe the species.

Materials and methods

The following mounting media were used when studying the specimens in the microscope: 1) Cotton Blue (CB): 0.1 g aniline blue (Merck 1275) dissolved in 60 g pure lactic acid; 2) Melzer's reagent (IKI): 1.5 g potassium iodine (KI) with 0.5 g crystalline iodine (I) and 22 g chloral hydrate dissolved in 20 ml aq. dist; 3) Potassium hydroxide (KOH): 2.5 g potassium hydroxide dissolved in 50 ml aq. dist. Cyanophilous reaction is abbreviated CB+, acyanophilous CB–, negative colour reaction in Melzer's reagent IKI–. When hyphae remain more or less unchanged in potassium hydroxide the note KOH– is used. All the drawings and measurements were made in CB.

Spores and basidia were measured with a 0.1 μm accuracy using magnification ×1000 and phase contrast illumination. The following abbreviations are used when reporting spore or basidium size: L = mean length; W = mean width; Q = L/W; Q' = variation in quotient of spore length and width of individual spores; n = a/b, where a represents the number of spores measured from b specimens (if b is omitted, all spores are from the same specimen). When reporting spore and basidium size variations, the overall variation is written in parentheses. In size variation figures without parentheses, the extreme 5% ends of variation have been excluded. Whenever the figures within and outside parentheses are identical, parentheses are omitted.

All specimens studied here are deposited in the herbaria GB, H, and TAA.

Species description

Trechispora elongata Miettinen & K. H. Larss. sp. nov. Fig. 1

Basidioma resupinatum, arachnoideum vel byssoideum, tenue, hymenio laevigato. Systema hypharum monomiticum, hyphae exiles, tenuitunicatae. Conidia praesentia vel absentia, cyanophilia, crassitunicata, ex fragmentatione hypharum oriunda, 3.6–6.6×2.6–4.2 µm. Basidiosporae aculeatae, anguste ellipsoideae, plus minusve arcuatae, 3.7–5×2.1–2.8 µm.

HOLOTYPE—Finland. Pohjois-Häme: Jyväskylä rural municipality, Vuoritsalo, on *Populus tremula*, 5.VIII.2002 O. Miettinen 6605 (H).

ETYMOLOGY—Latin word *elongata* refers to the elongated, i.e. long and narrow, basidiospores.

MYCOBANK ACCESSION NUMBER—MB510019

Basidiocarp resupinate, thin, commonly just a faint bloom on wood, surface smooth (except for the anamorph); easily separable from substrate but not pellicular, byssoid to usually arachnoid, always porose, pure white or appearing greyish due to thinness. Margin not differentiated, mycelial cords absent.

Hyphal system monomitic, all septa with clamps, all hyphae thin-walled (except for the anamorph), KOH–, CB– but plasma light blue in CB, hymenium stained more strongly, hyphae slightly yellowish in IKI. Crystals not detected.

Subiculum very thin, composed of sparse horizontal hyphae. Subicular hyphae straight, (1.5–)2–3(–5) µm in diameter, sparingly branched and clamped, rarely inflated, with no ampullate septa.

Subhymenial hyphae richly branched, slightly wider than subicular hyphae, cylindrical to slightly irregular, (2–)2.5–4(–5) µm in diameter, often rather short-celled but nearly always clearly longer than wide, only rarely swollen.

Basidia clavate or more often cylindrical, sometimes slightly constricted, with four curved, slender sterigmata (2.8–4 µm long), (6–)8.2–12.5(–15)×(3.5–)4–5.5(–7) µm, L=10.5 µm, W=4.7 µm, n=70/7.

Basidiospores narrowly ellipsoid to phaseoliform, aculeate, commonly curved, ventral side straight to concave, sometimes with an elongated proximal end, slightly CB+ to CB–. Spines of variable length but mostly 0.3–0.7 µm, single spines ≤ 1 µm, but generally shorter in the largest spores. Spores (not including spines) (3.3–)3.7–5(–5.7)×(1.8–)2.1–2.8(–3.1) µm, L = 4.2 µm, W=2.4 µm, Q'=(1.27–)1.45–2.09(–2.5), Q=1.75, n=222/7. Spores (including spines) (3.8–)4.1–5.2(–5.5)×(2.6–)2.8–3.8(–4) µm, L=4.6 µm, W=3.3 µm, Q'=(1.13–)1.19–1.73(1.85), Q=1.42, n=78/6.

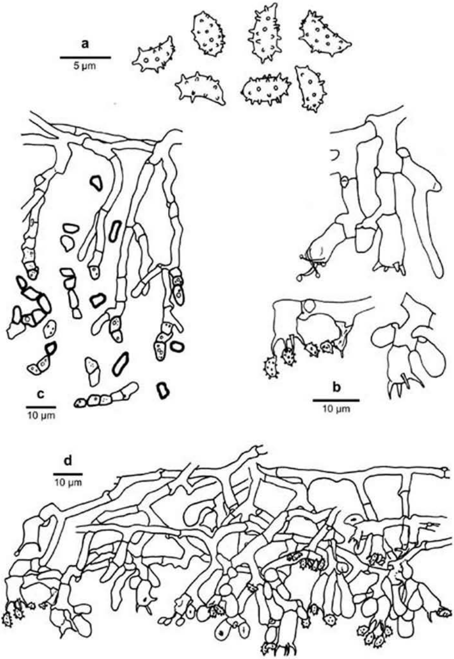


Fig. 1. *Trechispora elongata*, holotype. a) Basidiospores, b) basidia, c) conidiogenous hyphae and arthroconidia, d) section through the basidiocarp, slightly crushed.

Anamorph present or absent; forming white, roundish cushions, visible under the lens, and if large even with unaided eye. Conidia formed by fragmenting hyphae (arthroconidia), strongly CB+ and slightly dextrinoid, thick-walled, of variable length but of even thickness, with round corners, (3.4–)3.6–6.6(–6.8)×(2.3–)2.6–4.2(–4.7) µm, L=5.1 µm, W=3.3 µm, n=60/2, majority 3–3.5 µm wide. Anamorphic regions usually include some hymenium, but hymenium is formed mostly on different basal branches of subicular hyphae than conidia. Hyphae beneath the conidia-forming layer occasionally swollen, up to 8 µm wide.

Distribution and ecology. All the specimens studied grew on strongly decomposed wood. The holotype grew on *Populus tremula*, the other six specimens on *Picea abies* or *Pinus sylvestris*. Six of the collections originate from the Nordic countries and one from Poland. Collections range from nemoral (mountains of southern Poland) to middle boreal vegetation zone (central Finland). Collecting sites vary in their quality. Mostly they seem to be average managed coniferous forests. Although inconspicuous and thus easily overlooked, the species seems to be rather rare.

Remarks. *Trechispora elongata* is characterised by smooth, porose hymenium, narrowly ellipsoid spores with a tapering proximal end, and by the presence of arthroconidia. No other species of *Trechispora* has such long, relatively narrow spores as *T. elongata*. It comes close to *T. farinacea* and allied species (see Larsson 1992). *Trechispora elongata* can be distinguished from all the other species of this group based on spore morphology even in the absence of the conidial stage (Fig. 2, Tab. 1).

The conidial stage of *T. elongata* is quite similar to that of *T. stevensonii* (Berk. & Broome) K.H. Larss.: both look macroscopically the same and their conidia are formed by fragmenting hyphae with clamps. There are slight differences: the conidiogenous hyphae of the new species are wider than those of *T. stevensonii* (3–4 µm and 2.5–3 µm, respectively), and the majority of conidia of *T. stevensonii* are under 3 µm wide (3.2–5.4×2.2–3.5 µm, n=110/4) and weakly cyanophilous. Most conidia of *T. elongata* measure at least 3 µm wide and are rather strongly cyanophilous. Moreover, *T. stevensonii* has shorter, broadly ellipsoid basidiospores and a hydnoid hymenium in contrast to the new species.

Specimens of *T. farinacea* s. str. with smooth hymenophores resemble *T. elongata*. *Trechispora farinacea* has subglobose to broadly ellipsoid spores and wide and short subhymenial cells; *T. elongata* has narrowly ellipsoid spores and slender subhymenial cells.

Trechispora caucasica (Parmasto) Liberta bears some similarities with *T. elongata*: smooth and fragile basidiocarp, a macroscopically similar conidial stage and slightly curved, ellipsoid basidiospores. However, *T. elongata* produces arthroconidia and *T. caucasica* blastoconidia. Of the two, *T. elongata* has in relation narrower spores with a clearly tapering proximal end not present in *T. caucasica*. There is a clear difference in the Q values of the spores (Tab. 1). In addition, aculei of spores of *T. caucasica* are longer than those of *T. elongata* (most close to 1 µm), and it produces abundant rhizomorphs unlike *T. elongata*.

SPECIMENS STUDIED — *Trechispora elongata*. **Finland** (see *type). **Norway**. Sør-Trøndelag: Orkdal, Songli, on *Pinus*, 26.VIII.1982 K. H. Larsson **2907* (GB); on *Pinus*, 27.VIII.1982 K. H. Larsson *2935*. Telemark: Porsgunn, on *Picea*, IX.1996 J. N. Stokland et al. 4651

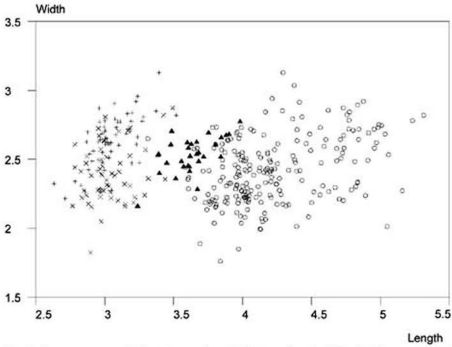


Fig. 2. Spore measurements (µm) comparing *Trechispora elongata* (○) with *T. caucasica* (▲), *T. farinacea* (+) and *T. stevensonii* (×). Each symbol represents a single spore. The points have been jittered, i.e. moved randomly within 0.05 µm around the original value along both axes.

Table 1. *Trechispora* species: basidiospore measurements of the specimens studied, spines excluded, and combined statistics for each species.

Specimen	Length (µm)	L	Width (µm)	W	Q′	Q	n
T. caucasica	**(3.2–)3.4–3.9(–4.0)**	**3.63**	**(2.2–)2.3–2.7(–2.8)**	**2.53**	**1.3–1.6**	**1.43**	**30**
T. elongata	**(3.3–)3.7–5.0(–5.7)**	**4.22**	**(1.8–)2.1–2.8(–3.1)**	**2.41**	**1.3–2.5**	**1.75**	**222/7**
holotype	(3.7–)3.8–5.0(–5.2)	4.34	(1.8–)2.0–2.7(–2.8)	2.29	1.5–2.5	1.89	38
Eriksson 1254	(3.7–)3.8–5.0	4.41	(2.0–)2.2–2.9(–3.0)	2.58	1.4–2.1	1.71	30
Hjortstam 11758	(3.6–)3.8–5.3(–5.7)	4.17	(2.1–)2.2–2.9(–3.1)	2.44	1.5–2.1	1.71	31
Larsson 2509	3.8–4.7(–5.1)	4.11	2.0–2.7(–2.9)	2.32	1.4–2.1	1.78	31
Larsson 2907	(3.7–)3.8–4.8(–5.2)	4.13	(2.0–)2.1–2.9(–3.1)	2.40	1.4–2.3	1.72	30
Larsson 2935	(3.3–)3.6–4.8(–5.0)	4.09	2.2–2.7(–2.8)	2.49	1.3–2.0	1.64	31
Stokland 4651	(3.7–)3.8–5.0	4.27	(1.9–)2.2–2.8	2.43	1.4–2.1	1.76	31
T. farinacea	**(2.6–)2.8–3.4(–3.6)**	**3.06**	**(2.2–)2.3–2.9(–3.1)**	**2.63**	**1.0–1.4**	**1.17**	**60/2**
Kotiranta 7336	(2.8–)2.9–3.5(–3.6)	3.06	2.3–2.8	2.59	1.1–1.4	1.18	30
Miettinen 6697	(2.6–)2.7–3.3(–3.4)	3.06	(2.2–)2.3–3.0(–3.1)	2.66	1.0–1.3	1.15	30
T. stevensonii	**2.8–3.4(–3.5)**	**3.04**	**(1.8–)2.2–2.8(–2.9)**	**2.41**	**1.1–1.6**	**1.26**	**60/2**
Jakobsson 1379	2.8–3.4(–3.5)	3.04	2.2–2.8(–2.9)	2.51	1.1–1.4	1.21	30
Saarenoksa 52190	2.8–3.3	3.04	(1.8–)2.0–2.6(–2.7)	2.30	1.1–1.6	1.32	30

(GB). **Poland.** Malopolska: Sucha Beskidzka, Babia Góra National Park, on *Picea*, 15.IX.1973 N. Hallenberg & K. H. Larsson 2509 (GB). **Sweden.** Dalsland: Dals-Ed, 3 km N of Ed, Käringedalen, on *Pinus*, 2.IX.1980 K. Hjortstam 11758 (GB). Småland: Värnamo, in between Alandryd and Gislabo, on gymnosperm, 9.X.1955 J. Eriksson 1254 (GB).—Specimens with an anamorph are marked with an asterisk (*).

Trechispora caucasica. **Azerbaidzhan.** Leriki, on *Parrotia persica*, 14.XII.1962 E. Parmasto 16448 (holotype TAA).

Trechispora farinacea. **Finland.** Etelä-Häme: Lammi, biological station, on *Quercus*, IX.2002 O. Miettinen 6697 (H). Uusimaa: Inkoo, Sommaröarna, on gymnosperm, 26.V.1989 H. Kotiranta 7336 (H).

Trechispora stevensonii. **Finland.** Etelä-Häme: Lammi, biological station, on *Corylus avellana*, 13.IX.1997 S. Vanhanen 334b (H). Keski-Pohjanmaa: Raahe, Seminaariranta, on *Alnus*, 3.IX.1995 S. Jakobsson 1379 (H). Uusimaa: Helsinki, Viikki, on *Prunus padus*, 5.IX.1989 R. Saarenoksa 20689 (H); Helsinki, Vanhakaupunki, on *Prunus padus*, 18.VII.1990 R. Saarenoksa 52190 (H).—All specimens with an anamorph.

Acknowledgments

Warm thanks are due to Tuomo Niemelä (Helsinki), who commented the manuscript and assisted in practicalities of drafting the microscopic description. We thank Heikki Kotiranta (Helsinki) and Erast Parmasto (Tartu) for reviewing the manuscript. Teuvo Ahti (Helsinki) kindly revised the Latin description. Emil Aaltonen Foundation provided financial support for this study.

Literature cited

Larsson KH. 1992. The Genus *Trechispora* (*Corticiaceae*, Basidiomycetes). University of Göteborg, Department of Systematic Botany, Göteborg (thesis).

Larsson KH. 1995. Taxonomy of *Trechispora farinacea* and proposed synonyms I. Species with a grandinioid or hydnoid hymenophore. Symb. Bot. Upsal. 30(3): 101–118.

Liberta A. 1973. The genus *Trechispora* (Basidiomycetes, *Corticiaceae*). Canadian J. Bot. 51: 1871–1892.

MYCOTAXON

Volume 96, pp. 199–206 April–June 2006

Two new species of *Wrightoporia* (Basidiomycota, *Aphyllophorales*) from southern China

YU-CHENG DAI

yuchengd@yahoo.com
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

BAO-KAI CUI

baokaicui@yahoo.com.cn
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

Graduate School, Chinese Academy of Sciences
Beijing 100039, China

Abstract — Two new species of *Wrightoporia*, *W. casuarinicola* and *W. unguliformis*, are described from southern China, and illustrated descriptions of the two species are supplied. *W. casuarinicola* was collected on *Casuarina* from Guangxi Autonomous Region. It has a perennial growth, resupinate basidiocarps, a lilac to vinaceous brown pore surface, simple septate generative hyphae, dextrinoid and weakly cyanophilous skeletal hyphae, and broadly ellipsoid to subglobose, slightly thick-walled, ornamented and amyloid basidiospores. *W. unguliformis* was collected from Hainan Province. It has perennial, woody hard and ungulate basidiocarps with a distinct rusty brown to dark brown crust; the pore surface is buff to pale brown, and its tube mouths are thick. The skeletal hyphae are dextrinoid and strongly cyanophilous, and its basidiospores are thick-walled, echinulate and amyloid.

Key words — polypore, wood-rotting fungi, taxonomy

Introduction

The genus *Wrightoporia* was based on *Poria lenta* Overh. & J. Lowe which is a temperate species (Pouzar 1966), but most species in the genus have been recorded from subtropics and tropics (Buchanan & Ryvarden 2000, David & Rajchenberg 1985, 1987, Hattori 2003, Johansen & Ryvarden 1979, Lindblad & Ryvarden 1999, Loguercio-Leite et al. 1998, Rajchenberg 1983, Rajchenberg & David 1990, Ryvarden 1982, 1983, 1989, 2000, Ryvarden & Johansen 1980). Until now there are about 30 species transferred to or described in this genus, and five species have previously been reported from China (Cui & Dai 2006, Dai 1995, Dai et al. 2004).

During the study of diversity and ecology of wood-inhabiting fungi in China, two undescribed species were found from southern China. They have a dimitic hyphal system, dextrinoid and cyanophilous skeletal hyphae, and echinulate and distinctly amyloid basidiospores. These features fit the genus *Wrightoporia* very well, but no existing names are suitable for them and they are therefore described as new taxa.

Materials and methods

The studied specimens are deposited at the Herbarium of the Institute of Applied Ecology, Chinese Academy of Sciences (IFP) and the Mycological Herbarium of the Institute of Microbiology, Chinese Academy of Sciences (HMAS). The microscopic procedure follows Niemelä et al. (2004). Spores were measured from sections cut from the tubes. IKI = Melzer's reagent, IKI+ = amyloid, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB– = acyanophilous. In presenting the variation in the size of the spores, 5% of measurements were excluded from each end of the range, and are given in parentheses. In the text the following abbreviations are used: L = mean spore length (arithmetic mean of all spores measured), W = mean spore width (arithmetic mean of all spores measured), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width of each specimen), n = number of spores measured from given number of specimens. Special colour terms are from Petersen (1996) and Rayner (1970).

Descriptions

Wrightoporia casuarinicola **Y.C. Dai & B.K. Cui, sp. nov.** Fig.1

Carpophorum perenne, resupinatum; facies pororum lilacina; pori rotundi vel angulati, 3–4 per mm. Systema hypharum dimiticum, hyphae generatoriae afibulatae, hyphae skeletales subiculi 2.8–9 µm in diam. Sporae perlate ellipsoideae vel subglobosae, hyalinae, asperae, amyloideae, 3.5–3.9 × 2.7–3.2 µm.

Type. — **China.** Guangxi Autonomous Region, Beihai, on living tree of *Casuarina equisetifolia* L., 12.VIII.2005 *Dai 6914* (holotype in IFP, isotype in H, HMAS).

Etymology. — *Casuarinicola* (Lat.): living on *Casuarina*.

Fruitbody. — Basidiocarps perennial, resupinate, when fresh corky to leathery, without odour or taste, becoming corky to woody corky upon drying, ca. 30 cm or more in longest dimension, 7 cm or more in widest dimension, tightly attached from the substrate. Sterile margin distinct, peach to brownish orange, up to 5 mm wide. Pore surface lilac when fresh, becoming vinaceous to cinnamon brown upon drying; pores round to angular, 3–4 per mm, tube mouths thin to thick, entire to lacerate. Context vinaceous to cinnamon brown, corky, up to 1 mm thick. Tubes vinaceous to vinaceous brown, corky, up to 6 mm long.

Hyphal structure. — Hyphal system dimitic; generative hyphae without clamp connections; skeletal hyphae dextrinoid, weakly CB+, tissue unchanged in KOH.

Context. — Generative hyphae infrequent, hyaline, slightly thick-walled, rarely branched, 2.4–4.8 µm in diam; skeletal hyphae dominant, hyaline to pale yellowish brown, thick-walled with a narrow lumen, frequently branched, more or less flexuous, interwoven, 2.8–9 µm in diam.

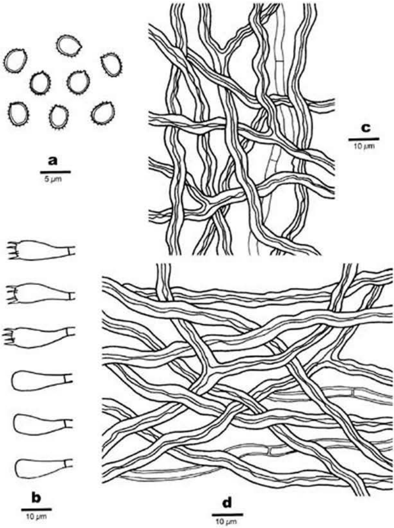


Fig. 1. Microscopic structures of *Wrightoporia casuarinicola* (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from trama. —d: Hyphae from subiculum.

Tubes. — Generative hyphae infrequent, hyaline, thin-walled, rarely branched, 2–4 µm in diam; skeletal hyphae dominant, hyaline to pale yellowish brown, thick-walled with a narrow lumen, rarely branched, more or less flexuous, interwoven, 2–6.3 µm in diam. Cystidia and cystidioles absent; basidia clavate, with a basal simple septum and four sterigmata, 12–16.7 × 5–7.2 µm; basidioles in shape similar to basidia, but slightly smaller.

Spores. — Basidiospores broadly ellipsoid to subglobose, hyaline, slightly thick-walled, echinulate, IKI+, CB–, (3.3–)3.5–3.9(–4) × (2.6–)2.7–3.2(–3.3) µm, L = 3.7 µm, W = 3 µm, Q = 1.2 (n = 30/1).

Type of rot. — White rot.

Remarks. — *Wrightoporia casuarinicola* is characterized by its perennial growth habit, resupinate basidiocarps, lilac to vinaceous brown pore surface, simple septate generative hyphae, dextrinoid and weakly cyanophilous skeletal hyphae, and broadly ellipsoid to subglobose, slightly thick-walled, ornamented and amyloid basidiospores.

Among the species of *Wrightoporia*, six have simple septate generative hyphae: *W. bracei* (Murrill) I. Lindblad & Ryvarden, *W. efibulata* I. Lindblad & Ryvarden, *W. gillesii* A. David & Rajchenb., *W. perplexa* Ryvarden, *W. ramosa* A. David & Rajchenb. and *W. rubella* Y.C. Dai.

Wrightoporia casuarinicola is closely related to *W. bracei*, sharing resupinate, perennial basidiocarps, lilac pore surface, and broadly ellipsoid to subglobose basidiospores. Some specimens of the latter from South America were studied; it has smaller pores (5–7 per mm), and its context becomes black in KOH. Microscopically its basidiospores are thin-walled, its skeletal hyphae are distinctly cyanophilous in Cotton Blue, and some of its tramal skeletals are inflated up to 12 µm in diam. In addition, its generative hyphae are both simple septate and having clamp connections, a feature pointed out by Ryvarden (2000) as well.

Wrightoporia efibulata differs mainly from *W. casuarinicola* by having thin basidiocarps (less than 5 mm thick) with cream to buff pore surface, smaller pores (6–8 per mm), indextrinoid skeletal hyphae, and globose basidiospores (3–3.5 µm in diam., Lindblad & Ryvarden 1999).

Wrightoporia gillesii differs from *W. casuarinicola* by having effused-reflexed basidiocarps with cream to ochraceous pore surface, smaller pores (8–9 per mm), narrow contextual skeletals (less than 5 µm in diam.) and smaller basidiospores (3–3.5 × 2–2.5 µm, David & Rajchenberg 1987). In addition, based on our examination on a specimen from Uganda it has both simple septate and clamp connections on its generative hyphae.

Wrightoporia perplexa is distinguished from *W. casuarinicola* by its distinctly pileate fruitbody and inamyloid and larger basidiospores (5–6 × 4–5 µm, Ryvarden 1989). *Wrightoporia ramosa* differs from *W. casuarinicola* by having bigger pores (2–3 per mm), gloeoplerous hyphae, and longer basidiospores (4–4.5 × 3–3.25 µm, David & Rajchenberg 1987). *Wrightoporia rubella* is also found in China, but it has a strongly rhizomorphic fruitbody and larger basidiospores (4–6 × 3–4.2 µm, Dai 1995).

Other specimens examined. — *Wrightoporia bracei.* **Argentina.** Missiones Prov., Iguazu National Park, Cataratas de Iguazu, on angiosperm wood, 1.III.1982 *Ryvarden 19768* (H, dupl.). **Brazil.** Sao Paulo State, Sants, Ubatuba, Ilha Anchieta, on bamboo, 17.I.1987 *Ryvarden 24237* (H. dupl.). **Costa Rica.** Guanacaste Prov., Santa Rosa National Park, on dead angiosperm wood, 27.X.1996 *Lindblad 2253* (H, dupl.). **French Guiana.** Senter Rorota-Cayenne, 22.I.1947 *Robert 1251* (H, dupl.). **Puerto Rico.** Guajataca Comm, Forest Verada, Nueva trail, on dead angiosperm wood, 26.VI.1996 *Ryvarden 39094* (H, dupl.). — *W. efibulata.* **Costa Rica.** Alajuela. Bijagua, Albergue Helicones, 12.VII.2001 *Ryvarden 43719* (H, dupl.). — *W. gillesii.* **Uganda.** Kanugu, Bwindi Forest National Park, Kanungu sector, Parinari forest, on fallen rotting branches, 15.XI.2002 *Ipulet F1049* (H, dupl.); 29.V.2003 *Ipulet F1776* (H, dupl.).

Wrightoporia unguliformis Y.C. Dai & B.K. Cui, sp. nov. Fig.2

Carpophorum perenne, solitarium, ungulatum; facies pororum bubalina vel pallide brunnea; pori rotundi, 1–3 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales contexti 2–5.4 µm in diam. Sporae perlate ellipsoideae vel subglobosae,hyalinae, asperae, amyloideae, 4.3–5.1 × 3.8–4.3 µm.

Type. — China. Hainan Prov., Ledong County, Jianfengling Nature Reserve, on fallen angiosperm trunk, 4.I.1960 *Anonymous of Forestry Survey Team 37* (HMAS 29718, holotype in HMAS, isotype in IFP).

Etymology. — *Unguliformis* (Lat.), hoof-shaped, referring to the shape of basidiocarp.

Fruitbody. — Basidiocarps perennial, pileate, solitary, woody hard. Pileus ungulate, projecting up to 12 cm, 9 cm wide, and 16 cm thick at base. Pileal surface rusty brown to reddish brown or umber brown, coarse, concentrically zonate and sulcate; margin blunt, greyish to pale brown. Pore surface buff to pale brown; pores round, 1–3 per mm, tube mouths thick, entire. Context buff, woody hard, ca. 0.5 cm thick; crust present at upper surface, rusty brown to dark brown, woody hard, up to 0.5 mm thick. Tubes multi-stratified, concolorous with pore surface, woody hard, up to 15 cm long; tube layers distinct, over 20 layers.

Hyphal structure. — Hyphal system dimitic; generative hyphae with clamp connections; skeletal hyphae dextrinoid, strongly CB+, tissue unchanged in KOH.

Context. — Generative hyphae infrequent, hyaline, slightly thick-walled, occasionally branched, 2–4.3 µm in diam.; skeletal hyphae dominant, hyaline to pale yellowish brown, thick-walled with a narrow lumen, frequently branched, interwoven, 2–5.4 µm in diam. Hyphae in crust pale yellowish, thick-walled with a narrow lumen, rarely branched, interwoven, 2–5.5 µm in diam.

Tubes. — Generative hyphae infrequent, hyaline, thin-walled, rarely branched, 1.4–3.2 µm in diam.; skeletal hyphae dominant, hyaline to pale yellowish, thick-walled with a narrow lumen, frequently branched, interwoven, 1.6–5 µm in diam. Cystidia absent, cystidioles present, fusoid, hyaline, thin-walled, 11.6–17× 4.2–6 µm; basidia clavate, with a basal clamp connection and four sterigmata, 12.3–19 × 5–7.4 µm; basidioles in shape similar to basidia, but slightly smaller.

Spores. — Basidiospores broadly ellipsoid to subglobose, hyaline, thick-walled, with finely echinulate ornamentation, IKI+, weakly cyanophilous, (4.2–)4.3–5.1(–5.2) × (3.7–)3.8–4.3(–4.5) µm, L = 4.8 µm, W = 4.1 µm, Q = 1.2 (n = 30/1).

Type of rot. — White rot.

Remarks. — *Wrightoporia unguliformis* is characterized by its perennial, woody hard and ungulate basidiocarp with a distinct rusty brown to dark brown crust, buff to pale brownish pore surface, thick tube mouths, dimitic hyphal system, dextrinoid and strongly cyanophilous skeletal hyphae, and thick-walled, echinulate and amyloid basidiospores. Macroscopically, *W. unguliformis* is very similar to *Fomitopsis pinicola*

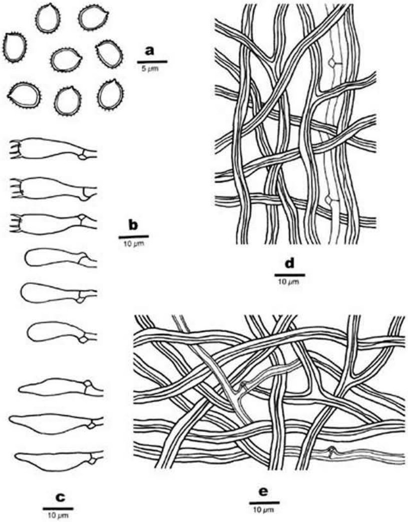


Fig. 2. Microscopic structures of *Wrightoporia unguliformis* (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Cystidioles. —d: Hyphae from trama. —e: Hyphae from context.

(Sw.:Fr.) P. Karst., however, the latter species has smooth and thin-walled basidiospores, its hyphae and basidiospores are IKI– and CB–, and it causes a brown rot.

Fourteen species of *Wrightoporia* have pileate basidiocarps, mainly recorded from tropical and subtropical areas (David & Rajchenberg 1985, 1987, Hattori 2003, Johansen & Ryvarden 1979, Loguercio-Leite et al. 1998, Núñez & Ryvarden 1999, Ryvarden 1982, 1989, 2000, Ryvarden & Johansen 1980). Most of them have an annual growth habit, but

W. dimidiata A. David & Rajchenb. is perennial with pileate basidiocarps. One specimen of *Wrightoporia dimidiata* from Singapore was examined; it differs from *W. unguliformis* by having dimidiate pileus, yellowish brown context, smaller pores (4–6 per mm), and its context becomes black in KOH. Microscopically its basidiospores are thin-walled and smaller (3.5–4 × 2.5–3 μm). In addition, its hyphal structure is trimitic, binding hyphae are frequently present in both trama and context, and its skeletal and binding hyphae are acyanophilous or very weakly cyanophilous. Besides, as mentioned by David & Rajchenberg (1987) *W. dimidiata* has gloeoplerous hyphae and gloeocystidia.

Other specimen examined. — *Wrightoporia dimidiata.* Singapore. Bukit Timah Reserve, Rotten trunk of *Dipterocarpus*, 10.V.1994 *Legoan* (H, dupl.)

Although each of the above two new species is based on a single specimen, these two type specimens are huge, well-developed and in very good condition. We have studied the materials of all the related taxa, and the differences between our new species and related taxa are striking. For these reasons we venture to publish the descriptions of the two species.

Acknowledgements

We express our gratitude to Prof. Teuvo Ahti (H, Finland) for revising the Latin description and improving the manuscript, and to Drs. Henning Knudsen (University of Copenhagen, Denmark) and Manfred Binder (Clark University, USA.), who reviewed the manuscript. Special thanks are due to Dr. Tuomo Niemelä and Mr. Otto Miettinen (H, Finland) for arranging specimens in H for our study. The research was financed by the National Natural Science Foundation of China (Project No. 30425042).

Literature cited

Buchanan PK, Ryvarden L. 2000: New Zealand polypore fungi: six new species and a redetermination. New Zealand J. Bot. 38: 251–263.

Cui BK, Dai YC. 2006: *Wrightoporia* (Basidiomycota, *Aphyllophorales*) in China. Nova Hedwigia (in press)

Dai YC. 1995: A new species of *Wrightoporia* (Basidiomycetes) from China. Karstenia 35: 85–89.

Dai YC, Wei YL, Wu XL. 2004: Polypores from Hainan Province 1. J. Fung. Res. 2: 53–57.

David A, Rajchenberg M. 1985: Pore fungi from the French Antilles and Guiana. Mycotaxon 22: 285–325.

David A, Rajchenberg M. 1987: A reevaluation of *Wrightoporia* and *Amylonotus* (*Aphyllophorales, Polyporaceae*). Mycotaxon 22: 285–325.

Hattori T. 2003: Type studies of the polypores described by E.J.H. Corner from Asia and West Pacific Areas 6. Species described in *Tyromyces* (3), *Cristelloporia, Grifola, Hapalopilus, Heterobasidion, Ischnoderma, Loweporus,* and *Steccherinum*. Mycoscience 44: 453–463.

Johansen I, Ryvarden L. 1979: Studies in the *Aphyllophorales* of Africa 7. Some new genera and species in the *Polyporaceae*. Trans. British Mycol. Soc. 72: 189–199.

Lindblad I, Ryvarden L. 1999: Studies in neotropical polypores 3. New and interesting Basidiomycetes (*Poriales*) from Costa Rica. Mycotaxon 71: 335–359.

Loguercio-Leite C, Gerber AL, Ryvarden L. 1998: *Wrightoporia porilacerata*, a new species of pore fungi from southern Brazil. Mycotaxon 67: 251–255.

Niemelä T, Dai YC, Kinnunen J, Schigel D. 2004: New and in North Europe rare polypore species (Basidiomycota) with annual, monomitic basidiocarps. Karstenia 44: 67–77.

Núñez M, Ryvarden L. 1999: New and interesting polypores from Japan. Fungal Diversity 3: 107–121.

Petersen JH. 1996. Farvekort. The Danish Mycological Society´s colour-chart. Foreningen til Svampekundskabens Fremme, Greve.

Pouzar Z. 1966: Studies in the taxonomy of polypores 1. Česká Mykol. 20: 171–177.

Rajchenberg M. 1983: New South American resupinate polypores. Mycotaxon 16: 500–506.

Rajchenberg M, David A. 1990: A new species of *Wrightoporia* Pouz. (*Polyporaceae*, Basidiomycetes). New Zealand J. Bot. 28: 185–186.

Rayner RW. 1970. A mycological colour chart. Commonwealth Mycol. Inst., Kew.

Ryvarden L. 1982: Synopsis of the genus *Wrightoporia*. Nordic J. Bot. 2: 145–149.

Ryvarden L. 1983: Type studies in the *Polyporaceae* 14. Species described by N. Patouillard, either alone or with other mycologists. Occas. Pap. Farlow Herb. 18: 1–39.

Ryvarden L. 1989: *Wrightoporia perplexa nov. sp.* (*Polyporaceae*). Opera Bot. 100: 225–227.

Ryvarden L. 2000: Studies in neotropical polypores 7. *Wrightoporia* (*Hericiaceae*, Basidiomycetes) in tropical America. Karstenia. 40: 153–158.

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

MYCOTAXON

Volume 96, pp. 207–210 *April–June 2006*

A new species of *Oxyporus* (Basidiomycota, *Aphyllophorales*) from Northwest China

BAO-KAI CUI

baokaicui@yahoo.com.cn
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

Graduate School, Chinese Academy of Sciences
Beijing 100039, China

MING-YUN HUANG

Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

YU-CHENG DAI*

yuchengd@yahoo.com
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

Abstract—A new poroid *Aphyllophorales*, *Oxyporus subpopulinus*, is described from northwest China. It is characterized by perennial basidiocarps, abundant thick-walled and apically encrusted cystidia, ellipsoid and distinctly thin-walled basidiospores, and by growth on *Picea crassifolia* exclusively. The new species is very similar to *Oxyporus populinus*, but the latter species has subglobose and slightly thick-walled basidiospores, thin- to thick-walled cystidia, and it grows on angiosperm trees, especially on *Acer*.

Key words — polypore, wood-rotting fungi, taxonomy

Introduction

During a survey of the wood-inhabiting fungi in northwest China, six specimens of a polypore were collected on living trees of *Picea crassifolia*. The basidiocarps were perennial and had abundant thick-walled and apically encrusted cystidia and a monomitic hyphal structure with simple septate generative hyphae. The basidiospores are distinctly ellipsoid, hyaline and thin-walled. These characters indicate the genus *Oxyporus* (Bourdot & Galzin) Donk, but no suitable existing name is available for it and it is therefore described as new.

Materials and methods

The studied specimens are deposited at the Herbarium of the Institute of Applied Ecology, Chinese Academy of Sciences (IFP). Microscopy was studied, and measurements and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. The microscopic routine used in the study is as presented by Dai & Niemelä (1997). Spores were measured from sections cut from the tubes. KOH stands for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and CB– acyanophilous, and IKI– means both inamyloid and indextrinoid. In presenting the variation in the size of the spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses. In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores measured), W = mean spore width (arithmetical mean of all spores measured), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width of each specimen), n = number of spores measured from given number of specimens. Special colour terms are from Petersen (1996) and Anonymous (1969).

Description

Oxyporus subpopulinus B.K. Cui & Y.C. Dai, sp. nov. Fig.1

Carpophorum perenne, pileatum, solitarium vel imbricatum. Facies pororum cremea vel pallide bubalina; pori rotundi vel angulati,5–7 per mm. Systema hypharum monomiticum, hyphae afibulatae, hyphae contexti 3–4.6 µm in diam. Sporae hyalinae, ellipsoideae, 3.4–4.7 × 2.3–3.2 µm.

Type. — China. Qinghai Prov., Xunhua County, Mengda Nature Reserve, on living tree of *Picea crassifolia*, 30.VIII.2005 *Cui 2313* (holotype in IFP, isotype in HMAS & H).

Etymology. — *Subpopulinus* (Lat.): resembling *Oxyporus populinus*.

Fruitbody. — Basidiocarps perennial, pileate or rarely effused-reflexed, mostly imbricate, occasionally solitary, woody hard when dry, without odour or taste when fresh. Pileus broadly attached, elongated, projecting up to 4 cm long, 13 cm wide, and 5 cm thick at the base. Pileal surface white to cream, or pale buff, azonate, margin sharp. Pore surface cream to pale buff; pores round to angular, 5–7 per mm, dissepiments thin, entire. Context white to cream, corky, azonate, up to 6 mm thick. Tubes concolorous with pore surface, cream to pale buff, corky, each layer up to 1–2 mm long, tube layers distinct.

Hyphal structure. — Hyphal system monomitic; hyphae simple septate, IKI–, more or less CB+, unchanged in KOH.

Context. — Contextual hyphae hyaline, thick-walled, frequently simple septate, occasionally branched, interwoven, 3–4.6 µm in diam.

Tubes. — Tramal hyphae hyaline, mostly thick-walled, some thin-walled, rarely branched, frequently simple septate, straight, parallel along the tubes, 2.2–3.5 µm in diam. Hyphoid cystidia abundant, clavate, distinctly penetrating above the hymenial surface, deeply rooting in the trama, thick-walled, apically encrusted with coarse crystals, 17–28 × 3.4–5.2 µm; basidia broadly clavate to barrel-shaped, with four sterigmata and a basal simple septum, 7.6–12 × 5–6 µm; basidioles in shape similar to basidia, but slightly smaller.

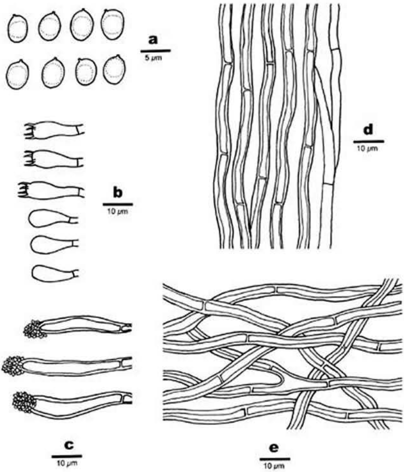


Fig. 1. Microscopic structures of *Oxyporus subpopulinus* (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Cystidia. —d: Hyphae from trama. —e: Hyphae from context.

Spores. — Basidiospores ellipsoid, hyaline, thin-walled, smooth, usually bearing a big guttule, IKI–, CB–, (3–)3.4–4.7(–5) × (2.1–)2.3–3.2(–3.5) µm, L = 3.9 µm, W = 2.9 µm, Q = 1.3–1.4 (n=180/6).

> *Additional specimens (paratypes) examined.* — **China.** Gansu Prov., Yuzhong County, Xinglongshan Nature Reserve, on base of living *Picea crassifolia*, 27.VIII.2005 *Cui 2236* (IFP) & *2238* (IFP); on living tree of *Picea crassifolia*, 27.VIII.2005 *Cui 2240* (IFP); Qinghai Prov., Xunhua County, Mengda Nature Reserve, on living tree of *Picea crassifolia*, 29.VIII.2005 *Cui 2251* (IFP) & *2261* (IFP).

Type of rot. — White rot.

Remarks. — *Oxyporus subpopulinus* is characterized by perennial basidiocarps, abundant thick-walled and apically encrusted cystidia, distinctly ellipsoid and thin-walled basidiospores, and by growth on *Picea crassifolia* exclusively. Macroscopically *Oxyporus subpopulinus* is very similar to *O. populinus* (Schumach.:Fr.) Donk, but the latter has distinctly subglobose and slightly thick-walled basidiospores, thin- to thick-walled cystidia, and mostly thin-walled tramal hyphae and it grows on angiosperm trees, especially on *Acer* (Dai 1998, Gilbertson & Ryvarden 1987, Núñez & Ryvarden 2001, Ryvarden & Gilbertson 1994).

Oxyporus nobilissimus W.B. Cooke has perennial basidiocarps, abundant thick-walled, hyphoid cystidia, and occurs on coniferous trees. However, it has both larger pores and basidiospores (3–5 per mm, 5.5–7 × 4–5 μm, Gilbertson & Ryvarden 1987).

According to our field investigations, *Oxyporus subpopulinus* only occurs on living trees of *Picea crassifolia*, and some trees were killed by the fungus. Therefore, this polypore seems to be pathogenic on the spruce, but further study is needed to confirm its pathogenicity.

> *Other specimens examined.* — *Oxyporus populinus.* **China.** Beijing, Baihuashan, on living tree of *Acer*, 2.XI.1993 *Dai 1824* (IFP, H); 2.XI.1993 *Dai 1839* (IFP, H); Jilin Prov., Antu county, Changbaishan Nature Reserve, on living tree of *Acer*, 16.IX.1995 *Dai 2149* (IFP, H); 13.VIII.1997 *Dai 2415* (IFP, H); 19.IX.1998 *Dai 3015* (IFP, H); on dead tree of *Populus*, 13.IX.1995 *Dai 2084* (IFP, H); Fushong County, Shuguang, on living tree of *Acer*, 22.VII.1993 *Dai 671* (IFP, H); Huinan County, Hongqi, on dead tree of *Acer*, 13.X.1993 *Dai 1608* (IFP, H). **Finland.** Uusimaa, Helsinki, Arabia, on fallen trunk of *Acer*, 2.XI.1996 *Dai 2311* (H); on stump of *Acer*, 2.XII.1996 *Dai 2354* (H).

Acknowledgements

We express gratitude to Drs. Henning Knudsen (University of Copenhagen, Denmark) and Manfred Binder (Clark University, USA.), who reviewed the manuscript. Special thanks are due to Dr. Tuomo Niemelä (H, Finland) for arranging specimens in H for our study. The research was financed by the National Natural Science Foundation of China (Project No. 30425042).

Literature cited

Anonymous. 1969: Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London.

Dai YC. 1998: Changbai wood-rotting fungi 9. Three new species and other species in *Rigidoporus*, *Skeletocutis* and *Wolfiporia* (Basidiomycota, *Aphyllophorales*). Ann. Bot. Fennici 35: 143–154.

Dai YC, Niemelä T. 1997: Changbai wood-rotting fungi 6. Study on *Antrodiella*, two new species and notices on some other species. Mycotaxon 64: 67–81.

Gilbertson RL, Ryvarden L. 1987: North American polypores 2. *Megasporoporia - Wrightoporia*. Fungiflora, Oslo. 434–885 pp.

Núñez M, Ryvarden L. 2001: East Asian polypores 2. *Polyporaceae s. lato.* Syn. Fungorum 14: 165–522.

Petersen JH. 1996: Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve.

Ryvarden L, Gilbertson RL. 1994: European polypores 2. Syn. Fungorum 7: 394–743.

MYCOTAXON

Volume 96, pp. 211–239 April–June 2006

Northern *Antrodiella* species: the identity of *A. semisupina*, and type studies of related taxa

Otto Miettinen[1]*, Tuomo Niemelä[1] & Wjacheslav Spirin[2]

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

[2] Kirochnaya 8–12,
191028 St.-Petersburg, Russia

Abstract—Type collections of *Antrodiella* (Basidiomycota, polypores) from Europe, North America and Siberia were studied. The current concept of *Antrodiella semisupina* includes many species; the European taxon is *A. pallescens*, comb. nov., while *A. semisupina* sensu typi occurs in North America. The identity of *A. romellii* was clarified and an epitype was selected to supplement its poor-quality holotype. *A. serpula*, comb. nov. is an earlier name for *A. hoehnelii*. In addition, the following new combinations are made: *A. leucoxantha* (=*A. genistae*), *A. subradula* (type from Siberia), *A. pachycheiles* (type from eastern U.S.A.), and *A. ellipsospora* (type from Siberia). *A. beschidica* and *A. farinacea* are reduced to the synonymy of *A. pallescens*; *A. thompsonii* is accepted as a good species. *Antrodiella ichnusana*, described from the Mediterranean, is reported from North Europe. Several other *Antrodiella* species are discussed. Spores are illustrated and their dimensions are given for the 17 accepted species. Gloeocystidia are considered an unreliable character for delimiting species in *Antrodiella*.

Key words—taxonomy, nomenclature, polyporoid clade

Introduction

The genus *Antrodiella* was described by Ryvarden & Johansen (1980) for *Polyporus semisupinus* and a few related East African species. The number of species grew rapidly, and at present 58 names are included in *Antrodiella* (Index Fungorum 2006). The genus has now become widely accepted. Vampola & Pouzar (1996), Ryvarden (2003) and Dai (2004) have published summarising articles on the genus. Johannesson et al. (2000) showed with ca. ten European species that they form a monophyletic group.

While studying specimens of *Antrodiella* it soon became evident that there are misconceptions and older names that cause changes in the current nomenclature. All the Nordic species are included, but when searching for correct species names, many North American and Siberian taxa were also reviewed.

Materials and methods

The work is mostly based on type and other herbarium materials, but North and Central European species have been studied extensively in the field, too. Collections in the herbarium H (Helsinki) served for the basis of the study, and the listed specimens are preserved in H unless otherwise indicated. Type materials and reference specimens were obtained from the herbaria BPI, HMAS, HUBO, K, KUO, L, NY, NYS, OULU, PAC, PC, PRM, and S.

The basic mountant medium used was 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 vs. dextrinoid reaction was studied in Melzer's reagent (IKI): 1.5 g KI, 0.5 g I, 22 g chloral hydrate, aq. dest. 20 ml; IKI– means neither amyloid nor dextrinoid reaction. Also 5% KOH was used for mountant; KOH– meaning almost unchanged. Spore and other measurements were made and illustrations were drawn in CB. As a rule 30 spores were measured from each specimen selected for closer scrutiny. Measurements were done using ×1000 or ×1250 magnification, phase contrast illumination and oil immersion; eyepiece scale bar with 1-µm-grid was used, and dimensions were estimated subjectively with an accuracy of 0.1 µm.

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; in case these values are identical, parentheses are omitted. MycoBank (http://www.MycoBank.org) accession numbers for the new combinations are given in parentheses after the species title in question.

The genus *Antrodiella*

Antrodiella sensu stricto is microscopically well defined and easily recognizable. However, some species now addressed to *Antrodiella* may fit better in other genera, e.g. *A. fissiliformis* and *A. ussurii*. Together with *Junghuhnia, Steccherinum, Flaviporus*, and perhaps *Irpex* and *Flavodon, Antrodiella* makes a complex, whose phylogenetic relationships are still unclear. In an analysis by Binder et al. (2005) *Antrodiella, Junghuhnia, Steccherinum* and *Ceriporiopsis* belong to the same lineage within the polyporoid clade.

Typical species of *Antrodiella* have annual, leathery tough basidiocarps with a tendency to effused growth, although thin, fingernail-shaped or spathulate pilei develop commonly. Context is thin and almost white, and overall colour is white to cream, with hues of tan, grey, orange and yellow. These are white-rot fungi, and strikingly many are successor species (Niemelä et al. 1995), which appear on trees previously decayed by certain other fungi. Such ecological links offer good hints for identification.

Species are often difficult to separate because of the small size of the basidiocarps and their fairly uniform microscopy. Hyphal structure and pore size can provide useful information, but spore dimensions are the key character. Spores of *Antrodiella* are small, subglobose, ellipsoid or short cylindrical. Hyphal system is dimitic, generative hyphae mostly with clamp connections, and skeletal hyphae narrow but thick-walled with a capillary lumen. The skeletals of context/subiculum may have occasional branches, and then the structure approaches trimitic. Typical to the genus is that skeletal walls are slightly cyanophilous, unlike in *Antrodia*, but in a similar way as in *Junghuhnia* and *Steccherinum*. In some species they are weakly amyloid or dextrinoid. Hymenial cells are small, basidia with 4 sterigmata, usually short clavate, basidioles similar but shorter, and cystidioles poorly differentiated, similar to basidioles but with a tapering apex. Gloeocystidia have been reported from several species, but they tend to be inconspicuous. We will discuss that feature later on.

The very small spore size, about 3–4×2 µm, makes their measuring troublesome, and satisfactory results can only be achieved with phase contrast microscope, oil immersion, ×1000 or ×1250 magnification, and viscid mountant in which the spores stay still—we are using Cotton Blue in lactic acid. Melzer's reagent and even more KOH let freely floating spores vibrate and roll continuously, and no exact dimensions can be measured. It is theoretically impossible to reach the resolution of 0.1 µm using visible light, but such distances can be subjectively estimated with a 1-µm-grid eyepiece. Measuring 30 spores from each specimen results in a tolerably small error when comparing average spore sizes between specimens and species (Parmasto & Parmasto 1987). In objects of this size, the eye easily catches different shapes, and, indeed, our measurement values agree with visible differences. Small systematic deviations may exist between individual observers, and so the measurements made by a single person are the most comparable.

Type species of the genus

Antrodiella semisupina (Berk. & M.A. Curtis) Ryvarden

in Ryvarden & Johansen, Prelim. Polypore Fl. East Africa: 261, 1980. *Polyporus semisupinus* Berk. & M.A. Curtis, in Berkeley, Grevillea 1:50, 1872. Holotype: 'Herb. Berk. 1879. Grev. 1:50. 1872. 5860 *Pol. (Anoderm.) semisupinus* [faint: N.S.]. Nov. Angl. Sprague' (K, studied).

Basidiocarps effused-reflexed with ca. 1×2 cm resupinate parts, and fingernail-shaped caps, projecting 4–6 mm, 1 mm thick at base, broadly attached and downcurved, margin sharp, when dry hard. Overall colour brownish cream with some mouse grey on upper side close to the attachment, and brown, translucent patches at bruised edges; however, colours have certainly changed in the old specimen. Pores round to angular (5–)6–8(–9) per mm, orifices regular or minutely denticulate; tubes in older (central) parts merged together, split, and pores then larger than given above. Hyphal system dimitic; generative hyphae clamped and thin-walled, skeletal hyphae dominating in all parts, flexuous, translucent, fairly thick, (2–)3–4.2(–5) µm diam., thick-walled, CB–, IKI– and KOH–, in tube trama subparallel and glued together. No cystidia, no gloeocystidia; angular crystal clusters abound among the hyphae. Hymenial cells ca. 11–13.3×3.2–4.7 µm, basidia with 4 sterigmata. Spores (2.6–)2.7–3.3(–3.4)×(1.7–)1.8–2.3(–2.5) µm, thin-walled, CB–, IKI–, almost egg-shaped, ventral side clearly rounded, not straight and never concave; no guttulae.

Specimens Examined—U.S.A. (see type).

The name *Antrodiella semisupina* has traditionally been addressed in Europe to the pileate or effused-reflexed species, typically growing on and around dead basidiocarps of *Fomes fomentarius* (L. : Fr.) J. Kickx f. However, after studying the type of *Polyporus semisupinus*, a different picture unfolded.

The collection includes two pieces of wood glued on a small sheet of paper, one piece broken and its fungus lost, the other bearing two small basidiocarps, which arise directly from wood. The host is most probably *Quercus* (of the *Q. rubra* group, teste Tuuli Timonen & Pirkko Harju, H) and the wood is white-rotted, with no mention or remnants of any preceding fungus. Even though small and over 100 years old, the specimen is in a fairly good condition, fertile, and most of the essential characteristics can be observed.

Pores size of the type specimen of *P. semisupinus* and the European specimens so called are fairly similar. A clear difference is seen in spores: they are shorter and slightly thicker in the type than in the European '*A. semisupina*'. The difference (Fig. 1) can be seen from the shape even without measuring. The lack of cyanophily in the skeletals of the holotype is deviating within the genus: *Antrodiella* species typically have a slight but clear CB+ reaction in their skeletal hyphae, which links them with the genera *Steccherinum* and *Junghuhnia*; cyanophily of the skeletals is distinct in the European '*A. semisupina*'. Anyhow, general habit and the other microscopic characters of the holotype are so similar to the other species in the group that we have no basis to propose a separation of *A. semisupina* sensu typi from the rest.

The identity of *P. semisupinus* sensu typi should be solved from further collections and field notes in eastern North America (New England), the area where the species was described. For instance, host characteristics and possible links with preceding other fungi would be of interest. The detailed description of *P. semisupinus* by Overholts (1953) matches very well with the type (for instance spores '2.5–3×2–2.5 µ', no mention of link with *Fomes fomentarius*) but not with the species so named in Europe.

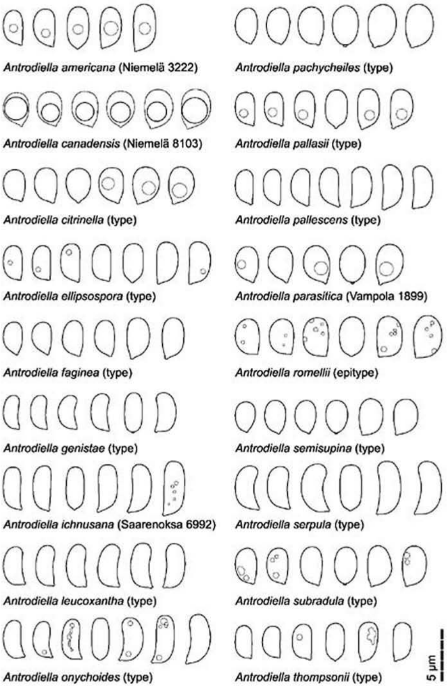
All this means that the epithet *semisupina* is inapplicable for the taxon growing almost invariably on wood decayed by *Fomes fomentarius* and usually arising from its dead basidiocarps. Of the species known to us, *A. semisupina* sensu typi comes closest to *A. faginea*.

Notes on *Antrodiella* species

Antrodiella americana Ryvarden & Gilb.

Mycotaxon 19:138, 1984. *Poria aestivalis* Overh., Bull. Penn. Agric. Exp. Sta. 418:20, 1942 (nom. inval.: ICBN (St Louis) Art. 36.1). Holotype: *Poria aestivale* [sic] Overholts, U.S.A., Pennsylvania, Cook Forest, *Fagus grandifolia*, 23.VI.1932 Overholts & White 14364 (PAC 0237862, studied).

Annual, resupinate, soft-looking but difficult to tear apart, when dry cardboard-like, basidiocarps irregularly roundish. Sterile margin fibrous, white. Pores (1–)2–4(–5) per mm, cream-coloured or honey yellow; orifices lacerate. Section: subiculum cream-coloured, tubes honey-coloured or resinous-looking. Dimitic, generative hyphae with clamps, skeletals CB(+), IKI–, KOH–, in subiculum interwoven, (2.1–)2.2–3.1(–3.5)



Antrodiella americana (Niemelä 3222)

Antrodiella pachycheiles (type)

Antrodiella canadensis (Niemelä 8103)

Antrodiella pallasii (type)

Antrodiella citrinella (type)

Antrodiella pallescens (type)

Antrodiella ellipsospora (type)

Antrodiella parasitica (Vampola 1899)

Antrodiella faginea (type)

Antrodiella romellii (epitype)

Antrodiella genistae (type)

Antrodiella semisupina (type)

Antrodiella ichnusana (Saarenoksa 6992)

Antrodiella serpula (type)

Antrodiella leucoxantha (type)

Antrodiella subradula (type)

Antrodiella onychoides (type)

Antrodiella thompsonii (type)

Figure 1. Spores of *Antrodiella* species.

Table 1. Spore measurements of *Antrodiella* species treated in this paper.

Asterisk (*) marks specimens with gloeocystidia. Currency sign (¤) marks specimens whose ITS has been sequenced by Johannesson et al. (2000). Column *n* gives the number of spores / specimens measured, if applicable. Summarising data of *A. pallescens* exclude *A. beschidica* and *A. farinacea.*

Species / specimen	n	L variation	L	W variation	W	Q' variation	Q
semisupina	**70/1**	**(2.6-)2.7-3.3(-3.4)**	**3.00**	**(1.7-)1.8-2.4(-2.5)**	**2.09**	**1.3-1.6**	**1.44**
americana	**130/4**	**(3.1-)3.2-4.4(-4.7)**	**3.72**	**(1.7-)1.9-2.3**	**2.05**	**(1.5-)1.6-2.1**	**1.81**
holotype	30	3.1-3.9	3.42	1.9-2.2(-2.3)	2.03	1.5-2.0(-2.1)	1.69
Niemelä 17.X.1976	40	(3.2-)3.3.-4.3(-4.4)	3.72	(1.7-)1.8-2.3	2.02	(1.6-)1.7-2.1	1.84
Niemelä 3332	30	3.2-4.0(-4.2)	3.53	(1.8-)1.9-2.2(-2.3)	2.06	(1.5-)1.6-1.9	1.72
Niemelä 6656	30	(3.8-)3.9-4.7	4.20	1.9-2.3	2.11	1.8-2.1	1.72
canadensis	**100/3**	**(3.0-)3.1-3.9(-4.0)**	**3.43**	**(2.2-)2.4-3.0(-3.1)**	**2.64**	**(1.1-)1.2-1.4**	**1.30**
Anttila 18.VIII.1993	30	3.1-3.8(-3.9)	3.43	2.4-3.0(-3.1)	2.69	(1.1-)1.2-1.3	1.27
Niemelä 8103	40	(3.0-)3.1-3.7	3.34	(2.2-)2.4-2.9	2.58	1.2-1.4	1.30
Penttilä 1321¤	30	3.3-4.0	3.57	(2.3-)2.4-3.0	2.66	1.3-1.4	1.34
citrinella	**160/4**	**(2.8-)2.9-3.4(-3.7)**	**3.14**	**(2.0-)2.1-2.6(-2.8)**	**2.31**	**(1.1-)1.3-1.5**	**1.36**
isotype	60	3.0-3.5(-3.7)	3.21	(2.0-)2.2-2.7(-2.8)	2.36	(1.1-)1.2-1.5	1.36
Laurila & Renvall 1982	30	2.8-3.3	3.05	2.1-2.5	2.26	1.2-1.5	1.35
Niemelä 6640	40	(2.8-)2.9-3.3(-3.5)	3.07	(2.0-)2.1-2.5(-2.6)	2.28	(1.2-)1.3-1.5	1.35
Penttilä 1223	30	3.0-3.4	3.15	(2.1-)2.2-2.5(-2.6)	2.30	1.3-1.4(-1.5)	1.37
ellipsospora	**70**	**3.2-4.0(-4.1)**	**3.51**	**(1.7-)1.8-2.1(-2.3)**	**1.95**	**(1.6-)1.7-2.0(-2.1)**	**1.80**
faginea	**646/37**	**(2.5-)2.8-3.7(-4.5)**	**3.20**	**(1.6-)1.8-2.2(-2.4)**	**1.97**	**(1.4-)1.5-1.8(-2.3)**	**1.62**
holotype*,¤	60	(2.9-)3.0-3.9(-4.3)	3.26	1.8-2.1	1.96	1.5-1.9(-2.0)	1.66
Dai 1077	30	(2.9-)3.0-3.7(-3.9)	3.29	(1.9-)2.0-2.3	2.09	1.5-1.7	1.58
Erkkilä 535	30	(2.8-)2.9-3.7(-3.9)	3.18	1.8-2.1	1.96	1.5-1.8	1.62
Kulju 7001*	32	(2.8-)2.9-3.7	3.16	1.7-2.0	1.85	(1.5-)1.6-1.9(-2.2)	1.71
Savola 18.IX.2003	30	2.9-3.6(3.9)	3.22	1.8-2.2(-2.3)	2.03	1.5-1.7(-1.8)	1.59
Niemelä 6867	30	2.9-3.4(-3.5)	3.13	1.8-2.2	1.99	(1.4-)1.5-1.7(-1.7)	1.57
Renvall 3217*,¤	30	(2.9-)3.0-3.6	3.24	(1.7-)1.8-2.2	1.97	1.5-1.9	1.64
Renvall 3347*,¤	30	2.9-3.4(-3.6)	3.15	(1.7-)1.8-2.1(-2.2)	1.90	1.5-1.8	1.66
Romell 24.VIII.1910*	30	3.0-3.5(-3.6)	3.23	1.9-2.3	2.08	1.5-1.7	1.56
Saarenoksa 18786	30	2.8-3.7(-3.8)	3.16	(1.7-)1.8-2.2	1.96	(1.4-)1.5-1.8	1.61
Saarenoksa 21687*	30	(3.0-)3.2-3.9(-4.0)	3.46	1.9-2.3(-2.4)	2.11	1.5-1.8(-1.9)	1.64
ichnusana	**150/5**	**(3.9-)4.0-5.2(-5.4)**	**4.55**	**(1.7-)1.8-2.1(-2.2)**	**1.95**	**(2.0-)2.2-2.6(-2.8)**	**2.33**
Bernicchia 7694	30	(4.1-)4.3-5.2(-5.3)	4.74	(1.8-)1.9-2.2	2.02	(2.0-)2.1-2.6	2.35
Saarenoksa 6992	30	4.0-5.3(-5.4)	4.64	1.7-2.2	1.93	2.2-2.7(-2.8)	2.40
Saarenoksa 11090	30	3.9-5.1	4.37	(1.7-)1.8-2.0	1.88	2.1-2.6	2.32
Saarenoksa 13892	30	(3.9-)4.0-5.2(-5.4)	4.45	1.8-2.1(-2.2)	1.94	2.1-2.5	2.29
Saarenoksa 16390	30	(4.0-)4.1-4.9(-5.1)	4.54	1.8-2.1(-2.2)	1.98	(2.0-)2.1-2.6	2.29
leucoxantha	**412/9**	**(2.9-)3.2-4.5(-5.6)**	**3.89**	**1.5-1.9(-2.1)**	**1.71**	**(1.7-)1.9-2.7(-2.9)**	**2.23**
lectotype*	62	(3.2-)3.4-4.7(-5.6)	3.89	(1.5-)1.6-2.0	1.79	(1.8-)1.9-2.5(-2.9)	2.17
lectotype of genistae	70	(2.9-)3.0-4.1(-4.3)	3.53	1.5-1.9(-2.0)	1.71	(1.7-)1.8-2.3(-2.4)	2.07
Jakobsson 918*	30	3.7-4.8(-5.3)	4.12	1.5-1.8(-2.1)	1.65	(2.1-)2.2-2.8	2.47
PRM 854493	30	(3.1-)3.2-3.8	3.47	1.5-1.8(-1.9)	1.65	(1.8-)1.9-2.4	2.10
PRM 871821	30	3.4-4.5(-5.0)	3.96	1.5-1.9	1.71	2.1-2.5(-2.6)	2.31
PRM 889755*	40	3.4-4.2(-4.3)	3.85	(1.6-)1.7-1.9(-2.0)	1.80	(1.9-)2.0-2.4	2.14
PRM 890852	30	3.2-3.9(-4.0)	3.46	(1.5-)1.6-1.9	1.75	1.8-2.3	1.98
Saarenoksa 58589	60	(3.3-)3.5-4.4(-4.5)	3.85	(1.5)-1.6-1.8(-1.9)	1.68	(2.1-)2.2-2.5(-2.6)	2.29
Särkkä 50	60	(3.5-)3.7-4.7	4.14	1.5-1.8(-1.9)	1.66	(2.1-)2.2-2.9	2.50
onychoides	**180/5**	**(3-)3.2-4.8(-5.3)**	**3.86**	**(1.5-)1.6-1.9(-2.4)**	**1.75**	**(1.6-)1.8-2.7(-3.0)**	**2.21**
holotype	60	(3.7-)3.8-4.9(-5.1)	4.31	1.6-1.9(-2.0)	1.77	(2.1-)2.2-2.7	2.44
Niemelä 3227	30	3.0-4.0(-4.3)	3.39	(1.5-)1.6-1.8	1.70	1.7-2.3(-2.4)	1.99
Saarenoksa 24791	30	(3.0-)3.1-4.3(-5.3)	3.64	(1.6-)1.7-1.9	1.78	(1.7-)1.8-2.2	1.99
Saarenoksa 45791	30	(3.1-)3.2-4.9(-5.3)	3.89	(1.5-)1.6-2.1(-2.4)	1.81	(1.6-)2.0-2.4	2.15

Table 1 continued.

Species / specimen	n	L variation	L	W variation	W	Q' variation	Q
Salonen 26.IX.2000	30	(3.2-)3.3-4.5	3.72	1.5-1.9(-2.0)	1.67	2-2.5(-3.0)	2.23
pachycheiles	**120/1**	**(3.1-)3.3-4.2(-4.4)**	**3.67**	**(2.0-)2.2-2.8(-3.1)**	**2.45**	**(1.3-)1.4-1.7**	**1.50**
pallasii	**190/6**	**(2.9-)3.0-3.7(-3.9)**	**3.23**	**(1.6-)1.8-2.1(-2.3)**	**1.93**	**(1.4-)1.5-1.9**	**1.67**
isotype¤	30	(2.9-)3.0-3.8	3.34	1.8-2.2	1.98	1.5-1.9	1.69
Kujala & Eriksson 9416	30	2.9-3.7(-3.8)	3.29	1.8-2.1(-2.2)	1.99	1.5-1.8	1.65
Niemelä 2143	30	2.9-3.3(-3.4)	3.12	(1.6-)1.7-2.0	1.85	1.5-1.9	1.69
Niemelä 6580	40	(2.9-)3.0-3.7(-3.8)	3.21	1.8-2.1(-2.2)	1.93	(1.4-)1.5-1.9	1.66
Niemelä 6617	30	(2.9-)3.9-3.5(-3.6)	3.21	1.7-2.0	1.90	1.5-1.8(-1.9)	1.68
Niemelä 7139	30	(2.9-)3.0-3.7(-3.9)	3.24	(1.7-)1.8-2.3	1.94	1.5-1.8	1.67
pallescens	**361/11**	**(2.9-)3.0-4.1(-4.8)**	**3.47**	**(1.6-)1.7-2.0(-2.3)**	**1.84**	**(1.5-)1.7-2.2(-2.5)**	**1.89**
lectotype	60	(3.0-)3.1-4.1(-4.8)	3.54	(1.6-)1.7-2.0(-2.1)	1.81	(1.7-)1.8-2.2(-2.5)	1.96
holotype of beschida¤	30	(3.1-)3.2-4.0(-4.1)	3.49	1.8-2.1	1.93	1.7-2.0(-2.1)	1.81
holotype of farinacea¤	30	2.9-3.5(-3.8)	3.10	1.6-1.9	1.78	1.6-1.9(-2.0)	1.74
Haikonen 15652	30	(3.4-)3.5-4.2	3.89	1.7-2.1	1.88	(1.8-)1.9-2.2	2.07
Jakobsson 1516	30	3.0-3.6(-3.7)	3.33	1.7-2.0	1.85	1.7-2.0	1.81
Miettinen 7972	30	(2.9-)3.0-3.9(-4.0)	3.29	(1.6-)1.7-1.9	1.75	(1.6-)1.7-2.2	1.87
Niemelä 2788	30	(3.0-)3.1-4.3(-4.6)	3.63	1.7-2.3	1.96	1.7-2.1(-2.4)	1.85
Niemelä 5548	30	3.2-3.8	3.42	1.7-2.1	1.84	1.7-2.0	1.86
Niemelä 6280	30	(3.0-)3.1-3.7(-3.8)	3.32	1.7-2.1	1.92	(1.5-)1.6-1.9	1.73
Niemelä 6705*	30	(3.1-)3.2-3.7(-3.8)	3.41	1.7-2.0	1.84	1.7-2.0(-2.1)	1.85
Niemelä 7363	30	(3.3-)3.5-4.4(-4.6)	3.91	1.8-2.0	1.92	1.8-2.3	2.05
Renvall 3337¤	30	3.0-3.5(-3.7)	3.20	1.6-1.9	1.76	1.6-2.0	1.82
Renvall 3360¤	31	(2.9-)3.0-3.7(-3.8)	3.17	1.7-1.8	1.76	1.7-2.1	1.80
parasitica	**191/6**	**(3.0-)3.2-4.1(-4.3)**	**3.63**	**(2.0-)2.2-2.9(-3.0)**	**2.50**	**(1.1-)1.2-1.8(-2.0)**	**1.45**
holotype¤	30	(3.0-)3.1-3.9(-4.1)	3.48	(2.3-)2.4-3.0	2.67	(1.1-)1.2-1.5(-1.6)	1.30
Dunger 13711	40	(3.2-)3.3-4.0(-4.1)	3.63	(2.1-)2.2-2.8	2.45	(1.2-)1.4-1.7	1.48
exsiccati Vampola	31	(3.2-)3.3-4.2(-4.3)	3.73	2.0-2.7	2.25	(1.3-)1.4-2.0	1.66
Vampola 1886	30	3.2-3.8(4.0)	3.52	2.3-2.8	2.50	(1.2-)1.3-1.6(-1.7)	1.39
Vampola 1899	30	(3.2-)3.3-4.1	3.65	(2.2-)2.3-2.9(-3.0)	2.62	1.3-1.5	1.40
Vampola 1901	30	3.3-4.0(-4.1)	3.77	2.3-2.7(-2.8)	2.51	(1.3-)1.4-1.7	1.50
romellii	**371/11**	**(3.0-)3.4-4.4(-5.1)**	**3.84**	**(2.2-)2.3-2.9(-3.1)**	**2.55**	**(1.2-)1.3-1.7(-2.0)**	**1.51**
epitype¤	41	(3.3-)3.4-4.0	3.71	2.3-2.7	2.49	1.3-1.6(1.7)	1.48
Jahn 1970	30	(3.7-)3.8-4.3(-4.4)	4.03	2.5-2.9(-3.0)	2.75	(1.3-)1.4-1.6	1.47
Kinnunen 1120	30	(3.9-)4.0-5.1	4.44	2.3-3.0(-3.1)	2.59	1.6-1.9(-2.0)	1.71
Laurila 9.IX.1937	30	3.2-3.9(-4.2)	3.56	2.2-2.7	2.37	1.3-1.6(-1.7)	1.50
Niemelä 5.IX.1971	40	(3.3-)3.4-4.2(-4.3)	3.97	2.3-2.7(-2.8)	2.56	1.4-1.7	1.55
Niemelä 6095	40	(3.2-)3.3-3.9(-4.0)	3.61	(2.2-)2.3-2.7(-2.8)	2.47	(1.2-)1.3-1.6	1.46
Niemelä 6757	30	4.0-4.5(-4.8)	4.29	(2.4-)2.5-3.0	2.72	1.5-1.7	1.58
Saarenoksa 11587	30	3.6-4.3(-4.4)	3.97	2.4-2.7(-2.8)	2.56	1.4-1.7	1.55
Saarenoksa 24293¤	40	3.3-4.0(-4.1)	3.63	(2.2-)2.3-2.7(-2.8)	2.49	1.3-1.6(-1.7)	1.46
Toresson 22.X.1995	30	(3.3-)3.4-4.0(-4.1)	3.80	(2.2-)2.5-2.9(-3.0)	2.71	1.3-1.5(-1.7)	1.40
isotype of subradula	30	(3.0-)3.3-4.1(-4.2)	3.72	2.2-2.6(-2.7)	2.43	(1.2-)1.3-1.7	1.53
serpula	**260/6**	**(3.3-)3.6-5.0(-5.7)**	**4.12**	**(1.6-)1.8-2.2(-2.5)**	**1.95**	**(1.8-)1.9-2.4(-2.7)**	**2.11**
holotype	60	(3.9-)4.0-5.3(-5.4)	4.59	(1.8-)1.9-2.4(-2.5)	2.09	1.9-2.6(-2.7)	2.20
Niemelä 3278	40	(3.3-)3.8-4.9(-5.7)	4.17	(1.7-)1.8-2.2	1.91	(1.8-)2.0-2.6	2.18
Niemelä 5529	30	3.6-4.5	3.96	1.8-2.2	1.97	1.8-2.2(-2.3)	2.01
Niemelä 6015	30	3.7-4.4(-4.5)	3.98	1.8-2.1	1.98	1.9-2.1(-2.2)	2.01
Niemelä 6899	40	(3.4-)3.6-4.7(-4.8)	3.90	1.7-2.2(-2.3)	1.89	(1.8-)1.9-2.3	2.08
Saarenoksa 18686¤	60	(3.5-)3.6-4.7(-5.0)	3.93	(1.6-)1.7-2.0(-2.2)	1.86	(1.8-)1.9-2.4(-2.6)	2.11
subradula	**60/1**	**3.1-3.9(-4.1)**	**3.49**	**2.0-2.3(-2.4)**	**2.18**	**(1.3-)1.5-1.8(-1.9)**	**1.60**
thompsonii*	**60/1**	**(2.8-)2.9-3.6(-3.8)**	**3.15**	**(1.6-)1.7-2.0**	**1.79**	**1.6-1.9(-2.0)**	**1.76**

µm, in tube trama subparallel, (2.2–)2.6–3.8(–4) µm, lumen distinct. Cubical crystals sometimes scattered on hyphae. No distinct cystidioles; gloeocystidia prominent, 15–60×4–8 µm, yellow, crowded at tube bottoms and scattered in hymenium deep in the tubes. Basidia with 4 sterigmata. Spores ellipsoid, thin-walled, CB–, IKI–, (3–)3.2–4.4 (–4.7)×(1.8–)1.9–2.3 µm.

> SPECIMENS EXAMINED—**Finland.** Varsinais-Suomi: Tammisaari, 17.X.1976 Niemelä. Uusimaa: Vantaa, 1985 Niemelä 3222. Etelä-Häme: Lammi, 1999 Niemelä 6656. **U.S.A.** (see type).
> —Finnish collections from *Corylus avellana+Pseudochaete tabacina.*

Of the studied *Antrodiella* species, Johannesson et al. (2000) found *Antrodiella americana* to be fairly distant from the others. Pores are slightly larger in the type than in European materials, originally 2 per mm, merging together and then 1–1.5 per mm; in Europe the measurements usually give 2–3 pores per mm. Spores of the American material are slightly smaller than in North Europe (Tab. 1), but well within the range and similar in shape. It may be difficult to find enough evidence to split this into two taxa. *Antrodiella americana* is a successor of *Pseudochaete tabacina* (Sowerby) T. Wagner & M. Fisch., usually fruiting on its dead basidiocarps.

Antrodiella canadensis (Overh.) Niemelä

Karstenia 45:75, 2005. *Polyporus canadensis* Overh. in Lowe, Mycotaxon 2:45, 1975. Holotype: Canada, Ottawa, Dow's Swamp, on spruce stump, 16.IX.1933 Groves 16860 (PAC, studied).

This species was described and illustrated by Niemelä (1985).

> SPECIMENS EXAMINED—**Canada** (see type). **Finland.** Kainuu: Suomussalmi, 21.VIII.1993 Anttila. Koillismaa: Salla, 2005 Niemelä 8103. Pohjois-Karjala: Lieksa, 1989 Penttilä 1321.
> —Finnish collections from *Pinus sylvestris.*

The complicated nomenclature of this taxon was discussed by Ryvarden & Gilbertson (1984), who renamed it as *Antrodiella overholtsii* Ryvarden & Gilb. because in their opinion the original description was not validly made. Niemelä et al. (2005) accepted the above-listed protologue as valid, and transferred the old name in the genus *Antrodiella.* Johannesson et al. (2000) studied the phylogeny of *P. canadensis* together with several *Antrodiella* species.

Antrodiella citrinella Niemelä & Ryvarden

Karstenia 23:26, 1983. Holotype: Norway, Oslo, *Picea abies* + dead *Fomitopsis pinicola,* 7.X.1982 Ryvarden 20563 (O, isotype H, studied).

The species was described and illustrated by Niemelä & Ryvarden (1983).

> SPECIMENS EXAMINED—**Finland.** Etelä-Häme: Lammi, 1989 Renvall 1982. Kittilän Lappi: Kolari, 1999 Niemelä 6640. Pohjois-Karjala, Lieksa, 1989 Penttilä 1223. **Norway** (see type).
> —All from *Picea abies+Fomitopsis pinicola.*

Antrodiella citrinella is characterised by bright yellow colour, roundish spores, and by its growth on wood previously brown-rotted by *Fomitopsis pinicola* (Sw. : Fr.) P. Karst. The

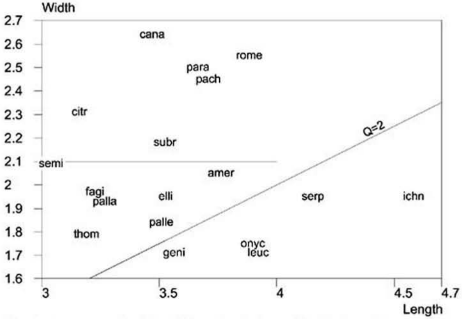


Figure 2. Average spore size of *Antrodiella* species. Species are abbreviated according to 4 to 5 first letters of their epithets. Lines group species into narrow-spored (Q>2), small-spored (width below 2.1 µm) and wide-spored groups.

commonest host is spruce, but also pine, birch, aspen and alder are accepted, provided that the preceding species was there. Often *A. citrinella* fruits directly on the dead basidiocarps of *F. pinicola*.

Antrodiella ellipsospora (Pilát) Niemelä & Miettinen, **comb. nov.**

(MB500769)

Basionym: *Leptoporus wynnei* f. *ellipsosporus* Pilát, Bull. Soc. Mycol. France 52:306, 1937. *Leptoporus ellipsosporus* (Pilát) Romagn., Bull. Soc. Mycol. France 60:88, 1944. Lectotype: Russia, Sayany, Arasuk, *Pinus* [*cembra* subsp.] *sibirica*, 1.IX.1932 [B.I.] Krawtzew (PRM 25017, studied). Selected as type by Kotlaba & Pouzar (1989:39).

Pileate, white to cream-coloured, hard when dry. Caps fingernail-shaped, strongly curved when dry, 10 mm wide, up to 2 mm thick, projecting 5 mm, surface matt, margin sharp. Pores 7–9 per mm, orifices entire, walls not appearing fragile. Section: context cream-coloured, hard when dry, tubes concolorous. Dimitic, generative hyphae with clamp connections, 2–3.2 µm in diam., skeletals CB(+), IKI–, interwoven and dominating except close to substrate and tube mouths, in subiculum (2.6–)3–3.5(–3.8) µm in diam., in tube trama 2.2–3(–3.3) µm, lumen narrow and indistinct in subicular skeletals, wide to narrow in trama. Basidia with 4 sterigmata, 8.5–12×3.7–4.6 µm. Spores ellipsoid to short cylindrical, thin-walled, CB–, IKI–, 3.2–4(–4.1)×1.8–2.1(–2.3) µm, ventral side convex, flat, or slightly concave.

Specimens Examined—Russia (see type).

Pilát (1937) described *Leptoporus wynnei* f. *ellipsosporus* from a specimen collected by Krawtzew from *Pinus cembra* subsp. *sibirica* in Siberia. Romagnesi (1944) raised the form to species rank as *Leptoporus ellipsosporus*. Kotlaba & Pouzar (1989) and Ryvarden & Gilbertson (1994: 696) showed the type to belong to the *Antrodiella semisupina* complex; they also discussed the complicated nomenclature of this taxon. We restudied the lectotype. It is small and young but in a rather good condition. Substrate is strongly brown-rotted gymnosperm wood, *Pinus sibirica* according to the label, supported by microscopic analysis (by Pirkko Harju, H). Macroscopy, gymnosperm host and spore size point towards *Antrodiella pallasii*, but that species has shorter, uniguttulate spores, narrower skeletals with distinct lumen in subiculum, and it is a follower of *Trichaptum abietinum* (Pers. : Fr.) Ryvarden, a white-rot fungus. *Antrodiella faginea* has clearly shorter and more ellipsoid spores and it grows on angiosperms. *Antrodiella pallescens* comes closest microscopically; its spores are slightly narrower and more uniformly straight cylindrical. Ecology is different: *A. pallescens* is restricted to angiosperm hosts and follows *Fomes fomentarius*, which is a white-rot fungus. We accept Pilát's taxon as a good species, and hence make the necessary combination. Yet new material is needed to establish the identity of this species.

Antrodiella faginea Vampola & Pouzar

Czech Mycol. 49:25, 1996. Holotype: Czech Rep., Moravia: Jihlava, Zborná, Ptačí vrch, alt. 637 m, *Fagus sylvatica*, 5.VII.1990 Vampola (PRM 842925, studied).

= ?*Antrodiella micra* Y.C. Dai, Mycotaxon 89:393, 2004. Holotype: China, Jilin, Antu, Changbaishan Nat. Res., *Populus+Phellinus gilvus*, 19.IX.1998 Dai 2998 (IFP, not studied).

Annual, pileate, effused-reflexed or resupinate, leathery, when dry hard. Caps fingernail-shaped, spathulate, flabelliform or even substipitate, 5–20 mm wide, up to 3 mm thick, projecting 2–20 mm, surface matt, cream-coloured, light ochraceous yellow or even greyish, somewhat hygrophanous, margin sharp and often incised; resupinate area 10–150 ×5–40 mm, roundish or ellipsoid, neighbouring areas later merging together. Pores cream-coloured, sometimes with purple-greyish patches at older centre and close to the attachment, (5–)6–8 per mm, orifices entire. Section: context cream, homogeneous, when dry hard, tubes concolorous. Dimitic, generative hyphae with clamps, skeletals CB(+), IKI– or faintly amyloid in tube trama, KOH–, in context/subiculum radially subparallel, (2.4–)2.7–4.2(–5.5) µm in diam., in tube trama tightly interwoven but not agglutinated, (1.8–)2.3–3.2(–4) µm, lumen wide to narrow in context skeletals, indistinct in subiculum, capillary in trama. Crystal clusters seen in between hyphae; occasional hyphal pegs. Cystidioles with conical apex; gloeocystidia 9–18×3.6–6 µm, sometimes common, in other specimens occasional or evidently absent, weakly differentiated, resembling juvenile basidia, often present at tube bottoms in old hymenium. Basidia with 4 sterigmata. Spores ellipsoid, thin-walled, CB–, IKI–, (2.5–)2.8–3.7(–4.5)×(1.6–)1.8–2.2(–2.5) µm, sometimes tapering to proximal apex, ventral side flat or a little convex.

Specimens Examined—**China.** Jilin: Antu, Changbai, *Acer*, 1993 Dai 1077; *Betula*, 1993 Dai 1074. **Czech Rep.** (see *type). **Finland.** Uusimaa: Helsinki, *Populus+Phellinus punctatus*, 1985 Erkkilä 535; *Salix+P. punctatus*, 1986 Saarenoksa 18786;

Salix+*Pseudochaete tabacina*, 1994 Saarenoksa 9694. Sipoo, *Alnus*, 1985 Saarenoksa 10185; *Betula*, 1987 Saarenoksa 26687; *Populus*, 1993 Saarenoksa *8093; *Salix*+*P. punctatus*, 1985 Saarenoksa 11185; *Sorbus*+*P. punctatus*, 1984 Saarenoksa *34384. Kirkkonummi, *Corylus*+*P. punctatus*, 1985 Saarenoksa 12995. Tuusula, *Corylus*+*Inonotus radiatus*, 1987 Saarenoksa 21687. Vantaa, *Prunus*, 1993 Renvall *3217; *Salix*+*P. conchatus*, 18.IX.2003 Savola. Etelä-Häme: Lammi, *Populus*, 1993 Renvall *3347. Pohjois-Karjala: Ilomantsi, *Betula*+*Pycnoporus cinnabarinus*, 2003 Penttilä 14342. Kainuu: Kuhmo, *Populus*, 1998 Miettinen *330, 373, 460, 495, *500, 599, 612, 623, 691; +*Phellinus tremulae*, 355, *365, 517, *674, 693, 723; +*Phellinus populicola*, *444, *600; +*Inonotus rheades*, *458. Oulun Pohjanmaa: Oulu, *Alnus*, 2001 Kulju *7001. Kittilän Lappi: Kittilä, *Salix*+*P. conchatus*, 2000 Niemelä 6867. **Sweden.** Torne Lappmark: Jukkasjärvi, *Betula*, 1910 Romell 14658 (S). **Ukraine.** Zakarpats'ka Oblast: Delovoye ("Trebušany"), *Fagus*, 1937 Pilát (H ex PRM 488786).

—Specimens marked with an asterisk (*) bear gloeocystidia.

Antrodiella faginea resembles *A. pallescens*, but the former is more commonly effused and pilei are thinner or spathulate. Hyphal structure is identical, but spores are thicker and often shorter (Figs. 1 and 3), with convex to straight ventral side, not concave like in *A. pallescens*; different shapes are seen in the Q values (Fig. 4). In the study of Johannesson et al. (2000) these two species were clearly separated on the basis of their ITS sequences.

Spore size of *A. faginea* comes also close to *A. pallasii* (Fig. 2), which grows on gymnosperms rotten by *Trichaptum*, and has slightly smaller spores and narrower subicular skeletals. Basidiocarps of the latter are yellowish, and tubes tend to split and therefore have lacerate orifices. *Antrodiella semisupina* sensu stricto resembles *A. faginea* as well, and their identities should be reconsidered when the American taxon becomes better known.

Antrodiella faginea is rather common throughout Finland. It is found in a wide variety of biotopes, ranging from small branches of deciduous trees in herb-rich forests in the hemiboreal southern coast, to aspen trunks in old-growth forests of boreal North Finland. The shape ranges from substipitate to strictly resupinate, and the occurrence of gloeocystidia in the basidiocarps varies. Consequently, it was suspected that several species might be involved, and detailed microscopic studies were made on the Finnish collections and Central European type material. We found no support of the existence of several species: there was no covariance between the area of occurrence, ecology, growth habit, or microscopy of the studied specimens. Johannesson et al. (2000) found Czech specimens to have identical to almost identical ITS sequences with Finnish specimens.

It also became clear that gloeocystidia are an unreliable character for identification purposes, since only 15 out of 38 specimens studied in detail bore them. Even if present they are usually inconspicuous and difficult to observe. One of the specimens (Renvall 3217) sequenced by Johannesson et al. (2000) and found to belong to *A. faginea* had practically no gloeocystidia whereas two others, including the type, bore plenty of them.

Antrodiella faginea seems to be a successor species of some *Hymenochaetaceae* species, most commonly *Phellinus conchatus* (Pers. : Fr.) Quél., *P. punctatus* (P. Karst.) Pilát and *P. tremulae* (Bondartsev) Bondartsev & P.N. Borisov. The author O.M. found it much more commonly from trunks with *P. tremulae* than any other polypore species in his study of over one thousand aspen trunks in Central Finland. Yet many finds show no connection to species of *Hymenochaetaceae*, and the link to a preceding species is evidently weaker than in, for instance, *A. pallescens* or *A. citrinella*.

Antrodiella micra was described from China (Dai 2004) as a species related to *A. faginea* but lacking gloeocystidia and being resupinate. These variable characters may not suffice for the separation of a species. Moreover, the growth on *Phellinus* fits well with *A. faginea*. We propose that *A. micra* represents *A. faginea*. The Chinese *faginea* specimens reported here are pileate and agree well with European material, although having a slightly larger average spore size.

Antrodiella ichnusana Bernicchia, Renvall & Arras

in Bernicchia, *Polyporaceae* s.l.: 127, 2005. Paratypes: Italy, Sardinia, Arzana (Nuoro), Villagrande, *Alnus glutinosa*, 30.XI.2003 Bernicchia & Arras 7694, 7695 (H ex KUO & HUBO, studied).

Annual, resupinate, soft leathery, when dry hard, basidiocarps 15–30×8–15 mm, irregularly roundish, usually emerging solitarily. Sterile margin narrow, fibrous, in young specimens hygrophanous. Pores (3–)4–5(–6) per mm, when fresh cream-coloured and hygrophanous, when dry dark cream-coloured or tan; orifices entire. Section: subiculum cream-coloured, tubes concolorous. Dimitic, generative hyphae with clamps, skeletals uniform, CB(+), IKI–, KOH–, interwoven in all parts but not agglutinated, 2–3.2 µm in diam. Crystal clusters sometimes present in between hyphae; no distinct cystidioles or gloeocystidia. Basidia with 4 sterigmata. Spores cylindrical, straight or a little drooping at apicular end, thin-walled, CB–, IKI–, (3.9–)4–5.1(–5.4)×(1.7–)1.8–2.1(–2.2) µm.

SPECIMENS EXAMINED—**Finland.** Uusimaa: Helsinki, 1993 Haanpää 1023, 1324, 1325; 1993 Niemelä 5671; 1987–1995 Saarenoksa 6992, 8390, 8491, 9295, 9391, 9490, 9594, 9991, 10291, 10591, 11090, 11695, 12791, 13892, 15790, 16190, 16290, 16390, 19792, 30190. Sipoo, 1990–1995 Saarenoksa 5195, 12395, 26390; 2004 Niemelä 7743. **France.** Sardinia, Nuoro: Lago Alto Flumendosa, 2000 Ryvarden 43171 (O, H). Savoie: Valmorel, *Acer*, 5.XI.1997 Pieri. **Italy** (see types). **Netherlands.** Zuid-Holland: Oostvoorne, *Quercus*, 1963 Donk 12501 ("*Poria romellii*", L 963.243123).

—Host *Alnus*, unless otherwise indicated. Only selected specimens are listed from Finland.

The species was described recently from Italy (Bernicchia 2005). However, the existence of this taxon was well known in Finland since the second half of the 1980s. Mr Reima Saarenoksa (Helsinki) collected it repeatedly and made field observations in seaside alder forests around Helsinki. Those annotated materials were preserved in the Botanical Museum of the University of Helsinki under the provisional name '*Antrodiella alni* Saarenoksa', referring to its growth on *Alnus glutinosa*. Growth sites are moist seaside forests with rich mull or mud soil and dense and tall field layer of *Filipendula*, *Aegopodium*, *Urtica*, *Equisetum*, *Lysimachia*, *Rubus*, etc. In addition to *Alnus*, also *Prunus padus*, *Salix caprea*, *Sambucus racemosa*, *Acer platanoides*, and scattered birch and spruce grow in the area. Basidiocarps develop on thin (1–2 cm diam.) fallen branches. These field notes were compiled from herbarium labels and personal discussions with Reima Saarenoksa, of which we are grateful. At present, the species is known in Finland only along the southern coastline of the metropolitan area. Records from France and the Netherlands are new.

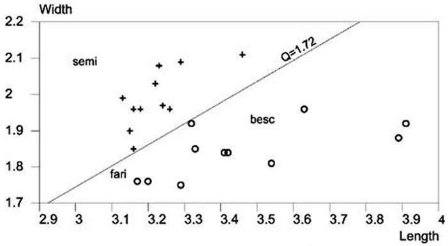


Figure 3. Average spore sizes of individual specimens of *A. faginea* (+), *A. pallescens* (○), *A. semisupina*, *A. farinacea* and *A. beschidica* (abbreviated by their epithets).

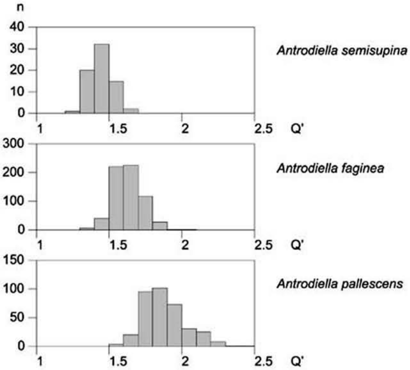


Figure 4. Histograms of Q' values (length/width ratio of individual spores) of three closely related *Antrodiella* species (n=number of spores).

At first sight *A. ichnusana* resembles very much *A. romellii*, and often the two are collected side by side in the same habitats. In the field, the species is separated from *A. romellii* by its larger pores. Under the microscope, the striking difference is the cylindrical spore shape of *A. ichnusana*, versus broadly ellipsoid in *A. romellii* (Fig. 1).

Antrodiella leucoxantha (Bres.) Miettinen & Niemelä, **comb. nov.**

(MB500772)

Basionym: *Polyporus leucoxanthus* Bres., Mycologia 17:73, 1925. **Lectotype** (designated here): U.S.A., Virginia, Great Falls, on *Robinia pseudoacacia*, 23.IX.1921, coll. J.R. Weir 21127, det. G. Bresadola (BPI US0211632, studied).

= *Coriolus hoehnelii* subsp. *genistae* Bourdot & Galzin, Bull. Soc. Mycol. France 41:145, 1925. *Coriolus genistae* Bourdot & Galzin, Bull. Soc. Mycol. France 41:145, 1925. Lectotype: '*Coriolus genistae* nob., sur genêt, bois de pins, environs d'Epinal (Vosges), XII.1904, leg. Galzin, det. H. Bourdot' (herb. Bourdot 3975, PC, studied). Selected as type by Donk (1974:264).

Annual, pileate with minute caps, 4–10 mm wide, projecting 3–5 mm from wood, 1–2 mm thick at base, downcurved, when fresh white, when dry cream or straw-coloured and hard, smooth and matt above, margin sharp. Pores round, 5–6(–7) per mm, orifices regular, not denticulate. Section: context and subiculum white, tubes cream-coloured. Hyphal system dimitic, generative hyphae with clamps, thin-walled, skeletals dominating in all parts, thick-walled and with a distinct lumen, in context/subiculum (2.1–)2.6–4(–5.6) µm in diam., in tube trama (2–)2.5–3.3(–3.7) µm, IKI– or slightly amyloid, CB(+), KOH–. Gloeocystidia mostly absent, sometimes present, 13–21×5.5–9 µm, clavate, distinct but not prominent; cystidioles like basidioles but with a tapering, fairly blunt apex. Basidia with 4 sterigmata. Spores narrow, cylindrical, thin- and smooth-walled, IKI–, CB–, (2.9–)3.2–4.5(–5.6)×1.5–1.9(–2.1) µm, almost always clearly curved with concave ventral side.

Specimens Examined—**Czech Rep.** Bohemia: Karlštejn, *Quercus*, 1996 Landa (PRM *889755). Roztoky, *Quercus*, 1996 Pouzar (PRM 890582). Zbořený Kostelec, *Quercus*, 1980 Kotlaba (PRM 871821). **Finland.** Uusimaa: Helsinki, *Populus*, 1989 Saarenoksa 58589. Keski-Pohjanmaa: Nykarleby, *Betula*, 1994 Jakobsson *918. Raahe, *Betula*, 1993 Särkkä 50. **France** (see type of *C. genistae*). **Slovakia.** Kalná Roztoka, *Fagus*, 1987 Kotlaba & Pouzar (PRM 854493). **U.S.A.** (*lectotype & same data BPI US0211634).

Excluded from the description above: 'Rossia, Wasilienka, *Polyporus leucoxanthus* Bres., on *Populus tremula*' (BPI US0211633). * = gloeocystidia observed.

Ryvarden (1988) showed *Polyporus leucoxanthus* to belong to the *Antrodiella semisupina* complex. Original collections in BPI include three packages, all marked as syntypes. Two of them (US0211632 = Weir 21127, and US0211634) are Weir's collections from *Robinia pseudoacacia* in Virginia, U.S.A., and one from *Populus tremula* in "Rossia, Wasilienka", now possibly Ukraine. The excluded syntype, with scanty spores, may represent *Antrodiella pallescens*.

US0211632 (Weir 21127) was the only specimen mentioned by number in Bresadola's (1925) description, and, even though small, it is in good condition and fertile. Annotations show that this was the specimen that Ryvarden (1988) examined for his type studies. Therefore it is here selected as **the lectotype** of *Polyporus leucoxanthus*.

US0211634 is obviously its duplicate, and similar in all respects. The lectotype specimen is indisputably an *Antrodiella*, characterised by small spores, dimitic hyphal structure and faintly cyanophilous skeletal hyphae. Spores are too narrow for the American *Antrodiella semisupina*, and too curved for *A. pallescens* (Fig. 1). Nothing points towards any other preceding fungus. *Robinia* is not mentioned as a host of *Fomes fomentarius* (predecessor of *Antrodiella pallescens*) or *Inonotus radiatus* (Sowerby: Fr.) P. Karst. (predecessor of *Antrodiella serpula*) (Gilbertson & Ryvarden 1986, Ryvarden & Gilbertson 1993), and it is fairly sure that neither *Fomes* nor *Inonotus* was growing on the tree.

Spores in the lectotype remind those of *Antrodiella onychoides*, *A. ichnusana* (a strictly resupinate species with larger pores, spores almost straight), and also *A. genistae* and *A. serpula* (= *A. hoehnelii*, see later), although they are usually longer in the last-mentioned species. Cap surface of *A. serpula* is rough with warts sharp to touch, while it is smooth in the present lectotype specimen. The minute pilei of the lectotype are perfectly developed with good tubes and sharp edge; in *A. serpula* such small pilei are juvenile nodules only, and its fully developed basidiocarps are more robust. Skeletal hyphae of *A. serpula* are thicker than in *A. leucoxantha*. For these reasons we don't consider them to be conspecific.

The identity versus *A. genistae* needed a detailed study. Spores are slightly longer in *A. leucoxantha*. Pore size is the same, and no striking differences were found in the other characters. When further European collections were studied, the differences in spore size became less significant: all transitions were present, and spore measurements in North European collections were even closer to the American type *(leucoxantha)* than to the European one *(genistae)*. So the slight difference between *A. genistae* and *A. leucoxantha* does not run along the continents. The material of this taxon was the most heterogeneous among the studied taxa, deserving further study.

The two names were published the same year, but *P. leucoxanthus* has priority (the March–April issue of Mycologia vol. 17, 1925) over *P. genistae* (second issue of Bull. Soc. Mycol. France vol. 41, 1925, date of publication 1 Sep 1925).

Antrodiella onychoides is strikingly similar to this species, e.g. in its spore characteristics. Ryvarden & Gilbertson (1993) suggested that *A. onychoides* may be just a haploid form of *A. genistae*.

Antrodiella onychoides (Egeland) Niemelä

Karstenia 22:11, 1982. *Polyporus onychoides* Egeland, Nyt Mag. Naturvidensk. 51:92, 1913.
Holotype: '*Polystictus onychoides* Egel. n. sp., [Norway.] Vestre Aker: Ekely, *Fraxinus*, 26.XII.1912' (O 55295, studied).

Annual, pileate with minute caps or effused-reflexed, 4–35 mm wide, projecting 3–7 mm from wood, 1–2 mm thick at base, downcurved, white to cream-coloured, smooth and matt above, margin sharp, when dry hard. Pores round, 5–8 per mm, orifices regular, not denticulate. Hyphal system dimitic, generative hyphae without clamps, thin- to slightly thick-walled, skeletals dominating in all parts except upper subiculum, thick-walled and with distinct lumen, in context/subiculum (2.2–)3.1–4(–4.6) µm in diam., in tube trama (2.5–)2.9–3.4(–4) µm, IKI– or slightly amyloid, CB(+), KOH– or swelling. No cystidia. Basidia with 4 sterigmata. Spores narrow, cylindrical, thin- and smooth-walled, IKI–, CB–, (2.9–)3.2–4.5(–5.6)×1.5–1.9(–2.1) µm, curved with a concave ventral side.

Specimens Examined—**Finland.** Uusimaa: Helsinki, *Betula*, 1985 Niemelä 3227; *Alnus*, 1991 Saarenoksa 24791; *Salix/Alnus*, 1991 Saarenoksa 45791. Satakunta: Hämeenkyrö, *Prunus padus*, 26.X.2000 Salonen. **Norway** (see type).

Antrodiella onychoides is the only consistently clampless *Antrodiella* species described so far. It reminds closely *A. leucoxantha* in its ecology (usually on branches of angiosperms in fertile habitats), macroscopy (small, whitish, pileate basidiocarps) and microscopy (the only difference being in generative hyphae). Relationships of these taxa would deserve further study; *Polyporus onychoides* is their oldest name, although we consider synonymy of these names unlikely. The sometimes reminiscent *A. pallescens* differs in not having clearly curved spores, and its subicular skeletal hyphae have an indistinct lumen.

Antrodiella pachycheiles (Ellis & Everh.) Miettinen & Niemelä, **comb. nov.**
(MB500774)

Basionym: *Polyporus pachycheiles* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 1894:322, 1894. **Lectotype** (designated here): '*Polyporus pachycheiles*', [U.S.A., Jew Jersey, *Acer rubrum*, Nov. 1893] (NY, isolectotype BPI US0305581, both studied).

Basidiocarps pileate, flabelliform, spathulate or floriform, with constricted base, 1–1.5 cm wide, 2–3 mm thick, projecting ca. 1 cm from substrate, dry pilei downcurved. Upper surface matt with minute radial streaks, light ochraceous yellow; bruised margin apricot, chestnut or dark brick-coloured, margin sharp. Poroid surface pale ochraceous or dark cream, pores round and very small, 7–8(–9) per mm, orifices regular. Section: context cream-coloured, tubes cream to tan. Hyphal system dimitic; generative hyphae clamped and thin-walled, skeletal hyphae dominating in all parts, flexuous, translucent, with indistinct lumen, in context thick, (2.5–)3.6–4.6(–5.6) µm, in trama (2.6–)2.9–3.7(–4.3) µm in diam., thick-walled, IKI–, CB(+), and swelling (commonly >6 µm) and in some areas dissolving in KOH, subparallel in context, and interwoven but not agglutinated in tube trama. Thin-walled hymenial cystidia found irregularly, mostly slightly subulate and projecting a little, 10-14.5×3.4-4.6 µm; angular crystals common among the hyphae. Basidia with 4 sterigmata. Spores ellipsoid, thin-walled, CB–, IKI–, (3.1–)3.2–4.3(–4.4)×(2–)2.2–3.1 µm, ventral side straight or more often a little rounded, never concave; no guttulae.

Specimens Examined—**U.S.A.** (see type).—Omitted from the description above, but good specimen of the species: '*Polyporus pachycheiles*?, U.S.A., Vermont, Newfane, [cf. *Betula*], 4.IX.1917 A. Hibbard 18995' (BPI US0305580).

Ellis & Everhart (1895) mention only one specimen in their description of *Polyporus pachycheiles*. Specimens matching the description are found in NY and BPI. The former is larger, in good condition, and was considered as the type by Lloyd. Thus the specimen in NY is selected as the **lectotype** of *Polyporus pachycheiles*. The specimen in BPI is evidently its duplicate, and its character data has been combined with the lectotype when making descriptions.

Polyporus pachycheiles has usually been reduced to the synonymy of *A. semisupina* (Overholts 1953, Lowe 1975, Gilbertson & Ryvarden 1986). However, *Polyporus pachycheiles* can be separated from *A. semisupina* sensu typi and *A. pallescens* by several macro- and microscopic characters. In our opinion, this is a well-defined species within the genus, characterised by flabelliform shape, fairly bright colours, and small pores. In the microscope it stands out among similar other species by the large spores (about the size of *A. romellii*, which is resupinate) and the skeletal hyphae that swell strongly and even dissolve in KOH. The lectotype bears in places thin-walled hymenial cystidia that do not stain any differently from the rest of the hymenium in IKI or CB. In specimen 0305580, there are pear-shaped, vesicular cystidia in the hymenium, probably just a secondary feature of a senescent basidiocarp.

Antrodiella pallasii Renvall, Johannesson & Stenlid

Mycol. Research 104: 95, 2000. Isotype: Finland, Sompion Lappi, Savukoski, *Picea abies*, 25.VIII.1992 Renvall 2990 (H, studied).

Annual, effused-reflexed or resupinate, light yellow when young, white when old and then often with violet-grey patches, tough but thin and appearing fragile when young, hard when dry. Caps fingernail-shaped, typically in rows of up to 20 cm, single caps 5–20 mm wide, projecting 2–10 mm, up to 2 mm thick; resupinate area 5–100 mm across, neighbouring areas later merging together, sterile margin distinct, white. Pores (5–)6–8 per mm, orifices finely toothed. Section: context/subiculum white to cream-coloured, usually less than 1 mm thick, tubes cream to yellowish, tube layer 0.5–2 mm. Dimitic, generative hyphae with clamps, skeletals CB– to CB(+), IKI– or faintly amyloid, KOH–, in subiculum (1.8–)2.7–3(–3.7) µm in diam., in tube trama subparallel, (2–)2.3–2.9(–3.2) µm, lumen capillary and visible or indistinct in subiculum, wide in trama, structure appearing almost monomitic in lower trama. Crystal clusters among hyphae common, oily substance present as small droplets. No cystidia or cystidioles seen. Basidia with 4 sterigmata. Spores ellipsoid, thin-walled, CB–, IKI–, (2.9–)3–3.7 (–3.9)×(1.6–)1.8–2.1(–2.3) µm, ventral side typically flat, sometimes a little convex or concave, often with an oil drop.

Specimens Examined—**Finland.** Perä-Pohjola: Rovaniemi, *Picea*, 1960 Eriksson 9416 (UPS). Kittilän Lappi: Kittilä, *Picea*, 1980–2001 Niemelä 2143, 6580; *Pinus*, Niemelä 7139. Kolari, *Picea*, 1999 Niemelä 6617. Sompion Lappi (see type).
—All on dead *Trichaptum abietinum*.

Antrodiella pallasii is a strict follower of *Trichaptum abietinum* and possibly other *Trichaptum* species. It is well defined by small spores, narrow skeletal hyphae and gymnosperm hosts. *Antrodiella parasitica* is similarly associated with *T. abietinum*, but has much wider spores. Spore size of *A. pallasii* comes close to *A. faginea*, which is found on angiosperm hosts and has clearly thicker skeletal hyphae. Gymnosperm-associated *A. ellipsospora* has slightly wider spores and thicker skeletal hyphae.

Antrodiella pallescens (Pilát) Niemelä & Miettinen, **comb. nov.**

(MB500770)

Basionym: *Coriolus pallescens* Pilát, Bull. Soc. Mycol. France 48:15, 1932. Lectotype: Sweden, Torne Lappmark: Jukkasjärvi, Björkliden, *Betula*, 1.IX.1909 Romell 14653 (S, studied). Selected by Ryvarden (1974:279).

= *Antrodiella beschidica* Vampola & Pouzar, Czech Mycol. 49:23, 1996. Holotype: Czech Republic, Moravia, Moravskolezské Beskydy, Jablunkov, *Abies alba*, 7.IX.1969 Pouzar (PRM 682098, studied).

= *Antrodiella farinacea* Vampola & Pouzar, Czech Mycol. 49:29. 1996. Holotype: Slovakia, Banská Bystrica, Badín, *Ulmus glabra*, 30.IX.1994 Vampola (PRM 842927, studied).

Annual, pileate, effused-reflexed or resupinate, leathery, when dry hard. Caps shelf- or fingernail-shaped, 10–40 mm wide, up to 5 mm thick, projecting 5–30 mm, surface matt, cream-coloured, often with faint tan or mouse grey zones or greyish all over, margin sharp; resupinate area 20–100×10–50 mm, roundish or ellipsoid, neighbouring areas later merging together. Pores cream-coloured, (4–)6–8 per mm, orifices entire. Section: context cream-coloured, homogeneous, when dry hard, tubes concolorous. Dimitic, generative hyphae with clamp connections, 2.3–3.3 µm, skeletals CB(+), IKI–, in context/subiculum radially subparallel, (2–)3–4.6(–5.4) µm in diam., in tube trama tightly interwoven but not agglutinated, (2–)2.4–3.2(–4.1) µm, lumen wide to narrow in context skeletals, indistinct in subiculum, capillary in trama. Crystal clusters occasional. Cystidioles poorly differentiated with conical apex; gloeocystidia mostly absent but seen in one specimen; hyphal pegs present. Basidia with 4 sterigmata. Spores short cylindrical or ellipsoid, thin-walled, CB–, IKI–, (2.9–)3–4.1(–4.8)×(1.6–)1.7–2(–2.3) µm, rarely tapering, ventral side flat or (longest spores) a little concave.

SPECIMENS EXAMINED—**Czech Rep.** (type of *A. beschidica*). **Finland.** Uusimaa: Mäntsälä, *Betula*, 1993 Haikonen 15652. Etelä-Häme: Kuru, *Betula*, 2003 Miettinen 7972. Koski, *Betula*, 1982 Niemelä 2788. Lammi, *Betula*, 1993 Renvall 3338; *Alnus*, 1993 Renvall 3360. Keski-Pohjanmaa: Nykarleby, *Betula*, 1995 Jakobsson 1516. Pohjois-Karjala: Lieksa, *Betula*, 1991 Niemelä 5548. Sompion Lappi: Sodankylä, *Betula*, 1998 Niemelä 6280. Kittilän Lappi: Kittilä, *Betula*, 2000 Niemelä *6705. Perä-Pohjola: Rovaniemi, *Alnus*, 2003 Niemelä 7636. **Slovakia** (type of *A. farinacea*). **Sweden** (see type).
—All Finnish collections with *Fomes fomentarius*. * = gloeocystidia observed.

Finding a name for the *Antrodiella* species growing on dead basidiocarps of *Fomes fomentarius* turned out to be a nomenclatural puzzle. The names *Polyporus pachycheiles* (Ellis & Everhart 1895), *P. leucoxanthus* (Bresadola 1925) and *Trametes subscutellata* (Murrill 1910) have been referred to the *A. semisupina* complex (Murrill 1907, Lowe 1975, Overholts 1953, Ryvarden 1985, 1988); we studied their types and prefer to keep them separate.

The name *Polyporus pallescens* was used from time to time for the European '*Antrodiella semisupina*'. Originally *P. pallescens* Fr. : Fr. (Fries 1818) was a name for the species that is now known as *Bjerkandera fumosa* (Pers. : Fr.) P. Karst. (Donk 1974). Karsten (1881a) transferred the epithet to his newly described genus *Tyromyces* as *T. pallescens* (Fr. : Fr.) P. Karst., and later the same year (Karsten 1881b) he created still another combination, *Bjerkandera pallescens* (Fr. : Fr.) P. Karst. These were mere technical new combinations of the old Friesian name, without descriptions or comments on the identity of the species.

Karsten's herbarium (in H), however, reveals that his concept of the taxon changed in the course of time (Lowe 1956), and it seems that in his later years Karsten abandoned to use the epithet for *Bjerkandera fumosa*, and coined it to the European '*A. semisupina*'. He also sent a specimen (Lowe 1956:119) of this kind to Romell in Stockholm (S). That, and own collections from Swedish Lapland, prompted Romell (1911) to describe a new species, *Polyporus pallescens* Romell ('*P. pallescens* Karst.') for the fungus growing on dead *Fomes fomentarius*. The description is clear, specimens good for typification are listed, and *P. pallescens* Fr. : Fr. is excluded. All the elements for a good description of a new species were there, except the unfortunate name which is a homonym of *Polyporus pallescens* Fr. : Fr.

Pilát (1932) seems to be the first to transfer *Polyporus pallescens* Romell to a new genus. In that paper the following subheading is found: "**Coriolus pallescens** Karsten, sensu Romell, Hymen. of Lappl., p. 19, nec Fries! f. *resupinata* m[ihi]" [bold face and italics original]. Then description of the resupinate form follows, and a Siberian specimen from *Salix* is listed (coll. Ziling 233). By doing this, Pilát in fact validated the Romellian *pallescens* by creating the nomen novum *Coriolus pallescens* Pilát, based on the description and collections of Romell and, via Romell, also of Karsten; simultaneously he described a new form from Siberian material. The correct citation is *Coriolus pallescens* Pilát, rather than Karsten (who did not describe the species but only sent a specimen so named to Romell) or Romell (who was not mentioned as the author in Pilát's description; ICBN (St Louis) Art. 46.4).

Consequently, the identity of *Coriolus pallescens* Pilát should be searched from the collections by Romell and/or Karsten. Fortunately good specimens exist. In Helsinki (herb. H) there are two such specimens—Herb. Karsten nos. 718 and 1846, both of which agree with the present species concept. In Stockholm (S) there are several specimens collected by Romell from Swedish Lapland; Ryvarden (1974) selected one of them as lectotype. That material is good quality and a typical representative of the species.

Antrodiella beschidica was described in Vampola & Pouzar (1996) from material collected from *Abies alba*. In spite of this unusual host, we consider this to be *A. pallescens*, as was already done by Johannesson et al. (2000) on the basis of identical ITS sequences. Spores and other microscopy agree in these two materials. *Fomes fomentarius*, the predecessor of *A. pallescens*, occasionally grows on *Abies alba*, but no such link was mentioned in the holotype collection.

Antrodiella farinacea was described from Slovakia from an elm tree (Vampola & Pouzar 1996). Type material consists of young, effused-reflexed basidiocarps with fingernail-shaped pilei. The nearly lacrymoid spores would match better with *A. faginea*, but spores typical of *A. pallescens* were also present. In the study of Johannesson et al. (2000), this grouped clearly among *A. pallescens*.

Anrodiella pallescens is very similar to *A. faginea*. Aside slightly different ecology, the only clear difference is in the spores, which are in *A. faginea* ellipsoid, never cylindrical, and have higher Q'-values (Figs. 1, 3 & 4).

Antrodiella parasitica Vampola

Česká Mykologie 45:10, 1991. Holotype: Czech Republic, Moravia: Řásná, NW of Telč, alt. 675 m, *Picea abies*, on living basidiocarps of *Trichaptum abietinum*, 10.V.1990 Vampola (PRM 842842, studied).

Annual, strictly resupinate, leathery, when dry brittle hard, basidiocarps small, mostly 5–15×5–30 mm, patchy, gregarious on living or recently dead *Trichaptum*. Sterile margin narrow to absent. Pores (4–)5–6(–7) per mm, cream-coloured; orifices entire or a little lacerate. Section: subiculum cream-coloured, tubes concolorous. Dimitic, generative hyphae mostly with clamps but simple septa also seen, skeletals rather uniform, CB(+), in places weakly amyloid, KOH–, interwoven in all parts, but not agglutinated, (2.1–)2.5–

3.3(–3.8) µm in diam, with a variably visible lumen. Crystal clusters sometimes present in between tramal hyphae; no distinct cystidioles or gloeocystidia. Basidia with 4 sterigmata. Spores ellipsoid or even subglobose, thin-walled, CB–, IKI–, (3.2–)3.3–4 (–4.1)×(2.2–)2.3–2.9(–3.2) µm, ventral side convex.

> SPECIMENS EXAMINED—**Czech Rep.** Moravia: Radostín, Vampola 1899; Polyp. Exs. Čechosl. 39. Řásná (see type). Loučky, 1990 Vampola 1886. Komárovice, 1990 Vampola 1901. **Finland.** Uusimaa: Sipoo, 1995 Jakobsson 1247. **Germany.** Sachsen: Oderwitz, 1984 Dunger 13711.
>
> —All on *Picea abies*+*Trichaptum abietinum*.

Basidiocarps of this species are completely resupinate and typically very small. The species name is well selected, because *A. parasitica* mostly grows on still-living basidiocarps of *Trichaptum abietinum*. Vampola (1991) described *A. parasitica* from an extensive Central European material as having broadly ellipsoid spores and bearing gloeocystidia. We were unable to find gloeocystidia in specimens of *A. parasitica* despite extensive search. The hymenial cells of the species are big and stain fairly strongly in CB and IKI, especially the young basidia, which also project somewhat above the hymenium. These cells may be mistaken for gloeocystidia, but a careful examination reveals that some of them bear sterigmata and in fact do not stain differently from the other hymenial cells. Even without gloeocystidia, the species is rather easy to identify based on its spore characters and ecology. The type specimen is mostly clamped, but bears frequent simple septa especially in the hymenium. This is untypical for most *Antrodiella* species. One Finnish specimen (Jakobsson 1247) is clampless throughout, but agrees otherwise with the Central European material. Is the presence or absence of clamps less determining for this species than for most other *Antrodiella*?

Antrodiella romellii (Donk) Niemelä

> Karstenia 22:11, 1982. *Poria romellii* Donk, Persoonia 5:84, 1967. Holotype: '*Boletus byssinus* Schrad. (Fungus nascens). Herb. Pers.' (L 0117094, studied). **Epitype** (designated here): Finland, Uusimaa, Tammisaari, 1987 Niemelä 4018 (L, isoepitype H).

Annual, resupinate, soft leathery, when dry hard, basidiocarps 30–60×10–30 mm, irregularly roundish, usually emerging solitarily. Sterile margin narrow, matt, hygrophanous especially in upper half of the basidiocarp. Pores 5–7 per mm, when fresh hygrophanous translucent or (after dry period) cream-coloured, when dry cream-coloured or with an apricot tint; orifices entire. Section: subiculum 0.1–0.5 mm, cream-coloured, tubes concolorous or darker. Dimitic, generative hyphae with clamps, skeletals rather uniform, CB(+), IKI–, 1.7–3.7 µm in diam., in subiculum with spaced and interwoven structure, basal layer almost monomitic; tramal hyphae interwoven, agglutinated; skeletals with variably visible lumen. crystal clusters sometimes present in between hyphae; hyphal tips at orifices often slightly inflated; no clear cystidioles or gloeocystidia. Spores ellipsoid, thin-walled, CB–, IKI–, (3–)3.4–4.4(–5.1)×(2.2–)2.3–2.9 (–3.1) µm, ventral side convex or (rarely) flat, never concave.

> SPECIMENS EXAMINED—**Finland.** Varsinais-Suomi: Tammisaari, *Corylus*, 5.IX.1971 Niemelä; see epitype. Turku, *Quercus*, 1937 Laurila 720, 721. Uusimaa: Helsinki, *Alnus*, 1993 Saarenoksa 24293. Sipoo, *Alnus*, 1987 Saarenoksa 11587. Etelä-Häme: Kuru, *Betula*,

2003 Miettinen 7919. Lammi, *Corylus*, 1997 Niemelä 6095; *Populus*, 2003 Miettinen 7488. Kittilän Lappi: Kittilä, *Betula*, Niemelä 6757. **Russia.** "Sibiria, Wasjuganje", *Betula*, 1934 Krawtzew W 115 (PRM 811661). **Sweden.** Uppland: Norra Warleda, *Corylus*, VIII.1970 Jahn. Kalmar, *Corylus*, 22.X.1995 Toresson.

The species is characterised by resupinate basidiocarps, large spores and agglutinated tramal hyphae. *Antrodiella pachycheiles* has similar spores, but it is pileate, its hyphal structure is different and skeletals swell and eventually dissolve in KOH. *Antrodiella subradula* (see below) is fairly similar but its spores are shorter and narrower and its tramal hyphae are separate, not agglutinated.

Donk (1967) proposed the name *Poria romellii* for a resupinate species that was featured by Romell (1926) and Eriksson (1949) as '*Poria byssina* (Schrad.) Fr.' In a thorough analysis Donk concluded that the name *P. byssina* must be typified elsewhere, and hence he gave a nomen novum, *Poria romellii*, for the taxon now included in *Antrodiella*. Donk emphasised that his species concept was based on texts and illustrations by Romell and Eriksson—and, in particular, the 'excellent' drawing by Eriksson (1949, Fig. 1). Accordingly, he designated the holotype (L 0117094) from the specimens that Romell and Eriksson had studied and identified in Persoon's herbarium.

We restudied the holotype; the specimen is a young basidiocarp, substerile, and partly mould-contaminated. Salient characters could be seen, however. There are 3–4 thin, resupinate, cream-coloured basidiocarps arising from the bark of (evidently) *Corylus avellana*. Pores are round, (5–)6–7 per mm. Only collapsed basidia with four sterigmata, and a few turgid spores (3.8–4.7×2.7–2.8 µm) were found. Hyphal system is dimitic, generative hyphae thin-walled and clamped, skeletals weakly cyanophilous and 2.2–3(–3.8) µm thick, no basal layer, no gloeocystidia. Trama is largely monomitic due to the young age of the basidiocarp; tramal tissue is dense and hyphae are subparallel. These characters match with the description and drawing by Eriksson (1949) and with the present concept of the species.

Since the type material is scanty and in a poor condition, its value as research material is inferior in a group where exact spore dimensions are the most important criteria for a species concept. In order to settle the identity of the species, we here select an **epitype** for *Poria romellii*, specimen Niemelä 4018 (L, H). This specimen is strikingly similar to the holotype, and in a good fertile condition. It was studied and sequenced by Johannesson et al. (2000) in their study of *Antrodiella*. Epitype's nuclear ribosomal RNA internal transcribed spacer (ITS) is deposited in GenBank (acc. no. AF126899).

Donk's concept of *Poria romellii* was mixed: we studied another specimen (L 0194116), determined by Donk, collected in 1963 by him in the Netherlands from a fallen branch of *Quercus*. That specimen has larger pores (3–5 per mm) and much narrower spores, about 3.7–4.8×1.9–2.3 µm, and it seems to be conspecific with the newly (Bernicchia 2005) described *Antrodiella ichnusana*; see its notes.

Antrodiella serpula (P. Karst.) Spirin & Niemelä, **comb. nov.**

(MB500771)

Basionym: *Bjerkandera serpula* P. Karst., Meddel. Soc. F. Fl. Fennica 14:79, 1887. Holotype: Finland. '*Bjerkandera serpula* Karst., Särkijärvi, ad *Pol. radiatum* et cort. *Alni*, m. Sept. 1886' (Herb. P.A. Karsten 4015, H, studied).

= *Polyporus hoehnelii* Bres. ex Höhnel. Sitzungsber. Kaiserl. Akad. Wiss. Wien, Math. Naturwiss. Kl. 121(1):344, 1912. Holotype: Austria. '*Polyporus höhnelii* Bres., typus!, ad *Carpinum*, leg. v. Höhnel' (BPI US0211065, studied).

= *Polyporus rufopodex* Romell, Svensk Bot. Tidskr. 6:641, 1912. Holotype: Sweden, Östergötaland, Simostorp, IX.1912 Haglund (Herb. Romell 13497, S; according to Ryvarden 1974, not studied).

Annual, pileate or effused-reflexed, leathery, when dry very hard. Caps at first nodulose, fully grown shelf-shaped or triangular in section, 10–60 mm wide, 5–20 mm thick, projecting 5–25 mm, surface matt or minutely hairy, when dry rough to touch, yellow, margin fairly sharp and yellow; resupinate area small and irregular in shape. Pores yellow or cream-coloured, 4–6(–7) per mm, orifices entire, serrate or dentate. Section: context cream-coloured, homogeneous, when dry hard, 2–8 mm thick; tubes concolorous or yellowish. Dimitic, generative hyphae with clamps, skeletals distinctly CB+, IKI–, in context interwoven, (2–)3–5.2(–6) µm in diam., in tube trama parallel, (2.8–)3–4.4 (–5.3) µm, especially in context and upper trama robust-looking, very thick-walled and with a distinct, wide lumen. Small, sandy or cubical crystals sometimes present on hyphae. Cystidioles with a conical apex; gloeocystidia evidently absent. Basidia with 4 sterigmata. Spores short cylindrical, thin-walled, CB–, IKI–, (3.3–)3.6–5(–5.7)×(1.6–) 1.8–2.2(–2.5) µm, curved along their whole length.

Specimens Examined—**Austria** (type of *P. hoehnelii*). **Czech Rep.** Bohemia: Sázava, *Fagus*, 1991 Niemelä 5529. **Estonia.** Pärnumaa: Koonga, *Corylus*, 1996 Niemelä 6015. **Finland.** Uusimaa: Helsinki, *Alnus*, 1986 Saarenoksa 18686. Etelä-Häme: Lammi, *Corylus*, 1985 Niemelä 3278; 2000 Niemelä 6899. Tammela (type of *B. serpula*).
—All on dead *Inonotus radiatus*, except type of *P. hoehnelii* (not indicated).

This is the most robust of the *Antrodiella* species treated here. Under the microscope it stands out in having thick skeletal hyphae, which often ramify in the context and are strikingly parallel in tube trama, and which are more strongly cyanophilous than in the other species.

While studying the specimens of Karsten, one of us (W.S.) found that the type of *Bjerkandera serpula* in fact represents the present species. The specimen is small but fertile, and it is growing on remnants of *Inonotus radiatus*. A closer study on spores and other microscopy confirmed this result. Holotype was depicted in Karsten's Icones (Karsten 1891), but even though coloured this lithograph is not very illustrative.

This is one of the best-known species in the genus, belonging to its narrow-spored group (Fig. 2). The yellow basidiocarps usually arise from angiosperm wood decayed by *Inonotus radiatus*. Hyphal structure is more robust than in most species of the genus, but in the phylogram by Johannesson et al. (2000) its position is in the core of the genus, close to *A. pallescens* (the European '*A. semisupina*'). The type of *Polyporus hoehnelii* is sterile, but agrees with the current concept of the species, e.g. in having the same characteristic hyphal structure as the type of *A. serpula*.

Pilát (1936–1942) doubtfully linked *Bjerkandera serpula* to *Trametes hoehnelii* (Bres. ex Höhn.) Pilát in the Index of his book, but did not treat the matter in the text and so the reasons for his conclusion are not known. Lowe (1956) studied the type, but could not agree with Pilát's proposal and left the decision open.

Donk (1974) lists *Polyporus scaber* Velen. 1922 as a synonym of the species, but the name is an illegitimate homonym of *P. scaber* Bres. (Bresadola 1920).

Antrodiella subradula (Pilát) Niemelä & Miettinen, comb. nov.

(MB500773)

Basionym: *Coriolus subradula* Pilát, Bull. Soc. Mycol. France 51:366, 1936. Lectotype: 'Sibiria, Distr. Tara, *Salix* sp., IX.1929 Ziling 233' (PRM 811662, studied). Selected as type by Donk (1974:370).

Annual, resupinate, when dry hard, basidiocarp ca. 6–15×5–10 mm, irregularly roundish. Sterile margin very narrow or absent. Pores (2–)3–5 per mm, cream-coloured, variably sized; orifices entire. Section: subiculum straw-coloured, tubes dark cream-coloured. Dimitic, generative hyphae with clamps, skeletals CB(+), IKI–, in subiculum (3–)3.7–4.6(–5.4) µm in diam. and in KOH swelling to up to 5.3–6 µm; in tube trama (2.2–)2.6–3.5 µm, tightly interwoven and agglutinated in upper trama and subparallel close to orifices. Crystals abundant in subiculum, mostly as small rhomboidal plates or prisms. No gloeocystidia, cystidioles 9–10.9×4–4.5 µm, inconspicuous with nipple-like apex. Basidia with 4 sterigmata. Spores ellipsoid, thin-walled, CB–, IKI–, (3.2–)3.3–3.9(–4.1)×(2–)2.1–2.3(–2.4) µm, ventral side convex or (rarely) flat, never concave.

Specimens Examined—**Russia** (see type).

Pilát (1936) returned to the form that he originally described as *Coriolus pallescens* f. *resupinata* (Pilát 1932) by raising it to species rank as *Coriolus subradula*. Two Siberian specimens were listed, one from *Betula* (Krawtzew W 115) and another from *Salix* (Ziling 233). If the specimen from *Betula* had been selected as type, this would be an older name for *Poria romellii*. However, Donk (1974:370) lectotypified both *Coriolus pallescens* f. *resupinata* and *Coriolus subradula* according to the specimen from *Salix* (Ziling 233). Pilát himself had written 'Typus!' on the label of the collection from *Betula* (W 115), but that was not published, and so Kotlaba & Pouzar (1989) were misled when they accepted this as the type (they later corrected their interpretation: F. Kotlaba & Z. Pouzar 1992, in herb.). This taxon is without doubt an *Antrodiella*, but spore dimensions do not match with any species that we know (Tab. 1, Fig. 2). Therefore we accept *A. subradula* as a good species in *Antrodiella*. The lectotype specimen was illustrated in Pilát (1936, Pl. 7:3, magnification ×8, not indicated in the paper).

The lectotype specimen is a small but very fertile, resupinate basidiocarp, resembling *Antrodiella romellii* but with larger pores (5–7 per mm in *A. romellii*), and having shorter and narrower spores. *Antrodiella faginea* is also fairly similar, but its spores and pores are smaller, and skeletal hyphae appear thicker. More material is needed.

Antrodiella thompsonii Vampola & Pouzar

Czech Mycology 49: 27, 1996. Holotype: *Poria*, Canada, Ontario, Lake Temagami, on *Populus grandidentata*, 26.VIII.1930 G.E. Thompson (PRM 810111, ex herb. L.O. Overholts).

Annual, resupinate, woody hard, 1–2 mm thick. Sterile margin almost nonexistent, i.e. pores extend to the edge; pore surface tan with darker brown flecks, pores angular, regular, 7–9 per mm. Section: subiculum thin but very distinct, 0.1–0.2 mm thick, creamy white, with a dense and homogeneous structure, tubes brownish and oily-looking, colour contrast strong between subiculum and tubes. Dimitic; generative hyphae with clamp connections, skeletals weakly but clearly cyanophilous, with a clearly

Table 2. Key characters of *Antrodiella* species treated in this paper.

Group	Species	Ecology	Macroscopy	Pore size (per mm)	Hyphal structure	Spores (L×W in µm)
Small ellipsoid spores W ≤ 2.1 µm L < 4 µm Q ≤ 2	*americana*	angiosperm wood decayed by *Pseudochaete tabacina*	resupinate, yellow, pores soon splitting	large (2–4)	CB(+) to CB+, clear gloeocystidia abundant (15-60×4-8 µm), skeletals rather narrow, mostly 2.2–3.1 µm in subiculum, with a clear lumen	narrow ellipsoid to cylindrical, uniguttulate (3.72×2.05)
	ellipsospora	type on brown-rotted *Pinus sibirica*	half-resupinate, white to cream-coloured	small to very small (7–9)	weak CB(+), skeletals rather robust in subiculum (3–3.5 µm), lumen indistinct	narrow ellipsoid (3.59×1.95)
	faginea	various deciduous trees, often associated with *Hymenochaetae.*	half-resupinate, pores white to cream-coloured	small (6–8)	CB(+), skeletals robust in subiculum (2.7–4.2 µm), lumen indistinct, gloeocystidia sometimes present	ellipsoid, not curved (3.20×1.97)
	pallasii	associated with *Trichaptum abietinum*, on gymnosperms	half-resupinate, yellowish, pore mouths often lacerate, splitting	small (6–8)	CB– to weak CB(+), subicular skeletals rather narrow, mostly ≤ 3 µm, tramal skeletals with large lumen	ellipsoid, belly often straight, uniguttulate (3.23×1.93)
	pallescens	associated with *Fomes fomentarius*	half-resupinate, pores white to cream-coloured	small (6–8)	CB(+), skeletals robust in subiculum (3–4.6 µm), lumen indistinct	straight/slightly curved belly (3.47×1.84)
	semisupina	type on *Quercus*	half-resupinate, orange tints	small (6–8)	CB–, hyphae flexuose, (2–)3–4.2(–5) µm	egg-shaped (3.00×2.09)
	thompsonii	type on *Populus*	resupinate, pores resinous	very small (7–9)	CB– to CB(+), tramal hyphae strongly agglutinated, skeletals 2.5–4 µm, gloeocystidia present	broad cylindrical to ellipsoid (3.15×1.79)

Slender spores $Q > 2$ $W \leq 2$ µm	*ichnusana*	on branches of *Alnus*	resupinate, white to straw-coloured, hygrophanous	relatively large (4–5)	CB(+), skeletals narrow, with a clear lumen, 2–3.2 µm	rather straight (4.55×1.95)
	leucoxantha	various deciduous trees	half-resupinate, whitish	medium (5–6)	CB(+), subicular skeletals rather large (2.6–4 µm), lumen distinct, gloeocystidia occasional	always curved (3.89×1.71)
	onychoides	various deciduous trees	half-resupinate, whitish	medium to small (5–8)	CB(+), no clamps, skeletals 3.1–4 µm in subiculum, with a distinct lumen	always curved (3.86×1.75)
	serpula	associated with *Inonotus radiatus*	pileate to half-resupinate, yellowish when old	medium (4–6)	CB+, skeletals very robust, commonly > 5 µm in subiculum, lumen distinct	always curved (4.12×1.95)
Wide spores $W >> 2$ µm	*canadensis*	on gymnosperms	pileate, white, greyish upper surface when dried	medium (5–6)	CB–, monomitic or almost so, hyphae thin- to thick-walled, 2.2–5.4 µm, subicular hyphae with finger-like, refractive branches	broad ellipsoid to subglobose, uniguttulate (3.43×2.64)
	citrinella	associated with *Fomitopsis pinicola*, usually gymnosperms	half-resupinate, yellow when fresh, colour fading upon drying	relatively large (4–5)	CB(+), skeletals with a clear lumen, rather narrow, 2.3–3.7 µm	broad ellipsoid to subglobose (3.14×2.31)
	pachycheiles	*type on Acer*, also *Betula*	half-resupinate, straw-coloured	small (7–8)	CB(+), skeletals wide, 3.6–4.6 µm in subiculum, swelling & dissolving in KOH, thin-walled cystidia	broad ellipsoid (3.67×2.45)
	parasitica	gymnosperms decayed by *Trichaptum abietinum*	resupinate, straw-coloured, orifices entire to lacerate	medium (5–6)	CB(+), tramal tissue dense, robust hymenium staining strongly in CB & IKI, basidia robust, skeletals 2.5–3.3 µm	broad ellipsoid, often uniguttulate (3.63×2.50)
	romellii	deciduous wood, often fallen branches	resupinate, cream-coloured or with apricot tint	medium to small (5–7)	CB(+), tramal hyphae agglutinated, skeletals 1.8–3.5, basidia robust	broad ellipsoid (3.84×2.55)
	subradula	type on *Salix*	resupinate, white	relatively large (3–5)	CB(+), skeletals rather narrow, 2.5–3.5 µm, not agglutinated	relatively narrow ellipsoid (3.49×2.18)

visible lumen, IKI–, KOH–. Subiculum with 5–20 µm thick basal layer of subparallel and glued-together generative hyphae; subiculum proper homogeneous with very tightly packed, interwoven, but separate hyphae, skeletals (1.8–)2.3–3.8(–4.2) µm. Tube trama with tightly interwoven hyphae, glued throughout into inseparable, glassy structure, skeletals 2–3.2 µm in diam. Cystidioles with a conical apex, hymenium with few and poorly differentiated gloeocystidia, 10–12×4–6.5 µm, best seen in IKI. Basidia with 4 sterigmata. Spores ellipsoid or short cylindrical, thin- and smooth-walled, IKI–, CB–, (2.8–)2.9–3.6(–3.8)×(1.6–)1.7–2 µm, ventral side flat, seldom slightly convex, almost never concave.

SPECIMENS EXAMINED—Canada (see type).

This seems to be a well-defined species, to us known from the type locality only. Externally it is characterised by resupinate habit, very small pores, and, in particular, the colour contrast between almost white subiculum and oily brownish tubes. Microscopic structure resembles that of *A. romellii* by its tightly glued hyphae of tube trama; this agglutination is even stronger than in *A. romellii*. Skeletal hyphae are fairly narrow. In the hymenium gloeocystidia can be seen, but they are not prominent and do not suffice for identification. The short cylindrical spores come closest to those of *A. pallescens*, but the other characters disagree.

Trametes subscutellata Murrill

Mycologia 2:191, 1910. **Lectotype** (designated here): *Trametes subscutellata*. Jamaica, Moneague to Union Hill, 17–18.I.1909 W.A. Murrill 1129 (NY, studied). Lowe (in herb.) and Ryvarden (1985) called this as 'type' and in the convolute there is a note 'part of type' by Murrill; hence this must be considered to be the lectotype.

Ryvarden (1985) considered this to be a synonym of *Antrodiella semisupina*. The type specimen is from Jamaica, i.e. subtropical Caribbean. The specimen is half-resupinate, button-shaped, whitish to straw-coloured, with small pores 8–9 per mm. Hyphal system is dimitic with branching skeletals (3.2–5 µm) that stain relatively strongly in CB for an *Antrodiella* species, and swell a little (up to 8 µm) but remain distinct in KOH. We could not find any hymenium in good condition, and only a few spores were found, broadly ellipsoid, within the range of 2.7–4.3×2–2.8 µm. The identity of this species should be solved based on collections from the Caribbean. We do not think it is conspecific with *A. semisupina*, whose skeletals are flexuous, CB–, or with *A. pallescens*, which has narrower spores and a more northerly distribution.

Discussion

Identifying species of *Antrodiella* is often difficult, since differences between the species are small. In Table 2 we summarise the main characters of all the species treated here. The species have been sorted into three groups based on their spore characters (see also Fig. 2).

Gloeocystidia have been used to delimit species (for instance *Postia leucomallella* (Murrill) Jülich) and even genera (*Gloeocystidiellum*) in *Aphyllophorales*. The exact meaning of the term varies greatly in the literature, sometimes used only for plasma-rich special cells that arise from subhymenium (like in *Antrodiella*), sometimes also for the terminal ends of gloeoplerous tramal hyphae that penetrate into the hymenium. Clémençon (2004) summarised the different types of these cells and their exact terms.

Here we use the term gloeocystidium for those thin-walled hymenial cystidia that stain more yellow or refract more strongly in IKI than other hymenial cells, and become deep blue-tinted in Cotton Blue. They are a good and constant character in some species (for instance, *Antrodiella americana*), but our work shows that they are unreliable in several other species of the genus. *A. faginea*, whose description was largely based on the presence of gloeocystidia, does not seem to bear them commonly. A similar case is *A. leucoxantha*, in which gloeocystidia are found only in some specimens. Of the studied tens of collections of *A. pallescens*, gloeocystidia were found in just one, otherwise typical specimen. One of the key characters of *A. parasitica* is said to be the presence of gloeocystidia (Vampola 1991). However, we could not find any clear cystidia in the studied specimens, rather just yellow-tinted hymenial cells.

Indeed, in all the *Antrodiella* species where gloeocystidia have been reported—except *A. americana*—they are weakly differentiated, rare, and often difficult to verify. They are commonly associated with senescent hymenium at tube bottoms. Difference between poorly differentiated gloeocystidia and thin-walled hymenial cystidia that do not stain in IKI *(A. pachycheiles)* is vague. We stick to the term gloeocystidia, since it has been traditionally used in this context. Other types of abnormal sterile cells are also commonly present in senescent basidiocarps, such as vesicular cells and projecting hyphoid elements. In our mind, taxonomic conclusions in *Antrodiella* should not be based on presence or absence of cystidia alone, although they may be a useful character among the others.

Acknowledgements

Reima Saarenoksa (Helsinki) gave his extensive *Antrodiella* collections at our disposal, and his notes on *A. ichnusana* were invaluable in outlining the ecology of this recently found species. Heikki Kotiranta (Helsinki) forwarded some Siberian collections to us. Pertti Renvall (Kuopio) and Annarosa Bernicchia (Bologna) gave us materials, e.g. of *A. ichnusana*. Tuuli Timonen and Pirkko Harju (Helsinki) identified some host tree species from wood attached to fungal specimens. Leif Ryvarden (Oslo) and Joost Stalpers (Utrecht) reviewed the manuscript. The museums listed in Materials and methods are thanked for loans of type and other materials. We thank the Finnish Ministry of Environment and Emil Aaltonen Foundation for research grants.

References

Bernicchia A. 2005. Fungi Europaei 10, *Polyporaceae*. Alassio, Edizioni Candusso.

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). Systematics Biodiversity 3: 113–157.

Bresadola G. 1920. Selecta mycologica. Ann. Mycol. 18: 26–70.

Bresadola G. 1925. New species of fungi. Mycologia 17: 68–77.

Clémençon H. 2004. Cytology and plectology of the Hymenomycetes. Biblioth. Mycol. 199: 1–488.

Dai YC. 2004. Notes on the genus *Antrodiella* (Basidiomycota, *Aphyllophorales*) in China. Mycotaxon 89: 389–398.

Donk MA. 1967. Notes on European polypores 2. notes on *Poria*. Persoonia 5: 47–130.

Donk MA. 1974. Check list of European polypores. Verh. Koninkl. Nederlandse Akad. Wetensch. Afd. Natuurk. Tweede Reeks 62: 1–469.

Ellis JB, Everhart BM. 1895. New species of fungi from various localities. Proc. Acad. Nat. Sci. Philadelphia 1894: 322–386.

Eriksson J. 1949. The Swedish species of the *Poria vulgaris* group. Svensk Bot. Tidskrift 43(1): 1–25, pls. 1–5.

Fries EM. 1818. Observationes mycologicae 2. Kjøbenhavn, Bonnier.

Gilbertson RL, Ryvarden L. 1986. North American polypores 1, *Abortiporus* to *Lindtneria*. Oslo, Fungiflora.

Index Fungorum. 2006. http://www.indexfungorum.org/Names/Names.asp [8 May 2006]

Johannesson H, Renvall P, Stenlid J. 2000. Taxonomy of *Antrodiella* inferred from morphological and molecular data. Mycol. Res. 104: 92–99.

Karsten PA. 1881a. Enumeratio boletinearum et polyporearum Fennicarum, systemate novo dispositarum. Rev. Mycol. 3: 16–19.

Karsten PA. 1881b. Hymenomycetes Fennici enumerati. Acta Soc. Fauna Flora Fennica 2(1): 1–40.

Karsten PA. 1891. Icones selectae Hymenomycetum Fenniae nondum delieatorum. Acta Soc. Scient. Fennicae 18: 101–110, pls. 1–6 (figs. 61–80).

Kotlaba F, Pouzar Z. 1989. Type studies of polypores described by A. Pilát 2. Česká Mykol. 43: 36–44.

Lowe JL. 1956. Type studies of the polypores described by Karsten. Mycologia 48: 99–125.

Lowe JL. 1975. *Polyporaceae* of North America. The genus *Tyromyces*. Mycotaxon 2: 1–82.

Murrill WA. 1907. Family 5, *Polyporaceae*. North American Flora 9(1): 1–72.

Murrill WA. 1910. The *Polyporaceae* of Jamaica. Mycologia 2: 183–197.

Niemelä T. 1985. On Fennoscandian polypores 9, *Gelatoporia* n. gen. and *Tyromyces canadensis*, plus notes on *Skeletocutis* and *Antrodia*. Karstenia 25: 21–40.

Niemelä T, Renvall P, Penttilä R. 1995. Interactions of fungi at late stages of wood decomposition. Ann. Bot. Fennici 32: 141–152.

Niemelä T, Ryvarden L. 1983. *Antrodiella citrinella*, a new polypore species. Karstenia 23: 26–30.

Niemelä T, Kinnunen J, Larsson KH, Schigel DS, Larsson E. 2005. Genus revisions and new combinations of some North European polypores. Karstenia 45: 75–80.

Overholts LO. 1953. The *Polyporaceae* of the United States, Alaska, and Canada. Ann Arbor, Univ. Michigan Press.

Parmasto E, Parmasto I. 1987. Variation of basidiospores in the Hymenomycetes and its significance to their taxonomy. Biblioth. Mycol. 115: 1–168.

Pilát A. 1932. Additamenta ad floram Sibiriae Asiaeque orientalis mycologicam 1. Bull. Soc. Mycol. France 48: 1–52, pls. 1–8.

Pilát A. 1936. Additamenta ad floram Sibiriae Asiaeque orientalis mycologicam 3. Bull. Soc. Mycol. France 51: 351–426, pls. 6–11.

Pilát A. 1937. Additamenta ad floram Sibiriae, Asiae centralis orientalisque mycologicam 4. Bull. Soc. Mycol. France 52: 305–336, pls. 3–9.

Pilát A. 1936–1942. *Polyporaceae*.1–624, pls. 1–374 in C Kavina, A Pilát (eds.), Atlas des Champignons de l'Europe 3. Praha, privately published.

Romagnesi H. 1944. Sur deux champignons nouveaux pour la flore française. Bull. Soc. Mycol. France 60: 88–90.

Romell L. 1911. Hymenomycetes of Lappland. Arkiv Bot. 11(3): 1–35, pls. 1–2.

Romell L. 1926. Remarks on some species of *Polyporus*. Svensk Bot. Tidskrift 20(1): 1–24.

Ryvarden L. 1974. Type studies in the *Polyporaceae* 3, species described by Lars Romell. Svensk Bot. Tidskrift 68: 273–284.

Ryvarden L. 1985. Type studies in the *Polyporaceae* 17, species described by W.A. Murrill. Mycotaxon 23: 169–198.

Ryvarden L. 1988. Type studies in the *Polyporaceae* 20, species described by G. Bresadola. Mycotaxon 33: 303–327.

Ryvarden L. 2003. A note on *Antrodiella*. Synopsis Fungorum 17: 80–90.

Ryvarden L, Gilbertson RL. 1984. Type studies in the *Polyporaceae* 15, species described by L.O. Overholts, either alone or with J.L. Lowe. Mycotaxon 19: 137–144.

Ryvarden L, Gilbertson RL. 1993. European polypores 1, *Abortiporus* to *Lindtneria*. Oslo, Fungiflora.

Ryvarden L, Gilbertson RL. 1994. European polypores 2, *Meripilus* to *Tyromyces*. Oslo, Fungiflora.

Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Oslo, Fungiflora.

Vampola P. 1991. *Antrodiella parasitica*, nový druch chorošů. Česká Mykol. 45: 10–14.

Vampola P, Pouzar Z. 1996. Contribution to the knowledge of the Central European species of the genus *Antrodiella*. Czech Mycol. 49: 21–33.

MYCOTAXON

Volume 96, pp. 241–252 *April–June 2006*

New records of *Pluteus* (*Pluteaceae, Agaricales*) from Brazil

FELIPE WARTCHOW

fwartchow@yahoo.com.br
Universidade Federal de Pernambuco, Departamento de Micologia, CCB
Av. Prof. Nelson Chaves, s/n°, CEP: 50670-901, Recife, PE, BRAZIL

VAGNER GULARTE CORTEZ & GILBERTO COELHO

cortezvg@yahoo.com.br, 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—The occurrence of some previously unreported species of *Pluteus* from Brazil (*P. aquosus*, *P. nigrolineatus*, and *P. globiger*) is reported. Collections of *P. albostipitatus* and *P. beniensis* are also described from Rio Grande do Sul State. All taxa are illustrated and discussed.

Key words—Basidiomycota, Agaricomycetidae, *Celluloderma*, *Hispidoderma*

Introduction

The knowledge of the genus *Pluteus* Fr. in Brazil started with Rick (1907, 1919, 1930, 1938) from the Rio Grande do Sul State. In his posthumous work (Rick 1961), Rick reported 18 species from this State, some described as new species: *P. cristatulus* Rick, *P. fibrillosus* Rick, *P. leptonia* Rick, *P. sensitivus* Rick, *P. straminellus* Rick, and *P. velatus* Rick. Singer (1953, 1959) studied several Rick's collections and considered most of them either dubious (due to the lack of preserved material) or synonyms of already described species in *Pluteus* and other genera (e.g. *Entoloma* (Fr.) P. Kumm.).

Singer (1956, 1959, 1973, 1989) described several new species collected in different Brazilian states, especially the Rio Grande do Sul, Amazonas, Rio de Janeiro, and Pará. Recent surveys on *Pluteus* from Brazil are those of Stijve & de Meijer (1993) for the state of Paraná (south Brazil) and Pegler (1997) for the state of São Paulo (southeastern Brazil). Putzke (1994) reported 23 *Pluteus* taxa in his checklist of Brazilian agarics. More recently, Wartchow et al. (2004) cited *P. thomsonii* (Berk. & Broome) Dennis for Brazil, and Rother et al. (2006) listed *Pluteus* species from Rio Grande do Sul State.

Materials and Methods

Microscopic analysis comprised 25 measurements each of basidiospores, basidia, cystidia and hyphae observed in 5% KOH preparations. The microstructures were drawn using a camera lucida. The specimens are deposited in the herbaria of the Biology Department of the Universidade Federal de Santa Maria (SMDB) and Department of Botany of the Universidade Federal do Rio Grande do Sul (ICN). Generic and infra-generic concepts follow Singer (1986).

Taxonomy

1. *Pluteus albostipitatus* (Dennis) Singer, Lloydia 21: 240, 1959. Figs. 1-5

= *P. spilopus* var. *albostipitatus* Dennis, Bull. Soc. Mycol. Fr. 69: 195, 1953.

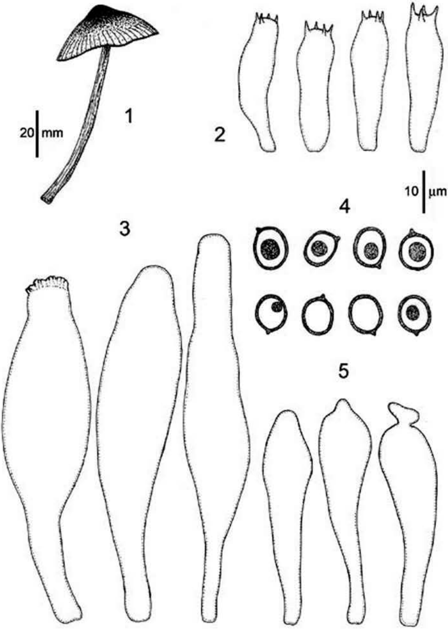
Pileus 50–55 mm diam., campanulate to plane, with a broad and low umbo, dark-brown in color, surface subviscid with a sulcate-striate margin. **Lamellae** free, abundant and close, ventricose, cream-colored then pink in maturity. **Stipe** 53–73 × 4–6 mm, central, cylindrical, cream to grayish colored, with longitudinal dark brown fibrils. **Context** fleshy, white. **Spore print** pink.

Basidiospores (6–) 6.4–9 (–9.6) × (4.8–) 5.6–7.6 µm, in average 7.7 × 6.5 µm, Q= (1.05–) 1.10–1.25 (–1.33), subglobose to broad ellipsoid, smooth, with a thickened wall, stramineous. **Basidia** 28–38 × 7.2–11.2 µm, clavate, bearing four sterigmata. **Pleurocystidia** 56.7–97.6 (–113) × 12–24 µm, fusoid or lageniform, with an apical constriction and the apex sometimes forming a broad capitellum, with a slightly thickened wall, hyaline. **Cheilocystidia** 35.2–71.2 × 8–18.4 µm, clavate, sometimes with a short mucro or a narrower neck on the apex, thin-walled, hyaline. **Pileipellis** is a repent cutis, composed by terminal hyphae 13.6–20 µm diam., with rounded apex, and containing a brownish pigment. **Clamp connections** absent.

Habitat: solitary, on decayed wood in a subtropical rain forest.

Studied material: BRAZIL. Rio Grande do Sul State: Santa Maria, Morro do Elefante, 22.V.2002, *F. Wartchow & J.C. Budke*, 22.V.2002, *Wartchow 039* (SMDB 9.712).

Remarks: This species belongs to stirps *Spilopus* of section *Hispidoderma* Fayod and was originally described as a variety of *Pluteus spilopus* by Dennis (1953). However, this paleotropical species differs in having black squamules on the stipe surface and clavate-pedicellate cheilocystidia (Pegler 1986). Singer (1973) described *P. albostipitatus* var. *poliobasis* Singer from the State of Veracruz (Mexico) based on the grayish color at the bottom of the stipe instead of a white color. Later, Rodríguez & Guzmán-Dávalos (2000) found the same variety in the State of Jalisco and described basidiospores globose to subglobose (6–8 × 5.6–8 µm); they also revised the type of Singer's variety and found basidiospores 4.8–7.2 × 4.4–6 µm. Courtecuisse (1991) recorded *P. albostipitatus* with smaller basidiome (12 mm diam.) and basidiospores (5.5–6.5 × 4.5–5.2 µm). In our collection the pleurocystidia have the same shape as those materials reported by Dennis (1953), Singer (1959), Pegler (1983), and Courtecuisse (1991), but the cheilocystidia sometimes presents a short mucro or a narrower neck on the apex. A close species is



Figs. 1-5. ***Pluteus albostipitatus.***
1. Basidiome. 2. Basidia. 3. Pleurocystidia. 4. Basidiospores. 5. Cheilocystidia.

P. melanopotamicus Singer, but it differs mainly by the shape of the pleurocystidia and its thick wall, but not truly metuloidal (Singer 1989).

Stijve & de Meijer (1993) studied some *Pluteus* species suspected or reported to be psychotropic and did not found psychoactive compounds in *P. albostipitatus*. This species can be considered common in tropical and subtropical America, being reported from several countries: Trinidad (Dennis 1953), Argentina (Singer 1956, 1959; Horak 1964), Martinique (Pegler 1983), Mexico (Singer 1973; Rodríguez & Guzmán-Dávalos 2000), Galapagos Islands (Reid et al. 1981), and the French Guyana (Courtecuisse 1991). A Central African report by Horak (1978) is also known. In Brazil, *P. albostipitatus* is known from the States of Paraná (Stijve & de Meijer 1993), São Paulo (Pegler 1997), and recently it was cited from Rio Grande do Sul by Rother et al. (2006).

2. *Pluteus aquosus* Singer, Trans. Br. Mycol. Soc. 39: 148, 1956. FIGS. 6-11

Pileus 12–20 mm diam., convex to plane, somewhat depressed on center, surface dry, with striate to slightly plicate-sulcate margin, whitish at disc to slightly pinkish toward the margin. **Lamellae** free, rather close, pinkish. **Stipe** 17–25 × 1–2 mm, central, cylindrical, hollow, white, longitudinally striate, presenting a whitish basal mycelium. **Context** thin, whitish. **Spore print** pinkish.

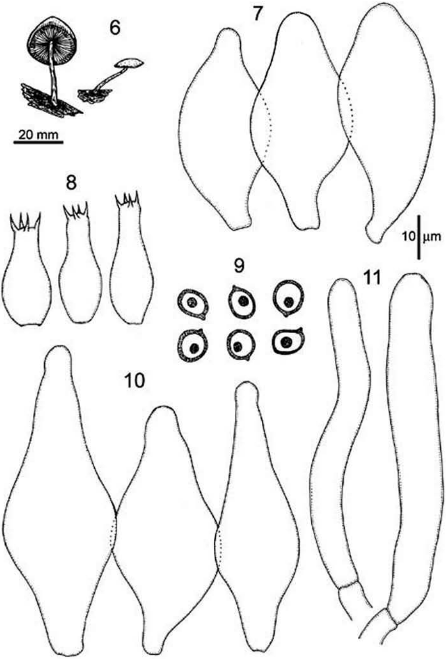
Basidiospores 5–7.5 × 4.5–6.5 µm, in average 6.2 × 5.6 µm, Q= (1–) 1.06–1.23 (–1.31), mainly subglobose, but also short-ellipsoid or globose, smooth, thin-walled, stramineous. **Basidia** 19–29 × 7.5–12.5 µm, bearing four (rarely two) sterigmata, ventricose, thin-walled. **Pleurocystidia** 37–73 × 15–29 µm, fusoid to fusoid-ventricose, with a rounded apex, thin-walled, hyaline. **Cheilocystidia** 39–59 × 17–30·5 µm, fusoid to ventricose, thin-walled, hyaline. **Pileipellis** consisting of hyphoid dermatocystidia, 63.5–164 × 9–30.5 µm, with rounded to slightly obtuse apexes, hyaline. **Clamp connections** absent.

Habitat: solitary on decayed wood in subtropical rain forest.

> **Studied material:** BRAZIL. Rio Grande do Sul State: Santa Maria, Morro do Elefante, 24.XII.2001, *V.G. Cortez* 053/01 (SMDB 9.263).

Remarks: *Pluteus semibulbosus* (Lasch) Quél., *P. haywardii* Singer, *P. niveus* Murrill, and *P. myceniformis* Murrill, belong to stirps *Semibulbosus* of section *Hispidoderma* together with *P. aquosus*. A very similar species is *P. haywardii*, known from the State of São Paulo (Pegler 1997), but this species is separated from *P. aquosus* by the presence of black fibrils on both pileus and stipe, and by the brownish cystidiod hyphae in the pileipellis (Singer 1959). Another similar taxon is *P. albidus* Pegler from Africa (Pegler 1977), differing from *P. aquosus* mainly by the broader basidiospores (6–8 × 5.5–7.5 µm). Our collection agrees with the original description by Singer (1956, 1959) except by the smaller pileus, but the microscopic data of the pileipellis elements and basidiospores support our identification.

Pluteus aquosus was originally described by Singer (1956) from the province of Tucumán, Argentina, and since then was not reported anywhere. The present report is probably the second world record of this species and the first from Brazil.



Figs. 6-11. *Pluteus aquosus*.
6. Basidiomes. 7. Cheilocystidia. 8. Basidia. 9. Basidiospores.
10. Pleurocystidia. 11. Pileipellis elements.

3. *Pluteus beniensis* Singer, Lloydia 21: 285, 1959. FIGS. 12-17

Pileus 19 mm, plane-convex, brown, rugose when fresh at the center with a short striate margin. **Lamellae** free, close, cream then pinkish and with a darker edge when fresh, but not evident after dried. **Stipe** 26 × 1 mm, central, cylindrical, cream, with a grayish base. **Context** very thin, whitish. **Spore print** not observed.

Basidiospores 5–7.2 × 4.4–6.4 µm, in average 5.7 × 5.2 µm, Q= (1–) 1.06–1.16, globose to subglobose, smooth, with a slightly thickened wall, stramineous. **Basidia** 19–27.5 × 6.8–9.2 µm, fusoid-clavate, bearing four sterigmata. **Pleurocystidia** 52–67.6 (–79.2) × 15.2–25 µm, mainly narrowly fusoid, some subclavate, thin-walled, hyaline. **Cheilocystidia** 24–42 × 9.6–18.4 (–24) µm, inflate-clavate, clavate to rarely fusoid, thin-walled, with brownish content. **Pileipellis** an epithelium, terminal elements 28.4–44.8 × 7.5–31.5 µm, pyriform, thin-walled, with dark brown dissolved content. **Clamp connections** absent.

Habitat: solitary, on decayed wood in a subtropical rain forest.

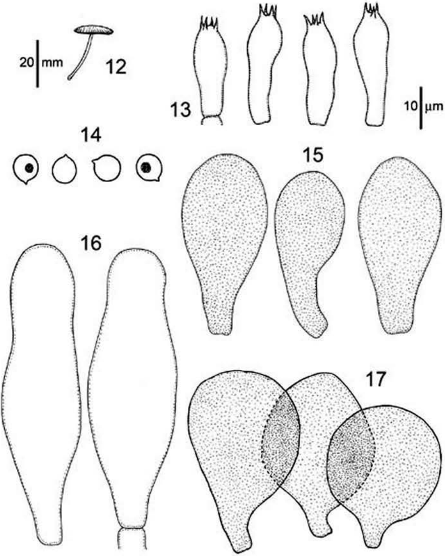
> **Studied material:** BRAZIL. Rio Grande do Sul State: Santa Maria, Morro do Elefante, 02.XI.2002, *D.L. Bordignon & J.C. Budke* (SMDB 9.711).

Remarks: This species is placed in stirps *Luctuosus*, belonging to subsection *Eucellulodermini* Singer of section *Celluloderma* Fayod by the absence of yellow, red or orange tones, cheilocystidia with brownish content, and pileipellis as a true epithelium without dermatocystidia (Singer 1986). *Pluteus luctuosus* Boud., known from Argentina, is a close species but has slightly larger (6–8 × 5.3–7.2 µm) and rounder basidiospores, the gill edge more strongly colored in dry specimens and a dark floccose surface of the stipe (Singer 1959, 1961). The other two species of this subsection, *P. riograndensis* Singer and *P. rimosoaffinis* Singer, have condensed brownish content in the pileipellis elements. Described originally by Singer (1959) from Bolivia, this species was also reported from Paraná State, as suspect of containing psychoactive substances (Stijve & de Meijer 1993). *Pluteus beniensis* was recently cited for the first time from Rio Grande do Sul State by Rother et al. (2006).

4. *Pluteus globiger* Singer in Singer & Digilio, Lilloa 25: 266, 1952. FIGS. 18-23

Pileus 7 mm diam., convex to plane, umbonate, surface humid, hygrophanous, slightly rugulose and brownish-orange on the umbo, to yellowish toward the margin, which is also striate. **Lamellae** free, close, ventricose, pinkish. **Stipe** 15 × 1 mm, central, cylindrical, with a tapered base, humid, with a slightly cartilaginous consistency, yellowish. **Context** very thin, pale yellowish. **Spore print** not observed.

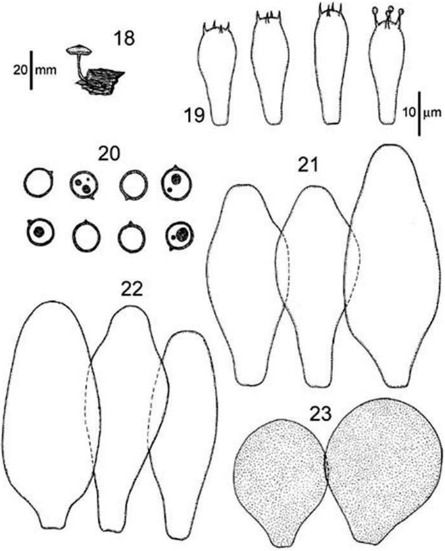
Basidiospores 5.5–6.5 µm, globose, smooth, with a thickened wall, stramineous, with a distinct apiculus. **Basidia** (20–) 22–25 (–28) × (7–) 8–9 µm, clavate to ventricose, bearing four (rarely two) sterigmata. **Pleurocystidia** 37–55 × 17–22 µm, clavate-vesiculose to ampullaceous and broad ventricose, with a rounded apex, very scattered, thin-walled, hyaline. **Cheilocystidia** 40–63 × (10–) 15–23 (–29) µm, very similar to the pleurocystidia in shape, hyaline. **Pileipellis** an epithelium, composed by 1-2 layers of subglobose to sphaeropedunculate elements, (17–) 22–30 µm wide, thin-walled, with a brownish pigment completely dissolved. **Clamp connections** absent.



Figs. 12-17. *Pluteus beniensis.*
12. Basidiome. 13. Basidia. 14. Basidiospores. 15. Cheilocystidia.
16. Pleurocystidia. 17. Pileipellis elements.

Habitat: solitary, on decayed wood in a subtropical rain forest.

Studied material: BRAZIL. Rio Grande do Sul State: Porto Alegre, Campus da Universidade Federal do Rio Grande do Sul, 30.IX.2004, *V.G. Cortez* 050/04 (ICN 139.025).



Figs. 18-23. *Pluteus globiger*.
18. Basidiome. 19. Basidia. 20. Basidiospores. 21. Pleurocystidia.
22. Cheilocystidia. 23. Pileipellis elements.

Remarks: *Pluteus globiger* is another poorly known species described by Singer from Argentina (Singer & Digilio 1952). The author placed this species in stirps *Globiger*, subsection *Eucellulodermini* of section *Celluloderma* (Singer 1959). Taxonomically, *P. globiger* is defined by the brightly yellow pileus, the brownish cells of the pileipellis, and by the globose basidiospores (Singer 1959). A similar species included by Singer in this group is *P. xanthopus* Singer (1959), which is distinguished by the pileus color (grayish-brown to olive-gray) and by the hyaline cells of the pileipellis. Singer (1959) also recognized several forms of *P. globiger*, based on variations of the pileus color and substrate (conifer or dicotyledonous wood), but did not proposed an infra-specific classification. He concluded that those specimens growing on dicotyledonous wood had a brighter colored pileus, as we observed on our material.

Pluteus globiger is a species with a subtropical to tropical distribution along the Americas, known from Mexico (Rodríguez et al. 1997), Venezuela (Dennis 1970), Argentina, Bolivia (Singer 1959), and now from Brazil.

5. *Pluteus nigrolineatus* Murrill, Mem. Torr. Bot. Club 66: 30. 1939. FIGS. 24-28

Pileus 30 mm, campanulate, depressed at the disc, blackish-gray with greenish tints, surface subviscid and somewhat fibrillose. **Lamellae** free, close, ventricose, white then pinkish. **Stipe** 58 × 4 mm, central, cylindrical with a slightly expanded base, white, with greenish tints at the base. **Context** very thin, whitish. **Spore print** pink.

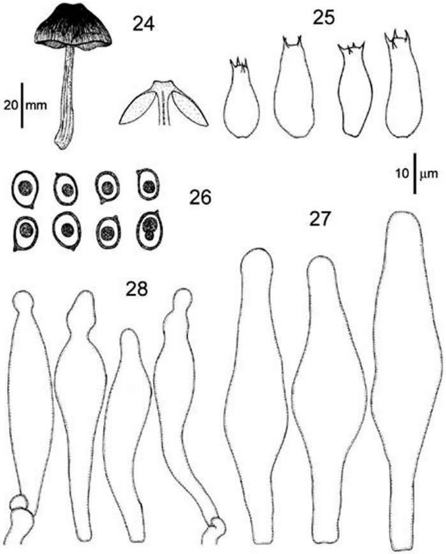
Basidiospores 5.6–8 × 4·8–5.6 µm, in average 6.9 × 5.2 µm, Q = (1.14–) 1.16–1.43 (–1.5), broadly ellipsoid, smooth, with slightly thickened wall, stramineous. **Basidia** 14.5–24.8 × 10.4–17.4 µm, ventricose, bearing four basidiospores. **Pleurocystidia** 45.6–76.8 × 10.4–17.6 µm, fusoid to lageniform, sometimes with a broad neck, projecting a subcapitellum or more frequently with a broad rounded apex, thin-walled, hyaline. **Cheilocystidia** 33.5–64 × 7.2–14.4 µm, fusoid-mucronate, often short mucronate or with a conspicuous neck, sometimes with a true capitellum, thin-walled, hyaline. **Pileipellis** with ascending hyphae, 75–90 × 7.2–12.5 µm, cylindrical with a rounded to sometimes acute apex, grayish-brown pigment, clamped. **Clamp connections** present, mainly on the base of the cheilocystidia and pileipellis hyphae.

Habitat: solitary, on decayed wood in subtropical rain forest.

> **Studied material:** BRAZIL. Rio Grande do Sul State: Santa Maria, Boca do Monte Passo do Tigre, 16.II.2003, *V.G. Cortez* 001/03 (SMDB 9.710).

Remarks: *Pluteus nigrolineatus*, because the presence of elongated elements on pileipellis and thin-walled pleurocystidia, belongs to the rare group of clamped species of stirps *Nigrolineatus*, section *Hispidoderma* (Singer 1986). This species is easily separated macroscopically from the other species of the group by the greenish base of the stipe. Homola (1972) reported from North America *P. cyanopus* Quél., another species with greenish tints in the stipe base, but the vesiculose to ellipsoid elements of the pileipellis and the absence of clamp connections, place this taxon in section *Celluloderma*.

According to Singer (1986), the other three species belonging to this stirps are: *P. brunneisucus* Pegler, from Africa, with abundant dark fibrils covering the stipe surface (Pegler 1966); *P. umbrinidiscus* Murrill, and *P. avellaneus* Murrill, which according to the type studies by Singer (1956) are synonyms, although Smith & Stuntz (1958) did not found clamp connections in the type of *P. avellaneus*. Banerjee & Sundberg (1993) analyzed both type specimens and concluded that *P. avellaneus* is in unsatisfactory conditions, and *P. umbrinidiscus* belongs to section *Celluloderma*.



Figs. 24-28. *Pluteus nigrolineatus.*
24. Basidiome and section. 25. Basidia. 26. Basidiospores.
27. Pleurocystidia. 28. Cheilocystidia.

Pluteus nigrolineatus is an American species, maybe common but probably overlooked, occurring from the United States and Mexico to Argentina and Chile (Singer 1961, 1969; Rodríguez & Guzmán-Dávalos 1997). The present report is the first one for the species from Brazil.

Acknowledgements

The authors thanks to Dr. Bernardo E. Lechner (INTECH, Argentina) and Dr. Laura Guzmán-Dávalos (Universidad de Guadalajara, Mexico) for kindly reviewing the manuscript, and Dr. Paul M. Kirk (IMI, UK) for English improvement. The help of Dr. Jair Putzke (UNISC, Brazil) is also thanked.

Literature cited

Banerjee P, Sundberg WJ. 1993. Reexamination of *Pluteus* type specimens: types housed at the New York Botanical Garden. Mycotaxon 49: 413-435.

Courtecuisse R. 1991. Eléments pour un inventaire mycologique des environs du saut Pararé (Arataye) et de l'inselberg des Nouragues (Guyane Française). V. *Pluteaceae* (*Pluteales*, Basidiomycota). Crypt. Bot. 2/3: 136-152.

Dennis RWG. 1953. Les *Agaricales* de l'Ile de la Trinité: rhodosporae-ochrosporae. Bull. Soc. Mycol. France 69: 147-198.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Add. Ser. 3: 1-531.

Homola R. 1972. Section *Celluloderma* of the genus *Pluteus* in North America. Mycologia 64: 1211-1247.

Horak E. 1964. Fungi Austroamericani II. *Pluteus* Fr. Nova Hedw. 8: 163-199.

Horak E. 1978. *Pluteus* (*Pluteaceae*). Fl. Illust. Champ. D'Afr. Centrale 6: 105-118.

Pegler DN. 1966. Tropical African *Agaricales*. Persoonia 4: 73-124.

Pegler DN. 1977. A preliminary agaric flora of East Africa. Kew Bull. Add. Ser. 6: 1-615.

Pegler DN. 1983. Agaric flora of Lesser Antilles. Kew Bull. Add. Ser. 9: 1-668.

Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bull. Add. Ser. 12: 1-514.

Pegler DN. 1997. The agarics of São Paulo, Brazil. London (UK): Royal Botanic Gardens, Kew/ HMSO.

Putzke J. 1994. Lista dos fungos *Agaricales* (Hymenomycetes, Basidiomycotina) referidos para Brasil. Cad. Pesq. Sér. Bot. 6: 1-189.

Reid DA, Pegler DN, Spooner BM. 1981. An annotated list of the fungi of the Galapagos Islands. Kew Bull. 32: 847-892.

Rick J. 1907. Contributio ad Monographiam Polyporacearum et Agaricacearum Brasiliensium. Broteria Ser. Bot. 6: 65-92.

Rick J. 1919. Contributio ad Monographiam Polyporacearum et Agaricacearum Brasiliensium II. Broteria Ser. Bot. 17: 101-111.

Rick J. 1930. Contributio ad Monographiam Polyporacearum et Agaricacearum Brasiliensium IV. Broteria Ser. Bot. 24: 27-118.

Rick J. 1938. Agarici Riograndensis III. Lilloa 3: 399-455.

Rick J. 1961. Basidiomycetes Eubasidii in Rio Grande do Sul – Brasilia. 5. *Agaricaceae*. Iheringia Ser. Bot. 8: 296-450.

Rodríguez O, Vargas O, Guzmán-Dávalos L. 1997. New reports of the genus *Pluteus* (*Agaricales*) from México. Mycotaxon 61: 473-480.

Rodríguez O, Guzmán-Dávalos L. 1997. New additions to the genus *Pluteus* (*Pluteaceae*, *Agaricales*) for Mexico. Micol. Neotrop. Apl. 10: 83-91.

Rodríguez O, Guzmán-Dávalos L. 2000 ('1999'). Algunas especies del género *Pluteus* Fr. (*Pluteaceae*, *Agaricales*) citadas en Nueva Galicia, México. Bol. Inst. Bot., Univ. Guadalajara 7: 61-77.

Rother MS, Putzke J, Severo MA. 2006. Espécies da ordem *Agaricales* (Fungos Basidiomicetos) no município de Passo Fundo, RS, Brasil. Cad. Pesq. Ser. Biol., in press.

Singer R. 1953. Type studies on Basidiomycetes. VI. Lilloa 26: 57-159.

Singer R. 1956. Contribution towards a monograph of the genus *Pluteus*. Trans. Brit. Mycol. Soc. 39: 145-232.

Singer R. 1959 ('1958'). Monographs of South American Basidiomycetes, especially those of the east slope of the Andes and Brazil. I. The genus *Pluteus* in South America. Lloydia 21: 195-299.

Singer R. 1961. Monographs of South American Basidiomycetes especially those of the east slope of the Andes and Brazil. IV. *Inocybe* in Amazone region and a supplement to part I. *Pluteus* in South America. Sydowia 15: 112-132.

Singer R. 1969. Mycoflora Australis. Beih. Nova Hedw. 29: 1-405.

Singer R. 1973. Diagnoses Fungorum Novorum Agaricalium III. Beih. Sydowia 7: 1-106.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4th ed. Koenigstein (Germany): Koeltz Scientific Books. 981 pp.

Singer R. 1989. New taxa and new combinations in the *Agaricales* (Diagnoses Fungorum Novorum Agaricalium IV). Fieldiana Bot. 21:1-133.

Singer R, Digilio APL. 1952 ('1951'). Pródromo de la Flora Agaricina Argentina. Lilloa 25: 5-461.

Smith AH, Stuntz DE. 1958. Studies on the genus *Pluteus*. I. Redescriptions of American species based on a study of type specimens. Lloydia 21: 115-136.

Stijve T, de Meijer AAR. 1993. Macromycetes from the state of Paraná, Brazil. 4. The psychoactive species. Arq. Biol. Tecnol. 36: 313-329.

Wartchow F, Cortez VG, Coelho G. 2004. *Pluteus thomsonii* (*Pluteaceae*): a northern agaric found in South America. Mycotaxon 89: 349-353.

MYCOTAXON

Volume 96, pp. 253–255 *April–June 2006*

New species of marasmioid genera (Basidiomycetes, *Tricholomataceae*) from tropical Africa - 6. *Marasmius cremeopileatus*, a new species from Zimbabwe

VLADIMÍR ANTONÍN[1] & CATHY SHARP[2]

[1]*vantonin@mzm.cz*
Moravian Museum, Dept. of Botany, Zelný trh 6
CZ-659 37 Brno, Czech Republic

[2]*mycofreedom@zol.co.zw*
P.O. Box 55, Kariba, Zimbabwe

Abstract—A new tropical African *Marasmius* species, *M. cremeopileatus*, collected from two localities in Zimbabwe is described. It belongs in sect. *Sicci*, ser. *Haematocephali*.

Key words—*Agaricales*, new taxa, taxonomy

This paper is a continuation of a series with new taxa of the genera *Gloiocephala*, *Marasmius*, and *Setulipes* in tropical Africa. The complete study of these genera will be published in a new series of monographs "Flora Fungorum Africae Tropicalis" edited by the National Botanical Garden in Meise (Brussels, Belgium) in 2006.

Marasmius cremeopileatus Antonín & C. Sharp **sp. nov.** (Figs. 1–4)

MB510042

Pileo 14–24 mm lato, convexo vel plano, cremeo. Lamellis distantibus, pallide luteis vel cremeo-brunneis. Stipite usque 35 mm longo, apicem pallide cremeo, ad basim sienna-brunneo. Basidiosporis (8,7–)9,0–11,5 x 3,5–4,2(–4,7) µm, fusiformibus, sublacrimoideis, hyalinis, inamyloideis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, 14–22 x 5,0–9,0(–11) µm, clavatis vel subcylindraceis. Pleurocystidiis 32–59 x 8,0–17 µm, fusiformibus, subutri-formibus, subclavatis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 11–20 x 7,0–12 µm, clavatis vel subcylindraceis, tenuitunicatis, apicem subcrassitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et medulla dextrinoideis. Ad folia putrida.

HOLOTYPUS: Zimbabwe, Bromley, Liemba Farm 1831 A2, 3. II. 1999 leg. C. Sharp 1321/99 (holotypus in herbario BRNM 699715 preservatur).

Pileus 14–24 mm broad, convex at first, then applanate, irregular, smooth or minutely rugulose, with smooth, entire margin, matt or finely tomentose, pale or cream coloured. Lamellae distant, L = 23–25, l = 2–3, ± free, pale yellowish or buff-cream coloured, with concolorous edge. Stipe up to 35 mm long, very slender, cylindrical or slightly tapering towards base, tough, elastic, longitudinally finely fibrillose, non-insititious (with basal mycelium), cream or buff coloured at apex, through golden or fulvous to sienna brown towards base. Context membranaceous. Basal mycelium buff or cream coloured, and covering stipe base. Spore print white.

Basidiospores (8.7–)9.0–11.5 x 3.5–4.2(–4.7) µm, E = 2.1–3.1, Q = 2.6–2.7, fusoid, sublacrimoid, rarely septate, thin-walled, smooth, hyaline. Basidia 18–28 x 7.0–8.0 µm, 4-spored, clavate. Basidioles 13–25 x 4.0–9.0 µm, clavate, (sub)fusoid, subcylindrical. Cheilocystidia shaped as broom-cells of the Siccus-type, 14–22 x 5.0–9.0(–11) µm, clavate, subcylindrical, entirely thin-walled or with slightly thick-walled apex, hyaline, with up to 10 thin- to slightly thick-walled, nodulose, obtuse to subacute, up to 7.0 x 1.0 µm projections; mixed with scattered smooth, clavate, subvesiculose cells with present transient forms. Pleurocystidia numerous, 32–59 x 8.0–17 µm, fusoid, subutriform, (sub)clavate, obtuse, often rostrate or with a pimple, thin-walled, with a refractive contents. Hymenophoral trama composed of cylindrical to subinflated, thin-walled, up to 12 µm wide hyphae. Pileipellis a hymeniderm composed of broom-cells of the Siccus-type, 11–20 x 7.0–12 µm, clavate, subcylindrical, thin-walled with slightly thick-walled apex, with c. 12–25 nodulose, obtuse to subacute, slightly thick-walled, up to 11 x 1.0(–1.5) µm projections. Stipitipellis a cutis consisting of cylindrical, parallel, slightly thick-walled, smooth, up to 4.0(–5.0) µm wide hyphae. Caulocystidia absent. Clamp-connections present in all tissues.

Chemical reactions: Hymenophoral trama hyphae dextrinoid, other structures non-dextrinoid.

Ecology. Saprotrophic, growing on leaf litter in mixed miombo woodland where dominant trees were *Brachystegia spiciformis* and *Julbernardia globiflora*.

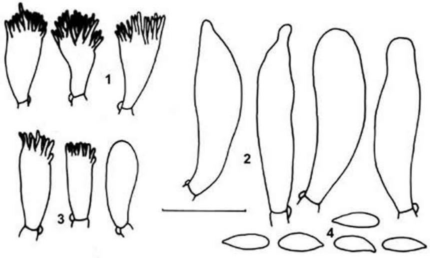
Distribution. Known only from a few localities in Zimbabwe.

> **Revised specimens.** Zimbabwe, Bromley, Liemba Farm 1831 A2, 3 Febr. 1999 leg. C. Sharp 1321/99 (holotype, BRNM 699715). – Zimbabwe, Karoi North, Ridges Farm 1629 DI, 15 March 2001 leg. D. Flight (Sharp 1558/01; BRNM 699714).

Remarks. *Marasmius cremeopileatus* is characterised by having pale (buff or cream) coloured carpophores, moderately large basidiospores, well-developed pleurocystidia and cheilocystidia, and pileipellis cells in the form of broom-cells of the Siccus-type; caulocystidia are absent. On account of these characteristics, it belongs to sect. *Sicci*, ser. *Haematocephali*.

The closest tropical African species is *M. pallidopileatus* Antonín (Antonín 2006), with a smaller, yellow-ochraceous pileus only up to 10 mm broad, a very pale, brownish stipe, and cheilocystidia of only one type – only in the form of broom-cells.

Among other species, *Marasmius splitgerberi* (Mont.) Singer collected in South America and Lesser Antilles seems to be a similar species. However, it differs by a smaller, only 2–11 mm broad pileus, larger basidiospores (10–15 x 3–4 µm according to Pegler 1983; (7–)9–12.5 x 2.7–4 µm according to Singer 1976), and inconspicuous pleurocystidia measuring 25–36 x 7–9 µm. *Marasmius musicola* Murrill known from Cuba and



Figs. 1–4. *Marasmius cremeopileatus*:
1. pileipellis cells, 2. pleurocystidia, 3. cheilocystidia, 4. basidiospores.
Scale bar = 20 µm.

Guadeloupe, has a smaller, 8–10 mm broad, sulcate-striate pileus, very distant lamellae (L = 6–11), larger basidiospores (15.5–19 x 2.5–4 µm according to Pegler 1983; 16.8–20.5 x 3.2–4.5 µm according to Singer 1976), and pleurocystidia with coarse oily contents (Pegler 1983, Singer 1976).

Acknowledgements

A basic project of African tropical marasmioid fungi was supported by the Grant Agency of the Czech Republic, project No. 206/01/0093. The Carter and Flight families kindly hosted the second author during collecting trips to Liemba and Ridges Farms respectively.

References

Antonín V. 2006. Monograph of *Marasmius*, *Gloiocephala*, *Palaeocephala* and *Setulipes* in tropical Africa. Flora Fungorum Africae Tropicalis 1 (in press).

Pegler DN 1983. Agaric flora of the Lesser Antilles. –Kew. Bull. Addit. Ser. 9: 1–668.

Singer R. 1976. *Marasmiae* (Basidiomycetes, *Tricholomataceae*). Fl. Neotrop. 17: 1-347.

MYCOTAXON

Volume 96, pp. 257–260 *April–June 2006*

Myxomycete flora of Derebucak (Konya) and Akseki (Antalya) districts in Turkey

DURSUN YAĞIZ & AHMET AFYON

dyagiz@selcuk.edu.tr aafyon@selcuk.edu.tr
Selçuk University, Education Faculty, 42099, Meram, Konya-TURKEY

Abstract—This study was based on myxomycete specimens collected from Derebucak (Konya) and Akseki (Antalya) district between 2002 and 2004. According to the "Natural" or "Moist Chamber Cultures" techniques, 47 taxa belonging to 17 genera from nine families have been identified. These taxa are listed in alphabetical order and provided in the result section. This list includes information on epithet, author, locality, habitat, altitude, date, and herbarium number for each taxon. The full checklist is available at http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon06-092.pdf.

Key words—Myxomycota, diversity, C3 floristic square

Introduction

This study was based on myxomycete specimens collected from Derebucak (Konya) and Akseki (Antalya) district between 2002 and 2004 (Figure 1). The study area is located in the C3 floristic square of Central Anatolia and Mediterranean regions (Davis 1965-1985). The first type of the east Mediterranean climate is seen in Derebucak and Akseki. While winter is the rainiest season for the Mediterranean climate, summer seasons are very dry (Akman 1990). Two important phytogeographic regions and their transition zone form the study area. Hence, Derebucak and its surrounding are in the Iran-Turan region and Akseki is in the Mediterranean phytogeographic region. This forest environment, formed by mixed and pure conifer and broad-leaved trees such as *Pinus* spp., *Abies* sp., *Cedrus* sp. and *Quercus* spp., forms an important part of the study area (Dural et al. 1995, Duran 2002). This research aims to find out the bio-diversity and distribution of myxomycetes in Turkey.

Materials and Methods

The myxomycetes were collected from the research area during field trips between 2002 and 2004. These samples come from the bark of trees, decaying wood, and litter collected during various field trips. Where myxomycetes were in the natural sporophore phase, these were collected with their substrates. The materials not carrying the naturally developed myxomycete sporophore were treated with the "Moist Chamber Cultures" method, developed by Gilbert & Martin (1933) in order to grow myxomycetes that might potentially develop spores. The incubated materials were examined periodically with a

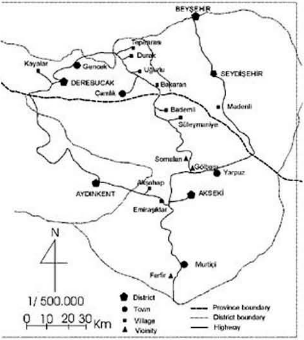


Figure 1: Map of the study area.

stereomicroscope. The preparations were examined under the microscope to determine the microscopic characteristics of the myxomycetes. A variety of resources were used to identify the samples (Martin & Alexopoulos 1969, Thind 1977, Farr 1981, Martin et al. 1983, Nannenga-Bremekamp 1991, Neubert et al. 1993, 1995, 2000, Stephenson & Stempen 2000). The myxomycete samples are kept in the herbarium of the Faculty of Education at the Selçuk University (KNYA).

Results

In this study, 47 taxa belonging to 17 genera from nine families were identified. All taxa are listed in alphabetical order in the full checklist posted at http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon06-092.pdf.. Distribution of the taxa according to their families is as follows: *Ceratiomyxaceae* 1, *Echinosteliaceae* 1, *Cribrariaceae* 8, *Reticulariaceae* 1, *Liceaceae* 5, *Didymiaceae* 1, *Physaraceae* 8, *Trichiaceae* 12 and *Stemonitaceae* 10.

Discussion

A total of 47 taxa representing 17 genera from nine families were determined. The percentage of the species by family are: *Trichiaceae* 25.5 %, *Stemonitaceae* 21.3 %, *Cribrariaceae* 17 %, *Physaraceae* 17 %, *Liceaceae* 10.6 %, *Ceratiomyxaceae* 2.1 %, *Didymiaceae* 2.1 %, *Echinosteliaceae* 2.1 % and *Reticulariaceae* 2.1 %. A relatively large number of taxa were identified within the limited area of this study, particularly when compared to other studies conducted over large areas.

Figure 2: Photo of a myxomcete sporophore — *Stemonitopsis hyperopta*

The usual habitats for the myxomycetes are forest areas. Naturally developed sporophores of myxomycetes identified are marked with an asterisk (*) in the list of taxa. These naturally sporulating samples represent 23.4 % of the total samples. Such a high percentage shows the availability of the suitable media for the development of myxomycetes.

Using the method of "Moist Chamber Cultures" enables us to grow myxomycetes without depending on the conditions of each season. In the laboratory, the spores of some naturally collected myxomycetes were used to produce the fruit body by the incubation technique. However, myxomyceticolous hyphomycetes and ascomycetes grow particularly fast during the hot summer months (July-August), which can greatly hamper the incubation success rate. The mycelia of the myxomyceticolous fungi were particularly common on species of *Comatricha* and *Stemonitis*. This result parallels the one found by Stephenson & Stempen (2000).

It was noted that the members of *Stemonitales* and *Trichiales* were often developed on dead wood of conifers. This finding is similar to the one suggested by Härkönen & Ukkola (2000).

Acknowledgements

We are thankful to TÜBİTAK (The Scientific and Technical Research Council of Turkey) (TBAG-2240) and the Commission for the Scientific Research Projects (BAP: F.E.B./031) at Selçuk University for supporting and funding this research study. Thanks are also due to Prof. Dr. Mustafa Işıloğlu, Dr. Stephan Helfer, and Dr. Shaun Pennycook for reviewing the paper and for their helpful comments.

Literature Cited

Akman Y. 1990. Iklim ve biyoiklim. Ankara: Palme Yayın Dağıtım.

Davis PH (ed.). 1965-1985. Flora of Turkey and the East Aegean Islands. Vol. 1-9, Edinburgh Univ. Press.

Dural H, Küçüködük M, Ertuğrul K. 1995. Yıldızlı Dağı (Akseki-Antalya) florasına katkılar. Ot Sistematik Botanik Dergisi, 2: 47-66.

Duran A. 2002. Flora of Tuzaklı, Otluk, Gidefi Mountains and surroundings (Akseki). Tr. J Botany 26: 303-349.

Farr ML. 1981. True slime moulds. Wm. C. Brown, Comp. Pulp. Dubuque, Iowa.

Gilbert HC, Martin G W. 1933. Myxomycetes found on the bark of living trees. Univ. Iowa Stud. Nat. Hist. 15 (3) 3-8.

Härkönen T, Ukkola T. 2000. Myxomycetes in the forests and woodlands of western Oregon. Mycotaxon 76: 213-245.

Martin GW, Alexopoulos CJ. 1969. The myxomycetes, University of Iowa. Iowa City.

Martin GW, Alexopoulos CJ, Farr ML. 1983. The genera of myxomycetes. University of Iowa, Iowa City.

Nannenga-Bremekamp NE. 1991. A guide to temperate myxomycetes. Biopress Limited Bristol.

Neubert H, Nowotny W, Baumann K. 1993. Die myxomyceten (Band 1). Karlheinz Baumann Verlag Gomaringen.

Neubert H, Nowotny W, Baumann K. 1995. Die myxomyceten (Band 2). Karlheinz Baumann Verlag Gomaringen.

Neubert H, Nowotny W, Baumann K. 2000. Die myxomyceten (Band 3). Karlheinz Baumann Verlag Gomaringen.

Stephenson SL, Stempen H. 2000. Myxomycetes: A handbook of slime molds. Timber Press, Portland, Oregon, USA.

Thind, K. S. 1977. The myxomycetes of India. Indian Council Agric. Res. New Delhi.

MYCOTAXON

Volume 96, pp. 261-307 April–June 2006

A taxonomical treatment of the North and Central American species in *Lactarius* sect. *Deliciosi*

JORINDE NUYTINCK

jorinde.nuytinck@ugent.be
Ghent University, Department of Biology, Research Group Mycology
K.L. Ledeganckstraat 35, B – 9000 Ghent Belgium

STEVEN L. MILLER

University of Wyoming, Botany Department
Laramie, WY 82071–3165 USA

ANNEMIEKE VERBEKEN

Ghent University, Department of Biology, Research Group Mycology
K.L. Ledeganckstraat 35, B – 9000 Ghent Belgium

Abstract — This paper deals with the 13 American species in *Lactarius* sect. *Deliciosi* that are supported or revealed in a molecular phylogenetic study of this section on a worldwide scale. Elaborate macro- and microscopical descriptions are given and illustrated for every species. Type specimens for nearly all taxa were examined in this study. None of the taxa treated here seems to occur in Asia or Europe. The name *L. deliciosus* is misapplied in North America but more research is needed to solve the taxonomy and relationships in this complex of varieties of "*L. deliciosus*". *Lactarius aurantiosordidus* is described as a new species.

Key words — morphology, *Lactarius* sect. *Dapetes*

Introduction

In North and Central America, *Lactarius indigo* is the most striking representative of *Lactarius* sect. *Deliciosi* (Fr. : Fr.) Redeuilh et al. (syn. *L.* sect. *Dapetes* (Fr. ex J. Kickx f.) Burl., syn. *L.* subgenus *Lactarius* sensu Hesler & Smith 1979). It differs from the other species in the section by its deep blue coloured latex. Most representatives have orange latex that turns more or less slowly reddish or have vinaceous red to brown latex from the beginning. The basidiocarps are similarly coloured but often paler due to the presence of a whitish layer covering the surface of the pileus and stipe. Other characteristic features are the mostly viscid pileus, and in some species also the viscid stipe, the often zonate pileus, the frequent presence of scrobicules and the green stains that develop upon bruising or with age.

Lactarius indigo was also the first species that was described from North America in this section (as *Agaricus indigo* by Schweinitz (1822), later also by Winder (1871) as *L. canadensis*). Peck (1872, 1878, 1898) contributed to the knowledge of *Lactarius* sect. *Deliciosi* in America by describing *L. chelidonium*, *L. subpurpureus* and *L. salmoneus*. Coker (1918), Beardslee & Burlingham (1940), and Murrill (1945) furthermore described *L. curtisii*, *L. paradoxus*, *L. pseudodeliciosus* and *L. paradoxiformis*. Hesler & Smith (1960) published an important revision in which they divide *Lactarius* sect. *Lactarius* (= sect. *Deliciosi*) into three subsections. The pileipellis structure was considered very important. *Lactarius* subsection *Versicolores* Hesler & A.H. Sm. contains species with a dry pileus: *L. salmoneus*, *L. curtisii* and *L. subaustralis* Hesler (the latter species was later transferred to *Lactarius* subgenus *Plinthogali*). *Lactarius* subsection *Lactarii* contains species with a viscid pileus and thus includes most species; a separate subsection *Caerulei* Hesler & A.H. Sm. was created for *L. indigo*. Most European species known at that time were treated in Hesler & Smith (1960); some of them were also recognised to occur in North America (*L. salmonicolor*, *L. sanguifluus* (Paulet) Fr., *L. deliciosus* (L.: Fr.) Gray var. *deliciosus* and *L. quieticolor* Romagn.). In their later monograph of the genus *Lactarius* in North America, Hesler & Smith (1979) raise the section to the level of subgenus and give up their subdivision of *Lactarius* subgenus *Lactarius* (= sect. *Deliciosi*). Furthermore, many European taxa are no longer included; the European names still present are *L. salmonicolor*, *L. deliciosus* var. *deliciosus*, var. *deterrimus* (Gröger) Hesler & A.H. Sm. and var. *piceus* Smotl. However, in an appendix listing extralimital species that have been reported form North America and are expected to be eventually verified, they mention many European taxa. Four new species and varieties were described by Hesler & Smith (1979) (*L. barrowsii*, *L. indigo* var. *diminutivus*, *L. rubrilacteus* and *L. deliciosus* var. *olivaceosordidus*) and four combinations were made. The many recognised varieties indicate uncertainty about the status of several taxa, but Hesler & Smith (1979) explicitly stated that they wanted to stress the diversity in the genus. Since then, only two new species have been described: *L. miniatosporus* and the hypogeous *L. rubriviridis* from Central and North America (Montoya & Bandala 2004, Desjardin 2003).

A molecular approach, using two DNA regions and including 33 North and Central American collections, support 13 species in *Lactarius* sect. *Deliciosi* for the area (Nuytinck et al. in preparation). Many of the described varieties, however, were not included. This paper lists all the species in *Lactarius* sect. *Deliciosi* that we provisionally recognise in North and Central America. For every species a macroscopical description is given, often based on literature data, and a detailed microscopical description is elaborately illustrated. A short discussion summarizes the most important diagnostic features of each species and conclusions from our molecular phylogenetic approach (Nuytinck et al. in preparation). For most species, the type specimen was examined. The status of the many varieties and the delimitation of taxa in the "*L. deliciosus*" complex remain problematic. Molecular data show that the name *L. deliciosus* is misapplied in North and Central America (Nuytinck 2005).

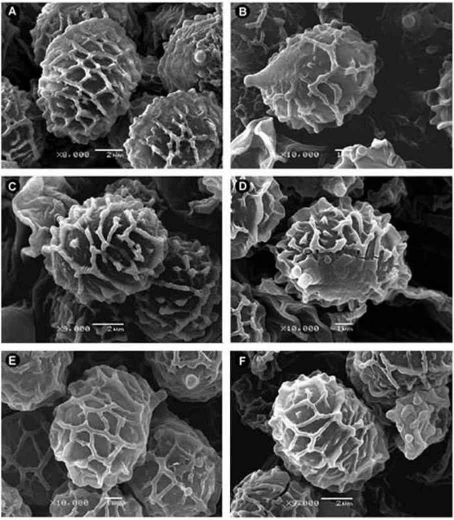


Fig. 1: SEM images of spores A. *L. barrowsii* (J. States AEF 1151); B. *L. chelidonium* (S.L. Miller 9649); C. *L. indigo* (R.E. Halling 8143); D. *L. paradoxus* (G.S. Burlingham 184233, lectotype); E. *L. pseudodeliciosus* var. *pseudodeliciosus* (Beardslee & Burlingham 22.12.1937, lectotype); F. *L. rubrilacteus* (J. States AEF 1055).

Materials & Methods

This study is based on herbarium material deposited in or obtained from FLAS, GENT, MICH, NY, NYS, PC, RMS, SFSU, XAL and ZT.

Macroscopical characters are based on fresh material or are compiled from literature. Colour codes are from Kornerup & Wanscher (1962). Microscopic measurements and drawings were made under oil immersion at 1000× with a Zeiss Axioscop 2 microscope and drawing tube. All observations and measurements (except for the spores) were made in Congo red in L_4 (7.2 g KOH, 160 ml glycerine, 840 ml dH_2O, 7.6 g NaCl and 5 ml Invadin (Ciba-Geigi), Clémençon 1972). Where necessary a short pre-treatment in 10% KOH was used to rehydrate the tissue. Basidia lengths exclude sterigmata lengths. We use the term cheiloleptocystidia for the thin-walled, mostly clavate to irregularly shaped cystidia, without specific content and with a rounded apex on the lamella edge. Observations and measurements of basidiospores where made in Melzer's reagent. Spores were measured in side view, excluding ornamentation and the measurements are given as (MIN) [Ava-2×SDa] – *Ava* – *Avb* – [Avb+2×SDb] (MAX) in which Ava = lowest mean value for the measured collections, Avb = greatest mean value and SDa/b = standard deviation of the lowest and greatest mean value respectively. MIN is the lowest value measured, MAX the highest value; MIN and MAX are only given when they exceed [Ava-2×SDa] or [Avb+2×SDb] respectively. Q stands for 'quotient length/width' and is given as MINQ – *Qa* – *Qb* – MAXQ in which Qa and Qb stand for the lowest and the highest mean quotient for the measured specimens respectively. MINQ/MAXQ stands for the minimum/maximum value over the quotients of all available measured spores. 20 spores were measured for every collection mentioned in the examined collections section. For species that are microscopically described using only one specimen, the measurements are given as (MIN) [Av-2×SD] – *Av* – [Av+2×SD] (MAX) in which Av is the mean value of the 20 spores measured from that collection and as MINQ – *Q* – MAXQ in which Q stands for the mean quotient of the measured spores.

Scanning electron photographs were taken with a JEOL JSM-5600 LV microscope. Small pieces of lamellae were taken from dried specimens and soaked overnight in strongly diluted ammonia. The material was then treated with 70% ethanol (2 × 15 min.) and dimethoxymethane (2 × 30 min.), before being submitted to the process of critical point drying. This was done with a BAL-TEC CDP 030 dryer. The samples were then coated with gold in a JEOL JFC-1200 Fine Coater for 60 sec. at 8 Pa and 30 mA, until a 15 nm thick layer covered the spores.

Synoptic key to the representatives of *Lactarius* sect. *Deliciosi* in North and Central America

Numbers refer to the species as treated in the text. The hypogeous L. rubriviridis *is excluded from this synoptic key. For several characters the state remains unknown for some of the species. For* L. pseudodeliciosus *var.* paradoxiformis *and* L. salmoneus *var.* salmoneus, *e.g., it is not known whether they have a zonate pileus and scrobicules on the stipe. The colour change of the latex on the context (after ± 30 min.), an important identification character, is unclear for, e.g.,* L. chelidonium, L. pseudodeliciosus *and* L. salmoneus.

Pileus colour

- whitish to buff: 1, 6.1, 6.2, 9.1, 9.2
- yellow: 2.1, 2.2, 4, 6.1
- orange: 2.2, 7, 9.2, 11, 12.1, 12.2, 13
- pinkish: 4, 10
- greyish green: 2.1, 2.2, 5, 12.1, 12.2, 13
- blue: 2.1, 2.2, 3.1, 3.2, 5

Pileus zonation

- azonate to faintly zonate: 1, 2.1, 2.2, 3.1, 3.2, 4, 6.1, 9.2, 12.1
- zonate: 2.1, 3.1, 3.2, 5, 7, 10, 11, 12.1, 12.2, 13

Lamellae colour

- orange to ochraceaous: 1, 5, 6.1, 6.2, 7, 9.1, 9.2, 11, 12.1, 12.2, 13
- yellowish: 2.1, 2.2, 6.1
- pinkish: 4, 5, 10
- blue: 3.1, 3.2

Stipe colour

- whitish to yellowish: 1, 2.1, 2.2, 6.1, 6.2, 9.1, 9.2
- orange: 2.2, 7, 9.2, 11, 12.1, 12.2, 13
- pinkish to red: 4, 5, 7, 10
- greyish green: 2.1, 13
- blue: 2.1, 3.1, 3.2

Stipe scrobiculate

- no: 1, 2.2, 3.2, 4, 7, 10, 11, 12.1, 12.2, 13
- yes: 3.1, 3.2, 4, 5, 6.1, 7, 10, 11, 12.1, 13

Latex colour (on context when cut)

- orange: 2.2, 6.1, 6.2, 9.1, 9.2, 11, 12.1, 12.2, 13
- yellow: 2.1, 2.2
- red: 1, 4, 5, 7, 10
- blue: 2.1, 2.2, 3.1, 3.2, 5
- greenish: 13

Latex colour changing on context (after ± 30 min.)

- orange to red: 9.1, 11, 12.1, 12.2
- no change: 1, 3.1, 3.2, 4, 5, 7, 10, 12.2

Discolouration of sporocarp

- becoming green: 1, 2.1, 2.2, 3.1, 3.2, 4, 5, 6.1, 6.2, 7, 9.2, 10, 12.1, 12.2, 13
- not changing to green: 9.1, 11

Host tree

- *Pinus*: 1, 2.1, 2.2, 3.1, 3.2, 4, 5, 6.1, 7, 9.1, 9.2
- *Quercus*: 3.1, 5, 6.1
- *Pseudotsuga*: 7
- *Tsuga*: 10
- *Picea*: 12.2, 13

Locality

- western North America: 1, 7, 12.1, 12.2, 13
- eastern North America: 2.1, 2.2, 3.1, 3.2, 5, 6.1, 6.2, 9.1, 9.2, 10, 11
- Central America: 3.1, 4, 5, 9.2

Descriptions and taxonomical conclusions

1. *Lactarius barrowsii* Hesler & A.H. Sm., N. Amer. Species *Lactarius*: 74 (1979)

Figs. 1, 2

Type: Barrows 35 of 1969 (MICH!), USA: New Mexico, near Santa Fe

DESCRIPTION (macroscopical description after Hesler & Smith 1979): Pileus 3–10 cm diam., convex to depressed with an incurved margin; surface glabrous, viscid but soon dry, azonate or only near the margin faintly zoned; colour whitish to light pinkish cinnamon at first, becoming mottled creamy to ochraceous orange or finally ± pinkish buff, often flushed green or olive or more olive-grey. Lamellae becoming decurrent, close, narrow; colour ochraceous to pinkish orange, becoming flushed green, green where injured. Stipe 2–4 × 1–2.5 cm, equal or nearly so, soon hollow; surface dry, not scrobiculate, at first with a white bloom, yellowish beneath this but soon stained green. Context firm, thick; colour whitish to pale pinkish cinnamon (especially around worm-holes), becoming flushed greenish, staining green quickly where cut; taste mild to peppery. Latex scanty, dark red (port-wine red). Spore deposit yellowish.

Spores 8.5–*9.3*–*9.4*–10.1 (10.4) × 6.3–*7.0*–*7.1*–7.6 (7.8) µm, broadly ellipsoid to ellipsoid (Q = 1.22–*1.31*–*1.34*–1.48); ornamentation up to 0.5 µm high, of medium thick ridges with some thinner ridges and isolated warts, forming a nearly complete reticulum with small meshes; plage distally weakly amyloid. Basidia 42–60 × 7–11 µm, subclavate, 4-spored, with a needle-shaped content. Pleuromacrocystidia scarce and inconspicuous, 39–50 × 4.7–8 µm, slightly emergent, subfusiform with a moniliform or narrowing apex, often with an ochre, smooth content or with small needle-shaped crystals, thin-walled. Pseudocystidia rather abundant, 2–6 µm broad, sometimes slightly emergent, tortuous, content oleiferic and ochre-brownish in KOH. Lamella edge mostly fertile and with abundant cheilomacrocystidia and basidioles; cheilomacrocystidia 34–50 × 5–7 µm, emergent, subfusiform with a moniliform to obtuse or capitate apex, with a needle-like to granular content, thin-walled. Subhymenium composed of small, ± rounded cells. Hymenophoral trama irregularly filamentous; lactifers abundant. Pileipellis an ixocutis, 100–200 µm thick, slime layer thin and inconspicuous, composed of regularly shaped, densely interwoven hyphae, 2–7 µm diam., shrivelled hyphae scarce. Stipitipellis a very dense cutis, up to 100 µm thick, of regularly shaped hyphae, 2–4 µm diam. Clamp-connections absent.

HABITAT: Scattered under *Pinus ponderosa* and *Pinus cembroides* in montane habitat (type locality, Hesler & Smith 1979).

DISTRIBUTION: Reported from New Mexico, Washington and Arizona.

COLLECTIONS EXAMINED: **USA**, New Mexico, Santa Fe Co., Near Santa Fe, Under Pinon pine, 01.09.1969, C.A. Barrows 35 (MICH), holotype – Washington, Spokane, Whitworth College Campus near MacKay Hall, 18.09.1978, leg. N. Gray (RMS) – Arizona, Cochise Co., east side Onion Saddle, Turkey Creek Road, Coal outcrop, 1620 m a.s.l., 03.09.1993, J. States AEF 987 (MICH) – Arizona, Cochise Co., Pinery Canyon Road, *Pinus*, 04.09.1993, J. States AEF 1039 (MICH) – Arizona, Santa Cruz Co., Santa Rita Mountains, 03.09.1994, J. States AEF 1271 (MICH) – Arizona, Coconino Co., Walnut Canyon National Monument, *Pinus edulis*, N35°10' W111°30.26', 10.09.1994, J. States AEF 1151 (MICH).

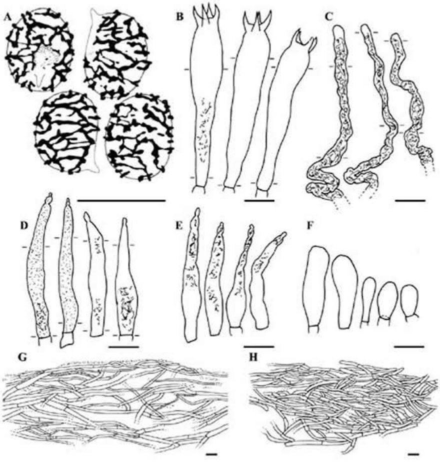


Fig. 2: *Lactarius barrowsii*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. basidioles and marginal cells from the lamella edge; G. section through the pileipellis; H. section through the stipitipellis. From C.A. Barrows 35 (type), J. States AEF 987, J. States AEF 1039, J. States AEF 1271 and J. States AEF 1151.

Scale bars = 10 µm, small bars indicate the height of the hymenium.

Discussion: Hesler & Smith (1979) remark that this species is amply distinct in the colour of the pileus from the other western American species with red latex, *L. rubrilacteus*. The latter species has an orange coloured and clearly zoned pileus. Both species also differ in spore size and ornamentation. *Lactarius barrowsii* has larger spores that are ornamented with a denser and more complete reticulum. Another striking feature of *L. barrowsii* is the frequently fertile lamella edge and as a consequence the occurrence of basidioles on the edge. *Lactarius barrowsii* is so far only know from New Mexico, Washington and Arizona and seems to be associated with *Pinus* spp. in mountainous habitat. We included two *L. barrowsii* specimens (originating from Arizona and Washington) in our phylogenetic analyses. They form a well-supported clade and group with a high confidence value with *L. rubriviridis*, a hypogeous species described from California and collected in the same type of habitat as *L. barrowsii*. *Lactarius barrowsii* does not seem to be very closely related to *L. rubrilacteus*.

2.1. *Lactarius chelidonium* Peck, Rep. (Annual) New York State Mus. Nat. Hist. 24: 74 (1872) var. *chelidonium* Figs. 1, 3

Holotype: missing from NYS, collected by Peck in New York, Saratoga.

Description (macroscopy after Peck 1872): Pileus fleshy, firm, centrally depressed; surface smooth, slightly viscid, of a greyish green colour with blue and yellow tinges and a few narrow zones on the margin. Lamellae close, narrow, forked and wavy at the base, sometimes anastomosing; colour greyish yellow. Stipe short, subequal, hollow; surface smooth; coloured like the pileus. Context when bruised at first stained yellowish, then changing to blue and finally to green. Latex sparse, of a yellowish colour resembling the juice of Celandine (*Chelidonium majus*) or the liquid secreted from the mouth of grasshoppers; taste mild. Spore deposit yellowish.

Spores (8.0) 8.1–*8.6*–9.2 (9.3) × 5.9–*6.4*–7.0 µm, broadly ellipsoid to ellipsoid (Q = 1.24–*1.35*–1.48); ornamentation up to 0.5 µm high, of medium thick ridges and quite abundant isolated warts, forming an incomplete reticulum; plage distally amyloid or with scattered, small amyloid spots. Basidia 40–55 × 8–10 µm, subclavate, 4-spored, sometimes with a needle-shaped content; sterigmata 4–6 µm long. Pleuromacrocystidia scarce, 45–65 × 4.5–7 µm, emergent, subfusiform with a narrowed to strongly constricted (moniliform) apex, sometimes with a needle-shaped content, thin-walled. Lamella edge sterile with abundant cheilomacrocystidia; cheiloleptocystidia 12–25 × 3–6 µm, subclavate to irregular, hyaline, thin-walled; cheilomacrocystidia 30–40 × 4.5–7 µm, emergent, subfusiform with a tapering, capitate or moniliform apex, with a needle-like content, thin-walled. Subhymenium of irregularly shaped cells, often arranged in short rows. Hymenophoral trama with abundant lactifers of 4–9 µm diam. Pileipellis an ixocutis, 100-200 µm thick. Clamp-connections absent.

Habitat: Sandy soil, under pine trees (type locality, Peck 1872).

Distribution: Hesler & Smith (1979) cite collections from Alabama, Michigan, Tennessee and Wisconsin. The type locality is in New York.

Collections examined: USA, New York, Bolton Landing, August 1921, C.H. Peck (NYS) – New York, Bethlehem, September 1921, C.H. Peck (NYS) – New York, St. Lawrence Co., near Star Lake, pine woods, 26.09.1997, S.L. Miller 9649 (RMS).

Discussion: Hesler & Smith (1979) state that *L. chelidonium* has been generally misidentified since Peck's time, which has led to much confusion with "*L. deliciosus*". The yellowish colour of the latex and the greyish and bluish tinges in the cap should make a clear distinction between both species possible. The blue colour of the pileus context is independent of the very commonly observed change to green in this section. This has been wrongly interpreted since the time of Peck (Hesler & Smith 1979). As the type of *L. chelidonium* is missing, we examined two collections identified by Peck. However, the collection from Bolton landing is in a very bad state.

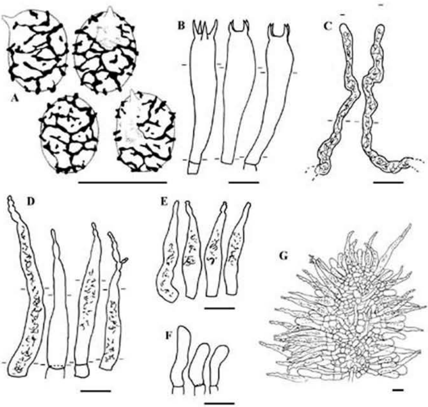


Fig. 3: *Lactarius chelidonium* var. *chelidonium*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. lamella edge. From Bethlehem, September 1921, C.H. Peck and S.L. Miller 9649.

Scale bars = 10 µm, small bars indicate the height of the hymenium.

Collection S.L. Miller 9649 (RMS) from New York was identified as *L. chelidonium* in the field and is included in our molecular analyses. Because the microscopical features are slightly deviating from the ones observed in Peck's material, a short description is given here separately.

> Spores 7.8–*8.4*–8.9 × 5.8–*6.4*–6.9 (7.0) µm, broadly ellipsoid to ellipsoid (Q = 1.25–*1.32*–1.37); ornamentation up to 0.5 µm high, of medium thick ridges and some isolated warts, forming an incomplete reticulum; plage distally amyloid or with scattered amyloid spots. Basidia 37–55 × 8–12 µm, subclavate, mostly 4-spored, sometimes 2-spored, mostly hyaline; sterigmata 4–7 (8) µm long. Pleuromacrocystidia quite abundant, 35–70 × 5.3–7 µm, emergent, subfusiform with a narrowing to moniliform apex, with a granular or needle-shaped content, thin-walled. Pseudocystidia relatively scarce, 2.5–5.5 µm broad, subcylindric to tortuous, with a yellowish content. Lamella edge sterile with very abundant cheilomacrocystidia; cheiloleptocystidia 12–30 × 4–6 µm, mostly

> subclavate, hyaline, thin-walled; cheilomacrocystidia 27–58 × 4–8 µm, subfusiform with a narrowing apex, with a granular to needle-shaped content, thin-walled.

This collection differs from the collections made by Peck by the abundant cheilo- and pleuromacrocystidia. Macrocystidia are only abundant in a zone of 100 µm close to the lamella edge in Peck's collections. More collections are needed to find out whether these differences fall into the intraspecific variation of *L. chelidonium*.

2.2. *Lactarius chelidonium* var. *chelidonioides* (A.H. Sm.) Hesler & A.H. Sm.,

N. Amer. Species *Lactarius:* 84 (1979) **Fig. 4**
≡ ***L. chelidonioides*** A.H. Sm., Brittonia 12: 127 (1960)

Holotype: Smith 62026 (MICH!), USA: Michigan, Dexter

DESCRIPTION (macroscopy after Hesler & Smith 1979, Kuo 2003): Pileus 3–8 cm diam., applanate to convex or shallowly depressed, becoming shallowly infundibuliform; surface smooth or finely roughened, glabrous, viscid but soon dry, azonate to slightly zonate, often mottled with watery spots; colour dirty bluish when young, passing through stages of yellowish brown and dull orange, readily bruising dark green, in age often green overall. Lamellae decurrent, narrow, fairly crowded; colour dull dingy yellowish to tawny olive (yellow-brown) but soon discolouring greenish, in old basidiocarps olive buff overall and stained darker green locally. Stipe 3–6 (8) × 1–2.5 cm, equal or enlarged below; surface fairly smooth, glabrous, dry, without scrobicules; colour similar to the cap but paler and more dingy yellowish orange at the base. Context becoming hollow in the stipe, pallid, staining azure blue in the upper half of the pileus, with a paler to dingy yellowish line above the lamellae, dingy pale yellow-brown in the cortex of the stipe, in age azure blue throughout except for the line above the lamellae and dirty yellowish orange in the stipe; smell subnauseous, like that of *Morchella esculenta*; taste tardily and slightly peppery. Latex very scarse (likely to be observed only in very young primordia), dirty yellowish to yellowish brown. Spore deposit pale buff.

Spores 8.1–*8.7*–9.2 × 5.9–*6.6*–7.0 µm, broadly ellipsoid to ellipsoid (Q = 1.27–*1.35*–1.42); ornamentation up to 1 µm high, of large isolated warts and some rather short and medium thick ridges, not organized into a reticulum or only a very incomplete one; plage distally slightly amyloid. Basidia 40–65 × 8–11 µm, subclavate, 4-spored, mostly hyaline; sterigmata 3–7 µm long. Pleuromacrocystidia absent but macrocystidia abundantly present very close to the edge (see under lamella edge). Pseudocystidia rather scarce, 2.5–5 µm broad, cylindrical to tortuous, with an ochre-yellow content. Lamella edge sterile with abundant macrocystidia 100–150 µm away from the edge, no real cheilomacrocystidia; cheiloleptocystidia 7–22 × 3.5–7.5 µm, mostly subclavate, hyaline, thin-walled; macrocystidia close to the edge 40–60 × 4.5–10 µm, subfusiform, with a moniliform apex, mostly hyaline, thin-walled. Subhymenium or irregularly shaped cells, arranged in short rows. Hymenophoral trama of interwoven, mainly irregularly arranged hyphae and abundant lactifers. Pileipellis an ixocutis of narrow, gelatinous, hyaline and appressed hyphae. Stipitipellis a cutis. Clamp-connections absent.

HABITAT: Under conifers, especially *Pinus strobus* and *Pinus resinosa*, late summer and fall.

DISTRIBUTION: Uncertain but probably limited to eastern North America; recorded in Michigan, Massachusetts, Vermont, Illinois and Quebec (Kuo 2003).

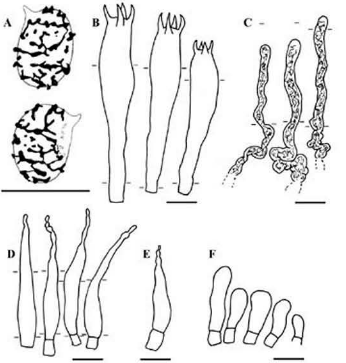


Fig. 4: *Lactarius chelidonium* var. *chelidonioides*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. macrocystidium close to the lamella edge; F. cheiloleptocystidia. From A.H. Smith 62026 (type). Scale bars = 10 µm, small bars indicate the height of the hymenium.

Collection examined: USA, Michigan, Washtenaw Co., Stinchfield Woods, NW of Dexter, Under *Pinus strobus*, 12.10.1972, A.H. Smith 62026 (MICH), holotype.

Discussion: Originally, Hesler & Smith (1960) described *L. chelidonioides* as a separate species, differing from *L. chelidonium* by its muddy yellow to brownish latex, its *Morchella*-like smell and the blue context of pileus. The colour of the context was observed at all stages from buttons 1 cm in diameter to the largest caps, and it became more intense and widespread up to maturity. In old basidiocarps the colour had faded out to greyish pallid (Hesler & Smith 1979). Because of the lack of well-defined differences, Hesler & Smith (1979) re-evaluated the status of *L. chelidonium* and treated it as a variety of *L. chelidonium*.

Microscopically, the most striking difference between Peck's collections of *L. chelidonium* var. *chelidonium* and the holotype of *L. chelidonium* var. *chelidonioides* is the ornamentation of the spores. The ornamentation is clearly higher in var. *chelidonioides* and forms a less complete network. In many spores the warts and short ridges are not organised in a reticulate pattern at all.

This variety seems to be collected more frequently than the type variety (e.g. Kuo 2003); the latter differs from var. *chelidonioides* by its mild taste, its indistinct smell and the latex that is bright yellow at first (becoming a pale tobacco to dirty brown, Hesler

& Smith 1979). More detailed research is needed on both varieties of *L. chelidonium* to decide on their taxonomic status.

3.1. ***Lactarius indigo*** (Schwein.: Fr.) Fr., Epicr. Syst. Mycol.: 341 (1838) var. ***indigo***

Figs. 1, 5

≡ ***Agaricus indigo*** Schwein.: Fr., Schr. Nat. Ges. Leipzig 1: 87 (1822)
≡ ***Lactifluus indigo*** (Schwein.: Fr.) Kuntze, Revisio Generum Plantarum, Pars II: 857 (1891)
= ***L. canadensis*** Winder, Mushrooms Canada, addenda [24] (1871)

Excluded: ***L. indigo*** sensu Imazeki et al. (1988), Nagasawa (1998) and probably several other authors (= *L. subindigo*) (see also Nuytinck et al. 2006).

Type: not typified, described from North Carolina.

Description: Pileus 5–15 cm diam., convex-depressed becoming deeply infundibuliform, with an inrolled margin at first; surface smooth (but actually with a lot of very small scrobicules), slightly viscid, nearly azonate to clearly zonate, often with fine but clear zones near the margin; colour bright blue when fresh and moist, fading to greyish to almost white (21A2) with a silvery sheen; zones staying deeper blue (22A-C4/5). Lamellae slightly decurrent, with a small decurrent tooth, rather close, medium thick, sometimes forked near the stipe; colour bright indigo blue (21B5/6) or paler, sometimes appearing yellowish from the mature spores, staining green where bruised; edge entire, slightly paler. Stipe 2–8 × 1–2.5 cm, central to more rarely eccentric, cylindrical, equal or tapering downwards; surface smooth, viscid but soon dry, mostly scrobiculate; colour indigo blue but often much paler (23A2/3) and with a whitish top layer; scrobicules deep blue (22B/C4/5). Context firm, hollow in the stipe, whitish buff to yellowish in the stipe, when cut immediately indigo blue in almost the entire pileus surface and the margins of the stipe, becoming deep bluish green after 1 h (26E5); smell agreeable, quite strongly fruity; taste mild to very slightly acrid after some chewing. Latex not very abundant, bright to dark blue (19/20C/D8 to 23D/E7/8), slowly turning green on the context; taste mild. Spore deposit cream colour (3A3/4).

$FeSO_4$ no reaction, KOH yellowish to pale watery orange on the pileus cuticle, stipe context and stipe cuticle, dirty orange on the hymenium, gaiac no reaction.

Spores (6.9) 7.0–*7.7*–*8.1*–8.9 (9.2) × 5.3–*5.9*–*6.2*–6.8 µm, subglobose to ellipsoid (Q = 1.19–*1.28*–*1.34*–1.45); ornamentation up to 0.5 µm high, of medium thick ridges and low warts, forming an incomplete reticulum; plage distally slightly amyloid. Basidia 37–53 × 7.3–10.5 µm, cylindrical to subclavate, 4-spored, sometimes containing oil-droplets; sterigmata 3–7 µm long. Pleuromacrocystidia very abundant near the edge, becoming scarcer further away, 30–62 × 4–8 µm, emergent, subfusiform with a moniliform apex, with a granular content, thin-walled. Pseudocystidia very abundant, 3–6 µm broad, tortuous, mostly not emergent, with a dark ochre content in KOH. Lamella edge sterile with scarce to very abundant cheilomacrocystidia; cheiloleptocystidia 8–25 × 3–6 µm, mostly subclavate, hyaline, thin-walled; cheilomacrocystidia 18–37 × 3–7.3 µm (up to 50 µm in some collections), subfusiform with a moniliform apex, emergent, with a granular content, thin-walled. Subhymenium composed of compactly arranged, short cells. Hymenophoral trama composed of irregularly interwoven hyphae; lactifers numerous. Pileipellis an ixocutis, 70–200 µm thick, of strongly interwoven hyphae, 1–5 µm diam.; shrivelled and gelatinised hyphae scarce; near the surface slender and strongly tortuous hyphae sometimes present. Stipitipellis a cutis, 50– 60 µm thick, of regularly shaped hyphae, (1) 3–6 µm diam., lactifers present close to the surface. Clamp-connections absent.

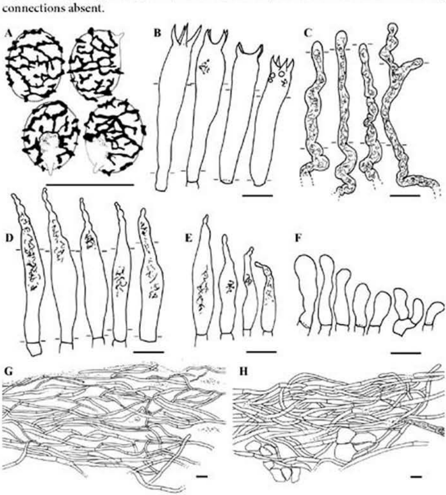


Fig. 5: *Lactarius indigo* var. *indigo*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystdia; G. section through the pileipellis; H. section through the stipitipellis. From B. Buyck 01.158, B. Kropp 29-Oct.-00-15, R.E. Halling 8143, R.F. Cain 24421 and S.L. Miller 9579. Scale bars = 10 µm, small bars indicate the height of the hymenium.

Habitat: Scattered to gregarious on soil, in both *Pinus* and *Quercus* woods.

Distribution: Not particularly common but fairly widespread in its distribution, found throughout eastern North America, southwards to southern Colombia (R. Halling pers. comm.).

COLLECTIONS EXAMINED: **Belize,** Mtn. Pire Ridge, Cayo district, *Pinus caribaea*, 29.10.2000, B. Kropp 29-Oct.-00-15 (RMS) – Cayo district, 03.08.2003, B. Kropp 3-Aug.-03-1 (RMS) – **Costa Rica,** B. Buyck 01.158 (PC) – Coto Brus, Las Mellizas, Zona Protectora Las Tablas, Finca La Cafrosa, Camino a Portones por El Tajo, *Quercus seemannii* & *Quercus* spp., scattered, on soil, 1475 m a.s.l., N8°55.034' W82°46.000', 07.06.2001, R.E. Halling 8143 (NY) – **USA,** R.F. Cain 24421 (ZT) – unknown, brought, West Virginia Mycological Association Foray in Green Briar State Forest, 09.09.1997, S.L. Miller 9579 (RMS) – Tennessee, Cocke Co., Greenbrier biological station (Tudor road), under Red Oak sp. and *Pinus* sp., 488 m a.s.l., N35°44.038' W083°25.45', 12.07.2004, J. Nuytinck 2004-002 (GENT).

DISCUSSION: Without a doubt, this is one of the most striking agarics seen anywhere. It is an unmistakable species, but Hesler & Smith (1979) warn not to confuse dried out specimens with *L. paradoxus*. This species shows quite some variability in colour (from young to old specimens) and in the placement of the stipe that can be eccentric (Hesler & Smith 1979). The macroscopical description given here is compiled from our own observations, Hesler & Smith (1979) and Kong Luz (1995).

At the very base of the stipe a whitish orange mycelium can be observed, that scarcely exudes a reddish orange latex (7A7/8 to 8C8); pale reddish orange coloured rhizomorphs can also be present at the base of the stipe (Kong Luz 1995, P. Leacock pers. comm.).

Found throughout eastern North America, *L. indigo* is distributed south to southern Colombia where it is associated with *Quercus humboldtii*. Tree partners in Costa Rica include *Q. seemannii, Q. copeyensis, Q. oocarpa, Q. oleoides, Q. corrugata* and *Q. costaricensis* (R. Halling pers. comm.). *Lactarius indigo* tends to be associated with *Pinus* in the northern part of its distribution area but with *Quercus* when moving southwards (B. Buyck pers. comm.). Records of *L. indigo* associated with *Pinus* are nonetheless known from Mexico (Kong Luz 1995).

There is a form (or perhaps a distinct taxon), found near Palo Verde in the northern Talamancas, that has narrow crowded lamellae, an azonate pileus and smaller stature (R. Halling pers. comm.). We had no material available for our phylogenetic analysis.

Microscopically the small spores are characteristic. This character state is shared with the very similar but not very closely related *L. subindigo* Verbeken & E. Horak, known from SE Asia to India (Verbeken & Horak 2000, Nuytinck et al. 2006).

3.2. *Lactarius indigo* var. *diminutivus* Hesler & A.H. Sm.,

N. Amer. Species *Lactarius*: 69 (1979) Fig. 6

Holotype: Hillhouse 249 (MICH!), USA: Texas, Brazoria County

DESCRIPTION: Pileus 3–5 cm broad at maturity, plano-depressed becoming broadly infundibuliform, rarely remaining convex, margin inrolled at first; surface glabrous, viscid to slimy, when dry appearing unpolished (almost velvety); colour dark blue when young and fresh, grey-blue with a silvery sheen when dry, in age grey-green to olive green overall; margin often finely striate when moist, subzonate (zones visible at maturity only). Lamellae decurrent to longly decurrent, fairly broad, concolorous with the pileus, quickly staining dark indigo where cut or bruised and then slowly turning to grey-green or olive, green in age. Stipe 1.5–2.5 × 0.5–0.8 cm, solid, soon becoming hollow, tapering downwards, concolorous with the pileus. Context white but quickly changing to dark blue by the abundant latex, changing to green in ± 0.5 h. Latex deep indigo blue, unchanging. Spore deposit white in a thin deposit.

Spores 7.0–*7.5–7.6*–8.2 × 5.5–*5.9–6.0*–6.4 µm, broadly ellipsoid (Q = 1.18–*1.26–1.29*–1.34); ornamentation up to 0.5 µm high, of (rather) thick ridges, rarely intermixed with finer ridges, with some small isolated warts, forming an almost complete reticulum; plage distally very slightly amyloid. Basidia 40–55 × 7–10 µm, subclavate to almost cylindrical, 4-spored, sometimes containing oil-droplets; sterigmata 3–6 µm long. Pleuromacrocystidia apparently absent. Pseudocystidia rather abundant, 2.5–5.5 µm broad, tortuous to cylindrical, sometimes branching, oleiferic, ochre-brown in KOH. Lamella edge often fertile, with scarce cheilomacrocystidia; cheiloleptocystidia 9–30 × 2.7–7 µm, subclavate, sometimes containing oil-droplets, thin-walled; cheilomacrocystidia 28–45 × 5.5–7 µm, emergent, subfusiform with a capitate to moniliform apex, with a needle-shaped content, thin-walled. Subhymenium composed of subglobose cells, often arranged in rows. Hymenophoral trama irregular, with (short) hyphae and abundant, conspicuous lactifers. Pileipellis an ixocutis, 150–250 µm thick, slime layer thin, few shrivelled or gelatinised hyphae; lactifers rather abundant and often situated close to the surface. Stipitipellis a thin ixocutis of hyaline narrow hyphae but no slime zone extending beyond the hyphal zone (surface lubricous to subviscid in wet weather). Clamp-connections absent.

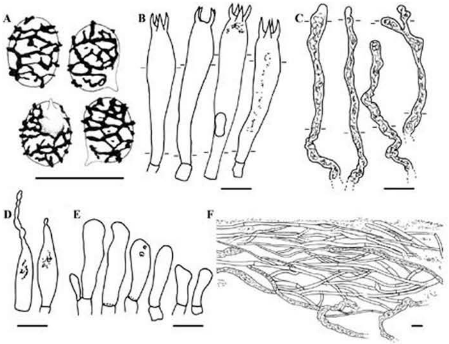


Fig. 6: *Lactarius indigo* var. *diminutivus*: A. spores; B. basidia; C. pseudocystidia; D. cheilomacrocystidia; E. cheiloleptocystidia; F. section through the pileipellis. From E. Hillhouse 249 (type) and M.C.Aime 811. Scale bars = 10 µm, small bars indicate the height of the hymenium.

Habitat: Type locality: on bottomland along sides of a muddy ditch under grasses and weeds, loblolly pine (*Pinus taeda*) nearby; gregarious in tufts of 2–3 or scattered; December and January (generally abundant but never found in any other than low muddy spots, Hillhouse in Hesler & Smith 1979).

Distribution: Described from Brazoria County, Texas, possibly also in Virginia.

Collections examined: USA, Texas, Brazoria Co., Liverpool, along ditch bottom and sides of old pipeline crossing, 26.12.1970, E. Hillhouse 249 (MICH), holotype – Virginia, Montgomery Co., Pandapas Pond Rec. Area, Jefferson National Forest, gregarious in one spot in bottom of moist creek bed, mixed woods, 26.08.1999, M.C.Aime 811 (RMS).

Discussion: *Lactarius indigo* var. *diminutivus* differs from var. *indigo* by its small size, the pronounced change to green of the pileus and stipe, the locally thicker spore ornamentation and the scarcer macrocystidia. A fertile lamella edge has only been observed in *L. indigo* var. *diminutivus*. More collections need to be thoroughly described macro- and microscopically to decide on the status of this taxon. We sequenced only one collection, collected in Virginia. It groups with the *L. indigo* var. *indigo* collections in the ITS trees but not in the *gpd* trees, indicating a possible genetic difference.

4. *Lactarius miniatosporus* Montoya & Band.-Muñoz, Mycotaxon 89: 48 (2004)

Fig. 7

Holotype: Montoya 3830 (XAL!), Mexico: Veracruz, Mpio. Xico.

Description (macroscopy after Montoya & Bandala 2004): Pileus 4–11 cm diam., convex to plano-convex, centrally depressed; margin incurved, tomentose when young, expanding and becoming glabrous and striate in age; surface viscid, azonate or with diffuse and vanishing zones; colour pinkish with pale reddish tinges to pale pinkish vinaceous (7A2–B3, 8A/B2), with dark pinkish vinaceous stains (8C/D5), fading to straw colour or yellowish white (4A2–5A2/3–B2–B4); margin remaining vinaceous pink or vinaceous red (10B–D8); centre yellowish white with pale pinkish tinges, irregularly staining blue-green (25D3–25E8). Lamellae adnate to subdecurrent, close to moderately subdistant, forked near the stipe; colour pinkish grey (7B3/4, 8B2/3) or vinaceous red when observed in mass; colour ± pale pinkish vinaceous (10C5) as seen singly, staining blue-green (25D3–25E8) when handled; cut areas staining vinaceous red by the latex. Stipe 1.5–7 × (0.8) 1–2 cm, cylindrical; surface smooth, dry, very rarely superficially spotted; colour dull pink (8A2–B3) to vinaceous pink (7B3–8A2–C4/5, 9B4–10B3) or at times vinaceous red (10C/D5), whitish and subtomentose at the apex, staining blue-green (25D3–E8). Context whitish, staining pink (5A2, 7/8A2) when exposed, especially towards the margin of both pileus and stipe, staining vinaceous red by the latex and staining blue-green (25D3–D4–E8) in all parts; smell mild or of chlorine; taste mild to faintly astringent. Latex vinaceous red (8C/B7, 9E7/8). Spore deposit pale yellowish brown.

Spores 7.0–*7.5*–8.1 (8.2) × 5.5–*5.8*–6.2 (6.3) µm, broadly ellipsoid to ellipsoid (Q = 1.21–*1.30*–1.41); ornamentation up to 0.5 µm high, composed of medium thick ridges and some isolated warts, forming a rather complete reticulum; plage distally slightly amyloid. Basidia 36–70 × 8–10 µm, subclavate, mostly 4-spored, often containing oil-droplets or with a granular content; sterigmata 4–5.5 µm long. Pleuromacrocystidia absent. Pseudocystidia abundant, 2–5.5 µm diam., often slightly emergent, tortuous and often branching, with an ochre-yellow content. Lamella edge sterile with rather scarce to moderately abundant cheilomacrocystidia; cheiloleptocystidia 8-30 × 2.6-8 µm, subclavate to irregularly shaped, hyaline, thin-walled; cheilomacrocystidia 28–46 × 5.3–9 µm, subfusiform with a moniliform apex, emergent, with a needle-shaped to granular content, thin-walled. Subhymenium composed of irregular to subglobose cells, sometimes arranged in short rows. Hymenophoral trama irregularly filamentous; with very abundant lactifers. Pileipellis an ixocutis, up to 250 µm thick, composed of strongly interwoven hyphae, 1–5 µm diam.; shrivelled and gelatinised hyphae abundant near the surface. Stipitipellis a cutis, up to 100 µm thick, composed of strongly interwoven, regularly shaped hyphae, 2–5 µm diam.; no shrivelled hyphae. Clamp-connections absent.

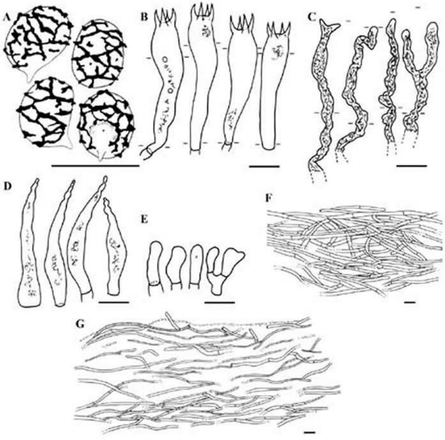


Fig. 7: *Lactarius miniatosporus*: A. spores; B. basidia; C. pseudocystidia; D. cheilomacrocystidia; E. cheiloleptocystidia; F. section through the stipitipellis; G. section through the pileipellis. From Montoya 3830 (type). Scale bars = 10 µm, small bars indicate the height of the hymenium.

Habitat: Associated with *Pinus* (type locality: in pure or mixed stands of *Pinus nubicola*, *P. pseudostrobus* and *P. patula*).

Distribution: Known from the central region of the Gulf area of Mexico only.

> Collections examined: **Mexico,** Veracruz, Mpio. Xico, E Cofre Perote, Ejido Ingenio El Rosario, El Revolcadero, 2850 m a.s.l., under *Pinus patula*, 3.07.2002, Montoya 3830 (XAL), holotype.

Discussion: *Lactarius miniatosporus* is a medium sized to quite large species, characterised by its pinkish pileus, soon fading to yellowish white, its red latex and its small spores.

Montoya & Bandala (2004) suppose a close relationship with *L. subpurpureus*, *L. thakalorum* and *L. sanguifluus*/*L. vinosus*, four species with vinaceous red latex and reddish tones in the basidiocarps. *Lactarius miniatosporus* differs from these species by its smaller spores and the absence of pleuromacrocystidia. Characteristic for *L. miniatosporus* is the tendency of the pileus colour to become duller in age (the colour becomes straw colour to yellowish white, the vinaceous pigmentation is only observed at the margin). Our molecular analyses reveal a well-supported, close relationship of *L. miniatosporus* with *L. paradoxus*. Branch lengths are very short for these taxa in the ITS trees but clearly longer in the *gpd* trees. Only one specimen was included for both *L. miniatosporus* and *L. paradoxus* and thus results need to be interpreted with care.

5. *Lactarius paradoxus* Beardslee & Burl., Mycologia 32: 584 (1940) Figs. 1, 8

> Lectotype: Burlingham, 16-11-1939 (NY!), USA: Florida, Fort Christmas Land Development Co., hammock at "Old Faithful", near Fort Christmas (designated in Hesler & Smith 1979).

Description: Pileus 4.3–8 cm diam., broadly convex, becoming centrally depressed, in age finally infundibuliform; margin inrolled at first, thin and even, translucently striate; surface glabrous, viscid when wet, with concentric canescent zones, becoming more conspicuous when dry; colour greyish indigo to deep blue (20D/E3), paler between the zones, at first with an overall silvery shade, fading to pale blue in age, with yellowish straw stains (3/4A3), staining green when bruised; margin initially vinaceous (11B3/4), becoming reddish vinaceous to pinkish vinaceous (9D5/6) when mature. Lamellae adnate to decurrent, close, narrow, becoming broad, some forked near the stipe; colour pinkish vinaceous (8B3), often with salmon to ochraceous (6A2-B3) or vinaceous salmon (7/8A3) tinges, green (25E5/6) where bruised. Stipe 2–3.5 × 1–2 cm, subcylindric to attenuate near the base, sometimes tapering downwards to a root-like extension; surface dry, superficially scrobiculate, rugose to fibrose; colour pinkish vinaceous (9C4-D5) to vinaceous (10B/C4-12B4), often with bluish shades, with a dingy vinaceous apex at the line of gill attachment and pruinose below this, staining green (25E7) in age and where bruised; base with whitish rhizomorphs. Context thick and firm, becoming hollow in the stipe; colour pallid with a pink to green tinge, vinaceous and staining blue near the pileipellis, dark vinaceous near the stipitipellis, slowly becoming greenish where bruised; smell none; taste mild or slowly peppery to slightly acrid and only slightly bitter. Latex scarce, dark vinaceous brown to blood red (9E7/8), in age staining green on the context. Spore deposit yellow-ochre (5B5/6).

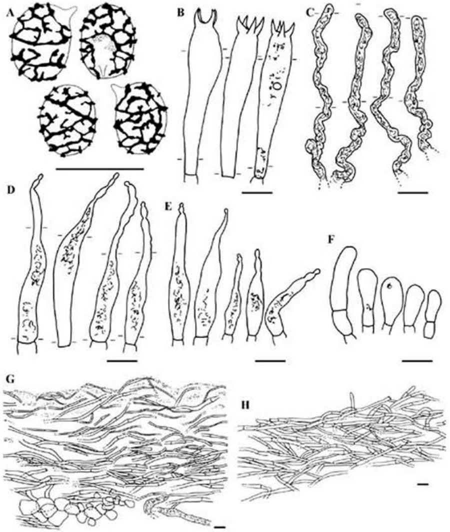


Fig. 8: *Lactarius paradoxus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis; H. section through the stipitipellis. From G.S. Burlingham 184233 (lectotype), G.S. Burlingham 184263 and D. Mitchell 01.02.2002. Scale bars = 10 µm, small bars indicate the height of the hymenium.

KOH no reaction.

Spores 7.8–*8.5–8.6*–9.3 × 5.8–*6.2–6.3*–6.7 (6.9) µm, broadly ellipsoid to ellipsoid (Q = 1.23–*1.36–1.38*–1.46); ornamentation up to 0.5 µm high, of rather thick ridges, forming an almost complete reticulum, isolated warts scarce; plage distally slightly amyloid. Basidia 47–54 × 8-11 µm, subclavate to cylindrical, 4-spored, often containing oil-droplets or needle-shaped crystals; sterigmata 3–6 µm long. Pleuromacrocystidia rather scarce to abundant, 37–76 × 5.3–8 µm, emergent, subfusiform, with a narrowing to strongly moniliform apex, sometimes with a granular, ochre-coloured content, thin-walled. Pseudocystidia abundant, 2–4 µm broad, slender, mostly not emergent, cylindrical to tortuous, with an oleiferic, ochre content. Lamella edge sterile with rather scarce to abundant cheilomacrocystidia; cheiloleptocystidia 10–23 × 4–8 µm, subclavate or more irregular, hyaline, thin-walled; cheilomacrocystidia 25–50 × 3.3–8 µm, emergent, subfusiform with a moniliform apex, often with a granular content, thin-walled. Subhymenium composed of small, globose to irregular cells, often in short rows. Hymenophoral trama composed of strongly interwoven hyphae; with abundant lactifers. Pileipellis an ixocutis, up to 200 µm thick, of strongly interwoven hyphae, 1–4 µm diam.; shrivelled hyphae abundant near the surface. Stipitipellis a cutis, up to 100 µm thick, of regular, strongly interwoven hyphae, 2-5 µm thick; shrivelled hyphae absent. Clamp-connections absent.

HABITAT: Scattered on sandy soil or in lawns; reported under *Quercus virginiana*, *Pinus banksiana*, *P. pseudostrobus*, *P. caribaea* and other *Pinus* spp.; found in the late summer and fall (August to September in the north, October to February in the south).

DISTRIBUTION: Known from the eastern USA (Florida, Michigan, Tennessee, Alabama, Mississippi, Texas and New York), southeast Canada (Ontario), Mexico and Cuba (Montoya et al. 1998).

> COLLECTIONS EXAMINED: USA, Florida, Old Faithful, under cabbage palmetto and live oaks in grass, 16.11.1939, G.S. Burlingham 184233 (NY), lectotype – Florida, 20.11.1939, G.S. Burlingham 184263 (NY), labelled as co-type, possible syntype – Florida, Gulf County, Port St. Joe, Port St. Joe Historical cemetery, 01.02.2002, D. Mitchell (RMS).

DISCUSSION: *Lactarius paradoxus* is a medium sized species, characterised by the bluish and often greenish tinges in the pileus and the vinaceous red to brown latex. Remarkable is the short root-like projection of the stipe that is often present. The macroscopical description given here was compiled from the original description, from Hesler & Smith (1979) and from Montoya et al. (1998). Quite some variability in microscopical characters was found in this species. Hesler & Smith (1979) report several collections with differently ornamented spores. A remarkable variability in the abundance of macrocystidia was observed by us (even between the two collections made by Burlingham); Montoya et al. (1998) report the pleuromacrocystidia to be absent.

6.1. *Lactarius pseudodeliciosus* Beardslee & Burl., Mycologia 32: 582 (1940)
var. *pseudodeliciosus* Figs. 1, 9

> Lectotype: Beardslee & Burlingham 22-12-1937 (NY!), USA: Florida, Orange Co., Rock Springs, Kelly Park (designated in Hesler & Smith 1979).

DESCRIPTION (macroscopy after Beardslee & Burlingham 1940): Pileus 6–8.5 cm diam., broadly convex, deeply umbilicate, expanding to infundibuliform, margin thin agglutinated-fibrous when young (under a lens); surface very viscid when wet, azonate to faintly zonate; colour nearly white at first, becoming yellowish with age, centrally pale pinkish buff to ochraceous-buff. Lamellae adnate to adnate-decurrent, intervenose; colour honey yellow as seen singly (except at the base, which is orange), with orange tones as seen in position. Stipe 1.2–2.5 × 1–2 cm, short, solid, extending to a root-like point on one side, somewhat scrobiculate; colour isabelline (dirty whitish), white-tomentose on the lower half. Context turning drab-green where bruised; smell none. Latex scanty, neutral orange; taste slowly peppery. Spore deposit ochraceous.

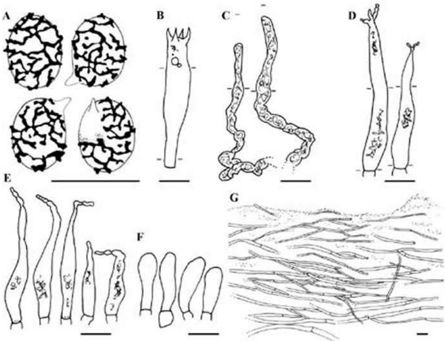


Fig. 9: *Lactarius pseudodeliciosus* var. *pseudodeliciosus*: A. spores; B. basidium; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis. From Beardslee & Burlingham 22.12.1937 (lectotype).

Scale bars = 10 µm, small bars indicate the height of the hymenium.

Spores 7.9–*8.4*–8.9 × 5.8–*6.3*–6.7 µm, broadly ellipsoid to ellipsoid (Q = 1.27–*1.34*–1.43); ornamentation up to 0.5 µm high, composed of mainly medium thick ridges with some thinner ridges and isolated warts, forming an incomplete reticulum; plage distally slightly amyloid. Basidia 35–45 × 6–9 µm, subclavate, 4-spored, with oil-droplets or a granular content; sterigmata 4–6 µm long. Pleuromacrocystidia not very abundant and often inconspicuous, 45–65 × 5–8 µm, subfusiform with a moniliform apex, sometimes branching, with a needle-shaped content, thin-walled. Pseudocystidia abundant, cylindrical to tortuous, usually not emergent, with a yellow-ochre content. Lamella edge sterile with abundant cheilomacrocystidia on the edge or close to the edge; cheiloleptocystidia 13–25 × 4–7 µm, mostly subclavate, some irregular, hyaline, thin-walled; cheilomacrocystidia 26–47 × 3.5–8 µm, emergent, subfusiform with a moniliform apex, with a needle-shaped content, thin-walled. Subhymenium composed of small, irregular cells. Hymenophoral trama with rather abundant, pale ochre coloured lactifers. Pileipellis an ixocutis, 150–300 µm thick, with abundant shrivelled and some gelatinised hyphae, 1–4 µm diam. Stipitipellis a cutis, of rather narrow hyphae. Clamp-connections absent.

HABITAT: Under *Quercus* and *Pinus*, November to February.

DISTRIBUTION: Only known from Florida.

> COLLECTIONS EXAMINED: **USA**, Florida, Orange County, Rock Springs, Wood road, laurel wood, oak & pine, sand, 22.12.1937, Beardslee & Burlingham (NY), lectotype.

DISCUSSION: This rather badly known and apparently uncommon species seems to be characterised by the general pale colours of the pileus and stipe, the orange latex and the development of greenish stains upon bruising. Beardslee & Burlingham (1940) mention that *L. pseudodeliciosus* differs from "*L. deliciosus*" by the agglutinated fibrous edge as seen with a lens, the nearly white and usually azonate pileus and the lack of odour. Microscopical differences we observed are the smaller spores that are ornamented with thinner ridges.

The specimen included in the phylogenetic analyses (from which only the ITS sequence was obtained) shows that *L. pseudodeliciosus* clusters with *L. salmoneus*. Both species are on very long branches, indicating a high divergence.

6.2. *Lactarius pseudodeliciosus* var. *paradoxiformis* (Murrill) Hesler & A.H. Sm., N. Amer. Species Lactarius: 82 (1979) **Fig. 10**

> ≡ ***L. paradoxiformis*** Murrill, Lloydia 7: 304 (1945)
>
> Holotype: Murrill, F19250 (FLAS!), USA: Florida, Marion Co., South of Orange Lake, Cherry Hill

DESCRIPTION (macroscopy after Murrill 1945): Pileus 6–8 cm diam., convex to applanate with a depressed centre; margin deflexed, even or striate over the lamellae, entire to undulate, paler; surface viscid, smooth, glabrous, cream-coloured, becoming in part or totally bluish green. Lamellae short-decurrent, arcuate, crowded or sub-crowded, rather narrow; colour ochraceous, becoming bluish green with age in places; edge entire. Stipe 2–5 × 1–1.5 cm, equal; surface smooth, glabrous; colour ochraceous, bluish green where bruised. Context pallid above, ferruginous below, unchanging, slightly fragrant, slightly but distinctly acrid. Latex not copious enough to form drops but stains orange to rusty. Spore deposit ochroleucous.

Spores 7.7–*8.4*–9.1 (9.2) × 5.7–*6.2*–6.7 µm, broadly ellipsoid to ellipsoid (Q = 1.25–*1.35*–1.43); ornamentation up to 0.5 µm high, of medium thick to thin ridges and isolated warts, forming an incomplete reticulum; plage distally slightly amyloid. Basidia 35–52 × 8–11 µm, subclavate, 4-spored, often with oil-droplets or a granular content. Pleuromacrocystidia not very abundant, inconspicuous, 36–50 × 5.5–7 µm, subfusiform with a moniliform apex, with a granular content, thin-walled. Pseudocystidia scattered, 2–5 µm diam., not emergent, tortuous. Lamella edge sterile with rather abundant

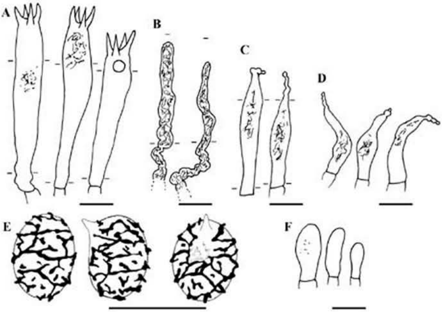


Fig. 10: *Lactarius pseudodeliciosus* var. *paradoxiformis*: A. basidia; B. pseudocystidia; C. pleuromacrocystidia; D. cheilomacrocystidia; E. spores; F. cheiloleptocystidia. From Murrill F19250 (type). Scale bars = 10 µm, small bars indicate the height of the hymenium.

cheilomacrocystidia; cheiloleptocystidia 10–20 × 4–8.6 µm, subclavate to irregular, hyaline, thin-walled; cheilomacrocystidia 18–30 × 3–5 µm, emergent, subfusiform with a moniliform apex, often with a needle-shaped content, thin-walled. Pileipellis a thick ixocutis. Clamp-connections absent.

Habitat: On the ground under hardwoods, especially red oak, fall to early winter (type locality).

Distribution: Only known from Florida

> Collections examined: USA, Florida, Marion County, Cherry Hill, south of Orange Lake, Under red oak and hawthorn, 07.12.1941, Murrill F19250 (FLAS), holotype.

Discussion: Hesler & Smith (1960) treated this taxon as a synonym of *L. pseudodeliciosus* but changed their mind in their later monograph of *Lactarius*. Their decision was based on the following differences in the original descriptions: *L. pseudodeliciosus* var. *paradoxiformis* has a striate pileus margin, a slightly fragrant smell and a distinctly acrid taste, while var. *pseudodeliciosus* has a thinly agglutinated fibrous edge, no distinct smell and a slowly, merely peppery taste. Another indicated difference is the lack of pleuromacrocystidia in *L. pseudodeliciosus* var. *paradoxiformis*, but we did observe (rather scarce and inconspicuous) pleuromacrocystidia in the type collection. Certainly more collections need to be examined to draw any further conclusion about this taxon. We should remark here that the type collection is in a very bad state.

7. ***Lactarius rubrilacteus*** Hesler & A.H. Sm., N. Amer. Species *Lactarius*: 76 (1979)

Figs. 1, 11

Misapplication: *L. sanguifluus* sensu Hesler & Smith (1960).

Holotype: W.B. Gruber 1200 (MICH!), USA: Oregon, Grants Pass.

DESCRIPTION (macroscopy after Hesler & Smith 1979, Methven 1997): Pileus 4–15 cm diam., convex to applanate, depressed in the centre, becoming broadly infundibuliform with age; margin inrolled when young; surface glabrous, (sub)viscid, zonate, with light orange zones (5A2-4), alternating with brownish orange zones (6C5-7), developing irregular, dull green stains (26D3/4), generally duller and paler in age. Lamellae adnate to subdecurrent, close to crowded, narrow to moderately broad, forked near the stipe; colour light orange (6A2-4) to greyish orange (6B2-4), staining reddish brown (8D4-6) and then greyish green (25C6-8) when bruised, in age stained greenish; edge entire. Stipe 2.5–8 × 1–3 cm, equal to tapering downwards; surface glabrous to pruinose, dry, sometimes scrobiculate; colour light orange (6A3/4) to brownish orange (7C3/4) or greyish red (8C2/3); with a light orange (8C2/3) tomentum at the base. Context firm, brittle, thick, becoming hollow in the stipe; colour dingy yellowish white, staining reddish brown (8D4-6) when cut, staining greenish in age; smell becoming faintly subaromatic; taste mild. Latex scanty, in young specimens brownish red (8D4-6), often paler and dingy orange-red in mature specimens; taste not distinctive. Spore deposit pale yellow (4A2/3).

Spores 8.1–*8.6*–*8.9*–9.4 × 5.9–*6.3*–*6.5*–7.5 µm, broadly ellipsoid to ellipsoid (Q = 1.22–*1.32*–*1.37*–1.45); ornamentation up to 0.5 µm high, of thin to medium thick ridges and very abundant warts, forming a (very) incomplete reticulum; plage distinct but almost inamyloid. Basidia 43.5–56 × 8–10.5 µm, subcylindrical to subclavate, 4-spored, hyaline or containing small guttules, sometimes content granular; sterigmata 4–5 µm long. Pleuromacrocystidia rather abundant, especially close to the edge, 48–75 × 5.4–7 µm, emergent, subfusiform, with a moniliform apex, content granular or needle-shaped, thin-walled. Pseudocystidia rather abundant, 3.5–5.5 µm broad, mostly not emergent, cylindrical to tortuous, with a refractive, ochre content. Lamella edge sterile with very abundant cheilomacrocystidia; cheiloleptocystidia 14–30 × 3.4–6.7 µm, mostly subclavate, hyaline, thin-walled; cheilomacrocystidia 35–55 × 5–6 µm, emergent, subfusiform, with a moniliform apex, with a needle-shaped, refractive content, thin-walled. Subhymenium composed of irregular, small cells. Hymenophoral trama irregularly filamntous; with abundant, ochre coloured lactifers. Pileipellis a thick ixocutis, up to 350 µm thick, with an unclear slime-layer, hyphae (1) 3–8 µm diam.; shrivelled hyphae scarce, many hyphae orientated anticline to the surface. Stipitipellis a cutis, up to 80 µm thick, of strongly interwoven, regularly shaped hyphae, 2–5 µm diam. Clamp-connections absent.

HABITAT: Scattered to gregarious, often abundant, under Douglas fir (*Pseudotsuga menziesii*) and *Pinus* spp.

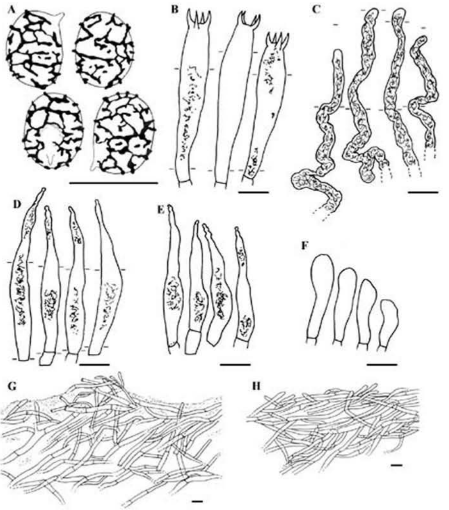


Fig. 11: *Lactarius rubrilacteus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis; H. section through the stipitipellis. From W.B. Gruber 1200 (type), S.L. Miller 19-04, J. States AEF 1055 and A.S. Methven 485. Scale bars = 10 µm, small bars indicate the height of the hymenium.

DISTRIBUTION: Occurring throughout the Pacific Northwest, south into California and in New Mexico, fruiting during the summer in the southern Rocky Mountains and in the fall in the Pacific Northwest (Hesler & Smith 1979).

COLLECTIONS EXAMINED: **USA**, Oregon, Josephine Co., Grants Pass, 17.11.1947, W.B. Gruber 1200 (MICH), holotype – California, Butte Co., Paradise, 2000 ft. a.s.l., 26.11.1968, D. Ripley 1626 (SFSU) – Arizona, Road between Big Lake & Alpine, Apache Natl. Forest, solitary in humus in mixed woods, 28.07.1972, H.D. Thiers 29827 (SFSU)

– Washington, Cispus Work Center near Randle, scattered in humus under Douglas fir, 20.10.1972, H.D. Thiers 30197 (SFSU) – California, Yuba Co., Bullard's Bar Reservoir, solitary to scattered in duff in mixed forest, 19.11.1981, H.D. Thiers, A.S. Methven 485 (SFSU) – California, Medocino Co., Jackson State Forest, "*Suillus* Park", gregarious in duff in mixed forest especially near *Pseudotsuga menziesii*, 6.11.1982, A.S. Methven 1912 (SFSU) – California, Santa Cruz Co., Hwy 9 near San Lorenzo Park, solitary in duff in hardwood-coniferous forest, 16.12.1982, H.D. Thiers, A.S. Methven 2360 (SFSU) – Washington, Kittatas Co., Stampede Pass Road, off I-90, East of Snoqualmie Pass, gregarious on moss and duff, under conifers, 9.10.1984, A.S. Methven 3444 (SFSU) – California, Sierra Co., Wild Plum campground, near Sierra City, solitary in soil under Douglas fir, 4.10.1989, H.D. Thiers 52786 (SFSU) – New Mexico, Hwy 64 between Taos and Angel Fire, in soil under mixed conifer hardwoods, 24.08.1991, E. Thiers & H.D. Thiers 53639 (SFSU) – Arizona, Coconino Co., Bismark Lake Trail, mixed conifer-*Populus*, 26.08.1992, J. States, AEF 947 (MICH) – California, Marin Co., Mt. Tamalpais watershed, Rock Springs area, Benstein Trail, collected under pure *Arctostaphylos glandulosa*, 22.12.1992, D.E. Desjardin 5595 (SFSU) – Arizona, Cochise Co., Onion Saddle, *Quercus* and *Pinus edulis*, 4.09.1993, J. States, AEF 1055 (MICH) – Arizona, Cochise Co., Onion Pass, *Pinus*, *Juniperus*, *Quercus* and *Pseudotsuga menziesii*, 4.09.1993, J. States, AEF 1060 (MICH) – California, 14.01.2004, S.L. Miller 11-04 (RMS) – California, 14.01.2004, S.L. Miller 19-04 (RMS).

DISCUSSION: *Lactarius rubrilacteus* is characterised by a zonate, brownish orange pileus and reddish brown latex (Methven 1997). Confusion with similar species, occurring in the same area, seems unlikely. It is reported under both *Pseudotsuga menziesii* and *Pinus* spp.; collection D.E. Desjardin 5595 (SFSU) was found in a pure *Arctostaphylos glandulosa* stand.

For years Hesler & Smith (1960, 1979) used the name *L. sanguifluus* for this species. After comparison with the plates of *L. sanguifluus* by Paulet (1811, plate 81, fig. 3–5) and Neuhoff (1956, plate 6, fig. 24), they decided that the species depicted on these plates could not be reconciled with the "*L. sanguifluus*" from the western United States (Hesler & Smith 1979). Our phylogenetic analyses indeed confirm this and even place *L. sanguifluus* and *L. rubrilacteus* in very different clades. Interestingly, according to the phylogenetic analyses of both ITS and *gpd* genes, *L. rubrilacteus* is very closely related to *L. porninsis*, a European species with white latex, associated with *Larix*.

8. *Lactarius rubriviridis* Desjardin, H.M. Saylor & Thiers, Mycologia 95: 148 (2003)

Figs. 12, 14

Holotype: DED 7312 (SFSU!), USA: California, Sierra Co., Cold Creek Campground.

DESCRIPTION (macroscopy after Desjardin 2003): Basidiomes hypogeous, 2.5–6 cm long × 2–4.5 cm broad × 1.5–3 cm thick, irregularly globose to ovoid or ellipsoid, sometimes lobed. Peridium absent, exterior surface alveolate to ridged and pitted from exposed locules and hymenophoral tramal tissue; ridges reddish brown to dark brown (8/9E/F5–7), staining deep greenish grey to bluish green or dark green (25–27F5–7) where bruised. Gleba loculate; locules irregular in shape, often elongate, 1–5 mm × 0.5–1.5 mm, filled with yellowish white to orange-white (4/5A2) or cream-coloured (4A3) basidiospores at maturity; hymenophoral tramal tissue firm, waxy, white to yellowish white (4A2), but becoming reddish brown (9D7/8) when cut from exuded latex; columella rudimentary to well-developed, composed of radiating dendritic veins arising from a central main vein, 1–4 mm diam., initially white, but staining greenish white (27A2/3) to greyish green (26C6/7) over time when cut. Latex scant, deep red (9B/C7/8), discolouring tramal tissue to dark brownish red (11/12E7/8). Odour not distinctive or sweet. Taste mild. Spores forcibly discharged, leaving an orange-white (5A2) to yellowish white (4A2) or cream (4A3) deposit.

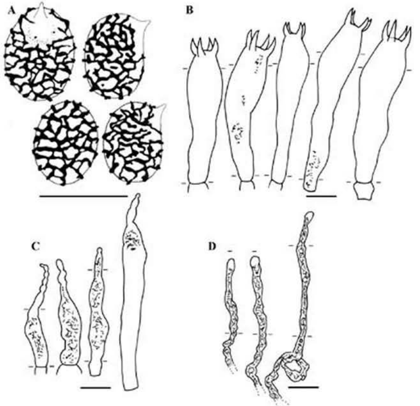


Fig. 12: *Lactarius rubriviridis*: A. spores; B. basidia; C. macrocystidia; D. pseudocystidia. From D.E. Desjardin 7312 (type). Scale bars = 10 µm, small bars indicate the height of the hymenium.

Spores 8.0–*8.9*–*9.2*–10.8 × 6.0–*6.7*–*6.9*–7.9 µm, broadly ellipsoid to ellipsoid (Q = 1.26–*1.33*–*1.34*–1.43), inequilateral in profile with an eccentric hilar appendix; ornamentation up to 0.5 µm high, of dense, rather tick ridges, forming a complete reticulum with very small meshes, isolated warts rare; plage rather large but only weakly amyloid. Basidia 40–60 × 10-12.7 µm, subclavate, 4-spored, sometimes with a granular content; sterigmata 3.3–6 µm long. Macrocystidia rather scarce, 34–67 × 4.3–8 µm, often hardly visible, rarely emergent, subfusiform with a moniliform apex, with a granular to needle-shaped content, thin-walled. Pseudocystidia rather abundant, 2–4 µm broad, slender and short, mostly not emergent, content oleiferic. Subhymenium of short-celled hyphae, not very well differentiated. Hymenophoral trama composed of densely compact, agglutinated hyphae, 3–10 µm diam., cylindrical to subglobose; lactifers abundant, contorted to strangulate, 3–5 (10) µm diam., refractive, yellowish orange in KOH. Columella tissues similar to the hymenophoral trama. Sphaerocytes absent in all tissues. Clamp-connections absent.

HABITAT: Buried under needle duff of conifers (*Abies* spp., *Pinus* spp.), June (type locality).

DISTRIBUTION: Only known from the Sierra Nevada, California.

COLLECTIONS EXAMINED: **USA**, California, Sierra Co., Highway 89, Cold Creek Campground, solitary, hypogeous under *Abies* and *Pinus* in montane conifer forest, 14.06.2001, D.E. Desjardin 7312 (SFSU), holotype.

DISCUSSION: Diagnostic features of *L. rubriviridis* are the gasteroid, hypogeous basidiome that lacks a peridium, the red latex, the green stains developing on the tissues, the well-developed dendritic columella and the reticulate ballistospores. The size and ornamentation of the spores are very similar in *L. rubriviridis* and its closest relative *L. barrowsii*. This is an extra indication that *L. rubriviridis* was recently derived from its epigeous, agaricoid ancestor *L. barrowsii*, that can be found in the same type of habitat.

Desjardin (2003) mentions that macrocystidia are absent in *L. rubriviridis*, while pseudocystidia are described as cylindrical with a tapered apex, projecting slightly beyond the basidia and hyaline or with orange globular contents. From this description we derive that macrocystidia were probably called pseudocystidia here and that pseudocystidia were overlooked.

9.1. ***Lactarius salmoneus*** Peck, Bull. Torrey Bot. Club 25: 369 (1898) var. ***salmoneus*** **Fig. 13**

Holotype: Earle & Baker (NYS!), USA: Alabama, Vaughn's Mills

DESCRIPTION (macroscopy after Peck 1898): Pileus 2.5–3.8 cm broad, rather thin, convex, becoming nearly applanate or slightly depressed in the centre; surface dry, subvelvety, sometimes irregular; colour white, becoming reddish where bruised. Lamellae adnate or decurrent, narrow, close; colour bright salmon colour. Stipe about 2.5 × 3–6 cm, short, solid, central or occasionally eccentric; surface velvety; colour white, salmon within. Context taste mild, slightly aromatic. Latex bright salmon coloured.

Spores 6.9–*7.6*–*7.9*–8.4 (8.5) × 5.1–*5.1*–*5.6*–6.1 µm, mostly ellipsoid, more rarely broadly ellipsoid (Q = 1.30–*1.34*–*1.41*–1.47); ornamentation 0.2–0.4 µm high, of medium thick ridges and some finer lines, forming an incomplete reticulum, isolated warts rather scarce; plage indistinct. Basidia 33–45 × 5.5–8 µm, mostly subcylindrical, 4-spored, often containing oil-droplets; sterigmata 3.5–6 µm long. Pleuromacrocystidia (very) scarce but locally abundant close to the edge, 35–60 × 5.5–8 µm, emergent, subfusiform with a moniliform apex, with a refractive, needle-shaped content, thin-walled. Pseudocystidia scarce, 2.5–4 µm broad, often emergent, mostly cylindrical, often branching, inconspicuous, with a pale yellow content. Lamella edge sometimes fertile, with scarce cheilomacrocystidia; cheiloleptocystidia 11–25 × 3.5–7 µm, subclavate to irregular, hyaline, thin-walled; cheilomacrocystidia 17–24 × 4–5.5 µm, subfusiform with a moniliform apex, with a needle-shaped content, thin-walled. Subhymenium composed of small, isodiametric cells. Hymenophoral trama composed of irregular, enlarged cells and abundant, yellow to ochre coloured lactifers. Pileipellis a cutis inclining towards a trichoderm locally, up to 200 µm thick, of regularly shaped, strongly interwoven and frequently branched hyphae, 2–4 µm diam., no shrivelled hyphae present; erect hyphae present at the surface, forming tufts. Stipitipellis a cutis, up to 70 µm thick, of regularly shaped, strongly interwoven hyphae, 2–4 µm diam. Clamp-connections absent.

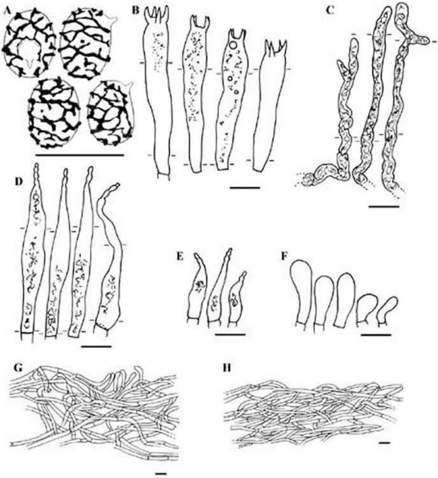


Fig. 13: *Lactarius salmoneus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis; H. section through the stipitipellis. From Earle & Baker (type), B. Kropp 29-Oct.-00-3 and B. Kropp 11-Aug.-00-14. Scale bars = 10 µm, small bars indicate the height of the hymenium.

HABITAT: In wet swampy places, usually on inundated ground, collected in August (Earle & Baker, type locality in Alabama); probably associated with *Pinus*.

Distribution: Reported from Alabama, North Carolina and Tennessee, USA (Hesler & Smith 1979).

> Collections examined: USA, Alabama, Vaughn's Mills, in wet swampy places, usually on naked ground that has been overflowed, August, Earle & Baker (NYS), holotype.

Discussion: Peck (1898) describes *L. salmoneus* as "a small but very distinct species easily recognized by the salmon colour of the milk and the change in the colour of the bruised flesh (turning reddish)". The spores are comparatively small. The white epicuticular covering of the pileus is the outstanding feature of both *L. salmoneus* var. *salmoneus* and var. *curtisii* (Hesler & Smith 1979). The inrolled margin is cottony but not as much as in *L. deceptivus* Peck. In both *L. salmoneus* var. *salmoneus* and var. *curtisii* anticline to ascending hyphae, single or in tufts are observed, but never forming a trichoderm. These elements become matted down in age and finally the layer is eroded. The layer is not distinct anatomically from the cuticular region of the pileus, but according to Hesler & Smith (1979) the entire region features very intricately interwoven, much-branched, relatively uninflated hyphae forming a layer quite unusual for the genus.

9.2. *Lactarius salmoneus* var. *curtisii* (Coker) Hesler & A.H. Sm.,

N. Amer. Species *Lactarius*: 72 (1979) **Figs. 13, 14**

= ***L. curtisii*** Coker, J. Elisha Mitchell Sci. Soc. 34: 41 (1918)

Holotype: Coker 1845 (NCU), USA: North Carolina, hill southwest of Sparrow's Mill

Description (macroscopy after Montoya et al. 1996, Hesler & Smith 1979): Pileus 2–6 (9) cm diam., convex becoming broadly depressed, with an arched margin or the margin nearly applanate and depressed in the centre; margin inrolled and cottony; surface dry and felty (as if covered with a layer of cotton), not at all zonate; colour evenly white or with a cream orange shade (5A3) at first, in age staining bluish green where bruised. Lamellae subdecurrent, many forked at the base, narrow, close; colour cadmium orange to ochraceous salmon, readily staining green where injured, sometimes faded to whitish; edge whitish. Stipe 1–4 × 0.9–1.5 cm, equal or enlarged above; covered by a white, fine felt-like coating (similar to that of pileus) at first; colour cadmium orange. Context solid, whitish, in age pallid orange, staining cadmium orange when cut, discolouring green; smell and taste not distinctive. Latex scanty, cadmium orange when first exposed, unchanging but finally greenish (4C3-4B3) on the context; taste faintly peppery in young basidiocarps, mild at maturity. Spore deposit yellowish.

$FeSO_4$ pale blue on the context, phenol no reaction, NH_4OH no reaction, H_2SO_4 black on the context (Montoya & Bandala 1996).

Spores 6.9–*7.6–7.8*–8.7 × 4.7–*5.1–5.3*–6.4 µm, mostly ellipsoid, more rarely broadly ellipsoid, shape quite variable (Q = 1.21–*1.34–1.42*–1.54); ornamentation less than 0.5 µm high, of mainly rather broad, irregular ridges and some finer lines, forming an incomplete reticulum, isolated warts rather scarce; plage inconspicuous and small, distally slightly amyloid. Basidia 33–55 × 5.5–8 µm, slender, mostly (sub)cylindrical, 4-spored, with a granular content and often containing oil-droplets; sterigmata 3.5–6 µm long. Pleuromacrocystidia (very) scarce but locally abundant close to the edge, 50–60 × 5.5–7.5 µm, emergent, subfusiform with a narrowing to moniliform apex, with a refractive, needle-shaped content, thin-walled. Pseudocystidia scarce, 2.5–4.5 µm broad, often emergent, mostly cylindrical, often branching, inconspicuous, with a pale yellow content. Lamella edge sometimes fertile, with scarce cheilomacrocystidia; cheiloleptocystidia 10–22 × 3.5–7 µm, subclavate to irregular, hyaline, thin-walled; cheilomacrocystidia 17–25 × 4–5.5 µm, subfusiform with a moniliform apex, with a needle-shaped content, thin-walled. Subhymenium composed of small, isodiametric cells. Hymenophoral trama composed of irregularly arranged hyphae and abundant, yellow to ochre coloured lactifers. Pileipellis a cutis inclining towards a trichoderm locally, 120–150 µm thick, of regularly shaped, strongly interwoven and frequently branched hyphae, 2–4 µm diam., no shrivelled hyphae present; upright hyphae present at the surface, united into fascicles. Stipitipellis a cutis, 50–70 µm thick, of regularly shaped, strongly interwoven hyphae, 2–4 µm diam. Clamp-connections absent.

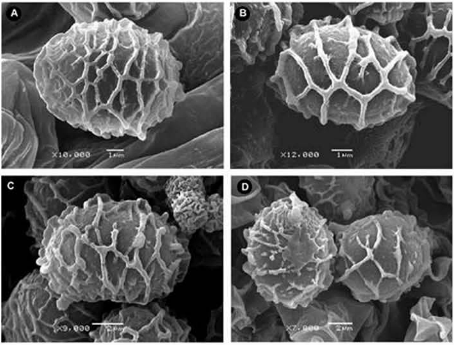


Fig. 14: SEM images of spores A. *L. rubriviridis* (D.E. Desjardin 7312, type); B. *L. salmoneus* var. *curtisii* (B. Kropp 11-Aug.-00-14); C. *L. subpurpureus* (J. Nuytinck 2004-014); D. *L. thyinos* (S.L. Miller 9648).

Habitat: Moist areas of lower altitude, under *Pinus* spp.

Distribution: Distributed throughout the pine belt of the southeast USA, also reported from Mexico (Cifuentes et al. 1989, Montoya et al. 1996) and Belize.

Collections examined: **Belize,** Cayo district, Mtn. Pire Ridge, under *Pinus caribaea*, 29.10.2000, B. Kropp 29-Oct.-00-3 (RMS), notes: latex orange, greenish stain, cap whitish – **USA,** Mississippi, Harrison Co., Harrison Exp. forest, under *Pinus*, 11.08.2000,

B. Kropp 11-Aug.-00-14 (RMS), notes: latex orange, slowly staining greenish, det.: Cibula B.

DISCUSSION: Hesler & Smith (1979), focussing on the diversity in the genus *Lactarius*, lowered *L. curtisii* to the rank of variety under *L. salmoneus* but admit there are few arguments to keep two different taxa. The only differences they report between both varieties are the lack of green discolouration and slightly larger spores in *L. salmoneus* var. *salmoneus*. Our request to see the holotype of *L. salmoneus* var. *curtisii* was never answered by NCU. The examined specimens from Belize and Mississippi showed a greenish staining reaction and were thus identified as *L. salmoneus* var. *curtisii*. It is very doubtful, that the distinction between both varieties can be maintained. The greenish discolouration in *Lactarius* sect. *Deliciosi* is often delayed, sometimes very faint and in some species sometimes erratic. Hesler & Smith (1979) expect that green staining will be found in the type variety of *L. salmoneus* when it becomes better known. Microscopical features are identical for both varieties. We were not able to study fresh collections from either variety of *L. salmoneus* and thus do not draw any further conclusions. As the microscopical features are identical drawings were united into one plate (Fig.13).

10. *Lactarius subpurpureus* Peck,

Rep. (Annual) New York State Mus. Nat. Hist. 29: 43 (1878) **Figs. 14, 15**

= ***Lactifluus subpurpureus*** (Peck) Kuntze, Revisio Generum Plantarum, Pars II: 857 (1891)

Holotype: Peck (NYS!), USA: New York, Sandlake

DESCRIPTION: Pileus 4–10 cm diam., convex when young, becoming applanate when mature with a slightly depressed centre, never deeply infundibuliform; margins bent downwards to flattened, vaguely striate; surface smooth, viscid, zonate to scrobiculate; zones fading in age; colour pinkish to vinaceous buff (9B2/3), paler flesh-coloured to pink in the centre (10A2), but deep pink to brownish near the margin (10D4), hygrophanous, becoming very pale vinaceous pink (9A2) in the centre, margin staying deeper pink (9C4/5), green discolouration (28A2) never very extensive. Lamellae adnate to subdecurrent, sometimes with a small decurrent tooth, moderately broad and subdistant, rarely anastomosing; colour vinaceous buff to dirty pinkish or pale vinaceous red (9B2/3 to 10A/B4), turning slightly green when bruised; edge entire, ± concolorous. Stipe 3–8 × 0.7–1.5 cm, almost cylindrical or broader at the base, relatively long and slender; surface smooth, dry, tomentose at the base with whitish orange coloured subiculum sometimes present, with scarce to rather abundant, darker scrobicules; colour pinkish (10C3 to 11C2/3), covered with a whitish layer, almost white near the apex and the base, greenish discolouration mainly near the base. Context not very firm and rather thin, turning hollow in the stipe, whitish buff but yellowish to brown in the stipe cavity, staining vinaceous red (10E/F7) underneath the pilei- and stipitipellis and above the lamellae, ± unchanging, green where affected by parasites; smell sweetish and fruity, agreeable; taste mild becoming very slightly acrid. Latex scarce, vinaceous red (10D5), very dark brownish red (11F8) after 1 h on the context; taste mild. Spore deposit pale yellow-orange (4A3).

KOH no reaction, gaiac slowly turning blue on context.

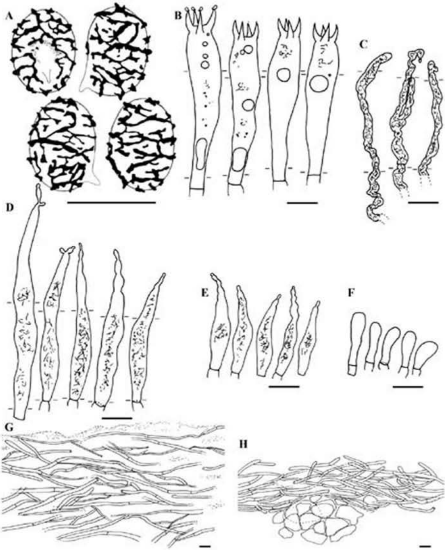


Fig. 15: *Lactarius subpurpureus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis; H. section through the stipitipellis. From C.H. Peck (type), J.R. Herr 348, J.R. Herr 574 and J. Nuytinck 2004-014. Scale bars = 10 µm, small bars indicate the height of the hymenium.

Spores 9.3–*10.0–10.6*–11.2 (12) × 6.8–*7.1–7.3*–7.7 µm, ellipsoid (Q = 1.30–*1.38–1.45*–1.52); ornamentation up to 0.5 µm high, of rather thick ridges mixed with finer interconnecting lines, some isolated warts present, forming an incomplete reticulum; plage distally slightly amyloid. Basidia 46–60 × 9–11 µm, subclavate, 4-spored, rarely 2-spored, containing oil-droplets; sterigmata 4–6 µm long. Pleuromacrocystidia abundant, 37–78 × 4.5–8 µm, emergent and very conspicuous, subfusiform with a tapering to moniliform, sometimes branching apex, with a needle-shaped content, thin-walled. Pseudocystidia abundant, 1.6–4 µm broad, rather slender, not to slightly emergent, mainly tortuous, sometimes branching, oleiferic, content deep ochre coloured. Lamella edge sterile with rather abundant to rather scarce cheilomacrocystidia; cheiloleptocystidia 12.5–18 × 4–6 µm, subclavate to irregular, hyaline, thin-walled; cheilomacrocystidia 25–33 × 3.4–6 µm, emergent, subfusiform, with a moniliform apex, with a needle-shaped to granular content, thin-walled. Subhymenium composed of densely interwoven hyphae, appearing like subglobose cells, mostly arranged in short rows. Hymenophoral trama of short hyphae, irregularly arranged; lactifers very abundant and conspicuous. Pileipellis an ixocutis, 70–150 µm thick, of strongly interwoven hyphae, 1–5 µm diam., shrivelled and gelatinised hyphae abundant. Stipitipellis a cutis to ixocutis, thin, up to 50 (70) µm thick, of strongly interwoven, regularly shaped hyphae, 2-4 µm diam. Clamp-connections absent.

HABITAT: On soil in coniferous and mixed woods, associated with hemlock (*Tsuga canadensis*), found in the summer and early fall (Hesler & Smith 1979).

DISTRIBUTION: Eastern half of the USA and southern Canada, south to the Gulf Coast region (Hesler & Smith 1979).

COLLECTIONS EXAMINED: USA, New York, Sandlake (& Brewerton), mossy ground in swamps, October, C.H. Peck (NYS), holotype – Virginia, Cherokee flats near interiors VA, in moist *Rhododendron* flat with hemlock and 2-needle pine, 21.08.1997, S.L. Miller 9572 (RMS) – Virginia, Poverty Creek Trail, Jeff. Nat. Forest, under hemlock, 09.03.1998, J.R. Herr 050 (RMS) – Virginia, Montgomery Co., Poverty Hollow, Jeff. Nat. Forest, Road 708, along trail through mixed hardwoods/conifers, 07.10.1999, J.R. Herr 491 (RMS) – Virginia, Giles Co., Cherokee Flats, Jeff. Nat. Forest, along trail through mixed hardwood/conifer forest, 09.10.1999, J.R. Herr 348 (RMS) – Virginia, Montgomery Co., Poverty Hollow, Pandapas Pond Rec. Area, Jeff. Nat. Forest, off Service Road 708, under mixed conifers/hardwoods, 07.08.2000, J.R. Herr 574 (RMS) – Tennessee, Cocke Co., Great Smoky Mountains National Park, Maddron Bald trail, between Gabed mountain trail & the Allbright grove, near Cosby, 777 m a.s.l., N35°45.352' W083°16.321', under *Tsuga canadensis*, 12.06.2004, J. Nuytinck 2004-003 (GENT) – Tennessee, Cocke Co., Great Smoky Mountains National Park, Greenbrier Ranger Station, second growth forest with *Pinus* spp. *Quercus* spp., *Tsuga canadensis* etc., 13.06.2004, J. Nuytinck 2004-006 (GENT) – North Carolina, Transylvania Co., Pisgah forest, close to Asheville, rich and mixed forest, under *Tsuga canadensis*, along creek, 17.06.2004, J. Nuytinck 2004-014 (GENT).

DISCUSSION: The dirty pinkish colour of the basidiocarps, the vinaceous red latex and the subdistant lamellae make *L. subpurpureus* an easy species to recognise. Microscopically, the large, ellipsoid spores and conspicuous pleuromacrocystidia are characteristic. *Lactarius paradoxus* is an eastern species with similarly coloured latex but is readily distinguished from *L. subpurpureus* by the colour of the cap and the spacing of the lamellae. *Lactarius miniatosporus* is superficially similar to *L. subpurpureus* but has much smaller spores and lacks pleuromacrocystidia (Montoya & Bandala 2004). *Lactarius subpurpureus* is closely related to two western species with red latex: *L. barrowsii* and *L. rubriviridis*.

11. *Lactarius thyinos* A.H. Sm., Brittonia 12: 135 (1960) Figs. 14, 16

Holotype: Smith 22150 (MICH!), USA: Michigan, Cheboygan County, Reese's Bog.

Description (macroscopy after Hesler & Smith 1979, Kuo 2004): Pileus 3–9 cm diam., convex at first, becoming applanate, with a shallow central depression to broadly infundibuliform; margin bent downwards to straight; surface viscid when fresh to thinly slimy, glabrous, zonate, zones carrot orange to salmon orange, alternating with pallid

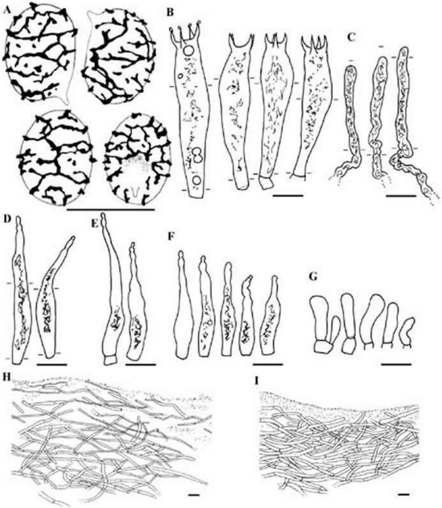


Fig. 16: *Lactarius thyinos*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. macrocystidia close to the lamella edge; F. cheilomacrocystidia; G. cheiloleptocystidia; H. section through the pileipellis; I. section through the stipitipellis. From A.H. Smith 22150 (type) and S.L. Miller 9648. Scale bars = 10 µm, small bars indicate the height of the hymenium.

yellow zones, in age weathering to greyish. Lamellae broadly adnate to decurrent, close at first, subdistant when mature; colour at first bright ochraceous salmon, gradually paler orange, when bruised staining (dark) vinaceous brown, not staining green at any stage. Stipe 4–8 × 0.8–2.0 (3.5) cm, more or less equal, or tapering somewhat to base; surface smooth, when young and fresh covered with a thin layer of slime but soon dry, often with a whitish sheen especially above; colour bright ochraceous salmon or paler, slowly staining dull vinaceous red to vinaceous brown where cut. Context thin, becoming hollow and fragile in the stipe, staining orange-buff when cut, in the base of the stipe staining slowly to vinaceous red; smell faintly fragrant; taste mild. Latex bright orange, slowly staining tissues (especially base of stipe) vinaceous red, no stains to green evident anywhere. Spore deposit pale yellow.

FeS0$_4$ no reaction, KOH no reaction, NH$_4$OH no reaction.

Spores 9.2–*10.1*–*10.7*–11.7 × 6.7–*7.4*–*8.2*–8.7 µm, broadly ellipsoid to ellipsoid (Q = 1.24–*1.31*–*1.36*–1.45); ornamentation up to 0.5 µm high, of thin ridges and isolated warts, forming an incomplete reticulum with rather wide meshes; plage distinct but almost inamyloid to distally slightly amyloid. Basidia 40–55 (60) × 8–11 µm, subclavate, 4-spored or rarely 2-spored, often with a granular content and containing oil-droplets; sterigmata 4–6 µm long. Pleuromacrocystidia abundant near the lamella edge, 40–80 × 4.5–8 µm, strongly emergent, subfusiform with a (long) moniliform apex, with a refractive, granular to needle-shaped content, thin-walled. Pseudocystidia relatively scarce, 3.3–5 µm broad, tortuous to cylindrical, inconspicuous, not emergent, pale yellow coloured (observation in KOH), hyaline in the apex. Lamella edge sterile with rather scarce cheilomacrocystidia; cheiloleptocystidia 8–20 × 2.7–6 µm, subclavate to more irregular, hyaline, thin-walled; cheilomacrocystidia 25–55 × 4–8 µm, strongly emergent, subfusiform with a moniliform apex. Subhymenium composed of almost isodiametric cells, sometimes arranged in rows. Hymenophoral trama with very abundant, pale yellow to ochre coloured lactifers. Pileipellis an ixocutis, 100–200 µm thick, composed of strongly interwoven and mainly shrivelled hyphae, 1–4 µm diam. Stipitipellis an ixocutis, up to 70 µm thick, with a distinct slime-layer; composed of regularly shaped hyphae, 2–4 µm diam. Clamp-connections absent.

HABITAT: Scattered to gregarious in woods of *Thuja* and in cold *Thuja* bogs and swamps, summer and fall, common, host tree unknown.

DISTRIBUTION: Northeastern USA (Vermont, New York and Michigan) and Canada (Nova Scotia, Ontario and Quebec).

> COLLECTIONS EXAMINED: **USA,** Michigan, Cheboygan, Carp Creek, Reese's Bog, 20.08.1946, A.H. Smith 22150 (MICH), holotype – New York, St. Lawrence Co., Star Lake, 26.09.1997, S.L. Miller 9648 (RMS).

DISCUSSION: *Lactarius thyinos* is a medium-sized species with a viscid (when fresh), zonate pileus and a carrot to salmon orange coloured pileus and stipe. When bruised the basidiocarps show vinaceous brown stains but never turn green. The spores are large and ornamented with a rather fine, incomplete reticulum. *Lactarius thyinos* has all of these characters in common with its European and Asian sister species *L. salmonicolor* and *L. laeticolor*. It is unclear with which tree *L. thyinos* forms ectomycorrhiza (*Thuja* spp. are reported not to be ectomycorrhizal, Simard et al. 1997).

12. The "*L. deliciosus*" complex in North America

Based on the available material, the taxonomic problems of this complex of varieties described from or recognised in North America could not be solved. Hesler & Smith (1979) report four varieties from eastern and western North America: *L. deliciosus* var. *olivaceosordidus*, var. *areolatus*, var. *piceus* and var. *deterrimus*.

First and most importantly, we showed with our phylogenetic analyses that these taxa form a separate clade and are not conspecific with *L. deliciosus* or with *L. deterrimus* occurring in Europe (and Asia). Bessette et al. (1997) already suggested the name *L. deliciosus* is misapplied in North America. Secondly, we want to remark that in our opinion *L. deliciosus* var. *piceus* (an invalid name) and *L. deterrimus* are taxonomic synonyms and should not be used alongside. But finally, we did not obtain any further resolution or obvious separation of taxa within this complex in our molecular analysis. Only one collection identified as *L. deliciosus* var. *olivaceosordidus* is convincingly different from the other collections in our phylogenetic analyses. It is described under the insufficiently known taxa and unidentified collections hereunder.

Main morphological characters that are used to separate the varieties are the presence and abundance of pleuromacrocystidia, the colour of the pileus and the staining reaction of the context (remaining orange or slowly staining red). These characters have to be used with care because they are known to show quite some variability in *Lactarius* sect. *Deliciosi*.

Hesler & Smith (1979) mention the problem of obtaining apparently mixed collections. Our own experiences support this. Specimens J. Nuytinck 2003-041a & b were collected at the same site and time in Wyoming and showed no differences at first sight. A closer look at the discolouration of the latex showed that J. Nuytinck 2003-041a had unchanging to very slowly (> 1 h) changing orange latex while J. Nuytinck 2003-041b possessed orange latex becoming red in 10 to 15 min. Neither ITS nor *gpd* sequences from the separated collection were identical but they did both fall in the "*L. deliciosus*" clade together with all other collections of "*L. deliciosus*" from North America.

One taxon, *L. deliciosus* var. *areolatus*, is characterised by clearly larger spores. Sequenced specimens of this variety do group together in the ITS tree, but fall within the larger "*L. deliciosus*" clade. The *gpd* phylogeny shows a closer relationship to *L. porninsis*, *L. rubrilacteus* and an unidentified collection from Washington.

For the moment, we decided not to draw any further taxonomical conclusions and consequently not to propose any new names. We describe *L. deliciosus* var. *areolatus* and var. *olivaceosordidus* in the following part; for both taxa the type specimen was studied. The macroscopical descriptions were adapted from Hesler & Smith (1960, 1979) and Methven (1997) and we refer to these publications for more details on the other varieties. Methven (1997) distinguishes four varieties in California: *L. deliciosus* var. *olivaceosordidus*, var. *areolatus*, var. *piceus* and var. *deliciosus*. Table 1 gives a comparison of the distinguishing characters Methven (1997) describes.

Table 1. Summary of the most important features distinguishing the varieties of "*L. deliciosus*" treated in Methven (1997).

L. deliciosus **var.**	**Colour: pileus**	**Colour: latex**	**Pleuro-macrocystidia**	**Habitat: host tree**
areolatus	brownish to greyish orange or plain orange	orange, staining context reddish	absent	montane coniferous-deciduous forests
deliciosus	obscurely zonate, brownish to greyish orange	orange, unchanging	absent	*Picea sitchensis*?
olivaceosordidus	greyish green with orange tinges	orange, unchanging	present	*Picea sitchensis*?
piceus	light to greyish orange	orange, staining context reddish	present	*Picea* spp.

12.1. *Lactarius deliciosus* var. *areolatus* A.H. Sm., Brittonia 12: 135 (1960) Fig. 17

Holotype: Smith 46914 (MICH!), USA: Idaho, Payette Lakes

Description (after Hesler & Smith 1960, 1979, Methven 1997): Pileus 5–15 cm diam., convex becoming convex-depressed to ± plano-depressed or broadly infundibuliform in age; surface glabrous and shining, thinly slimy to merely viscid and soon becoming dry, sometimes becoming areolate-scaly, zonate to azonate; colour variable, orange (6A6/7), brownish orange (5C4-6) or greyish orange (6B4-6), soon staining greyish green (26C3/4) to dull green (26D3/4), often sordid in age as the green staining becomes apparent. Lamellae adnate to subdecurrent, narrow to moderately broad, close to subdistant, forked near the stipe; colour light orange (5A3/4), slowly staining reddish brown (8D4-6), then dull green (26D3-4), finally entirely green in age; edge concolorous. Stipe 2–5 (10) × 1–3 (4) cm, ± equal; surface glabrous, dry, not to slightly scrobiculate; colour light orange (6A3/4) and dull, pruinose at first. Context firm, thick, brittle, soon hollow in the stipe; colour white to pale yellow (4A2/3), staining pale orange-buff, slowly changing to greyish red (8C3/4) or reddish brown (8D4-6) on exposure; smell not distinctive; taste mild becoming bitterish to ± acrid. Latex (very) scarce, orange (6A6/7), slowly staining purplish red to vinaceous red on the context. Spore deposit pale yellow (4A2/3).

$FeSO_4$ no reaction, KOH no reaction, phenol no reaction, NH_3 no reaction (Wells & Kempton in Hesler & Smith 1979).

Spores 8.5–*9.2*–*9.8*–10.5 (11) × 6.0–*6.5*–*7.1*–7.6 µm, broadly ellipsoid to ellipsoid (Q = 1.31–*1.36*–*1.40*–1.46); ornamentation up to 0.5 µm high, of medium thick ridges and some isolated warts, forming an incomplete reticulum with rather wide meshes; plage distinct and distally slightly amyloid. Basidia 45–60 × 8–12 µm, subclavate, 4-spored, often containing oil-droplets; sterigmata 3.5–4.5 µm long. Pleuromacrocystidia absent or very scarce. Pseudocystidia abundant, 3.5–5.5 µm diam., tortuous, sometimes slightly emergent, sometimes branching, with an ochre content. Lamella edge sterile with abundant cheilomacrocystidia; cheiloleptocystidia 8.5–20 × 3.2–7.3 µm, subclavate to irregular, hyaline, thin-walled; cheilomacrocystidia 30–45 × 5.3–6.7 µm, subfusiform with a moniliform apex, emergent, with and ochre, refractive, granular to needle-shaped content, thin-walled. Subhymenium composed of mainly small, irregular cells. Hymenophoral trama with abundant, wide lactifers, with an ochre-brown content in KOH. Pileipellis an ixocutis, 200–300 µm thick, of strongly interwoven, rather dense, regularly shaped hyphae, 2–4 µm diam.; few gelatinised and shrivelled hyphae present near the surface. Stipitipellis a cutis to ixocutis, up to 100 µm thick, of mostly regularly shaped hyphae, 3–4 µm diam.; shrivelled and gelatinised hyphae (1 µm diam.) present near the surface. Clamp-connections absent.

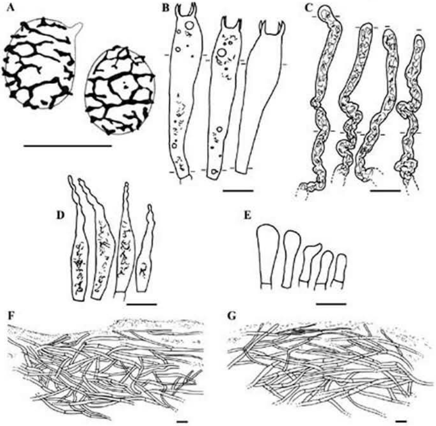


Fig. 17: *Lactarius deliciosus* var. *areolatus*: A. spores; B. basidia; C. pseudocystidia; D. cheilomacrocystidia; E. cheiloleptocystidia; F. section through the pileipellis; G. section through the stipitipellis. From A.H. Smith 46914 (type) and A.S. Methven 360.

Scale bars = 10 µm, small bars indicate the height of the hymenium.

Habitat: Scattered to gregarious under mixed conifers (Hesler & Smith 1979).

Distribution: Western North America; reported from Alaska, California, Colorado, Idaho, New Mexico and Wyoming.

COLLECTIONS EXAMINED: USA, Idaho, Valley Co., Payette Lake, Payette National Forest, 27.08.1954, A.H. Smith 46914 (MICH), holotype – California, Sierra Co., Lincoln Creek Campground, Highway 49, scattered in duff in mixed forest under *Abies* and *Pinus*, 25.09.1982, A.S. Methven 1619 (SFSU) – California, Yuba Co., Schoolhouse Campground, Bullard's Bar Reservoir, gregarious in soil in mixed wood, 30.10.1982, H.D. Thiers 45335 (SFSU) – California, Mendocino Co., Jackson State Forest, solitary to scattered in duff in mixed forest, 07.11.1982, A.S. Methven 360 (SFSU) – California, Medocino Co., Jackson State Forest, "*Suillus* Park": densely gregarious in duff in mixed forest, 12.12.1982, A.S. Methven 2301 (SFSU).

DISCUSSION: *Lactarius deliciosus* var. *areolatus* seems to be the most common variant of the "*L. deliciosus*" group in western North America (Hesler & Smith 1979, Methven 1997). The areolate condition of the cap, considered as a characteristic feature in the original description, is the result of dry weather conditions and is not present in normally developing basidiocarps (Hesler & Smith 1979). Hesler & Smith (1979) give an overview of the variability they encountered in the colour of the pileus, the taste and the discolouration of the latex in different collections from different regions.

12.2. *Lactarius deliciosus* var. *olivaceosordidus* Hesler & A.H. Sm.,

N. Amer. Species *Lactarius*: 95 (1979) Fig. 18

Holotype: Smith 83831 (MICH!), USA: Oregon, Pacific City

DESCRIPTION (macroscopy after Hesler & Smith 1979, Methven 1997): Pileus 4-8 cm diam., plano-convex, soon becoming centrally depressed and in age broadly infundibuliform; margin incurved, faintly translucently striate; surface glabrous, thinly viscid, soon dry, obscurely zonate or scrobiculate; colour greyish green (27D4-6) on an orange (5A6/7), golden yellow (5B6/7) or brownish yellow (5C6/7) ground colour. Lamellae (sub)decurrent, close to subdistant, forked near the stipe; colour light orange (5A3-5), becoming dingy yellow, staining deep green where cut (25E7/8). Stipe 3–5 (7) × 0.5–1.0 (1.2) cm, slightly enlarged downwards; surface glabrous, moist to dry, not scrobiculate, orange (5A6/7), staining deep green (25E7/8). Context thin, yellowish centrally, olive underneath the pileipellis, staining orange when cut, unchanging; smell not distinctive; taste mild to very slowly slightly acrid. Latex scarce, orange (6A6/7), unchanging on the context; taste mild. Spore deposit pale yellow (4A2/3).

Spores 8.4–*9.0*–*9.4*–9.9 × (6.3) 6.4–*6.8*–*7.1*–7.4 µm, broadly ellipsoid to ellipsoid (Q = 1.23–*1.30*–*1.36*–1.44); ornamentation up to 0.5 µm high, of thin and medium thick ridges and some isolated warts, forming an incomplete reticulum; plage almost inamyloid. Basidia 36–50 × 7–9 µm, subclavate, 4-spored, mostly hyaline; sterigmata 3–5.5 µm long. Pleuromacrocystidia abundant near the lamella edge, 45–70 × 4.5–7 µm, subfusiform but very slender, with a moniliform apex, containing needle-shaped crystals, thin-walled. Pseudocystidia rather scarce to abundant, 3–5.5 µm broad, cylindrical to tortuous, not emergent, with a deep ochre coloured content in KOH. Lamella edge sterile with very abundant cheilomacrocystidia; cheiloleptocystidia 12–21 × 3.3–6 µm, subclavate, hyaline, thin-walled; cheilomacrocystidia 25–47 × 4.5–7.3 µm, subfusiform and slender, with a moniliform or capitate apex, containing needle-shaped crystals, thin-walled. Subhymenium of irregularly arranged, small cells. Hymenophoral trama containing short hyphae and ochre coloured lactifers. Pileipellis an ixocutis, up to

300 µm thick, composed of mostly rather thick hyphae, 2–6 µm thick; shrivelled hyphae scarce; lactifers present close to the surface. Stipitipellis an ixocutis to cutis, up to 100 µm thick. Clamp-connections absent.

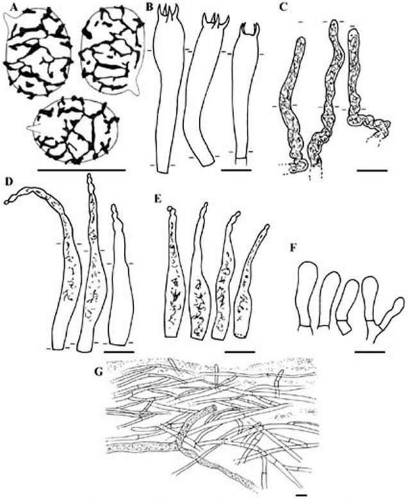


Fig. 18: *Lactarius deliciosus* var. *olivaceosordidus*: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheilomacrocystidia; F. cheiloleptocystidia; G. section through the pileipellis. From A.H. Smith 83831 (type).

Scale bars = 10 µm, small bars indicate the height of the hymenium.

Habitat: Scattered to gregarious under *Picea sitchensis*.

Distribution: Western USA, reported to be uncommon in California (Methven 1997).

Collections examined: USA, Oregon, Tillamook Co., Pacific City, under spruce, 15.11.1972, A.H. Smith 83831 (MICH), holotype – California, Del Norte Co., Wilson Creek Rd near Klamath, scattered in duff under *Picea sitchensis*, 23.10.1982, D.E.

Desjardin 1622 (SFSU) – California, Del Norte Co., Wakefield's Farm, Northcrest Dr. Crescent City, scattered in duff under *Picea sitchensis*, 23.10.1982, A.S. Methven 1840 (SFSU) – California, Humbolt Co., Big Lagoon, Patrick's Pt State Park, gregarious in duff under *Picea sitchensis*, 24.10.1982, A.S. Methven 1895 (SFSU) – Washington, Grays Harbor Co., Quinault Research Natural Area, 10-1-d-11, in humus, litter & mosses, *Tsuga* and *Picea*, 02.10.1992, JA 10762 (RMS) – Washington, Grays Harbor Co., Griffiths-Priday Ocean State Park, under Sitka spruce in sandy soil, 12.11.2000, P.B. Matheny 2054 (RMS).

Discussion: The green to olive stains are a prominent feature of even young material in this variety. The dried basidiocarps are uniformly dingy orange-brown, washed green. Only a slight tendency to become red on cut surfaces was noted (Hesler & Smith 1979).

13. *Lactarius aurantiosordidus* Nuytinck & S.L. Mill. sp. nov. **Fig. 19**

Mycobank number: MB 510020

Pileus 17–25 mm diam., convexus ad leviter infundibuliformem; pileipellis laevis, leviter viscida, saepe leviter zonata, primo pallide sordide aurantia ad irregulare olivaceam, tum griseoviridis, atroviridis in centro. Stipes 25–55 mm longus, 6–12 mm crassus, regularis, leviter tomentosus, pileo concolorus, vix scrobiculatus. Lamellae adnatae ad leviter decurrentes, confertae, salmoneae, tum griseoaurantiacae. Contextus pallide griseoaurantiacus, sub pileipelle viridis, aurantiascens, gustu mitis vel leviter acris. Latex atro-aurantiacus, virescens.

Sporae late ellipsoideae ad ellipsoideas, 8.7–9.3–9.9 × (6.5) 6.6–7.0–7.5 μm, incomplete ad subcomplete reticulatae, verrucis et cristis usque ad 0.5 μm ornatae; macula suprahilaris non amyloidea. Basidia 40–55 × 8–11 μm, subclavata. Pleuromacrocystidia dispersa, 40–45 × 6–8 μm. Pseudopleurocystidia abundantia. Pileipellis ixocutis.

Typus: USA, California, Davison Road, near Humbolt, N41° 21.287' W124° 04.127', scattered or in small groups under Redwood, Sitka spruce with Hemlock and Red alder nearby, 23.10.2003, **S.L. Miller 213-03 (holotypus RMS!, isotypus GENT!).**

Etymology: aurantio (Lat.): orange-coloured, sordidus (Lat.): dirty-looking, dingy, soiled.

Description: Pileus 2–5.5 cm diam., broadly convex at first, then plane to slightly wavy or slightly upturned, shallowly infundibuliform with a small central depression with age; margin slightly incurved to downturned when young, becoming plane, mostly entire but occasionally with faint or moderately well developed transverse wrinkles or lobes, not striate; surface smooth, glabrous, thinly viscid and shiny when moist, drying quickly, often faintly zonated; colour pale dirty orange (6B3–5) when young, zonations slightly paler (5B3), soon flushed or mottled with olive to greyish green (28/29D4–6), often darker green (to 28/29E6/7) centrally but green tinges mostly lacking at the margin. Lamellae adnate to slightly decurrent, crowded when young, becoming close; colour salmon to pinkish orange (6A3) when young, dull greyish orange (6B3) in age; edge entire. Stipe 2.5–5.5 × 0.6–1.2 cm, mostly equal, occasionally tapered below, sometimes irregularly shaped; surface faintly tomentose or felted when young, remaining so at the base but felted aspect soon disappearing where handled, basal tomentum whitish to buff, scrobicules rare or absent, concolorous with the pileus, frequently paler at the apex.

Context firm and solid when young, becoming hollow in the stipe; colour pale greyish orange (6A2) when young but greenish immediately beneath the pileipellis, discolouring orange near the lamellae and in the stipe when cut; smell indistinctive; taste mild to very slowly faintly acrid. Latex scarce, dark orange when fresh, slowly turning to green on the context in an hour or more. Spore deposit pale yellow-orange (between 4A2 and 4A3).

$FeSO_4$ becoming quickly dull green.

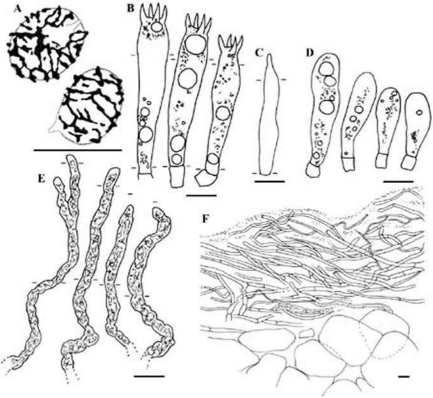


Fig. 19: *Lactarius aurantiosordidus*: A. spores; B. basidia; C. pleuromacrocystidium; D. marginal cells; E. pseudocystidia; F. section through the pileipellis. From S.L. Miller 213-03 and S.L. Miller 216-03. Scale bars = 10 µm, small bars indicate the height of the hymenium.

Spores 8.7–*9.3*–9.9 × (6.5) 6.6–*7.0*–7.5 µm, broadly ellipsoid to ellipsoid (Q = 1.24–*1.32*–1.39); ornamentation up to 0.5 µm high, of medium thick ridges and isolated warts, forming an incomplete reticulum; plage mostly not amyloid. Basidia 40–55 × 8–11 µm, subclavate to almost cylindrical, with a striking, dark coloured, granular content and abundant, pigmented oil-droplets. *Basidioles* with a similar content to the basidia, only very few hyaline basidioles present. Pleuromacrocystidia very scarce, 40–45 × 6–8 µm, slightly emergent, subfusiform with a narrowing apex, hyaline, thin-walled. Pseudocystidia very abundant, 2.5–5.5 µm broad, sometimes slightly emergent, tortuous to cylindrical, sometimes branching, with a striking, deep ochre-brown colour. Lamella edge sterile without cheilomacrocystidia; marginal cells 20–35 × 7–10 µm, subclavate, with a dark coloured granular content and oil-droplets. Pileipellis a thin ixocutis, up to 100 µm thick, composed of strongly interwoven hyphae, 1.5–5 µm broad, shrivelled hyphae scattered, pigmented hyphae and lactifers present close to the surface. Clamp-connections absent.

Habitat: Probably associated with *Picea sitchensis*.

Distribution: USA, California.

Collections examined: USA, California, Davison Road, near Humbolt, N41° 21.287' W124° 04.127', scattered or in small groups under Redwood, Sitka spruce with Hemlock and Red alder nearby, 23.10.2003, S.L. Miller 213-03 (RMS) – California, Davison Road, near Humbolt, N41° 21.287' W124° 04.127', scattered or in small groups under Redwood, Sitka spruce with Hemlock and Red alder nearby, S.L. Miller 216-03 (RMS).

Discussion: In our molecular analyses these collections do not group with any of the known species. Although there is a resemblance with *L. deliciosus* var. *olivaceosordidus*, these specimens do not group with the collections of "*L. deliciosus*" from North America. This species is characterised by its small size and its dirty orange tinges and extensive dirty greenish discolouration. The dried specimens are conspicuously dark in colour. Microscopically, the strongly and deeply pigmented content of nearly all hymenium elements is striking. Strongly pigmented hyphae were also noted in the pileipellis. The collections lack cheilomacrocystidia and pleuromacrocystidia are scarce.

Insufficiently known taxa and unidentified collections

Lactarius salmonicolor R. Heim & Leclair, Rev. Mycol. (Paris) 18: 221 (1953)

Heim (1953) reports *L. salmonicolor* from the col de Toluca, Mexico under *Abies religiosa*. The herbarium material that he deposited in PC unfortunately seems to be lost. Kong Luz (1995) also gives a detailed macro- and microscopical description of collections of *L salmonicolor* from Mexico that resembles the European *L. salmonicolor* very well. Only the spore size he reports (8.8–9.35 × 6.43–7.28 µm on average) is smaller than what we measured from European material (10.0–10.6 × 7.3–8.2 µm on average). Furthermore Kong Luz (1995) admits a more detailed comparison with *L. thyinos* is necessary. We were unable to study collections identified as *L. salmonicolor* from Mexico or elsewhere in North America and thus do not draw any further conclusions.

***Lactarius* sp.** Collection MTS 3445 (RMS)
originally identified as *L. deliciosus* var. *olivaceosordidus* **Fig. 20**

Microscopical Description: Spores (8.5) 8.6–*9.1*–9.6 × 6.3–*6.8*–7.4 µm, broadly ellipsoid to ellipsoid (Q = 1.27–*1.33*–1.40); ornamentation up to 0.5 µm high, of medium thick ridges and isolated warts, forming an incomplete reticulum; plage distally slightly amyloid. Basidia 40–50 × 9–11 µm, subclavate, 4-spored, mostly hyaline, sometimes with a granular content; sterigmata 3.5–5.5 µm long. Pleuromacrocystidia scarce, 45–55 × 5–7 µm, emergent, subfusiform with a tapering apex, sometimes slightly constricted at the apex but not capitate and never moniliform, hyaline and inconspicuous, thin-walled. Pseudocystidia abundant, 2–5 µm broad, not emergent, tortuous to cylindrical, with and ochre-yellow content. Lamella edge sterile with rather scarce cheilomacrocystidia; cheiloleptocystidia 7–25 × 3.5–8 µm, subclavate or more irregular, hyaline, thin-walled; cheilomacrocystidia small, 20–25 × 4–7 µm, only slightly emergent, subfusiform with a capitate to rarely moniliform apex, often apex merely tapering, content granular or needle-shaped, thin-walled. Subhymenium composed of small, ± isodiametric cells. Hymenophoral trama with abundant lactifers except near the edge. Pileipellis an ixocutis, up to 250 µm thick, composed of strongly interwoven hyphae, 1–5 µm broad, shrivelled hyphae only present near the surface, some extracellularly pigmented hyphae and lactifers present close to the surface. Clamp-connections absent.

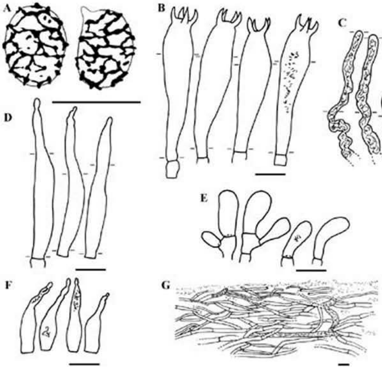


Fig. 20: *Lactarius* sp.: A. spores; B. basidia; C. pseudocystidia; D. pleuromacrocystidia; E. cheiloleptocystidia; F. cheilomacrocystidia; G. section through the pileipellis. From MTS 3445. Scale bars = 10 µm, small bars indicate the height of the hymenium.

Collection examined: USA, Washington, Grays Harbor Co., Quinault Research Natural Area, plot 10-1-c-11 (0), solitary on moss covered conifer twig & surrounding conifer debris, common, 07.10.1992, G. Walker, J. Ammirati & M. Seidl, MTS 3445 (RMS).

Discussion: This specimen was included in our phylogenetic analyses and was originally identified as *L. deliciosus* var. *olivaceosordidus*. In both ITS and *gpd* phylogenies, this collection does not fall in the "*L. deliciosus*" clade from North America. It was collected in Washington at the same site as collection JA 10762 (RMS) that also was identified as *L. deliciosus* var. *olivaceosordidus*. Collection JA 10762 however, groups with the other specimens identified as "*L. deliciosus*" or one of its varieties collected in North America in the molecular analyses. This means that *L. deliciosus* var. *olivaceosordidus* as currently identified in North America is polyphyletic. Based on microscopical data alone, it is impossible to draw any further conclusions. The microscopical features of this collection are very similar to those of the type of *L. deliciosus* var. *olivaceosordidus*. The spores are practically identical in size and ornamentation. The only differences noted concern the pleuro- and cheilomacrocystidia. Collection MTS 3445 (RMS) has rather exceptional pleuromacrocystidia with a narrowing or sometimes a slightly constricted apex that never is capitate or moniliform as in the type material of *L. deliciosus* var. *olivaceosordidus*. Furthermore the cheilomacrocystidia are scarce in MTS 3445 while they are very abundant in the type of *L. deliciosus* var. *olivaceosordidus*.

In conclusion and as Horton (2002), who revealed three different ITS-RFLP types in "*L. deliciosus*" from a locality in Oregon, already indicated, especially the "*L. deliciosus*"-complex needs more taxonomic attention in North America.

Acknowledgements

We are grateful to Ursula Eberhardt and Ruben Walleyn for reviewing this manuscript. We thank the curators of the herbaria FLAS, MICH, NY, NYS, PC, RMS, SFSU, XAL and ZT and the collectors mentioned in the examined specimens sections. This research was funded by the Institute for the Promotion of Innovation by Science and Technology in Flanders (IWT), Belgium.

Literature cited

Beardslee HC, Burlingham GS. 1940. Interesting species of *Lactariae* from Florida. Mycologia 32: 575-586.

Bessette AE, Bessette AR, Fisher DW. 1997. Mushroom of Northeastern North America. Syracuse University Press, Syracuse, New York. 582 pp.

Cifuentes J, Pérez-Ramírez L, Villegas M. 1989. Descripción de macromicetos poco estudiados de México III. Revista Mex. Micol. 5: 101-115.

Clémençon H. 1972. Zwei verbesserte Präparierlösungen für die microskopische Untersuchung von Pilze. Z. Pilzk. 38: 49-53.

Coker WC. 1918. The *Lactariae* of North Carolina. J. Elisha Mitchell Sci. Soc. 34 (1-2): 1-61.

Desjardin DE. 2003. A unique ballistosporic hypogeous sequestrate *Lactarius* from California. Mycologia 95: 148-155.

Heim R. 1954 "1953". A propos des Lactaires à lait rouge. Rev. Mycol. (Paris) 18: 221-224.

Hesler LR, Smith AH. 1960. Studies on *Lactarius* I. The North American species of sect. *Lactarius*. Brittonia 12: 119-139.

Hesler LR, Smith AH. 1979. North American species of *Lactarius*. Ann Arbor, University of Michigan Press. 841 pp.

Horton TR. 2002. Molecular approaches to ectomycorrhizal diversity studies: variation in ITS at a local scale. Pl. & Soil 244: 29-39.

Imazeki R, Otani Y, Hongo T. 1988. Fungi of Japan. Yama-Kei Publishers Co., Ltd. Tokyo, Japan, 623 pp.

Kong Luz A. 1995. Estudio taxonomico sobre el genero *Lactarius* (*Russulales*, Mycetae) en el volcan la Malintzi, Tlaxcala. Unpublished thesis, Universidad Nacional Autonoma de Mexico.

Kornerup A, Wanscher JH. 1962. Farver i Farver. Politikens Forlag, Copenhagen.

Kuo M. 2003, August. Retrieved from the *MushroomExpert.Com* Web site: http://www.bluewillowpages.com/mushroomexpert/contact.html

Methven AS. 1997. The *Agaricales* (Gilled Fungi) of California 10. *Russulaceae* II. *Lactarius*. Mad River Press, California. 78 pp.

Montoya L, Bandala VM. 1996. Additional records on *Lactarius* from Mexico. Mycotaxon 57: 425-450.

Montoya L, Bandala VM. 2004. *Lactarius* subgenus *Piperites*: a new species and a new name. Mycotaxon 89: 47-54.

Montoya L, Bandala VM., Guzmán G. 1996. New and interesting species of *Lactarius* from Mexico including scanning electron microscope observations. Mycotaxon 57: 411-424.

Montoya L, Bandala VM, Herrera S, Ortíz J. 1998. An interesting record of *Lactarius* from the Gulf and Caribe. Z. Mykol. 64: 91-96.

Murrill WA. 1945. More fungi from Florida. Lloydia 7: 304-305.

Nagasawa E. 1998. A preliminary checklist of the Japanese Agaricales II, The suborder Russulineae. Reports of the Tottori Mycological Institute 36: 36-71.

Neuhoff W. 1956. Die Milchlinge *(Lactarii)*. In Die Pilze Mitteleuropas Bd. IIb. Julius Klinckhardt, Bad Heilbrunn. 248 pp.

Nuytinck J. 2005. *Lactarius* section *Deliciosi* (*Russulales*, Basidiomycota) and its ectomycorrhiza: a morphological and molecular approach. PhD dissertation, Ghent University.

Nuytinck J, Wang XH, Verbeken A. 2006. Descriptions and taxonomy of the Asian representatives of *Lactarius* sect. *Deliciosi* (*Russulales*). Fungal Diversity: accepted.

Paulet JJ. 1811. Traité des champignons: 2 (9ed). Paris.

Peck CH. 1872. Rep. (Annual) New York State Mus. Nat. Hist. 24: 41-108.

Peck CH. 1878. Report of the Botanist. Rep. (Annual) New York State Mus. Nat. Hist. 29: 31-88.

Peck CH. 1898. Contributions of the Alabama biological survey. 1. New species of Alabama fungi. Bull. Torrey Bot. Club 25: 368-372.

Schweinitz LD von. 1822. Synopsis fungorum Carolinae superioris. Schriften Naturf. Ges. Leipzig 1: 20-131.

Simard SW, Perry DA, Jones MD, Myrold DD, Durall DM, Molina R. 1997. Net transfer of carbon between ectomycorrhizal tree species in the field. Nature 388: 579-582.

Verbeken A, Horak E. 2000. *Lactarius* (Basidiomycota) in Papua New guinea. 2. Species of tropical montane rainforests. Austral. Syst. Bot. 13: 649-707.

Winder DK. 1871. The Mushrooms of Canada, Toronto.

MYCOTAXON

Volume 96, pp. 309–322 April–June 2006

A new species of *Cephalotheca* isolated from a Korean patient

Takashi Yaguchi[1]*, Ayako Sano[1], Kyoko Yarita[1],
Moo Kyu Suh[2], Kazuko Nishimura[1] &
Shun-ichi Udagawa[3]

*t-yaguchi@faculty.chiba-u.jp
[1]Research Center for Pathogenic Fungi and Microbial Toxicoses
Chiba University, 1-8-1 Inohana, Chuo-ku, Chiba 260-8673, Japan

[2]Department of Dermatology, Gyeongju Hospital, College of Medicine
Dongguk University, Geyongju 780-350, Korea

[3]Tama Laboratory, Japan Food Research Laboratorie
6-11-10 Nagayama, Tama-shi, Tokyo 206-0025, Japan

Abstract—The causative agent isolated from a Korean patient with subcutaneous fungal infection is described as *Cephalotheca foveolata*, a new species of *Cephalotheca*, *Cephalothecaceae*, Ascomycota. It is characterized by globose cleistothecia, covered with yellow to brown hairs, cephalothecoid peridium, prototunicate asci, broadly reniform and foveolate ascospores, and a *Phialemonium*-like anamorph. Based on the analysis of sequences of the D1/D2 region of 28S rDNA, the fungus is phylogenetically a member of *Cephalotheca*. This is a new record of the genus from a patient with a human mycosis.

Key Words—systematics

Introduction

The genus *Acremonium* Link and its related genera such as *Lecythophora* Nannf., *Phaeoacremonium* W. Gams et al. and *Phialemonium* W. Gams & McGinnis have been increasingly isolated as causative agents in cases of opportunistic and/or emerging human infections (Fincher et al. 1991, Guarro et al. 1997, 2003, Padhye et al. 1998, Matsui et al. 1999, Kitamura et al. 2000, Alfonso et al. 2004, Kan et al. 2004, Proia et al. 2004, Scott et al. 2004, Mostert et al. 2006). With the exception of *Acremonium alabamense* Morgan-Jones (teleomorph: *Thielavia terrestris* (Apinis) Malloch & Cain), *Phaeoacremonium krajdenii* L. Mostert et al. (teleomorph: *Togninia krajdenii* L. Mostert et al.), *P. parasiticum* (Ajello et al.) W. Gams et al. (teleomorph: *T. parasitica* L. Mostert et al.), *P. rubrigenum* W. Gams et al. (teleomorph: *T. rubrigena* L. Mostert et al.) and *Lecythophora* sp. (teleomorph: *Coniochaeta ligniaria* (Grev.) Massee), pathogenic species of these genera could not produce ascospores on an artificial culture. We isolated a *Phialemonium*-like fungus from a Korean patient with chronic subcutaneous infection in the foot. The isolate produced a teleomorph similar to those of *Cephalotheca sulfurea* and *Albertiniella polyporicola* (= *Cephalotheca polyporicola* Jacz.) in the *Cephalothecaceae*, *Sordariales* (Chesters 1934, Booth 1961, Jaczevski 1922, Petrak 1947, Udagawa & Horie 1971, Malloch & Cain 1972, Lundqvist 1992). However, the phenotypic and genotypic characteristics of this isolate were different from those of both these species and other known species. Based on this evidence, we concluded that the isolate proved to be sufficiently different from those previously described to warrant the proposal of a new taxon of the genus *Cephalotheca* Fuckel. This is a new record of this genus as a human pathogen.

Materials and Methods

Fungal isolate

The strain was isolated from a Korean patient with chronic subcutaneous infection of the foot at Gyeongju Hospital, College of Medicine, Dongguk University, Gyeongju, Korea, in 2002. For comparison, the strains used in this study are listed in Tables 1 and 2, along with their strain numbers and GenBank accession numbers.

Incubation and observation

The isolate was incubated at 25-40°C under natural light or continuous near UV-light on potato-dextrose agar (PDA) and oatmeal agar (OA). For 14-80 days, colonies were examined by a light microscope (LM) and a scanning electron microscope (SEM: Hitachi S-800, Tokyo, Japan). Colony colors were designated according to the Methuen Handbook of Colour (Kornerup & Wanscher 1978).

Deposition of fungal materials

The type specimen and freeze-dried type culture were deposited in the Research Center for Pathogenic Fungi and Microbial Toxicoses, Chiba University, Chiba, Japan (IFM 53377) and the Department of Biotechnology, National Institute of Technology and Evaluation, Kisarazu, Chiba, Japan (NBRC 100905).

DNA analyses

DNA was extracted with a DEXPAT® (TaKaRa, Ohtsu, Japan) kit. The D1/D2 region of 28S rDNA was sequenced directly from PCR products using primer pair NL-1 (5′-GCA TAT CAA TAA GCG GAG GAA AAG-3′) and NL-4 (5′-GGT CCG TGT TTC AAG ACG G-3′) (Kurtzman & Robnett 1997). PCR products were sequenced using the BigDye Terminator Cycle Sequencing Ready Reaction Kit (Applied Biosystems, Foster City, Calif., US) on the ABI PRISM 3100 Genetic Analyzer (Applied Biosystems), according to the manufacturer's instructions.

DNA sequences were edited using ATGC Ver. 4 sequence assembly software (Genetyx Co., Tokyo, Japan), and alignment of the sequences was performed using Clustal X software (Thompson 1997). Maximum parsimony (MP) analysis (Fitch, 1971) was performed by heuristic search with random addition sequences and branch swapping by tree bisection-reconnection (TBR), using PAUP* 4b10 (Swofford, 2002). Relative robustness of the individual branches was estimated by bootstrapping, with 1000 replicates, using heuristic search and branch swapping by TBR. For the neighbor-joining (NJ) analysis (Saitou & Nei 1987), the distances between sequences were calculated using Kimura's two-parameter model (Kimura 1980).

Table 1. List of taxa sequenced in this study

Taxon	Strain number	DDBJ* accession number
Albertiniella polyporicola (Jacz.) Malloch & Cain	NBRC 9424	AB178270
Albertiniella polyporicola	NBRC30914	AB178271
Cephalotheca foveolata Yaguchi, Nishimura & Udagawa sp. nov. (ex type)	IFM 53377 (= NBRC 100905)	AB178269
Cephalotheca sulfurea Fuckel	CBS 135.34	AB189153
Cryptendoxyla hypophloia Malloch & Cain (ex type)	CBS 508.70	AB191032
Cryptendoxyla hypophloia	CBS 138.78	AB191031
Cryptendoxyla hypophloia	CBS 509.70	AB191033
Cryptendoxyla hypophloia	CBS 661.93	AB191034
Cryptendoxyla hypophloia	CBS 796.84	AB191035
Fragosphaeria purpurea Shear	CBS 133.34	AB189154
Fragosphaeria reniformis (Sacc. & Therry) Malloch & Cain	CBS 134.34	AB189155
Lecythophora hoffmannii (J.F.H. Beyma) W. Gams & McGinnis	IFM 53859	AB189164
Phialemonium curvatum W. Gams & W.B. Cooke (ex type)	CBS 490.82	AB189156
Phialemonium curvatum	CBS 246.91	AB189157
Phialemonium curvatum	CBS 631.94	AB189158
Phialemonium dimorphosporum W. Gams & W.B. Cooke (ex type)	CBS 491.82	AB189159
Phialemonium dimorphosporum	CBS 492.82	AB189160
Phialemonium obovatum W. Gams & McGinnis (ex type)	CBS 279.76	AB189161
Phialemonium obovatum	CBS 116.74	AB189162
Phialemonium obovatum	CBS 396.82	AB189163

*: DNA Data Bank of Japan.

Table 2. List of additional taxa included in the analysis

Taxon	Strain number	GenBank accession number
Acremonium alternatum Link	CBS 223.70	U57349
Lecythophora decumbens (J.F.H. Beyma) E. Weber et al. (ex type)	CBS 153.42	AF353597
Lecythophora fasciculata (J.F.H. Beyma) E. Weber et al. (ex type)	CBS 205.38	AF353598
Lecythophora mutabilis (J.F.H. Beyma) W. Gams & McGinnis (ex type)	CBS 157.44	AF353604
Pseudeurotium zonatum J.F.H. Beyma	CBS 329.36	AF096198
Xylaria hypoxylon (L) Grev.	ATCC42768	U47841
Penicillium chrysogenum Thom (out group)	NRRL 807	AF033465

Results

Phylogenetic analyses

DNA sequences of the D1/D2 region of 28S rDNA in the strains listed in Table 1 were determined. New sequences were deposited in the DNA Data Bank of Japan (DDBJ) and the accession numbers were listed in Table 1. Additional taxa included in the analysis are listed in Table 2.

MP analysis of D1/D2 sequences (Fig. 1) yielded a parsimonious tree based on 154 parsimony informative characters, 474 steps in length with a consistency index (CI) of 0.637 and a retention index (RI) of 0.666. No difference was seen between the tree topologies from the MP and NJ analyses (NJ-tree not shown).

According to the two trees, the isolate IFM 53377, *Albertiniella polyporicola*, *Cephalotheca sulfurea*, *Cryptendoxyla hypophloia* and *Phialemonium obovatum* formed a same clade and were found to be their placements in the *Cephalothecaceae*. The isolate was closely related to *C. sulfurea* and *P. obovatum*. In the D1/D2 region, there was 95% sequence homology between the isolate and *C. sulfurea*. Although the isolate is morphologically similar to *Albertiniella polyporicola*, there was only 90% sequence homology between the isolate and two NBRC strains of *A. polyporicola*. No relationship was evident with either *Fragosphaeria purpurea* or *F. reniformis*.

Morphological relationships

The genus *Cephalotheca* was described with a single species, *C. sulfurea*, collected on decaying oak boards in Rheingau. The species of *Cephalotheca* have the following characteristics in common: Ascomata are spherical, non-ostiolate, brown to black, with a membranaceous pseudoparenchymatous wall with sutures; asci are numerous, borne at all levels within the cavity of the ascoma, globose to pyriform, and generally disintegrate after the ascospores are formed; and ascospores are continuous, small, brown, and globose to ellipsoidal or reniform. One of the above features common to the genus is the arrangement of the peridial cells to form plate-like complexes (Fig. 4). Each of these plates is made up of radiating groups of cells and is separated from adjacent plates by well-defined sutures of dehiscence. To describe such structures, we are using the term "cephalothecoid", as in the cleistothecial ascomata of the *Cephalotheca* (Ulloa & Hanlin 2000). *Cephalotheca* and other cleistothecial ascomycetes have traditionally been separated using only the presence or absence of a cephalothecoid peridium. As a result, for those fungi with a cephalothecoid ascomatal peridium, several reports bring the number of additional species of *Cephalotheca* to approximately 15 (Booth 1961). With increasing taxonomical studies on the cleistothecial ascomycetes, however, such distinctions are regarded as largely artificial (Malloch & Cain 1970). Cephalothecoid peridia are found in a range of clearly unrelated ascomycetes, e.g. *Argynna* Morgan (*Argynnaceae*), *Chaetomidium* (Zopf) Sacc. (*Chaetomiaceae*), *Diffractella* Guarro et al. (*Lasiosphaeriaceae*), *Eremomyces* Malloch & Cain (*Eremomycetaceae*), *Rhytidospora* Jeng & Cain (*Ceratostomataceae*), *Testudina* Bizz. and its allies (*Testudinaceae*), *Thielavia* Zopf (*Chaetomiaceae*), and *Zopfia* Rabenh. and its allies (*Zopfiaceae*). Thus, included in the genus *Cephalotheca* were a number of unrelated taxa which are now distributed among several families as referred here. At present, in "Dictionary of the Fungi, 9th Edition", four species of *Cephalotheca* were recognizable (Kirk et al. 2001).

The isolate is easily distinguished from known species of *Cephalotheca* and other morphologically similar genera in the *Cephalothecaceae* (Table 3). *Cephalotheca sulfurea* differs in that cleistothecia are seated on a small dense mat of sulfur-colored hyphae and its ascospores are broadly elliptic-fusiform rather than reniform (Chesters 1934, Booth 1961, Dennis 1978). *Cephalotheca clarkii* Dennis is very similar to the isolate as its cleistothecia with long stiff hairs emerge from the center of the polygonal segments of cleistothecial peridium and its ascospores have a punctate ornamentation. However, it differs because of its subglobose, large ascospores (Dennis 1974, 1978). *Cephalotheca zeyheriae* C. Ram is different from the isolate due to its smooth-walled cleistothecia covered with aerial mycelium and oval (not reniform) ascospores, which are brightly colored at maturity (Ram 1972). Apart from the marked difference shown by its *Tritirachium* anamorph, *Cephalotheca savoryi* C. Booth has small cleistothecia covered with white downy mycelium and smaller ascospores (Booth 1961).

The genera most similar to *Cephalotheca* are *Albertiniella* Kirschst. and *Cryptendoxyla* Malloch & Cain. *Albertiniella polyporicola* and the isolate differ little in their microscopic characteristics, except that the former can be distinguished by its larger (340-600 μm diam), glabrous cleistothecia and slightly smaller ascospores (Udagawa & Horie 1971, Lundqvist 1992). *Cryptendoxyla hypophloia*, the only known species of the genus so far, has been collected on several occasions beneath bark on the wood of dead standing trees and on logs in Canada and has been cultured (Malloch & Cain 1970). The genus is characterized by a cephalothecoid cleistothecial peridium, prototunicate asci, cylindrical brown ascospores and a phialidic *Chalara* anamorph. Recently this species was isolated as a contaminant from a human toenail mycosis in Canada (Suh et al. 1999).

Data for maximum growth temperatures have assisted in differentiating the isolate and two closely related species. The maximum growth temperature of the isolate is 39°C and distinct from that of *C. sulfurea* CBS 135.34 (28°C) and *A. polyporicola* NBRC 9424 and 30914 (31°C).

Taxonomy

Based on morphological characters as well as DNA phylogeny, we consider the isolate from a Korean patient to represent an undescribed species of *Cephalotheca*.

Cephalotheca foveolata Yaguchi, Nishim. & Udagawa, sp. nov. (Figs. 2-10)

> *Coloniae in agaro decocto tuberorum effusae, velutinae, planae, ex mycelio basali coacto tenuiter constantes, albae, deinde aurantiaco-schistaceae; conidiogenesis moderata; cleistothecia abundantibus formentes sub luce naturali; reversum laete brunneum. Cleistothecia superficialia, sparsa, primum laete brunnea, deinde nigra, globosa vel subglobosa, 150-300 µm diam, non ostiolata, cum pilis rectis vel leviter sinuatis, laete flavis deinde brunneis; peridium cephalothecoideum, crassum, ex cellulis elongatis compositum. Asci 8-spori, pyriformes vel late ellipsoidei, evanescentes. Ascosporae primum hyalinae vel flavae, deinde brunneae, late reniformes, saepe complanatae, 4-5 × 3-4 × 2.5-3 µm, foveolatae sub SEM. Conidiophora destituta vel indistincta. Cellulae conidiogenae terminales vel laterales, vulgo monophialidicae, cylindricae, (5-)10-20 × 2-3 µm, laeves. Conidia hyalina, cylindrica, 4-5 × 1.5-2 µm, laevia. Chlamydosporae terminales vel intercalares, hyalinae, globosae vel subglobosae, 3-6 µm diam, laeves et incrassatae.*
>
> ***Etymology***: from Latin, *foveolata* = foveolate, referring to the ascospore ornamentation.
>
> *HOLOTYPUS. IFM 53377, isolatus ex pede humano, Gyeongju, in KORIA, 2002, a Suh MK. ISOTYPUS. NBRC 100905.*

Colonies on PDA growing more or less rapidly, attaining diam of 45-50 mm after 14 days at 25°C, velvety and loose-textured, plane, consisting of a thin basal felt, white, later becoming Orange Grey (M. 5B2) with a brownish extudation; conidiogenesis moderate; cleistothecia abundantly produced under natural light or near-UV light after more than 60 days; reverse Light Brown (M. 6D8) to Brown (M. 6E8). Colonies on OA growing more or less rapidly, attaining diam of 45-50 mm after 14 days at 25°C, plane, thin, consisting of spreading submerged mycelium, white to yellowish white, later becoming Brownish Orange (M. 6C3) with a brownish exudation; conidiogenesis and cleistothecial production similar to those on PDA; reverse uncolored to Greyish Orange (M. 6B6).

At 37°C, growth was slower than at 25°C. Maximum growth temperature was 39°C.

Cleistothecia superficial, scattered, at first pale brown, later becoming nearly black, globose to subglobose, 150-300 µm diam, non-ostiolate, with straight or slightly waved, light yellow, later becoming brown hyphal hairs. Peridium cephalothecoid (at maturity breaking into polygonal plates), thick-walled, multilayered, consisting of long elongated cells. Asci prototunicate, 8-spored, hyaline to pale brown, pyriform to broadly ellipsoidal, 6-8 × 4-6 µm, evanescent. Ascospores at first hyaline to yellow, later brown, broadly reniform, often flattened, 4-5 × 3-4 × 2.5-3 µm, with walls nearly smooth by LM and foveolate by SEM.

Conidial state *Phialemonium*-like. Conidiophores lacking or undifferentiated from the hyphae, simple or few branched, frequently reduced to conidiogenous cells. Conidiogenous cells terminal or lateral, determinate, mostly monophialidic, slender, cylindrical, (5-) 10-20 × 2-3 µm, smooth-walled. Conidia hyaline, cylindrical, 4-5 × 1.5-2 µm, smooth-walled, accumulated in slimy balls. Chlamydospores present, terminal or intercalary, globose to ellipsoidal, 3-6 µm diam, smooth, thick-walled.

Specimens examined. IFM 53377 (**HOLOTYPE**), a dried specimen and freeze-dried culture of an isolate from a Korean patient with subcutaneous fungal infection, Gyeongju Hospital, College of Medicine, Dongguk University Gyeongju, KOREA, by Suh MK, in 2002. **Isotype.** NBRC 100905.

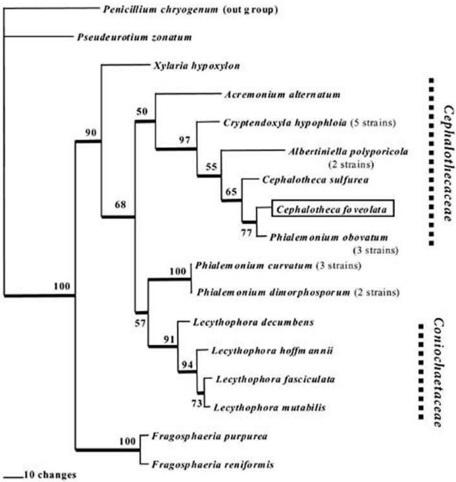
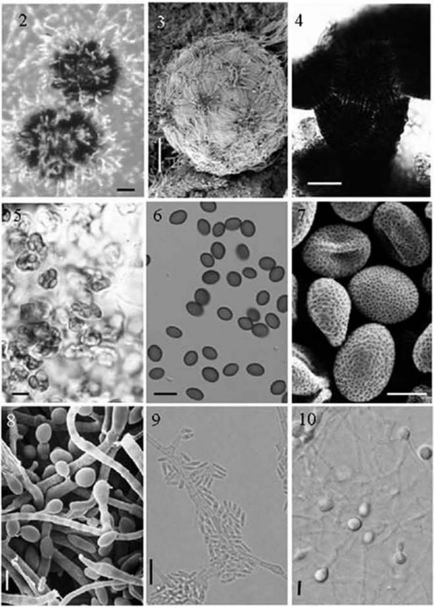


Fig.1. Single most parsimonious tree obtained from analysis of D1/D2 region of 28S rDNA using PAUP. Tree was 474 steps in length with CI of 0.637 and RI of 0.666. Percentages of 50% or higher based on 1000 bootstrap replications are given on tree branches accentuated as bold lines.



Figs.2-10. *Cephalotheca foveolata* IFM 53377. 2, 3. Cleistothecia. 4. Peridium. 5. Asci. 6, 7. Ascospores. 8, 9. Conidiogenous cells and conidia. 10. Chlamydospores. Scale bars: 2, 3, 4 = 50 μm, 5, 6, 8-10 = 5 μm, 7 = 2 μm.

Table 3. Comparison of *Cephalotheca foveolata* IFM53377 to its related species

Fungus	Acsomatal covering	Ascospores	Anamorph	Classification	Homology* (%)
Cephalotheca foveolata	Yellow, straight or waved hairs	Reniform, 4-5 × 3-4 × 2.5-3 µm, foveolate	*Phialemonium*-like	*Cephalothecaceae*	-
Cephalotheca sulfurea	Sulfureous hyphae when young, then glabrous	Elliptic-ovate, 4-6 × 3-4 µm, smooth**	*Phialemonium*-like	*Cephalothecaceae*	95
Cephalotheca clarkii	Long, straight	Subglobose, 8-7 × 7-9 µm, reticulate	Lacking	*Cephalothecaceae*	ND***
Cephalotheca savoryi	White villous	Reniform, 2.5-3 × 2.5-3 × 1.5-2 µm, smooth**	*Tritirachium*	*Cephalothecaceae*	ND***
Cephalotheca zeyheriae	Glabrous	Oval, 4-6 × 3-5 µm, smooth**	*Phialemonium*-like	*Cephalothecaceae*	ND***
Albertiniella polyporicola	Glabrous	Reniform, 3-4 × 2.5-3.5 × 2-2.5 µm, reticulate	*Phialemonium*-like	*Cephalothecaceae*	90
Cryptendoxyla hypophloia	Glabrous	Cylindrical, 4.2-5.5 × 2-3 µm, smooth**	*Chalara*	*Cephalothecaceae*	93
Fragosphaeria purpurea	Purple villus when young, then glabrous	Reniform, 2.5-3 × 1.5-2 µm, smooth**	Sympodulo-conidia	*Ophiostomataceae*	86
Fragosphaeria reniformis	Fuliginous hairs when young, then glabrous	Reniform, 4-5 × 3-3.5 µm, smooth**	Sympodulo-conidia	*Ophiostomataceae*	86

*: The value of the sequence homology with *C. foveolata* IFM 53377 on the D1/D2 region of 28S rDNA.

: Observed by light microscope only. *: Not determined.

Discussion

The family *Cephalothecaceae* was erected for *Cephalotheca* and a few similar cleistothecial ascomycetes with a specialized ascomatal structure for the liberation of the ascospores, showing a cephalothecoid peridium (Höhnel 1917). Booth (1961) provided descriptions of four wood-inhabiting species of *Cephalotheca* that had been considered to be close relatives of *Pseudeurotium* J.F.H. Beyma.

Subsequently, Malloch & Cain (1970) proposed the family *Pseudeurotiaceae* in which they included nine genera: *Cryptendoxyla*, *Emericellopsis* J.F.H. Beyma, *Fragosphaeria* Shear, *Hapsidospora* Malloch & Cain, *Leuconeurospora* Malloch & Cain, *Mycoarachis* Malloch & Cain, *Nigrosabulum* Malloch & Cain, *Pseudeurotium*, and *Testudina* Bizz. In some genera of the *Pseudeurotiaceae* the ascomatal peridium is made of plates, a condition described as cephalothecoid. The *Pseudeurotiaceae* is characterized by generally dark cleistothecial ascomata containing prototunicate asci with dark ascospores that lack germ pores; the anamorphs are morphologically simple, and conidia are produced from phialides or by sympodial proliferation of the conidiogenous cells in some cases. The family is more or less equivalent to the *Cephalothecaceae*, but Malloch & Cain disregarded the cephalothecoid peridium as a valid family characteristic because this peridial characteristic has been found in a number of unrelated taxa. They included only the genus *Cephalotheca* in the *Cephalothecaceae*.

In 1972, Malloch & Cain revived *Cephalotheca polyporicola* as a new combination, *Albertiniella polyporicola*, and designated it to "Family Unknown" (Incertae sedis). They stated that *Albertiniella reticulata* Kirschst. (Kirschstein 1936) and *C. polyporicola* were conspecific and made the name *Albertiniella* available. Malloch noted that final disposition of the genus awaited the determination of the presence or absence of germ pores in its ascospores (Benny & Kimbrough 1980). The absence of germ pores would suggest a relationship to the *Pseudeurotiaceae*. Thereafter, detailed discussion and illustration of *A. polyporicola* were provided by Lundqvist (1992). The ascospores, previously described as smooth, were found to be reticulate under the SEM with no clear germ pores or slit, and a *Phialemonium*-like anamorph was noted. As defined by Malloch (1981), Lundqvist suggested that the genus continue to be retained in the probably heterogenous *Pseudeurotiaceae*.

The genus *Teberdinia* was recently established by Sogonov et al. (2005) to be related anamorphs of *Pseudeurotium* species. The anamorph state of *C. foveolata* was superficially similar to *Teberdinia*, but phylogenetically separated from the genus *Phialemonium* because the distant relationship was obviously observed between the *Phialemonium* species and *P. zonatum* in Fig. 1.

Recently Suh & Blackwell (1999) presented evidence to place cephalothecaceous and pseudeurotiaceous species among their closest relatives, although all of the relationships were not well resolved. Their molecular phylogenetic analysis by partial sequences of 18S rDNA and 28S rDNA revealed that some species in the Pseudeurotiaceae were closely related to the taxa of four different orders of the perithecial ascomycetes (*Hypocreales*, *Sordariales*, *Ophiostomatales* and *Xylariales*).

In their study, *Cephalotheca sulfurea* formed a monophyletic sister group with pseudeurotiaceous species of *Albertiniella* and *Cryptendoxyla*, and thus the

Cephalothecaceae was well supported as a lineage of cleistothecial ascomycetes within the *Sordariales*. Our molecular data concurred with this finding.

In the molecular studies of phylogenetic relationships of members of the *Sordariales*, the *Cephalothecaceae* was also confirmed by Huhndorf et al. (2004). Although it was provisionally placed in the Sordariomycetidae inc. sed., they suggested that the family could be placed in a new order *Coniochaetales*, which is separate from the *Sordariales* and clusters as a sister group to the *Xylariales* and *Hypocreales*.

A group of *Acremonium*-like fungi with slimy, commonly pink to salmon-colored or pale yellow (sometimes with brown chlamydospores) colonies comprises the anamorphs of *Coniochaeta* (Sacc.) Cooke. These fungi compose the genus *Lecythophora*, which has been reintroduced by Gams & McGinnis (1983) and more recently redefined by Weber (2002). *Lecythophora* is also characterized by the predominant occurrence of intercalary phialides (adelophialides). On the other hand, Gams & McGinnis (1983) erected the genus *Phialemonium* to accommodate another group of hyphomycetes intermediate between *Acremonium* and *Phialophora* Medlar. *Phialemonium* is characterized by white (not turning pink, but occasionally yellow green) colonies, short cylindrical, lateral intercalary phialides which either lack collarettes or have very inconspicuous collarettes, no visible periclinal wall thickening, and somewhat discrete slender ventricose phialides. Its narrow vegetative hyphae (0.5 μm diam) distinguish *Phialemonium* from the otherwise similar *Lecythophora*. These fungi tend to be similar morphologically, and identification based on micromorphology and/or colony characterictics is likely to continue to be difficult. However, *Lecythophora* and *Phialemonium* now are clearly separated and a reliable set of sequence data is available for most species of these genera. Analysis of 28S rDNA sequence data by Weber et al. (2002) clearly indicates a phylogenetic affinity between *Lecythophora* and *Coniochaeta* species; e.g. *L. lignicola* Nannf., the type species, as well as *L. hoffmannii*, *L. mutabilis*, *L. luteoviridis* (J.F.H. Beyma) F. Weber et al., *L. decumbens*, and *L. fasciculata*, form a single cluster together with the tested species of *Coniochaeta*, including the type species, *C. ligniaria*, and associated *Lecythophora* anamorphs.

In this study, four species of *Lecythophora* have very similar DNA sequences and also appear as a monophyletic group (Fig. 1). On the contrary, our molecular data support the close relationships between *Phialemonium obovatum*, the type species, and three members of the *Cephalothecaceae*. The data obtained in this study strongly suggest that phialidic anamorphs of *Cephalotheca* and *Albertiniella* are placed in *Phialemonium* rather than *Lecythophora*. However, the placement of the other two species of *Phialemonium*, *P. curvatum* and *P. dimorphosporum* into the *Cephalothecaceae* was not supported by the analysis of rDNA sequence data (Weber et al. 2002, Fig. 1 in this study).

Species of *Acremonium* and related genera have increasingly been isolated from clinical materials, although their teleomorphs are not known. The teleomorphs include members of at least five families, the *Bionectriaceae*, *Nectriaceae*, *Cephalothecaceae*, *Coniochaetaceae* and *Phyllachoraceae*, but due to difficulties in recognizing and identifying these species in laboratory culture, these taxa are not familiar to most clinical mycologists. Prior to laboratory identification, cultures of these ascomycetous fungi should be incubated for at least three weeks under exposure to natural light or near-UV light, and hence their role in diseases may be underestimated. It appears that reliable identification of these fungi will become even more dependent on molecular methodologies in the future.

This paper and the case report by Suh et al. (2006) are the first report of an ascomycete classified in the genus *Cephalotheca* as a causative pathogen in human diseases. Further extensive environmental sampling and ecological studies are needed on *C. foveolata* and other *Acremonium*-like fungi in order to characterize their natural habitats and their relationship to diseases in man and animals.

Acknowledgements

We are grateful to Prof. Emer. Nils Lundqvist, Swedish Museum of Natural History, for his kind advice, and to Dr. Donald T. Wicklow, National Center for Agricultural Utilization Research, and Prof. Seiichi Ueda, Siebold University of Nagasaki, for reviewing the manuscript. We also thank NBRC for providing two *A. polyporicola* strains.

This work was supported in part by the National Bioresource Project-Pathogenic microbes in Japan (http://www.nbrp.jp/) and Grant-in-Aid for Scientific Research (C-18510201) from Japan Society for the Promotion of Science.

Literature cited

Alfonso JF, Baamonde MB, Santos MJ, Astudillo A, Fernandez-Vega L. 2004. *Acremonium* fungal infection in 4 patients after laser *in situ* keratomileusis. J Cataract Refract Surg 30: 262-267.

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

Booth C. 1961. Studies of Pyrenomycetes: VI *Thielavia*, with notes on some allied genera. CMI Mycol Pap 83: 1-15.

Chesters CGC. 1934. Studies on British Pyrenomycetes 1. The life histories of three species of *Cephalotheca* Fuck. Trans Brit Mycol Soc 19: 261-279.

Dennis RWG. 1974. New or interesting British microfungi, II. Kew Bull 29: 157-179.

Dennis RWG. 1978. British Ascomycetes. J Cramer, Vaduz. 585p.

Fincher RME, Fisher JF, Lovell RD, Newman CL, Espinel-Ingroff A, Shadomy HJ. 1991. Infection due to the fungus *Acremonium* (*Cephalosporium*). Medicine 70: 398-409.

Fitch WM. 1971. Towards defining the course of evolution: minimum change for a specific tree topology. Syst. Zool 20: 406-416.

Gams W, McGinnis MR. 1983. *Phialemonium*, a new anamorph genus intermediate between *Phialophora* and *Acremonium*. Mycologia 75: 977-987.

Guarro J, Gams W, Pujol I, Gené J. 1997. *Acremonium* species: new emerging fungal opportunists – in vitro antifungal susceptibilities and review. Clin Infect Dis 25: 1222-1229.

Guarro J, Alves SH, Gené J, Grazziotin NA, Mazzuco R, Dalmagro C, Capilla J, Zaror L, Mayayo E. 2003. Two cases of subcutaneous infection due to *Phaeoacremonium* spp. J Clin Microbiol 41: 1332-1336.

Höhnel F. 1917. Mycologische Fragmente 174. Ueber *Sphaeria uliginosa* Fr. und die Cephalothecaceen. Ann Mycol 15: 360-363.

Huhndorf SM, Miller AN, Fernández FA. 2004. Molecular systematics of the Sordariales: the order and the family *Lasiosphaeriaceae* redefined. Mycologia 96: 368-387.

Jaczevski AA. 1922. Materials or contributions for mycology and phytopathology in Russia. Discoveries in Russian mycological flora. Part IV: 3-15 (Gussewa K. 1925.Zer entwicklungsgeschiche von *Cephalotheca polyporicola* Jaczewski. J Soc Botan Russia 10: 229-238.)

Kan SF, Tsai TH, Hu CH, Lee WR. 2004. Cutaneous hyalohyphomycosis caused by *Acremonium* in an immunocompetent patient. Br J Dermatol 150: 789-790.

Kimura M. 1980. A simple method for estimation evolutionary rate of base substitutions through comparative studies of nucleotide sequences. J Mol Evol 16: 111-120.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi, 9th Edition. CABI Publishing, Wallingford, UK. 655p.

Kirschstein W. 1936. Beiträge zur Kenntnis der Ascomyceten und ihrer Nebernfrucht form besonders aus der Mark Brandenburg und der Beayerrischen Walde. Ann Mycol 34: 180-210.

Kitamura K, Mochizuki T, Ishizaki H, Udagawa S, Fukushiro R. 2000. Phaeomycotic cyst casused by *Phaeoacremonium parasiticum*. Jpn J Med Mycol 41: 89-95 (In Japanese).

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour, 3rd ed. Methuen, London.

Kurtzman CP, Robnett CJ. 1997. Identification of clinically important ascomycetous yeasts based on nucleotide divergence in the 5′ end of the large-subunit (26S) ribosomal DNA gene. J Clin Microbiol 35: 1216-1223.

Lundqvist N. 1992. *Albertiniella polyporicola*, en askomycet på platticka, funnen i Sverige. Svensk Bot Tidskr 86: 261-270.

Malloch D. 1981. The Plectomycete Centrum. In: Ascomycete Systematics. The Luttrellian Concept, ed Reynolds DR, pp73-91. Springer, New York.

Malloch D, Cain RF. 1970. Five new genera in the new family *Pseudeurotiaceae*. Can J Bot 48: 1815-1825.

Malloch D, Cain RF. 1972. New species and combinations of cleistothecial Ascomycetes. Can J Bot 50: 61-72.

Matsui T, Nishimoto K, Udagawa S, Ishihara H, Ono T. 1999. Subcutaneous phaeohyphomycosis caused by *Phaeoacremonium rubrigenum* in an immunosuppressed patient. Jpn J Med Mycol 40: 99-102.

Mostert L, Groenewald JZ, Summerbell RC, Gams W, Crous PW. 2006. Taxonomy and pathology of *Togninia* (Diaporthales) and its *Phaeoacremonium* anamorphs. Stud Mycol 54: 1-115.

Padhye AA, Davis MS, Baer D, Reddick A, Sinha KK, Ott J. 1998. Phaeohyphomycosis caused by *Phaeoacremonium inflatipes*. J Clin Microbiol 36: 2763-2765.

Petrak F. 1947. Ueber die Gattung *Albertiniella* Kirschst. Sydowia 1: 83-85.

Proia LA, Hayden MK, Kammeyer PL, Ortiz J, Sutton DA, Clark T, Schroers HJ, Summerbell RC. 2004. *Phialemonium*: an emerging mold pathogen that caused 4 cases of hemodialysis-associated endovascular infection. Clin Infect Dis 39: 373-379.

Ram C. 1972. Timber-Attacking fungi from the state of Maranhão, Brazil 'New species of Pyrenomycetes XI'. Nova Hedwigia 21:225-230.

Saitou N, Nei M. 1987. The neighbor-joining method: A new method for reconstructing phylogenetic trees. Mol Biol Evol 4: 406-425.

Scott IU, Cruz-Villegas V, Flynn HW Jr, Miller D. 2004. Delayed-onset, bleb-associated endophthalmitis caused by *Lecythophora mutabilis*. Am J Ophthalmol 137: 583-585.

Sogonov MV, Schroers H-J, Gams W, Dijksterhuis J, Summerbell RC. 2005. The hyphomycete *Teberdinia hygrophila* gen. nov., sp. nov., and related anamorphs of *Pseudeurotium* species. Mycologia 97: 695-709.

Suh MK, Lim JK, Lee YH, Ha GY, Kim H, Kim JR, Yaguchi T, Nishimura K. 2006. Subcutaneous hyalohyphomycosis due to *Cephalotheca foveolata* in an immunocompetent host. Br J Dermatol 154: 1184-1189.

Suh S-O, Blackwell M. 1999. Molecular phylogeny of the cleistothecial fungi placed in *Cephalothecaceae* and *Pseudeurotiaceae*. Mycologia 91: 836-848.

Suh S-O, Kevin KG, Blackwell M. 1999. A group I intron in the nuclear small subunit rRNA gene of *Cryptendoxyla hypophloia*, an ascomycetous fungus: Evidence for a new major class of group I introns. J Mol Evol 48: 493-500.

Swofford DL. 2002. PAUP*: phylogenetic analyis using parsimony (*and other methods). Version 4b10. Sunderland, Massachusetts: Sinauer Associate.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The clustal X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. 24: 4876-4882.

Udagawa S, Horie Y. 1971. Taxonomical notes on mycogenous fungi I. J Gen Appl Microbiol 17: 141-159.

Ulloa M, Hanlin RT. 2000. Illustrated Dictionary of Mycology. The American Phytopathological Society Press, St. Paul, Minn, USA. 448p.

Weber E. 2002. The *Lecythophora-Coniochaeta* complex I. Morphological studies based on *Lecythophora* species isolated from *Picea abies*. Nova Hedwigia 74: 159-185.

Weber E, Görke C, Begerow D. 2002. The *Lecythophora-Coniochaeta* complex II. Molecular studies based on sequences of the large subunit of ribosomal DNA. Nova Hedwigia 74: 187-200.

MYCOTAXON

Volume 96, pp. 323–326 *April–June 2006*

A new species of *Exobasidium* (*Exobasidiales*) on *Rhododendron* from China

ZHENYING LI[1,2] & LIN GUO[1*]

lizheny@mails.gucas.ac.cn
**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, *Exobasidium racemosum* causing shoot and leaves deformation on *Rhododendron racemosum*, is reported. The specimen was observed in Yunnan Province, China. In comparision with morphology based on macroscopical and microscopical structure of the validly described taxa on *Ericaceae* plants, this fungus differs from two similar species in the numbers of sterigmata and the mode of germination of basidiospores.

Key words—Ustilaginomycetes, symptom, taxonomy

A new species of *Exobasidium* on *Rhododendron racemosum* was collected from Lijinag, Yunnan Province in 2005. This species infects shoot and its clustered leaves, causing hypertrophy. The color of the infected parts is white and sometimes red. The transverse section of the diseased leaves shows hypertrophy of plant cells, but there is no differentiation between the palisade and mesophyll cells. Hyphae intercellular, protruding between epidermal cells in fascicles, forming a continuous layer on the undersurface of the leaves at maturity. In some microscopical slides of the fresh material, basidiospores germinate to conidia. The conidia can emerge from both ends and the septal regions of basidiospores. This recently collected *Exobasidium* species has (2-)3-7 sterigmata, and its basidiospores measure 9-15 x 3-4 µm. When comparing the morphology of the validly described taxa on *Ericaceae* plants, two species on *Rhododendron* show similarities in the sizes of sterigmata and basidiospores. The new species is different from *Exobasidium japonicum* Shirai (1896:52, Ezuka 1990:439) and *E. japonicum* var. *hypophyllum* Ezuka (1990:443) in the numbers of sterigmata and the mode of germination of basidiospores, the latters having only (2-)3-4(-5) sterigmata and germinating by germ tubes.

---

* *Corresponding author*

Exobasidium racemosum Z.Y. Li & L. Guo, sp. nov. **Figs. 1-5**

> *Hymenium hypophyllum. Basidia hyalina, clavata vel cylindrica, 6-11 µm lata, terminaliter (2-)3-7 sterigmatibus 4-7 x 1-1.8 µm praedita. Basidiosporae clavatae, ellipsoideae vel curvae, 9-15 x 3-4 µm, hyalinae, laeves, primo continuae, dein 1-septatae, per conidia germinantes. Conidia baciliformia vel clavata, 5-7 x 1.2-2 µm, hyalina, continua, laevia.*

Hymenium hypophyllous, white. Basidia with (2-)3-7 sterigmata, clavate or cylindrical, 6-11 µm wide. Sterigmata, conical, 4-7 x 1-1.8 µm. Basidiospores clavate or ellipsoidal, 9-15 x 3-4 µm, hyaline, smooth, at first continuous, then 1-septate, slightly curved. Basidiospores germinate to produce conidia. Conidia bacilliform or clavate, 5-7 x 1.2-2 µm, hyaline, continuous, smooth.

On *Rhododendron racemosum* Franch. (*Ericaceae*), Yunnan: Lijiang, Yufengsi, alt. 2720 m, 17 IX 2005, Z.Y. Li, L. Guo & N. Liu 173, HMAS 140194 (holotype).

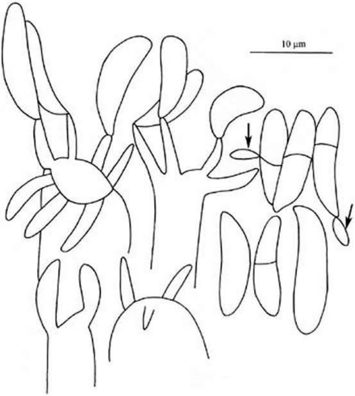


Fig. 1 (above). Basidia, sterigmata, basidiospores and conidia (arrows) of *Exobasidium racemosum* on *Rhododendron racemosum* (HMAS 140194, holotype).

Figs. 2-5 (to right). *Exobasidium racemosum* on *Rhododendron racemosum* (HMAS 140194, holotype). Fig. 2. Symptom. Fig. 3. Basidium, sterigmata and basidiospores as seen by LM (light microscopy). Figs. 4-5. Basidia, sterigmata and basidiospores as seen by SEM (scanning electron microscopy).

While the coverage of the Israeli literature is good, that of recent general systematic lichen literature is poor, with hardly any papers appearing after 2000 being cited apart from ones from the authors' research groups. This means that the whole has a somewhat dated appearance, with one notable exception: the treatment of *Xanthoria* of which Kondratyuk is a specialist. Ten species are accepted in that genus, and to have a key to these in English rather than Russian or Ukrainian is most welcome, though I was surprised to see the name *X. papillifera* used for *X. ectaneoides* since *X. aurolea* appears to be the correct name for that species.

There are numerous small and sometimes irritating mistakes, and it is clear the book would have benefited from the editorial pen of an experienced lichenologist. Nevertheless, this is a great step forward in providing a framework for future studies of Israeli lichens and means than ecologists as well as lichenologists in the country will be able to identify a much greater proportion of their collections than was hitherto possible.

Galun, M. (1970) *The Lichens of Israel*. Israel Academy of Sciences and Humanities, Jerusalem.

Hongos Liquenizados. By Martha Chaparro de Valencia & Jaime Aguirre Ceballos. November 2002. Universidad Nacional de Colombia, A. A. 7494, Bogotá DC, Colombia. Pp. 220, figs 63, incl. 8 coloured plates. ISBN 958 701 241 0. Price: Not indicated.

The lack of textbooks and identification guides in Spanish and Portuguese to lichens in South America is a major constraint to their study in the continent. It is therefore very pleasing to welcome this textbook. It covers the nature of lichens, the partners, anatomy and morphology, establishment and growth, ecology, chemotaxonomy, classification, methods of collection and study, a glossary, and a balanced bibliography with references including ones from 2000. The section on classification is in two main parts. First, there is a 23-page key to macrolichen genera in the Andes and Páramo, which includes many of the recently segregated genera. Second, there is a systematic arrangement by orders and families, with notes on their characters, which includes genera of all growth forms recorded in the country. Further, the number of species known from Colombia is placed after each generic name. Although the system used is somewhat dated (being based on the 1998 "Outline of the Ascomycetes") this is sure to be a great help to those starting to struggle with Colombian lichens. Sadly, the paper quality and level of resolution used in printing do not do justice to the coloured photographs, though the species are, in general, recognizable. As there is such a shortage of general lichen textbooks in Spanish, this work merits a wide circulation in Spain as well as in Central and South America.

Conidial fungi

***Sporidesmium*, *Endophragmiella* and Related Genera from China.** By Wenping Wu and Wenying Zhuang. January 2005. Fungal Diversity Press, Centre for Research in Fungal Diversity, Department of Ecology and Biodiversity, University of Hong Kong, Pokfulham Road, Hong Hong SAR, People's Republic of China. Pp. x + 351, figs 152, tables 1. ISBN 9628 6765 8 X. [Fungal Diversity Research Series No. 15.] Price: US$ 60.[7]

This book reports 143 species in 25 genera of dematiaceous hyphomycetes in the *Sporidesmium* and *Endophragmiella* complex from mainland China. Among these fungi are one new genus, 43 new species, and 16 new combinations. In this complex, the conidiophores are macronematous, mononematous sometimes synematous, with or without percurrent proliferations or reduced to a single conidiogenous cell. These cells are integrated, terminal, and with or without percurrent proliferations. The conidia are euseptate or distoseptate and vary in shape from obclavate, fusiform, rostrate, ellipsoidal, obovate, clavate or cylindrical and usually have a truncate base and an acute or rounded apex. Conidial secession is schizolytic or rhexolytic.

In the introductory pages, a short discussion is given of the included genera. This consists of a brief history along with the mode of conidiogenesis and the morphological characters used to describe the conidiophores, conidiogenous cells, and conidia. A table is presented for the known teleomorph-anamorph connections. Among the genera synonymised in this treatment are *Podoconis*, *Penzigomyces*, *Imimyces* and *Imicles*. A dichotomous key is presented for the genera found in China based on conidial shape and septation, conidiophore characters and the nature of the conidiogenous cell.

Sporidesmium s. str. of Subramanian is represented in this work by 13 new species and 19 new records. Each of these species is comprehensively described and beautifully illustrated. A dichotomous key to 36 species is given based on the characters of the conidiogenous cells, conidiophores and conidia. In this treatment of *Sporidesmium*, the following points were noted: on p. 12 couplet 6, *S.* "*mucrurum*" should be *S. macrurum*; *S. flagellatum* mentioned on pages 14 and 75 is omitted from the index; on p. 38, fig. 16, the epithet should be "*guadongense*" not "*guangdongse*"; in the notes for *S. nivae* on p. 53, the ? species *S. domingshanse*, not treated in this work, is compared with *S. njalaense*; in the treatment of *Stanjehughesia*, a segregate genus of *Sporidesmium*, four of the seven species are novelties; on p. 89 line 4, the sentence should read '1 locus per conidiogenous cell'; *Ellissembia* as circumscribed here includes the genus *Imicles*; in all 27 species are described and illustrated, including six novelties and 11 new combinations; in the key on p. 105, couplet 8 should read *E. calyptrate*, and on p. 106 couplet 24 *E. plovercovensis*; and *Ellisembia crassispora* described on p. 125 is omitted from the index. *Linkosia multiseptatum*, described on p. 185 is omitted from the index along with *Morrisiella indica* (the type species of *Morrisiella*, described and illustrated on p. 190.

The new genus, *Novozymia*, typified by *N. elegans*, is described from Guangdong Province. The conidiophores are synematous, the conidiogenous cells annelidic, and

---

[7] See also the more general review in *Mycotaxon* 94: 389-390 (2006 ["2005"]).

the conidia are distoseptate and secede by schizolytic succession. *Sporidesmina* is represented in China by the type species, *S. malabarica* and is considered to have similar conidiogenesis to *Sporidesmium* but differs in being synematous and the conidia have a mixture of eu- and distosepta. Five species of *Brachysporella* are treated, of which one is new and one a new combination. In the key on p. 208, couplet 2 prime should read 2-septate. The sanctioning author for *Actinocladium*, listed in the table of contents on p. v should be Fries. *Ceratosporella disticha* and *C. flagellifera* should be listed in the index as on p. 239. The authorities for *Triposporium foliicola* in the legend of fig. 109 on page 243 should be "Gamundí, Aramaní & Giaiotti".

Endophragmiella and related genera form the second large group of hyphomycetes treated by Wu & Zhuang. A key to eight genera is presented based on the presence or absence of appendages on the conidia, conidial septation, branched or unbranched conidiophores, the width of the conidiogenous locus and the presence or absence of a basal, downward directed fimbriate margin on the conidia. Conidial succession is rhexolytic.

Many of the hyphomycetes reported here have previously been noted elsewhere, and the excellent keys, complete descriptions, and the well executed illustrations make this work a valuable identification manual for areas both within and outside of China. Contrary to Rec. 7A of the *Code*, the type material of the novelties described in this work remain in the first author's personal herbarium. Also, 29 of the 152 figures in the manual have inverted numerals on the scale bar, and while the place of original publication is given for each new combination, the word basionym is not employed.

It is also interesting to note that the descriptions and illustrations presented here are based solely on Wenping Wu's collections. With a little more proof-reading and editing, this treatment could have met the high standards set by Martin B. Ellis and "Stan" J. Hughes.

Ellis, M.B. (1971) *Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute. Kew.

Ellis, M.B. (1976) *More Dematiaceous Hyphomycetes*. Commonwealth Mycological Institute. Kew.

Hughes, S. J. (1979) Relocation of species of *Endophragmia* auct. With notes on relevant generic names. New Zealand Journal of Botany 17: 139-188.

J. LELAND CRANE
Illinois Natural History Survey, 1816 South Oak St,
Champaign, IL 61820, USA

Nomenclatural novelties proposed in Mycotaxon 96

Achroomyces dennisii P. Roberts, p. 100
Agyrium aurantium W.Y. Zhuang & Zhu L. Yang, p. 169
Antrodiella ellipsospora (Pilát) Niemelä & Miettinen, p. 219
Antrodiella leucoxantha (Bres.) Miettinen & Niemelä, p. 224
Antrodiella pachycheiles (Ellis & Everh.) Miettinen & Niemelä, p. 226
Antrodiella pallescens (Pilát) Niemelä & Miettinen, p. 227
Antrodiella serpula (P. Karst.) Spirin & Niemelä, p. 231
Antrodiella subradula (Pilát) Niemelä & Miettinen, p. 233
Beltraniopsis aquatica R.F. Castañeda & M. Stadler, p. 155
Brevicatenospora R.F. Castañeda, Minter & Saikawa, p. 152
Brevicatenospora enteroproliferata R.F. Castañeda, Minter & Saikawa, p.153
Cephalotheca foveolata Yaguchi, Nishim. & Udagawa, p. 314
Chlorophyllum sphaerosporum Z.W. Ge & Zhu L. Yang, p. 187
Cystoderma andinum I. Saar & Laessøe, p. 124
Cystoderma papallactae I. Saar & Laessøe, p. 126
Didymium reticulosporum Novozh. & Zeml., p. 148
Exidia aeruginosa P. Roberts, p. 91
Exidiopsis scutelliformis (Berk. & M.A. Curtis) P. Roberts, p. 94
Exobasidium racemosum Z.Y. Li & L. Guo, p. 324
Graphis albidofarinacea Adaw. & Makhija, p. 53
Graphis cinnamomea Adaw. & Makhija, p. 54
Graphis colliculoides Adaw. & Makhija, p. 54
Graphis kollaimalaiensis Adaw. & Makhija, p. 55
Graphis nigrocarpa Adaw. & Makhija, p. 56
Graphis nilgiriensis Adaw. & Makhija, p. 59
Graphis verruciformis Adaw. & Makhija, p. 58
Inocutis texana (Murrill) Seb. Martínez, p.3.
Kananascus europaeus Treigienė, p. 174
Koorchaloma europaea Treigienė, p. 177
Lactarius aurantiosordidus Nuytinck & S.L. Mill., p. 302
Marasmius cremeopileatus, Antonín & C. Sharp, p. 253
Orbilia tenebricosa (Svrček) Baral, p. 167
Oxyporus subpopulinus B.K. Cui & Y.C. Dai, p. 208
Pertusaria alboaspera var. *disflavens* Jariangprasert, p. 109
Pertusaria kansriae var. *stictica* Jariangprasert, p. 110
Pertusaria methylstenosporica Jariangprasert, p. 111
Pertusaria microstoma var. *isidiata* Jariangprasert, p. 111
Pertusaria neoknightiana Jariangprasert, p. 112
Pertusaria orientalis Jariangprasert, p. 113

Author Index—Volume 96

Reviewers, Volume Ninety-six

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.

Brian P. Akers
Vagn Alstrup
André Aptroot
Alan W. Archer
Timothy J. Baroni
Robert Bauer
Dominik Begerow
Gerald L. Benny
Manfred Binder
Lori M. Carris
J. Leland Crane
Ursula Eberhardt
John A. Elix
Gražina Adamonytė
Lisa Grubisha
Gro Gulden
Laura Guzmán-Dávalos
Roy E. Halling
Richard Hanlin
David L. Hawksworth
Stephan Helfer
Mustafa Işıloğlu
Rajesh Jeewon
Volker John
Makoto Kakishima
Igor V. Karatygin
W. Bryce Kendrick
James W. Kimbrough
Henning Knudsen
Richard P. Korf
Heikki Kotiranta
Annette Kretzer
Ernestas Kutorga
Bernardo E. Lechner
Taihui Li
Xingzhong Liu
D. Jean Lodge
Vadim A. Mel'nik
Karen K. Nakasone
Machiel E. Noordeloos
Lorelei L. Norvell
Gen Okada
Nichole O'Neill
Erast Parmasto
Shaun R. Pennycook
Meike Piepenbring
Zdeněk Pouzar
Mario Rajchenberg
Huzefa Raja
Scott A. Redhead
Peter Roberts
Claude Roux
Leif Ryvarden
Mark R.D. Seaward
Ulrik Søchting
Brian M. Spooner
Joost Stalpers
Steven L. Stephenson
Tor Tønsberg
Seiichi Ueda
Kálmán Vánky
Else C. Vellinga
Ruben Walleyn
Donald T. Wicklow
Chi-Guang Wu

ERRATA

VOLUME 93

p.7, line 1	for: *brachysporus*	read: *brachyspora*
p.14, line 19	for: *pusilla*	read: *pusillus*
p.20, line 26	for: *neprhidius*	read: *nephridius*
p.20, line 28	for *P. puiggarii*	read: *Polystictus puiggarii*
p.22, line 38	for *rufo-atratus*	read: *rufoatratus*
p.40, line 7	for: *specious*	read: *speciosus*
p.73, line 39	for: *tomini*	read: *tominii*
p.249, name 8	for: *salmoneo-stramineus*	read: *salmoneostramineus*
p.252, line 32	for: *salmoneo-stramineus*	read: *salmoneostramineus*
p.270, line 25	for: *auriscalpum*	read: *auriscalpium*
p.305, name 1	for *Aeurobasidium*	read: *Aureobasidium*
p.305, name 6	for *M.*	read: *Mycosphaerella*
p.305, name 13	for: *Cochiobolus*	read: *Cochliobolus*
p.305, name 26	for: *M.*	read: *Melanomma*
p. 305, legend lines 4-5	for: *Phaeosph aeriaceae*	read: *Phaeosphaeriaceae*
p.340, name 9	for: *bilsii*	read: *bilsii*
p.340, name 11	for: *Phomma*	read: *Phoma*
p.347, next to last name in Fig	for: *kaufmanii*	read: *kauffmanii*
p.386, legend, line 6	for: *wightii*	read: *wrightii*
p.417, line 12	for: p. 362	read: p. 368
p.417, line 13	for: p. 371	read: p. 370
p.417, line 14	for: p. 370	read: p. 371
p.417, line 29	insert: *Polyporus saltensis* (Speg.) R.M. Silveira & J.E. Wright, p. 38	

VOLUME 94

p.105,line 36	or: *bubacii*	read: *bubakii*
p.143,line 21	for: lepidiotum	read: lepidiotaep.
p. 219, abstract line 2	for: *cyathicola*	read: *cyatheicola*
p. 223, lines 1, 23, 27	for: *cyathicola*	read: *cyatheicola*
p.272, line 12	for: *aurantio-cinnabarina*	read: *aurantiocinnabarina*
p.274, line 12	for: *aurantio-cinnabarina*	read: *aurantiocinnabarina*
p.276,f.a,line 13	for: *Clavulinopsis amoena*	read: *Clavaria amoena*
p.276,f.a,line 14	for: *Clavulinopsis aurantio-cinnabarina* read: *Clavaria aurantiocinnabarina*	
p.276,f.b,line 13	for: *Clavulinopsis amoena*	read: *Clavaria amoena*
p.276,f.b,line 14	for: *Clavulinopsis aurantio-cinnabarina* read: *Clavaria aurantiocinnabarina*	
p.309, line 23	for: *lendormandii*	read: *lenormandii*
p. 393	for: *Lecanicillium pissodis* Kope & Leal read: *Lecanicillium pissodis* Kope & I. Leal	
p. 393	for: *Lepiota catenariocystidiata* Han C. Wang & Zhu L. Yang, p. 52 read: *Lepiota catenariocystidiata* Han C. Wang & Zhu L. Yang, p. 51	
p.393, line 22	for: p. 52	read: p. 51
p.393, line 26	insert: *Ophiostoma loreanum* Masuya, J.-J. Kim & M.J. Wingf., p. 169	
p. 393	for: *Thyrostoma*	read: *Thyrostroma*
p.393. line 30	for: *cyathicola*	read: *cyatheicola*

VOLUME 95

p.341, line 5	for: *Calostoma zanchianum* Baseia & Calonge read: *Calostoma zanchianum* (Rick.) Baseia & Calonge
p.341, line 6	for *Coccomyces taiwanensis* C. L. Hou, R. Kirschner & Chee J. Chen, p. 73 read: *Coccomyces taiwanensis* C. L.. Hou, R. Kirschner & Chee J. Chen, p. 74
p. 341, line 9	for: *Embellisia oxytropis* Q. Wang, Nagao & Kakish., p. 25 read: *Embellisia oxytropis* Q. Wang, Nagao & Kakish., p. 257
p. 341, line 13	for: *Kalmusia amphiloga* O.E. Erikss., p. 67 read: *Kalmusia amphiloga* (Petr.) O.E. Erikss., p. 67
p. 341, line 21	for: *Paecilomyces verticillatus* Z.Q. Liang, Z. Li & Y.F. Han et al, p. 134 read: *Paecilomyces verticillatus* Z.Q. Liang, Z. Li & Y.F. Han, p. 134
p. 341, line 25	for: *Repetophragma fasciata* (R.F. Castañeda) Casteñeda, Gusmão & Saikawa read: *Repetophragma fasciatum* (R.F. Castañeda) R.F. Casteñeda, Gusmão & Saikawa
p. 341, line 26	for: *Repetophragma filifera* (Piroz.) R.F. Castañeda, Gusmão & Heredia, p. 269 read: *Repetophragma filiferum*(Piroz.) R.F. Castañeda, Gusmão & Heredia, p.269
p.347, line 1	*for:* Ninety-four *read:* Ninety-five

FROM THE *EDITOR-IN-CHIEF*

Authors are asked to download instructions and forms from our Instructions to Authors webpage on <www.mycotaxon.com> before preparing a paper for submission to our journal. An abbreviated set of instructions was also published in Mycotaxon 94: 401–411 (2005/2006). All files are also available as Email attachments from the *Editor-in-Chief* <editor@mycotaxon.com> on request.

Mycotaxon submission and publication preparation involves four steps:

Step 1—PEER REVIEW: Authors send their formatted text document, illustration files, and Reviewer Guidelines + checklist to two experts for peer review. Peer reviewers must (a) return edited manuscripts and detailed comments to the authors and (b) Email completed checklist forms and brief comments to the *Editor-in-Chief* **before** authors submit for nomenclatural review.

Step 2—NOMENCLATURAL & FRENCH LANGUAGE REVIEW: After considering peer review recommendations, authors Email a revised master clone (containing footnotes, tables and captions but *NO* illustrations) to the *Nomenclature Editor* at <PennycookS@LandcareResearch.co.nz>. The Email message *MUST* include the word 'Mycotaxon' on the subject line and list names and Email addresses of all peer reviewers. Manuscripts written in French should also be submitted to the *French Language Editor* <hennebertg@mbla.ucl.ac.be> at this time. Each Editor will return annotated files with a list of needed corrections to the authors and *Editor-in-Chief*.

Step 3—FINAL SUBMISSION: Authors Email/post the following to the *Editor-in-Chief*: a completed Mycotaxon submission form; one manuscript PDF/MSWord file **or** printed copy showing all text, legends, tables, footnotes & graphics in place; a body text clone (and table/legend text clones when tables, footnotes, and legends are present), and artwork files. All materials ***must*** be correct so that the manuscript can be prepared for immediate publication if necessary. The *Editor-in-Chief* usually acknowledges receipt within two weeks, but acknowledgments of new submissions may slow near press deadlines or when the editorial office is closed for research.

Step 4—PRESS PREPARATION: The *Editor-in-Chief* combines all files together to produce a press-quality PDF. Entries for the Nomenclatural novelties and Author index pages are sent with the PDF proof to all coauthors for approval after conversion. Editorial errors are always corrected free of charge. Authors who request correction of errors present in original author-prepared files, however, must pay at least $10 per correction (minimum charge of $40) to cover editorial time and the production/delivery of an invoice. Payment arrangements of all fees should be made by writing the *Treasurer* <info@mycotaxon.com>

Mycotaxon frequently updates its webpages and regularly posts abstracts, table of contents, indices, distributional checklists, and revised instructions and forms on its website. We invite all of you to browse our website frequently for updated journal and other interesting mycological news.

www.mycotaxon.com

Mycotaxon is published quarterly during the periods of January–March, April–June, July–September, and October-December by **Mycotaxon, Ltd.**, 316 Richard Pl., Ithaca, NY 14850. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2005: In U.S. and possessions, one year, $330; reduced rate for personal subscribers, one year, $150. Foreign subscriptions, add $40 for IMEX air mail.

POSTMASTER!
Send address changes to **Mycotaxon, Ltd.**
P.O. Box 264, Ithaca, NY 14851-0264 USA

EDITORS OF MYCOTAXON

MYCOTAXON is a quarterly, peer-reviewed journal devoted to mycological taxonomy and nomenclature. All articles are reviewed by specialists prior to submission. Publication is open to everyone. Papers may be in English or in French. Summaries in those or any additional languages desired by the authors are given for longer articles. Printing is on high quality, acid-free book paper. Authors prepare their own *text-ready* files after having received critical comments from pre-submission reviewers and nomenclatural review by the Nomenclature Editor. *Instructions to Authors* (Mycotaxon 94: 401–411, 2005) and *Guidelines for Reviewers* are updated and can be downloaded from our website at <www.mycotaxon.com>.

SUBSCRIPTION INFORMATION

All subscriptions are on an annual basis, with four quarterly volumes each year. Personal subscriptions are available at a substantially reduced rate for those who agree not to deposit their copies in a library other than their personal one within 3 years of receipt. Address all orders to the MYCOTAXON ORDER DEPARTMENT, P.O. Box 264, Ithaca, NY 14851-0264 USA, or your agent. Prices and availability of back volumes are posted on-line at <www.mycotaxon.com> or can be requested by E-mail from <subscriptions@mycotaxon.com>. Mycotaxon may be obtained on a journal-exchange basis. Proposals for such exchanges from journals, institutions, or individuals with difficulty in obtaining foreign currency should be addressed to<info@mycotaxon.com>.

The annual subscription rates for 2006 (four volumes annually) are

	USA	**Foreign (IMEX air assist)**
REGULAR (multi-user)	$330	$370
PERSONAL (individual)	$150	$190

All back volumes [except volumes 22, 24, 34(2), 35, 41, 54, and 64, currently out of print] are available at $35 each by surface mail, $55 each by air mail. Volumes 1, 38, 39, 43 and 46 were reprinted in 2001; the original printing of volume 1, part 1 is provided, with parts 2 and 3 reprinted.

CUMULATIVE INDICES

Printed versions of the *Mycotaxon Cumulative Indices* for Volumes 1-20 (ISBN 0-930845-00-5), Volumes 21-40 (ISBN 0-930845-01-03), and Volumes 41-60 (ISBN 0-930845-07-02) are available (see descriptions at <www.mycotaxon.com> and order there or through your local bookstore's listings under "Books in Print"). An online *Cumulative Index to Taxa in Volumes 61-ff.* and the *Cumulative Author Index to Volumes 61-ff.* are posted at <www.mycotaxon.com>.

AVAILABILITY IN MICROFILM, PHOTOCOPY, & ELECTRONIC VERSIONS

MYCOTAXON is also partially available in *microfilm* from National Archive Publishing Company <www.napubco.com>. *Tear sheets* or *photocopies* of individual articles may be obtained from ISI Document Solution <www.isidoc.com>. Many back volumes are available as free downloads through Cyberliber <www.cybertruffle.org.uk/cyberliber/index.htm> under 'Catalogues & Journals.'

CONTACTING MYCOTAXON'S EDITOR-IN-CHIEF BY E-MAIL OR FAX

To reach the Editor-in-Chief regarding manuscripts, E-mail to <editor@mycotaxon.com> or Fax to Lorelei L. Norvell at +503.297.3296.

CONTACTING MYCOTAXON'S ORDER DEPARTMENT BY E-MAIL OR FAX

To reach the Order Department for information or placing orders, you may E-mail to <subscriptions@mycotaxon.com> or Fax to Orders, Mycotaxon, Ltd., +607.273.4357.

VISIT MYCOTAXON ON THE WORLD WIDE WEB AT <www.mycotaxon.com>