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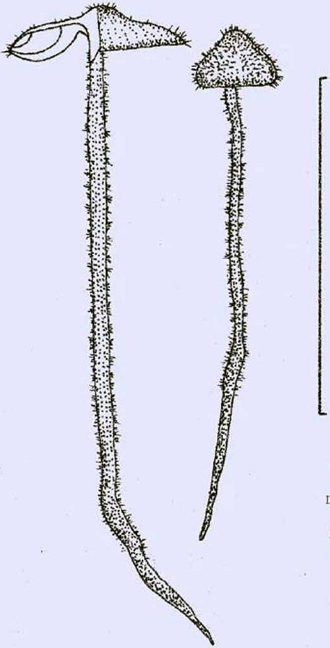

Xerula setulosa.
Basidiomata.
Illustrative reconstruction.
Standard bar = 40 mm
RONALD H. PETERSEN
&
TIMOTHY J. BARONI
PAGE 115

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INDICES & INFORMATION

MYCOTAXON

Volume 101, pp. 1–4 July–September 2007

Two new species of *Urocystales* from China

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Abstract—Two new species, *Urocystis dunhuangensis* on *Calamagrostis epigejos* and *Doassansiopsis guangdongensis* on *Sagittaria* sp., are described. They were collected from Dunhuang, Gansu Province, Northwestern China and Guangdong Province, Southern China respectively.

Key words—*Ustilaginomycetes*, smut fungi, taxonomy

A new species of *Urocystis* on *Calamagrostis epigejos* was collected from Gansu Province of Northwestern China in 2003 and 2004. So far, only one *Urocystis* species is known on *Calamagrostis*, *Urocystis calamagrostidis* (Lavrov) Zundel. The new species differs from *U. calamagrostidis* in having large spore balls (22–51.5 × 17–39 µm) and more ustilospores (mostly 2-ustilospored) per spore ball [(0–)1–6(–8), 0=1%, 1=14%, 2=31%, 3=29%, 4=11%, 5=6%, 6=4%, 7=2%, 8=2%; n=100], while *U. calamagrostidis* has small spore balls (20–46 µm in diameter, Vánky 1994) and 1–5 ustilospores [mostly 1-ustilospored (Zundel 1953)] per spore ball. The new species is described as:

Urocystis dunhuangensis S.H. He & L. Guo, sp. nov. **Figs. 1-2**

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Sori in foliis et vaginis foliorum strias longas facientes, primo epidermide obtecti, deinde rupti. Massa sporarum atrobrunnea, pulverulenta. Glomeruli sporarum subglobosi, ellipsoidei, ovoidei vel leniter irregulares, 22–51.5 × 17–39 µm, e ustilosporis (0–)1–6(–8) constructi, cellulis sterilibus perfecte circumdati. Ustilosporae ellipsoideae, ovoideae, subglobosae vel leniter irregulares, 11–20(–22) × 10–15 µm, rubrobrunneae vel flavidobrunneae. Cellulae steriles ovoideae, subglobosae vel ellipsoideae, 8.5–14 × 6–11 µm, flavidobrunneae; pariete ca. 1–1.5 µm crasso, levi, minute et dense verruculoso sub SEM.

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[*] corresponding author

Sori in leaves and sheaths as long striae, at first covered by the epidermis which later ruptures. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or slightly irregular, 22–51.5 × 17–39 µm, composed of (0–)1–6(–8) ustilospores, completely surrounded by sterile cells. Ustilospores ellipsoidal, ovoid, subglobose or slightly irregular, 11–20(–22) × 10–15 µm, reddish-brown or yellowish-brown. Sterile cells ovoid, subglobose, ellipsoidal, 8.5–14 × 6–11 µm, yellowish-brown; wall 1–1.5 µm, surface smooth as seen by LM (light microscopy), minutely and densely verruculose as seen by SEM (scanning electron microscopy).

Specimens examined—On *Calamagrostis epigejos* (L.) Roth (*Poaceae*), China: Gansu, Dunhuang, Mogao Grottoes, alt. 1100 m, 24 VIII 2004, L. Guo & W. Li 3214, HMAS 168528 (holotype), HUV 21444 (isotype); Gansu, Dunhuang, Mogao Grottoes, alt. 1100 m, 4 × 2003, L. Guo & H.C. Zhang 2415, HMAS 172006 (paratype).

A specimen of smut fungus labeled as *Doassansia intermedia* Setch. [= *Doassansiopsis intermedia* (Setch.) Vánky] on *Sagittaria* sp. was found in our Herbarium (HMAS). It was collected in Guangdong Province, Southern China. This smut forms flat spots on the leaves, without swellings, possessing spore balls with a single layer of ustilospores and unclear cortex of sterile cells. The spore balls of *Doassansiopsis intermedia* have several (2–5) layers of ustilospores (Vánky 1994). So, this specimen was evidently misidentified as *D. intermedia*. The host plant, *Sagittaria* belongs to *Alismataceae*. So far *D. furva* (Davis) Vánky is the only *Doassansiopsis* species known on *Sagittaria* that does not produce swellings of the host plants (Vánky 1981). The *Doassansiopsis* species from Guangdong is similar to *D. furva* in having flat sori, but differs mainly in ellipsoidal, often tangentially elongated ustilospores, and unclear cortex of sterile cells, while *D. furva* has ellipsoidal, radically elongated ustilospores and polyhedral cortical cells, 6–17 µm in diameter (Fischer 1953). The new species is described as:

Doassansiopsis guangdongensis **S.H. He & L. Guo, sp. nov.** **Figs. 3-4**
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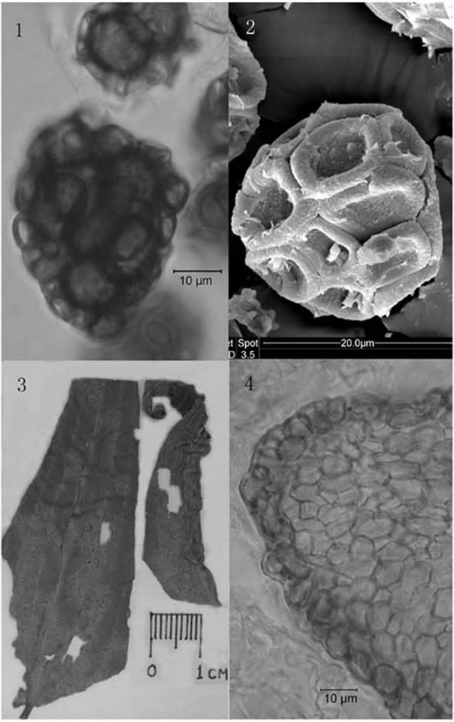
Sori in foliis, ca. 0.2 mm diam. Glomeruli sporarum in contextis matricis inclusi, irregulares, ellipsoidei vel subglobosi, 169–260(–344) × 108–184 µm, compositi e massa centrali parenchymatica telae fungalis, circumdata strato ustilosporae et strato externo corticali cellularum sterilium. Ustilosporae ovoideae, ellipsoideae, subglobosae vel irregulares, 9–12.5 × 5–10 µm, brunneae; pariete ca. 1–2 µm crasso, levi. Cellulae steriles centrales ovoideae, ellipsoideae, subglobosae vel irregulares, saepe angulosae, 7–14 × 5.5–10 µm, flavidobrunneae.

Figs. 1-2. Spore balls, ustilospores and sterile cells of *Urocystis dunhuangensis* on *Calamagrostis epigejos* (HMAS 168528, holotype). Fig. 1. As seen by LM. Fig. 2. As seen by SEM.

Figs. 3-4. *Doassansiopsis guangdongensis* on *Sagittaria* sp. (HMAS 17625, holotype). Fig. 3. Sori. Fig. 4. Spore ball, ustilospores, parenchymatous fungal cells and cortical sterile cells as seen by LM.


1
10 µm
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1 CM
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10 µm

Sori in the leaves, not swollen, ca. 0.2 mm in diameter, host plants not deformed. Spore balls embedded in the host tissue, irregular, ellipsoidal or subglobose, 169–260(–344) × 108–184 µm, composed of a central mass of parenchymatous fungal cells surrounded by a layer of ustilospores and an outer cortical layer of sterile cells. Ustilospores ovoid, ellipsoidal, subglobose or irregular, arranged irregularly, often with ellipsoidal ustilospores transversely arranged, 9–12.5 × 5–10 µm, brown, smooth; wall 1–2 µm thick. Central parenchymatous cells ovoid, ellipsoidal, subglobose or irregular, often angular, 7–14 × 5.5–10 µm, yellowish-brown. Outer cortical sterile cells ca. 5 × 3 µm.

Specimen examined—On *Sagittaria* sp. (*Alismataceae*), China: Guangdong, HMAS 17625 (holotype), HUV 21445 (isotype).

This specimen has no date, collector, or detailed location.

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MYCOTAXON

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Aphyllophoraceous wood-inhabiting fungi on *Pinus* spp. in Italy

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Abstract—203 species of 92 genera of aphyllophoraceous fungi growing on *Pinus* spp. in Italy are reported. *Dacryobolus karstenii*, *Hypochnicium cremicolor* and *Trechispora kavinioides* are reported as new to Italy. *Antrodia citrina* has previously been described as a new species from this substrata while many species have to be considered rare or infrequent in Italy. The complete checklist of fungi is available on http://www.mycotaxon.com/resources/weblist.html.

Key words—lignicolous fungi, diversity, coniferous forests, Europe

Introduction

In line with previous works (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006, Bernicchia et al. 2007), an annotated checklist of aphyllophoraceous fungi growing on *Pinus* spp. is presented.

The genus *Pinus* L. includes around 120 species in the northern hemisphere making it the most numerous among all the conifers. Pine forests are widely represented in Europe mainly in the mountainous areas and absent in the less elevated zones north of France, the British Isles, The Netherlands, Belgium, Germany, and Denmark (AFE 2007). In Italy about ten *Pinus* species grown naturally (AA.VV. 2005), and many others occur timber or shelter plantations. In the alpine and mountainous zones the most important species are: *P. sylvestris* L. (Scots pine), *P. cembra* L. (Swiss pine), *P. mugo* Turra (Dwarf mountain pine) and its subsp. *uncinata* (Ramond ex. DC.) Domin (Swiss mountain pine). *Pinus pinaster* Aiton (Maritime pine), *P. pinea* L. (Stone pine) and *P. halepensis* Mill. (Aleppo pine) represent the typical Mediterranean pines. *Pinus nigra*

J.F. Arnold s.l. and its subsp. *nigra* (Austrian pine) also grow in many Italian regions while the subsp. *laricio* (Poir.) Maire (Corsican pine) is limited to a few Mediterranean areas in Calabria and Sicily and found in some plantations in Sardinia. Other species found in coniferous forestry plantations that are discussed include *P. radiata* D. Don (Monterey pine), *P. strobus* L. (Weymouth pine) and *P. heldreichii* var. *leucodermis* (Antoine) Markgr. ex Fitschen (Black pine or Bosnian pine). The last grows mixed with *Abies* and *Fagus* in the southern Italian mountains in dry, sunny areas.

Italy has a typically Mediterranean climate characterized by cold, rainy winters and dry summers, except for the Alpine zone to the extreme north and the north and central east Continental zones. The varying climate regimes and wide ecological adaptations of the different pine species produce the highly diverse coniferous forests in Italy, particularly in the mountainous zones.

Previously, only scattered regional works have reported on fungi of Italian pine forests (Bernicchia 1997, Bernicchia & Campadelli 1987, Bernicchia et al. 1981). This summary and the fully annotated species list (http://www.mycotaxon.com/resources/weblist.html) provide a complete list of wood-inhabiting aphyllophoraceous fungi growing on pine.

Materials and methods

During the last 25 years, fungi have been collected in the most representative regions of Italy where *Pinus* is present. Samples were taken to the laboratory for microscopical examination and identified following Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Kõljalg (1995), Ryvarden & Gilbertson (1993, 1994) and Bernicchia (2005). All the specimens are kept in Herbarium HUBO. The list is partially referred to Bernicchia (1995, 2001) and Onofri (2005), some distributional dates to Losi (1999, 2003) and the nomenclature to Donk (1984), Parmasto (1997), Hjortstam (1998), Kirk et al. (2001) and CBS (2007). A list and map of the 96 collection localities are available on the web Checklist.

Results

This survey reports on 664 specimens of aphyllophoraceous wood-inhabiting fungi collected on different species of *Pinus*. The specimens represent 203 taxa, counting four determined only to genus level.

Dacryobolus karstenii (Bres.) Oberw. ex Parmasto, *Hypochnicium cremicolor* (Bres.) H. Nilsson & Hallenb. and *Trechispora kavinioides* B. de Vries are reported as new to Italy. Particularly rare or uncommon species are *Amylocorticium subincarnatum* (Peck) Pouzar, *A. subsulphureum* (P. Karst.) Pouzar, *Antrodia albobrunnea* (Romell) Ryvarden, *A. alpina* (Litsch.) Gilb. & Ryvarden, *A. citrina*

Bernicchia & Ryvarden, *Cerinomyces crustulinus* (Bourdot & Galzin) G.W. Martin, *Ceriporia alachuana* (Murrill) Hallenb., *C. sulphuricolor* Bernicchia & Niemelä, *Fomitopsis iberica* Melo & Ryvarden, *Gloeophyllum protractum* (Fr.) Imazeki, *Gyrodontium sacchari* (Spreng.) Hjortstam, *Hyphoderma cryptocallimon* B. de Vries, *H. galactinum* Manjón et. al., *Metulodontia nivea* (P. Karst.) Parmasto, *Mucronella bresadolae* (Quél.) Corner, *M. calva* (Alb. & Schwein.) Fr., *Oligoporus cerifluus* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *O. septentrionalis* Vampola, *O. simanii* (Pilát) Bernicchia, *Paullicorticium pearsonii* (Bourdot) J. Erikss., *Perenniporia fulviseda* (Bres.) Dhanda, *Phlebiella christiansenii* (Parmasto) K.H. Larss. & Hjortstam, *Piloderma bicolor* (Peck) Jülich, *Scytinostroma ochroleucum* (Bres. & Torrend) Donk, *Scytinostromella olivaceoalba* (Bourdot & Galzin) Ginns & M.N.L. Lefebvre, *Skeletocutis lilacina* A. David & Jean Keller and *Trechispora clancularis* (Park.-Rhodes) K.H. Larss.

Some of these species (e.g., *Antrodia citrina*) have been recorded only from *Pinus pinea* and the type locality; *Perenniporia narymica* (Pilát) Pouzar grows on *Pinus* in Italy while elsewhere it usually is recorded on deciduous substrata. Some species are more common on deciduous substrata than on conifers as *Abortiporus biennis* (Bull.) Singer, *Antrodia albida* (Fr.) Donk, *Bjerkandera adusta* (Willd.) P. Karst., *Chondrostereum purpureum* (Pers.) Pouzar, *Hapalopilus nidulans* (Fr.) P. Karst., *Oligoporus tephroleucus* (Fr.) Gilb. & Ryvarden, *Peniophora meridionalis* Boidin and *Steccherinum fimbriatum* (Pers.) J. Erikss.

Conclusions

Compared with the other hosts investigated as substrata for wood-inhabiting fungi in Italy, *Pinus* supports a very high fungal diversity (203 species), even more than the conifers *Abies alba* (190 species) (Bernicchia et al. 2007) and *Juniperus* spp. (105 species) (Bernicchia 2000). Even fewer species were collected from broadleaved hosts, e.g., 126 species on *Castanea sativa* (Mayrhofer et al. 2001), and 52 species on *Arbutus unedo* (Pérez Gorjón et al. 2006). This high diversity is partly due to the great range of distribution of pine forests, both in the coastal and on mountainous pinery forests. At least one recently described species, *Antrodia citrina,* has been recorded only on *Pinus pinea,* till now.

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Flammula croceolamellata and *Naucoria intertrunca* described by Albert Pilát are identical with *Gymnopilus* species

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Abstract—Type specimens of *Flammula croceolamellata* and *Naucoria intertrunca* (*Fungi, Agaricales*) described by the Czech mycologist Albert Pilát were thoroughly revised. *F. croceolamellata* proved to be identical with *Gymnopilus penetrans* and *N. intertrunca* with *Gymnopilus bellulus*. Consequently, the names published by Pilát are synonyms of these *Gymnopilus* species. Problems concerning discrepancies within type material of *N. intertrunca* are discussed.

Key words—macromycetes, taxonomy, type study, Slovakia, Ukraine

Introduction

Monographic study of the genus *Pholiota* in central and western Europe (Holec 2001) showed that some species of fungi described as *Pholiota* or *Flammula* belong in fact to the genus *Gymnopilus*. It concerns e.g. *Flammula croceolamellata* (Pilát 1939), which was earlier revised by Holec (2001: 184) who concluded that it "clearly belongs to *Gymnopilus*" and "should be studied by a specialist of the genus *Gymnopilus*". Subsequent studies of *Gymnopilus* (Holec 2005a, b) created a background that enabled identification of *F. croceolamellata* at the species level. Simultaneously, Egon Horak (pers. comm.) advised me in 2006 that, according to his 1979 type study, *Naucoria intertrunca* (Pilát 1953) also represents a *Gymnopilus* species, probably "a later synonym of *G. bellulus*."

The aim of this paper is to clarify the identity of the two species described by Albert Pilát (1903-1974), an important Czech mycologist of world renown.

Material and methods

All examinations were made using an Olympus BH-2 microscope. The observations and measurements were made on material mounted in a 5 % KOH solution. Iodine reaction was studied in Melzer's reagent prepared according to the formula given in Moser (1983). For spore size measurements, 20 randomly selected mature spores were used per collection. Immature spores (extremely small or having a thin wall and hyaline content) or aberrant spores (1.5–2 times longer than the normal ones) were not measured. Spores were measured without the hilar appendix (apiculus). Illustrations of microcharacters were drawn at a magnification of 1250 x using a drawing tube. Permanent microscopic mount was made after studies of fungal material in 5 % KOH using Entellan embedding medium (Merck, Germany). The term suprahilar disc instead of plage is used here for the smooth area in the region of the suprahilar depression in accordance with Pegler & Young (1971: 21) and Rees et al. (1999). For translation of Latin descriptions, the botanical vocabulary by Stearn (1992) was used. Collections studied are kept at the Mycological Department of the National Museum, Prague, Czech Republic (herbarium PRM).

Results and discussion

Flammula croceolamellata Pilát FIG. 1

Bull. Soc. Mycol. Fr. 54(3–4): 251, 1939 ("1938"); black and white photograph on plate 3.

HOLOTYPE—Ukraine, W part: Eastern Carpathians ("Carpatorossia": a part of Czechoslovakia at the time when Pilát found and described his new species), in mixed woods close to a meadow called "Tiščora" near Trebušany (Trebušany = village named Dilove at present, near the town of Rachiv (Rakhiv), see Holec 2002), on coniferous wood (*Picea abies* in the publication, *Abies alba* on the label of the holotype), Aug. 1938, leg. Anna Pilátová (PRM 494289). The holotype consists of one well-preserved fruitbody. A revision label by E. Horak is added in the envelope and contains the following data: studied in December 1965, aff. *Gymnopilus spectabilis*.

TRANSLATION OF THE ORIGINAL LATIN DESCRIPTION—Pileus 50–100 mm in diam., with central to slightly eccentric stipe, rounded, hemisphaerically expanded, with subinvolute margin, brown-ferruginous to almost nut-brown. Pileus cuticle disrupted into small scales which are appressed, almost triangular, darker coloured. Stipe cylindrical, 20–40 x 7–10 mm, glabrous to slightly sulcate. Lamellae crowded, 7–10 mm high, adnate to emarginate, at maturity brightly ferruginous-croceous (remaining so in dried fruitbody), mostly with denticulate edge. Cortina not very visible when mature, disappearing. Context of pileus somewhat hard, 2–4 mm thick, becoming pale yellowish. Hyphae of lamellar trama plus minus parallel to subparallel, thin-walled, 4–7 µm thick. Hyphae of pileus trama loosely irregularly interwoven, thin-walled, hyaline, pressed together, branched, 4–9 µm thick. Pileus cuticle 80 µm thick, made up of similar type of hyphae, densely interwoven, rather glued together, oil-coloured or brownish. Cystidia present only on edge of lamellae, clavate-capitate, thin-walled, 15–20 x 5–8 µm, very frequently filled with brown content, not very distinct. Basidia 15–20 x 5.5–7 µm. Spores rusty-saffron yellow, glabrous, ellipsoid, with oblique apiculus, very frequently with one drop, 6.5–8 x 4–4.5 (–5) µm.

MICROSCOPIC STUDY OF THE HOLOTYPE—Spores (7.2–)7.6–8.4(–8.8) x (4.4–) 4.8–5.2 µm, in face view ellipsoid, ovoid-ellipsoid to ellipsoid-amygdaliform, in side view ellipsoid to amygdaliform-ellipsoid with a distinct suprahilar depression and hilar appendix (apiculus), without suprahilar disc (plage), yellow-ochre, slightly to moderately dextrinoid (vinaceous-brown) in Melzer's reagent, wall rusty brown, moderately to coarsely verrucose, some (immature) spores thin-walled, pale yellow, glabrous or finely verruculose. Basidia 4(2)-spored, narrowly clavate with slight median constriction, 26–30 x 7–8 µm, sterigmata 4–6 µm long. Basidiolae clavate. Cheilocystidia 16–27 x 6–8 µm, hyaline, thin-walled, sphaeropedunculate when young, then fusiform, lageniform to utriform, with subcapitate to capitate head. Pleurocystidia not observed. Lamellar trama regular, of cylindrical hyphae 4–14(–16) µm broad, some cells slightly fusiform inflated, cells hyaline, with yellow incrustations. Pileipellis a cutis of densely arranged parallel hyphae 2.5–8 µm broad, covered with yellow incrustations. Clamps present in all tissues.

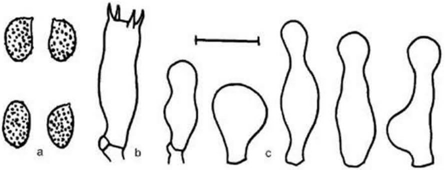

Fig. 1. *Flammula croceolamellata*, holotype (PRM 494289). a: spores, b: basidium, c: cheilocystidia. Bar = 10 µm.

DISCUSSION—*Flammula croceolamellata* is only represented by the type specimen. There are no other collections by Pilát and the name was not used in mycological literature later except for the results of a preliminary revision carried out by Holec (2001). Pilát (1939) placed his new species into *Flammula*. One character leading to this classification certainly was the glabrous spores observed by him. However, revisions of the holotype showed (Horak: revision label, Holec 2001: 184) that it was an erroneous observation as the spores of *F. croceolamellata* are distinctly verrucose (Fig. 1). Egon Horak concluded (revision label) that the species is close to *Gymnopilus spectabilis*. However, the following characters do not fit *G. spectabilis*: absence of a membranaceous ring, growth on coniferous wood which is very rare in *G. spectabilis* (see Holec 2005a: 7), occurrence in the mountains (in Europe, *G. spectabilis* prefers areas with warm to temperate climate), smaller spores (in *G. spectabilis* mostly about 8–11 x 5–7 µm, see e.g. Orton 1993: 71, as *G. junonius*; Breitenbach & Kränzlin 2000: 136, as *G. junonius*; Holec 2005a: 6) and the absence of a suprahilar disc (plage) which is present on spores of *G. spectabilis* (Holec 2005a: 6). Note: the concept of *G. spectabilis* used here (= *G. junonius* sensu most recent authors, i.e. robust fungus with distinct membranaceous ring growing in clusters) is thoroughly described by Holec (2005a).

Pilát himself wrote that his new species belongs to *Flammula* sect. *Sapinei* (sensu Fries 1874), i. e. close to *Gymnopilus penetrans* and *G. sapineus*. If the characters of *F. croceolamellata* are compared with these species, it is evident that almost all characters are really identical with those of *Gymnopilus penetrans* as described e.g. by Kühner & Romagnesi (1953), Ludwig (2000, 2001), Breitenbach & Kränzlin (2000) and Holec (2005a). The most important characters supporting this conclusion are: growth on wood of a conifer in the montane area, cortinoid veil, all characters of spores (especially size, shape and absence of the suprahilar disc, see Fig. 1a), upper layer of pileus cuticle composed of hyphae up to 8 µm broad (in *G. sapineus*, they are mostly 8–16 µm broad; see Holec 2005a: 24, Clémençon 2003).

There are only two characters of *F. croceolamellata* that deviate slightly from the "normal" *Gymnopilus penetrans*: the scales on pileus surface and the ferruginous-croceous colour of lamellae (Pilát 1939). However, the characters are within the range of variability of *G. penetrans*, which is a very variable species (see e.g. Ludwig 2000: tab. 44). As shown by Holec (2005a), in some fruitbodies the pileus can be covered with "disrupted covering forming fine, appressed, fibrillose scales". This characterisation is almost identical with Pilát's description of pileus surface in *F. croceolamellata* (see above). Similarly, the colour of lamellae can be "yellow-rusty or orange ochre-rusty" (Holec 2005a) which is almost identical with ferruginous-croceous colour given by Pilát (1939).

Conclusion—*Flammula croceolamellata* represents a slightly aberrant form of *Gymnopilus penetrans* (Fr.) Murrill and the name can be considered a synonym of it.

Naucoria intertrunca Pilát FIG. 2

Sborník Národního Musea v Praze, Řada B, Přírodovědecká (Acta Musei Nationalis Pragae, Ser. B, Historia Naturalis) vol. 9, no. 2: 55, 1953.

HOLOTYPE—Slovak Republic, central Slovakia, near Detva village E of Zvolen town, Poľana mountain, near-natural montane forest on andesite background, alt. ca. 1200 m, on decayed wood of *Abies alba*: in ridge of a fallen trunk lying on soil, 26 Aug. 1951 leg. Albert Pilát (PRM 717775). A revision label by E. Horak is added in the envelope and contains the following data: 'studied in 1979, = *Gymnopilus*.'

The holotype consists of three entities: 1. large amount of decayed wood of *Abies* where no fruitbodies were found, 2. two very small fragments (1 x 1 and 1 x 3 mm) of pileus with attached lamellae in a small envelope, 3. permanent microscopic mount containing fungal tissue, probably made by E. Horak during his revision. It agrees with statement by Pilát (1953: 55) that only one fruitbody was found in the herbarium specimen. A part of this fruitbody was certainly used for his microscopic study and later by E. Horak for revision. Consequently, the remaining material is scanty.

TRANSLATION OF THE ORIGINAL LATIN DESCRIPTION—Pileus 5–8 mm in diam., subglobose, then applanate, asymmetric, with distinctly eccentric stipe insertion, fragile, minutely pubescent under lens, rusty to yellowish brown (clay-coloured), rather dull-coloured. Lamellae adnate, rather thick and scattered, distinctly fragile, of similar colour like the pileus or slightly paler. Stipe 5–8 x 1 mm, rectangularly curved, concolorous with pileus, the whole surface but especially the upper part somewhat pubescent, cylindrical, with slightly thickened upper part. Spores rusty, ellipsoid-amygdaliform, slightly irregular and indistinctly verrucose, with somewhat oblique apiculus, 5.5–6.5 (–7) x 3.5–4 µm.

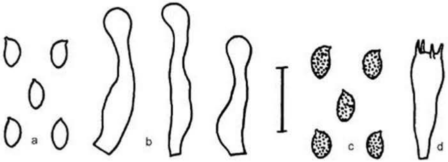

Fig. 2. *Naucoria intertrunca*, holotype (PRM 717775). a-b: from dried material, a: spores, b: cheilocystidia. c-d: from permanent microscopic mount probably made by E. Horak, c: spores, d: basidium. Note the difference between spores from the dried material and the permanent mount. Bar = 10 µm.

MICROSCOPIC STUDY OF THE DRIED MATERIAL—A small piece removed: ca. 0.5 x 0.5 mm, containing fragment of pileus with lamellae, poorly preserved, overdried, forming a mass of almost indiscernible cells under light microscope, a permament microscopic mount of this material was finally made using Entellan embedding medium, labelled by name of J. Holec and added into the envelope of the holotype. Spores (4.4–)4.8–5.2(–5.6) x (2.4–)2.8–3.2 µm, ellipsoid to ellipsoid-ovoid in face view, ellipsoid-ovoid to amygdaliform-ellipsoid in side view, with slight suprahilar depression, pale yellowish in KOH, not dextrinoid in Melzer's reagent, wall 0.2–0.3 µm, relatively thin, smooth (Fig. 2a). Basidia and basidiolae not discernible, probably collapsed. Cheilocystidia 20–30 x 4–5 µm, narrowly lageniform to almost cylindrical (Fig. 2b), with narrower neck (2–3 µm) and subglobose to globose head (4–5 µm). Other structures like trama hyphae or clamps not possible to recognize.

MICROSCOPIC STUDY OF THE PERMANENT MOUNT PROBABLY MADE BY E. HORAK—Material poorly preserved, composed of spores and mass of undiscernible collapsed cells. Spores 4.8–5.6(–6.0) x 3.2–3.6 µm, ellipsoid to broadly ellipsoid-amygdaliform, in side view with a slight but mostly distinct suprahilar depression, without suprahilar disc (plage), yellow-rusty, verrucose (Fig. 2c). Basidia rare, mostly collapsed, about 20 x 5.5 µm (Fig. 2d), sterigmata about 3 µm long, cheilocystidia not found, probably collapsed. Other structures like trama hyphae or clamps not possible to recognize.

DISCUSSION—*Naucoria intertrunca* is represented only by the type specimen. There are no other collections by Pilát in PRM herbarium and the name was not used again in the mycological literature. There is a surprising discrepancy between study of dried material and the permanent microscopic mount. The dried material contains small, smooth spores with rather pale walls (Fig. 2a) and narrowly lageniform cystidia having relatively short necks and large heads (Fig. 2b). Of lignicolous *Agaricales* that might be considered, *Galerina sideroides* possesses such spores and cheilocystidia (Watling & Gregory 1993: 45, Breitenbach & Kränzlin 2000: 324) and grows on decayed wood of conifers. However, as the data obtained by the revision are incomplete, a reliable identification is not possible.

On the other hand, the microscopic mount contains verrucose spores (Fig. 2c) resembling those of *Gymnopilus bellulus*. Spores of this species are readily distinguished within *Gymnopilus* by their small size and characteristic shape: ellipsoid to amygdaliform-ellipsoid with suprahilar depression (see e.g. Breitenbach & Kränzlin 2000: 134, Holec 2005a: 11, 44). The description and line drawings published by Pilát are in agreement with macro- and microcharacters of *G. bellulus* (e.g. the habit of fruitbodies with slightly eccentric stipe: compare Holec 2005a: p. 27, fig 1; ferruginous pileus; pubescent stipe surface; size and ornamentation of spores).

These data show that the holotype specimen contains material of two different fungi: *Gymnopilus bellulus* (microscopic mount) and a species resembling *Galerina sideroides* (dried material). It is probable that the material collected by Pilát in the field was a mixture of two fungal taxa. This is possible as *G. bellulus* is very similar to some lignicolous *Galerina* species which often grow on the same trunk. Second hypothesis is that a confusion (an erroneous substitution of dried material?) turned up during the study of the material by Pilát or Horak.

CONCLUSION—The original description of *Naucoria intertrunca* and revision of permanent microscopic mount kept in holotype specimen show that the fungus represents in fact *Gymnopilus bellulus* (Peck) Murrill. Consequently, the name *N. intertrunca* can be included within the synonymy of *G. bellulus*. This conclusion agrees with opinion of E. Horak (see Introduction). However, the holotype specimen contains two species of fungi – the dried material represents a species resembling *Galerina sideroides* (Bull.) Kühner. The reasons for such a discrepancy cannot be explained satisfactorily based on contemporary data.

Acknowledgements

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Immersisphaeria gen. nov. from Poland

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Abstract—The new genus *Immersisphaeria* is proposed for *Hypocrea eichleriana* upon morphological examination and comparative analysis of its type specimen. It is characterized by perithecia immersed in a corticiaceous host, hyaline peridium and unitunicate cylindrical asci without a distinct apical apparatus, containing brown unicellular ascospores.

Key words—fungicolous, *Coniochaeta*, *Helminthosphaeria*, morphology, systematics

Introduction

Although non-lichenized perithecial ascomycetes exhibit few morphological traits useful for taxonomy, numerous genera have been described. Many of them are kept apart by differences hardly detectable by classical morphological methods, making recognitions of new genera using characters provided by such methods difficult. In addition, molecular data are increasingly used in recognition of species and genera, alone or in combination with morphological, ecological and physiological data. Currently it is therefore often difficult to describe new genera without molecular data, except when discriminant characters are clearly evident. Molecular phylogeny has shown that fungi with similar morphology are often not closely related. On the other hand, taxa founded on clear morphological differences are usually supported by molecular data, except for few studies showing that e.g. ascospore septation may not always be a good distinguishing characteristic on the generic level, as e.g. in *Mycosphaerella* and *Sphaerulina* (Crous & al. 2003). Thus, morphology is still a good and valid means for the description of new species and genera, particularly if the application of modern methods is restricted.

In a monographic study on European species of *Hypocrea*, the examination of the holotype specimen of *Hypocrea eichleriana* revealed a fungus that cannot be assigned to any genus hitherto described. It is described below.

Materials and methods

Morphological observations—A small part of the dry specimen was rehydrated overnight in water vapor in a TLC chamber, imbedded in Tissue-Tek O.C.T. Compound 4583 (Sakura Finetek Europe B.V., Zoeterwoude, The Netherlands) and sectioned at a thickness of 12 µm with a freezing microtome. A permanent preparation of the sections was made as described by Volkmann-Kohlmeyer & Kohlmeyer (1996).

Measurements are reported as maxima and minima in parentheses and the mean plus and minus the standard deviation of a number of measurements given in parentheses. Nomarski differential interference contrast (DIC) was used for observations and measurements. Photographs and measurements of continuous characters were made using the DS-U2 digital camera and the NIS-Elements D2.20 software (Nikon Optoteam, Vienna).

Taxonomic descriptions

Immersisphaeria **Jaklitsch gen. nov.**

MycoBank MB 510734

Perithecia solitaria, omnino immersa basidiomatibus Corticiacearum. Peridium hyalinum, pseudoparenchymatosum. Hamathecium paraphysium periphysiumque. Asci cylindrici, unitunicati, 8-spori, inamyloidei. Ascosporae uniseriatae, aseptatae, brunneae, rima germinativa praeditae.

Species typica: Immersisphaeria eichleriana (Bres.) Jaklitsch.

Perithecia solitary, entirely immersed in corticiaceous basidiomes; peridium hyaline, ostioles obtuse, periphyses and apically free paraphyses present, asci cylindrical, inamyloid, without a well-differentiated apical apparatus, containing eight, uniseriately arranged, unicellular, brown ascospores showing a germ slit.

Immersisphaeria eichleriana **(Bres.) Jaklitsch comb. nov.** **Fig. 1.**

MycoBank MB 510735

Basionym: *Hypocrea eichleriana* Bres., in Saccardo & Sydow, Syll. Fung. XVI: 586 (Feb 1902)

Perithecia (Fig. 1 b,c) (140-)147-185(-212) × (90-)120-180(-220) µm (n=20), globose, ellipsoidal to obpyriform, base rounded, solitary or gregarious, entirely immersed in the host tissue and visible on the surface of the host as dark brown to black circular dots (Fig. 1 a) (40-)45-73(-94) µm (n=30) diam due to brown and partly ejected ascospores. Peridium (Fig. 1 e) (15-)19-27(-31) µm (n=30) wide, well defined or indistinctly separated from surrounding host tissue, pseudoparenchymatous, of thin-walled, hyaline, angular cells (2.5-)5-14(-22) × (2-)3-6.5(-8.5) µm (n=30), oblong inside, more isodiametric outwards. Ostioles (20-)23-42(-53) µm long, (25-)28-42(-45) µm (n=10) wide at the apex,

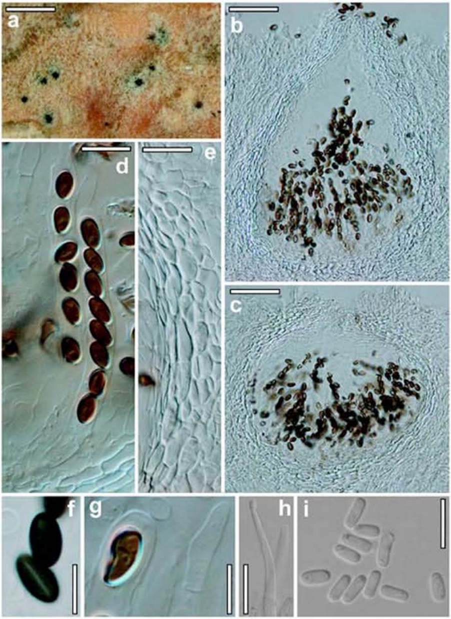

Fig. 1. *Immersisphaeria eichleriana*. a. host with dots on surface, b, c. perithecia, d. asci, e. peridium, f. ascospores, one with germ slit, g. apical cell of a paraphysis and apex of an ascus, h. phialide from host surface, i. conidia from host surface. b-e, and g in lactic acid, f, h and i in 3 % KOH.

Scale bars: a = 0.4 mm, b = 30 µm, c = 40 µm, d = 11 µm, e, h = 15 µm, f, g = 6 µm, i = 8 µm.

perforation 7-15(-17) µm (n=7) wide, conical, only rarely slightly (max 25 µm) projecting above the surface of the host. Hamathecium of periphyses emerging from upper part of the peridium, convergent in the centre of ostioles, and sparse, apically free, septate paraphyses, (FIG. 1 g) (2-)2.5-4(-4.5) µm (n=30) wide, regularly septate, narrowly rounded at the apex, inconspicuous, length only slightly exceeding asci. Asci (FIG. 1 d) (50-)57-68(-72) × (4.8-)5.2-6(-6.4) µm (n=25), with spore part (43-)45-55(-65) µm and stipe (5-)8-18(-23) µm long, cylindrical, unitunicate, wall wide when immature, containing 8 ascospores in uniseriate arrangement; apex slightly thickened or not, inamyloid, no apparatus seen; arising from a narrow hyaline pseudoparenchymatous subhymenium at the base of the perithecium; stipe cylindrical or sometimes thickened at base, no croziers seen. Ascospores (6-)6.5-7.7(-8.3) × (3.5-)3.7-4.3(-4.6) µm, l/w (1.5-) 1.6-1.9(-2.2) (n=50), 1-celled, medium brown, lighter in lactic acid, blackish brown in 3% KOH, ellipsoidal, smooth, eguttulate (according to the protologue with 2 hyaline guttules when fresh), straight to sigmoidal germ slit (nearly) along entire length seen in a small fraction of ascospores examined (FIG. 1 f).

Ecology and distribution: only known from the Polish type material on *Phanerochaete tuberculata*.

Holotype: Poland, Miedzyrzec, close to Siedlce, leg. B. Eichler, 1900, holotype of *Hypocrea eichleriana* Bres., ex herb. Bresadola (S, reg. nr. F10556), mentioned by Bresadola (1903).

Further characterization of the type specimen: The material consists of a single flat piece of hardwood 31 x 14 mm, covered by a corticiaceous basidiomycete determined as *Phanerochaete tuberculata* (P. Karst.) Parmasto; surface light ochre to cream-yellowish, pale ochraceous after reconstitution, compact, waxy, 0.15-0.25 mm thick, smooth except for some coarse shiny glassy orange protuberances; greatest part covered by white radiating mycelium of hyaline branched hyphae (2.5-)3-5(-7.2) µm (n=30) wide, bearing solitary subulate phialides (FIG. 1 h) (18-)24-35(-36) × (2.6-)3-4(-4.5) µm, l/w (4.6-)7-10, (2.2-) 2.8-3.8(-4) µm (n=14) wide at the base, producing hyaline cylindrical to oblong (rarely ellipsoidal) conidia (FIG. 1 i) (3-)4.2-6(-7) × (1.8-)1.9-2.3(-3.1) µm, l/w (1.6-)2-3(-3.6) (n=40).

Discussion

The genus *Hypocrea* Fr. is characterized by perithecia immersed in an internally light-coloured fleshy stroma and cylindrical asci containing 8 hyaline or green bicellular ascospores disarticulating while still in the ascus (Chaverri & Samuels 2003, Jaklitsch & al. 2006). Some mycologists of the 19th and early 20th centuries used this generic name in a wider sense, thereby disregarding ascospore morphology. Superficially, *H. eichleriana* has many things in common with *Hypocrea* but was erected on fundamental misinterpretations. First, the "stroma" is a corticiaceous host, i.e. the fungus is non-stromatic. Secondly, the ascospores are brown and aseptate; thirdly, perithecia contain apically free paraphyses not found in *Hypocrea*, where the hamathecium is confined to periphyses.

The combination of characteristics exhibited by this fungus is unique, in particular the combination of a hyaline perithecial wall with brown ascospores in persistent cylindrical asci, and the fungicolous habit.

Hyaline peridia are found in the *Hypocreales* and *Phyllachorales*. Many representatives of the former share the fungicolous habit with *Immersisphaeria*, but ascospores are light-coloured and no apically free paraphyses are known in this order. *Phyllachorales* with light coloured perithecial walls on the other hand have their perithecia immersed in plant tissue, often within stromata, are usually biotrophic, and ascospores are light-coloured with few exceptions like e.g. in the brown-spored *Sphaerodothis* (Sacc. & P. Syd.) Shear (Arx & Müller 1954).

Immersisphaeria shares the fungicolous habit with species of the genus *Helminthosphaeria* Fuckel. However, the latter differs by brown perithecial walls, dark setae on perithecial apices, germ pores in uni- to bicellular brown ascospores and brown 2- to several celled conidia of presumed anamorphs. Also species of *Phaeotrichosphaeria* Sivan. may occur on aphyllophoraceous basidiocarps, e.g. *P. hymenochaeticola* Sivan. (Sivanesan 1983). *Phaeotrichosphaeria* is characterized by superficial, black, setose perithecia, evanescent asci, 0-1 septate ascospores, and *Endophragmiella* anamorphs. Another perithecial fungus associated with aphyllophoralean fungi (*Steccherinum ochraceum*) was described as *Ceratostomella* sp. (Réblová 2006). Apart from small brown amerospores, perithecia of this species have long black beaks and a dark peridium.

Small brown amerospores are also found in *Camarops* P. Karst. (including the segregates *Camaropella* Lar. N. Vasiljeva and *Peridoxylon* Shear, see e.g. Vasilyeva & al. 2007) which differs by formation of stromata, dark peridium, ascospores with germ pores, and lignicolous habit (Nannfeldt 1972).

Unicellular brown ascospores with germ slits in cylindrical asci occur in *Coniochaeta* (Sacc.) Cooke, with lignicolous or fimicolous black setose perithecia, inamyloid asci and *Lecythophora* anamorphs (Checa & al. 1988, Weber & al. 2002), and the newly segregated genera *Coniolariella* D. García & al. with *Cladobotryum*-like anamorphs, and *Coniocessia* D. García & al. with *Nodulisporium*-like anamorphs (García & al. 2006) and particularly in genera of the *Xylariaceae*. Xylariaceous genera (Ju & Rogers 1996, Læssøe & Spooner 1994) differ from *Immersisphaeria* by the formation of stromata (with few exceptions), amyloid ascal rings (with few exceptions), and usually heavily melanized perithecial walls.

A connection of *Immersisphaeria* with a putative anamorph cannot be safely deduced from the fungus present on the surface of the host, because this is apparently hypocrealean, judging from the phialides and conidia present. However, phialidic anamorphs have been described for *Coniochaeta* and similar genera; therefore, a relationship of *Immersisphaeria* with one of these genera would be imaginable, if the hyphomycete on the host surface was connected with the immersed teleomorph, also in light of similar asci and ascospores.

No appropriate placement for *Immersisphaeria* has been found in the current outline of the *Ascomycota* (Eriksson 2006). It is therefore proposed to file this fungus as *Sordariomycetes* incertae sedis, until more information from freshly collected material may be available.

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MYCOTAXON

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Cladonia lutescens, a new lichen species from the Himalayas

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Abstract—A new lichen species, *Cladonia lutescens*, is described from the state Himachal Pradesh, India. It contains usnic and homosekikaic acids and presumably belongs to sect. *Cocciferae*.

Key words—*Lecanorales*, fruticose lichen

Introduction

In 2002 the author Ahti visited the National Botanical Research Institute, Lucknow, India, to study the large Indian collections of the lichen genus *Cladonia* deposited in the herbarium (LWG) of that institute. Some of the results of this survey, including a few new species, have been published (Ahti et al. 2002, Ahti & Upreti 2004) and more data will be published in a forthcoming book by Awasthi. Meanwhile, fieldwork by D.K. Upreti and others revealed the presence of one more unknown species, which is described below.

Cladonia lutescens Ahti, Upreti & Nayaka, **sp. nov.** **Fig. 1**
Mycobank # MB510477

Thallus primarius inconspicuous, minute squamulosus, infra mox sorediosus. Podetia 0.3–1.5 cm alta, valde gracilia, simplicia vel raro parce ramosa, lutescentia, initio ascyphosa, subsubulata, demum apice scyphis angustis, farinoso-sorediosa, basi parce corticata. Apothecia non visa sed primordia ascogonialia ochracea. Conidiomata ochracea vel nigrescentia, terminalia. Acidum usnicum et acidum homosekikaicum continens.

Etymology: Referring to the yellowish colour of the thallus.

Typus: INDIA, Himachal Pradesh, Kinnaur District, Chitkul forest area, 3000–4000 m, on bark, 04-11-2003, D.K. Upreti, R. Srivastava and P.S. Kunwar 03-002716 (LWG-holotype; H-isotype).

Primary thallus inconspicuous, squamulose, persistent, ascending, cream to yellowish grey, squamules 0.3–1.5 mm wide, 250–280 µm thick, rotund, margin smooth or incised, granular sorediate with age, soredia developing from below, upper cortex 20–30 µm thick, lower cortex absent.

Podetia clearly cream yellow to yellow, 0.35–1.5 cm tall, 0.2–0.8(–1) mm thick, unbranched to rarely sparsely branched or proliferating at tips, with closed axils, tapering towards the tips, apically blunt or widening to produce irregular, very shallow, closed scyphi; surface corticated at base up to 0.5–2 mm, otherwise ecorticate, farinosely sorediate; soredia 20–40 µm in diam.; small podetial squamules may be present at the base. ***Cortex*** 30–120 µm, medulla 10–30 µm, stereome 20–90 µm, central cavity 110–230 µm, necrotic tissue not melanotic.

Hymenial discs not seen but ascogonial primordia developed on margins of scyphi or escyphose tips, ochraceous to brownish, 0.08–0.2 mm in diam. *Conidiomata* ochraceous to black, terminal on the podetia, conidia not seen.

Chemistry: K+ yellow, C–, KC+ yellow, P–, UV–; usnic acid and homosekikaic acid present (TLC, solvent system A; Walker & James, 1980).

Distribution and ecology: *Cladonia lutescens* is a corticolous species found abundantly on coniferous (apparently *Pinus*) tree trunks at the type locality in Himachal Pradesh in the Himalayas at 3900–4000 m.

Additional specimen (paratype) examined: India, Himachal Pradesh, Kinnaur District, Chitkul forest area. 3000–4000 m, on bark, 04-11-2003, D.K. Upreti, R. Srivastava and P.S. Kunwar 032728 (LWG).

Remarks: *Cladonia lutescens* apparently belongs to the traditional section *Cocciferae*, which predominantly contains red-fruited species, but also includes several ochraceous-fruited members. One very similar species is *C. bacilliformis* (Nyl.) Glück, which is widespread on conifers in the boreal zone. However, it produces barbatic acid besides usnic acid, never homosekikaic acid. Its scyphi are also deeper and it seems to be more intensely yellow in colour than *C. lutescens*.

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Figure 1. Habit of *Cladonia lutescens* (holotype, bar = 0.5 cm)

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MYCOTAXON

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Taxonomic notes on two powdery mildews: *Phyllactinia chorisiae* and *Ovulariopsis wissadulae* (*Erysiphaceae*: *Phyllactinieae*)

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Abstract — The powdery mildew *Phyllactinia chorisiae* has been considered conspecific with *P. guttata*. A re-examination of the type material of *P. chorisiae* and another specimen showed that this fungus, unlike *P. guttata*, has dimorphic conidia and its anamorph does not belong to the genus *Ovulariopsis*, which is the typical anamorph for *Phyllactinia* species. This suggests that *P. chorisiae* is morphologically distinct from *P. guttata* and should no longer be accepted as a synonym. Re-evaluation of type material of *Oidiopsis wissadulae* revealed that it has monomorphic conidia (mostly lemon-shaped) and hemiendophytic mycelium, a combination of characters that clearly places this fungus in the genus *Ovulariopsis*. Emended descriptions of *P. chorisiae* and *Ovulariopsis wissadulae* are presented.

Key words — *Phyllactinioideae*, new combination

Introduction

The powdery mildew fungi belonging to the tribe *Phyllactinieae* (*Erysiphaceae*) contain three anamorphic genera: *Ovulariopsis* Pat. & Har., *Oidiopsis* Scalia, and *Streptopodium* R.Y. Zheng & G.Q. Chen. Known teleomorphs are the genera *Phyllactinia* Lév., *Leveillula* G. Arnaud and *Pleochaeta* Sacc. & Speg., respectively (Braun 1987, Braun et al. 2002). There is a fourth teleomorphic genus, *Queirozia* Viégas & Cardoso (Liberato et al. 2006). *Ovulariopis*, *Oidiopsis* and *Streptopodium* are distinguished according to their conidiophore origin and conidial shape. Many anamorphic states in this subfamily have been poorly described or even neglected. Recent scanning electron microscopy and molecular studies have led to significant changes in the taxonomy of the *Erysiphaceae*. The morphological characteristics of the anamorphs are now regarded as fundamental for the classification of the holomorph at the generic level, while teleomorph characters are regarded as more useful for delimiting taxa at the species level (Braun et al. 2002). As part of an ongoing study aimed at elucidating the status of some dubious powdery mildews species belonging to the *Phyllactinieae*, the type specimens of *Phyllactinia chorisiae* and *Oidiopsis wissadulae* were re-examined.

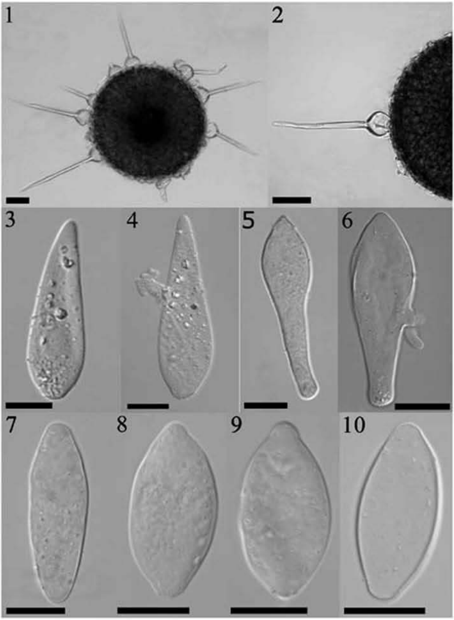
Material and methods

Two specimens of *P. chorisiae* and three of *O. wissadulae* were re-examined. In order to clarify whether the conidiophores were produced from external or internal mycelium, a critical feature for separating anamorphic genera in the *Phyllactinieae*, a leaf clearing and staining technique was used. Leaf pieces infected with powdery mildew were immersed in solution of 50 g chloral hydrate in 20 mL of distilled water and left in stoppered glass vials at room temperature, for 24 h. The leaf pieces were then mounted on microscope slides in 85% lactic acid with aniline blue 1 g/L (Liberato et al. 2005). Morphology of the fungus was examined on microscopic mounts in lactic acid. Biometric data were obtained only from the examination of turgid structures and only mature conidia (those unattached to conidiophores) were measured. Nomenclatural novelties were deposited in MycoBank (www.mycobank.org).

Results

The teleomorph state of *P. chorisiae* was present only on the specimen IACM 1453. Its ascomata have equatorial, rigid, hyaline, acicular appendages with bulbous swellings at the base, which is a key character for the genus *Phyllactinia*. The fact that the anamorph state has dimorphic conidia excludes it from the anamorphic genus *Ovulariopsis*. Unfortunately the author was unable to determine the conidiophore origin due to the small size of the available samples (specimens) and also because the abundant long trichomes of the host plant in the specimens IACM 1453 and 4214 did not allow the cover slip to sit properly on the lower leaf surface.

In the case of *Oidiopsis wissadulae*, despite the high density of trichomes on the lower leaf surface of *Wissadula* sp., the leaf clearing and staining technique enabled the visualization of conidiophores arising from external mycelium (IACM 2755 and 3660) and hyphae entering the leaf through the stomata, which is evidence of the presence of hemiendophytic mycelium, a characteristic almost exclusive to the tribe *Phyllactinieae*. It was also observed that *Oidiopsis wissadulae* has monomorphic conidia (mostly lemon-shaped). This combination of characters clearly indicates that this fungus belongs to the genus *Ovulariopsis*. A new combination for this fungus follows the emended description of *P. chorisiae* below.



Figs 1-6. *Phyllactinia chorisiae.* **Figs 1-2.** Ascomata and appendages (IACM 1453, bar = 50 µm). **Figs 3-4.** Primary conidia (IACM 1453, bar = 20 µm). **Figs 5-6.** Secondary conidia (IACM 4214 and 1453, bar = 20 µm). **Figs 7-10.** *Ovulariopsis wissadulae.* Conidia (bar = 20 µm) (Figs 7-9: IACM 2755, fig 10: IACM 4161).

Taxonomic description

Phyllactinia chorisiae Viégas, Bragantia 4: 26, 1944 (emended) **Figs. 1-6**

Mycelium hypophyllous. Mycelial appressoria coral-like. *Conidia* single, dimorphic: primary conidia lanceolate, apically pointed, 67.5–100 × 15–25 µm (l/w ratio 3–6.7); secondary conidia clavate, apex rounded or with a protusion, basally subtruncate ends, (45–)63–108 × 15–25 µm (l/w ratio 2–6.1), aseptate, hyaline, smooth, germ tube with coral-like appressorium.

Ascomata on leaves, scattered, embedded in hyphal masses, 142–256 µm in diameter. Peridial outer cells reddish brown. Appendages equatorial, rigid, straight, thick-walled, up to 201 µm long, acicular with a bulbous swelling at the base, hyaline, appendage base up to 38 µm wide. Penicillate cells present (cells apically digitately branched) on the ascoma. *Asci* not observed.

Notes: Viégas (1944) observed conidiophores up to 90–100 × 6–8 µm, appendage bases 30–40 × 18–20 µm, ascoma somewhat flattened at maturity and immature asci.

SPECIMENS EXAMINED – **Brazil,** Fazenda Santa Elisa, IAC, Campinas, São Paulo, on *Chorisia speciosa* A. St.-Hil., 12 Mar 1936, H.P. Krug (HOLOTYPE: IACM 1453); Campinas, São Paulo, on *Chorisia* sp., 12 June 1943, A.P. Viégas (IACM 4214).

Ovulariopsis wissadulae (Viégas) Liberato **comb. nov. (emended)** **Figs. 7-10**

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≡ *Oidiopsis wissadulae* Viégas Bragantia 4: 24, 1944.

Mycelium hypophyllous. Superficial *hyphae* penetrating the leaf through the stomata. *Conidiophores* produced from the external mycelium, hyaline, smooth. Conidia produced singly, monomorphic, most lemon-shaped, sometimes with a protrusion, not apically pointed, 37.5–63 × 17.5–28 µm, l/w ratio 1.7–3.6, aseptate, hyaline, smooth.

Teleomorph: not found.

Notes: It was possible to measure only a few conidiophores, 105–143 µm long, with foot-cells 8–13 µm wide. Viégas (1944) observed internal mycelium, superficial hyphae entering the leaf through the stomata, conidiophores simple or branched, 100–200 × 5–7 µm.

SPECIMENS EXAMINED – **Brazil,** Estação Experimental Tietê, Tietê, São Paulo, on Wissadula sp., 9 Feb 1939, A.S. Costa (HOLOTYPE: IACM 2755); Estação Experimental Alagoinha, Alagoinha, Paraíba, on Wissadula sp., March 1940, J. Deslandes (IACM 3660); Cidade Jardim, Belo Horizonte, Minas Gerais, on Wissadula amplissima (L.) R.E. Fr., 19 Jan 1943, A.P. Viégas (IACM 4161).

Discussion

Only five specimens of *P. chorisiae* are known and were collected in the states of Minas Gerais and São Paulo, Brazil, in the 1930's and 1940's (Viégas

1944). There is no additional report on the occurrence of this fungus (Amano 1986, Braun 1987, Mendes et al. 1998). Braun (1987) considered *P. chorisiae* conspecific with *Phyllactinia guttata* (Wallr.) Lév. However, whereas *P. guttata* has an anamorphic state belonging to *Ovulariopsis* (monomorphic conidia), the anamorphic state of *P. chorisiae* has dimorphic conidia and does not belong to the anamorphic genus *Ovulariopsis*. Instead it belongs in the anamorphic genus either *Streptopodium* or *Oidiopsis*. The status of the anamorph of *P. chorisiae* remains unknown, as the author was unable to determine the origin of its conidiophores (if from external or internal mycelium). It has been here presented that *P. chorisiae* is distinct morphologically from the *P. guttata* and should not be considered as a synonym.

Some published descriptions of *Phyllactinia* suggest that *Ovulariopsis* is not the only anamorph for *Phyllactinia*: *P. gorteri* Eicker (Eicker 1988) and *P. cassiae* G.J.M. Gorter & Eicker (Gorter & Eicker 1987) were described as having anamorphs with dimorphic conidia, which was also observed for *P. caricaefolia* Viégas (Liberato et al. 2004).

Eight specimens of *O. wissadulae* are known and were collected in the states of São Paulo and Paraíba, Brazil, in the 1930's and 1940's (Viégas 1944). There is no additional report on the occurrence of this fungus (Amano 1986, Braun 1987, Mendes et al. 1998). Its conidia are lemon-shaped, an uncommon shape for powdery mildew conidia and which has also been reported for *Queirozia turbinata* Viégas & Cardoso (Liberato et al. 2006).

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MYCOTAXON

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Catatrama costaricensis (*Agaricales*): a strange lepiotoid fungus is found in South America

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Abstract—*Catatrama costaricensis*, an interesting agaric with a lepiotoid appearance but strongly echinulate basidiospores and bilateral hymenophoral trama, is reported for the first time from Brazil. Description, discussion, illustrations and scanning electron microscopy (SEM) of the basidiospores are provided.

Key words—*Basidiomycota*, *Agaricomycetidae*, Neotropics, taxonomy

Introduction

During a survey of *Agaricaceae* sensu Singer (1986) in the Atlantic Forest of Pernambuco State, in Northeast Brazil, an interesting lepiotoid fungus was collected on rotten wood. The sub-free lamellae and the microscopic features (e.g. strongly echinulate inamyloid basidiospores and bilateral hymenophoral trama) indicated this agaric as belonging to the genus *Catatrama* Franco-Mol., originally placed in *Tricholomataceae* R. Heim ex Pouzar close to *Ripartitella* Singer (Franco-Molano 1991), a position followed by Hawksworth et al. (1995) and Kirk et al. (2001).

Material and methods

The basidioma was collected in the Ecological Reserve of Dois Irmãos, an Atlantic Forest fragment in the municipality of Recife (7°55'43" – 08°09'17" S and 34°52'05" – 35°00'59" W), Pernambuco State, Northeast Brazil (SECTMA 2001). Measurements of microscopic structures were made in 5% KOH and line drawings with the aid of a camera lucida.

Material for scanning electron microscope (SEM) was prepared following Franco-Molano (1993) and Wartchow et al. (2007)

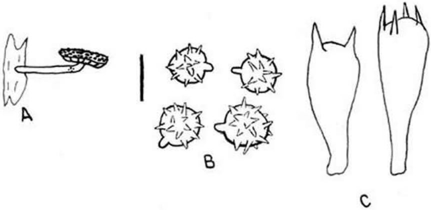

Figure 1: A-C. *Catatrama costaricensis*. A. Habit. B. Basidiospores. C. Basidia. Scale bar: A = 10 mm; B, C = 8 µm.

The specimen is deposited at the Herbarium of the Department of Mycology of the "Universidade Federal de Pernambuco" (URM).

Taxonomy

Catatrama costaricensis Franco-Mol., Mycologia 83: 501. 1991. FIGS. 1-2

Pileus 11 mm diam., plane to slightly convex, with large, verrucose, brownish scales on a cream colored surface; margin of pileus entire, not sulcate. **Lamellae** sub-free, cream colored, crowded, membranous. **Stipe** 16 × 1.5 mm, central, cylindrical recurved, cream color, slightly fibrillose, with remnants of veil near the apex forming an annular belt.

Basidiospores 5–8 µm, average 6.8 µm, symmetrically globose or nearly so, hyaline, inamyloid, cyanophilic, strongly ornamented with conical spines c. 1 µm high, thin-walled, no germ pore. **Basidia** (22.5–)27.5–36 × (6–)7.5–10 µm, clavate, 2 or 4 sterigmata. **Pleurocystidia** and **cheilocystidia** absent. **Hymenophoral trama** bilateral from a central mediostratum. **Pileipellis** a cutis of elongate hyphae with terminal elements 32.5–97.5 × 7.5–21 µm (few elements up to 120 µm long), cylindrical, few inflated-clavate or ovoid, hyaline, moderately thick-walled. **Clamp-connections** present in all tissues.

Habitat: Solitary, on rotten wood in a tropical forest.

Material examined: BRAZIL. Pernambuco: Recife, Ecological Reserve of Dois Irmãos, 22/VII/2003, *J. Putzke & F. Wartchow s.n.* (URM 78654).

Remarks: When Franco-Molano (1991) described *Catatrama*, she did not place it in *Amanitaceae* R. Heim ex Pouzar, mainly because of the cyanophilic

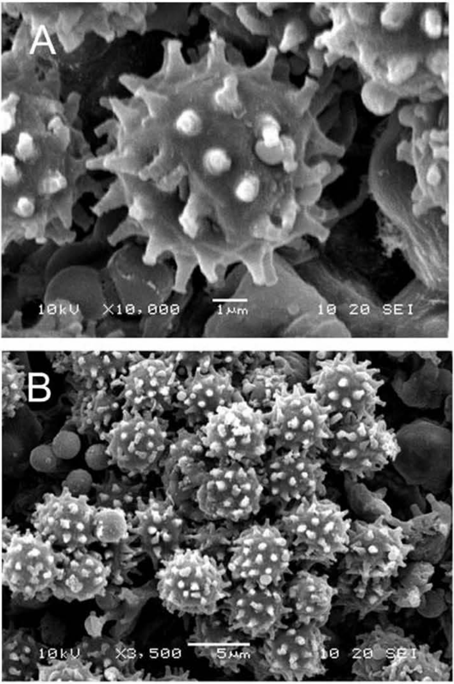

Figure 2: *Catatrama costaricensis*. A-B. Scanning electron microscopy (SEM), basidiospores (Photo by Rafael Padilha, LIKA).

basidiospores and the absence of acrophysalides, which are clavate terminal cells on a diffuse system of narrow, branched and longitudinal hyphae in the stipe trama (Bas 1969). More recently, molecular studies placed *Limacella* Earle and *Catatrama* in the same clade, but the latter was equivocally referred with viscid pileus and amyloid basidiospores (Moncalvo et al. 2002: 377).

A related genus is *Rhodotus* Maire, with bilateral hymenophoral trama and strongly echinulate globose basidiospores, but gelatinous pileus surface and context, and pink spore print (Maire 1924). Later, Pouchet (1932) reported hymenial cystidia in *R. palmatus* (Bull.: Fr.) Maire, and SEM images revealed a slightly adaxial applanation of its basidiospores and verrucose, mostly 0.5–0.7 µm high, projections of the spore wall (Pegler & Young 1975), shorter than the spines of *Catatrama*.

Ripartites P. Karst., another genus with ornamented basidiospores, has decurrent lamellae, regular hymenophoral trama and ellipsoid, ovoid to subglobose pale brownish basidiospores, without pileal squamules (Métrod 1946, Huijsman 1960, Pegler & Young 1974). Some species of *Oudemansiella* Speg. [e.g., *O. steffenii* (Rick) Singer and *O. macracantha* Singer] have also globose and echinulate basidiospores, but gelatinous context and regular hymenophoral trama (Clémençon 1979, Pegler & Young 1986).

The lignicolous habit observed in the Brazilian collection is reported for the first time for *C. costaricensis*. Other uncommon features of this specimen are the small size of the basidioma and the scarcity of squamules on the stipe surface, which form an annular belt in its upper part. On the other hand, the microscopical features agree with the description of the material collected in Costa Rica (Franco-Molano 1991) and India (Vrinda et al. 2000). The genus *Catatrama* is therefore reported for the first time in South America.

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Goidanichiella cylindrospora sp. nov. from Connecticut, USA

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Abstract — A new hyphomycete species, *Goidanichiella cylindrospora* sp. nov., is described and illustrated following the examination of a specimen collected from Connecticut, USA. The history of the genus is reviewed and a comparison is made of the new taxon to other species of *Goidanichiella*. *G. cylindrospora* develops uniseriate heads and cylindrical to fusiform conidia, 4.3 – 6.3 × 1.5 – 1.9 µm.

Key Words — mitosporic fungi, taxonomy, type

Introduction

Two species of *Goidanichiella* G.L. Barron ex W. Gams are now known following the validation of the genus (Gams et al. 1990, Hyde et al. 2003). A specimen of *Goidanichiella* was collected on bark in early winter of 2006 from a mixed forest at the Connecticut Agricultural Experiment Station, Valley Laboratory in Windsor, Connecticut. The fungus differs in conidial size and shape from previously described species of *Goidanichiella*. A new species of *Goidanichiella* is described and illustrated.

Materials and methods

Conidiophores and conidia of the fungus were mounted in lacto-fuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid) (Carmichael 1955). Microscopic observations were made using Nomarski differential interference contrast optics. Attempts were made to isolate the fungus on Malt Extract Agar (MEA), containing 15 g malt extract broth (Difco), 15 g agar (Oxoid), 0.075 g

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chloramphenicol (Fisher), 750 mL distilled water, 0.75 mL trace metal solution [1.0 g $\mathrm{ZnSO_4 \cdot 7H_2O}$, 0.5 g $\mathrm{CuSO_4 \cdot 5H_2O}$, 100 mL distilled water], 1 mL 1N NaOH; and Corn Meal Agar (CMA), containing 12.75 g corn meal agar (Difco), 0.075 g chloramphenicol (Fisher), 750 mL distilled water. The plates were incubated at 25°C for four weeks.

Results

Goidanichiella cylindrospora D.W. Li & G.H. Zhao **sp. nov.** Figures 1–5

MycoBank MB 510597

Conidiophora, macronemata, erecta, simplicia vel ramosa, brunnea, 133–223 µm longa et 8.6–11.5 µm crassa. Vesicula globosa, subglobosa vel pyriforma, 18.1 – 25.3 ×16.1 – 21.8 µm. Phialidae ellipsoidae, ovatae, vel ampulliformae, pallide brunnae vel brunnae, 5.5 – 6.9 × 3.2 – 4.1 µm, collulo conspicuo praeditae. Conidia cylindrica, clavata vel fusiforma, 4.3 – 6.3 × 1.5 – 1.9 µm, longa/crassa 2.4 – 4.8, in massam mucosam. Teleomorphosis ignota.

Holotypus BPI 877773 per De-Wei Li ex Quercus sp. (?) latrare, ad Windsor, Connecticut, USA de 12 December 2006.

Etymology: Referring to the cylindrical morphology of the conidia.

Conidiophores determinate, macronematous, solitary or in groups of 2-4, erect, simple or branched, straight or undulating, smooth, 3–7 (–14) septate, dark brown, 133 – 223 µm long and 8.6 – 11.5µm wide, swollen at the apex and forming a fertile vesicle (Figs 1–2).

Vesicles globose to subglobose, occasionally pyriform or clavate, (14.9–) 18.1 – 25.3 (–27.6) (mean = 21.7 ± 3.6, n = 16) × (14–) 16.1 – 21.8 (–23.3) (mean = 18.97 ± 2.87) µm, covered completely by phialides (Figs 3–4). Phialides determinate, discrete, ellipsoidal or ovoid, occasionally ampulliform, unicellular, smooth, pale brown to brown, borne directly on the vesicle and forming a dense palisade layer, (4.8–) 5.5 – 6.9 (–7.6) (mean = 6.2 ± 0.7, n = 30) × (2.5–) 3.2 – 4.1 (–4.4) (mean = 3.6 ± 0.4) µm, with conspicuous collarettes (Figs 3–4). Conidia unicellular, cylindrical, clavate, or fusiform, hyaline to pale brown, smooth, (3.9–) 4.3 – 6.3 (–8.5) (mean = 5.3 ± 1.0, n = 30) × (1.4–) 1.5 – 1.9 (–2.2) (mean = 1.7 ± 0.2) µm, ratio of length/width 2.4 – 4.8 (mean = 3.1), aggregating in slimy masses (Figure 5).

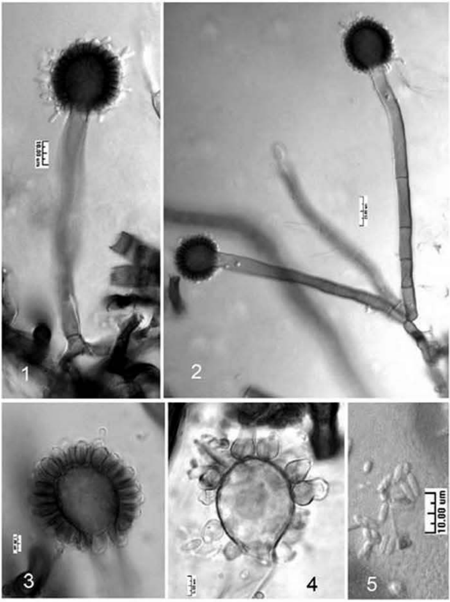
Teleomorph unknown.

Geographical distribution: Connecticut, USA.

Habitat: saprobic on bark of dead oak, *Quercus* sp. (?).

Specimen examined: UNITED STATES, Connecticut, Windsor, The Connecticut Agricultural Experiment Station, Valley Laboratory, 41°51′ 00″N, 72°39′ 30″W, on *Quercus* sp. (?) bark, 12 December 2006, De-Wei Li sp. nov., holotype (BPI 877773).

We were unable to isolate *G. cylindrospora* from the holotype collection despite several attempts using two culture media (MEA and CMA).



Figures 1-5. 1. Conidiophore, vesicle, phialides, and conidia. 2. Branched conidiophores, vesicles, phialides, and conidia. 3–4. Vesicle and phialides. 5. Conidia.

Scale bars: 1, 5 = 10 µm, 2 = 20 µm, 3–4 = 5 µm.

Discussion

The genus *Goidanichiella* was originally proposed as *Goidanichia* by Arnaud (1954) for *Goidanichia scopula* (Goid.) G. Arnaud (≡ *Scopularia scopula* Goid.)

(Barron 1968, Gams et al. 1990). However, Arnaud's *Goidanichia* was invalid because of the lack of a Latin diagnosis and illegitimate because the same name had been proposed earlier for a lichen-forming fungus, *Goidanichia* Tomas. & Cif. 1952 (Barron 1968). Although Arnaud wrote a replacement name, *Goidanichiella*, by hand on several reprints of his paper once he discovered the earlier homonym, Gams et al. (1990) regarded *Goidanichiella* as formally established by Barron in 1968.

Barron (1968) discussed *Goidanichiella* in relation to a fungus he isolated from soil in Ontario, Canada, that produced phialoconidia in slimy masses on pigmented *Aspergillus*-like conidiophores. He listed "*Goidanichiella*" *scopula* as type, provided a generic description, and noted that he had only once isolated "a *Goidanichiella* species" (which he did not formally describe). Barron noted that *Goidanichiella* was invalid without a Latin diagnosis but did not validate either genus or type species name. Matsushima (1975) likewise failed to validate the genus when proposing *Goidanichiella sphaerospora* Matsush. based on a culture from forest soil in Hokkaido, Japan.

When they validated the genus *Goidanichiella* G.L. Barron ex W. Gams, Gams et al. (1990) noted that *Goidanichiella scopula* was invalid and could not serve as type for a newly validated *Goidanichiella* because it was possibly synonymous with *Haplographium catenatum* (Preuss) Hol.-Jech. Because loss of the holotype of *Goidanichiella sphaerospora* prevented validation of that species name, Gams et al. elected to typify the genus with Barron's (1968) "*Goidanichiella* sp.," which they formally described as *G. barronii* W. Gams et al. They considered *Goidanichiella* to be monospecific at the time of validation.

Hyde et al. (2002) later described *G. fusiformis* (as '*fusiforma*') K.D. Hyde et al. from palm fronds in Thailand.

Our species has uniseriate vesicles and cylindrical conidia, 4.3 – 6.3 × 1.5 – 1.9 µm, which differ from currently recognized species of *Goidanichiella*. Conidia of *G. barronii* are globose and 3–4 × 2–3 µm, or allantoid and 4–6.5 × 1.4–2 µm (Gams et al. 1990), while conidia of *G. fusiformis* are fusiform and larger, 9–14 × 2–3 µm (Hyde et al. 2002). *Goidanichiella barronii* is biseriate, whereas *G. fusiformis* is uniseriate. Pending neotypification, *G. sphaerospora* may represent a fourth species (Gams et al. 1990) with biseriate vesicles, much broader conidiophores (12–20 µm) and subglobose to obovate conidia (2.5 µm in diam. or 3 × 4 µm) (Matsushima 1975).

Goidanichiella barronii is phylogenetically closely related to *Custingophora* Stolk et al. and *Knoxdaviesia* M.J. Wingf. et al. (Viljoen et al. 1999, Jacobs et al. 2005). However, *Goidanichiella* differs from the two genera by its aspergilloid conidiophores that lack subapical or apical proliferations. *Goidanichiella* differs from *Gliocephalis* Matruchot (Matruchot 1899) by its septate, dematiaceous conidiophore stipes (Jacobs et al. 2005).

Key to species of *Goidanichiella*

1. Metulae present, conidia bimorphic .... *G. barronii*
   Metulae absent, conidia monomorphic 2

2. Conidia, relatively large, fusiform, 9–14 × 2–3 µm .... *G. fusiformis*
   Conidia smaller, cylindrical or clavate, 4.3–6.3 × 1.5–1.9 µm ... *G. cylindrospora*

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MYCOTAXON

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Studies on *Tulostoma* (*Gasteromycetes*) in the Neotropics. Some Brazilian species

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Abstract — This taxonomical research was made in several habitats of three states of northeastern Brazil. Seven species of *Tulostoma* were found: *T. cretaceum, T. cyclophorum, T. exasperatum, T. excentricum, T. fimbriatum, T. obesum* and *T. xerophilum*. Five of these species constitute new records from Brazil and six are reported for the first time from the neotropics.

Key words — *Agaricomycetidae*, taxonomy, biodiversity

Introduction

The Neotropical zone is a terrestrial ecoregion that comprises the New World that stretches southward from the Tropic of Cancer and includes Southern Mexico, Central and most of South America, and the West Indies. This region has more species than the paleotropics (Prance 1994) and the mycota is estimated at approximately 550 000 fungi species (Thiers 2003).

Tulostoma possesses about twenty-five neotropical species reported by Spegazzini (1927), Coker & Couch (1928), Dennis (1970), Nieves-Rivera et al. (1998), Daga et al. (2001), Baseia & Milanez (2002) and Calonge & Carranza (2003). This genus is the most representative of the family *Tulostomataceae*, comprising 79 species worldwide that are predominantly found in dry and sandy areas (Kirk et al. 2001). Studies on *Tulostoma* are scarce in Brazil, and currently only about ten valid species have been recorded. Our principal goal is to expand the knowledge about *Tulostoma* diversity in the Neotropics.

Materials and methods

Collecting expeditions were conducted during the rainy seasons of 1997 to 2003. Most specimens studied are preserved in the herbarium UFRN, Dept. of

Bot., Ecologia e Zoologia, Centro de Biociencias, Univ. Federal de Rio Grande do Norte, Natal, Brazil. The areas investigated represent Atlantic rainforest and semi arid regions enclosed in the States of Rio Grande do Norte, Paraíba and Pernambuco (Northeastern Brazil). Macro and microscopic characters were determined according to Wright (1987). Scanning Electron Microscopy (SEM) was obtained with a Phillips XL 30. Spores were mounted directly on aluminium studs coated with a layer of gold and processed in a standard sputter. Fruitbody colors were coded according to Kornerup & Wanscher (1978), with the indication "KW", bracketed in the text, and simultaneously described. They were dried slowly and placed in containers with naphthalene.

Results

Tulostoma cretaceum Long, Mycologia 36: 321-322 (1944). Fig. 1

Spore sac subglobose, 8 x 12 mm. Exoperidium persistent, hyphal, granulose surface, light brown (KW-6D5). Endoperidium smooth, membranous, yellowish white (KW-4A2). Mouth, initially fibrillose, soon lacerate. Socket conspicuous, membranous. Gleba dark brown (KW-6F6). Stem light brown (KW-6D6), 50-65 mm, woody, cylindrical, fibrillose, longitudinally striate, tapering towards the base. Spores globose to ovoid, smooth, 3-6 µm diam. Capillitium subhyaline, branched, thick walled, 2.5-6 µm diam.

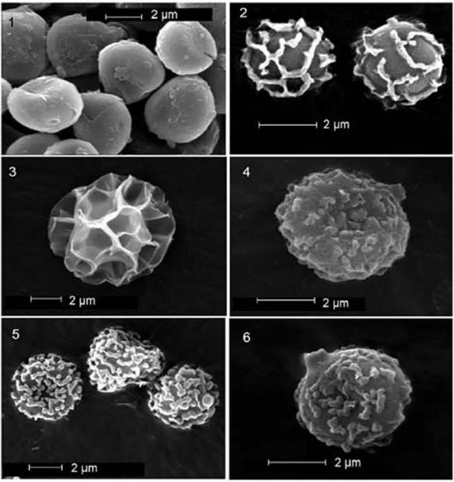
Habitat: growing solitary on sandy soil of Atlantic rainforest.

> Material examined: Brazil. Pernambuco, Recife, Horto Florestal Dois Irmãos, 18/VI/2001, (UFRN-Fungos 213); United States. Albuquerque, 30/VII/1962, det. C. R. Benjamin (URM 29864, 29879, 29889, 29931).

Comments: *Tulostoma cretaceum* is recognized by the presence of a hyphal exoperidium, fibrillose mouth that later becomes lacerate and the smooth spores. The type normally shows a volviform thickening at the base of the stem and mycelial cords, so as a capillitium showing short branches and scant septa (Wright 1987) which have not been observed here. According to Moreno et al. (1995), this species is close to *T. meristostoma* Long, *T. leiospermum* Speg., *T. leiosporum* R.E. Fr. and *T. puncticulosum* Long & S. Ahmad, which belong to a species complex that needs further study. Its distribution is known from the U.S.A. (Long 1944, Wright 1987), Mexico (Moreno et al. 1995, Esqueda et al. 2004) to Argentina (Wright 1987). This is the first record from neotropics.

Tulostoma cyclophorum Lloyd, The Tylostomeae: 25 (1906) Fig. 2

Spore sac globose-depressed, 7 x 10 mm. Exoperidium persistent, membranous, smooth surface, brown (KW-5E4). Endoperidium with tomentose surface and, presence of mycosclereids, dark blond (KW-5D4). Mouth fibrillose, mammose, somewhat prominent. Socket conspicuous, separated from the stem. Gleba dark



Figs. 1-6. 1: *Tulostoma cretaceum*: spores as seen under SEM. Fig. 2: *Tulostoma cyclophorum*: spores as seen under SEM. Fig. 3: *Tulostoma exasperatum*: spores as seen under SEM. Fig. 4: *Tulostoma excentricum*: spores as seen under SEM. Fig. 5 *Tulostoma fimbriatum*: spores as seen under SEM. Fig. 6: *Tulostoma xerophilum*: spores as seen under SEM.

brown (KW-6F5). Stem dark brown (KW-6F5), 12-18 mm, woody, cylindrical, mycelial bulb present at the base. Spores globose to subglobose, reticulate with anastomosed crests, 3.2-4.5 µm diam. Capillitium slightly yellowish, branched, septate, 2-8 µm diam.

Habitat: growing in groups on humose soil of Atlantic rainforest.

> Material examined: Brazil. Rio Grande do Norte, Baía Formosa, Reserva Particular do Patrimônio Natural, Mata Estrela, 28/VII/2002, (UFRN-Fungos 214); Rio Grande do Sul, São Leopoldo, 1930, det. J. E. Wright (PACA 15069), Santa Maria: 1935, det. J. E. Wright (PACA 15087); Uruguay, 1934, det. Herter (PACA 94547).

Comments: Our specimens are characterized by the membranous exoperidium, fibrillose and prominent mouth, reticulate spores and the presence of mycosclereids in the endoperidium. According to Wright (1987) this taxon has several synonyms and from Brazil was incorrectly identified by Batista & Vital (1955) as *T. recifese* Bat. & A.F. Vital, *T. heroicum* Bat. & A.F. Vital and *T. nanicum* Bat. & A.F. Vital. Its distribution is known from the U.S.A. (Long 1947, Wright 1987); Brazil (Rick 1961, Wright 1987); Israel (Binyamini & Wright 1986); Argentina, Paraguay, Uruguay, South Africa, Israel, France, and Australia (Wright 1987); Spain (Moreno et al. 1990); and Mexico (Esqueda et al. 2004). This is the first record from the neotropics.

Tulostoma exasperatum Mont. Ann. Sc. Nat., Bot., ser. II, 8: 362 (1837) Fig. 3

Spore sac globose-depressed, 15 x 16 mm. Exoperidium formed by a dense layer of conical warts, deciduous in age, dark brown (KW-6F4). Endoperidium having a reticulate appearance from the polygonal scars left by the exoperidium when the warts fall off, light brown (KW-5D4). Mouth valvate, slightly raised when open. Socket inevident. Gleba brown (KW-5F5). Stem dark brown (KW-6F4), up to 40 mm, woody, cylindrical, scales imbricates which are often deciduous. Spores globose, reticulate, 4-8 µm diam. Capillitium hyaline, branched, septate, 2-6 µm diam.

Habitat: Solitary growing on decaying wood in Atlantic rainforest.

Material examined: Brazil. Paraíba, Mamanguape, Reserva Guaribas, 04/VI/2003, (UFRN-Fungos 215); Rio Grande do Sul, São Leopoldo, 1932, det. J.E. Wright (PACA 15070, 15073, 15075).

Comments: *T. exasperatum* is easily identified for its conspicuous exoperidium formed by a dense layer of pyramidal, conic or spiny tubercles, reticulate spores and lignicolous habitat (Wright 1987). This species has spores similar to *T. exasperatosporum* J.E. Wright, differing in its membranous exoperidium and tubular mouth. *Tulostoma exasperatum* has been recorded from Cuba (Saccardo 1888, White 1901), Argentina (Spegazzini 1927), India (Long & Ahmad 1947), Venezuela (Dennis 1970), the U.S.A. (Long 1947), Rwanda, Burundi (Demolin & Dring 1975), and Brazil (Lloyd 1906, Rick 1961, Bononi et al. 1984, Baseia & Milanez 2002, Baseia & Galvão 2002).

Tulostoma excentricum Long, Mycologia 36: 332-333 (1944). Fig. 4

Spore sac globose-depressed, 5-10 x 10-15 mm. Exoperidium deciduous, hyphal, with granulose surface, brownish orange (KW-5C4). Endoperidium smooth, yellowish white (KW-4A2). Mouth tubular, prominent. Socket conspicuous, segregated from the stipe. Gleba light brown (KW-6D5). Stem yellowish white (KW-4A2), 30 mm, woody, cylindrical, fragile, lightly scaly. Spores elliptic to irregular, rugose, 4-6 µm diam. Capillitium subhyaline, branched, septate, thick walled, 2.5-5.5 µm diam.

Habitat: Solitary growing on sandy soil of semi arid regions (called caatinga).

> Material examined: Brazil. Pernambuco, Serra Negra, Reserva Biológica de Serra Negra, 18/VI/2001, (UFRN-Fungos 216); United States, Albuquerque, 30/VII/1962, det. C.R. Benjamin (URM 29889).

Comments: This species is characterized by the tubular mouth, hyphal exoperidium and minutely verrucose spores. The studied materials agree with Wright´s (1987) description. There are few studies on *T. excentricum*, being recorded from the U.S.A. (Long 1944, Wright 1987), Asia (Wright 1987). This is the first record from neotropics.

Tulostoma fimbriatum Fr., Syst. Mycol. 3: 43 (1829). Fig. 5

Spore sac globose to subglobose, 10-15 x 10-20 mm. Exoperidium persistent, hyphal, granulose surface, sandy mixed, yellowish brown (KW-5E5). Endoperidium smooth, scars of sand grains visible, yellowish white (KW-4A2). Mouth tenuous fibrillose, discrete. Socket inconspicuous. Gleba light brown (KW-6D5). Stem yellowish brown (KW-5E5), 12-20 mm, woody, cylindrical. Spores globose, verrucose, 3.5-5.5 µm diam. Capillitium hyaline, branched, thick walled, 2.5-5.5 µm diam.

Habitat: Growing in groups on humose soil of Atlantic rainforest.

> Material examined: Brazil. Rio Grande do Norte, Baia Formosa, Reserva Particular do Patrimônio Natural, Mata Estrela, 28/VII/2002, (UFRN-Fungos 217).

Comments: *T. fimbriatum* is segregated by hyphal exoperidium, fibrillose mouth and verrucose spore ornamentation that appears sub-reticulate in SEM. This species exhibits several variable characters. The characteristics of the Brazilian specimens agree with those of Moreno et al. (1995), except by the spores in Moreno´s specimen are larger, up to 6 µm. According to Calonge (1996) this species is widespread in Europe and very common in Spain. *T. fimbriatum* has been recorded from Israel (Binyamini & Wright 1986), Spain (Calonge & Wright 1989, Calonge & Demoulin 1975), Mexico (Moreno et al. 1995, Esqueda et al. 2004), Canary Islands (Beltran-Tejera et al. 1998) and Argentina (Dios et al. 2004). This is the first record from the neotropical zone.

Tulostoma obesum Cooke & Ellis, Grevillea 6: 82, pl. 100, fig. 24 (1878)

= *T. boissieri* Kalchbr., Rev. Mycol. 3: 24, tab. XV, fig. 2 (1881).
= *T. barbeyanum* Henn., Bull. Herb. Boissier 1: 99 (1893).
= *T. ruhmerianum* Henn., Hedwigia 37: 288 (1898).
= *T. kansense* Peck ex V.S. White, Bull. Torrey Bot. Club 28: 430, tab. 32, figs. 7-9 (1901).
= *T. volvulatum* var. *elatum* Har. & Pat., Bull. Trimest. Soc. Mycol. France 26: 207, tab. IX, fig. 2 (1910).

= *T. giolianum* Bacc. in Chiovenda, Resultati scientifici della Missione Stefanini-Paoli nella Somalia Italiana, 1: 189 (1916).
= *T. volvulatum* var. *obesum* (Cooke & Ellis) J.E.Wright, Biblioth.. Mycol. 113: 212 (1987).

Spore sac globose-depressed, 15 x 20 mm. Exoperidium membranous, persistent, deciduous, smooth, light brown (KW-6D7). Endoperidium smooth, yellowish white (KW-4A2). Mouth circular smooth, soon lacerate. Socket conspicuous, forming a membrane around the base of the spore sac. Gleba brown (KW-6E8). Stem brown (KW-6E7), 68 mm, woody, cylindrical, rugose scaly. Spores globose to subglobose, frequently deformed, smooth, 3.7-5 µm diam. Capillitium subhyaline, branched, 2-4.5 µm diam.

Habitat: growing in groups on humose soil of Atlantic rainforest.

Material examined: Brazil. Paraíba, João Pessoa, Jardim Botânico de João Pessoa, 09/VII/1997, (UFRN-Fungos 219); India. Rohtak District., 30/VII/1962, det. C.R. Benjamin (URM 29920).

Comments: This taxon is characterized by the membranous exoperidium, circular mouth that soon becomes lacerate, and the perfectly smooth spores. The type material shows a volviform structure at the base of the stem, chocolate brown gleba and capillitium without septa (Altés et al. 1999). We only found remains of a rudimentary volva in our material. Until recently *T. volvulatum* I.G. Borshch. was classed as a smooth-spored species. However, Altés et al. (1999) were able to study the type material and realized that the spores were really warty and belonged to *T. giovanellae* Bres. Their study of the synonyms of all possible described materials corresponding to this taxon led the conclusion that the oldest valid name is *T. obesum* (Altés et al. 1999). *T. obesum* has been recorded from Africa, Asia, North America and Europe (Altés et al. 1999). This is the first record from neotropics.

Tulostoma xerophilum Long, Mycologia 38: 85-87 (1946). Fig. 6

Spore sac globose-depressed, 7 x 10 mm. Exoperidium persistent at the basal portion, membranous, with sand mixed, light brown (KW-6D6). Endoperidium smooth, yellowish white (KW-4A2). Mouth tubular to plane. Socket inconspicuous with a short membrane. Gleba brown (KW-6E8). Stem brown (KW-6E5), 40 mm, woody, cylindrical, scaly. Spores globose, slightly verrucose, 3.5-4.5 µm diam. Capillitium hyaline, branched, septate, 2.5-7.5 µm diam.

Habitat: found in groups from humose soil of Atlantic rain forest.

Material examined: Brazil. Pernambuco, Recife, Cabo de Santo Agostinho, Reserva Ecológica de Gurjaú, 25/IV/1998, (UFRN-Fungos 220); Beberibe, 25/V/1965, det. C. A. Batista (URM 47843).

Comments: This species is easily separated by following characters: membranous exoperidium, mouth slightly projected to plane, and spore ornamentation that is minutely verrucose. Our specimens and those of Eckblad (1983) have similar spore dimensions. *T. xerophilum* is known from India (Long & Ahmad 1947), Mexico (Esqueda et al. 2004) Spain (Calonge 1998) and the U.S.A. (Wright 1987). This is the first record from the neotropics.

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Fuscoporia (*Basidiomycota, Hymenochaetales*) in Southern Brazil

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Abstract — A morphological analysis of 35 species of *Phellinus* collected in southern Brazil resulted in the recognition of a group of nine species with a set of differentiating characters – presence of hymenial setae, incrusted generative hyphae, and hyaline, thin-walled, non-dextrinoid and acyanophilous basidiospores. These features define the genus *Fuscoporia*, and the nine species are accepted in this genus. Three new combinations are proposed.

Key words — *Basidiomycetes, Hymenochaetaceae*, taxonomy

Introduction

In a revision of the 35 species of *Phellinus* Quél. s.l. that occur in southern Brazil (States of Santa Catarina and Rio Grande do Sul) (Table 1), one group of species share a set of features that separate them from all others. Only some of these have been previously transferred to the genus *Fuscoporia* Murrill (Cunningham 1948, Wagner & Fischer 2002, Spirin et al. 2006).

Currently, the genus *Phellinus* is recognized by the occurrence of perennial basidiomata and dimitic hyphal system. These characters, however, have been repeatedly demonstrated as questionable, and intermediate taxa occur (Wagner & Fischer 2001).

The original concept, established by Quélet in 1886, however, was much wider and lumped together many species with very defined characters that could be better distributed in more homogeneous genera.

Apparently, Murrill (1907) did not accept the genus *Phellinus*, having proposed several new genera like *Fuscoporia*, *Fomitiporia* Murrill and

Table 1 — Poroid Hymenochaetales belonging to *Phellinus* sensu lato from southern Brazil (SC - Santa Catarina and RS - Rio Grande do Sul).

Species	SC	RS	Species	SC	RS
P. allardii (Bres.) S. Ahmad	X		*P. melanodermus* (Pat.) O. Fidalgo	X	
P. apiahynus (Speg.) Rajch. & J.E. Wright	X	X	*Phellinus nilgheriensis* (Mont.) G. Cunn.		X
P. bambusarum (Rick) M.J. Larsen	X		*P. portoricensis* (Overh.) O. Fidalgo		X
P. bambusinus (Pat.) Pat.		X	*P. pseudopunctatus* A. David et al.		X
P. calcitratus (Berk. & M.A. Curtis) Ryvarden		X	*P. pullus* (Mont. & Berk.) Ryvarden	X	
**P. callimorphus* (Lév.) Ryvarden	X		**P. punctatiformis* (Murrill) Ryvarden	X	X
P. cesatii (Bres.) Ryvarden	X		*P. punctatus* (Fr.) Pilát	X	X
**P. contiguus* (Pers.) Pat.		X	**P. rhabarbarinus* (Berk.) G. Cunn.	X	X
P. everhartii (Ellis & Galloway) A. Ames		X	*P. rimosus* (Berk.) Pilát		X
P. fastuosus (Lév.) S. Ahmad	X	X	*P. robustus* (P. Karst.) Bourdot & Galzin		X
**P. ferreus* (Pers.) Bourdout & Galzin	X	X	*P. spinescens* J.E. Wright & G. Coelho		X
P. ferrugineovelutinus (Henn.) Ryvarden		X	*P. tricolor* (Bres.) Kotl.		X
**P. ferruginosus* (Schrad.) Pat.		X	*P. tropicalis* M.J. Larsen & Lombard		X
**P. flavomarginatus* (Murrill) Ryvarden	X		*P. umbrinellus* (Bres.) S. Herrera & Bondartseva	X	X
**P. gilvus* (Schwein.) Pat.	X	X	*P. undulatus* (Murrill) Ryvarden	X	
P. glaucescens (Petch) Ryvarden	X		*P. vaninii* Ljub.		X
P. grenadensis (Murrill) Ryvarden	X	X	**P. wahlbergii* (Fr.) D.A. Reid	X	X
P. linteus (Berk. & M.A. Curtis) Teng	X				

*now accepted in *Fuscoporia* (see this paper)

Fomitiporella Murrill, among others, and some authors have accepted these genera (Fiasson & Niemelä 1984, Bondartseva et al. 1992, Fischer 1996, Dai 1999, Wagner & Fischer 2001, 2002).

The present study, which is part of a revision of *Phellinus* s.l. from southern Brazil, aimed to reevaluate the morphological features of species that exhibit a distinct set of characters in order to decide whether they should be transferred to *Fuscoporia*.

Material and methods

The present work was mainly based on authentic specimens preserved in the Herbaria FLOR, ICN, and PACA (Holmgren & Holmgren 1998), which were mentioned in Silveira & Guerrero (1991), Loguercio-Leite & Wright (1995), Coelho & Wright (1996), Gerber & Loguercio-Leite (1997, 2000), Gonçalves & Loguercio-Leite (2001), Groposo & Loguercio-Leite (2002), as well as in theses and other monographic works still unpublished (Sousa 1977, Loguercio-Leite 1990, Coelho 1994, Willerding 1994).

The characters obtained from the descriptions and/or verified in the preserved materials were:

- macroscopic: type of basidiome, pores/mm, and context color.
- microscopic: type and shape of setae, incrustations on generative hyphae, and basidiospores (shape, color, wall thickness, dextrinoid and cyanophilous reactions).

Three continuous characters – shapes (length/width ratio) of both setae and basidiospores, and pores/mm – were coded according to the gap weighting procedure, proposed by Thiele (1993), in order to avoid subjectivity.

Results and discussion

Out of the 37 species of *Phellinus* s.l. studied (Table 1), five species have already been segregated from *Phellinus* s.l. and transferred into *Fuscoporia* (*F. contigua*, *F. ferrea*, *F. ferruginosa*, *F. gilva*, and *F. wahlbergii*). Three additional species presented the typical features of the latter genus and are consequently transferred to *Fuscoporia* in the present work (*Phellinus callimorphus*, *P. flavomarginatus*, and *P. rhabarbarinus*). The genus *Fuscoporia* is well characterized by the presence of hymenial setae, incrusted generative hyphae, and hyaline, thin-walled, indextrinoid and acyanophilous basidiospores (Wagner & Fischer 2001). We accept the genus and propose three new combinations for additional species (*Phellinus callimorphus*, *P. flavomarginatus*, *P. rhabarbarinus*) that also show features characteristic of *Fuscoporia*. Among these nine *Fuscoporia* species (Table 2), four putative groups could be distinguished: (i) *F. contigua* and *F. ferruginosa*, which are the only species with tramal setae; (ii) *F. ferrea* and *F. punctatiformis*, which have cylindrical spores; (iii) *F. wahlbergii*, which has hymenial setae with both hooked and straight apexes; and (iv) the remaining taxa (*F. callimorpha*, *F. gilva*, *F. rhabarbarina* and *F. flavomarginata*), which form a residual group of morphologically similar species.

Fuscoporia callimorpha (Lév.) Groposo, C.L. Leite & Góes-Neto, **comb. nov.**
MYCOBANK MB 510730.
Basionym: *Polyporus callimorphus* Lév., Ann. Sci. Nat. Bot. sér. 3, 5:133, 1846.

Comments--Ryvarden & Johansen (1980) asserted that *Phellinus callimorphus* could be easily separated from *P. gilvus* by its narrower spores. In the analyzed material, both species presented ellipsoid spores. *Fuscoporia callimorpha* had spores measuring (3.2) 3.6-3.9 (4.3) x 2.2 µm, while the spores of *F. gilva* were 2.9-4.9 x 2.0-3.6 µm [Thiele orders 2 and 4, respectively]. In addition, our material showed differences in the hymenial setae – subulate in *F. callimorpha* and ventricose in *F. gilva*, as well as absence of tomentum in the former.

Specimens examined--**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina**, Campus Universitário, Loguercio-Leite & Furlani 90, 28.I.1988 (FLOR 10551); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 232, 26.VII.1988 (FLOR 10620); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 278, 4.VIII.1988 (FLOR 10644).

Fuscoporia contigua (Pers.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 73:4, 1948.

Comments--This is the only *Fuscoporia* in southern Brazil that exhibited large pores (2-3 pores/mm), order 0, according to Thiele's gap weighting method. This species, in addition to a fully resupinate basidiome and large pores, is also characterized by its long subulate hymenial setae, reaching up to 99 µm, and long tramal setae, up to 184 µm. *F. ferruginosa* is very similar in appearance, but has hymenial setae that are ventricose and smaller, and tramal setae that are shorter and wider. Unlike *F. ferruginosa*, *F. contigua* does not have distinct tube layers and crystals in the hymenophoral trama.

Specimens examined--**BRAZIL. RIO GRANDE DO SUL: Santa Maria**, Cerrito, P. Palotinos, Coelho, 13.IX.1993 (ICN 97698); **Santa Maria**, Caturrita, S. Aldorindo, Coelho, G. (ICN 97696); **Santa Maria**, Caturrita, S. Aldorindo, Coelho, 07.IV.1993 (ICN 97696).

Fuscoporia ferrea (Pers.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 73:7, 1948.

Comments--This species is very similar to *F. punctatiformis*, but it could be distinguished by the shorter, cylindrical basidiospores (order 7 – *F. ferrea*; order 8 – *F. punctatiformis*, according to Thiele's method) and the presence of distinct tube layers. *F. ferruginosa* is also similar to *F. ferrea* (Lowe 1966, Gilbertson 1979, Loguercio-Leite & Wright 1995, Dai 1999). Both species can be distinguished by their basidiospores shape, ellipsoid in *F. ferruginosa* and cylindrical in *F. ferrea*, as well as by the occurrence of tramal setae in *F. ferruginosa* and absence in *F. ferrea*. Descriptions and analyzed materials exhibited a certain variation among the two Brazilian States. The specimens from Rio Grande do Sul had crystals in the hymenophoral trama, ventricose cystidioles, and slightly wider setae than those from Santa Catarina. We are uncertain about any taxonomic significance of this variation.

Specimens examined—**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina**, Costa da Lagoa, Loguercio-Leite & Zanin, 25.V.1985 (FLOR 10133); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 270, 4.VIII.1988 (FLOR 10642). **RIO GRANDE DO SUL: Cambará do Sul**, Itaimbezinho, Silveira & Guerrero 243, 09.XII.1989 (ICN 80536); **Porto Alegre**, Belém Novo, Silveira, 30.VIII.1991 (ICN 80731).

Fuscoporia ferruginosa (Schrad.) Murrill, N. Amer. Flora 9(1): 5, 1907.

Comments--*Fuscoporia ferruginosa* is the designated type for the genus *Fuscoporia*. This species resembles *F. ferrea* and *F. contigua*, but it differs from the former by the presence of tramal setae and from the latter by ventricose hymenial setae, and shorter and wider tramal setae. Usually the specimens show distinct tube layers and crystals in the trama.

Specimens examined—**BRAZIL. RIO GRANDE DO SUL: Santa Maria**, Cerrito, P. Palotinos, Coelho, 13.IX.1993 (ICN 27718); **Santa Maria**, Cerrito, P. Palotinos, Coelho, 20.XII.1993 (ICN 97719); **Santa Maria**, Caturrita, S. Aldorindo, Coelho, 7.IV.1993 (ICN 97714).

Fuscoporia flavomarginata (Murrill) Groposo, C.L. Leite & Góes-Neto, **comb. nov.**
Mycobank MB 510731.
Basionym: *Fomitiporia flavomarginata* Murrill, N. Am. Flora 9:11, 1907.

Comments--Some authors (Ryvarden & Johansen 1980, Gilbertson & Ryvarden 1987) considered this name to be a synonym of *Phellinus ferrugineo-velutinus*. However, the latter species does not have incrusted generative hyphae. According to the description, this species is very similar to *F. gilva*, but it can be separated by the presence of distinct tube layers and the absence of tomentum. This was the only *Fuscoporia* species in southern Brazil that has at least some yellowish spores. Apparently, the color depends on the age of the spores. According to Dai (1999), the spores of *F. wahlbergii* may turn yellowish when aging in old tubes, but most of the spores in new tubes are distinctly hyaline.

Specimens examined--**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 190, 26.VII.1988 (FLOR 10597); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 193, 26.VII.1988 (FLOR 10600); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 199, 26.VII.1988 (FLOR 10604).

Fuscoporia gilva (Schwein.) T. Wagner & M. Fisch., Mycologia 94:1013, 2002.

Comments--*F. gilva* is one of the commonest species in southern Brazil and exhibits a wide morphological variation that should be carefully examined. This species is characterized by a pileus with thin tomentose or finely velutinate upper surface, abundant ventricose hymenial setae, and small ellipsoid spores [Thiele order 2].

Specimens examined--**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina,** Morro da Lagoa da Conceição, Gerber, Loguercio-Leite, Althoff & Góes-Neto 722, 28.VI.1995 (FLOR 11239); **Santo Amaro da Imperatriz,** Parque Estadual Serra do Tabuleiro, Groposo 67, 10.XI.2000 (FLOR 11930); **Paulo Lopes,** Parque Estadual Serra do Tabuleiro, Groposo 100, 22.II.2001 (FLOR 31312). **RIO GRANDE DO SUL: Derrubadas,** Parque Estadual do Turvo, Souza, 21.XI.1975 (ICN 6494); **Derrubadas,** Parque Estadual do Turvo, Souza, 23.XI.1975 (ICN 6501); **Cambará do Sul**, Itaimbezinho, Silveira & Guerrero

Table 2 — Synoptic comparison of selected characters among the species of *Fuscoporia* from southern Brazil.

Characters	*contigua*	*ferruginosa*	*ferrea*	*punctatiformis*	*wahlbergii*	*callimorpha*	*gilva*	*rhabarbarina*	*flavomarginata*
Basidiome	resupinate	resupinate	resupinate	resupinate	pileate	pileate	effuse-reflexed	pileate	effuse-reflexed
Pores/mm*	0	4	4	5	5	6	6	5	5
Context color	brown	brown	yellow	yellow	brown	brown	brown	yellow	brown
Shape of hymenial setae*	5	1	2	1	1	3	2	0	1
Apex of hymenial setae	straight	straight	straight	straight	straight & hooked	straight	straight	straight	straight
Tramal setae	present	present	absent	absent	absent	absent	absent	absent	absent
Incrusted hyphae	present	present	present	present	present	present	present	present	present
Spore wall thickness	thin	thin	thin	thin	thin	thin	thin	thin	thin
Spore pigmentation	absent	absent	absent	absent	absent	absent	absent	absent	present (yellow**)
Dextrinoid reaction	negative	negative	negative	negative	negative	negative	negative	negative	negative
Cyanophilous reaction	negative	negative	negative	negative	negative	negative	negative	negative	negative
Shape of spores*	2	2	6	7	1	4	2	2	2

* Continuous characters coded according to the gap weighting procedure (Thiele 1993).

Pores/mm: 1-5 (orders 0 to 3); 6-9 (orders 4 to 7); 10 (orders 8 and 9).

Hymenial setae: ventricose (orders 0 to 2); subulate (orders 3 to 7); lanceolate (orders 8 and 9).

Spores: globose (order 0); ellipsoid (orders 1 to 4); cylindrical (orders 5 to 8); allantoid (order 9).

** See explanation in the text.

75, 01.V.1988 (ICN 80453); **Cambará do Sul**, Itaimbezinho, Silveira & Guerrero 144, 19.XI.1989 (ICN 80458); **Cachoeirinha,** Reserva Biológica Tancredo Neves, Groposo 44, 20.II.1997 (PACA 85490).

Fuscoporia punctatiformis (Murrill) Zmitr., V. Malysheva & Spirin, Novosti Sistematiki Nizshikh Rastenii 40: 185, 2006.

Comments--This species is very similar to *F. ferrea*. It only differs in the size of the spores, which are smaller than those of *F. ferrea* (up to 6.0 x 2.5 µm versus up to 8.0 x 2.5 µm), and in the absence of distinct tube layers.

SPECIMENS EXAMINED—**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 62, 13.I.1988 (FLOR 10524); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 264, 04.VIII.1988 (FLOR 10640). **RIO GRANDE DO SUL: Santa Maria,** Itaara, Coelho, 28.XII.1991 (ICN 97744); **Santa Maria,** Itaara, Coelho, 28.XII.1991 (ICN 97745); **Santa Maria,** Cerrito, Coelho, 20.XII.1993 (ICN 97755).

Fuscoporia rhabarbarina (Berk.) Groposo, C.L. Leite & Góes-Neto, **comb. nov.**
MYCOBANK MB 510733.
Basionym: *Polyporus rhabarbarinus* Berk., Ann. Mag. Nat. Hist. 3:388, 1839.

Comments--This species is characterized by the yellow context, glabrous pileus in sulcate zones, and a distinct black crust. It differs from other close species, *F. callimorpha*, *F. gilva*, and *F. flavomarginata*, by the ventricose hymenial setae, the absence of tomentum, and the absence of distinct tube layers, respectively.

SPECIMENS EXAMINED—**BRAZIL. SANTA CATARINA: Florianópolis,** Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 186, 26.XII.1988 (FLOR 10929). **RIO GRANDE DO SUL: Cachoeirinha,** Reserva Biológica Tancredo Neves, Groposo 149, 11.VIII.1997 (PACA 85544).

Fuscoporia wahlbergii (Fr.) T. Wagner & M. Fisch., Mycol. Res. 105:780, 2001.

Comments--The main feature that characterizes this pileate species is the presence of hymenial setae with both straight and hooked apexes in the same basidiome. Other microscopic characters are similar to both *F. gilva* and *F. flavomarginata.*

SPECIMENS EXAMINED--**BRAZIL. SANTA CATARINA: Santo Amaro da Imperatriz,** Parque Estadual Serra do Tabuleiro, Groposo 11, 28.VII.2000 (FLOR 11793); **Santo Amaro da Imperatriz,** Parque Estadual Serra do Tabuleiro, De Toni, 11.VIII.1999 (FLOR 11761). **RIO GRANDE DO SUL: Santa Maria,** Coelho, 7.VI.1992 (ICN 97828); **Cambará do Sul,** Itaimbezinho, Silveira & Guerrero 30, 18.XI.1987 (ICN 80461); **Tenente Portela**, Parque Estadual do Turvo, Souza & Waechter 09.VII.1975 (ICN 6524).

A key for the identification of the species of *Fuscoporia* in southern Brazil is presented on the next page.

Key to *Fuscoporia* species in the southern Brazil

1 Basidiome completely resupinate	2
1 Basidiome effuse-reflexed to pileate	5
2 Tramal setae present, spores ellipsoid	3
2 Tramal setae absent, spores cylindrical	4
3 Subulate hymenial setae present, large pores (2-3 pores/mm)	*F. contigua*
3 Ventricose hymenial setae present, 6 pores/mm	*F. ferruginosa*
4 Tube distinctly layered	*F. ferrea*
4 Tube not layered	*F. punctatiformis*
5 Hooked and straight hymenial setae both present	*F. wahlbergii*
5 Only straight hymenial setae present	6
6 Hymenial setae subulate	*F. callimorpha*
6 Hymenial setae ventricose	7
7 Pileus with tomentose or finely velutinate upper surface	*F. gilva*
7 Pileus glabrous	8
8 Distinct tube layers present, context yellow	*F. rhabarbarina*
8 Distinct tube layers absent, context brown	*F. flavomarginata*

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MYCOTAXON

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Two new species of *Cirrenalia* from soil

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Abstract—Two new species of *Cirrenalia*, *C. pallescens* and *C. rhodospora* from soil in China, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, soil fungi, dematiaceous *Hyphomycetes*

Introduction

To date, sixteen species in the genus *Cirrenalia* Meyers & R. T. Moore have been proposed (Zhao & Liu 2005). Among them, seven species were described as marine fungi (Meyers & Moore 1960, Kohlmeyer 1966, 1968; Schmidt 1969, 1985; Raghu-Kumar et al. 1988, Kohlmeyer et al. 1997), the others were isolated from terrestrial environments (Sutton 1973, Rao & Reddy 1978, Matsushima 1980, 1996; Kirk 1981, Sugiyama 1981, Mel'nik 1988, Somrithipol et al. 2002, Zhao & Liu 2005). But all species in this genus often occur in wet habitats.

During an investigation of the soil dematiaceous *Hyphomycetes* in Hubei Province, two marginally helicosporous hyphomycete species were obtained from soil of a lotus pond and a rice field, respectively. Both of them match the characteristics of *Cirrenalia* morphologically but do not agree with any described taxon in the genus and are therefore described as new taxa.

Taxonomic description

Cirrenalia pallescens Y. L. Jiang & T. Y. Zhang, **sp. nov.** FIGURE 1
Mycobank MB 510826

Coloniae in PDA effusae, griseae. Mycelium partem superficiale et partem immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1-3 µm crassis reticulatis compositum.

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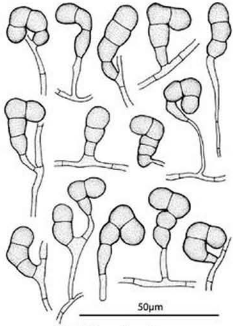

Fig. 1 *Cirrenalia pallescens*
Conidia and conidiophores on PDA (ex holotype)

Conidiophora simplicia vel obsoleta, non ramosa, recta vel flexuosa, pallide brunnea, septata, laevia, 2.5-50×1-4 μm. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, determinatae. Conidia acrogena, solitaria, sicca, laevia, helicoidea, in ¼-1 spiris convoluta, 12.5-25 μm diametro, pallide brunnea vel medio-brunnea, 2-6-transverse septata, pro maxima parte 2-3-transverse septata, constricta ad septa. Cellulis e basi ad terminem diametro increscentibus. Cellula apicalis 6-12.5×7-11 μm, subglobosa, cellula ad basim cylindrica, 4-11×3-10 μm.

Holotype: from soil of a lotus pond in Enshi, Hubei Province, China. Oct. 18. 2004, Y.L. Jiang, HSAUP046000.

Etymology: in reference to the light coloured conidia

Colonies on PDA effuse, grey. Mycelium partly superficial, partly immersed, hyphae branched, septate, hyaline, smooth, 1-3 μm wide. Conidiophores unbranched, straight or flexuous, pale brown, smooth, 2.5-50×1-4 μm. Conidiogenous cells monoblastic, integrated, terminal, determinate. Conidia acrogenous, solitary, dry, smooth, helicoid, mostly coiled ¼-1 times, 12.5-25 μm in diameter, pale brown to medium brown, 2-6 (commonly 2-3) transversely septate, distinctly constricted at the septa. Cells usually increasing in diameter from base to apex. Apical cells 6-12.5×7-11 μm, subglobose; basal cells cylindrical, 4-11×3-10 μm.

The species most similar to the new taxon is *C. basiminuta* Raghu. & Zainal (Raghu-Kumar et al. 1988). However, the size range of the apical and basal cells of the conidia of the latter (9-16×9-14 µm and 5-17×3-7 µm, respectively) is obviously bigger than that of the new fungus. Besides, the conidia of *C. basiminuta* mostly have 3-5 transverse septa, while those of the new taxon are commonly 2-3 septa.

Cirrenalia rhodospora Y. L. Jiang & T. Y. Zhang, **sp. nov.** **FIGURE 2**

Mycobank MB 510827

Coloniae in PDA effusae, granulosae, italicsgriseo-brunnea. Mycelium superficialibus vel in substrato immersis, hyphis ramosis, septatis, pallide brunneis, laevibus, 1-4.5 µm crassis reticulatis compositum. Conidiophora simplicia vel obsoleta, non ramosa, recta vel flexuosa, pallide brunnea, septata, laevia, 6-31×2-8 µm. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, determinatae. Conidia acrogena, solitaria, laevia, helicoidea, in ¼-1½ spiris convoluta, 16-44 µm diametro, rubro-brunnea, 2-8-transverse septata, pro maxima parte 3-4-septata, constricta ad septa. Cellula apicalis 8-19.5×10.5-16 µm, subglobosa vel ellipsoidea, cellula ad basim minuta, subhyalina, cylindrica, subglobosa, 5-16×4-14.5 µm.

Holotype: from soil of a rice field in Xiangfan, Hubei Province, China. Oct. 14. 2004, Y.L. Jiang, HSAUP046001.

Etymology: in reference to the dark reddish brown conidia

Colonies on PDA effuse, granular, dark greyish brown. Mycelium superficial or partly immersed, hyphae branched, septate, pale brown, smooth, 1-4.5 µm wide. Conidiophores simple, unbranched, straight or flexuous, pale brown,

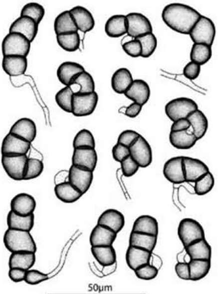

Fig. 2 *Cirrenalia rhodospora*
Conidia and conidiophores on PDA (ex holotype)

smooth, 6-31×2-8 µm. Conidiogenous cells monoblastic, integrated, terminal, determinate. Conidia acrogenous, solitary, smooth, helicoid, mostly coiled ¼-1½ times, 16-44 µm in diameter, dark reddish brown, 2-8 (commonly 3-4) transverse septa, constricted at septa. Most conidium cells irregularly increasing in diameter from base to apex, apical cells 8-19.5×10.5-16 µm, subglobose to ellipsoidal; the basal cells small, 5-16×4-14.5 µm, subhyaline, cylindrical or subglobose.

This new taxon differs from all described species in the genus in its small, subhyaline basal cells and degree of coiling.

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Podoscypha aculeata, a new record for the neotropics

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Abstract — 14 species of *Podoscypha* are being reported from Brazil. *P. aculeata* is a new record for the neotropics. Its description and a key to the Brazilian species of *Podoscypha* are presented.

Key words — stipitate stereoid fungi, Pernambuco

Introduction

Among the stipitate stereoid fungi, *Podoscypha* Pat. can be distinguished by its dimitic hyphal structure, presence of gloeocystidia, and inamyloid spores. *Cymatoderma* Jungh., another stipitate stereoid genus, also shares these features, but differs from *Podoscypha* by its usually larger and robust basidiomata, folded or ribbed hymenial surface, and by bearing clamp-connections at the septa of the undifferentiated hyphae that form the tomentum. *Podoscypha* is the type genus of *Podoscyphaceae* D.A. Reid and is widespread in planet, both in tropical and temperate zones (Reid 1965).

After the monograph of the stipitate stereoid fungi by Reid in 1965, few nomenclatural changes on *Podoscypha* were done (Ryvarden 1997, Boidin et al. 1998, Boidin & Gilles 2001) or new species were described (Douanla-Meli & Langer 2004), one of them in the neotropics (Welden 1993). In Brazil, *Podoscypha* has not been studied, but references to it can be found in the works of Burt (1920), Teixeira (1945), Reid (1965), Bononi (1984, 1992), Gibertoni & Cavalcanti (2003), and Gibertoni et al. (2006).

Results and discussion

Literature about stereoid fungi has been consulted, and macro- and microscopical analysis of collections of *Podoscypha* have been performed.

Fourteen species of *Podoscypha* are reported from Brazil and a key for their identification is provided. *P. aculeata* is a new record for the neotropics.

Podoscypha aculeata (Berk. & M.A. Curtis) Boidin, Rev. Mycol. 24: 210, 1959.

Basidiomata terrestrial, up to 10 radius x 13 high cm, consisted of numerous stipitate, flabelliform pilei, fused at the base of the stipes, forming a rosette-like basidioma. Abhymenial surface glabrous to velutine, white to cream when fresh, darkening to light to dark grey when dried. Margin distinctly fimbriate. Context thin. Hymenial surface smooth, white to cream when fresh, darkening to light to dark grey when dried. Hyphal structure dimitic; generative hyphae hyaline, thin-walled, clamped, 2.5-6.0 µm; skeletal hyphae hyaline, thick-walled, 2.5-5.0 µm. Basidia clavate, 10-20 x 4.-6.0 µm. Gloeocystidia hyaline, thin-walled, 30-50 x 2.5-3.5 µm. Basidiospores hyaline, subglobose to globose, gutullate and apiculate, smooth, thin-walled, 5.0-6.0 (7.0) x 4.0-5.0 µm.

Studied collections – BRAZIL. Pernambuco state, Recife Municipality: Campus of the Universidade Federal de Pernambuco, near the Cavouco Lake, 03.2007, on soil, col. unknown (URM78845).

Distribution: Known previously only from USA (Missouri and South Carolina) (Reid 1965).

Discussion: The studies about *P. aculeata* are based mostly on few collections undertaken by the end 19th century in the States of Missouri and South Carolina in USA (Burt 1920, Lentz 1955, Reid 1965). This seems to represent a rediscovery of the species, since it was no longer reported after those collections and those studies. *P. aculeata* is macroscopically close to *P. multizonata* (Berk. & Broome) Pat., but the latter has pileogloeocystidia in its abhymenial surface and is reported from Europe and Asia (Reid 1965). Of the species of *Podoscypha* registered in Brazil, *P. aculeata* may be distinguished by its typical basidiomata with merismatoid rosette of flabellate fused pilei, and tuberous base.

Key to the Brazilian species of *Podoscypha*

1. Hymenial metuloids present .... *P. mellissii* (Berk. ex Sacc.) Bres.
1'. Hymenial metuloids absent 2

2. Undifferentiated hairs or pileocystida present in the abhymenial surface 3
2'. Undifferentiated hairs or pileocystidia absent in the abhymenial surface 6

3. Pileocystidia present; basidiospores longer than 3.75 µm
and up to 2.5 µm wide 4
3'. Undifferentiated hairs present, basidiospores up to 3.75 µm long
and 2.5 µm wide 5

4. Basidiospores more than 5.5 µm, broadly ovate .... *P. ovalispora* D.A. Reid
4'. Basidiospores up to 5 µm, ovate to elliptical .... *P. petalodes* (Berk.) Boidin

5. Abhymenial surface with well developed tomentum;
basidiospores broadly elliptical or ovate .... *P. viridans* (Lloyd) D.A. Reid
5'. Abhymenial surface without well developed tomentum;
basidiospores broadly elliptical .... *P. replicata* (Lloyd) D.A. Reid

6. Basidiomata effuse-reflexed .... *P. semiresupinata* A.L. Welden
6'. Basidiomata stipitate 7

7. Merismatoid rosette of flabellate fused pilei, tuberous base .... *P. aculeata*
7'. Pilei different, flabellate to infundibuliform 8

8. Caulocystidia present 9
8'. Caulocystidia absent 10

9. Basidiospores 2.2-3.2 x 2-2.2 (-3) µm subglobose to broadly elliptical
.... *P. moelleri* (Bres. & Henn.) D.A. Reid
9'. Basidiospores 3.75-4.75 x (2.2-) 2.5-3.2 µm elliptical to broadly elliptical
or ovate .... *P. bubalina* D.A. Reid

10. Cuticle distinct, basidiospores narrowly elliptical
or subcylindric .... *P. cristata* (Berk. & M.A. Curtis) D.A. Reid
10'. Cuticle distinct, basidiospores narrowly to broadly elliptical,
oval or subglobose 11

11. Basidiospores (1.2-) 1.75-2.2 µm wide, narrowly to broadly elliptical
.... *P. fulvonitens* (Berk.) D.A. Reid
11'. Basidiospores wider than 2.2 µm 12

12. Basidiospores 2.2-3.2 µm wide, broadly elliptical
to elliptical or oval .... *P. ravenelii* (Berk. & M.A. Curtis) Pat.
12'. Basidiospores, in average, 3-4 µm wide, narrowly to broadly
elliptical, oval or subglobose 13

13. Basidiospores (4.75-) 5-7 (-7.2) x (3.0-) 3.5-4 (-4.2) µm,
elliptical to broadly elliptical .... *P. brasiliensis* D.A. Reid
13'. Basidiospores 3.75-5.75 x 3-4 (-4.2) µm, oval to very broadly
elliptical or subglobose .... *P. nitidula* (Berk.) Pat.

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MYCOTAXON

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Two new species of *Sporidesmium* from Yunnan, China

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Abstract — This paper provides descriptions and illustrations two new species in the hyphomycete genus *Sporidesmium* on dead branches from Yunnan Province, China. *S. fraxini-paxianae* and *S. fraxini-orni* occurred on the hosts *Fraxinus paxiana* and *Fraxinus ornus*, respectively.

Key words — hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on dead branches from tropical forest revealed two previously undescribed species of *Sporidesmium*. All specimens were collected from Banna locality in Yunnan Province of China.

Taxonomic descriptions

Sporidesmium fraxini-paxianae Jian Ma & X.G. Zhang, **sp. nov.**
MYCOBANK MB 510853 FIGURE 1

Coloniae effusae, fuscae, breve pilosae. Mycelium semper immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, levibus, 2-4 µm crassis compositum. Conidiophora singula, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, cylindrica, brunnea, 3-5-septata, 35-45 µm longa, 3.5-4.0 µm crassa. Conidia singula in apice conidiophori oriunda, recta vel leviter flexuosa, obclavata, ad apicem conica, ad basim conico-truncata, brunnea, sursum pallidiora, levia, 4-6-septata, 35-40 µm longa, 8-10 µm crassa, apicem versus ad 3-4 µm attenuata, basi 2-3 µm lata.

Holotype: On dead branches of *Fraxinus paxiana* Lingelsheim, tropical forest of Banna, Yunnan Province, China. Oct. 10. 2004, X. G. Zhang, HSAUP IV $_{0zxg}$0025 (isotype: HMAS 143708).

Etymology: in reference to the host, *Fraxinus paxiana*

Colonies effused, dark blackish brown, shortly hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-4 µm thick. Conidiophores arising singly,

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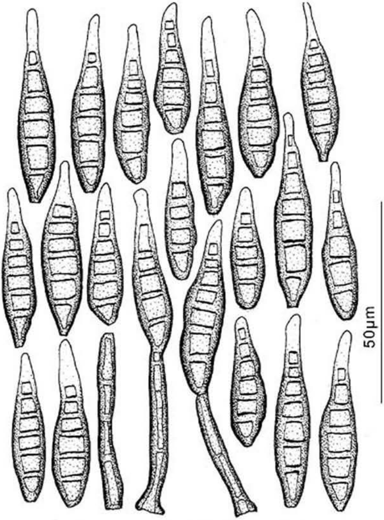

Fig. 1 Conidia and conidiophores of *S. fraxini-paxianae*

terminally and laterally on the hyphae, erect, simple, straight or slightly flexuous, cylindrical, brown, 3-5-septate, 35-45 µm long, 3.5-4.0 µm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly flexuous, obclavate, conical at the apex, conico-truncate at the base, brown, paler at the tip, smooth-walled, 4-6-septate, 35-40 µm long, 8-10 µm thick in the widest part, tapering to 3-4 µm at the apex, 2-3 µm wide at the base.

In conidial shape, this taxon resembles *S. penzigii* (Ellis 1961), *S. jasminicola* (Ellis 1958), *S. bambusinum* (Sharma 1980) and *S. parvum* (Ellis 1958). However, the conidia of the new taxon are smaller than those of *S. penzigii* (43-57 × 9-13 µm), *S. jasminicola* (53-70 × 10-11 µm) and *S. bambusinum* (33-48

× 9-112 µm), but larger than those of *S. parvum* (18-24 × 8-9 µm). In addition, conidia of this new taxon have fewer septa (4-6) than those of *S. penzigii* (7-11), *S. jasminicola* (6-8) and *S. bambusinum* (7-10). The conidia of *S. parvum* also have a large basal cell, as opposed to that of the new taxon.

Sporidesmium fraxini-orni Jian Ma & X.G. Zhang, **sp. nov.**

MYCOBANK # MB 510854 **FIGURE 2**

Coloniae effusae, fuscae. Mycelium partim superficiale sed fere immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, levibus, 2-4 µm crassis compositum.

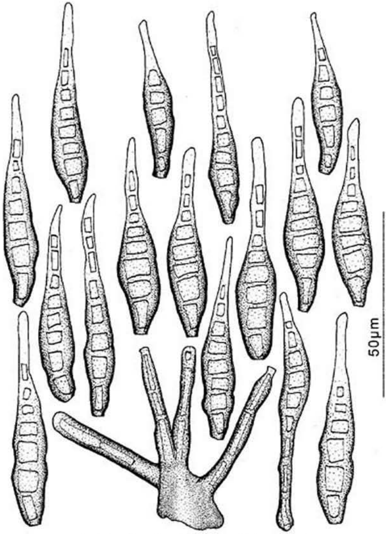

Fig. 2 Conidia and conidiophores of *S. fraxini-orni*

Conidiophora singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, pallide brunnea vel brunnea, 2-5-septata, 45-60 µm longa, 3.5-4.5 µm crassa. Conidia singula in apice conidiophori oriunda, recta vel leviter curvata, obclavata, ad basim conico-truncata, ad apicem conica, levia, subhyalinis vel pallide brunnea, sursum pallidiora, 5-7-septata, 65-71 µm longa, 14-16 µm crassa, apicem versus ad 2.5-3.5 µm attenuata, basi 3-4 µm lata.

Holotype: On dead branches of *Fraxinus ornus* L., tropical forest of Banna, Yunnan Province, China. Oct. 10. 2004, X. G. Zhang, HSAUPIV[illegible]0184 (isotype: HMAS 143709).

Etymology: in reference to the host, *Fraxinus ornus*

Colonies effused, blackish brown. Mycelium partly superficial, but mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2-4 µm thick. Conidiophores arising singly or in fascicles terminally and laterally on the hyphae, erect, simple, straight or slightly flexuous, pale to mid brown, 2-5-septate, 45-60 µm long, 3.5-4.5 µm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly curved, obclavate, conico-truncate at the base, conical at the apex, smooth-walled, subhyaline to pale brown, distal end paler, 5-7-septate, 65-71 µm long, 14-16 µm thick in the widest part, tapering to 2.5-3.5 µm at the apex, 3-4 µm wide at the base.

The conidia of *Sporidesmium fraxini-orni* are similar to those of *S. densum* (Mason & Hughes 1953), *S. penzigii* (Ellis 1961) and *S. jasminicola* (Ellis 1958). However, the new taxon can be separated from the other three species by its distinctly thicker conidia with fewer septa. In addition, the conidia of the new species are longer than those of *S. penzigii* (43-57 µm), and shorter than those of *S. densum* (25-90 µm).

Acknowledgments

The authors are deeply grateful to Prof. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30370009, 30499340).

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MYCOTAXON

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A new species of *Corynespora* from Yunnan, China

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Abstract — *Corynespora erythropsidis* sp. nov., found on dead branches of *Erythropsis colorata* from subtropical forest in Yunnan Province of China, is described, illustrated, and compared with similar taxa.

Key words — hyphomycetes, dematiaceous

Introduction

During an investigation of the saprobic fungi on dead branches of *Erythropsis colorata* (Roxb.) Burkill in the Hekou forest of Yunnan Province, an interesting species of *Corynespora* was discovered. Based on its distinctive morphological characteristics, it could not be assigned to any of the described species and is treated herein as new. It is compared with *C. salasiae* (Castañeda et al. 1995) and *C. occidentalis* (Castañeda 1988), which also produce ellipsoid, doliiform to broadly clavate conidia.

Taxonomic description

Corynespora erythropsidis X.M. Wang & X.G. Zhang, **sp. nov.**
Mycobank MB 510852 FIGURE 1

Coloniae griseae vel fuscae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, laevibus, 3.5-4.0 µm crassis compositum. Stromata nulla. Conidiophora singula, mononemata, non ramosa, recta vel flexuosa, cylindrica, laevia, 1-3-septata, pallide brunnea vel brunnea, per usque ad 1-2 proliferationes percurrentes successivas cylindricae, 145-206 µm longa, 5-7 µm crassa. Cellulae conidiogenae monotreticae, terminales, cylindricae, percurrentes, integratae, 15-20 µm longa, 4-6 µm crassa. Conidia singula, primo in apice conidiophori et dein

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* *Corresponding author*

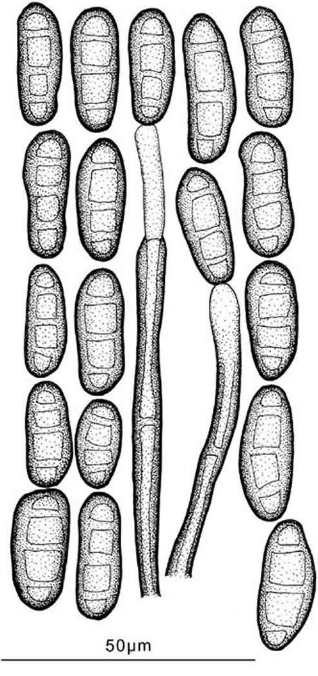

Fig. 1 Conidia and conidiophores of *C. erythropsidis*

proliferationis cujusque successivae oriunda, pallide brunnea vel olivaceo-brunnea, ellipsoidea, doliiformia, usque crassa clavata, ad apicem rotundata, ad basim rotundata, recta vel curvata, laevia, 4-pseudoseptata, 25-31 μm longa, 9-12 μm crassa.

Holotype: On dead branches of *Erythropsis colorata*, Arboretum of Hekou, Yunnan Province, China. Oct. 9. 2005, X. G. Zhang, HSAUPIV$_{[illegible]}$ 0596 (isotype: HMAS 143716).

Etymology: in reference to the host, *Erythropsis colorata*

Colonies grey to dark blackish brown, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 3.5-4.0 μm thick. Stroma absent. Conidiophores arising singly, mononematous, unbranched, straight or flexuous, cylindrical, smooth, 1-3-septate, pale brown to brown, with up to 1-2 successive percurrent cylindrical proliferations, 145-206 × 5-7 μm. Conidiogenous cells monotretic, terminal, cylindrical, percurrent, integrated, 15-20 × 4-6 μm. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia pale brown to olivaceous brown, ellipsoid, doliiform to broadly clavate, rounded at the apex and the base, straight or curved, smooth-walled, 4-pseudoseptate, 25-31 × 9-12 μm.

In conidial morphology, this species resembles *C. salasiae* (Castañeda et al. 1995) and *C. occidentalis* (Castañeda 1988). However, the conidia of the new taxon have 4-pseudosepta, while those of *C. salasiae* and *C. occidentalis* have 0-2 and 3-6-pseudosepta, respectively. In addition, the 25–31 μm long conidia of *C. erythropsidis* are shorter than those of *C. occidentalis* (30-45 μm) and longer than those of *C. salasiae* (17-20 μm).

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The authors are deeply grateful to Prof. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30370009, 30499340).

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MYCOTAXON

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Studies in lichens and lichenicolous fungi: Notes on some North American taxa

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Abstract — *Arthonia digitatae* is reported as new to North America. *Biatorella nannaria* is transferred to *Piccolia*, and the new combination *Piccolia nannaria* is proposed. *Biatora franciscana* is transferred to *Lecania*, and the new combination *Lecania franciscana* is proposed. *Lecania brattiae* is placed in synonymy with *L. hassei*. *Lecania subdispersa* is recognized as a lichenicolous species of *Toninia*, and the new combination *T. subdispersa* is proposed. *Toninia talparum* is placed in synonymy with *T. subdispersa*.

Key Words — lichen flora, mycota

1. ***Arthonia digitatae*** Hafellner, Linzer Biologische Beiträge 31(1): 509. 1999.

Arthonia digitatae was described to accommodate an *Arthonia* growing on *Cladonia digitata* (L.) Hoffm. *Cladonia incrassata* Flörke and *C. digitata* are both members of *Cladonia* sect. *Cocciferae*. Considering that *C. incrassata* is common in eastern North America, it is not surprising that a recent collection of *C. incrassata* was found to host *A. digitatae*. The species is reported here for the first time from North America. We suspect that careful examination of *C. incrassata* in the field and herbarium will lead to the discovery of additional records of this species. For a detailed description of *A. digitatae*, refer to Hafellner (1999).

Specimen Examined. – **U.S.A. New Jersey, Atlantic Co.,** clay pits E of Egg Harbor Ave., SW of McKee City, *J.C. Lendemer 5318 & A.E. Schuyler* (hb. Lendemer).

2. *Lecania hassei* (Zahlbr.) W.J. Noble, in Ahti et al., Mycotaxon 28: 93. 1987.

Placolecania hassei Zahlbr., in Hasse, The Bryologist 17: 61. 1914. TYPE: U.S.A. California, Los Angeles Co., Santa Monica Mountains, Topanga Canyon, on shaded sandstone boulders, *H.E. Hasse* s.n. (W, holotype; FH!, isotype).

Solenopsora hassei (Zahlbr.) Zahlbr., Cat. Lich. Univ., 5: 755. 1928.

Syn. nov. *Lecania brattiae* B.D. Ryan & van den Boom, in Nash et al., Lichen Flora of the Greater Sonoran Desert Region 2: 167-168. 2004. TYPE: U.S.A. California, Santa Cruz Island, Sierra Blanca Ridge, 300 m, *C. Bratt 8555* (SBBG!, holotype; hb. v.d. Boom, isotype).

Hasse collected *Lecania hassei* in Topanga Canyon in the Santa Monica Mountains of southern California on shaded sandstone boulders. He originally determined his collections as *Lecania brunonis* (Tuck.) Herre, but Zahlbrucker (1914) recognized them as a separate species having longer and usually narrower spores and well-developed squamules up to 3 mm across that might easily be mistaken for a species of *Psora*. Zahlbruckner (1914) originally placed this taxon in the genus *Placolecania*, but eventually transferred it to the genus *Solenopsora* (Zahlbruckner 1928). Noble (1987) finally recognized this taxon as a species of *Lecania* and reported it from British Columbia, Canada.

Recently, *Lecania hassei* has been collected in the Santa Monica Mountains of Southern California by both the first author (KK) and C.M. Wetmore. These new collections and the specimens collected by Hasse (FH) were compared with collections of *Lecania brattiae* from the Channel Islands, California and Guadeloupe Island, Baja California (ASU, MIN). No clear division was discerned between the specimens examined or the species concepts of *Lecania brattiae* and *Lecania hassei* proposed by van den Boom & Ryan (2004). According to van den Boom & Ryan (2004: 160), "*Lecania brattiae* has a squamulose but paler thallus with grayish edges and shorter ascospores." The thalli examined had a range of variation from poorly developed to well-developed squamules. Thallus color varied from dark to bright browns, from dull to glossy, and grayish edges were not consistently observed, even among authentic specimens of *L. brattiae*. Cortex thickness varied greatly in the specimens examined and the spore sizes given by van den Boom and Ryan (2004) overlap significantly (14-18-(20) × 3-4-(4.5)µm in *L. brattiae*, (16)-18-22 × 3.4-4.5(-5) µm in *L. hassei*). We consider the thalline variation to be environmentally modified by microhabitat conditions and thus consider *L. brattiae* a synonym of *L. hassei*.

We did not examine the collection from British Columbia determined by Noble that would represent an intriguing disjunctive population.

Selected specimens examined. – **Mexico. Baja California,** 2 km S of Colonet, 31°4'0"N, 116°13'0"W, 50 m, *T.H. Nash 29490* (ASU); Guadalupe Island, on west coast, on cliffs above the sea, 28"58'50"N, 118°18'50"W, 80 m, *C.M. Wetmore 75791* (MIN). **U.S.A. California, Los Angeles Co.,** Santa Monica Mountains, Topanga Canyon, 1896, *H.E. Hasse 4020* (FH); NW of Topanga in Old Topanga Canyon, 2.5 miles off Topanga Canyon Road, 1300 ft, on sandstone, *C.M. Wetmore 16818* (MIN); Malibu Creek, half mile down stream from Cold Creek, 34°04'34"N, 118°42'07"W, 139 m, *K. Knudsen 7143.1* (UCR); **Santa Barbara Co.**, Santa Cruz Island, ridge north of Ragged Mountain, 33°59'30"N, 119°49'15"W, 350 m, *C.M. Wetmore 74011* (MIN); Santa Rosa Island, near Black Mountain, 33°58'45"N, 120°04'30"W, 240-320 m, *C.M. Wetmore 73579* (MIN); upper part of Cherry Canyon, 33°60'N, 120°01'W, 75 m, *B.D. Ryan 31454* (ASU).

3. *Piccolia nannaria* (Tuck.) Lendemer & Beeching comb. nov.

MycoBank MB 510765

Heterothecium nannarium Tuck. Gen. Lich., 1: 176. 1872. TYPE: U.S.A. Texas, [Blanco Co.], on the Blanco, 1850, *C. Wright s.n.* (FH-TUCK!, lectotype designated here).

Biatorella nannaria (Tuck.) Zahlbr., Cat. Lich. Univ., 5: 44. 1927.

Hafellner (1995) removed the genus *Piccolia* A. Massal., from synonymy with *Biatorella* De Not., recognizing four species distributed throughout the tropics world-wide. Lendemer & Yahr (2004) conditionally referred a specimen from the coastal plain of North Carolina, USA to *Piccolia conspersa* (Fée) Hafellner based on the similarity of the material to the description and illustrations provided by Hafellner (1995).

Sean Beeching (pers. comm.) first pointed out the existence of the name *Biatorella nannaria* to the second author (JCL). Following the key to *Biatorella* species provided by Fink (1935) the material we had originally assigned to *P. conspersa* easily keyed to *B. nannaria*. Comparison of the type specimen of *B. nannaria* with our material confirmed that they were same taxon. And, comparison of the above material with Tuckerman's specimens of *P. conspersa* (cited as *P. conspersa* by Hafellner (1995)) confirmed that they represent a taxon distinct from *P. conspersa*. The two species share a number of characters including deposits of orange (K+ red-purple) crystals in the apothecia, polysporous asci with numerous globose hyaline ascospores, and tiny hyaline ellipsoid conidia. Both species also have a peculiar ascus type that led Hafellner (1995) to hesitate in the placement of the genus (the current version of Myconet includes *Piccolia* in an uncertain position within the *Lecanoromycetes* (Eriksson 2006)). Despite the similarities in apothecial anatomy as well as ascospore and conidia characters, *P. nannaria* is easily distinguished from *P. conspersa* by its yellow-green rather than orange thallus and much smaller apothecia (0.25 mm vs 0.4-0.8mm).

Based on the available collections *P. nannaria* appears to be uncommon but widely distributed in the coastal plain of southeastern North America, where it occurs on the bark and undersides of twigs of hardwoods in sand ridge – oak scrub communities. Considering the small size of *P. nannaria*, it is possible that the species has generally been overlooked by collectors. It is also possible that specimens of *P. nannaria* have been misidentified as species of *Caloplaca* because of the presence of anthraquinones (K+ magenta) in the thallus apothecia.

Additional specimens of *Piccolia nannaria* examined. – **U.S.A. Georgia, Talbot Co.**, Big Lazar Creek Wildlife Management Area, *S.Q. Beeching s.n.* (hb. Lendemer); **North**

Carolina, Pender Co., Holly Shelter Game Lands, *J.C. Lendemer 8422 & A. Moroz* (hb. Lendemer); **South Carolina, Allendale Co.,** S of Allendale, just over state border, 4.I.2007, *I. Brodo 31919 & F. Brodo* (CANL).

Comparative material of *Piccolia conspersa* examined. – **CUBA.** Sine loc., *C. Wright 224* (FH-TUCK); sine loc., 1860, *C. Wright s.n.* (FH-TUCK). **U.S.A. Alabama,** Brooklyn, 1860, *Beaumont 425/543* (FH-TUCK).

4. ***Toninia subdispersa*** (Nyl. ex Hasse) K. Knudsen **comb. nov.**

MycoBank MB 510759

Lecanora subdispersa Nyl. ex Hasse, Lich. S. Cal. p. 12. 1898. TYPE: U.S.A. California, Santa Monica Mountains, Stone Canyon, parasitic on *Lecania brunonis*, 1896, *H.E. Hasse 897* [#480 on inside of packet, with note "Little black apothecia- it is next to the more conspicuous *L. brunonis*"] (NY!, lectotype designated here; NY!, isolectotype).

Lecania subdispersa (Nyl. ex Hasse) Hasse, Contrib. U.S. Nat. Herb., 17(1): 97. 1913.

Syn. nov. *Toninia talparum* Timdal, Op. Bot. 110: 103. 1992. TYPE: U.S.A. California, Los Angeles Co., Santa Catalina Island, east end of White Cove, parasitic on *Lecania brunonis* on volcanic rock, 0-40 m, *W.A. Weber & R. Santesson L-42810* (COLO, holotype [not available for loan at the time of this study]).

This taxon was originally collected by Hasse in Stone Canyon in the Santa Monica Mountains of southern California (Hasse 1898, 1913), which is now adjacent to Beverly Glen in the Bel-Air area. It is rare in the Santa Monica Mountains and all Hasse's specimens appear to come from the type locality based on his writings, although the location is not annotated on every label. Despite the abundance of black lecideine apothecia (>0.6 mm in diameter) growing on thalli of *Lecania brunonis* in all specimens we have examined, Nylander and Hasse did not recognize *L. subdispersa* as a parasite. They simply assumed the species was growing amongst *L. brunonis*. Their placement of the species in *Lecanora* is perplexing, based on the specimens examined. Citing black apothecia with a "margin indistinct or disappearing" as well as spores 10-12 × 5µm long (10-15 × 4-6µm in the specimens we examined), Hasse (1898) clearly applied the name *L. subdispersa* to the taxon we here recognize as a species of *Toninia*. Hasse's handwritten note on the lectotype further confirms this conclusion.

Hasse (1913) compounded the confusion over this taxon by transferring it to *Lecania* and in the final description of the species conflating the squamules and conidia of the host *L. brunonis* with the correct apothecial details of the parasite. Timdal (1991) later described this same taxon as a new species, *Toninia talparum*, unaware of the earlier description or Hasse specimens. All the Hasse specimens examined are conspecific with Timdal's *Toninia talparum* and appear to occur on the same type host, *Lecania brunonis*. By priority the correct name for the species is *L. subdispersa*, and the new combination *Toninia subdispersa*, is provided here.

Toninia subdispersa is common on the Channel Islands of southern California and along the coast from Baja California to central California (Timdal 2002). It is specific to the genus *Lecania*, and besides the type host, is common on *Lecania franciscana* as well as on *L. fructigena* and *L. dudleyi* (which is also the host of *Toninia subtalparum* van den Boom). It has also been reported from the Czech Republic on *Lecania inundata* (Hepp. ex Körb.) H. Mayrhofer and on an undetermined *Lecania* sp. from Spain (Kocourková & van den Boom 2005). For a description of the species see Timdal (1992, 2002) and Kocourková & van den Boom (2005).

The recognition that *Lecanora subdispersa* is a *Toninia* then brings up the question of what is the correct name for the *Lecania* taxon treated as *Lecania subdispersa* by van den Boom & Ryan (2004). This question is answered below in the discussion of species 5.

[Regarding species 4 and 5: No one yet has developed a clear explanation of Hasse's system of numbering specimens, which appears to have changed several times over the course of his lichen research.]

Selected Specimens studied – **U.S.A. California, Los Angeles Co.,** Los Angeles, Griffith Park, east end of the Santa Monica Mountains, Royce Canyon, 34°59'30"N, 119°49'15"W, 263 m, parasitic on *Lecania brunonis*, *K. Knudsen et al. 2349* (PRM 857330); Santa Monica Range, 1897, *H.E. Hasse 480* (H-NYL); **Riverside Co.,** Bautista Canyon, 33°40'01"N, 116°49'57"W, 759 m, *K. Knudsen 8293 & J. Kocourková* (UCR, hb. Lendemer); **Santa Barbara Co.,** San Miguel Island, lower east slope of Green Mountain, 34°2'15"N, 120°22'35"W, 170 m, *T.H. Nash III 41198* (ASU); near trail to Green Mountain, 34°2'14"N, 120°21'02"W, 175 m, parasitic on *Lecania franciscana* on carbonate-rich soil, *K. Knudsen 6719* (UCR); **Santa Diego Co.,** San Diego, Point Loma, Cabrillo National Monument, coastal slope above Gatchell Road, 32°40'13"N, 117°14'23"W, 128 m, *K. Knudsen* 8412 (UCR).

5. *Lecania franciscana* (Tuck.) K. Knudsen & Lendemer comb. nov.

MycoBank MB 510758

Biatora franciscana Tuck., Syn. N. Amer. Lich. 2: 32. 1888. TYPE: U.S.A., California, Oakland Hills, on sandstone rocks, *H.N. Bolander s.n.* (FH-TUCK!, holotype).

Catillaria franciscana (Tuck.) Herre, Proc. Wash. Acad. Sci., 12: 95. 1910.

Syn. nov. *Lecania subdispersa* B.D. Ryan (as "(Nyl. ex B.D. Ryan) B.D. Ryan"), nom. illegit. [non *Lecania subdispersa* (Nyl. ex Hasse) Hasse] in Nash et al., Lichen Flora of the Greater Sonoran Desert Region 2: 167-168. 2004. TYPE: U.S.A. California, Santa Monica Range, 1897, *H.E. Hasse 480* (H-NYL!).

Tuckerman (1888) described *Biatora franciscana* from a Bolander collection from the Oakland Hills in California. He also reported it from the Cliff House in San Francisco without citing a collection. This rocky shoreline is directly on the Pacific, south of the Golden Gate Bridge and now part of the Golden Gate National Recreation Area. Tuckerman compared it with the taxon now referred to as *Lecania crytella* (Ach.) Th. Fr.

The type is a *Lecania* and the new combination *Lecania franciscana* is made here.

Biatora franciscana was transferred to *Catillaria* by Herre (1910) probably because the thalline margin is excluded in mature ascomata and lecideine in appearance. Herre reported it as occurring on rocks along the coast southward from San Francisco. Hasse (1913) later reported *C. franciscana* from the coast of Southern California in the Santa Monica Mountains, as well as farther south from White Point on the Palos Verdes peninsula near San Pedro and from Newport Beach in Orange County. Though reported by Hasse from the Sonoran Lichen Flora study area, *C. franciscana* was not examined for the *Catillaria* treatment in Volume Three (T.H. Nash III, pers. comm.) of that work. It cannot automatically be assumed all specimens determined by Hasse and Herre as *Catillaria franciscana* are *Lecania franciscana* as treated here.

In the study of *Lecania* species of the Sonoran area by van den Boom & Ryan (2004), the type of *Biatora franciscana* was not examined. The holotype of *Biatora franciscana* is conspecific with specimens of *Lecania subdispersa* B.D. Ryan, collected by Ryan and Nash (ASU) as well as the collections from the Channel Islands made by Kerry Knudsen and C.M. Wetmore cited below. By priority, the correct name for this taxon is *Lecania franciscana*.

It should be noted that Ryan (in van den Boom & Ryan 2004) did not recognize that Hasse's validly published species *Lecania subdispersa* (Nyl ex Hasse) Hasse referred to the parasite and not the host. Thus he rejected Hasse's protologue and did not locate original material at NY, then described a new species based on his determination of the host of *Hasse 480* (H-NYL) rather than the parasite abundant upon it in contravention of all the requirements of ICBN that he invoked to justify his actions, thereby publishing an illegitimate homonym. *Lecania subdispersa* B.D. Ryan is here placed in synonymy with *L. franciscana*.

We thus accept the description of *L. subdispersa* in van den Boom & Ryan (2004) as a description of *L. franciscana*, qualifying it with the observation that a better spore range is 13-22 × 3-5 µm with spores tending to be 15 × 4 µm in specimens examined. The species is easily distinguished from other *Lecania* in California by its pale areolate thallus and usually dark brown-black apothecia becoming emarginate and convex.

SELECTED SPECIMENS EXAMINED. – **U.S.A. California, Los Angeles Co.,** Santa Catalina Island, Empire Landing area, Rippers Cove, 33°25'45"N, 118°26'W, 50-100 m, *C.M. Wetmore 73336* (MIN); Santa Monica Range, Hasse, *Lichens Exsiccati 31* (hb. Knudsen); **Santa Barbara Co.,** Santa Rosa Island, upper part of Lobos Canyon, 34°00'15"N, 120°05'15"W, 50-100 m, *C.M. Wetmore 73865* (MIN); San Miguel Island, Nidever Canyon, 34°02'40"N, 120°21'09"W, 52.1 m, on consolidated soil, *K. Knudsen 6820* (UCR); along trail to Harris Point, 34°03'21"N, 121°21'35"W, on soil, *T.H. Nash III 41132* (ASU); **Ventura Co.,** San Nicholas Island, west end, 33°55'N, 119°33'W, on soil, *T.H. Nash III 38715* (ASU).

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MYCOTAXON

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Anamorphic fungi from submerged plant material: *Acumispora verruculosa, Pleurophragmium aquaticum,* and *P. miniumbonatum*

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Abstract — *Acumispora verruculosa* sp. nov. and *Pleurophragmium aquaticum* sp. nov. on decaying leaves of an unidentified plant and wood, respectively, submerged in a stream at the "Los Tuxtlas" rainforest, Veracruz, Mexico, are herein described and illustrated. The former is distinguished by obclavate, rostrate, 2-septate, verruculose, very pale brown conidia and the latter is characterized by navicular, fusiform to subclavate, 3-septate, smooth, brown and pale brown conidia which are paler at each end and at the septa. A key for *Acumispora* is provided. *Pleurophragmium miniumbonatum* comb. nov. is proposed.

Key words — freshwater fungi, hyphomycetes, systematics, tropical fungi

Introduction

In contrast to fungi in other habitats in the tropics, fungal diversity of freshwater biotypes have received little attention or study. Submerged plant debris in tropical streams, rivers and lakes recently have been determined to harbor various undescribed taxa of anamorphic fungi (Sivichai et al. 2000, Castañeda et al. 2005a,b, 2006). During an expedition in 2002 in several undisturbed rainforests of "Los Tuxtlas" (Veracruz), Mexico, two interesting hyphomycetes were collected on submerged decaying leaves and wood in a stream. These fungi were distinctly different morphologically from previously described hyphomycetes and are therefore described as new species.

Materials and methods

Samples of submerged plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dish moist chambers at 25° C, in plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Aeration was supplied with a fan (Daytron) for 5 to 10 minutes at 45 minutes intervals. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000.

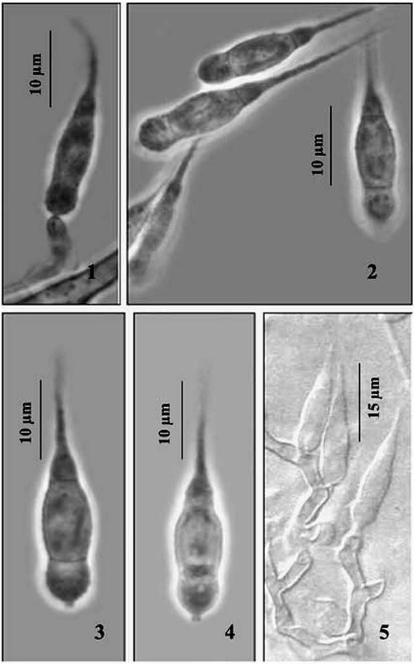
Taxonomy

Acumispora verruculosa Heredia, R.F. Castañeda & R.M. Arias,
anam. sp. nov. **Figs. 1-4, 10, 11**
MycoBank MB 510704

Ad omnibus speciebus Acumisporae differt in conidia solitaria, acrogena et lateralia, obclavata usque ad leviter ovata constricta ad septa, sed elongata rostrata ad apicem, 2-septata, 25.4–33.5 × 4.4–5.5 µm, verruculosa, dilute brunnea.

Etymology: Latin, *verruculosa*, referring to the small wart-like projections covering the outer wall of the conidia.

Colonies on natural substratum effuse, funiculose, amphigenous, brown. Mycelium mostly superficial composed of septate, 1–2 µm diam., branched, prostrate, smooth-walled, brown hyphae. **Conidiophores** macronematous, mononematous, erect, simple, 1-2-septate, pale brown to brown, up to 60 µm tall, 2–4 µm wide at the base, smooth-walled. **Conidiogenous cells** multilocal, hologenous, integrated, indeterminate, sympodially proliferating, denticulate, pale brown. **Conidiogenous loci** apical and lateral and observed as broken denticles. **Conidial secession** rhexolytic. **Conidia** acrogenous and lateral, obclavate to slightly ovate, constricted at the septa with a large rostrate apical cell, 2-septate, verruculose, dry, 25.4–33.5 × 4.4–5.5 µm, pale brown. Teleomorph unknown.



Figs. 1-4. *Acumispora verruculosa*, from holotype (XAL CB747).
Fig. 1. Conidiogenous cell and conidium. **Figs. 2-4.** Conidia.
Fig. 5. *Acumispora biseptata*, from INIFAT C97/113, conidiogenous cells with attached conidia.
Scale is indicated by bars.

> TYPUS: **Mexico. Veracruz:** "Los Tuxtlas", on decaying leaves of unidentified plant submerged in a stream, 19.V.2002, coll. R. M. Arias and J. Y. C. Elizondo. **Holotype:** XAL CB747, Instituto de Ecología, Xalapa, Veracruz, México. **Isotype:** MUCL 45624.

Comments: Three species have been described in the genus *Acumispora*: the type species *A. uniseptata* Matsush., *A. biseptata* Matsush. and *A. phragmospora* Matsush. (Matsushima 1980). *Acumispora verruculosa* is most similar morphologically to *A. biseptata*, but that species has smooth conidia measuring 16-25 x 3.8–5.0 µm, which are shorter than those of *A. verruculosa*.

Key to *Acumispora* species

1. Conidia 1-septate (navicular to obturbinate, rostrate, 23–28 × 5.5– 6.5 µm, smooth-walled, very pale brown) .... ***A. uniseptata***

1* Conidia with more than one septum 2

2, Conidia 2-septate 3

2* Conidia 3-6 –septate (cylindrical to fusiform, acuminate, 24–45 × 4-5 µm, smooth-walled, pale brown) .... ***A. phragmospora***

3. Conidia smooth-walled, 16-25 x 3.8–5.0 µm .... ***A. biseptata***

3* Conidia verruculose, 25.4–33.5 × 4.4–5.5 µm .... ***A. verruculosa***

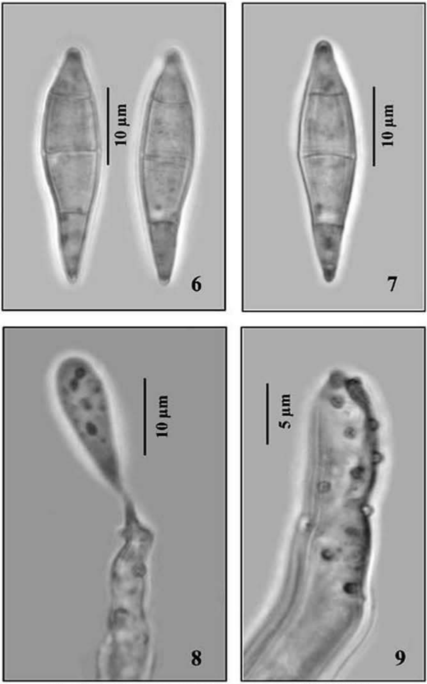
Pleurophragmium aquaticum **R.F. Castañeda, Heredia & R.M. Arias, anam. sp. nov.** **Figs. 6-9, 12**

MycoBank MB 510728

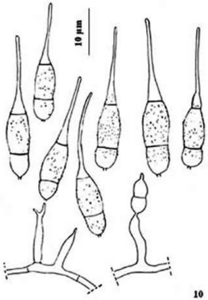
> *Ad omnibus speciebus Pleurophragmii differt in conidia solitaria, acrogena et lateralia, fusiformia ad usque clavata, interdum navicularia, leviter fasciata dilute brunnea circa utrimque et circa septa, brunnea cetero, sicca, levia, 25–30 × 6.0–6.5 µm.*
>
> Etymology: Latin, *aquatic*, refers to its growing in water.

Colonies on natural substratum effuse, hairy, brown. Mycelium superficial and immersed, composed of septate, 1.5–2.0 µm diam., branched, smooth-walled, brown hyphae. **Conidiophores** macronematous, mononematous, erect, straight or flexuous, 4-7-septate, brown at the base, subhyaline or pale brown at the apex, smooth- walled, 200–390 µm tall, 5–11 µm wide at the base. **Conidiogenous cells** multilocal, hologenous, integrated, indeterminate, sympodially proliferating, denticulate, pale brown or subhyaline. **Conidiogenous loci** apical and lateral and observed as conspicuous denticles. **Conidial secession** schizolytic. **Conidia** acrogenous and lateral, fusiform to clavate, sometimes navicular, truncated at the base, sub-umbonate at the apex, 3-septate, smooth-walled, dry, 25–30 × 6.0–6.5 µm, with brown pigmented cells, but pale brown to subhyaline at the ends and near septa. Teleomorph: unknown

> TYPUS: **Mexico. Veracruz:** "Los Tuxtlas", on decaying wood submerged in a stream, 19.V.2002, coll. R. M. Arias and J.Y. C. Elizondo. **Holotype:** XAL CB743, Instituto de Ecología, Xalapa, Veracruz, México. **Isotype:** MUCL 45625.



Figs. 6-9. *Pleurophragmium aquaticum*, from holotype (XAL CB743).
Figs. 6-7. Conidia. **Fig. 8.** Conidiogenous cell with attached conidium. **Fig. 9.** Conidiogenous cell with conspicuous denticles. Scale is indicated by bars.



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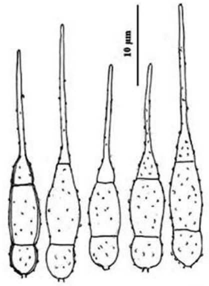

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Figs. 10-11. *Acumispora verruculosa*, from holotype (XAL CB747). **Fig. 10.** Conidiogenous cells and conidia. **Fig. 11.** Conidia. Scale is indicated by bars.

Comments: More than 20 accepted species have been described in *Pleurophragmium* (Ellis 1971, 1976; De Hoog & Arx 1973, Matsushima 1975). The genus is characterized by brown to dark brown conidiophores and sympodially proliferating, denticulate conidiogenous cells producing holoblastic, simple, septate, brown to dark brown conidia. The last character has been used to separate *Pleurophragmium* from *Dactylaria* (De Hoog 1985), which has hyaline, 1-several-septate conidia on cylindrical, multi-denticulate rachids. Other described *Pleurophragmium* species with 3-septate conidia but which lack the other characters indicated above have been accommodated in the genera *Dactylaria* (De Hoog 1985), *Spiropes* and *Pseudospiropes* (De Hoog & Arx 1973)

Accepted *Pleurophragmium* species with 3- or more septa include: *P. bitunicatum* Matsush., *P. cylindrosporum* Matsush., *P. subfusiforme* Matsush., *P. triseptatum* Matsush., *P. varieseptatum* Matsush. (Matsushima 1975), *P. arecae* (Matsushima 1985), *P. angamosense* (Matsushima 1995) (Table 1). None of these species has conidia with a sub-umbonate apex and zonate pigmentation such as *P. aquaticum*, and only *Pleurophragmium bitunicatum* is similar in conidial size and pigmentation, but the conidia are bitunicate.

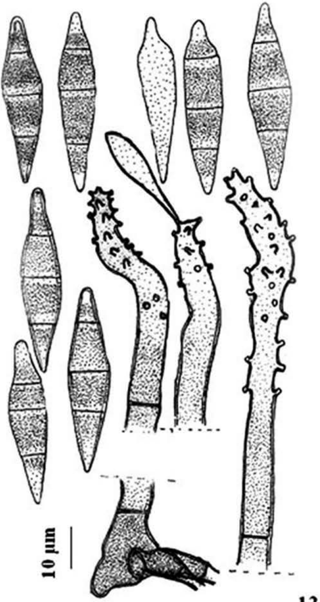

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Fig. 12. *Pleurophragmium aquaticum*, from holotype (XAL CB743). Conidiophore, conidiogenous cells and conidia. Scale is indicated by bar.

Table 1. *Pleurophragmium* species with conidia having 3 or more septa.

Species	Number of septa	Conidial shape	Conidial size (µm)
P. angamosense	3-7 mostly 5	fusiform, curved	24.5–40 × 5-8
P. bitunicatum	3 (-5)	fusiform, tunicate	20–35 × 4.5–7
P. cylindrosporum	3	cylindrical	30–40 × 5–6
P. subfusiforme	3-7	fusiformia	21–38 × 5.8–9.2
P. triseptatum	3 rarely 1-6	cylindrical	14–25 × 4–5
P. varieseptatum	1-4	cylindrical	(3-septa) 11–19 × 3.5–5.0 (4-septa) 19–22 × 4–5
P. arecae	(2-) 3 (-4)	fusiform to clavate	12–24 × 3.0– 4.5

Cordana miniumbonata (Castañeda et al. 1999) has denticulate conidiogenous cells with denticles developing across the apical part of the conidiophores after sympodial proliferations, making it more similar to the genus *Pleurophragmium*. The following new combination is therefore proposed.

Pleurophragmium miniumbonatum (R.F. Castañeda, Iturr. & Guarro) R.F. Castañeda, **comb. nov.**

MycoBank MB 510729.

Basionym: *Cordana miniumbonata* R.F. Castañeda, Iturr. & Guarro, Mycotaxon 73: 5 (1999).

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Macalpinomyces flaccidus sp. nov. and *Urocystis poae-palustris* new to China and Asia

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Abstract — A new species, *Macalpinomyces flaccidus* on *Pennisetum flaccidum* is described, which was collected from Yunnan Province, China. *Urocystis poae-palustris* on *Poa supina*, which is new to China and Asia, is also reported.

Key words — *Ustilaginomycetes*, smut fungi, taxonomy

A new *Macalpinomyces* species on *Pennisetum flaccidum* was collected in Yunnan Province, Southwestern China. Its sori are covered by a peridium, and lack a columella. The species is peculiar in forming 3–7 fascicle-like sori in some spikelets of an inflorescence. So far, only one *Macalpinomyces* species, *M. tilletioides* Vánky (Vánky 2005) was known on *Pennisetum*. The new species differs from *M. tilletioides* in having cylindrical or filiform, 8–21 mm long sori, sparsely echinulate ustilospores, and small sterile cells (5–10 × 5–9 µm), while *M. tilletioides* has short sori (2–3 mm in length), densely verrucose-echinulate ustilospores, and large sterile cells (7–16 × 6.5–12 µm). It is described as:

Macalpinomyces flaccidus S.H. He & L. Guo, **sp. nov.** **Figs. 1-3**
MycoBank MB510867

Sori in spiculis nonnullis inflorescentiae evoluti, 3–7-fasciculati, cylindrici vel filiformes, 8–21 × 0.5–1 mm, cum apice acuto, peridio brunneo operti, quo tandem rupto. Columellae desunt. Massa sporarum atrobrunnea, semiagglutinata vel pulverulenta. Ustilosporae subglobosae ovoideae, ellipsoideae, polyedricae vel leniter irregulares, saepe angulatae, 10–13(–15) × 8.5–12.5(–13) µm, brunneae; pariete aequaliter vel inaequaliter crasso, ca. 0.5 µm, echinulato. Cellulae steriles subglobosae, ellipsoideae vel ovoideae, 5–10 × 5–9 µm, hyalinae, leves.

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*corresponding author

Sori in some spikelets of an inflorescence, composed of 3–7 cylindrical or filiform fascicles, 8–21 × 0.5–1 mm, with acute tips, covered by a pale brown peridium, which later ruptures. Columellae absent. Spore mass blackish-brown, semi-agglutinated to powdery. Ustilospores subglobose, ovoid, ellipsoidal, polyhedral or slightly irregular, often angular, 10–13(–15) × 8.5–12.5(–13) µm, brown; wall evenly or slightly unevenly thick, ca. 0.5 µm, echinulate as seen by LM, minutely and sparsely verruculose between the spines as seen by SEM. Sterile cells subglobose, ellipsoidal or ovoid, 5–10 × 5–9 µm, hyaline, smooth.

SPECIMENS EXAMINED—On *Pennisetum flaccidum* Griseb. (*Poaceae*), China: Yunnan Province, Eryuan, near Yuhua reservoir, alt. 2440 m, 16. IX. 2005, L. Guo, N. Liu & Z.Y. Li 3522, HMAS 172153 (holotype), HUV 21448 (isotype); Yunnan Province, Kunming, Dapuji, alt. ca. 1900 m, 10. IX. 1945, X.Y. Yin, HMAS 172152 (paratype).

A specimen of *Urocystis* on *Poa supina* was collected from Xinjiang Uygur Autonomous Region, Northwestern China in 2003. Its spore balls are composed of 1–5 ustilospores surrounded by a discontinuous to continuous layer of sterile cells, and mostly 2-ustilospored (1=26%, 2=49%, 3=18%, 4=5%, 5=2%; n=100). So far, only two species of *Urocystis* are known on *Poa*: *Urocystis poae* (Liro) Padwick & A. Khan and *U. poae-palustris*. *U. poae-palustris* differs from *U. poae* in having more ustilospores per spore ball, namely 1–5, mostly 2, while *Urocystis poae* has 1–2(–4) ustilospores per spore ball, mostly one (1=67%, 2=31%, 3=1.75%, 4=0.25%) (Vánky 1976). *U. poae-palustris* was known only from Romania and Argentina (Roivainen 1977). It is new to China and Asia.

Urocystis poae-palustris Vánky, Bot. Notiser 129: 119, 1976. **Fig. 4**

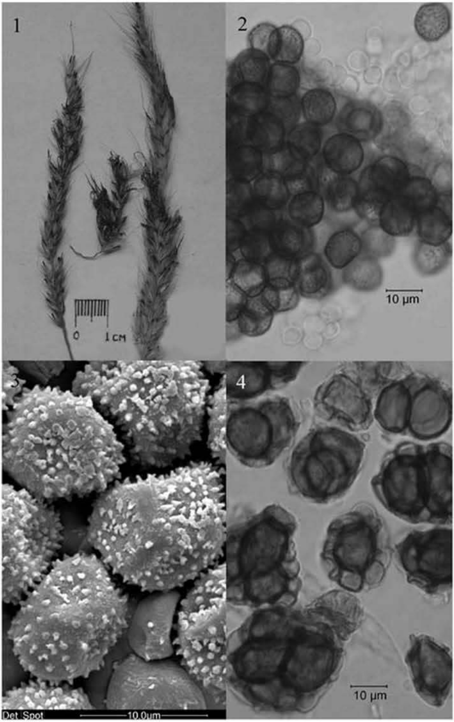
Type on *Poa palustris* L., Romania, Transylvania, Topliţa [Maroshéviz], 11.VII.1965, K. Vánky, HUV 2928 (holotype); Vánky, Ust. exs. no. 193 (isotypes).

Urocystis permagna Roiv., Karstenia 17: 6, 1977.

Type on *Poa ?oligeria* Steud., Argentina, S Tierra del Fuego, Ushuaia, Bahia Susana, 18.I.1970, H. Roivainen, H (holotype); HUV 7137 (isotype).

Sori in the leaves and sheaths as short or long, narrow striae, at first covered by the epidermis which later longitudinally ruptures. Spore mass black, powdery. Spore balls subglobose, ellipsoidal, ovoid or slightly irregular, 12.5–40 × 11–32 µm, composed of 1–5 ustilospores surrounded by a discontinuous to continuous layer of sterile cells. Ustilospores subglobose, ovoid, ellipsoidal or irregular, 12.5–18.5(–20) × 8.5–15 µm, light brown; wall ca. 1 µm, smooth. Sterile cells ovoid, subglobose, elongated or irregular, 5–12.5 × 4–7 µm, light yellowish-brown; wall 0.5–1.5 µm.

Figs. 1-3. *Macalpinomyces flaccidus* on *Pennisetum flaccidum* (HMAS 172153, holotype). Fig. 1. Sori. Fig. 2. Ustilospores and sterile cells as seen by LM. Fig. 3. Ustilospores and sterile cells as seen by SEM. Fig. 4. Spore balls, ustilospores and sterile cells of *Urocystis poae-palustris* on *Poa supina* (HMAS 172141) as seen by LM.


1
0
1 CM
2
10 µm
3
Det Spot
10.0um
4
10 µm

Specimen examined—On *Poa supina* Schrad. (*Poaceae*). China: Xinjiang, Jimsar, Quanzijie, alt. 1700 m, 13. VIII. 2003, L. Guo, H.C. Zhang 2134, HMAS 172141.

Vánky (1976) gave the percentage of ustilospores per spore ball of *Urocystis poae-palustris* as: 1=33%, 2=46.5%, 3=14.5%, 4=4%, 5=2%, which is similar to the Chinese specimen (HMAS 172141). In China, so far 50 *Urocystis* species have been reported (Guo & Liu 2007, He & Guo 2007, Yang et al. 2007), of which two are on *Poa*.

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Additional studies on *Geastrum* from northeastern Brazil

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Abstract– Surveys on *Geastrum* diversity from areas of northeastern Brazil have been carried out in the last years. Three species belonging to the genus *Geastrum* were reported for the first time from this region: *G. coronatum*, *G. fimbriatum* and *G. hieronymi* and three from the rest of Brazil: *G. elegans*, *G. fornicatum* and *G. ovalisporum*. Descriptions, comments and illustrations of basidiomata are given.

Key words– *Basidiomycota, Phallales, Gasteromycetes*, taxonomy, neotropics

Introduction

Neotropical regions revealed several new taxa of *Geastrum* Pers. in recent years: *G. lilloi* (Domínguez de Toledo 1996), *G. ovalisporum* (Calonge et al. 2000), *G. schmidelii* var. *parvisporum* (Dios et al. 2000), *G. setiferum* (Baseia & Milanez 2002), *G. albonigrum* (Calonge & Mata 2004) and *G. hirsutum* (Baseia & Calonge 2006). According to J. E. Wright (pers. comm.) probably, the abundance of this group is bigger than expected and the South America would be a "gold mine" on fungi diversity.

Tropical forests constitute an important reservoir of biodiversity, sheltering an ample variety of fungi. However, only the 7.5 % of the original Atlantic rainforests remain intact (Mayers et al. 2000). Thus, more specific studies on the gasteroid fungi of Brazil are urgently needed.

Materials and methods

Fieldtrips have been carried out during rainy seasons from 1998 to 2004 in Rio Grande do Norte (Parque Estadual Dunas de Natal - 0,5°48' S and 35°12' W), Paraíba (Reverva Biológica Guaribas - 0,6°45' S and 35°12' W) and Pernambuco (Refúgio Ecológico Charles Darwin - 0,7°49' S and 34°52' W; Reserva Ecológica de Gurjaú - 0,8°14' S and 35°03' W; Parque Dois Irmãos - 0,7°55' S and 34°52' W; Reserva Biológica de Serra Negra 0,5°48' S and 35°12' W). All these places are remnants of the Atlantic rainforest.

Basidiomata were examined and photographed in the field. Macro and microscopic characters were determined according to Sunhede (1989). Hand-cut sections of fresh and dried material were done for microscopic examination in 2% KOH. Additionally, several samples were examined under the scanning electron microscope (SEM) Phillips XL 20. Spore measurements include the ornamentation. Colours were coded according to Kornerup & Wanscher (1978), with the indication "KW", bracketed in the text, and simultaneously described. They were dried up slowly and placed in containers with naphthalene. The techniques employed followed, basically, Miller & Miller (1988). Mycological terminologies follow the Dictionary of Fungi (Kirk et al. 2001). Additional collections were loaned from PACA and URM Herbarium. The specimens studied were incorporated to the UFRN collection.

Results

Geastrum coronatum Pers., Syn. Meth. Fung. p. 132 (1801) **Fig. 1, 7**

Immature basidiomata hypogeal, subglobose, without pointed apex, 15-25 mm broad, 15-25 mm high. Exoperidium fornicate, nonhygroscopic, split into 10-14 unequal rays with acute tips when open; expanded basidiomata 40-60 mm (Fig.1); mycelial layer encrusted with debris; pseudoparenchymatous layer up to 3-4 mm thick, brown (KW 6E4), frequently areolate, sloughing away to reveal a fibrous layer; endoperidium globose to subglobose 15-18 mm broad, with a short pedicel and apophysis; surface of endoperidium initially dusted with minute granules, soon glabrous, greyish brown (KW 8E3); peristome slightly elevated, with an inconspicuous lighter border, fimbriate not delimitated; gleba brown (KW 6E4); basidiospores globose, 4.8-6.6 µm diam. including the ornamentation, dark brown; capillitium, 4.8-7.5 µm broad (Fig. 7).

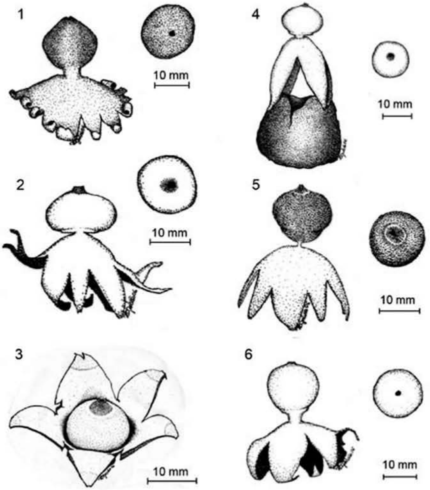
Habitat: scattered to gregarious on soil with plant debris.

Material examined: Brazil, Pernambuco, Igarassu: Refúgio Ecológico Charles Darwin, 12/V/2001, Baseia, UFRN-fungos 224.

Additional material examined: Germany, Berlin-Südende, 05/IX/1931; Hennig, PACA 15962.

Distribution: Brazil (Rick 1961), Canary Islands (Eckblad 1975), Costa Rica (Calonge et al. 2005), Europe (Eckblad 1955, Sunhede 1989, Calonge 1998), Mediterranean Islands and Southern Africa (Kreisel 2001), Mexico (Ochoa et al. 2000, Calonge et al. 2004).

Comments: *Geastrum coronatum* is easily recognized by following characters: a debris-encrusted mycelial layer, endoperidium base with a short pedicel and



FIGS. 1-6. Schematic representations of *Geastrum* basidiomata.
FIG. 1 – *Geastrum coronatum*. FIG. 2 – *Geastrum elegans*. FIG. 3 – *Geastrum fimbriatum*.
FIG. 4 – *Geastrum fornicatum*. FIG. 5 – *Geastrum hieronymi*. FIG. 6 – *Geastrum ovalisporum*.

discrete apophysis. This species is close to *G. minimum* Schwein. due to the same macroscopic characters, differing in size and basidiospores ornamentation (Pegler et al. 1995). According to Kreisel (2001) and Sunhede (1989), *G. limbatum* Fr. and *G. atratum* F. Šmarda are synonymous of this taxon. This is the first report of *G. coronatum* from northeastern Brazil.

Geastrum elegans Vittad., Monogr. Lycoperd. pp. 15-16 (1842) **Fig. 2, 8**

Immature basidiomata hypogeal, globose to subglobose, without pointed apex, 20-25 mm broad, 20-25 mm high. Exoperidium fornicate, nonhygroscopic, when open splits into 7-9 unequal rays with acute tips; expanded basidiomata 47-50 mm (Fig. 2); the tips gradually becoming elevated below the endoperidium; mycelial layer encrusted with debris and soil; pseudoparenchymatous layer up to 2.3-2.8 mm thick, yellowish brown (KW 6E4); endoperidium globose to ovoid 15-17 mm broad, 15-20 mm high, sessile without apophysis; surface of endoperidium glabrous, dark brown (KW 6F4); conical,not delimited, peristome, with many folds, slightly elevated, concolor; gleba brown (KW 6E4); basidiospores globose, 2.5-4 µm diam. including the ornamentation, dark brown; capillitium 3-6 µm broad (Fig. 8).

Habitat: Gregarious, on sandy soil.

> MATERIAL EXAMINED: Brasil, Pernambuco, Recife: Reserva Ecológica de Gurjaú, 24/VI/1998, Baseia, UFRN-fungos 225.

Distribution: U.S.A.(Long & Stouffer 1948), Finland (Haeggström 1997), Europe (Sunhede 1989, Calonge, 1998, Kreisel 2001).

Comments: Macroscopically, *Geastrum elegans* is similar to *G. morganii* Lloyd, but this differs in the peristome which shows only 1-3 folds. In accordance with Sunhede (1989), *G. badium* Pers. and *G. umbilicatum* Fr. are synonymous of this species. This species is recorded for the first time from Brazil.

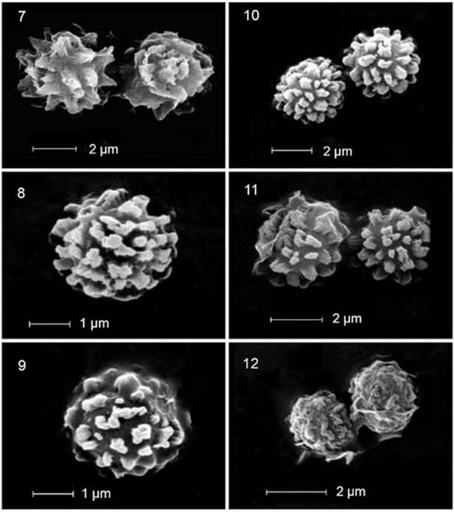
Geastrum fimbriatum Fr., Syst. Mycol. 3, p. 16 (1829) **Fig. 3, 9**

Immature basidiomata epigeal, subglobose, with pointed apex, 15-20 mm broad, 10-15 mm high. Exoperidium saccate, nonhygroscopic, split into 6-8 recurved rays with acute tips, when open; expanded basidiomata 20-30 mm (Fig. 3); mycelial layer glabrous, pale yellow (KW 4A3); pseudoparenchymatous layer up to 2-3 mm thick, yellowish brown (KW 6E4); endoperidium sessile, subglobose, up to 10 mm broad, and 8 mm high, without apophysis; surface of endoperidium fibrillose, light grey (KW 1D1); peristome fibrillose, concolor; gleba yellowish brown (KW 5F5); basidiospores globose 3-4 µm diam. including the ornamentation, light brown; capillitium, 3-4 µm broad (Fig. 9).

Habitat: Solitary on soil with plant debris.

> *MATERIAL EXAMINED: Brasil, Pernambuco, Recife: Horto Florestal Dois Irmãos, 21/II/200, Baseia (1378), UFRN-fungos 226. Rio Grande do Sul, S. Leopoldo: 1905, 1906, J. Rick PACA 15959, 15971. .*

Distribution: U.S.A. (Coker & Couch 1928), Brazil (Sydow & Sydow 1907, Rick 1961), Cuba (Ponce de León 1946), Great Britain (Demoulin & Marriott 1981), Europe (Sunhede 1989, Calonge 1998), Argentina (Soto & Wright 2000), Bolivia (Calonge et al. 2000), Costa Rica (Calonge et al. 2005).



FIGS. 7-12. *Geastrum* basidiospores as seen under SEM.
FIG. 7 – *Geastrum coronatum*. FIG. 8 – *Geastrum elegans*. FIG. 9 – *Geastrum fimbriatum*.
FIG. 10 – *Geastrum fornicatum*. FIG. 11 – *Geastrum hieronymi*. FIG. 12 – *Geastrum ovalisporum*.

Comments: *Geastrum fimbriatum* is macroscopically distinguished by its sessile or rarely very short-stalked endoperidium and fibrillose peristome; microscopically is characterized by its pale capillitium and small basidiospores. According to Sunhede (1989), Calonge (1998) and Kreisel (2001) *G. sessile* (Sowerby) Pouzar and *G. tunicatum* Vittad. are synonymous of *G. fimbriatum*. This is the first record from northeastern Brazil.

Geastrum fornicatum (Huds.) Hook., Flora Londinensis 4, p 575 (1821) Fig. 4, 10

Immature basidiomata hypogeal, globose, without pointed apex, 20-25 mm diam. Exoperidium fornicate, nonhygroscopic, split into 4 equal rays when open, which recurve and the tips remaining attached to a basal cup, the rays surface scaling irregularly in age to expose a light brown under layer; expanded basidiomata 30-40 mm broad (Fig. 4); mycelial layer encrusted with debris; pseudoparenchymatous layer up to 2 mm thick, dark brown (KW 6F4); endoperidium subglobose 13-16 mm broad, 10-13 mm high, with a short pedicel and apophysis; endoperidium with a roughened surface, brown (KW 6D4); peristome elevated, fimbriate, indistinctly delimited; gleba dark brown (KW 6F5); basidiospores globose, 3.5-5 µm diam. including the ornamentation, dark brown; capillitium, 6-10 µm broad (Fig. 10).

Habitat: Gregarious on soil with decaying wood.

> MATERIAL EXAMINED: Brazil, Pernambuco, Igarassu: Reserva Biológica Charles Darwin, 21/VI/2001, Baseia, UFRN-fungos 227. U.S.A., New Mexico, Long & Stouffer, URM 31415.

Distribution: U.S.A.(Coker & Couch 1928), Mexico (Ochoa & Moreno 2006), Great Britain (Palmer 1968, Demoulin & Marriott 1981) Europe (Sunhede 1989, Calonge 1998), Canaries Islands, South Africa, Australia, North America and Argentina (Kreisel & Hausknecht, 2002).

Comments: This is a distinctive species recognized by it's strongly fornicate rays which recurve and elevate the endoperidium, the tips remaining attached to a mycelial layer that form a basal cup. *Geastrum quadrifidum* is close to *G. fornicatum*, but differs in the well-delimited peristome of *G. quadrifidum* Pers. *G. fornicatum* is recorded for the first time from Brazil. According to Kreisel & Hausknecht (2002) the first record from South America was made in Argentina.

Geastrum hieronymi Henn., Hedw. 36, p. 211 (1897) Fig. 5, 11

Immature basidiomata hypogeal, subglobose, without pointed apex, 17-23 mm broad, 15-25 mm high. Exoperidium fornicate, hygroscopic, split into 7-9 unequal rays with acute tips when mature; expanded basidiomata 30-40 mm (Fig. 5); mycelial layer encrusted with debris; pseudoparenchymatous layer up to 2.5-3 mm thick, brown (KW 6E4); endoperidium globose to subglobose 14-16 mm broad, with a pedicel and inconspicuous apophysis; surface of endoperidium glabrous, brownish orange (KW 5C3); fibrillose peristome, concolor; gleba brown (KW 6E4); basidiospores globose, 3-5 µm diam. including the ornamentation, brown; capillitium, 4.2-6.3 µm broad (Fig. 11).

Habitat: solitary on litter and soil with plant debris.

Material examined: Brazil, Pernambuco, Serra Negra: Reserva Biológica de Serra Negra, 17/V/1998; Baseia, UFRN-fungos 228. U.S.A., New Mexico, 14/I/1942; D. J. Stouffer. URM 29871.

Distribution: U.S.A. and Canada (Coker & Couch 1928, Long & Stouffer 1948), Argentina, Brazil, México (Ponce de León 1968) and Southern Africa (Kreisel 2001).

Comments: *G. hieronymi* can be macroscopically recognized by the following characters: fornicate exoperidium with the mycelial layer strongly attached to the fibrous layer, endoperidium stalked with a inconspicuous basal apophysis and fibrillose mouth. Microscopically can be segregated by the spore size. According to Sunhede (1984), *G. hieronymi* does not belong to the truly hygroscopic species as e.g. *G. pseudolimbatum* Hóllos, *G. campestre* Morgan or *G. floriforme* Vittad. This species resembles *G. rufescens* Persoon, from which *G. hieronymi* differs by the endoperidium surface asperulate and by the dark color. This is the first record from northeastern Brazil.

Geastrum ovalisporum Calonge & Mor.-Arr., Bol. Soc. Micol. Madrid 25, pp. 273-275 (2000) Fig. 6, 12

Immature basidiomata hypogeal, subglobose, without pointed apex, 15-25 mm broad, 15-25 mm high. Exoperidium fornicate, nonhygroscopic, split into 6-8 unequal rays with acute tips, when open; expanded basidiomata 20-30 mm (Fig. 6); mycelial layer persistent encrusted with debris, brownish orange (KW 5C4); pseudoparenchymatous layer up to 1-2 mm thick, grayish orange (KW 5B4); endoperidium ovoid, globose to subglobose 10-15 mm broad, 12-17 mm high, with a pedicel and apophysis; surface of endoperidium covered by crystalline elements, dark brown (KW 7F4); peristome conical, concolor; gleba dark brown (KW 7F4); basidiospores ovoid, 2-3 x 2-2,5 µm diam. including the ornamentation, dark brown; capillitium, 4.5-8 µm broad (Fig. 12).

Habitat: gregarious growing on soil with decaying wood.

Material examined: Brazil, Rio Grande do Norte, Natal: Parque Estadual Dunas do Natal, 10/VII/2004, Baseia, UFRN-fungos 229.

Distribution: Bolivia (Calonge et al. 2000).

Comments: *Geastrum ovalisporum* is fundamentally segregated by the uncommon spores, which are ovoid. Macroscopically, there are several similar species, such as *G. javanicum* Lév., with a sessile endoperidium and globose espores; *G. dissimile* Bottomley, with sulcate peristome and bigger globose spores, 3.4-5.1 µm. Other two species show affinities: *G. minimum*, with endoperidium covered by crystalline bodies, but with bigger globose spores, 4.5-7 µm. *Geastrum lloydianum* has bigger basidiomata, 40-60 mm diam. and globose spores.

Geastrum ovalisporum was originally described from Bolivia (Calonge et al. 2000), and this is the first record to Brazil and the second in the world.

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Xerula hispida and *Xerula setulosa* (comb. nov.), two similar subtropical New World agarics

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Abstract — *Gymnopus setulosus*, described from Jamaica, is now known from the Caribbean, Central and tropical South America. Apparently, *Lentinus pilosus* Rick, described from southern Brazil, is a synonym. The species belongs in *Xerula* sect. *Xerula*, and a new combination is proposed to accommodate this placement. *Xerula hispida*, described from Costa Rica, appears to be a 2-spored state of *X. setulosa*, and is reported here from northern South America for the first time.

Key words — biogeography, distribution, anamorphic state

Introduction

When William Alphonso Murrill wrote notes on the single basidiome of *Gymnopus setulosus* from Jamaica, he commented, "quite peculiar." A small, gracile, spindly basidiome fruiting out of a wet clay bank, the entire outer surface of the pileus and stipe was covered with stiff, lanceolate setae, and the fruitbody formed a pseudorhizal extension of the stipe base.

Since that initial collection, no other basidiome has been accessioned under this name or its equivalent, *Collybia setulosa*. Its taxonomic placement has remained obscure in spite of Dennis's voluminous literature on Venezuelan and Caribbean fungi and Pegler's floristic work on the Lesser Antilles.

Somewhat later, Rick described *Lentinus pilosus* from southern Brazil. Pegler's impression, taken from the original description, was that Rick's specimen "almost certainly" represented a species of *Crinipellis*. Singer (1953) examined the type specimen and concluded that it was a *Xerula*, closely related to *X. pudens*.

Much more recently, Halling & Mueller (1999) described *Xerula hispida*, a 2-spored, clampless species from *Quercus* forests of Costa Rica.

The intent of this paper is to describe *Xerula setulosa* (comb. nov.), inclusive of *X. pilosa*, and to redescribe *X. hispida* with additional geographical range.

Materials and methods

Abbreviations: TFB = Tennessee Field Book; comprising notes, photos and other tracking numbers, superceded by a TENN number, the accession number of the herbarium specimen. PhC = Phase Contrast Microscopy. Color terminology within quotation marks refer to Ridgway (1912).

Results

Xerula setulosa (Murrill) R.H. Petersen & T.J. Baroni, **comb. nov.** Figs. 1–8
MYCOBANK MB 510847

Basionym: *Gymnopus setulosus* Murrill 1916. North American Flora 9: 373.
≡ *Collybia setulosa* (Murrill) Murrill 1916. Mycologia 8: 219.
≡ *Marasmius setulosus* (Murrill) Singer 1951 ('1949'). Lilloa 22: 326
[non *M. setulosus* Murrill 1940. Bull. Torrey Bot. Club 67: 150].
≡ *Marasmius murrillianus* Singer, nom. nov. 1952. Lilloa 25: 488.
Holotype (des. Murrill): JAMAICA, Cinchona, 25.XII.1908-8.I.1909,
coll WA Murrill, Murrill 632 (NY!).

= *Lentinus pilosus* Rick 1938. Lilloa 2: 310, nom. illeg.
[non *Lentinus pilosus* (Fr.) Fr. 1838. Epicrisis Systematis Mycologici: 395].
≡ *Xerula pilosa* (Rick) Singer 1953. Lilloa 26: 86, nom. nov.
[see also Revue Mycol. 18: 6. 1953]
≡ *Oudemansiella pilosa* (Rick) Singer. 1962 ('1961'). Sydowia 15: 59 [see also:
Raithelhuber 1962. Fl. Mycol. Argentina, Hongos III (Stuttgart): 95].
Holotype (des Rick, teste Singer): Unspecified. [see Singer, 1953: BRAZIL, Rio Grande
do Sul, São Leopoldo, as *Lentinus pilosissimus*, Rick no 13.845 (PACA).

Basidiomata (Fig. 1) gracile, diminutive, collybioid, radicating. **Pileus** 7–20 mm diam, 1–6 mm high, plano-convex with truncate to mammilate umbo, rugose, occasionally delicately areolate, Isabel to raw umber (223) to deep gray-brown (6F5) over disc, outward gray-brown (6E4) fuliginous outward (drying to dark purplish brown), covered with white, tawny, rufous or brownish bristles up to 700 µm long; margin undulate, slightly incurved. Flesh thin (less than 1 mm thick), white, unchanging with bruising, with no odor or taste. **Lamellae** adnate to adnexed, non-collariate but sometimes seceding to a pseudocollarium, moderately broad (–1.5 mm broad), pruinose, non-marginate, pure white, subdistant; edge concolorous. **Stipe** 40–60 × 0.5–2.5 mm, flattened, off-white apically, downward salmon colored, Isabel, or deep golden brown (5D7–6D7), pubescent with brown bristles (drying cinnamon brown), hollow, expanded at base; pseudorhiza abruptly tapered, furrowed, pubescent, brownish gold, radicating.

Habitat: Under broad-leaved trees; in Belize under *Quercus oleoides*, *Coccoloba brasiliensis* and mixed hardwoods.

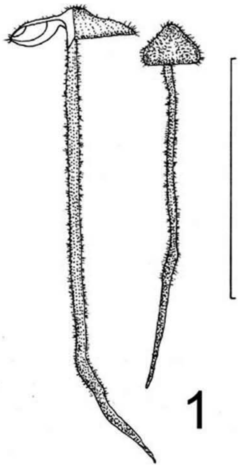

Fig. 1. *Xerula setulosa*. Basidiomata. Illustrative reconstruction.
Standard bar = 40 mm.

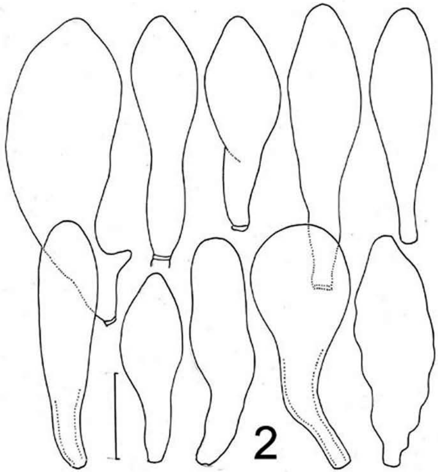

Fig. 2. *Xerula setulosa.* Pileicystidia. Holotype.
Standard bar = 20 µm.

Pileipellis hymeniform, constructed of two elements. **Pileocystidia from disc** (Fig. 2) 28–70 × 9–15 µm, clavate, fusoid-ventricose, lageniform, subglobose or fusiform, thick-walled (wall consistently 1.2 µm thick), with outer limit of wall indistinct (but inner surface distinct), arising from somewhat inflated, thick-walled subpellis cells, without clamp onnections; contents uniformly pallid olive-brown, inamyloid; **pileosetae from disc** (Fig. 3) rudimentary, up to 85 µm long, appearing ochraceous orange (PhC). **Pileocystidia from**

pileus margin 26–56 × 15–33 µm, hardly pedicellate, subsphaeropedunculate, arising from inflated subpellis hyphae, usually with thickened basal septum, firm-walled; contents usually heterogeneous, occasionally homogeneous and then uniformly deep olive-brown; **pileosetae from pileus margin** 63–180(–800) × 7–28 µm, arising with single base (not basally furcate) but sometimes with 1–3 small proximal knobs, cylindric-acuminate or lanceolate, obtuse,

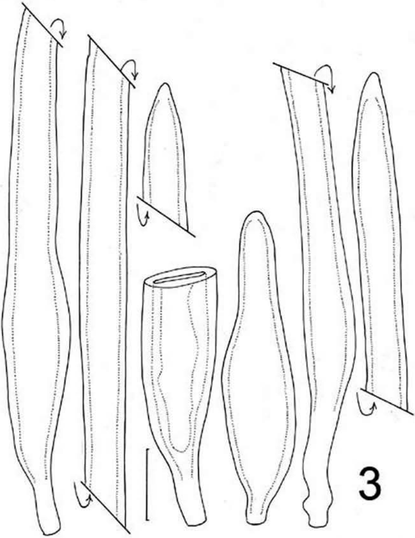

Fig. 3. *Xerula setulosa*. Pileisetae. TJB 7239.
Standard bar = 20 µm.

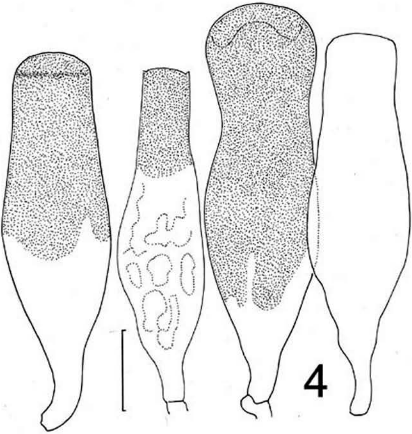

Fig. 4. *Xerula setulosa*. Pleurocystidia. Holotype.
Standard bar = 20 µm.

subacute or acute, melleous or brownish orange, tawny or ferruginous, thick-walled (wall 3–8 µm thick), inamyloid. Pileus trama interwoven, sarcodimitic. **Pleurocystidia** (Figs. 4, 5) 60–130 × 12–33 µm, thin-, firm-, or thick-walled, especially over pedicel, ventricose or broadly lageniform, with bluntly rounded apex, often long-pedicellate, hyaline, firm- to thick-walled (especially over proximal inflation), without clamp connections; contents heterogeneous, with apical 1/3–2/3 minutely multigranular, hardly refringent, and the lower portion with coagulated protoplasm. **Hymenophoral trama** bilateral, with wide mediostratum and narrow divergent lateral strata, subgelatinous; hyphae inamyloid, without clamp connections, of two cell types: 1) greatly inflated, catenulate, up to 75 µm long, up to 40 µm diam, firm-walled but easily collapsed, hyaline, clampless; contents homogeneous; and 2) slender (3.5–4.5 µm diam), interwoven, thin-walled, hyaline; contents homogeneous. Basidioles subclavate or ventricose, hyaline, thin-walled. **Basidia** (Fig. 6) 30–60 × 10–19 µm, (2-, 3-)4-spored, clavate from somewhat pinched base, rarely obviously clamped; contents multiguttulate when immature, becoming several-guttulate by maturity. **Basidiospores** (Fig. 6) (7–)10–12.8(–14) × (7–)9–12 µm (E = 1.00–1.40;

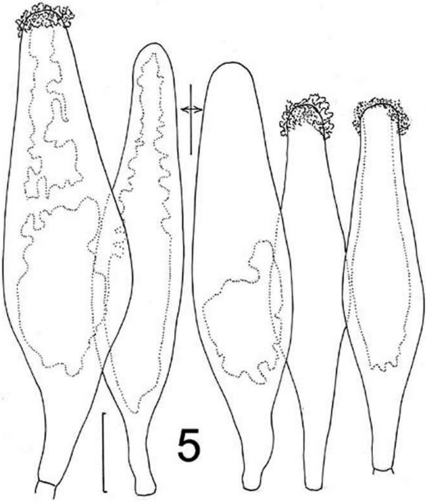

Fig. 5. *Xerula setulosa*. Pleurocystidia. Left; TJB 7239. Right; Ventura 1891.
Standard bar = 20 µm.

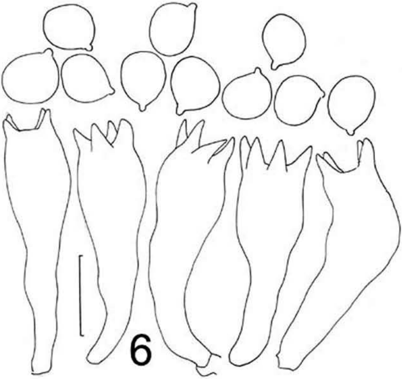

Fig. 6. *Xerula setulosa*. Basidia and basidiospores. Holotype. Standard bar = 20 µm.

Em = 1.17; Lm = 12.20 µm), globose to subglobose, smooth to delicately puckered, hyaline; contents opalescent to granular, yellowish in iodine. Lamellar margin fertile, with scattered cheilo- and pleurocystidia. **Cheilocystidia** (Fig. 7) 49–76 × 10–24 µm, short-pedicellate, utriform, fusiform, lecithiform, or subulate, hyaline; contents homogeneous. **Stipe apex** outer cortex of hyphae with reddish-brown walls; hyphae 3–8 µm diam, thick-walled (wall up to 1 µm thick); inner stipe apex hyphae of two types: 1) inflated, unbranched, 5–16 µm diam; and 2) infrequently branched, 1.5–4 µm diam. Stipe midsection with surface layer of straw-colored, slender (4-8 µm diam), thick-walled (wall up to 1.5 µm thick), simple-septate, apparently coherent hyphae, with inner flesh hyphae similar but hyaline; stipe surface beset with blond setae, in clusters including abortive, hyaline individuals and 1-3 well-developed individuals. **Stipe surface** of two elements: 1) caulocystidia 10–32 × 5.5–8 µm, cylindric or subclavate, obtuse, rarely lobed, hyaline or yellowish, inamyloid, thick-walled (wall up to 1 µm thick); and 2) caulosetae (Fig. 8) 100-460 ×

10–20 µm, lanceolate, melleous, reddish brown to burnt orange-ochre near base, soon yellow-ochre, then pallid yellow and finally subhyaline at apex, thick-walled (wall 1–7 µm thick), similar to pileisetae or longer, somewhat flexuous.

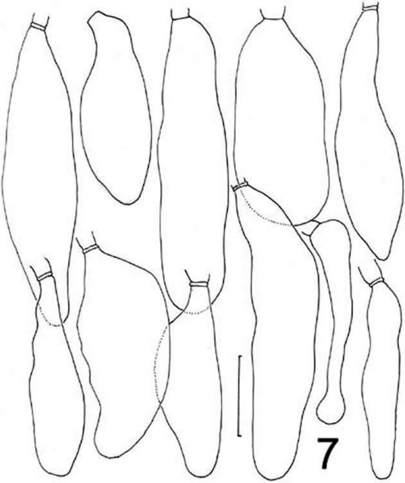

Fig. 7. *Xerula setulosa*. Cheilocystidia. TJB 7239.
Standard bar = 20 µm.

Commentary: Material with the type specimen at NY includes three annotations as well as Murrill's original notes. When collated, Alexander Smith's informal notes on the type specimen, his published observations (Smith 1938), Desjardin's (1989) observations, a brief annotation by Gilliam,

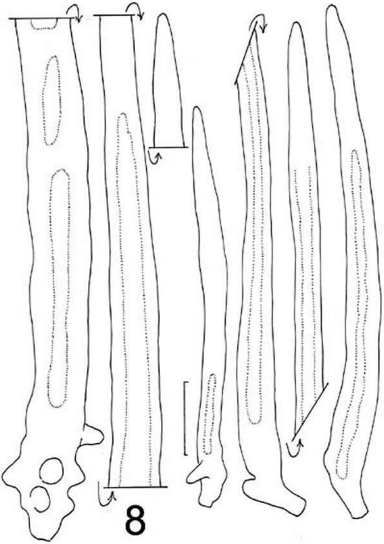

Fig. 8. *Xerula setulosa.* Mid-stipe caulosetae. Holotype.
Standard bar = 20 µm.

and our examination of the type specimen, a rather complete description of the basidioma can be extrapolated. Although originally published as a *Gymnopus* species, the epithet was not taken up by Halling (1983).

In herb. Kew, no specimen exists under the binomial *G. setulosus*, but a sheet with aquarelle, drawings, and notes is available. Pertinent notes (some apparently in the hand of RWG Dennis) and other material follows:

> 1) note: "Cinchona, 25 Dec – 8 Jan, 1908-9. About 1500 m. WA and EL Murrill 632;"
>
> 2) "Fig. 116. Wet bank. Radicate in mossy clay. Irreg. conic. 1.6 [cm] d[iam], 6 [mm] high, top truncate, cap rugose & uneven, Isabel at top, rest fulig[ineous], all covered with white to brownish bristles, many undulate, sl[ightly] incurved, gills pure white, 1 mm apart, free it seems, stem flattened, Isabel with brown bristles, hollow, 5 cm long, .25 [cm] d[iam] at center, enlarged at base and radicate like *Collybia radicata* & tough too. Very peculiar. (Collector's notes with type);"
>
> 3) [spores] globose, smooth, hyaline, granular, 7-11 µ;
>
> 4) [Murrill's notes] "the few spores found on the gill – though immature – are consistent with this. Trama of apparently non-gelatinized, non-amyloid but hypodermium is reddish in Melzer. Too few spores to determine iodine reaction;"
>
> 5) drawings of typical pleuro- and cheilocystidia, 2-4-spored basidia, pileipellis and pileosetae, plus aquarelle of basidiomata. The aquarelle closely resembles the aquarelle at NY and surely is a copy of it.

We conclude that Dennis examined the type specimen of *G. setulosus*, probably as part of his work on tropical South American fungi. The name, however, was not taken up in Dennis's (1951, 1961, 1968, 1970) publications which included agarics from the region, nor is there a reference to it by Pegler (1983a) for the Lesser Antilles.

The cumulative description above closely resembles that of *X. hispida* except for 4-spored basidia. Desjardin specifically noted that hyphae were clampless, and this would not ordinarily accompany 4-spored basidia. Murrill illustrated a short, tapering pseudorhiza, while basidiomata of *X. hispida* usually bear rather long, gradually tapering pseudorhiza.

Murrill (1916a) published *Gymnopus setulosus* for a single specimen from Cinchona, Jamaica. Later (Murrill 1916b) he published a long list of "currently accepted generic names" for species published in NAF. These names cannot be accepted as "simultaneous names" in the sense of the ICBN. Therefore, *Collybia setulosa* is a nomenclatural synonym of *Gymnopus setulosus*.

Later (Murrill 1940), Murrill described *Marasmius setulosus* as a separate taxon.

Singer (1951) transferred Murrill's *Gymnopus setulosus* to *Marasmius*, but later found that the combination was preoccupied by Murrill's 1940 name. Singer (1952), therefore, proposed a nomen novum for his sense of *Marasmius setulosus*, and he chose *Marasmius murrillianus*.

Smith's (1938) report of the type specimen indicated a single, well-preserved fruit-body, while Desjardin found only 1/3 of a single pileus and some additional fragments. Smith reported on basidia and basidiospores, while Desjardin saw none of either. Now, the type specimen has been reduced to five small fragments, two of pileus + lamellae (but with lamellar edges absent), the others of stipe. The largest fragment remaining is of the pseudorhiza, also beset with setae. The stipe seems quite slender (although only a couple longitudinal fragments remain). An approximation of the cap might be 2 cm broad (see Murrill's notes). Information may be sought at http://sweetgum.nybg.org/vh/specimen.php?im=579487.

It is probable, based on the few specimens reported here, that *X. setulosa* produces smaller and more gracile basidiomata than its 2-spored analog, *X. hispida*. A very similar organism, *X. sinopudens* R.H. Petersen & Nagas., also 4-spored, forms gracile, spinulose fruitbodies. Both Baroni specimens exhibited a mixture of 2- and 4-spored basidia, an unusual situation, especially with tramal hyphae and basidia without clamp connections.

In TJB 7289, the pileus surface is delicately shagreened to areolate, with the underlying flesh straw colored, overlaid by the outer layer of dark olive. The umbo is solidly so (i.e. not cracked and uniform in color). Areolation is more and more delicate outward, with the pileus margin extremely delicately so. The first appearance of setae (20X) is on the pileus limb, half way to the margin, and the margin is the most setose area of the pileus. This seems typical of basidiomata of *Xerula* sect. *Xerula*.

Specimens examined: BELIZE, Cayo District, Banglor d'Silva Forestry Station, 13.I.2002, coll TJ Baroni, TJB 7289 (CORT). **JAMAICA**, Cinchona, 25.XII.1908-8.I.1909, coll WA Murrill, Murrill 632 (holotype of *G. setulosus*, NY!). **MEXICO**, Est. Hidalgo, km 4 de la desviación hacia El Mineral del Chico, 18.IX.1983, coll R Valenzuela (as *Oudemansiella*), Valenzuela 2547 (ENCB); Est. Puebla, Carretere Tezuitlan a Tlapacoyan, Puente Colorado, 30.VII.1970, coll F Ventura, Ventura 1891 (ENCB) [annot. "revisó y determinó" E. Perez Silva, 1985, as *O. pilosa*]. UNITED STATES, **PUERTO RICO**, Palo Hueco, east of Rio Espiritu Santo, N 18° 18' 51", W 65° 49' 21", 550 m, 16.VII.1998, coll SA Cantrell & C Laboy, det DJ Lodge (as *Xerula* sp), TJB 4899 (CORT).

Xerula pilosa

According to Singer (1953: 86), a specimen deposited by Rick as *Lentinus pilosissimus* (Rick 13845) and published by Rick (1938: 310) as *Lentinus pilosus*, is a *Xerula*, "closely related to *Xerula pudens* (Pers. ex S.F. Gray) Sing." Singer (1953, 1962, 1964) furnished three descriptions of the species, but at least two of these (Singer 1953, 1964) cited only the type specimen as the source. Singer's generic concept changed over the years, and the terminal stop for the epithet was as *Oudemansiella pilosa* (Rick) Singer (1962). Dörfelt (1985) examined the type specimen and augmented Singer's descriptions somewhat. Combining these sources, a comprehensive description of the type specimen can be offered. Dorfelt's (1985) description appears in Roman type; Rick's (1938) description is in italics; and Singer's (1964) description is in bold face.

Two basidiomata. Small, thin-fleshed (*elastico, submembranaceo*), dark brown agaric from *Crinipellis* habitat. **Pileus** 0.5-1 cm diam (*1 cm. lato*; **10 mm broad**), subumbonate (*papillato*; **with papilla**) to nearly plane (*plano-depresso*; **flat to depressed**), chocolate brown (*brunneo*; **brown, not striate**) with disc darker; surface dry (**dry**), densely prickly through macrosetae (*setuloso, setulis magnis*; **beset with setulose brown hairs**); macrosetae on cap surface 300–450(–1200) µm long. **Lamellae** free (!) to attached (?) (*ventricosis, adnatis, inaequalibus confertis, albis; albis notabilis*; **white, ventricose, polydymous, adnate, close**), in dried specimen brownish-white, seceded. **Stipe** (*ferrugineo-setuloso*; **rusty-brown, setose-pilose**), 4.5–6 cm long (!) (*1 dm longa*; **about 100 mm long**), (1–)2–2.5 mm thick (cap diameter: stipe length, 1:10), basally clearly straight (**subequal**), twisted when dry; ground color of stipe surface chocolate brown; macrosetae concolorous but shining; pseudorhiza broken off, up to 2 cm long and then broken (*radicante*), appearing like the stipe. **Veil none. Context white, thin, elastic in pileus, toughish in stipe.**

Spores almost round to broadly ellipsoid (*ovato-sphaericis, apiculatis, 12 μ*; **broadly ellipsoid**), 9.5–12 µm diam and/or 10–16 × (8.5–)9.5–14 µm, mostly 13 × 11 µm (!) (**about 10.2 × 6.9 µm**): basidia 30–36(–40) × (7–)10–20 µm (!) (*magnis clavatis*; **about 40 × 7 µm or more broad**); cystidia 37–83 × 17–24 µm (S) (**37–83 × 17–24 µm**), rotund to flask-shaped or apically broadly rounded off (*paucis magnis, lageniformibus*), sometimes apically encrusted or with crystals, these more seldom than in *Xerula pudens* [**with rounded tips, reminiscent of those of *Inocybe*, ampullaceous-ventricose, with thick (at least 2 µm) wall, smooth or somewhat hyaline-incrusted, metuloid, somewhat opalescent, hyaline, sometimes compressed and thus shortened above, on edges and sides of lamellae**]; macrosetae [cheilocystidia] always pointed, smaller mostly tapering, larger usually abrupt with tips appearing like fence slats, in the middle (10–)13–16(–19) µm thick, base to 22 µm; wall (1.5–)2.5–7 µm thick, very seldom under 1 µm (!). **Hyphae hyaline, inamyloid with clamp connections.** Macrosetae of pileus surface [pileisetae] seldom inserted in the cells of the hymeniderm, most in the "mesopileus" range of the cap trama, arising in the subhymenial range and erupting through the cap trama and hymenoderm [**these "hairs" (i.e. pileosetae) 300–450 × 13.4–20 µm, thick-walled (wall 2.7–7 µm thick), rarely entirely subhyaline, mostly melleous to castaneous-succineous, gradually tapering and becoming lighter colored toward the needle- sharp, acute tip, usually more pigmented in the inner layer of the complex wall, inamyloid (not pseudoamyloid!)**]; hymenoderm irregular and as all *Xerula* taxa, deviating from a strict cutis and/or trichoderm-type structure (teste Singer: "not forming a true hymeniform layer..."). Elements of upper pileus surface not regularly inserted in a layer, stalked, apically inflated or somewhat subglobose (vaguely pear-shaped), 8–16 µm diam, with brown intracellular pigment; stipe surface of long, parallel hyphae outward forming a plectenchymatous rind, macrosetae inserted relatively superficially.

Pérez-Silva & Aguirre-Acosta (1985) included a brief description of *O. pilosus* from Puebla and Veracruz, Mexico, adopting Singer's concept of the species. Although illustrating some important characters (i.e. pileipellis elements, cystidium, spores), the number of sterigmata per basidium was not reported. Their description could refer to diminutive basidiomata of *X. hispida*.

Putzke & Pereira (1988) redescribed *X. pilosa* from fresh material from near its topotype area. Not only do their observations on microscopic characters match the descriptions of type material (i.e. basidia 4-spored, cystidia metuloidal, basidiomata very slender, gracile, pilei- and caulosetae lanceolate, blond) but their illustration of basidiomata comes very close to the illustration furnished above. Their reported collections were from São Francisco de Paula, Rio Grande do Sul, Brazil, which, together with the type specimen, represent the southernmost stations for the species. Lately, Meijer (2002) included the species (as *X. pilosa*) in a floristic study of macromycetes of Paraná, Brazil, but without description. This entry was repeated in a new report (Meijer 2006). Pegler did not mention the epithet in any of his floristic publications, but in the monograph of *Lentinus* (Pegler 1983b: 251) he reported: "On the basis of the original description, this tiny fungus almost certainly represents a species of *Crinipellis*," an impression reported by Singer and appearing on a herbarium sheet at Kew.

Unfortunately, Rick's type specimen was unavailable for our study, so a final judgment as to its identity cannot be rendered. From its diminutive, gracile stature, semi-tropical topotype, and comprehensive data from other authors (see above), we conclude that it is a synonym of Murrill's *Gymnopus setulosus*. As a later name, consideration of *Xerula pilosa* does not threaten Murrill's epithet.

Xerula hispida Halling & G.M. Muell. 1999. Mycotaxon 71:105. Figs. 9–15

Holotype (des. Halling & Mueller 1999): COSTA RICA, Prov. San José, San Gerardo de Dota, Albergue de Montaña, 10.VI.1994, Mueller 4696 (USJ; isotype F[!]).

Basidiomata (Fig. 9) diminutive, gracile, pseudorhizal. **Pileus** 8–45 mm broad, umbonate to depressed-umbonate, dry, fibrillose-hispid, sometimes hygrophanous, usually radially puckered, striate; umbo "olive brown," "dark olive," "olive buff," "sayal brown," "buffy brown" (6-7E–F5-7); margin "tawny olive," "olive buff," to cream with yellow-brown streaks, ciliate with "tawny" pileisetae; trama white, thin. **Lamellae** up to 5 mm deep, white, free to subadnexed, subdistant, tough, eventually pallid cream with age and after drying; margin blunt, not marginate, sometimes fringed with white cheilocystidia (15X). **Stipe** 30–85 × 2–4.5 mm, velutinous, "light olivaceous

Fig. 9. *Xerula hispida*. Basidiomata. TFB 10881.
Standard bar = 40 mm.

buff" (5A4) apically, downward "ochraceous tawny," "tawny" to "sayal brown," (6D8, 5D6–8), profoundly hollow; **pseudorhiza** 15–35 mm long, hardly expanded upward, tapering downward gradually, velutinous, concolorous with stipe base. **Odor** negligible; **taste** negligible.

Distribution: Central America and northern South America, apparently associated with *Quercus* (*Q. rapurahuensis*, *Q. seemannii*, *Q. copeyensis*, *Q. humboldtii*); solitary to gregarious; pseudorhizal in humus or soil.

Pileipellis (Fig. 10) constructed of two discrete elements. **Pileocystidia** 50–83 × 12–32 µm, sphaeropedunculate to broadly clavate, pedicellate, often with a

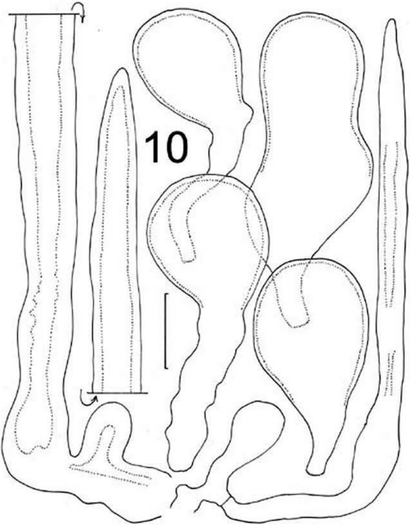

Fig. 10. *Xerula hispida*. Pileipellis structures. TFB 10881.
Standard bar = 20 µm.

small spur proximal to inflated apex, thick-walled (wall up to 1.5 µm thick); contents homogeneous, hyaline to distinctly pigmented olive-tan. **Pileosetae** 150–600 × 10–23 µm, sagitate, lanceolate (especially acute when small), often with basal spur or lobe, thick-walled (wall up to 6 µm thick, occluding cell lumen distally), yellow to ochraceous orange (PhC), refringent; in some specimens (including the type) small, aborted pileisetae abundant. Pileosetae and pileocystidia arise from same hyphae; clamp connections absent. **Pleurocystidia** (Figs. 11, 12) without clamps, of two types: 1) 95–120(–185)

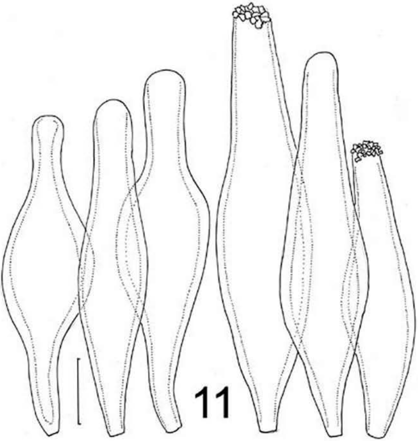

Fig. 11. *Xerula hispida*. Pleurocystidia. Left; TFB 10881. Right; TFB 9463. Standard bar = 20 µm.

× 20–30 µm, narrowly ten pin-shaped, thick-walled (wall up to 6 µm thick in median portion, thinner over capitulum and at base), refringent, sometimes with apical crystalline deposit or (in fresh condition) apical droplet; and 2) 53–72 × 13 µm, fusiform with lanceolate apex, obscurely thick-walled, refringent. **Basidia** (Fig. 13) 38–62 × 10–13 µm, clavate, arising from pinched base, without clamps, 2-spored (sterigmata up to 9 µm long); contents multiguttulate, with 2-4 major guttules. **Basidiospores** (Fig. 13) 11–14 × 8–12 µm (E = 1.08–1.50; Em = 1.26; Lm = 12.53 µm) subglobose to ovoid, slightly flattened adaxially, smooth to very delicately dimpled, hyaline; contents uniguttulate, strongly refringent under phase contrast. **Lamellar margin** apparently fertile, hardly extended in KOH, punctuated by differentiated cheilocystidia. **Cheilocystidia**

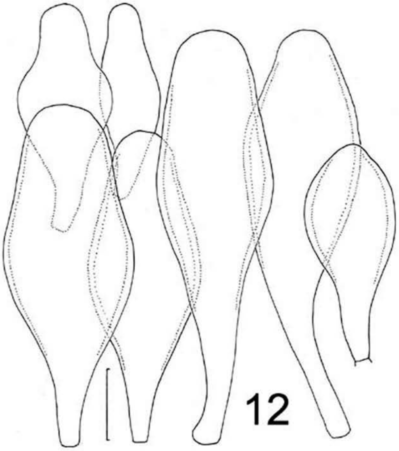

Fig. 12. *Xerula hispida*. Pleurocystidia. Guzmán 11300.
Standard bar = 20 µm.

of two types: 1) (Fig. 14) 28–50 × 8–15 µm, fusiform to clavate, hyaline, thin-walled, without clamp connection; and 2) cheilosetae occasional, 45–82 × 10–25 µm, setiform, similar to pleurocystidia but smaller, lanceolate apically, hyaline, thick-walled (wall up to 2 µm thick in larger individuals), without clamp connection. **Upper stipe surface** a textura of lobose cells producing two types of cystidia: 1) caulocystidia 30–75 × 8–14 µm; and 2) caulosetae up to 450 µm long, 10-14 µm broad, ochraceous (PhC), thick-walled (wall up to 5 µm thick, obscurely so in proximal area), in fascicles, arising from surface hypha, sometimes with a proximal lobe or spur. **Caulocystidia from mid-stipe** (Fig. 15) a lawn of gnarled, hyaline, digitate to clavate hyphal tips, and fascicles

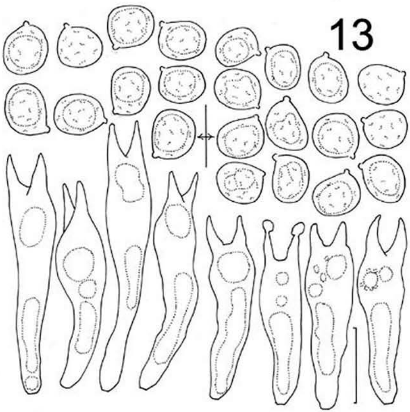

Fig. 13. *Xerula hispida*. Basidia and basidiospores. Left; TFB 10881. Right; TFB 9463. Standard bar = 20 µm.

(×15) of caulosetae; caulocystidia clavate to digitate or substrangulate, thin-walled, hyaline, arising from a textura of gnarled or lobose cells; caulosetae in stellate fascicles with one or two dominant, sclerified,, pigmented individuals and several hyaline, thick-walled individuals arising from hyaline, superficial stipe surface hyphae; caulosetae type 1): 15–50 × 5–8 µm, hyaline, sinuous, thick-walled (wall up to 1.5 µm thick at proximal end); type 2) 150–400 × 7–18 µm, setiform, ochraceous yellow, thick-walled (wall up to 6 µm thick, obscurely so proximally and thinning distally); base usually pinched but in one specimen with abortive sclerified knobs as though multi-rooted.

Commentary: Initial description and acceptance of *X. hispida* raises the issue of possible anamorphs within the International Code of Botanical Nomenclature. A self-cross pairing experiment using TFB 10881 (data not shown) showed that only one mating type was present in the population of 12 SBIs, an indication that basidiospores from that basidioma were unisexual, probably the products

14

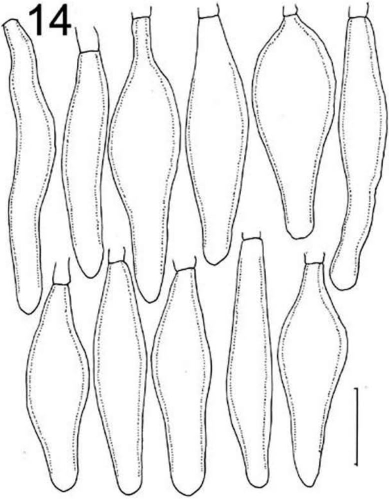

Fig. 14. *Xerula hispida*. Cheilocystidia. Upper; TFB 10881. Lower; DED 4838.
Standard bar = 20 µm.

of mitosis, not meiosis. This was shown to be the case in *X. radicata* f. *bispora* by Petersen & Methven (1994), and might be assumed in other 2-spored forms as recently surmised (Petersen & Nagasawa 2006). In some cases, the 4-spored taxon was described prior to the 2-spored (i.e. *X. radicata* is prior to *X. radicata* f. *bispora*). In uncommon instances, however, the 2-spored (assumed asexual) form was named prior to the 4-spored (i.e. *X. raphanipes* as 2-spored; *X. chiangmaiae* as 4-spored). In the latter case, Petersen & Nagasawa (2006) chose to coin a binomial combination for the 4-spored taxon (*X. chiangmaiae*)

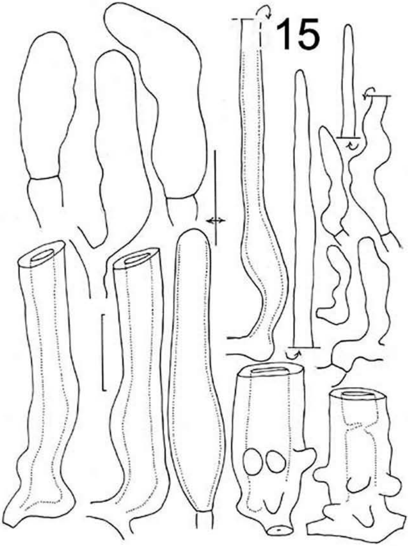

Fig. 15. *Xerula hispida*. Caulosetae.
Left; stipe apex; TFB 10881. Right; stipe midsection, TFB 9463.
Standard bar = 20 µm.

and to place the prior name as a synonym (*X. chiangmaiae* var. *raphanipes*). If the basidiomata represented by *X. chiangmaiae* var. *raphanipes* are asexual, then the asexual organism should be treated as a "form taxon" under Article 59, not conforming to the Linnaean sexual system of nomenclature. In the case of *X. hispida*, the 4-spored analog exists and its epithet is priorable, making nomenclatural treatment straightforward. The question, with the allegedly asexual *X. hispida* already in the literature, is how to deal with the assumedly asexual *X. hispida*. Future workers may wish to propose *X. hispida* as an infraspecific taxon under *X. setulosa*.

Halling & Mueller describe cheilocystidia of *X. hispida* as "similar to pleurocystidia but generally smaller." Most are so, but some cheilocystidia are mucronate at apex, not subcapitate or truncate as pleurocystidia.

Pilei- and caulosetae across *Xerula* sect. *Xerula* are consistently similar. Bases may be bifurcate (i.e. arising as a side branch of subsetal hypha) or, more typically, a hyphal tip, arising from the same inflorescence as pilei- or caulocystidia. Likewise, pileicystidia are similar in general formation, but differ somewhat in shape, wall thickness and length of pedicel.

The pleurocystidia of *X. hispida* are unique in our experience. Although apically rounded, the apex is bluntly so, and the presence of crystalline material after prolonged storage is also unique. Halling & Mueller (1999) correctly described the pleurocystidia as "setiform," referring to wall thickness and stiffness. The term "metuloid" could also be applied. Most similar are those of *X. sinopudens*, similar in shape, but considerably thinner-walled.

The stipitipellis in *X. hispida* is considerably more complex than that of *X. americana*. In *X. americana*, caulosetae occur as a lawn or turf, but without many intermediate or aborted individuals. In *X. hispida*, hyaline, gnarled outgrowths of surface hyphae occur as small as lateral knobs or even mere protuberances. Short, very acute setae arise as lateral branches of surface hyphae, but the large setae, while apparently arising as terminal structures, often produce knobs at the base as though multi-rooted.

Mueller et al. (2001) found that *X. hispida* from Costa Rica and putatively from China formed a monophyletic clade in phylogenetic reconstructions of wider taxonomic breadth. Only two collections were sequenced, and no other similar basidiomata (i.e. *X. americana*, *X. caussei*, etc.) were included. The monophyletic clade, therefore, is subject to question, especially since the commonly found 4-spored Asian analog has been described under a separate binomial as *X. sinopudens* (Petersen & Nagasawa 2006). A 2-spored variant of *X. sinopudens* is known but has not been described.

With exclusively 2-spored basidia, Guzmán 11300 (ENCB) cannot qualify as *X. setulosa*. It is closer to *X. hispida*, but with somewhat foreshortened pleurocystidia (but similar to those illustrated from TFB 10881; Fig. 10). Spore dimensions and statistics agree with other observations on the species. The specimen comes from the northern Mexican state of Nuevo Leon, and therefore represents the northernmost station for *X. hispida*.

Specimens examined: **COLOMBIA**, Dpto. Nariño, La Josefina, 17 km S of Pasto, 23.XI.1988, coll E Franco, det DE Desjardin (as *Pseudohiatula*), DED 4880 (SFSU); same location, 20.XI.1988, coll DE Desjardin & RE Halling (as *Pseudohiatula* cf. *setulosa*), DED 4838 (SFSU). **COSTA RICA**, Prov. San José, vic. Empalme, "Jardin de Dota," N 9° 42.667', E 83° 58.277', 25.VI.00, coll. JL Mata, TFB 10871 (TENN 58735); Prov. San José, San Gerardo, forest at Rio Savegre, 9° 33.020' N, 83° 48.489' W, 26.VI.00, coll. R.E. Halling, TFB 10881 (TENN 58745, TOPOTYPE); Prov. San José, San Gerardo, forest at Rio Savegre, 9° 33.020' N, 83° 48.489' W, 26.VI.00, coll. RHP, TFB 10882 (TENN 58746; TOPOTYPE); Prov. San José, San Gerardo, 5 km SW Cerro de la Muerte, 9° 33.020' N, 83° 48.489' W, 26.VI.00, coll. K Shanks, TFB 7890 (TENN 53746); Prov. San José, Dota Co., Jardin de Dota, 1.VII.98, coll. RHP, TFB 9463 (TENN 56437); Prov. San José, Dota, San Gerardo, more or less 5 km SW of Cerro de la Muerte, Albergue de la Montaña, Savegre, 9° 32'2" N, 83° 48' 27" W, 2500 m, 11.VI.2003, coll Halling et al, Halling no 8382 (NY, TOPOTYPE); Prov. San José, Dota, San Gerardo, more or less 5 km SW of Cerro de la Muerte, Albergue de la Montaña, Savegre, 9° 32'2" N, 83° 48' 27" W, 2500 m, 10.VI.1994, coll Halling & Baroni, Halling no 7270 (NY, TOPOTYPE, annot. Michael Weiss, Universität Tübingen. Dec. 11, 2000); same location, 8.VI.1994, coll Halling & Baroni, Baroni 7482 (CORT; TOPOTYPE); Prov. San José, El Jaular, Est. Biol Cuerici, N 9° 33' 17 ", W 83° 40' 15", 2900 m, 24.VIII.1995, leg AE Franco-Molano, AE F-M no. 1443 (NY). **MEXICO**, Est. Nuevo Leon, vic Monterrey, Villa Santiago, Posada del Maestro, 16.VIII.1973, coll. G. Guzmán (as *Oudemansiella*), Guzmán 11300 (ENCB) [rev. E. Pérez-Silva, 1985 as *O. longipes*]. **VENEZUELA**, Parque Nac. Henry Pittier, Pasade Portachuelo, 15.VII.1987, leg RE Halling (as (*Pseudohiatula dorotheae*), Halling 5386a (NY).

Acknowledgements

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Notes on four mediterranean *Cortinarius* fruiting in sclerophilous and heliophilous plant ecosystems

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Abstract — Four mediterranean *Cortinarius* (subgenus *Telamonia*) taxa associated with oaks and pure *Cistus* stands are described and discussed. New type material of *C. contui* is designated, and the type material of *C. bulbosovolvatus* is confirmed. The new taxon *C. assiduus* var. *plesiocistus* is proposed. Micrographs (including those of holotypes) and FESEM photographs of the spores, as well as photographs of the basidiomes in their habitat are included. Analysis of nucleotide sequences (ITS region) is afforded.

Key words — *Cortinariaceae*, *Quercus*, Spain, Europe

Introduction

According to our observations, two of the four taxa studied in the present work (*Cortinarius bulbosovolvatus* and *C. contui*) grow exclusively under *Cistus* sp. on acid soil. The other two taxa are varieties of *C. assiduus*: the typical variety, which fruits on basic soil under both *Quercus ilex* and *Cistus*, and is recognized by the scarcely developed universal veil, and var. *plesiocistus* (described in the present work), which is a exclusive *Cistus monspeliensis* associate that grows especially on acid soil and exhibits a conspicuous veil.

C. contui is a species that has been often misinterpreted by Spanish (Ortega & Mahiques 1995, Vila 2002, Vila & Llimona 2002, Torrejón 2003) as well as Italian (Contu 1991) mycologists, who have identified as *C. contui* several collections characterized by fasciculate habit, a hardly hygrophanous pileus with abundant white veil also present on the stipe, and broadly ellipsoid spores, a combination of features which is reminiscent of *C. bulbosovolvatus* and, above all, *C. assiduus* s.l. Since the original material of *C. contui* is missing and no isotype was designated by its authors (Henry & Contu 1987), we think it is necessary to designate a neotype based on material conserved at CAG (University of Cagliari, Sardinia).

C. bulbosovolvatus grows in similar ecosystems and is recognized by its general appearance, which brings to mind a small *C. bulbosus* (Sowerby) Fr. (Henry & Contu 1985, Phillips 1980, Soop 2005). However, the latter has a distinct volva and different spores and habitat. Part of the original material of *C. bulbosovolvatus* is kept at PC (the herbarium label states *Cortinarius* sp., while the collection number is the same as that reported by Henry & Contu 1985). Notwithstanding, its deficient conservation prevented us from confirming the identity.

Some *Cistus monspeliensis*-associated forms of *C. assiduus* exhibit characters that permit a separation from these fruiting in woods, especially by the less hygrophanous pileus, the fasciculate habit and abundant veil. These forms are frequently found in France, where it has been known as *C. cistoadelphus* nom. prov. (Bidaud 1994).

The present work focuses on the study of the types of the above taxa, as well of other material from Italy and the Iberian Peninsula, with the purpose of establishing a concept for each taxon and its taxonomic circumscription.

Material and methods

We have studied the type material of *C. assiduus* var. *assiduus* (MES-3541, R. Mahiques private herbarium), *C. bulbosovolvatus* (CAG, herb. Istituto Orto Botanico, Cagliari; PC, herb. Museum National d'Histoire Naturelle, Paris), *C. cistoadelphus* (AB. N° 92-11-422, A. Bidaud private herbarium) and *C. contui* (CAG); as well as other collections of these species from Italy (Sardinia; CAG) and Spain (Andalusia, Catalonia, Valencian Community: GDAC-GDA; JA-Cussta; MES; JVG, J. Vila private herb.; MTH, M. Torrejón private herb.). Basically, the bibliography that refers to these taxa includes Henry & Contu (1985, 1987) and Mahiques et al. (2001). The morphological study of spores has been carried out by means of a Zeiss scanning electron microscope of the FESEM type (Field Electron Scanning Electron Microscope), model 1539 Geminis. Sporal data include mean spore size (length, width, and L/W ratio), from 30 spores of each collection. Code of colour: Kornerup & Wanscher (1973). The analysis of DNA sequences of *C. assiduus* var. *assiduus* and *C. assiduus* var. *plesiocistus* has been made by Dr. S. Garnica (University of Tübingen, Germany).

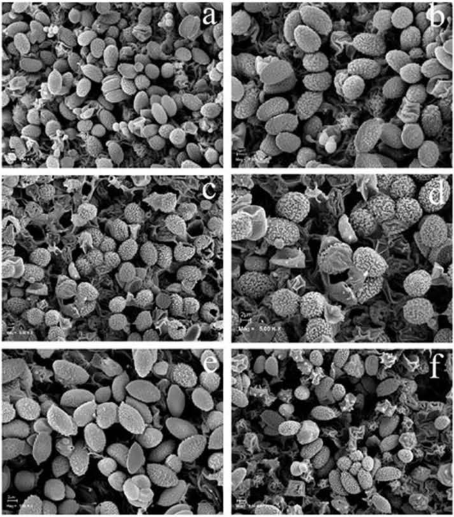

Plate 1.- Spores under FESEM microscope: a-b) *Cortinarius assiduus* var. *plesiocistus* (holotype); c-d) *C. contui* (neotype); e-f) *C. bulbosovolvatus* (holotype and CAG890108/2).

Results

Cortinarius assiduus Mahiques, A. Ortega & Bidaud var. ***assiduus***,
Bull. Féd. Mycol. Dauphiné-Savoie 41(162): 42 (2001)

SPECIMENS EXAMINED — SPAIN. GRANADA: Cortijos of Valparaiso (La Alcaicería), under *Quercus ilex* subsp. *ballota* and *Cistus laurifolius*, in decarbonated soil, 14.12.2005, GDA 52898.- Wood path of las Pajareras, km 0.5 (natural park of the Sierra de Huétor, Huétor, Santillán), under *Q. ilex* subsp. *ballota*, in decarbonated soil, 13.11.2006, leg. A. Ortega, GDA 53896.- Ibid., 26.11.2006, GDA 52897. JAÉN: Castañeda, near the Quiebrajano reservoir, under *Q. ilex* subsp. *ballota*, in calcareous soil, 1.1.1987, GDAC

36735.- Cuesta Grande (Santiago, Pontones), 1350 m, under *Q. ilex* subsp. *ballota*, in calcareous soil, 25.10.2002, leg. J.D. Reyes, JA-Cussta 2150.- Castro Ferraz (Santa Elena), 900 m, under *Q. ilex* subsp. *ballota*, *Q. suber*, *C. ladanifer* and *Pinus pinea*, in decarbonate soil, 27.11.2003, leg. J.D. Reyes, JA-Cussta 3296. **TARRAGONA:** Vilanova de Prades (Conca de Barberà), Corral del Sanç, 1005 m, under *C. laurifolius*, in acid soil, 16.4.2002, leg. X. Llimona, J. Vila, J. Llistosella & C. Gutiérrez, JVG 1020416-24.- Prades (Baix Camp), road to Albarca, 910 m, under *C. albidus* y *Q. ilex* subsp. *ballota*, in basic soil, 16.4.2002, leg. X. Llimona, J. Vila, J. Llistosella & C. Gutiérrez, JVG 1020416-12 (EMBL accession number AM 713179). **VALENCIA:** Els Surars (Pinet), 660 m, under *Q. suber* and *P. pinaster*, in sandy soil, 11.11.1999, leg. R. Mahiques, MES 3541 (holotypus).- Ibid., MES 3359, 3363, 3364, 3541.

Discussion: See *C. assiduus* var. *plesiocistus*.

Cortinarius assiduus var. ***plesiocistus*** A. Ortega, Vila & Bidaud **var. nov.**

MYCOBANK MB510869

A typo differt sporibus maioris, cuticula leviter hygrophana et habitat stricto inter Cistum monspeliensem.

Holotypus: *prope vico Cadaques dicto, in NE Catalonia (Hispania), a X. Llimona et J. Vila lectus, 25-1-1999, 40 m altitudinis, sub Cisto monspeliensi, in herb. GDA 52535, Universidad de Granada conservatus (isotypus in JVG 990125-31).*

Etymology: an adjective, from the Greek *plesios* = neighbouring, and *Kistus* (*Cistus*).

Basidiomes normally in small groups of 3-4 specimens, more rarely solitary. Pileus 20–50 mm in diam., at first hemispherical to convex, then conico-applanate, later expanded from plano-convex to applanate, occasionally with a low, blunt umbo, not depressed; margin incurved when young, then straight, normally smooth but in some specimens slightly sulcate. Universal veil abundant, whitish, later with a silvery sheen, fibrillose, forming rather persistent patches, especially at the disc, hardly present along the margin; some collections with reduced veil to some marginal fibrils. Surface shiny, sometimes more or less viscid, hardly hygrophanous (with small scattered hygrophanous spots), reddish-brown (7C-8), generally darker, especially at the disc, somewhat much paler at the margin, often with vinaceous (9C-4, 9E-8, 10D-5) or violaceous (8 C-3) tinges. Lamellae relatively thick, slight to moderately crowded, adnate to adnate-sinuate or decurrent by a tooth, brown (6E-8) or rusty brown (6D-8) with more or less lilac (10C-3) tinges; edge even and concolorous. Lamellulae numerous. Stipe 30–60 × 10–20 mm, rather thick-set, sometimes curved, base terete or slightly enlarged, white, rarely with brownish spots, surface fibrillose. Cortina white, copious, becoming rusty due to the spores. Context firm, whitish with violaceous (8C-3) tinges, especially in stipe apex; odour and taste subraphanoid.

Spores (7.5–)8.8–10(–11.2) × (4.6–)5.2–5.6(–6.5) µm, ellipsoid to narrowly ellipsoid (Q: L/w = (1.43–)1.55–1.9(–2.1), ochraceous-brown (OM), with slight to moderately sized, sparse warts. Basidia up to 30 × 10 µm, clavate

Plate 2.- Habitus: a) *Cortinarius assiduus* var. *plesiocistus*; c-d) *C. contui*.

to subcylindrical, 4-spored, with basal clamps. Marginal sterile cells hardly differentiated. Suprapellis composed by a thin layer of narrow, cylindrical hyphae, with numerous colourless or slightly pigmented terminal elements, below which the hyphae are more packed and exhibit a mixed pigmentation: intracellular and incrusting epiparietal, brownish or reddish-brown. Mediopellis cellular, with chains of short, broad, clearly differentiated cells, colourless or slightly pigmented in the upper layers. Subpellis subcellular.

Molecular analysis: analysis of nucleotide sequences (ITS region) indicates a six base pair difference between *C. assiduus* var. *assiduus* and *C. assiduus* var. *plesiocistus.*

SPECIMENS EXAMINED — **SPAIN.** **CASTELLÓN:** Mas Blanc (Benicasim), natural park of las Palmas Desert, 170 m, under *Cistus monspeliensis* and *C. salviifolius*, in acid soil, 27.11.2001, leg. M. Torrejón, MTH 219.- Ibid., MTH 226. **GIRONA:** Roses (Alt Empordà), plains between Can Marés and Canyelles Petites, 130 m, under *C. monspeliensis* and *C. albidus*, in acid soil, 25.1.1999, leg. J. Vila & X. Llimona, JVG 990125-50.- Roses (Alt Empordà), la Falconera, near the road to the abandoned military installations, 95 m, under *C. monspeliensis*, *C. salviifolius* and *C. albidus*, in acid soil, 23.1.2001, leg. J. Vila & X. Llimona, JVG 1010123-12.- Cadaqués (Alt Empordà), Cala Jonquet, 40 m, under *C. monspeliensis*, in acid soil, 25.1.1999, leg. J. Vila & X. Llimona, GDA 52535 (holotypus), JVG 990125-31 (isotypus) (EMBL accession number AM 713178).- Ibid., 1.2.2000, leg. J. Vila & X. Llimona, JVG 1000201-14.

Discussion: *C. assiduus* s.l. is a mediterranean species close to *C. saturninus* (Fr.) Fr., exhibiting an ample variability and different ecological preferences. It may, in fact, grow in sclerophilous woods of *Quercus ilex* subsp. *ballota*, *Q. coccifera*, *Q. suber*, both in acid and basic soil, as well as in *Cistus* formations, in some cases thermophilous (thermo-mediterranean belt) and in others more mesophilous (meso- and supra-mediterranean belts), where it may establish relationships with several species (*C. monspeliensis*, *C. salviifolius*, *C. ladanifer* and *C. laurifolius* among others).

The populations fruiting in association with oaks are often characterized by strongly hygrophanous basidiomes and show bluish-violaceous or bluish-lilacineous tinges on lamellae, upper stipe, context and even on the pileus surface. The development of the universal veil is scanty and ephemeral and the spores are on average smaller, 7.8–9.5 × 4.6–4.9 µm, than those observed in the collections associated with *Cistus*. In acidophilous *Cistus monspeliensis* formations, especially of Catalonia and Valencia, we have observed populations rather different from the former, as basidiomes generally are smaller, less hygrophanous (hygrophanity irregular, in patches), the bluish-violaceous tinges are hardly visible, the universal veil has a stronger and lasting development (feature observed in many *Cistus* associates), and the spores are larger, 8.8–10 × 5.2–5.6 µm. We refer to these collections as *C. assiduus* var. *plesiocistus.* The analysis of DNA sequences prove the differences between the *Quercus* (sometimes with *Cistus laurifolius* or *C. ladanifer*) and *Cistus monspeliensis* populations of *C. assiduus.*

Table 1. Herbarium collections examined.

Herb	Coll. number / Status	Original name	Final disposition
CAG	860119/01 (duplicate holotype)	*C. contui*	*C. assiduus* var. *plesiocistus* & *C. bulbosovolvatus*
CAG	840127/01 (holotype)	*C. bulbosovolvatus*	*C. bulbosovolvatus* & *C. contui*
CAG	890108/02 (part of PC 0090926)	*C. contui*	*C. bulbosovolvatus*
Hry	n°84/159 (isotype *bulbosovolvatus*)	unnamed	damaged (*C. bulbosovolvatus*?)
PC	0090926 (RH and C 89)	unnamed	*C. bulbosovolvatus* & *C. contui*
Hry	n°86/47 (PC) (holotype)	*C. contui*	destroyed

Cortinarius bulbosovolvatus Rob. Henry & Contu, Doc. mycol. 16 (61): 32 (1985)

ORIGINAL DESCRIPTION— *Pileo (15)–30–45–(50) mm, sat carnoso, primo regulari subhemisphaerico, demun plano ad saepe irregulari, rare umbonato, hygrophano, glabro, nudo, sublucente; cute humida luteo-brunnea vel obscure brunnea, ad medium subnigra; margine pellucido-striata, sicca pallidiore, separabili. Lamellis haud confertis, sat spissis, inaequalibus, adnato-decurrentibus, ex argillaceis fusco-castaneis, acis integris; raro denticulatis. Stipite (30)–40–45–(50) mm alto, apice 5–10 mm spisso, non vero elato, sat firmo, cylindrico sed ad basim constanter bulboso volvaque alba conspicua praedito fragili; ceterum indumento sericeo fibrilloso induto saepe diffracto; sursum deorsumque albo, in medio subbrunneo, residuis brunneis cortinae decorato, mycelio albo. Carne firma, fragili, ex albida pallide cinereo-brunnea, sub cute flavobrunnea, odore nullo, sabore debili interdum acidulo. Cortina copiosa fibrillosa alba in juventute valde conspicua. Sporis ellipsoideo-ovoideis vel anguste, amygdaliformibus, acute apiculatis, verrucosis (8.7–10.8 × 4.3–5 µm). Basidis 4-sp. (29–36 × 7.2 µm). Pilis sterilibus (15 × 7.2 µm). Gregarius saepe caespitosus (5-6 sp), in Cistitis sabulosis acidiphilisque, praecipus sub C. monspeliensis. Vere autommoque, sat frequens.*

SPECIMENS EXAMINED— ITALY. CAGLIARI: surroundings of Maracalagonis, locality Pixina Nuxedda, under *Cistus monspeliensis*, in acid soil, 27.1.1984, leg. M. Contu & L. Curreli, CAG 840127/01 (holotypus), herb. R. Henry 84/159 (isotypus).- Maracalagonis, Pixina Nuxedda, under *Cistus*, 8.1.1989, leg. M. Contu & V. Nieddu, CAG 890108/02 (as *C. contui*), herb. R. Henry (RH) and C 89, PC 0090926 (as *Cortinarius* sp.). SPAIN. GIRONA: Cadaqués (Alt Empordà), Cala Jonquet, 40 m, under *C. monspeliensis*, a single specimen, in acid soil, 25.1.1999, leg. J. Vila & X. Llimona, JVG 990125-30.

Discussion: The collection CAG 840127/01 (holotypus), of which we have studied two specimens, is in good condition. One of the specimens matches

Cortinarius bulbosovolvatus very well, with a pileus of 25 mm in diameter and a stipe of 45 × 5 mm, with the base sheathed in a visible fibrous-membranous volva (less evident than in collections CAG 890108/02 and PC 0090926). The spores measure (8–)9.2–9.7(–11.2) × (4.8–)5.2–5.3(–6) µm, are ellipsoid to subcylindrical (Q: L/w = (1.5–)1.78–1.83(–2)) and have a slight to moderate ornamentation, consisting of more or less coalescing warts. The second specimen studied is quite different; there is no volva and the spores are significantly larger, (9–)10.1–10.3(–11) × (5.5–)5.9–6.1(–6.8) µm; for this reason we think it might represent *C. contui*. The voucher CAG 980108/02 (labelled *C. contui*) consists of seven basidiomes, pileus 24–40 mm in diameter, stipe 30–45 × 8 mm (base 12–14 mm), sheathed in an conspicuous volva, spores (8.8–)9.5–10(–11) × (4.8–)5.2–5.4(–5.7) µm, ellipsoid to almost cylindrical (Q: L/w = (1.6–)1.8–2(–2.2)), with a slight to moderate ornamentation, consisting of more or less coalescing warts and a suprapellis with hyphae 1.5–3 µm wide, arranged in fascicles forming a loose surface layer with numerous free cylindrical terminal elements, under which there is another layer with compact hyphae; the mediopellis is composed of parallel hyphae with variable wide (5–6 µm, 10–18 µm, or 10–24 µm) forming several layers, the deeper ones with moniliform elements; pigment cellular, ochraceous-yellowish, basically localized in the subpellis hyphae; subpellis cellular. This collection is certainly to be ascribed to *C. bulbosovolvatus* and matches most of the specimens in collection PC 0090926.

The collection Hry n° 84/159 (not labelled), which is the isotype, is poorly preserved so that it was possible to study only the spores: 8.4–10 × 5–6 µm. In the same envelope, there is also additional unnamed material (three specimens) with the references RH and C 89, PC 0090926. Two of the specimens have a cap of 28–40 mm in diam., stipe 31 x 5 mm, with a conspicuous volva and spores (8–)9.1–9.2(–10) × (4.8–)5.1–5.3(–5.7) µm, ellipsoid (Q: L/w = (1.5–)1.7–1.8(–2)), with a morphology and ornamentation similar to that of the other collection (Hry n° 84/159). In our opinion they fit perfectly the concept of *C. bulbosovolvatus*. The third specimen is much smaller, has no volva and its spores are different, 8.9–10.8 × 5.3–6.1 µm, and we think it might be ascribed to *C. contui*.

So far, *C. bulbosovolvatus* was known only from Sardinia (Italy) and was confused with other *Cistus*-associated taxa. Its separation from *C. contui* and *C. assiduus* s.l. is not difficult due to its macro- and microscopic features: presence of a distinct white volva, which remains visible even in herbarium material, and the pileipellis lacking the pseudoparenchymatic layer occurring in the other species. It deserves to be pointed out that the observed spore size is much more variable than noted in the original description.

Cortinarius contui Rob. Henry & Contu, Doc. Mycol. 17 (68): 41 (1987),
non *C. contui* sensu Contu (1991), non *C. damascenus* subsp. *contui*
sensu Ortega & Mahiques (1995).

Neotypus (designated here): ITALY. Cagliari: Foresta Demaniale dei Sette Fratelli, loc. Monte Cresia, in a pure *Cistus* formation with *C. monspeliensis* and *C. salviifolius*, in acid, sandy soil, leg. M. Contu, det. R. Henry & M. Contu, M.C. 86/02 (CAG).

Basidiomes growing in fascicles of 5-6 specimens sharing a common base which is distinctly enlarged and sheathed in a copious mycelium with remnants of substrate. Pileus 25–65 mm in diam., hemispherical-convex, convex or plano-convex with a central depression in fully expanded specimens, rarely with a low rounded umbo; margin at first incurved, then straight, regular; universal veil hardly developed, even though some whitish fibrillose remnants can be observed both on the disk and along the margin. Surface smooth, shiny, hygrophanous, reddish-brown (8E-8), but soon drying to orange-brown (7C-8, 7C-4); herbarium material showing a yellowish-brown colour (5E-6) with greyish-orange tinges (5B-3), brownish-orange (5C-3) or Sahara (6C-5). Lamellae thick, moderate crowded, adnate-sinuate or adnate-subdecurrent, reddish-brown (8C-8, 8D-8). Stipe 35–65 × 7–14 mm, rather firm, thick-set and rigid, cylindrical or with slightly enlarged base, very dark (7C-8) with age or when handled; surface smooth. Herbarium material shows fibrillose-membranous remnants of the universal veil, which may form a more or less distinct volvate structure. Cortina white, then brownish, copious over the stipe surface. Context firm, whitish but pale browning; odour and taste raphanoid.

Spores (7.2–)8.6–10.5(–11.2) × (5–)5.6–6.6(–7.2) µm, very variable in morphology: amygdaliform, ellipsoid, broadly ellipsoid even subglobose (Q: L/w = (1.26–)1.37–1.7(–1.77)), ochraceous-yellowish to ochraceous-brown (OM), with moderate ornamentation, consisting of more or less coalescing, isolated or anastomosed warts. Basidia 20–28 × 7–8 µm, cylindric-clavate, hyaline or with ochraceous vacuolar content, 4-spored. Marginal sterile cells 13–16 × 7–8 µm, similar to basidia, clavate or subpyriform. Pileipellis differentiated. Suprapellis a loose layer of yellowish hyphae, 4–6 µm wide, with numerous free, cylindrical terminal elements. Mediopellis pseudoparenchymatic, with compacted hyphae, some 7–9 µm wide, others 8–12 µm, rarely up to 25 µm, with septa so numerous as to give it a cellular appearance. Subpellis hardly differentiated, cellular. Pigment intracellular, but also slightly incrusting in some superficial hyphae.

SPECIMENS EXAMINED— ITALY. Cagliari: Foresta Demaniale dei Sette Fratelli, loc. Monte Cresia, in a pure *Cistus* formation with *C. monspeliensis* and *C. salviifolius*, in acid, sandy soil, leg. M. Contu, det. R. Henry & M. Contu, M.C. 86/02 (CAG, ***neotypus***). SPAIN. Girona: Roses (Alt Empordà), Coll de la Perafita, 250 m, under *C. monspeliensis*, thickly gregarious, in acid soil, 28.11.2000, leg. J. Vila & X. Llimona, JVG 1001128-16, GDA 52536.

Discussion: This species fruits exclusively in association with *Cistus* in acid soil; however, it does not seem to be as frequent as claimed by Contu (1991) and Henry & Contu (1987). We think it likely that it has been confused with *C. assiduus* s.l. (*C. castaneus* sensu Konrad & Maublanc, Malençon & Bertault) and with *C. bulbosovolvatus*. As pointed out above, the material designated as type by Henry & Contu (1987) is missing (Henry's herb. n. 86/47 in PC 0090925). Therefore, we obtained information from CAG, where many taxa coming from the same locality as *C. contui* are deposited, that the herbarium holds three collections labeled *C. contui*. The first one (CAG 860119/01), labeled "duplicato dell'holotypus (herb. R. Henry/Vesoul)", includes several specimens; of the specimens studied exhibit characters which do not fit the concept of *C. contui*, one is to be ascribed to *C. assiduus*, the other, most likely, to *C. bulbosovolvatus*. The second, CAG 890108/02, of which we have studied two specimens and photographed the whole collection, matches perfectly *C. bulbosovolvatus*. Finally, the third (M.C. 86/02), including a single basidiome which we have studied and photographed, fits perfectly the concept of *C. contui*. Accordingly, we propose it as a neotype. We think that, according to the comments of Contu (1991) about the holotype of this species, and on the basis of both its features and microanatomy, the material labelled CAG 860119/01 corresponds to *C. assiduus*, which would substantiate the hypothesis by Henry & Contu (1987) that *C. contui* may also grow under oaks.

The relationship between *C. contui* and *C. damascenus* Fr. appears obvious; the fasciculate growth, a similar appearance and pileipellis structure. They separate by the abruptly tapered stipe base (it brings to mind a pencil) and the much smaller spores (rarely over 9 x 5.5 µm) of *C. damascenus*, as reported by many authors (Brandrud 1992, Breitenbach & Kränzlin 2000, Henry 1983, Herzog 2001, Horak 2005, Marchand 1983).

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New and noteworthy *Antrodia* species *(Polyporales, Basidiomycota)* in Russia

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Abstract — A new species, *Antrodia minuta*, is described. It belongs to the *Antrodia heteromorpha* complex and is closely related to the East-Asian *A. leucaena*. *Antrodia minuta* is characterized by small-sized, mostly pileate basidiocarps, a dimitic hyphal structure with solid skeletal hyphae, and cylindrical basidiospores; its distribution is hemiboreal. Taxonomy of *Antrodia malicola*, *A. sitchensis* and *Cartilosoma ramentaceum* is briefly discussed. A new combination, *Fibroporia pseudorennyi*, is proposed. Conidial state is first described for *F. gossypium*.

Key words — polypores, wood-inhabiting fungi

Introduction

Antrodia P. Karst. is a large polypore genus having a worldwide distribution. Now it comprises over 40 species; most species are boreal or hemiboreal. Recent studies reveal an existence of many species complexes within a genus (David & Dequatre 1985, Niemelä & Penttilä 1992, Renvall & Niemelä 1992, Dai & Niemelä 2002, Bernicchia 2005, Pieri & Rivoire 2005, Dai et al. 2006), therefore new data on morphological variability, ecology and geography of the species are needed. This paper is devoted to study of five species belonging to *Antrodia* sensu lato (including *Cartilosoma* Kotl. & Pouzar and *Fibroporia* Parmasto).

Materials and methods

The specimens were collected during field works in 1999–2006, in Nizhny Novgorod Region and Samara Region (European Russia). Study areas are described in Malysheva & Malysheva (2004), and Spirin (2005). Additional material was studied in herbaria of Komarov Botanical Institute (LE, St. Petersburg, Russia) and Finnish Museum of Natural History (H, Helsinki, Finland). The microscopic characters were observed in Karl Zeiss-amplival microscope and measured in Cotton Blue (CB) mountant, with use of oil immersion objective.

Taxonomic descriptions

Antrodia minuta Spirin sp. nov. FIG. 1

MYCOBANK MB 510808

Basidiomata annua, pileata, raro effuso-reflexa, minuta, dura. Pilei imbricati, 0.5–1 cm diam., pallido-ochracei, radialiter striati. Poris rotundo-angularis, 3–5 per mm. Systema hypharum dimiticum; hyphae sceletales solidae. Sporae cylindricae, 6.7–9.6 × 2.6–3.5 µm, inamyloideae.

Etymology: from the Latin *minutus*–minute, small-sized.

Basidiocarps annual, pileate, very rarely effused-reflexed or resupinate, often growing in small imbricate clusters. Pilei small, (3) 5–10 (13) mm wide, 1–3 (6) mm thick, laterally attached, densely coriaceous in fresh condition, corky when dry. Upper surface uneven, radially striate, sometimes finely tomentose, first cream-coloured or pale ochraceous, then pale tan to brownish. Margin thickened, even, pale ochraceous to brownish, sterile. Context 1–2 (3) mm thick, cream-coloured to pale ochraceous, corky. Tubes 1–3 mm thick, cream-coloured to pale ochraceous, dense; pores firstly more or less round, later angular, 3–5 per mm, with thin entire or slightly dentate dissepiments. Smell faint, phenolic; taste mild.

Fig. 1. *Antrodia minuta* (holotype): hymenium and spores. Scale bar = 10 µm.

Hyphal structure dimitic; hyphae IKI– and CB–. Context dimitic, with dominating skeletal hyphae 4.0–5.5 µm; hyphae subsolid, densely arranged, sometimes dichotomously branched. Tramal hyphae subparallel; skeletal hyphae (2.8) 3.1–4.0 (4.9) µm, with a very narrow lumen (subsolid to solid) in CB, slightly swelling in KOH (lumen becoming almost invisible), straight, mostly unbranched; generative hyphae 2.5–3.5 µm wide, thin-walled, clamped. Skeletocystidia present, 4–5.5 µm wide, embedded or rarely penetrating into hymenium, clavate, thick-walled; some hyphal tips poorly encrusted by small cubical or irregular crystals. Cystidioles 16–25 × 4.5–7 µm, conical or bottle-shaped. Basidia 14–24 × 5–7 µm, clavate, clamped, in senescent hymenium thick-walled at the base. Basidiospores (6.3) 6.7–9.6 (10.6) × (2.5)

2.6–3.5 (3.7) µm, cylindrical, straight, distal end rounded, very rarely slightly fusiform or even sigmoid (in specimen *Spirin 2104*), IKI– and CB–.

Causes a slow brown rot in dead hardwoods (*Populus tremula*, *Quercus robur*).

HOLOTYPE, ISOTYPE AND PARATYPES—**RUSSIA. NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Razino, *Populus tremula*, 24.IX.2000 *Spirin 1725* (holotype H, isotype LE 213643). Paratypes. **RUSSIA. NIZHNY NOVGOROD REG.:** Bor Dist., Kerzhensky State Res., *Quercus robur*, 6.X.2002 *Zhukov* (H); Lukoyanov Dist., Panzelka, *Populus tremula*, 10.VIII.2005 *Spirin 2366* (H), Kurley, *P. tremula*, 14.VIII.2005 *Spirin 2429, 2430* (H); Nizhny Novgorod City, *Q. robur*, 19.X.2001 *Spirin* (LE 211276); Sharanga Dist., Kilemarsky Nat. Res., *P. tremula*, 16.VIII.2004 *Spirin 2104* (H). **SAMARA REG.:** Stavropol' Dist., Zhigulevsky Nat. Res., *P. tremula*, 14.IX.2006 *V. Malysheva & Zmitrovich* (LE).

Identification and taxonomy–*Antrodia minuta* is easily recognized due to its tiny pileate basidiocarps with relatively small pores. In microscope the long cylindrical spores and subsolid skeletal hyphae are highly characteristic. However, it strongly resembles *A. leucaena* Y.C. Dai & Niemelä, recently described from northeast China (Dai & Niemelä 2002). The latter differs in having widely effused basidiocarps with small reflexed upper part. In microscope *A. leucaena* is easily identified from the hyphoid cystidioles with cap-like crystalline incrustation; it has skeletals with a highly visible lumen. In its turn, *A. minuta* is characterized by a presence of skeletocystidia, and its skeletal hyphae are subsolid to almost solid. The spores of both species are almost identical.

Another East-Asian species, *A. wangii* Y.C. Dai & H.S. Yuan, is characterized by more robust basidiocarps and narrower spores, 6.3–7.8 × 2.1–2.6 µm; its host tree is *Prunus* (Dai et al. 2006).

Thick-walled basidia were observed in a senescent hymenium of *A. minuta*; this feature links the new species with the *A. heteromorpha* complex (see Sarkar 1959). Other species in this complex also have hymenial skeletocystidia (for example, *A. albidoides* A. David & Dequatre and *A. heteromorpha* (Fr.: Fr.) Donk s.str. – see David & Dequatre 1985, Niemelä & Penttilä 1992); however, their basidiocarps are more robust with larger (1–3 per mm), irregular pores. The spores of *A. heteromorpha* are ellipsoid, 7.5–11.8 (12) × (4.2) 4.3–5.8 (6.0) µm.

Antrodia macra (Sommerf.) Niemelä and *A. pulvinascens* (Pilát) Niemelä are closely related to this species complex. *Antrodia macra* has narrow-ellipsoid spores, 7.5–11 × 3.0–4.1 µm; its basidiocarps are almost resupinate, with large pores (2–3 per mm). The spores of *A. pulvinascens* are ellipsoid, (5.1) 5.9–7.5 × (2.2) 2.4–3.2 µm, and skeletals are faintly amyloid. Kotiranta et al. (2007) discussed the variability of *A. pulvinascens*, and described the narrow-spored specimens from Russia. Both specimens studied (Spirin 2017, 2384) agree well with this description.

Ecology–The species was collected on decorticated fallen aspen and oak logs in old broad-leaved forests, dominated by *Populus tremula* and *Tilia cordata*, more rarely by *Quercus robur*. Evidently, it belongs to the hardwood-dwelling polypores, inhabiting forests on rich calcareous soils, as *Antrodiella faginea* Vampola & Pouzar, *Gelatoporia subvermispora* (Pilát) Niemelä, *Irpex foliaceodentatus* Nikol., *Junghuhnia autumnalis* Spirin et al., *J. nitida* (Pers.: Fr.) Ryvarden, *Perenniporia narymica* (Pilát) Pouzar, *P. tenuis* (Schwein.) Ryvarden, and *Steccherinum murashkinskyi* (Burt) Maas Geest.

ADDITIONAL SPECIMENS EXAMINED–***Antrodia albidoides***. **PORTUGAL. ESTREMADURA:** Monsanto, *Fraxinus sp.*, 20.IV.1978 *Melo et al. 337* (H ex LISU).

– ***Antrodia heteromorpha***. **RUSSIA. NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Panzelka, *Tilia cordata*, 17.VII.1998 *Spirin* (LE 208479); Sechenovo Dist., Talyzino, *T. cordata*, 25.V.1999 *Spirin* (LE 208476). **KOMI REP.:** Pechoro-Ilychsky Nat. Res., *Picea abies*, 2002 *Kosolapov* (H). **SWEDEN.** Göteborg, Botanical Garden, *Malus sylvestris*, 22.XI.1982 *Nordin* (H).

– ***Antrodia leucaena***. **CHINA. JILIN PROV.:** Antu Co., Changbaishan Nat. Res., *Populus davidiana*, 14.IX.1998 *Niemelä & Dai 2190a* (holotype H).

– ***Antrodia macra***. **RUSSIA. NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Razino, *Populus tremula*, 1.VIII.2004 and 14.VIII.2006 *Spirin 2010, 2512* (H).

– ***Antrodia pulvinascens***. **RUSSIA. NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Razino, *Populus tremula*, 1.VIII.2004 and 11.VIII.2005 *Spirin 2017, 2384* (H).

Antrodia malicola (Berk. & M.A. Curtis) Donk

The species concept for this taxon is not satisfactorily worked out, and the specimens are rather variable. The Russian collection cited below is resupinate or nodulose, rose-brownish, with irregular pores 2–4 per mm. In microscope it is characterized by yellowish-brownish skeletal hyphae 2.5–4.8 µm wide, and narrowly ellipsoid spores (6.2) 6.3–9.1 (10.3) × (2.7) 2.8–4.0 (4.2) µm; the rhomboid crystals are scattered in the tube trama. In contrast, the Chinese specimens of *A. malicola* are pileate or effused-reflexed, brighter coloured (cinnamon to brown), with more regular and slight smaller pores 3–4 per mm. The basidiospores are of the same size as in the Russian specimen, but clearly tapering to the apiculus.

SPECIMENS EXAMINED–**RUSSIA. NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Alatyr', *Salix alba*, 2.VIII.1997 *Spirin* (LE 208004, H). **CHINA. JILIN PROV.:** Antu Co., Changbaishan Nat. Res., *Tilia*, 1993–1995 *Dai 1095, 2012* (H).

Antrodia sitchensis (D.V. Baxter) Gilb. & Ryvarden FIG. 2

First European records of this rare polypore were published only 15 years ago (Niemelä et al. 1992, Vampola & Pouzar 1992), and until now its identity is questionable. The characters that best diagnose this species are relatively thick (up to 15 mm) tough perennial fruitbodies with thick-walled pores (4–7 per mm) and dark-brown resinous margin, irregularly arranged amyloid skeletal hyphae, and short-cylindrical spores (3.8) 4.0–5.5 × (1.9) 2.0–2.5 (2.7) µm.

However, three collections treated here as *A. sitchensis* (*Spirin 1401, Parmasto TAA 59287, 174833*) differ in having some deviating characters. These specimens are much thinner (2–4 mm thick) and brittle, and their spores are longer and somewhat narrower [(4.1) 4.2–6.4 (6.7) × (1.6) 1.7–2.2 (2.3) µm]. Evidently, they do not belong to *A. sordida* Ryvarden & Gilb., which clearly differs in its smaller pores (7–9 per mm), narrower and curved spores 4.2–5.7 × 1.6–1.9 µm, and its skeletal hyphae are dissolving in KOH (as well as in *A. crassa* (P. Karst.) Ryvarden). The tropical *A. pini-cubensis* Vampola et al. is similar, but its skeletal hyphae are inamyloid, and the basidiocarps are very thin (Vampola et al. 1994). Unfortunately, as many collections of *A. sitchensis* are almost sterile, it is not possible to know true limits of the spore variability. Therefore, I refrain from describing a new species until more abundant material is collected.

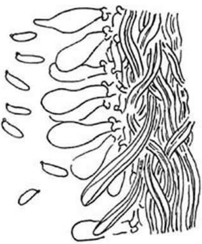

Fig. 2. *Antrodia sitchensis* (specimen Spirin 1401): hymenium and spores. Scale bar = 10 µm.

The *Antrodia crassa* complex (including *A. carbonica, A. sitchensis,* and *A. sordida*) has an isolated position within the genus. Vampola & Pouzar (1992) placed it in *Amyloporia* Bondartsev & Singer, alongside the generic type *Polyporus vulgaris* var. *calceus* Fr. (= *Amyloporia xantha* (Fr.) Bondartsev & Singer). Recent molecular data (Kim et al. 2005), which confirmed an independent status for *Amyloporia*, did not, however, include any members of the *A. crassa* complex. It is also possible that the complex is closely related to *Laricifomes officinalis* (Batsch: Fr.) Kotl. & Pouzar.

Specimens examined–***Antrodia sitchensis.*** RUSSIA. **Karelia:** Pudozh Dist., Besov Nos, *Picea abies*, 23.VIII.2002 *Spirin* (LE 214732). **Leningrad Reg.:** Tikhvin Dist., Veps Nat. Res., *P. abies*, 5.VI.2000 *Miettinen 2141* (H). **Nizhny Novgorod Reg.:** Vetluga Dist., Klenovik Nat. Res., *Abies sibirica*, with *Perenniporia subacida*, 9.VIII.1999 *Spirin 1401* (H, LE). **Primorye Reg.:** Chuguevo Dist., Bulyga-Fadeevo, Klyuch Yelovyi, *Picea ajanensis*, 6.IX.1975 *Parmasto* (TAA 59287, H). CANADA. **British Columbia:** Vancouver, *Picea sitchensis*, 27.VIII.1938 *Touzeau & Mounce* (H ex DAOM). ESTONIA. **Võrumaa:** Haanja, *Picea abies*, 26.VII.2000 *Parmasto* (TAA 174833, H). FINLAND. **Etelä-Häme:** Vesijako Nat. Res., *P. abies*, 15.IX.1994 *Niemelä 5833* (H).

– ***Antrodia crassa.*** RUSSIA. **Nizhny Novgorod Region:** Sharanga Dist., Kilemarsky Nat. Res., *Picea abies*, 18.VIII.2004 *Spirin 2176* (H); Tonshaevo Dist., Okhtarskoye, *Abies sibirica*, with *Byssocorticium lutescens*, 30.V.2000 *Spirin* (LE 211365). **Primorye Reg.:**

Ternei Dist., Maisa, 16.IX.1990 *Parmasto* (TAA 151116). **FINLAND. Etelä-Häme:** Tammela, Mustiala, *Picea abies*, 6.VI.1872 *Karsten 2303* (lectotype – see Lowe 1956, H), IX.1886 *Karsten* (syntype, H).

– ***Antrodia sordida.*** CANADA. **Ontario:** Ontario Co., Glen Major, *Prunus*, 22.IX.1935 *Bell* (LE 25832). **U.S.A. New Hampshire:** North Conway, 10.VIII.1920 *Snell 557* (holotype, PAC).

Cartilosoma ramentaceum (Berk. & Broome) Teixeira

Kotlaba & Pouzar (1958) described a new genus *Cartilosoma* for *Trametes subsinuosa* Bres. Donk (1966), who showed that the earliest name of *T. subsinuosa* is *Polyporus ramentaceus* Berk. & Broome, included the species in *Antrodia*. However, *P. ramentaceus* possesses some characters that do not fit well in the genus *Antrodia* s. str. (= the *A. heteromorpha* complex): its fruitbodies are soft and fleshy when fresh, and the hymenophore is gelatinous. In microscope this species is characterized by thick-walled generative hyphae gradually merging with skeletals. These features bring *P. ramentaceus* close to *Rhodonia placenta* (Fr.) Niemelä et al. (see Niemelä et al. 2005). Some specimens of *R. placenta* have very thick-walled hyphae that might be interpreted as skeletal hyphae (T. Niemelä, pers. comm.). Future molecular studies could indicate whether these species are closely related. Some other possible relatives of *Rhodonia placenta* were briefly discussed by Spirin et al. (2006). Here *Cartilosoma* is regarded as a separate genus, with the sole species *Cartilosoma ramentaceum* (Teixeira 1986).

Selected specimens–***Cartilosoma ramentaceum.*** **RUSSIA. Nizhny Novgorod Reg.:** Lukoyanov Dist., Panzelka, *Pinus sylvestris*, 15.VIII.2006 *Spirin 2552* (H).

– ***Rhodonia placenta.*** **RUSSIA. Nizhny Novgorod Reg.:** Lukoyanov Dist., Panzelka, *Pinus sylvestris*, 3.VIII.2004 *Spirin 2069* (H). **FINLAND. Etelä-Häme:** Vesijako Nat. Res., *Picea abies*, 29.VIII.1976 *Niemelä* (H).

Fibroporia pseudorennyi (Spirin) Spirin, **comb. nov.** Fig. 3

Mycobank MB 510809

Basionym: *Oligoporus pseudorennyi* Spirin, Nov. Syst. Plant. non Vasc. 37: 162, 2004.

This species was recently described as a member of *Oligoporus* (Spirin 2004a), and its close relationships with *Oligoporus norrlandicus* Berglund & Ryvarden were discussed. There are evident reasons to transfer *O. pseudorennyi* to *Fibroporia*. The basidiospores of *O. pseudorennyi* are very similar to those of *Fibroporia norrlandica* (Berglund & Ryvarden) Niemelä: (4.3)4.5–6.2 × (2.3)2.4–2.9(3.2) µm versus (4.7)4.8–6.4(7.0) × (2.5)2.6–3.4 (3.6) µm in the latter (Niemelä et al. 2001, Spirin 2004b). The hyphal structure of *O. pseudorennyi* was originally described as monomitic; however, some thick-walled non-branching clampless hyphae are observed in subiculum. Therefore it might be interpreted as dimitic, while *F. norrlandica* is strictly monomitic. This feature links *O. pseudorennyi* with another *Fibroporia* species – *F. gossypium* (Speg.) Parmasto, a species with monomitic tubes and dimitic subiculum. *Fibroporia gossypium* differs in having smaller ellipsoid spores, (4.1)4.2–5.0(5.2) × (2.2)2.3–2.8(2.9) µm, and it has no cystidia.

Commonly *F. gossypium* is described as a species that does not produce chlamydospores (in contrast to *F. norrlandica*). One collection of *F. gossypium* (LE 210088) was studied; it is characterized by a presence of thick-walled chlamydospores 8–9 × 6–8 µm in subiculum (Fig. 3).

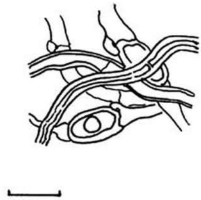

Fig. 3. *Fibroporia gossypium* (specimen Spirin LE 210088): subicular hyphae with chlamydospores. Scale bar = 10 µm.

SPECIMENS EXAMINED–***Fibroporia gossypium***. **RUSSIA.** **NIZHNY NOVGOROD REG.:** Sharanga Dist., Kilemarsky Nat. Res., *Picea abies*, 24.VIII.2000 *Spirin* (LE 210088), 17–22.VIII.2004 *Spirin 2122, 2277* (H).

– ***Fibroporia norrlandica***. **RUSSIA.** **NIZHNY NOVGOROD REG.:** Vetluga Dist., Klenovik Nat. Res., *Picea abies*, 12.VIII.1999 *Spirin* (LE 213356).

– ***Fibroporia pseudorennyi***. **RUSSIA.** **NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Panzelka, *Pinus sylvestris*, 6.X.2001 *Spirin* (holotype of *Oligoporus pseudorennyi* – LE 211363).

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Two new *Polycoccum* (*Dothideales, Dacampiaceae*) species on lichens from Turkey

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Abstract — Two new *Polycoccum* species are described from Turkey: *P. aksoyi* on the areoles of *Aspicilia cinerea,* and *P. acarosporicola* on *Acarospora cervina*. *P. aksoyi* is characterized by ascomata with a very small ostiole with a pale brown lower part, smooth ascospores with a thin (0.5 µm thick) colourless gelatinous sheath, and the host: a member of *Aspicilia*. *P. acarosporicola* differs from all species of the genus in the host selected (*Acarospora cervina*) and from *P. cartilaginosum* in the narrower and differently shaped ascospores. The single previous report of *P. cartilaginosum* from Turkey is a misidentification for the species now named *P. acarosporicola*.

Key words — *Ascomycota,* lichenicolous fungi, Aladağlar National Park.

Introduction

The genus *Polycoccum* (*Ascomycota, Dothideales, Dacampiaceae*) currently comprises 48 accepted species (www.indexfungorum.org). The species are generally restricted in host range, and can occur on a wide range of crustose, foliose, and fruticose lichens where they often form galls. However, the species can be separated on characters of the fungi themselves, and a non-host based key to the 23 then accepted species was provided by Hawksworth & Diederich (1988) along with ascospore outlines and notes on the species. In addition, Atienza et al. (2003) provided a key to the 13 *Polycoccum* species known in

Spain, including synopses of their world distributions. One of us (MGH) collected two *Polycoccum* species on *Aspicilia cinerea* and *Acarospora cervina* during his PhD study on the lichenized and lichenicolous fungi of Aladağlar National Park in Central Anatolia, Turkey, which differ from the previously described taxa. These are therefore described here as new species.

Material and methods

The type specimens of these two new species are deposited in the herbarium of Erciyes Üniversitesi Fen Edebiyat Fakültesi and VAB. They were examined by standard microscopic techniques, and drawings were made using a drawing tube. Sections were prepared by hand and examined in I (Lugol's iodine and Metzler's iodine, with [K/I] and without [I] pre-treatment with 10% KOH), 10% KOH alone, and water. Ascospore measurements were made in water and 10% KOH; the mean values are given it italics, and the extreme values outside the main range are given in parentheses. The length/breadth (l/b) ratio of the ascospores is given in the same way.

The species

Polycoccum aksoyi **Halici & V.Atienza, sp. nov.** FIGURES 1-2

MYCOBANK MB 510870

Similis Polycocco peltigerae *sed differt in ascomatis 150–235 µm diam et ascosporis (11–) 13.5–14–15(–16) × 6.5–7–7.5 µm*

Typus: Turkey, Kayseri, Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, near Ger Stream 37°51'N, 35°22'E, alt. 1210 m, on areoles of *Aspicilia cinerea*on exposed siliceous rocks, 25 August 2006, *M.G.Halıcı 0.3128* (VAB 25680 – holotypus; Erciyes Üniversitesi Fen Edebiyat Fakültesi – isotypus).

Etymology: The epithet "*aksoyi*" honours Ahmet Aksoy, the supervisor of MGH who suggested his PhD project.

Description: Lichenicolous, on the areoles of *Aspicilia cinerea*, causing bleaching and suppressing host ascomatal production in infected areoles. **Ascomata** perithecioid, arising singly, immersed at first with only the ostiole and surrounding zone externally visible, semi-immersed (⅔ to ½) at maturity, 150–235 µm diam, 1–3 per areole, ostiole 30 µm diam, black, globose. Ascomatal wall pale brown at the base, c. 25 µm thick and dark brown and thickened in the upper part, up to 100 µm thick in the area surrounding the ostiole, in vertical section composed of several layers of ± radially compressed cells, forming a textura angularis, cells 4–7.5 µm diam. Cell walls dark brown, paler towards the inner part of the ascomata, and surrounded externally by 25 µm thick of several layers of colourless cells of uncertain origin. **Hamathecium** of interascal filaments, numerous, septate, branched and anastomosing 1.25–2 µm wide; hymenial gelatine I + blue (Lugol's). **Asci** subcylindrical, very short

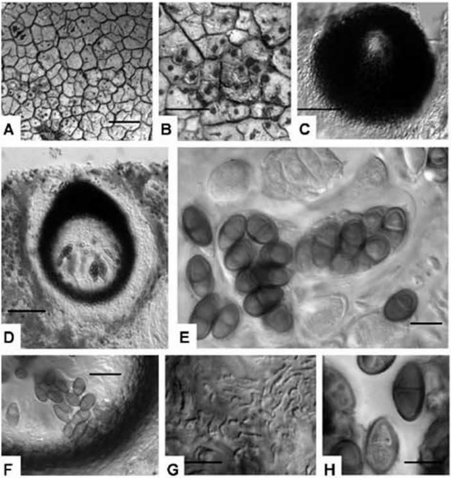

Fig. 1. ***Polycoccum aksoyi*** (holotype). A, B, infected host thallus. C, ascoma showing the ostiole area. D, vertical section of an ascoma. E, mature and young asci and ascospores. F, Detail of ascomata wall. G, interascal filaments. H, ascospores showing the gelatinous sheath.
Scales A-B = 2 mm, C-D = 50 µm, E-H = 10 µm, F-G = 25 µm.

stalked, bitunicate in structure, 8-spored in mature asci, (31.5–)*38*(–44) × (12–)*16*(–18) µm. **Ascospores** distichously arranged in the asci, ellipsoid, brown, smooth walled, (0–)1-septate, somewhat constricted at the septum, both cells ± equal in size, the lower cell somewhat attenuated, (11–)13.5–*14*–15(–16) × 6.5–7–7.5 µm (*n*=12), with a thin colourless gelatinous sheath 0.5 µm thick; l/b = (1.6–)1.85–2.15(–2.45). **Conidiomata** not observed.

Ecology and distribution: The species is pathogenic as bleaching is seen in the infected areoles of the host thallus and ascoma production is suppressed. This new species is known only from the original collection from Central

Anatolia (Turkey). As the host lichen has a wide distribution in the Northern Hemisphere, the species should be searched for elsewhere.

Observations: *Polycoccum aksoyi* is characterized morphologically by the ascomata having a very small ostiole, the wall paler in the lower part and pale brown, smooth-walled ascospores with a thin colourless gelatinous sheath; in addition it is the first member of the genus to be recognized on *Aspicilia cinerea*. This new species differs from *P. peltigerae*, which has ascospores with similar length, not only by occurring on a different host species, but in the ascomata often being entirely immersed and forming swellings on the host thallus, the narrower subcylindrical asci of 45–55(–75) × (7.5–)8–10(–12) µm and the ascospores being narrower ((12–)13.5–16(–18) × (4–)6(–7) µm) monostichously arranged in the asci (Aa 1989, Hawksworth & Diederich 1988). *P. kerneri*, which occurs on *Lecidea fuscoatra*, also has somewhat similar ascospore sizes, but they are rather wider ((12–)14–15(–17.5) × (7–)8.5–10 (–10.5) µm) with a coarsely warted perispore, and in addition the ascomata (200–300 µm) and asci (85 × 22 µm) are larger (Hawksworth 1994).

Polycoccum acarosporicola Halici & D.Hawksw., sp. nov. FIGURES 3-4

MYCOBANK MB 510871

Similis Polycocco cartilaginosum *sed differt in ascosporis (25–)28.5–31.5(–34) × (7–)8–9.5 µm.*

Typus: Turkey, Kayseri, Yahyalı, Aladağlar Milli Parkı, Narpuz Valley, Entrance to 2. Narpuz, 37°49'N, 35°07'E, alt. 2210 m, on thallus of *Acarospora cervina* on exposed limestones, 30 August 2005, *M.G.Halıcı 3211* (Erciyes Üniversitesi Fen Edebiyat Fakültesi – holotypus).

Etymology: The epithet "*acarosporicola*" refers to the host lichen genus, *Acarospora*.

Description: Lichenicolous on the squamules of *Acarospora cervina*, causing bleaching. **Ascomata** perithecioid, arising singly, immersed at first with only the ostiole visible but semi-immersed at maturity, black, globose, 180–250 µm diam, 1–2 per squamule, ostiole 20–30 µm diam. Ascomatal wall pale reddish brown at the base, c. 30 µm, dark reddish brown and thickened to 80 µm in the upper part surrounding the ostiole, in vertical section composed of several layers of ± radially compressed cells forming a textura angularis, cells c. 9.5 × 6 µm, cell walls dark reddish brown, paler towards the inner part of the ascomata. **Hamathecium** of interascal filaments, numerous, septate, branched and anastomosing, 2–2.5 µm wide; hymenial gelatine I – and K/I – (Lugol's and Metzler's), ascus contents I + yellowish (Lugol's and Metzler's). **Asci** cylindrical to clavate, short stalked, bitunicate in structure, 8-spored in mature asci, 85–96 × 15.5–18.5 µm. **Ascospores** distichously arranged in the asci, ellipsoid, colourless for a long time and brown when mature, verruculose, 1-septate, somewhat constricted at the septum, cells ± equal in size, both ends rounded,

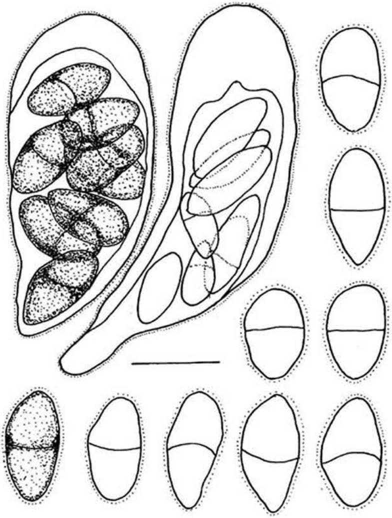

Fig. 2. ***Polycoccum aksoyi*** (holotype). Mature and young asci, 9 ascospores outlines, surface pigmentation in one. Scale = 10 µm.

especially in some young ascospores, 2–5 guttulate, without a gelatinous sheath, (25–)28.5–31.5(–34) × (7–)8–9.5 µm (*n*=12), l/b = (2.77–)3–3.6(–4.15). **Conidiomata** not observed.

Ecology and distribution: The species is evidently pathogenic as bleaching is seen in the infected squamules of the host thallus. This new species is known only from two collections in Central Anatolia, Turkey. As the host lichen has a

Fig. 3. ***Polycoccum acarosporicola*** (holotype). A, Ascus and pseudoparaphyses in K. B, Asci and ascospores in Lugol's I., C, An ascospore showing the verruculose ornemantation

Scales A = 10 µm, B = 25 µm, C = 5 µm.

wide distribution in the Northern Hemisphere, this species may have a wider distribution. In the holotype there is also a sterile unidentified endolithic *Verrucaria*-like sp. which is infected by *Polycoccum marmoratum*.

Observations: The new species is the first in the genus to be recognized on *Acarospora cervina*. *Polycoccum microstictum* has been described from *Acarospora fuscata* (Hawksworth & Diederich 1988) but it has generally coarsely verruculose ascospores which are much smaller (14–18 × 7–8.5 µm), and also smaller ascomata ((50–)100–150 µm).

Polycoccum cartilaginosum seems to be the closest species to *P. acarosporicola*. The first species described from an unknown host was reported from Turkey on *Acarospora cervina* by Halıcı et al. (2007). *Polycoccum cartilaginosum* also has verruculose ascospores, but their size is given as 8–9 µm wide by those

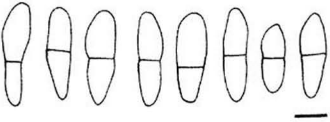

Fig. 4. *Polycoccum acarosporicola* (holotype). 8 ascospores outlines. Scale = 10 µm.

authors. However, the width of the ascospores in *P. cartilaginosum* is given as 12–14(–15) µm in Hawksworth & Diederich (1988). After re-examining the specimens, we concluded that the species first reported as *P. cartilaginosum* is actually *P. acarosporicola*.

Polycoccum crassum has coarsely ornamented, wider ascospores (8–10(–14) µm) borne uniseriately in 4-spored asci, and occurs on *Peltigera*. However, the shape of ascospores is similar to those in the new species, and further some guttules are often present (Hawksworth & Diederich 1988).

Additional specimen examined: Turkey, Malatya, East of Kurşunlu Village, 38° 40' N, 37° 52' E, alt. 1820 m, on thallus of *Acarospora cervina* on calcareous rocks, 19 Aug. 2005, *M. Candan* (ANES 9837).

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MYCOTAXON

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A new species of *Dissoconium* from China colonizing apples

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Abstract—A new species of *Dissoconium* is described. The fungus was found on the cuticle of apple fruit sampled from an orchard in Shaanxi Province, China. Its morphology is compared with other *Dissoconium* species, and phylogenetic analysis based on ITS sequence is presented.

Key words—*Dissoconium mali, Mycosphaerella,* taxonomy, sooty blotch, internal transcribed spacer, rDNA

Introduction

The genus *Dissoconium* de Hoog et al. (1983) was established as a hyphomycete with conidiophores lightly pigmented, forming septate and aseptate conidia in sympodial order. The conidia are hyaline, one or two-celled, and detach forcibly in pairs.

Currently the genus contains four species (Kirk et al. 2001). Two further species were introduced into MycoBank (Crous et al. 2007). Batzer et al. (2005) reported five putative *Dissoconium* species within the sooty blotch complex on apple fruit. Recently, during investigations of sooty blotch and flyspeck of apple in China, a fungus with one- and two-celled conidia was found. It is described as a new species of *Dissoconium* based on ITS sequence analysis and morphological comparison.

Materials and methods

Thalli were transferred to a potato dextrose agar (PDA) slant directly from the apple fruit surface, then cultured at 25°C in darkness (Sun et al. 2003). Morphological description of the species was based on 1-month-old cultures.

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Table 1 Sequences downloaded from GenBank

GenBank code	Teleomorph	Anamorph	Reference
AF173308		*Dissoconium aciculare*	Crous et al. (1999)
AF173311	*Mycosphaerella parkii*	*Stenella parkii*	Crous et al. (1999)
AF309591	*M. marasasii*	*Pseudocercospora marasasii*	Crous et al. (2001)
AF309605	*M. juvenis*	*Uwebraunia juvenis*	Crous et al. (2001)
AF309608	*M. irregulariramosa*	*Pseudocercospora irregulariramosa*	Crous et al. (2001)
AF309609	*M. heimioides*	*Pseudocercospora heimioides*	Crous et al. (2001)
AF309611	*M. crystallina*	*Pseudocercospora crystallina*	Crous et al. (2001)
AF309621	*M. suttonii*	*Phaeophleospora epicoccoides*	Crous et al. (2001)
AY266151	*M. fijiensis*	*Pseudocercospora fijiensis*	Stewart et al. (1999)
AY598874		*Dissoconium* sp.	Batzer et al. (2005)
AY598875		*Dissoconium* sp.	Batzer et al. (2005)
AY598876		*Dissoconium* sp.	Batzer et al. (2005)
AY598877		*Dissoconium* sp.	Batzer et al. (2005)
AY626979	*M. parkii*	*Stenella parkii*	Glen et al. (2007)
AY725541	*M. communis*	*Dissoconium commune*	Crous et al. (2004)
AY725544	*M. communis*	*Dissoconium commune*	Crous et al. (2004)
AY725545	*M. ellipsoidea*	*Uwebraunia ellipsoidea*	Crous et al. (2004)
AY725552	*M. lateralis*	*Dissoconium dekkeri*	Crous et al. (2004)
DQ019332	*M. colombiensis*	*Pseudocercospora colombiensis*	Feau et al. (2006)
DQ302951	*M. cryptica*	*Colletogloeopsis nubilosum*	Crous et al. (2006)
DQ302961	*M. gracilis*	*Pseudocercospora gracilis*	Crous et al. (2006)
DQ302966	*M. heimii*	*Pseudocercospora heimii*	Crous et al. (2006)
DQ302976	*M. madeirae*		Crous et al. (2006)
DQ302990	*M. molleriana*	*Colletogloeopsis molleriana*	Crous et al. (2006)
DQ303048	*M. sumatrensis*		Crous et al. (2006)
DQ303091	*M. capsellae*	*Pseudocercosporella capsellae*	Crous et al. (2006)
DQ632685	*M. citri*	*Stenella citri-grisea*	Burgess et al. (2007)
AY152565	*M. rubi*	*Septoria rubi*	Verkley et al. (2004)

To sequence the ITS region, template DNA was obtained using the method described by Barnes et al. (2001). The ITS region (ITS1, 5.8S rDNA gene, ITS2) was amplified using primers ITS1-F (Gardes et al. 1993) and ITS4 (White et al. 1990). Cycling conditions for amplification were an initial denaturation at 94°C for 1 min followed by 35 cycles of denaturation at 94°C for 30 s, annealing at 52°C for 30 s, and extension at 72°C for 30 s. Purifying and automated sequencing of the PCR product was performed at Organism Technology Co., Ltd., Shanghai, China. Accession Number in GenBank is EF627451 for isolate LQ45, EF627452 for isolate LQ73.

BLAST searches were conducted. Partial sequences with high homology base pairs were downloaded from GenBank (Table 1). After all sequences were pruned to include the complete sequences of ITS1, the 5.8S rDNA gene, and ITS2, they were aligned using Clustal X (1.83). The alignments were adjusted by eye using BioEdit 5.0.9.1. Maximum parsimony analysis was conducted with PAUP version 4.0b10 for 32-bit Microsoft Windows (Swofford 2001). Heuristic searches were performed with 1000 random sequence addition. A majority consensus tree was constructed and the robustness was evaluated by 1000 bootstrap replications. Other measures including tree length, consistency index, retention index, and rescaled consistency index (CI, RI and RC) were also calculated. *Uwebraunia ellipsoidea* was used as outgroup taxon.

Results and discussion

Two isolates, LQ45 and LQ73, were obtained from the cuticle of apple fruit, and their ITS sequences were obtained subsequently. Based on ITS data including 28 sequences downloaded from GenBank and sequences of these two isolates, a majority rule consensus tree with 896 steps (CI = 0.566, RI = 0.797, RC = 0.451) was constructed (Fig.1). There was a major clade with 74% bootstrap value, and another clade included several anamorphs of *Mycosphaerella* with a lower bootstrap value. Crous et al. (2000) accepted *Dissoconium* as an anamorph genus of *Mycosphaerella*, and found that *Dissoconium* species clustered together as a single clade from other anamorphs of *Mycosphaerella* in a phylogram tree. In our tree all of the *Dissoconium* species clustered together with 100% bootstrap support as a sub-clade in the major clade and LQ45 and LQ73 clustered together as a dependent clade. Consequently, the two isolates were identified as a species of *Dissoconium*. Morphological comparison, described below, suggested that the two isolates should be a new species.

Taxonomic description

Dissoconium mali G.Y. Sun, Zhu Zhang & Rong Zhang **sp. nov.** Fig.2

MycoBank MB510861

Coloniae in PDA post 30 dies temperature ambiente ad 45 mm diam., albidae, dilute oliveaceae, coactae; Hyphae hyalinae, septatae, 1.5-2.0 μm latae; Conidiophora orthotropice ex hyphis indistinctis vegetativis oriunda, constanter pallide brunnea, recta, 4.0-150 μm longa, crassitunicata, continua vel septata, non-ramosa; cellulae conidiogenae terminal, cicatrices. Conidia sympodialiter, hyaline, ovoidea, 3.4-6.2×1.6-3.0 μm, vel symmetrice bicellularia in medio constricta, 6.0-12.6×2.1-2.8 μm.

Holotypus: ex cuticulae fructi Malus pumila Mill., Liquan, Shaanxi, China, HMUABO (Herbarium Mycologicum Universitatis Agriculturalis Boreali-Occientalis) 822500; cultus LQ73.

Table 2 Size of macroconidia of *Dissoconium* and *Uwebraunia* species

Species	Size (µm)	Reference
D. aciculare	12-25×5-8	Crous et al. 1983
D. subuliphorum	11-16×3.8-4.5 (-5)	Crous et al. 1999
D. dekkeri	22-30×3.8-4.5	de Hoog et al. 1991
D. commune	20-30×4-5	Crous et al. 2004
D. australiense	(20)23-25(27)×(3-)4(-5)	Crous et al. 2007
D. eucalypti	(8)10-12(14)×(4.5)5-6	Crous et al. 2007
D. mali	6.0-12.6×2.1-2.8	In this study
U. ellipsoidea	(16-)17-21(-22)×(3-)4-5(-6)	Crous & Wingfield 1996
U. juvenis	(25-)26-30(-40)×(4-)4.5-5.5(-6)	Crous & Wingfield 1996

Colony diameter on PDA reaching 45 mm in one month at 25°C, felty, pale olivaceous. Hypha hyaline, thin-walled, septate, 1.5-2.0 µm wide. Conidiophores arising orthotropically from undifferentiated hyphae, evenly pale brown, straight, 4.0-150 µm long, 1.5-2.6 µm, 0-4 septate and mostly 0-1 septate, conidiogenous cells terminal, polyblastic, unbranched, unpigmented scars, elongate with age. Conidia produced in sympodial order on the conidiophore apex. Conidia hyaline, thin walled, one-celled and obovoid, 3.4-6.2×1.6-3.0 µm, occasionally two-celled and constricted at the septum, 6.0-12.6×2.1-2.8 µm.

> Additional specimen examined: LQ45 (dried culture), ex apple fruit surface, Liquan, Shaanxi, China.

Currently the genus contains six species, namely, *Dissoconium aciculare* de Hoog et al. (de Hoog et al. 1983), *D. subuliphorum* (Matsush.) R.F. Castañeda (Crous et al. 1999), *D. dekkeri* de Hoog & Hijwegen (de Hoog et al. 1991, = *Uwebraunia lateralis* Crous & M.J. Wingf.; teleomorph *Mycosphaerella lateralis* Crous & M.J. Wingf.), *D. commune* Crous & Mansilla (Crous et al. 2004, teleomorph *M. communis* Crous & Mansilla), *D. australiense* Crous & Summerell (Crous et al. 2007), and *D. eucalypti* Crous & Carnegie (Crous et al. 2007). Our species seldom produced two-celled conidia, but if present, they were narrower or shorter than those of other *Dissoconium* species (Table 2). Therefore, it is easy to distinguish *D. mali* from other known species in the genus.

Uwebraunia is similar morphologically to *Dissoconium*, but both species known in *Uwebraunia* have percurrently proliferating conidiogenous cells and broader and longer macroconidia than *Dissoconium mali* (Table 2).

Based on the ITS sequence analysis and morphological comparison, the species is a new member of *Dissoconium*.

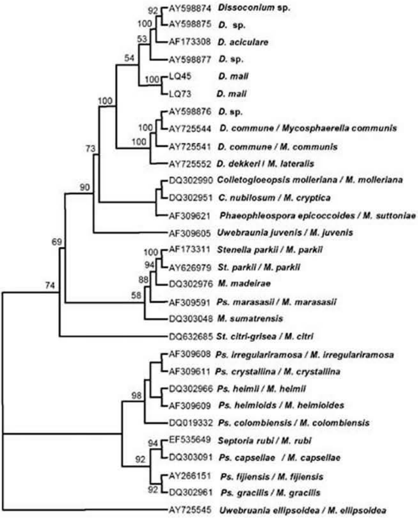

Fig. 1. The majority consensus tree (length = 896, CI = 0.566, RI = 0.797, RC = 0.451) derived from a heuristic search option in PAUP version 4.0b10 for 32-bit Microsoft Windows with 1000 randomizations of sequence input orders and 1000 bootstrap replications using the data set of ITS1, 5.8S and ITS2. The bootstrap values higher than 50% are indicated above or below the tree branches.

Although the type species, *D. aciculare*, and another species, *D. dekkeri* (anamorph of *Mycosphaerella lateralis*), were described as hyperparasites on other fungi (de Hoog et al. 1991), and *D. subuliphorum* was isolated from soil (Matsushima 1975), *D. commune* (anamorph of *M. communis*) was described

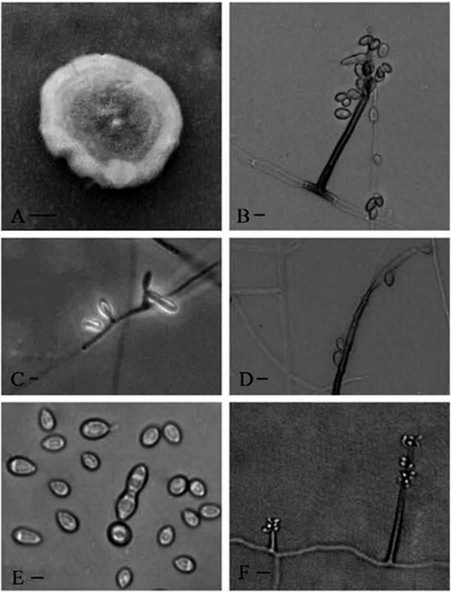

Fig. 2. *Dissoconium mali*
A, colony on PDA; B-F, conidia and conidiophores
bar (A) = 5 mm, bars (B-E) = 2 µm, bar (F) = 5 µm

as a leaf spot pathogen of *Eucalyptus* (Crous et al. 2004). In this article, *D. mali* is reported as a member of the apple sooty blotch complex. We speculate that *Dissoconium* species could live in parasitic, hyperparasitic, or saprotrophic modes.

Acknowledgments

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Rhynchomeliola quercina, a new rostrate ascomycete from oak trees in western Canada

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Abstract — A new rostrate fungus with 2-celled, pale brown, verruculose ascospores was collected from dead buds of Oregon white oak in Canada. The fungus is identified and described as a new member of the genus *Rhynchomeliola*, *R. quercina*, and compared with other known species.

Key words — taxonomy, *Rhynchostoma*

Introduction

A nonstromatic perithecial fungus with a long neck has been collected from dead buds of Oregon white oak in Canada by M.E. Barr who identified it as a *Rhynchomeliola* Speg. species. Recently, a study of rhynchostomatoid fungi on *Proteaceae* was published by Lee et al. (2003). They introduced new species of *Rhynchostoma* P. Karst. and *Rhynchomeliola* and amended the description of *R. australiensis* (Petr.) E. Müll. (≡ *Rhynchostoma australiense* Petr.). Their paper discussed taxonomic affinity and history of both genera and the placement of *Rhynchostoma* based on nrDNA data. As the generic prefix of both genera "rhyncho (rostrate or beaked in Greek)" implies, they are characterized by ascomata with a distinctly long ostiolar neck together with brown, 2-celled, ornamented ascospores and filamentous paraphyses. Phylogenetic analyses showed that *Rhynchostoma* is closely related to chaetothyriaceous fungi that have completely different morphological characteristics (Lee et al. 2003). Winka & Eriksson (2000) proposed the family *Rhynchostomataceae* in *Chaetothyriomycetes* to encompass *Rhynchostoma*.

Since its introduction in 1884 (Spegazzini 1884), *Rhynchomeliola* has been placed in the *Sphaeriaceae* (*Sphaeriales*) (Müller & Arx 1962), in the *Trichosphaeriaceae* (*Trichosphaeriales*) (Hawksworth et al. 1995), in the *Rhynchostomataceae* with uncertainty (Eriksson 2006, Winka & Eriksson 2000) or remained uncertain about the familial placement (Kirk et al. 2001). The genus comprises eight species on leaves, especially on trichomes, of various plants and lichens in the Southern Hemisphere (Batista & Maia 1964, Batista et al. 1960, Henssen & Kantvilas 1985, Lee et al. 2003, Müller & Arx 1962). The study of recently collected material based on morphological characteristics revealed the fungus is a good species of *Rhynchomeliola*. Its detailed description and illustrations are provided with comparison with other *Rhynchomeliola* species.

Materials and methods

Dead buds of Oregon white oak, *Quercus garryana* Dougl. ex Hook. (*Fagaceae*), were collected in Sidney, British Columbia, Canada. Dried specimens were directly used for the study. Morphological characteristics were observed using a Nikon Eclipse E600 light microscope with differential interference contrast (DIC) or a Nikon SMZ800 dissecting microscope. Photography was made on a Nikon Digital Camera DXM 1200 mounted on the microscopes. Fungal structures were mounted in clear lactophenol, or otherwise as specified. Ascospore dimensions were derived from 30 observations with 95% confidence intervals with the extremes given in parentheses. Dimensions of other fungal structures were described in the extremes with less than 30 observations. Sections of ascomata were prepared on a Leica CM1100 Cryostat microtome (Leica Instruments, Germany) from material mounted with Jung tissue freezing medium™. Herbarium specimens are deposited at PREM (Pretoria, South Africa) and at DAOM (Ontario, Canada).

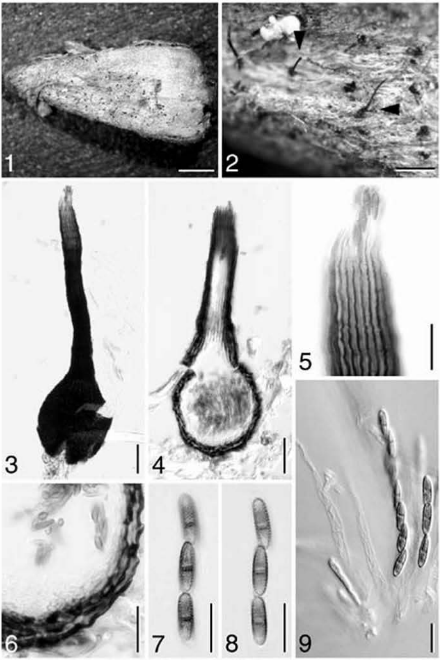
Taxonomic description

Rhynchomeliola quercina Marinc. & M.E. Barr **sp. nov.** **Figs. 1–9**
MycoBank MB510876

Ascomata nonstromatica rostrata; asci cylindrici, sine apparati apicali; paraphyses filamentosae; ascosporae pallide brunneae verruculosae uniseptatae ellipsoideae vel oblongae, (10–)11–12(–14) × (2.5–)3(–3.5) µm.

Etymology: from the Latin *quercus* = host genus, *Quercus*.

EXPANDED DESCRIPTION–Ascomata nonstromatic, perithecial, superficial among minute fiber-like trichomes, gregarious or separate, venter globose to subglobose, up to 187 µm high, up to 150 µm wide, with an ostiole in the neck, necks central, single, cylindrical, up to 400 µm high, up to 45 µm wide at the base, and up to 37.5 µm wide at the apex, consisting of longitudinally angular cells, individual neck cells 3–4 µm wide. **Peridium** up to 15 µm thick, composed of two layers, the outer layer consisting of a few rows of compressed, thick-walled, brown cells, the inner layer consisting of a few rows of compressed,



Figs. 1–9. *Rhynchomeliola quercina* (Holotype, PREM 58937) 1. Host substrate. 2. Ascomata with long necks among trichomes (arrowheads). 3. Squashed ascoma (in water). 4. Vertical section of ascoma. 5. Apex of ostiolar neck. 6. Peridium. 7, 8, Ascospores. 9. Paraphyses and asci.
Scale bars: Fig. 1 = 2 mm; 2 = 0.2 mm; 3, 4 = 50 µm; 5, 6 = 25 µm; 7–9 = 10 µm.

Table 1. Distribution, host substrates and ascospore characteristics of *Rhynchomeliola* species.

Fungi	Ascospore characteristics	Host substrates	Known areas
R. australiensis	Striate 10–14 × 3.5–4.5 µm	_Grevillea_ sp. (_Proteaceae_)	Australia
_R. licaniae_*	Smooth 4–6.5 × 2–2.5 µm	_Licania_ sp. (_Chrysobalanaceae_)	Brazil
_R. lichenicola_*	Verruculose 8–10.5 × 3.5–8 µm	Lichen	Australia
R. lomatiae	Verruculose 8–11 × 2–4 µm	_Lomatia polymorpha_ R. Br. (_Proteaceae_)	Australia
_R. pulchella_*	Striate 7–8 × 2.5–3 µm	_Feijoa sellowiana_ (O. Berg) O. Berg (_Myrtaceae_)	Brazil
_R. pusilla_*	Not mentioned 7.5–10 × 3–4 µm	_Rondeletia affinis_ Hemsl. (_Rubiaceae_)	Costa Rica
_R. rosacearum_*	Smooth 2.5–4 × 1–2.5 µm	A species of _Rosaceae_	Brazil
_R. usteriana_*	Verruculose 13–18 × 3.5–5.5 µm	A species of _Myrtaceae_	Brazil, Papua New Guinea
R. quercina	Verruculose, forming parallel longitudinal rows 10–14 × 2.5–3.5 µm	_Quercus garryana_ (_Fagaceae_)	Canada

*information obtained from the literature

thin-walled, hyaline cells. **Paraphyses** hyaline, scanty, 3–4 µm wide at the base, tapering into 1.5–2 µm at the apex, unbranched, filamentous, flexuose, septate. **Asci** unitunicate, cylindrical, lining the perithecial wall, persistent but becoming indistinguishable when ascospores are fully developed, 76–110 × 3.5–4 µm, no apical apparatus observed. **Ascospores** hyaline, becoming pale brown at maturity, oblong or ellipsoidal, (10–)11–12(–14) × (2.5–)3(–3.5) µm, 1-septate, verruculae forming parallel longitudinal rows, germ pore inconspicuous.

SPECIMENS EXAMINED–CANADA. British Columbia: Sidney–On bud scales of *Quercus garryana*, 22 March 1998, M.E. Barr 9649 (**HOLOTYPE–PREM 58937**); 16 June 1993, M.E. Barr 8536, PREM 58936; 25 May 2004, M.E. Barr 10963, PREM 58938; 21 November 2005, M.E. Barr 12000, PREM 59666; 23 October 2006, M.E. Barr 12026, PREM 59665.

COMMENTS–Among known species, *Rhynchomeliola quercina* is similar to *R. australiensis* in spore dimensions. However, ascospores of *R. quercina* are mostly oblong-shaped without constriction at septum and have minute warts on the surface that form parallel longitudinal rows. Besides long beaked ascomata, *Rhynchomeliola* species have ascospores with ornamentations such as striations or minute warts (verruculose). *Rhynchomeliola pulchella* Speg., the type species, and *R. australiensis*, have striated ascospores. *Rhynchomeliola lichenicola* Henssen & Kantvilas, *R. lomatiae* S.J. Lee & Joanne E. Taylor, *R. pusilla* (Syd.) E. Müll. and *R. usteriana* (Speg.) Arx & E. Müll. have verruculose ascospores. The original descriptions of *Rhynchomeliola licaniae* Bat. & J.L. Bezerra and *R. rosacearum* Bat. & Cavalc. illustrate ascospores as "liso (smooth in Portuguese)". It is, however, possible that ascospore ornamentation may have been overlooked due to their minute size. For example, *Rhynchomeliola australiensis* was described as having smooth ascospores (Müller & Arx 1962), but later striations were observed on the type specimen of the species (Lee et al. 2003). All the species are foliicolous except for *R. lichenicola* that occurs on lichens and *R. quercina* on bud scales. *Rhynchomeliola quercina* is the first species of the genus that is reported from temperate regions of the Northern Hemisphere (Table 1). Various attempts have been made to grow it on artificial media. A couple of ascospores produced a germ tube of less than 1 cm length but ceased to grow further.

Key to the species of *Rhynchomeliola*

1a. Occurring on lichen	***R. lichenicola***
1b. Occurring not on lichen	2
2a. Ascospores less than 4 µm in length	***R. rosacearum***
2b. Ascospores more than 4 µm in length	3
3a. Ascospores 4–11 µm in length	4
3b. Ascospores more than 10 µm in length	7
4a. Ascospores 4–6.5 µm in length	***R. licaniae***
4b. Ascospores more than 7 µm in length	5
5a. Ascospores with striations	***R. pulchella***
5b. Ascospores without striations	6
6a. Ascospores fusiform	***R. lomatiae***
6b. Ascospores oblong ellipsoid or oblong fusoid	***R. pusilla***
7a. Ascospores with striations	***R. australiensis***
7b. Ascospores verruculose	8
8a. Ascospores oblong	***R. quercina***
8b. Ascospores fusiform	***R. usteriana***

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Hysteriaceous fungi of Southern Anatolia

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Abstract – The plant species *Juniperus excelsa* is described as new host for several hysteriaceous fungi. Data are presented on *Hysterographium flexuosum*, *H. subrugosum* and *Hysterium insidens*. Microscopic and macroscopic features are described, images provided, and their taxonomic position and geographical distribution are discussed. These three cosmopolitan species were recorded in Turkey for the first time. Moreover, the genus *Hysterium* is a new addition to the mycoflora of Asia Minor.

Key words – Crimean juniper, Termessos National Park

Introduction

Fungi are heterotrophs; because of this, they play several distinctive roles in terrestrial ecosystems: as saprotrophs, as parasites of plants and animals, as mutualistic symbionts of many phototrophic organisms (e.g., cyanobacteria and algae) in the form of lichens, and as mycorrhizal partners of vascular plants (Dix & Webster 1995). About 75 000 species of fungi have been described, but it is estimated that 1 to 1.5 million species exist (Hawksworth et al. 1995). These interact in various ways with their hosts, with their substrates, with their competitors (including other fungi) and with abiotic variables of their environment. They show great variation in morphology, reproduction, life cycles and modes of dispersal. They exist in almost every conceivable habitat where organic carbon is available, including in fresh water and the sea, in soil, litter, in dung, in living plants and decaying remains of plants and animals (Dix & Webster 1995).

Most species of the family *Hysteriaceae* are saprobic on wood and bark, although a few are plant parasites (Alexopoulos & Mims 1996, Landecker 1993). During a taxonomical study of lichens in the Termessos National Park of Antalya (Tufan 2004) we have found three saprotrophic hysteriaceous species on the bark of crimean juniper (*Juniperus excelsa* M. Bieb.).

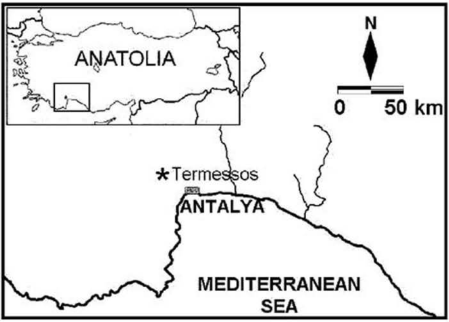
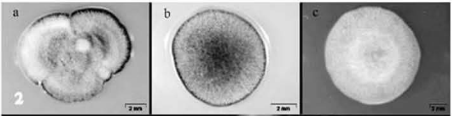


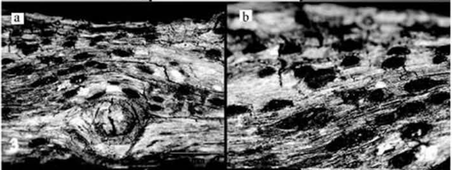
Figure 1. Collection site of hysteriaceous fungi.

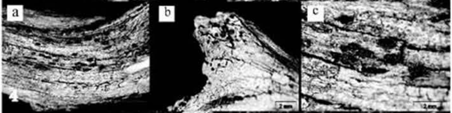
Material and methods

Materials for this paper were obtained from Termessos National Park (6702 hectares), which is 34 km northwest of Antalya within the border of Antalya province in south Anatolia (Figure 1). The study area is located in the Mediterranean phytogeographical region. The infected plant samples were collected at the autumn in 2002. The morphological and ecological characteristics of the microfungi were recorded and they were photographed in their natural habitats. The samples were taken with a scalpel previously cleaned with 70 % ethyl alcohol. They were transferred to paper bags and stored in a dry location at room temperature until microbiological processing.

The hysteriaceous fungi were isolated from the samples by picking single fungal colonies using needles under a dissecting microscope (Wollenzien et al. 1995) and transferring them onto agar plates (Figure 2) with 2 % malt–peptone medium (2 % malt extract, 2 % glucose, and 0.1 % yeast peptone, 1.5 % agar, pH 7). The plates were incubated at room temperature. The isolates were purified in two or three steps by transfer to fresh medium. Purity was checked and maintained by repetitive light microscopic observation. The cultures are conserved in the ACBR (Austrian Centre of Biological Resources and Applied Mycology) Culture Collection (Vienna, Austria) for further investigation.







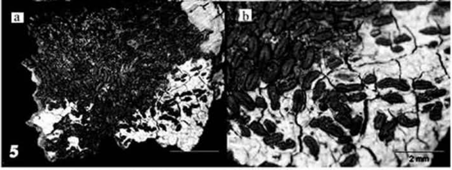
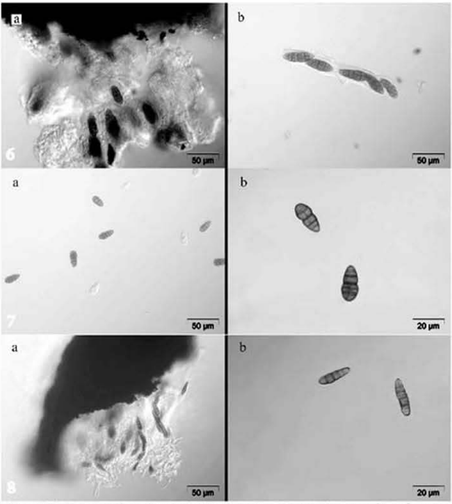


Figure 2. Hysteriaceous fungi on the agar plates. a. *Hysterographium flexuosum*, b. *Hysterographium subrugosum*, c. *Hysterium insidens*.

Figures 3–5. Three hysteriaceous species on the bark of *Juniperous excelsa*. Figure 3. *Hysterographium flexuosum*. Figure 4. *Hysterographium subrugosum*. Figure 5. *Hysterium insidens* (between the thalli of *Pertusaria* sp.).

For identification, mounts of the mycelium were prepared in lactophenol and observed with a light microscope. The isolates were identified with the help of works by Zogg (1962), Göbelez (1962), Amano (1983), Ellis & Ellis (1987), Linde (1992), Ellis (1993), Vasilyeva (1999). The plant species were identified



Figures 6–8. Ascospores from three hysteriaceous species. Figure 6. *Hysterographium flexuosum*. Figure 7. *Hysterographium subrugosum*. Figure 8. *Hysterium insidens*.

using Flora of Turkey Davis (1965–85). The specimens are deposited in the Akdeniz University Herbarium (AKDU).

Results

In this paper we present information on *Hysterographium flexuosum*, *H. subrugosum*, and *Hysterium insidens*. Analysis of the available literature has indicated that they are new records for the locality in which they were found. These three fungi were found to occur on an important tree, *Juniperus excelsa* for the first time (Figures 3–5). Moreover, the genus *Hysterium* is added to the mycoflora of Turkey. The species identified from the research area, their taxonomic position, micro- and macroscopic features and locality in which they were collected are given below are given below:

Taxonomy

Ascomycota, Ascomycetes, Dothideomycetidae, Hysteriales, Hysteriaceae

Hysterographium Corda, Icon. Fung. 5 : 34, 1842

Hysterothecia superficial, scattered or aggregated, dark brown to black, carbonaceous, oblong; asci claviform or cylindrical, shortly stipitate; ascospores oblong to fusiform or muriform, brown, sometimes with mucilaginous sheath.

Eleven species of *Hysterographium* are known (Zogg 1962, Ahmad 1964, Tilak 1970, Tilak & Kale 1970, Rao 1971, Panwar & Kaur 1977, Pande 1980, Amano 1983, Barr 1990, Hsieh et al. 1997). In this group of species *H. flexuosum* has the largest ascospores except *H. longisporum* (Hsieh et al. 1997).

Hysterographium flexuosum (Schwein.) Sacc., Syll. Fung. 2: 781, 1883 Figure 6

Hysterothecia superficial, scattered, dark brown to black, carbonaceous, up to 3.5 mm long, 0.5–2 mm wide, oblong; asci claviform, 120–205 × 19–24 µm (Figure 6), shortly stipitate; ascospores fusiform, brown, sometimes with mucilaginous sheath, 15–20 transverse and 3–4 longitudinal septa, 50–80 × 15–20 µm (Figure 6 a, b).

Specimen examined: Turkey, Antalya, Termessos National Park, Top of Keldağ Hill, 640 m, N 37° 01.235' E 30° 30.535', 15. IX. 2002, Ö. Tufan 1657.

Hysterographium subrugosum (Cooke & Ellis) Sacc., Syll. Fung. 2: 780, 1883 Figure 7

Hysterothecia superficial, scattered or in groups, dark brown to black, carbonaceous, 0.5–3 mm long, 0.2–0.8 mm wide, oblong or elongated; asci cylindrical, 78–115 × 15–22 µm, shortly stipitate, stipe 2–3 µm; ascospores fusiform or clavate, pale brown, 5–8 transverse septa and 1 longitudinal septum, 22–38 × 7–12 µm (Figure 7).

Specimen examined: Turkey, Antalya, Termessos National Park, Top of Keldağ Hill, 640 m, N 37° 01.235' E 30° 30.535', 15. IX. 2002, Ö. Tufan 1675.

Hysterium Pers., Neues Mag. Bot. 1: 85, 1794

Hysterothecia superficial, scattered or in small groups, brown to black, carbonaceous, oblong; asci cylindrical or claviform, shortly stipitate; ascospores ellipsoidal or fusiform, brown, oblong, sometimes with several transverse and longitudinal septa.

The genus *Hysterium* includes 20 species (Zogg 1962, Tilak 1963, Tilak & Rao 1965–66, Messuti & Lorenzo 1997, Farr 1973). During our study we found the species *Hysterium insidens* between the thalli of an unidentified lichen species (*Pertusaria* sp.) on crimean juniper bark.

Hysterium insidens Schwein., Trans. Amer. Phil. Soc. 4: 244, 1832 Figure 8

Hysterothecia erumpently superficial, scattered, brown to black, carbonaceous, 0.3–1.8 mm long, 0.15–0.6 mm wide, oblong; asci claviform to cylindrical, 92–140 × 9–22 µm; ascospores ellipsoidal, rusty, 4–9 septate, 22–36 × 6–12 µm (Figure 8).

Specimen examined: Turkey, Antalya, Termessos National Park, North slopes of the Keldağ Hill, 580 m, N 37° 01.410' E 30° 30.590', 15. IX. 2002, Ö. Tufan 1684.

Discussion

The crimean juniper, formerly an important timber tree, is once again increasing in importance. The fragrant wood is very durable, of good quality and toxic to many insects. Native Americans made extensive use of the cones of juniper species for drugs, including use as diuretics, cough medicine, cold remedies and disinfectant. The crimean juniper is a beautiful tree for large sites, especially in mass plantings in naturalized landscapes (Tree Guide Online 2003). In addition, juniper is important for ecosystems. Birds and small mammals disperse their seeds, and the fleshy cones are an important winter food source (Sert & Erdogan 2004).

Tables 1–3 present data on plant species infected by *Hysterographium flexuosum* (Table 1), *H. subrugosum* (Table 2) and *Hysterium insidens* (Table 3) throughout the world. The geographical distributions of these microfungi appear rather widespread. Up to now, the diseases have been observed on this most important host only in Antalya, Turkey. But crimean junipers are widely dispersed. *Juniperus excelsa* grows in Albania, Yugoslavia, Greece, Bulgaria, Turkey, Cyprus, Syria, Lebanon, Georgia, Armenia, Azerbaijan, Iran to near Ashkhabat in Turkmenia; also on the coast of the Black Sea at the foot of the Caucasus and in the Crimea (Farjon 1992). Spores may carry from known hosts to uninfected hosts and may cause the disease to spread widely across Turkey and into other countries. Therefore, more research is needed on these pathogens, especially on their control and host range.

Previously reported hysteriaceous fungi from Southern Anatolia include *Hysterographium fraxini* (Pers.) De Not. on *Olea europaea* L. (Göbelez 1963) and *H. hiascens* Rehm on wood of *Quercus coccifera* L. (Hüseyin & Yıldızbaş 2005). Our research brings the number of hysteriaceous fungi known in Southern Anatolia to five.

Table 1. Plant species infected by *Hysterographium flexuosum* — botanical families, world collection sites and references.

Species	Families	Sites	References
Acer barbinerve	*Aceraceae*	Russia	Vasilyeva (1999)
A. ginnale	*Aceraceae*	Russia	Vasilyeva (1999)
A. mono	*Aceraceae*	Russia	Vasilyeva (1999)
A. pseudosieboldianum	*Aceraceae*	Russia	Vasilyeva (1999)
A. rubrum	*Aceraceae*	U.S.A	Hanlin (1963)
A. ukurunduense	*Aceraceae*	Russia	Vasilyeva (1999)
Arbutus menziesii	*Ericaceae*	U.S.A	Shaw (1973)
Arctostaphylos columbiana	*Ericaceae*	U.S.A	Shaw (1973)
Betula utilis	*Betulaceae*	Pakistan	Ahmad (1978)
Castanea pumila	*Fagaceae*	U.S.A	Hanlin (1963)
Chosenia arbutifolia	*Salicaceae*	Russia	Vasilyeva (1999)
Crataegus sp.	*Rosaceae*	Russia	Vasilyeva (1999)
Fagus sylvatica	*Fagaceae*	Greece	Pantidou (1973)
Fraxinus sp.	*Oleaceae*	Russia	Vasilyeva (1999)
Lonicera chamissoi	*Caprifoliaceae*	Russia	Vasilyeva (1999)
L. maximowiczii	*Caprifoliaceae*	Russia	Vasilyeva (1999)
Padus maackii	*Rosaceae*	Russia	Vasilyeva (1999)
Populus davidiana	*Salicaceae*	Russia	Vasilyeva (1999)
Quercus coccinea	*Fagaceae*	U.S.A	Hanlin (1963)
Q. nigra	*Fagaceae*	U.S.A	Hanlin (1963)
Q. velutina	*Fagaceae*	U.S.A	Grand et al. (1975)
Rhododendron dauricum	*Ericaceae*	Russia	Vasilyeva (1999)
Salix babylonica	*Salicaceae*	U.S.A	Hanlin (1963)
Salix sp.	*Salicaceae*	U.S.A.	Shaw (1973)
Salix sp.	*Salicaceae*	Russia	Vasilyeva (1999)
Vitis rotundifolia	*Vitaceae*	U.S.A	Hanlin (1963)
Vitis vulpina	*Vitaceae*	U.S.A	Anonymous (1960)

Table 2. Plant species infected by *Hysterographium subrugosum* — botanical families, world collection sites and references.

Species	Families	Sites	References
Castanea dentata	*Fagaceae*	U.S.A	Hanlin (1963)
Cercocarpus ledifolius	*Rosaceae*	U.S.A	Shaw (1973)
Quercus catesbaei	*Fagaceae*	U.S.A	Hanlin (1963)
Q. coccinea	*Fagaceae*	U.S.A	Hanlin (1963)
Q. incana	*Fagaceae*	Pakistan	Ahmad (1978)
Q. leucotrichophora	*Fagaceae*	Pakistan	Ahmad (1969)
Salix sp.	*Salicaceae*	Russia	Vasilyeva (1999)

Table 3. Plant species infected by *Hysterium insidens* — botanical families, world collection sites and references.

Species	Families	Sites	References
Celastrus scandens	*Celastraceae*	Canada	Conners (1967)
Quercus sp.	*Fagaceae*	U.S.A	Grand et al. (1975)
Robinia pseudoacacia	*Fabaceae*	U.S.A	Grand et al. (1975)

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The genus *Cladonia* in Manitoba: Exploring taxonomic trends with secondary metabolites

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Abstract — Thirteen secondary metabolites are reported in 50 species and 638 specimens of *Cladonia* from Manitoba. The most common metabolite was fumarprotocetraric acid in 23 species. Twenty-five species contained more than one compound in the same specimen. The most common combination of compounds was fumarprotocetraric acid and atranorin in seven species. Eleven species contained more than one chemotype. A new chemical variant is reported for *C. amaurocraea*. Taxonomic patterns were reflected in the frequency of occurrence of metabolites separating gray and non-fluorescent compounds from fluorescent and yellow-green compounds. Despite current literature hypotheses, no ecological trends were evident in this study. The variation was compared with other studies, biogenetic relationships were hypothesized, and taxonomic issues were discussed. Taxonomic considerations cannot be separated from effects of environmental changes or gene regulation.

Key words — environmental effects, lichenized fungi, polyketides

Introduction

Chemotaxonomy is the classification of organisms based on biochemical similarities and differences, usually found in the secondary metabolites. Study of secondary metabolites and chemotaxonomy has been ongoing in vascular plants (Smith 1976), bryophytes (Mues 2000), and fungi (Paterson 1998). However, few disciplines (except bacteriology) use chemotaxonomy to the extent that it is used with lichenized fungi (Hawksworth 1976) where it forms an integral part of all taxonomic studies and where secondary products have become important characters in taxonomic keys. Over 800 secondary compounds have been described from lichen fungi (Huneck & Yoshimura 1996, Miao et al. 2001). Many described compounds are polyketides (Elix 1996), natural products derived from successive condensation of small carboxylic acids. Fungal polyketides are produced by gene clusters comprised of genes for polyketide synthases (PKS) and other associated enzymes such as reductases, dehydrogenases, methyltransferases, and oxidases (Keller & Hohn 1997). From knowledge of the polyketides and their structures, biosynthetic pathways can be deduced revealing the enzymes required to synthesize the polyketide.

Most lichen secondary compounds are thought to be produced by the fungal partner (Culberson & Armaleo 1992, Culberson et al. 1985). Numerous roles have been reported for the secondary compounds including light filters for algal photosynthesis, chelation of ions for rock penetration by fungal hyphae, and a number of biological activities (reviewed in Huneck 1999, Lawrey 1986). Lichen secondary compounds have historically been used in the taxonomy of lichens (Culberson 1986, Hawksworth 1976) despite problems associated with the use of compounds as diagnostic characters (Brodo 1986). Some compounds are consistently present in the thallus, providing a diagnostic feature for the species. Other compounds are variable in their presence and are called accessory compounds (Elix 1982). Chemical variation may correlate with morphological or geographical patterns at the genus or species level, or there may be no correlation (Egan 1986). For example, the *Ramalina siliquosa* group shows correlations between secondary compounds and ecogeography (Culberson et al. 1990).

A large genus of well-known lichens, *Cladonia* P. Browne, has been characterized in terms of the presence of its diagnostic secondary metabolites (Ahti 2000, Huovinen & Ahti 1982). The genus *Cladonia* includes the reindeer lichens, the British soldiers, and the pixie cup lichens (Brodo et al. 2001). Secondary compounds in the genus *Cladonia* are well known and diverse (Culberson & Culberson 1970). The compounds are mainly derived from the acetyl polymalonyl pathway. There are no shikimic acid products and only one mevalonic acid derived compound has been reported in *Cladonia* (Culberson & Culberson 1970). Huovinen & Ahti (1982) have constructed biosequential schemes and even presented a classification of *Cladonia* based on biosequential patterns of the secondary products. With growing knowledge of gene regulation and characterization of the PKS gene clusters (Katz & Donadio 1993, Schumann & Hertweck 2006), few studies have examined the expression of these gene clusters along with environmental influence (Culberson & Armaleo 1992, Culberson et al. 1977a, Stocker-Wörgötter 2001). The genus *Cladonia* is represented by approximately 400 species distributed worldwide. The province of Manitoba contains 57 known species of *Cladonia* (Brodo et al. 2001, Piercey-Normore 2003, 2005, 2006; Thomson 1953, 1984). The objectives of this study were to report a synopsis of the secondary metabolites present in the genus *Cladonia* in Manitoba and to explore taxonomic and ecological trends based on the occurrence of secondary metabolites.

Materials and methods

Lichen material was collected throughout the province of Manitoba for a number of previous studies (Piercey-Normore 2003, 2004, 2005, 2006; Robertson &

Piercey-Normore 2007). The material was air-dried and vouchers are deposited in the cryptogamic division of the University of Manitoba Herbarium (WIN). Thin layer chromatography (TLC) was performed on all specimens following a procedure modified from Culberson (1972). Secondary metabolites reported in the above previous studies were compiled and described in Tables 1-3. Chemical classes were determined using Culberson et al. (1977b). The Principal Coordinate Analyses (PCoA) were performed using ORDIN in SYN-TAX ver. 5.02 (Podani 1994). Ordination of the chemical compounds and species was performed using data based on 1) presence or absence of each compound in each species including the seven species reported for Manitoba that are not in the author's collection, and 2) the frequency of occurrence of each compound in the total number of specimens collected (638). Euclidean and Chord distance was used for each analysis. Compounds listed by Thomson (1984) were used for the seven species of *Cladonia* reported in Manitoba but not collected by the author.

Table 1: List of secondary metabolites reported for *Cladonia* in Manitoba showing the number of species and the number of specimens in which the compound was detected.

Secondary metabolite	**No. species**	**No. specimens**
SINGLE COMPOUND		
Fumarprotocetraric acid (depsidone)	26	285
Usnic acid (usnic acid)	14	251
Atranorin (para-depside)	11	124
Barbatic acid (para-depside)	9	85
Squamatic acid (para-depside)	6	43
Zeorin (terpene)	3	37
Perlatolic acid (para-depside)	2	27
Psoromic acid (depsidone)	2	7
Thamnolic acid (meta-depside)	2	2
Merochlorophaeic acid (meta-depside)	1	12
Norstictic acid (depsidone)	1	9
Cryptochlorophaeic acid (meta-depside)	1	1
Grayanic acid (depsidone)	1	5
COMBINATION OF COMPOUNDS		
Fumarprotocetraric acid and atranorin	7	78
Usnic and barbatic acids	6	62
Usnic acid and zeorin	3	37
Usnic and fumarprotocetraric acids	2	6
Usnic and perlatolic acids	1	26
Usnic and squamatic acids	1	15
Norstictic acid and atranorin	1	9
Barbatic and squamatic acids	1	8
Merochlorophaeic and fumarprotocetraric acids	1	5
Atranorin and psoromic acid	1	5
Grayanic and fumarprotocetraric acids	1	3
Barbatic and thamnolic acids	1	1

Results

In total, thirteen secondary metabolites (Table 1) were found in 638 specimens representing 50 species of *Cladonia* collected in Manitoba. The most common metabolite was fumarprotocetraric acid (23 species, 349 specimens), followed by usnic acid, atranorin, barbatic acid, squamatic acid, and zeorin. All other compounds occurred in just one or two species. Twelve combinations of compounds are reported (Table 1). The most frequent combination was fumarprotocetraric acid and atranorin, followed by usnic and barbatic acids, usnic acid and zeorin, and usnic and fumarprotocetraric acids. All other combinations occurred in single species. The 13 secondary metabolites represented four chemical classes: dibenzofurans (usnic acids), depsidones, depsides, and triterpenoids (Table 2). Twenty-six species contained more than one compound in the same specimen (Table 3). These included 13 species with more than one chemotype. The occurrence of chemical variation in C. *amaurocraea* has not been previously reported.

Table 2: Class of chemical compounds present in *Cladonia* showing numbers of species and specimens in which they are present and the number of compounds within each class. A comparison is made with Ahti (2000).

Chemical class	No. species	No. specimens	No. compounds	
			This study	Ahti (2000)
Acetyl-polymalonyl pathway				
Dibenzofuran	14	251	1	3
Depsidone	30	306	4	5
Depside	32	294	7	16
Mevalonic acid pathway				
Triterpenoid	3	37	1	2

Table 3: List of species of *Cladonia* examined in this study showing the secondary compounds* (see below) reported for each species and the species epithet abbreviation used in Figures 1a and 1b. The alternative chemotype is shown in parentheses. "Other species" refers to species reported for Manitoba in the literature but not collected in this study.

Species	Compound	Species abbreviation
Cladonia acuminata (Ach.) Norrl.	NOR, AT (AT)	acu
C. amaurocraea (Flörke) Schaer.	US, BAR (BAR)	ama
C. arbuscula (Wallr.) Flot.	US, FU (US)	arb
C. bacilliformis (Nyl.) Glück	US, BAR	bac
C. borealis S. Stenroos	US, BAR	bor
C. botrytes (K.G. Hagen) Willd.	US, BAR (BAR)	bot
C. cariosa (Ach.) Spreng.	AT, FU (AT)	car
C. cenotea (Ach.) Schaer.	SQU	cen
C. cervicornis subsp. *verticillata* (Hoffm.) Ahti	FU	cer

C. chlorophaea (Flörke ex Sommerf.) Spreng.	FU	chl
C. coccifera (L.) Willd.	US, ZE	coc
C. coniocraea (Flörke) Spreng.	FU	con
C. cornuta (L.) Hoffm.	FU	cor
C. crispata (Ach.) Flot.	SQU, BAR (SQU)	cri
C. cristatella Tuck.	US, BAR	cris
C. cryptochlorophaea Asahina	CR	cry
C. cyanipes (Sommerf.) Nyl.	US, BAR	cya
C. dahliana Kristinsson	AT, PSO	dah
C. decorticata (Flörke) Spreng.	PER	dec
C. deformis (L.) Hoffm.	US, ZE	def
C. digitata (L.) Hoffm.	THAM	dig
C. ecmocyna Leight.	FU, AT	ecm
C. fimbriata (L.) Fr.	FU	fim
C. glauca Flörke	SQU	gla
C. gracilis (L.) Willd. subsp. *gracilis*	FU	gragra
C. gracilis subsp. *turbinata* (Ach.) Ahti	FU	gratur
C. grayi G. Merr. ex Sandst.	GR, FU (GR)	gray
C. macilenta Hoffm.	BAR	macil
C. macroceras (Delise) Ahti	FU, AT	macroc
C. macrophylla (Schaer.) Stenh.	PSO	macroa
C. macrophyllodes Nyl.	FU, AT	macrod
C. merochlorophaea Asahina	MER, FU (MER)	mer
C. mitis Sandst.	US	mit
C. multiformis G. Merr.	FU	mul
C. parasitica (Hoffm.) Hoffm.	THAM, BAR	par
C. phyllophora Hoffm.	FU	phy
C. pleurota (Flörke) Schaer.	US, ZE (US)	ple
C. pocillum (Ach.) O. J. Rich.	FU, AT (FU)	poc
C. pyxidata (L.) Hoffm.	FU	pyx
C. rangiferina (L.) F.H. Wigg.	FU, AT (AT)	ran
C. scabriuscula (Delise) Leight.	FU	sca
C. squamosa (Scop.) Hoffm.	SQU	squ
C. stellaris (Opiz) Pouzar & Vezda	US, PER (US)	ste
C. stygia (Fr.) Ruoss	FU, AT (AT)	sty
C. subfurcata (Nyl.) Arnold	SQU	subf
C. subulata (L.) F.H. Wigg.	FU	subu
C. sulphurina (Michx.) Fr.	US, SQU	sul
C. symphycarpa (Flörke) Fr.	AT	sym
C. turgida Hoffm.	FU, AT	tur
C. uncialis (L.) F.H. Wigg.	US	unc
Other species		
C. bellidiflora (Ach.) Schaer.	US, SQU, BEL	
C. brevis (Sandst.) Sandst.	PSO	
C. carneola (Fr.) Fr.	US, ZE	
C. nemoxyna (Ach.) Arnold	HOM, SEK	
C. stricta (Nyl.) Nyl.	AT, FU	
C. subcervicornis (Vain.) Kernst.	AT, FU	
C. trassii Ahti	AT, FU	

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* AT (atranorin), BAR (barbatic acid), BEL (bellidiflorin), CR (cryptochlorophaeic acid), FU (fumarprotocetraric acid), GR (grayanic acid), HOM (homosekikaic acid), MER (merochlorophaeic acid), NOR (norstictic acid), PER (perlatolic acid), PSO (psoromic acid), SQU (squamatic acid), US (usnic acid), THAM (thamnolic acid), ZE (zeorin), SEK (sekikaic acid)

Patterns in the secondary metabolites of each species are reported for the frequency of occurrence of metabolites. Despite mathematical artifacts sometimes associated with ordination of frequency data, similar trends were observed for each of presence/absence data and for frequency data, and using two distance coefficients, suggesting that no artifacts are present. Ordination of species with frequency of occurrence produced a first axis that explained 36% of the variation and a second axis that explained only 16% of the variation (Fig. 1a). When secondary compounds were ordinated, the first axis explained 15% and the second axis 10% of the variation (Fig. 1b). Even with the additional seven species included that were not in the author's collection, presence-absence data produced similar trends (results not shown). Ordination of species with presence-absence data and Euclidean distance produced a first axis explaining 36% and a second axis explaining 14% of the variation; Chord distance produced one axis explaining 35% and a second axis explaining 15% of the variation. Ordination of secondary compounds with presence-absence data and Euclidean distance produced one axis explaining 35% and a second axis explaining 21% of the variation; Chord distance produced one axis explaining 15% and a second axis explaining 12% of the variation.

Discussion

Members of the genus *Cladonia* in Manitoba represent the major chemical groups found in *Cladonia* except the higher aliphatic acids (Table 2). Compounds reported in the literature for some species were not detected in this study such as rangiformic acid in *C. mitis*. Culberson & Culberson (1970) reported 23 compounds, and Ahti (2000) reported about 30 compounds in the *Cladoniaceae* that are major or taxonomically significant. However, Huovinen & Ahti (1982) reported 35 substances in *Cladonia* from six chemical groups and two biosynthetic pathways, acetate-polymalonate and the mevalonic acid pathways. Intermediate compounds are likely to be present but in small quantities not detectable by TLC. For example, the depsidone, 4-0-demethylgrayanic acid (DMGR), and the depside, 4-0-demethylsphaerophorin (DMSPH), in *C. grayi* (Culberson & Armaleo 1992) are thought to give rise to grayanic acid and were detected by time-course experiments using HPLC. In this study barbatic (para-depside) and thamnolic (meta-depside) acids in *C. parasitica* may be an example of biosequentially related products since Elix (1996) suggested that para-depsides are potential precursors to meta-depsides. Barbatic and squamatic acids (both para-depsides) in *C. crispata* may be parallel end products. On the other hand usnic acid (dibenzofuran) and zeorin (triterpenoid) in *C. coccifera*, *C. deformis*, and *C. pleurota* are derived from different pathways, the acetyl-polymalonyl pathway and the mevalonic acid pathway, respectively. Huovinen

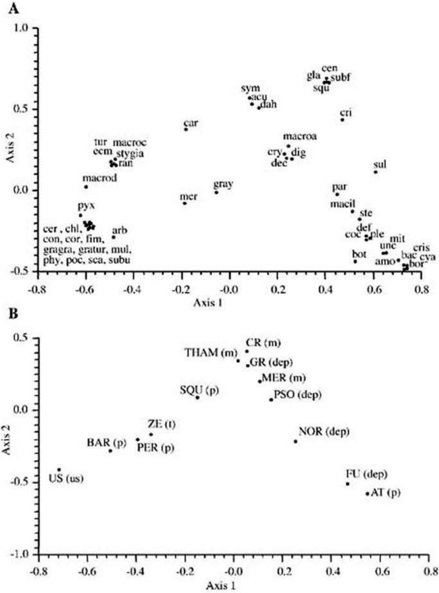

Figure 1: Ordination of *A.* species and *B.* secondary compounds based on frequency of secondary metabolites using Chord distance. All data are based on collections by the author. See Table 3 for abbreviations for species epithets and secondary compounds. Chemical classes are depsidone (dep), meta-depside (m), para-depside (p), triterpenoid (t), and usnic acid (us).

& Ahti (1982) suggested that if two compounds are biosequentially closely related they are not sufficient to be used to support separation of the taxa.

Cortical compounds may not be considered taxonomically significant when variation in concentration of the cortical compounds depends on changes in environmental conditions (Hawksworth 1976, Huovinen & Ahti 1982). Medullary compounds have greater taxonomic significance than cortical compounds because they may be less directly influenced by the environment. In this study, eight of the 12 combinations of compounds included both a cortical and a medullary compound. In contrast with this argument, the cortical compounds (usnic acid and atranorin) remained constant and the medullary compounds varied in seven species (Table 3) suggesting that environment may have influenced production of the medullary compounds.

Since the sensitivity of TLC is insufficient to detect small quantities, the absence of a compound in this study may reflect low undetectable concentrations. Variation in concentration may reflect variation in ecological habitats. However, no ecological trends, such as the grouping of species with similar ecology, were observed in this study. As provided by literature evidence, quantitative variation in chemical phenotype within species may be explained by changes in the microhabitat, or by genetic events. Changes in the microhabitat may be reflected in changes in nutrient conditions, which may determine chemical phenotype (Leuckert et al. 1990). Light levels in the habitat may also cause the production of cortical compounds to vary such as atranorin and usnic acid (Hawksworth 1976). Atranorin was variable in *C. pocillum* and usnic acid was variable in *C. amaurocraea,* and *C. botrytes* (Table 3). Other ecological factors such as desiccation (Culberson & Armaleo 1992), or stress (Stocker-Wörgötter 2001) also play roles in production of secondary metabolites. Microhabitat conditions affecting primary metabolites (Drew & Domain 1977) may be responsible for shifts in biosynthetic pathways of secondary metabolites among populations within the same species. Genetic events would indicate changes in the genes or regulation of gene clusters. Regulation of fungal secondary metabolites is encoded by genes arranged sequentially in clusters (Katz & Donadio 1993, Schumann & Hertweck 2006). If entire clusters are multiplied (Fierro et al. 1995) or individual genes are duplicated (Chu & Yang 2002) variability will be reflected in these genetic events. This may arise in species at the edge of their distributions where environmental conditions may be marginal or where species undergo high levels of recombination.

Taxonomic patterns, as described below, were reflected in the frequency of occurrence of secondary metabolites. Taxonomic trends were similar to those suggested by Huovinen & Ahti (1982). Species that contain non-fluorescent and gray compounds (atranorin and fumarprotocetraric acid) were clustered on the left of axis 1. Species containing fluorescent compounds (squamatic acid) were in the upper right, and yellow-green compounds (usnic acid) were clustered toward the lower right, somewhat reflecting the taxonomic sections in *Cladonia* (Ahti 2000; Fig. 1). However, members of the previously recognized genus *Cladina* (Nyl.) Nyl. were at both ends of the PCoA plot. *Cladonia arbuscula* contains both usnic and fumarprotocetraric acids, but it often lacks fumarprotocetraric acid in Manitoba, causing it to fall more closely with other single compound species (Fig. 1a). The second axis may reflect species that are less common in Manitoba on one end and species more common in Manitoba on the other end of the axis. The secondary compounds showed similar trends and clustered chemical classes together such as the para-depsides on the right, the meta-depsides in the upper center, and the depsidones on the left (Fig. 1b) with some exceptions. Species containing usnic and fumarprotocetraric acids alone and in combination are common in Manitoba. Those containing other polyketides especially when alone in the thallus are less common in Manitoba. This raises questions about the adaptive advantage of some of the compounds for those species in Manitoba.

In conclusion, taxonomic considerations cannot be separated from broader issues of environmental effects or regulation of the gene complexes. Two issues may be derived from this information: 1) external cues from a large number of environmental variables may play a role in quantifiable secondary metabolite production, and 2) internal thallus features may be as variable as the external cues. Environmental variables affect gene expression, which is also acted upon by natural selection conferring adaptive advantages to some compounds (Lawrey 1977). Internal features such as localization of production in medulla or cortex, young or old tissues, or a variety of gene mutations, are more difficult to detect but may play equally significant roles in production of diagnostic compounds in lichenized fungi.

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MYCOTAXON

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The genus *Phellinus* s.l. (*Basidiomycota*) in Iran

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Abstract — *Phellinus allardii*, *P. rosmarini* and *P. senex* are reported as new to Iran, with the last species also new to the Caucasus. Two new combinations, *Fomitiporia rosmarini* and *Fuscoporia senex*, are proposed. A key to the species of *Phellinus* s.l. in Iran is provided. Spore and seta dimensions of the species were measured and their statistical variations are given. The doubtful assignment of a *Phellinus* commonly collected from NW Iran to *Phellinus baumii* is discussed. Earlier reports of *Phellinus chrysoloma*, *P. johnsonianus*, *P. laevigatus*, *P. merrillii* and *P. tremulae* in the country are shown to be based on misidentifications; none of these taxa are yet verified from Iran. The occurrence of *Fomitiporia robusta*, *Phellinus ferrugineovelutinus* and *Phellinus rimosus* in Iran is doubtful. Altogether 12 *Phellinus* s.l. species are recognized in Iran. Notes on host preferences are given together with the known distribution. A provisional world key to *Fuscoporia* species is provided.

Key words — Arasbaran forests, *Fuscoporia discipes*, polypore, taxonomy, wood-inhabiting

Introduction

The genus *Phellinus* Quél. in the wide sense comprises more than 150 species (Larsen & Cobb-Poulle 1990) confined primarily to the tropics. Because of its heterogeneity, *Phellinus* has been segregated into more homogeneous taxa, e.g. *Fomitiporia* Murrill, *Fuscoporia* Murrill, and *Phylloporia* Murrill. Several morphological and molecular studies have supported subdivisions into smaller and better-defined genera (Fiasson & Niemelä 1984, Fischer 1996, Wagner & Fischer 2002, Fischer & Binder 2004, Jeon et al. 2005). More tropical taxa should be incorporated into future phylogenetic studies, however, as the majority of the above mentioned treatments deal with taxa from Northern Hemisphere.

Table 1. Spore dimensions of the *Phellinus* s.l. species in Iran.*

Species	L variation (µm)	W variation (µm)	L (µm)	W (µm)	Q variation	Q
Fomitiporia punctata **(60/2)**	**(4.3-)4.7-6.5(-7.0)**	**(3.5-)4.0-6.0(-6.3)**	**5.65**	**4.94**	**(1.00-)1.03-1.30(1.36)**	**1.15**
NH 1709	(4.3-)4.7-6.0(-6.3)	(3.5-)3.9-5(-5.9)	5.28	4.50	(1.03-)1.06-1.31(-1.36)	1.18
NH 1691	5.2-6.8(-7.0)	(4.3-)4.9-6.0(6.3)	6.01	5.34	(1.00-)1.03-1.20	1.13
Fomitiporia robusta	**(5.5-)5.8-7.3(-8.2)**	**(4.8-)5.3-6.8(-7.3)**	**6.6**	**6.1**	**-**	**1.1**
Fomitiporia rosmarini **(90/3)**	**(4.2-)4.9-6.6(-7.0)**	**4.0-6.0(-6.4)**	**5.5**	**4.9**	**(0.82-)1.00-1.25(1.30)**	**1.13**
Holotype	(4.2-)4.9-5.6(-0.6)	(4.0-)4.3-5.2	5.09	4.71	(0.82-)1.00-1.17(-1.25)	1.08
MGH 52	(4.8-)5.0-6.0	4.0-5.0(-5.5)	5.24	4.55	(1.02-)1.04-1.25(-1.29)	1.16
Bernicchia 7349	(5.0-)5.7-7.0	(4.0-)4.4-6.0(-6.4)	6.07	5.33	1.03-1.25(-1.30)	1.14
Fuscoporia contigua **(30/1)**						
NH 1378	**(4.0-)4.1-6.0**	**2.7-3.2(-3.5)**	**4.94**	**3.06**	**(1.26-)1.33-1.87(-2.00)**	**1.62**
Fuscoporia ferruginosa **(60/2)**	**(3.6-)4.0-5.0(-5.7)**	**2.8-3.6(-4.0)**	**4.3**	**3.1**	**(1.08-)1.14-1.62(-1.78)**	**1.38**
MGH 385	(3.6-)4.0-5.0	2.8-3.6(-3.9)	4.27	3.16	(1.08-)1.14-1.57(-1.67)	1.36
NH 2456	3.8-5.0(-5.7)	2.8-3.5(-4.0)	4.35	3.12	(1.14-)1.25-1.64(-1.78)	1.40
Fuscoporia senex **(60/2)**	**(3.3-)3.6-4.5(-4.9)**	**2.5-3.2(-3.7)**	**4.06**	**3.00**	**(1.11-)1.16-1.52**	**1.35**
NH 2096	3.5-4.5(-4.9)	2.5-3.2(-3.7)	4.07	3.00	(1.11-)1.20-1.52	1.36
Niemelä 4594	(3.3-)3.8-4.6	(2.5-)3.0-3.5	4.06	3.00	(1.16-)1.27-1.43(-1.52)	1.35
Fuscoporia torulosa **(60/2)**	**(3.8-)4.0-5.0**	**(2.8-)3.0-4.0(-4.4)**	**4.2**	**3.3**	**(1.08-)1.00-1.50(-1.59)**	**1.30**
MGH 511	3.9-4.6(-4.8)	2.8-3.5	4.18	3.08	1.14-1.59	1.36
MGH 374	3.8-4.7(-5.0)	3.0-4.0(-4.4)	4.27	3.47	1.08-1.45(-1.56)	1.24
Phellinus allardii						
Lambinon 75/225	**3.8-4.7(-5.1)**	**2.6-3.9**	**4.25**	**3.23**	**1.14-1.52**	**1.32**
Phellinus **cf.** ***baumii*** **(60/2)**	**3.0-4.1(-4.5)**	**(2.1-)2.5-3.4**	**3.84**	**2.95**	**(1.10-)1.17-1.46(-1.62)**	**1.31**
MGH 126	(3.0-)3.4-4.1(-4.5)	2.1-3.4	3.85	2.91	1.17-1.46(-1.62)	1.33
MGH 393	3.2-4.2	2.5-3.4	3.82	2.98	(1.10-)1.17-1.38(-1.56)	1.28
Phellinus baumii IRAN.11305	**(3.4-)3.8-4.6(-5.0)**	**2.5-3.8**	**4.12**	**3.12**	**1.11-1.67**	**1.33**
Phellinus igniarius						
NH 2011	**(3.9-)4.3-5.2(-5.6)**	**(2.6-)3.0-4.0(4.4)**	**4.80**	**3.51**	**1.16-1.67**	**1.36**
Phellinus tuberculosus						
MGH 359	**(3.8-)4.0-5.0**	**2.8-4.0**	**4.35**	**3.45**	**1.14-1.36(-1.47)**	**1.27**
Phylloporia ribis						
MGH 482	**(2.8-)3.0-3.5**	**2.0-2.6(-2.9)**	**3.13**	**2.27**	**(1.07-)1.20-1.55(-1.65)**	**1.40**
Phylloporia spathulata						
Uotila 19317	**2.5-3.2(-3.5)**	**1.8-2.5**	**2.95**	**2.11**	**(1.20-)1.25-1.60**	**1.40**

*The figure in brackets following each species name represents n (see Materials and methods); for single specimens n=30/1.

Occurrence of *Fomitiporia robusta* in Iran is doubtful; the spore measurements are from Niemelä (2005).

Measurements given for *Phellinus allardii* are taken from a non-Iranian specimen due to the poor condition of the collection from Iran.

Abbreviations: MGH, Masoomeh Ghobad-Nejhad; NH, Nils Hallenberg.

Reports on *Phellinus* in Iran have been published by Saber (1972, 1974, 2000, 2002), Soleimani (1974, 1976), Niemelä & Uotila (1977), and Hallenberg (1979, 1981). The purpose of this paper is to integrate these data with newly made collections, examine the identity of some recent records, and emphasize the need for additional studies on wood-decaying fungi in Iran.

Materials and methods

This study is based on the examination of the Iranian material preserved in fungal herbarium of the Plant Pests and Diseases Research Institute in Iran (IRAN), material collected by MGH during 2005–06, and Iranian specimens stored in the Gothenburg herbarium (GB). Additional specimens examined are kept in the Botanical Museum of University of Helsinki (H) or were obtained on loan from other herbaria.

The spore and seta measurements given in Tables 1 and 2 were made in Cotton Blue in lactic acid (CB) from at least 30 measurements per specimen (n = the number of spores or setae measured from the given number of specimens). Seta measurements refer to hymenial setae. The 5% of measurements excluded from each end of the range are presented in parentheses. The following abbreviations are used for spore and seta measurements: L = mean length, W = mean width, and Q = mean value of the L/W ratio. Measurements were taken from hand cut sections at ×1000 magnification through a Leica Biomed light microscope. Because host range is an important character for the identification of some *Phellinus* species (Fischer & Binder 2004), hosts are cited for Iranian material in detail. Notes on known species distributions are also given. Excluded or doubtful names are listed alphabetically. The abbreviations MGH and YCD refer to the authors of this paper.

Key to the species of *Phellinus* s.l. in Iran

1. Hyphal system monomitic, species without setae and with a black line in the upper part of the context 2
1. Hyphal system dimitic, species with or without setae 3
2. Basidiocarp stipitate .... *Phylloporia spathulata*
2. Basidiocarp sessile .... *Phylloporia ribis*
3. Spores dextrinoid and conspicuously cyanophilous 4
3. Spores not dextrinoid, acyanophilous, or only weakly cyanophilous 6
4. Basidiocarp resupinate .... *Fomitiporia punctata*
4. Basidiocarp pileate 5
5. Spore length more than 6 µm .... *Fomitiporia robusta**
5. Spore length less than 6 µm .... *Fomitiporia rosmarini*

*occurrence in Iran doubtful.

Table 2. Seta dimensions of the *Phellinus* s.l. species in Iran.*

Species	L variation (µm)	W variation (µm)	L (µm)	W (µm)	Q variation	Q
•Fomitiporia punctata	-	-	-	-	-	-
•Fomitiporia robusta	-	-	-	-	-	-
***Fomitiporia rosmarini* (90/3)**	**8-29(-33)**	**3-7(-9)**	**17.8**	**5.1**	**1.43-6.67(-8.67)**	**3.64**
Holotype	10-33	3-9	20.30	5.03	1.89-8.67	4.26
MGH 52	8-20	4-7	11.90	4.97	1.43-4.00	2.43
Bernicchia 7349	14-25(-30)	3-7	21.23	5.17	2.50-6.25(-6.67)	4.24
Fuscoporia contigua NH 1378	**(20-)31-65**	**4-8(-10)**	**40.83**	**6.80**	**(2.50-)4.00-10.25**	**6.18**
***Fuscoporia ferruginosa* (60/2)**	**(12-)19-43(-52)**	**5-7**	**31.1**	**5.8**	**(2.40-)3.20-8.20(-10.00)**	**5.45**
MGH 385	(12-)19-45(-52)	5-7	29.40	5.85	(2.40-)3.10-7.50	5.04
NH 2456	(16-)23-43(-50)	5-7	32.80	5.67	3.20-8.20(-10.00)	5.87
***Fuscoporia senex* (60/2)**	**12-35**	**4-7**	**21.8**	**5.2**	**2.17-7.00**	**4.25**
NH 2096	13-35	5-7	23.53	5.67	2.17-7.00	4.22
Niemelä 4594	12-27	4-6	20.13	4.73	2.60-6.25	4.28
***Fuscoporia torulosa* (60/2)**	**(12-)15-33(-37)**	**(4-)5-7**	**25.3**	**5.6**	**(2.00-)3.00-6.60**	**4.58**
MGH 511	16-33	5-7	26.20	5.50	2.67-6.60	4.83
MGH 374	12-37	(4-)5-7	24.30	5.67	(2.00-)3.00-6.17	4.32
•Phellinus allardii	-	-	-	-	-	-
***Phellinus* cf. *baumii* (60/2)**	**(8-)10-20(-22)**	**4-7(-8)**	**14.7**	**5.6**	**1.43-3.80(-5.25)**	**2.71**
MGH 126	10-22	4-7(-8)	15.77	5.67	1.43-3.70(-5.25)	2.88
MGH 393	8-20	4-7	13.60	5.43	1.50-4.00	2.53
Phellinus baumii IRAN.11305	**12-20**	**5-7(-8)**	**15.57**	**5.97**	**1.71-3.20(-4.00)**	**2.65**
Phellinus igniarius NH 2011	**10-20(-23)**	**(4-)5-7**	**14.78**	**5.60**	**1.83-4.00(-4.60)**	**2.70**
Phellinus tuberculosus MGH 359	**10-21(-24)**	**(4-)5-7**	**15.43**	**5.53**	**1.67-4.20(-4.80)**	**2.83**
•Phylloporia ribis	-	-	-	-	-	-
•Phylloporia spathulata	-	-	-	-	-	-

*Species without seta are marked with a filled circle (•).

The figure in brackets following each species name represents n (see Materials and methods); for single specimens n=30/1.

Occurrence of *Fomitiporia robusta* in Iran is doubtful; setae in this species are very rare.

Abbreviations: MGH, Masoomeh Ghobad-Nejhad; NH, Nils Hallenberg.

6. Generative hyphae encrusted in Cotton Blue, spores hyaline, spore wall thin 7
6. Generative hyphae smooth in Cotton Blue, spores hyaline or pigmented, spore wall distinct and not very thin 10
7. Basidiocarp resupinate 8
7. Basidiocarp pileate 9
8. Pores 6-8 per mm .... *Fuscoporia ferruginosa*
8. Pores 2-4 per mm .... *Fuscoporia contigua*
9. Pileal surface with broad distinct zones, margin and pore surface with yellowish tint .... *Fuscoporia torulosa*
9. Pileal surface with indistinct zones, margin and pore surface brownish .... *Fuscoporia senex*
10. Basidiospores hyaline 11
10. Basidiospores pigmented 12
11. Pileal surface without crust, context corky, usually on *Prunus* .... *Phellinus tuberculosus*
11. Pileal surface with crust, context hard woody, on hosts other than *Prunus* .... *Phellinus igniarius* s.l.
12. On species of *Lonicera*, *Syringa*, setae present .... *Phellinus baumii*
12. On other hosts, setae absent .... *Phellinus allardii*

Discussion

Among known subdivisions segregated from *Phellinus*, the genera *Fomitiporia*, *Fuscoporia* and *Phylloporia*, as well as *Phellinus* s.s., are represented in Iran. Both *Fomitiporia* and *Fuscoporia* comprise well-supported clades in DNA sequence analyses (Wagner & Fischer 2001, 2002; Decock 2005, Jeon et al. 2005). *Phylloporia* constitutes an additional assemblage of homogenous taxa that has been shown to be monophyletic (Wagner & Ryvarden 2002).

Fulvifomes Murrill could also be a potential genus for two species occurring in Iran: *Phellinus allardii* and *Phellinus baumii* have both been assigned to *Phellinus* subg. *Fulvifomes* (Murrill) Y.C. Dai (Dai 1999, Parmasto & Parmasto 2001), and even earlier Bondartseva et al. (1992) proposed the combination *Fulvifomes allardii*. However, the delimitation of *Fulvifomes* is controversial: in Wagner & Fischer's (2002) molecular study on *Phellinus* s.l., *Phellinus baumii* and some related species nested out of the *Fulvifomes* subclade, appearing instead in the *Inonotus* s.s. clade. For this reason the authors transferred some species to *Inonotus*, including *Inonotus baumii* (Pilát) T. Wagner & M. Fisch. Dai (1999) discussed earlier the variability of several important characters in subg. *Fulvifomes*, and taxa assigned to *Fulvifomes* also did not cluster together in the recent analysis by Jeong et al. (2005). These studies imply that *Fulvifomes* has its closest relatives in *Inonotus* and/or *Phylloporia* (Wagner & Ryvarden 2002). We choose to retain *Phellinus allardii* and *Phellinus baumii* in *Phellinus* s.l., rather than refer them to *Fulvifomes* until additional studies include data sampled from more taxa, especially those from tropical regions.

Phellinus igniarius and *Phellinus tuberculosus* are the only two representatives of *Phellinus* s.s in Iran. Here *P. igniarius* is treated as a collective name.

This paper reports the westernmost known Asian distributions of *Phellinus allardii* and *Fuscoporia senex (Phellinus senex)* (cf. Afyon et al. 2005, Bondartseva & Parmasto 1986, Rattan et al. 1978, Melik-Hačatryan & Martirosyan 1971, Czederpiltz et al. 2004, Reichert & Avizohar-Hershenzon 1959, Avizohar-Hershenzon. & Jaqenoud 1979-1980, Binyamni 1981, 1983, 1984, 1987, 1993; Gvritishvili et al. 2007). Neither of these two species has yet been reported from Europe.

Notes on the species

Fomitiporia punctata (P. Karst.) Murrill
=*Phellinus punctatus* (P. Karst.) Pilát

Key characters—Basidiocarps strictly resupinate with 5–6 pores/mm; basidiospores dextrinoid and cyanophilous, (4.3-)4.7-6.5(-7.0) × (3.5-)4.0-6.0(-6.3) µm. Compared to Decock et al. (2005) and to Niemelä (2005), the Iranian specimens have a slightly smaller spore size (see Table 1).

A similar species is *Phellinus hartigii* (Allesch. & Schnabl) Pat. whose basidiocarps are reflexed and live on conifers. Fischer (2002) has recently described *Fomitiporia mediterranea* M. Fisch., which is morphologically indistinguishable from *F. punctata* but distinct in their DNA sequences of the ribosomal ITS1-5.8S-ITS2 region and by mycelial growth rates and intersterility. Besides, *F. mediterranea* is mostly associated with *Vitis vinifera*, and probably also *Olea europaea* in the Mediterranean area (Fischer 2002, see also Fischer & Binder 2004). It is a severe pathogen infecting citrus trees in Greece (Elena et al. 2006). Due to considerable plantations of *Vitis vinifera*, *Olea europaea* and citrus varieties in Iran, the occurrence of *F. mediterranea* is probable.

Fomitiporia australiensis M. Fisch. et al. described on grapevines in Australia is microscopically very similar to *F. punctata* and *F. mediterranea*, but distinguished by forming both resupinate and pileate basidiocarps and by the sequences of the ribosomal ITS region (Fischer et al. 2005).

Ecology and distribution—*F. punctata* is known from all continents on dead wood of different conifers and angiosperms. In Central Europe it exists both as a parasite and saprotroph, especially on *Salix* and *Corylus* (Fischer 2002). In forests of North Iran it has been collected on a fallen log of *Buxus hyrcana* and on live standing trees of *Carpinus* (Hallenberg 1981). Nematolahi et al. (2004) reported it on plantations of *Rosa damascena* in Kashan, Esfahan province.

Specimens Examined—**Iran.** Mazandaran: Khoshkedaran forest, *Buxus*, *Carpinus*, 1976 Hallenberg 1709 and 1691 (GB). Gorgan: Rank-aou forest, *Carpinus*, 1976 Hallenberg 1482 (GB).

Fomitiporia rosmarini (Bernicchia) Ghobad-Nejhad & Y.C. Dai, **comb. nov.**
MycoBank MB510848
Basionym: *Phellinus rosmarini* Bernicchia, *Polyporaceae* s.l. in Italia: 426, 1990.

Basidiocarp pileate, margin yellowish. Pore surface brown with 5-6 pores/mm (6-8 in type). Hyphal system dimitic, contextual skeletal hyphae 3-4 µm wide, tramal skeletal hyphae interwoven, 2.5-3 µm wide. Hymenial setae rare, brown, subulate, ventricose, 8-29(-33) × 3-7(-9) µm, L=17.8 µm, W=5.1 µm, Q=3.64. Cystidioles present. Basidiospores hyaline, globose to subglobose, dextrinoid, cyanophilous, thick-walled, (4.2-)4.9-6.6(-7.0) × 4.0-6.0(-6.4) µm, L=5.5 µm, W=4.9 µm, Q=1.13.

Key characters—Good distinguishing characters are the rare hymenial setae, presence of cystidioles, and globose to subglobose cyanophilous and dextrinoid basidiospores mostly less than 6 µm wide.

In their study on poroid *Hymenochaetales* with dextrinoid basidiospores, Decock et al. (2005) felt that seven species of *Phellinus* s.l., including *Phellinus rosmarini*, are related to *Fomitiporia* (see also Pieri & Rivoire 2000). We compared the Iranian and additional Italian collections to the type specimen of *P. rosmarini* and found them to be conspecific. Also, as noted by Bernicchia (1990), *P. rosmarini* comes close to species in the *Phellinus punctatus-robustus* complex, which are referred to the genus *Fomitiporia* (Fischer 1996, Dai 1999, Wagner & Fischer 2002, Decock et al. 2005). Therefore, the species is here referred to as *Fomitiporia rosmarini*.

Compared with the material from Italy, the Iranian specimen has a slightly thicker basidiocarp and darker context.

Ecology and distribution—Bernicchia (2005) mentions the species from different hardwoods: *Arbutus unedo, Cistus* spp., *Crataegus monogyna, Erica arborea, Ostrya carpinifolia, Pistacia lentiscus, Rhamnus alaternus, Rosmarinus officinalis*. In Iran, the single specimen was found on *Quercus* sp. Known from Mediterranean Europe, France (see Pieri & Rivoire 1992), Italy (type country), Spain?

Specimens Examined—**Iran.** Kohgiluyeh and Boyer-Ahmad: Yasooj, *Quercus*, 2003 Hamidipour & A. Ghobad-Nejhad (52, dupl. H). **Italy.** Latina: Parco Nazionale del Circeo, *Rhamnus alaternus*, 1984 Bernicchia 3464 (type, HUBO) – Leede: Suore del Fico, alt. 100 m, *Pistacia lentiscus*, 1993 Bernicchia 6228 (HUBO) – Siene: Cipressete S. Agnex, alt. 400m, *Erica arborea*, 1996 Bernicchia 7349 (HUBO).

Fuscoporia contigua (Pers.) G. Cunn.
=*Phellinus contiguus* (Pers.) Pat.

Key characters—The species is identified by large pores, 2-4/mm, hyaline cylindrical basidiospores, and stellate crystals on generative hyphae.

Ecology and distribution—the species grows mostly on deciduous trees. All Iranian material have been collected on fallen logs and branches of *Quercus* *castaneifolia* and other angiosperms (Hallenberg 1981) mostly collected in summer time. Distributed throughout the tropical zone and in warmer parts of temperate zones (Ryvarden 2004).

Specimens Examined—**Iran.** Gorgan: Shast-kalateh forest, on a fallen branch, 1976 Hallenberg 1433 (GB); Khanbebin, Shir-abad forest, on a fallen branch, 1976 Hallenberg 1634 (GB); Ghorogh, forest, *Quercus castaneifolia*, 1976 Hallenberg 1378 (GB).

Fuscoporia ferruginosa (Schrad.) Murrill
=*Phellinus ferruginosus* (Schrad.) Pat.

Key characters—This species resembles *F. contigua* but has smaller pores (more than 4/mm) and very long setae in the margin and subiculum.

Ecology and distribution—The species occurs on various dead hardwoods. In Iran numerous collections were made on *Carpinus betulus, Quercus* and *Fagus orientalis* (see Hallenberg 1981 and specimens examined). Cosmopolitan. Its northern limit in Europe is almost identical with that of *Quercus*.

Specimens Examined—**Iran.** East Azerbaijan: W Kaleibar, 15 km from Asheqloo, Vaighan, *Carpinus betulus*, N38°52'40": E46°49'30", alt. 1350m, 2.X.2006 Ghobad-Nejhad 385 (MGH ref. herb.). Golestan: Golestan National Park, *Quercus*, 1978 Hallenberg 2456 (GB); Shast-kalateh forest, on a fallen branch, 1976 Hallenberg 1442 (GB). Gilan: Asalem, on a fallen decayed branch, 1976 Hallenberg 1941 (GB).

Fuscoporia senex (Nees & Mont.) Ghobad-Nejhad, **comb. nov.**
MycoBank MB510849
Basionym: *Polyporus senex* Nees & Mont., Ann. Sci. Nat. Sér. 2, 5: 70, 1836.
=*Phellinus senex* (Nees & Mont.) Imazeki

Basidiocarp pileate, upper surface narrowly sulcate with persistent tomentum, cuticle absent. Hyphal system dimitic, generative hyphae with scattered crystals, tramal hyphae interwoven, 2.5-3 µm wide. Pores roundish, 5-11/mm. Setae brown subulate, 12-35 × 4-7 µm, L=21.8 µm, W=5.2 µm, Q=4.25. Basidiospores ellipsoid, hyaline, thin-walled, KOH-, CB- or weakly cyanophilous, non-dextrinoid, (3.3-)3.6-4.5(-4.9) × 2.5-3.2(-3.7) µm, L=4.06 µm, W=3.00 µm, Q=1.35.

Key characters—*Fuscoporia senex* goes close to *Fuscoporia torulosa* in microscopical features of spores and hyphal structure, but is distinguished by the pileal surface with indistinct zones, and brownish margin and pore surface. Moreover, its skeletal hyphae do not swell in KOH.

Dai (1999) referred *Phellinus senex* to *Phellinus* subg. *Fuscoporia* (Murrill) Y.C. Dai. Several members of this subgenus were grouped in a distinct lineage assigned to the *Phellinus torulosus* group in one study (Rizzo et al. 2003). *Phellinus senex* also clustered in the *Fuscoporia* clade in the study by Jeon et al. (2005). For these reasons, the new combination *Fuscoporia senex* is proposed.

The Iranian material of this species was earlier misidentified as *Phellinus johnsonianus* (Hallenberg 1981), a species not yet verified from Iran. The specimen was collected from Golestan National Park hyrcanian forests in N Iran. These forests are the southeastern-most stretch of Caucasian forests, and this is the first time *Fuscoporia senex* (≡*Phellinus senex*) is reported from the Caucasus.

Ecology and distribution—*Fuscoporia senex* grows on dead wood. In Iran the single specimen was collected on *Parrotia persica* (Persian ironwood), a relict tertiary element in Hyrcanian forests of North Iran. Pantropical.

Specimens Examined—**Iran.** Golestan: Golestan National Park, *Parrotia persica*, 1978 Hallenberg 2096 (GB). **India.** Himachal Pradesh, Dehra Dun, *Callitris glauca*, 1972 Korhonen 1149 (H). **Tanzania.** Tanga Reg., Lushoto Dist., Shume Forest Res., *Ocotea usambarensis* 1988 Niemelä 4594 (H).

Fig. 1. *Fuscoporia torulosa* on dead stump of *Quercus*. Photo MGH (Ghobad-Nejhad 511).

Fuscoporia torulosa (Pers.) T. Wagner & M. Fisch. Fig. 1.
≡*Phellinus torulosus* (Pers.) Bourdot & Galzin

Key characters—Basidiocarps develop on the base of trees or roots, mostly covered by mosses. Hyaline, broadly ellipsoid spores and fine crystals at dissepiment hyphae characterize the species.

Ecology and distribution—Basidiocarps of this species are associated with basal parts of trees. It is known to grow on hardwoods, rarely on conifers. Probst (1977) studied its ecology in the Hyrcanian forests of N Iran thoroughly and all his collections were on *Parrotia persica*. Hallenberg (1981) denotes *Parrotia persica* as the main host in N Iran, and adds *Crataegus* and *Quercus* as other hosts, with the majority of collections being made in summer time (July). In Arasbaran forests, NW Iran several collections have been made by MGH from *Juniperus*. In this area, two to three *Juniperus* species comprise natural communities mostly mixed with other deciduous trees/shrubs like *Paliurus spina-christi*, from which several specimens of *F. torulosa* were harvested as well. *F. torulosa* is widespread in the warm temperate zone of Northern Hemisphere and Africa.

SPECIMENS EXAMINED—**Iran.** E Azerbaijan: Kaleibar, Shah-heidar, *Paliurus spina-christi*, 2006 Ghobad-Nejhad 370, 371, 374 (dupl. H); Oshtobin, *Quercus* and cf. *Acer*, 2006 Ghobad-Nejhad 511 (MGH ref. herb.); Missan, *Juniperus excelsa*, 2006 Ghobad-Nejhad 356, 512 (MGH ref. herb.). Golestan: Golestan National Park, indet tree, 2000 Karawar, Falsafi and Eskandari (IRAN ??296).

Phellinus allardii (Bres.) S. Ahmad

Key characters—The basidiocarps are variable in size and shape. The absence of setae and brown ellipsoid basidiospores are good microscopic features.

The specimen from Iran has been misidentified and reported as *Inonotus rheades* (Saber 2000). The basidiocarp is severely eaten by insects but still tough, and was recognized as *Phellinus allardii*. The species has been referred to as *Fulvifomes allardii* (Bres.) Bondartseva & S. Herrera, but as discussed earlier, *Fulvifomes* does not seem to be a clearly defined genus, and no support can be found from DNA studies. Therefore, *P. allardii* is here left in *Phellinus* s.l.

Ecology and distribution—*Phellinus allardii* grows on different hardwoods. The Iranian material has been collected on *Acacia nubica* in South of Iran. Widespread in tropical zones of Africa and Asia, West Pakistan (Ahmad 1972) and India (Sharma 1995). Not known from Europe (Pieri & Rivoire 2005).

SPECIMENS EXAMINED—**Iran.** Hormozgan: Qeshm, *Acacia nubica*, 1999 Dadkhahipour and Falsafi (IRAN 2308/10556F). **Kenya.** Nairobi: Karura Forest, alt.1750 m. *Albizia gummifera*, 1975 Lambinon 75/225 (TN ref. herb.)

Phellinus baumii Pilát Fig. 2.

Key characters—Comparing similar species in *Phellinus linteus* group, Parmasto & Parmasto (2001) distinguish *P. baumii* by mean spore length (3.75-4.2 µm), mean spore width (3.05-3.5 µm), and pore size (7.7-9.5 pores/mm) (see below).

Placement of *P. baumii* in the *Phellinus linteus* complex has been controversial. As noted earlier, this and some other species in the complex have been assigned to the genus *Inonotus* (Wagner & Fischer 2002, Larsson et al. 2006). According to Parmasto & Parmasto (2001), *Phellinus baumii* is confined to East Asia and

Fig. 2. *Phellinus* cf. *baumii* on *Lonicera caucasica*. Photo MGH (Ghobad-Nejhad 393).

reports from other areas are misidentifications (restated by Lim et al. 2003). They differentiate among four similar species in this group (i.e., *P. lonicerinus* (Bondartsev) Bondartsev & Singer, *P. baumii*, *P. linteus* (Berk. & M.A. Curtis) Teng, *P. lonicericola* Parmasto) based on spore size, number of pores/mm, and host preference. During several visits to Arasbaran forests, NW Iran, MGH collected some *Phellinus* specimens on *Lonicera* (*L. caucasica* fide Mozaffarian 2005). After extensive studies by YCD on *P. baumii* from China and the Far East (Dai & Xu 1998, 1999), the Arasbaran collections were thought to represent *P. baumii*. However, because they possess larger pores (4-5 pores/mm) and slightly narrower spores (W=2.95 µm) than cited for *P. baumii* by Parmasto & Parmasto (2001), we have identified the Arasbaran specimens as *Phellinus* cf. *baumii*.

There is still one more specimen collected from N Iran that has erroneously been reported as *Inonotus radiatus* (Saber 2002). Its spore size accords with *Phellinus baumii* sensu Parmasto & Parmasto (2001).

Ecology and distribution—According to Dai & Niemelä (2006), *P. baumii* can occur on a vast variety of angiosperms. In Iran, the single specimen was found on *Zelkova carpinifolia* in Hyrcanian forests of N Iran. The species is known from East Asia.

SPECIMENS EXAMINED—**Iran.** Golestan: Golestan National Park, *Zelkova carpinifolia*, 2000 Karavar, Falsafi, Eskandari (IRAN.11305)- ***Phellinus* cf. *baumii*. Iran.** East Azerbaijan: W Kaleibar, 15 km from Asheqloo, Vaighan, *Lonicera caucasica*, N38°52′40″: E46°49′30″, alt. 1350m, 2006 Ghobad-Nejhad 393 (dubl. H); Aynaloo, *Lonicera caucasica*, N38° 50′ 03″: E 6° 47′ 29″, 2005 Ghobad-Nejhad 126 (MGH ref. herb.)- **Related specimens studied: *Phellinus lonicericola*. China.** Guizhou Prov., angiosperm, 2000 Dai 3212 (H)- **Russia.** Primorsk Terr., Distr. Ussurijsk, *Syringa amurensis*, 1979 Saar (Ex TAA 118570 in H)-***Phellinus lonicerinus*.** Turkmenia, Distr. Geok-Tepe, Dushak Mt., *Lonicera*, 1971 Parmasto (H 55696).

Phellinus igniarius (L.) Quél. s.l.

Key characters—Species in the *Phellinus igniarius* group produce basidiocarps with crusty surfaces, hard woody context, and hyaline spores. Recently Sell (2006) found statistically significant differences between spore sizes in some species in this group.

The Iranian specimens have smaller spores (Table 1) than those cited by Niemelä (2005).

Ecology and distribution—*P. igniarius* grows mostly on hardwoods. Iranian collections are from *Carpinus betulus, Crataegus, Fagus orientalis* and *Vitis* (Hallenberg 1981). Saber (2000) cites other hosts like *Juglans regia, Parrotia persica, Alnus subcordata, Populus* and *Salix*. *P. igniarius* is circumpolar in the boreal-temperate zone of the northern hemisphere.

SPECIMENS EXAMINED—**Iran.** Golestan: Golestan National Park, *Crataegus*, 1978 Hallenberg 2011 (GB). Gorgan, Rank-aou forest, on a stump, 1976 Hallenberg 1470 (GB). ***Phellinus cf. igniarius*. Iran.** Gorgan: Shamoushak, *Fagus*, 1999 Eskandari (IRAN 10658). Gilan: Siahkal, *Parrotia persica*, 1999 Eskandari (IRAN 10714); Fuman to Masouleh, *Alnus*, 1999 Eskandari (IRAN 2329/10708F). Chahar Mahal and Bakhtiari: Borujen to Shahrood, *Salix*, 1998 Kalanaki (IRAN 10492).

Phellinus tuberculosus (Baumg.) Niemelä Fig. 3.

= *Phellinus pomaceus* (Pers.) Maire

Key characters—Association with *Prunus*, lack of crust on the surface, and a corky context are diagnostic characters.

The Iranian specimens have smaller spores (Table 1) than those cited by Niemelä (2005).

Ecology and distribution—*P. tuberculosus* is essentially associated with *Prunus* spp., although it is also reported from other deciduous trees. Iranian collections are from dead and live standing trees or stumps of *Prunus* sp. (Hallenberg 1981). It is collected by MGH on *Acer campestre* and cultivated stands of *Prunus armeniaca* in NW Iran. Circumpolar, common in Europe up to the southern Fennoscandia.

SPECIMENS EXAMINED—**Iran.** East Azerbaijan: Aynaloo, *Acer campestre*, 2005 Ghobad-Nejhad 89 (dubl. H); Oshtobin, 38 50 46N, 46 29 27E, alt. 1150m, 2006 Ghobad-Nejhad

Fig. 3. *Phellinus tuberculosus* on cultivated stand of *Prunus armeniaca*. Photo MGH.

514 (dupl. H); Daran, 39 04 786N, 46 92 230E, *Prunus armeniaca*, 2006 Ghobad-Nejhad 359, 361 (MGH ref. herb.); Missan, 38 51 07N, 46 26 21E, alt. 1372m, *Prunus*, 2006 Ghobad-Nejhad 321 (MGH ref. herb.); Qale-darasi, 38 50 43N, 47 00 36E, alt. 1800m, indet. deciduous tree, 2006 Ghobad-Nejhad 451 (dupl. H); Kaleibar, 4 km from the road of Khoda-afarin to Jolfa, Kalale, N38°56'12": E46°45'52", alt. 1200 m, *Prunus*, 2006 Ghobad-Nejhad 475 (dupl. H).

Phylloporia ribis (Schumach.) Ryvarden Fig. 4.
=*Phellinus ribis* (Schumach.) Quél.

Key characters—The species is recognized by applanate basidiocarps with zonate tomentum and yellowish pore surface.

Ecology and distribution—*Ribes* and *Euonymus* are the most common hosts, but *Phylloproia ribis* may also be found on other hardwoods. In Iran it has been collected from the base of living trees or stumps of *Populus, Salix, Prunus, Crataegus,* and *Quercus* (Hallenberg 1981) and at the base of *Euonymus latifolius* by MGH (see specimens examined). *Ph. ribis* is distributed in the Northern Hemisphere.

Specimens Examined—**Iran.** East Azerbaijan: Kaleibar, 4 km from the road of Khoda-afarin to Jolfa, Kalale, *Euonymus latifolius*, N38°56'12": E46°45'52", alt. 1200 m, 2006 Ghobad-Nejhad 482 (dupl. H).

Fig. 4. *Phylloporia ribis* on *Euonymus latifolius*. Photo MGH (Ghobad-Nejhad 482).

Phylloporia spathulata (Hook.) Ryvarden
=*Coltricia spathulata* (Hook.) Murrill

Key characters—The species is characterized by yellow to cinnamon, stipitate basidiocarps. It has 7-9 pores/mm, and small ellipsoid, yellow basidiospores.

Ecology and distribution—*Phylloporia spathulata* grows on the ground. In Iran the single specimen was collected on the ground in a deciduous forest, Mazandaran province, N Iran (Niemelä & Uotila 1977, as *Coltricia spathulata*). Pantropical.

SPECIMENS EXAMINED—**Iran.** Mazandaran: 27 km S of Amol to Tehran, on the ground, 1972 Uotila 19317 (H).

Doubtful and excluded taxa

Three doubtful occurrences and five excluded taxa in *Phellinus* s.l. were found among Iranian records:

Fomitiporia robusta (P. Karst.) Fiasson & Niemelä
=*Phellinus robustus* (P. Karst.) Bourdot & Galzin

Soleimani (1974, 1976) provided two reports of this species in Iran, but the material could not be found again. *F. robusta* has been reported from neighboring Turkey (see Doğan et al. 2005, Sesli & Denchev 2005) and Pakistan (Ahmad 1972), however. As it is likely to be collected with more surveys in different parts of Iran, we include *F. robusta* (marked with an asterisk) in the present identification key.

Phellinus ferrugineovelutinus (Henn.) Ryvarden

There is one specimen under this name in the IRAN herbarium reported from Chaloos, N Iran (Saber 2000). The material is in a very poor condition and almost destroyed and unidentifiable. According to Gilbertson & Ryvarden (1987), *P. ferrugineovelutinus* has been reported from USA and South America (Florida and Georgia, West Indies, Colombia and Brazil). Its occurrence in N Iran seems unlikely.

Phellinus rimosus (Berk.) Pilát

The voucher of this species was missing in IRAN. The specimen was reported from *Cupressus* (Saber 2000). As *P. rimosus* grows on hardwoods, especially *Fabaceae*, the report on *Cupressus* seems questionable.

Phellinus chrysoloma (Fr.) Donk

This species was reported by Saber (2002). Examination of the specimen revealed that it is *Phellinus torulosus*.

Phellinus johnsonianus (Murrill) Ryvarden

The report is based on a single specimen collected from N Iran (Hallenberg 1981) now kept in GB. While *P. johnsonianus* has 7-9 pores/mm and slightly pigmented spores, the Iranian specimen has only 5 pores/mm and the spores are hyaline. This species fits well with *Phellinus senex*, which is proposed in this paper as *Fuscoporia senex*.

Phellinus laevigatus (Fr.) Bourdot & Galzin

Saber (1998) reported this species on *Alnus* sp. The number of pores/mm in *Phellinus laevigatus* is 8-10, but the report is based on a specimen with only four pores/mm. Moreover the shape of basidiocarp does not correspond to *P. laevigatus*. Here it is left as *Phellinus* cf. *igniarius*.

Phellinus merrillii (Murrill) Ryvarden

The report of this species was made by Saber (1998). The specimens were studied in IRAN. They are immature and sterile but containing setae, which excludes them from *P. merrillii*. As *P. merrillii* is restricted to southeastern USA (Gilbertson & Ryvarden 1987), its occurrence in N. Iran is rather unlikely.

Phellinus tremulae (Bondartsev) Bondartsev & P.N. Borisov

The hosts from which this species was reported for Iran (Saber 1998) were *Fagus*, *Salix* and *Parrotia persica*. All these trees are very improbable hosts for *Phellinus tremulae*. All three basidiocarps available in IRAN under this name are in poor condition and might be referred to as *Phellinus* cf. *igniarius*.

Remarks on ecology

From a distribution point of view, some species in *Phellinus* s.l. in Iran are known primarily from tropical-subtropical areas of the world (e.g., *Fuscoporia senex*, *Phellinus allardii* and *Phylloporia spathulate*) or from warmer temperate regions (e.g., *Fuscoporia contigua*, *Fuscoporia torulosa*). In Iran *F. contigua* and *F. torulosa* have mostly been collected from dry areas.

Host preference of *Phellinus* in forests of N Iran should be noted. Some species that exclusively or preferably inhabit relict tree elements in the Hyrcanian forests include *Fuscoporia contigua* (all four collections were found on *Quercus castaneifolia*) and *Fuscoporia torulosa* (collected mainly on *Parrotia persica*).

Additional notes on *Fomitiporia, Fuscoporia* and *Phylloporia*

Fifteen of the world's *Fomitiporia* species were keyed by Decock et al. (2005). The addition of five species by Fischer & Binder (2004), Fischer et al. (2005), Dai & Cui (2005), and this paper brings the total known species to twenty.

Wagner & Ryvarden (2002) provided a key to twelve of the fifteen species accepted in *Phylloporia*. The three remaining species were proposed later by Ryvarden (1972), Ipulet & Ryvarden (2005), and Douanla-Meli et al. (2007).

The following provisional key to 18 accepted species in *Fuscoporia,* follows the circumscription of *Phellinus* subgen. *Fuscoporia* outlined by Dai (1999). We propose the following new combination, based on material studied by Dai (1999):

Fuscoporia discipes (Berk.) Y.C. Dai & Ghobad-Nejhad, **comb. nov.**
MycoBank MB510877
Basionym: *Polyporus discipes* Berk., London J. Bot. 6: 499 (1847).

Provisional world key to *Fuscoporia*

1. Basidiocarp usually laterally stipitate, hymenial setae absent . *F. discipes* (see above)
1. Basidiocarp resupinate to pileate, hymenial setae present 2
2. Basidiocarp resupinate 3
2. Basidiocarp pileate 12
3. Basidiospores cylindrical to allantoid 4
3. Basidiospores oblong ellipsoid to ovoid 7

4. Basidiospores allantoid, 6--7.6 × 1.6–2 μm, basidiocarp perennial .... *F. viticola* (Schwein.) Murrill

4. Basidiospores cylindrical, 5.5–8.5 × 1.5–2.7 μm, basidiocarp annual or perennial 5

5. Basidiospores 7–8.5 μm long, basidiocarp perennial, young basidiocarps resupinate, pileate when mature .... *F. tawhai* G. Cunn.

5. Basidiospores 5.5–7.6 μm long, basidiocarp annual to biennial, resupinate 6

6. Pores 4–6 per mm, basidiospores broadly ellipsoid, 3.5–4.5 × 2.3–3.5 μm, some setae hooked .... *F. undulata* (Murrill) Bondartseva & S. Herrera

6. Pores 5–7 per mm, basidiospores cylindrical, 5.5–7.6 × 2–2.6 μm, setae never hooked .... *F. ferrea* (Pers.) G. Cunn.

7. Pores large, 1–4 per mm 8

7. Pores small, 5–8 per mm 9

8. Basidiocarp with soft consistency, pores 1-2 per mm, setae originating from hymenium, 5-7 μm wide, known on palms only from Cuba and Mexico .... *F. palmicola* (Berk. & M.A. Curtis) Bondartseva & S. Herrera

8. Basidiocarp firm, pores 1-4 per mm, setae mostly originating from trama, 6-9 μm wide, on various hosts, distributed in tropical and warm temperate zones .... *F. contigua*

9. Basidiospores ovoid 10

9. Basidiospores ellipsoid to subglobose 11

10. Basidiospores 6.5-8.2 × 3.2-4.2 μm, known from China .... *F. montana* Y.C. Dai & Niemelä

10. Basidiospores 5-7 (-8.5) × 2.5-3 μm, known from New Zealand .... *F. kamahi* G. Cunn.

11. Basidiospores subglobose, 4-4.5 × 3-4 μm, known from Cuba, Venezuela, Costa Rica .... *F. altocedronensis* (Murrill) Bondartseva & S. Herrera

11. Basidiospores ellipsoid, 4.2-5.2 × 2.9-3.5 μm, cosmopolitan .... *F. ferruginosa*

12. Hymenial setae usually hooked in apex .... *F. wahlbergii* (Fr.) T. Wagner & M. Fisch.

12. Hymenial setae straight 13

13. Basidiospores allantoid or cylindrical 14

13. Basidiospores ellipsoid 16

14. Basidiospores allantoid, 1.6-2 μm wide, pores 4-5 per mm, setae often more than 40 μm long .... *F. viticola*

14. Basidiospores cylindrical, 2-3.5 μm wide, pores 6-8 per mm, setae often less than 40 μm long 15

15. Basidiospores 2.5-3.5 μm wide, known from Jamaica, Mexico, Panama, West Indies on different hardwoods .... *F. cinchonensis* (Murrill) Bondartseva & S. Herrera

15. Basidiospores 2-2.5 μm wide, only known from Japan on *Schima mertensiana* .... *F. macroferrea* (T. Hatt. & Ryvarden) Zmitr. et al.

16. Basidiocarps usually annual, occasionally perennial, margin acute, dissepiments lacerate to dentate .... *F. gilva* (Schwein.) T. Wagner & M. Fisch.
16. Basidiocarps perennial, margin obtuse, dissepiments entire 17
17. Basidiocarps subungulate, pileal surface widely zonate, contextual skeletal hyphae with no septa, basidiospores usually free-floating.................. *F. torulosa*
17. Basidiocarps usually applanate, pileal surface narrowly zonate, contextual skeletal hyphae frequently septate, basidiospores usually in tetrads 18
18. Basidiospores less than 2.5 µm wide, skeletal hyphae unchanged in KOH .... *F. rhabarbarina* Groposo et al.
18. Basidiospores more than 2.5 µm wide, skeletal hyphae swelling in KOH .... *F. senex* (see above)

Species with uncertain affinities

Inclusion of the following taxa in *Fuscoporia* remains uncertain and awaits further study:

Fuscoporia punctatiformis (Murrill) Zmitr., V. Malysheva & Spirin

The original collection of *Fomitiporia punctatiformis* Murrill was studied by Niemelä et al. (2001), who concluded for this species: "an appropriate genus is *Fuscoporia*. We refrain from making the combination, until more fertile material will be studied."

Although Spirin et al. (2006) later transferred the species to *Fuscoporia*, they did not examine the type. For the time being, we prefer to exclude this species from the key until further comparisons can be made.

Fuscoporia longisetulosa (Bondartseva & S. Herrera) Bondartseva & S. Herrera

The species lacks hymenial setae, but has setal hyphae. It might be a species in *Phellinidium*.

Phellinus setifer T. Hatt.

Hattori (1999) referred to this species as "a member of *Fuscoporia* defined by Fiasson & Niemelä (1984), and probably most allied to *P. viticola*". The definition by Fiasson & Niemelä (1984) is in accordance with subgen. *Fuscoporia* sensu Dai. However, we did not examine the species, which could allow us to make any genus rearrangements.

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MYCOTAXON

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Two noteworthy boletes from China

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Abstract — Two species of boletes from China are described and illustrated. They are *Chroogomphus pseudotomentosus* and *Gyroporus longicystidiatus*. The first is new for China, while the second is new for the mainland of China.

Key words — *Boletales*, taxonomy, distribution

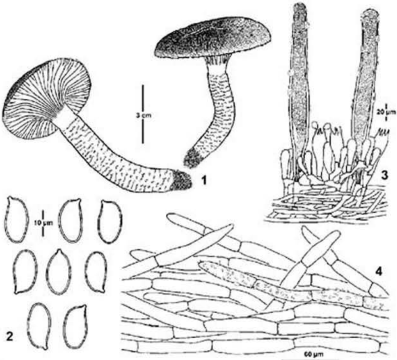
Material and methods

All materials are deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS), which is not listed in the index or relevant publications. In the description, macro-morphology is based on the field notes and color slides of the materials; micro-morphology is based on observation of the materials under microscope. In the description of basidiospores, the abbreviation n/m/p means n basidiospores measured from m fruit-bodies of p collections in 5% KOH solution. The notation of the form (a) b–c (d) stands for the dimensions of the basidiospores; the range b–c contains a minimum of 90% of the measured values, a or d given in parentheses stands for extreme values. Q is used to mean "length/width ratio" of a basidiospore in side view; **Q** means average Q of all basidiospores ± sample standard deviation.

Taxonomy

Chroogomphus pseudotomentosus O.K. Mill. & Aime,
Trichomycetes and Other Fungal Groups: 327, Figs. 6–9, 2001. **Figs. 1-4**

Pileus 4–7 cm in diam., convex to applanate, often somewhat umbonate when young, pale orange to orange brown, somewhat darker over disc, with matted tomentose to nearly radially fibrillose squamules; margin sometimes extended



Figs. 1-4 ***Chroogomphus pseudotomentosus*** **(HKAS 48661)**

1. Basidiocarps; 2. Basidiospores; 3. Basidia and pleurocystidia; 4. Pileipellis

and finely striate. Lamellae decurrent, pale orange to grayish brown, somewhat vinaceous or with dark tinge when mature, distant, thick, sometimes forking; short lamellulae sometimes single and sometimes anastomosing and forking. Stipe 7–15 × 1–2 cm, subcylindric, tapered towards base, yellowish to light orange, but orange to light brown at apex and pale orange yellow at base, with fibrillose to tomentose squamules, sometimes with a weak superior, fugacious annulus; basal mycelium pale salmon. Context of pileus and stipe pale orange to orange. Taste and odor not distinctive.

Basidia 33–65 × 10–16.5 µm, clavate, 4-spored, rarely 2-spored, thin-walled, hyaline in KOH and yellowish to yellowish brown in Melzer's reagent. Basidiospores [370/14/8] (13.0)14.5–18.0(19.5) × (6.0)8.0–9.5(10.0) µm, [Q = (1.56)1.67–2.10(2.13), **Q** = 1.84 ± 0.11], ellipsoid, slightly thick-walled, dextrinoid, yellow to yellowish brown in KOH. Lamellar trama hyphae 5–12 µm wide, with scattered amyloid cell walls and amyloid incrustation. Pleuro- and cheilocystidia (100)130–200 × 15–25 µm, subfusiform, colorless or with vinaceous vacuolar pigment in KOH, thick-walled (up to 5.5 µm in thickness); walls brownish in KOH and yellowish brown in Melzer's reagent. Squamules on pileus composed of subrepent, yellowish to yellowish brown, non-amyloid hyphae; surface of hyphae covered with yellowish to yellowish brown incrustation; terminal cells (20)40–130(160) × 8–20 µm, subcylindric or slightly attenuate towards the apex. Pileipellis made up of subradially, non-viscid, hyaline hyphae 6–21 µm in diam., with scattered amyloid cell walls and covered with amyloid incrustation. Pileal trama composed of yellow brown to ochreous hyphae 6–28 µm in diam., with deeply amyloid cell walls and content; surface of hyphae with deeply amyloid granules. Squamules on stipe composed of longitudinally arranged hyphae 5–11 µm in diam., yellowish to yellowish brown, non-amyloid. Basal mycelium composed of loosely interwoven hyphae 4–10 µm in diam., with deeply amyloid cell walls and content; surface of hyphae with abundant deeply amyloid incrustation; clamp connections not observed.

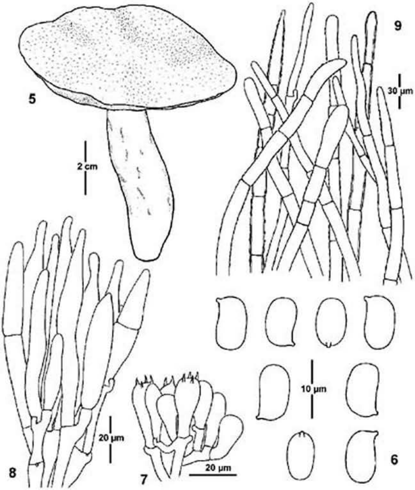
Habitat and known distribution: in mixed forests of *Abies*, *Picea*, *Pinus*, and *Quercus*, sometimes with *Rhododendron* or *Salix* at altitude of 2700–3600 m. Known from Japan, Korea and Nepal. New to China.

SPECIMENS EXAMINED — China. Yunnan Province: *Lijiang County, Laojun Mountain* alt. 3400 m, 28 July 2001, X. H. Wang 1289 (HKAS 39219); the same mountain, alt. 3400 m, 1 August 2005, Z. L. Yang 4495 (HKAS 48661); the same mountain, alt. 3200 m, 1 August 2005, Z. L. Yang 4504 (HKAS 48670). *Shangri-La County, Bitahai*, alt. 3600 m, 7 August 2005, Z. L. Yang 4562 (HKAS 48726); *Shangri-La County, Jisha*, alt. 3450 m, 30 August 2003, H. D. Zheng 03-442 (HKAS 44095); Sichuan Province: *Mianning County, Yele Nature Reserve*, alt. 2700 m, 12 July 2005, Z. W. Ge 488a (HKAS 48984a); *Jiulong County, Tanggu*, alt. 3600 m, 17 July 2005, Z. W. Ge 531 (HKAS 49027); Heilongjiang Province: *Daxinganling*, bought on free market, October 2006 Y. C. Li 754 (HKAS 51966).

Gyroporus longicystidiatus Nagas. & Hongo,
Rept. Tottori Mycol. Inst. 39: 18, Fig. 5, 2001. Figs. 5-9

Pileus 5–8 cm in diam., convex to applanate, dry, brownish orange, but pale orange to grayish orange towards margin, covered with concolorous, small squamules. Hymenophore free to subfree, cream initially, dirty white to yellowish when mature; pores small, about 0.3 mm in diam., with rust brown stains here and there when old; tubes relatively short, up to 8 mm in length. Stipe 4–8 × 1.5–2.1 cm, narrowly clavate, surface roughened and with scattered strigose hairs, often whitish to pale orange at apex when young, paler than pileus or almost concolorous with pileus when mature, spongy then hollow in age. Context white to grayish, unchanging in color when injured. Taste and odor not distinctive.

Basidia 20–35(45) × 9–14 µm, clavate, hyaline in KOH and yellowish in Melzer's reagent, 4-spored, sometimes 2-spored, clamped at base. Basidiospores (300/10/8) (7.0)7.5–9.5(10.5) × 4.5–6.0 µm, [Q = (1.33)1.45–1.82(2.0), **Q** = 1.65



Figs. 5-9 ***Gyroporus longicystidiatus*** **(HKAS 43345)**

5. Basidiocarp; 6. Basidiospores; 7. Basidia; 8. Cheilocystidia; 9. A squamule on pileus

± 0.13], ellipsoid to somewhat oblong, smooth, light brown to tawny in KOH and yellowish brown in Melzer's reagent. Cheilocystidia (30)46–92(110) × (6.5)8–15 µm, clavate to subfusiform, thin-walled, hyaline in KOH and yellowish to yellow in Melzer's reagent, forming a sterile edge to the pore. Pleurocystidia absent. Squamules on pileus composed of tangled hyphae, often appressed to the surface, occasionally clamped, thin-walled or sometimes thick-walled, hyaline or encrusted with yellow to yellowish brown pigment in KOH; terminal cells (35)45–100 × (6)7–15(17) µm, clavate to subcylindrical or subfusiform, with rounded or attenuated apices. Pileipellis consisting of yellow to yellowish brown interwoven hyphae 6–18 µm in width. Pileal trama composed of broad interwoven hyphae up to 45 µm in width. Stipitipellis composed of yellow to yellowish brown, interwoven hyphae 5–16 µm in width.

Habitat and known distribution: solitary to scattered, in mixed forests of *Pinus*, *Quercus*, *Fagus*, *Lithocarpus* and *Corylus*. Described from Japan and reported from Taiwan Island by Chang et al. (2001) and Chou et al. (2005). New to the mainland of China.

> SPECIMENS EXAMINED — CHINA. YUNNAN PROVINCE: *JINGDONG, AILAOSHAN, XUJIABA*, 1 August 2000, Q. B. Wang 827 and 828 (HKAS 37431 and 37432 respectively); *TENGCHONG, JIETOU*, alt. 1790 m, 4 August 2000, F. Q. Yu 79 (HKAS 37430); same location, 5 August 2000, X. H. Wang 1122 (HKAS 37433); *TENGCHONG QUSHI*, alt. 1500 m, 22 July 2003, L. Wang 250 (HKAS 43345); *BAOSHAN TOWN, LONGYANG DISTRICT*, Baihua Mountain, 24 July 2003, X. H. Wang 1633 (HKAS 44123); *LONGLIN COUNTY, YIWANSHUI*, alt. 1700 m, 10 September 2002, L. F. Zhang 127 (HKAS 41706). HUNAN PROVINCE: *SANGZHI COUNTY, BADAGONGSHAN NATURE RESERVE*, alt. 1300 m, 24 July 2003, H. C. Wang 344 (HKAS 42460).

Discussion

Chroogomphus pseudotomentosus is very similar to *C. tomentosus* (Murrill) O.K. Mill. in macro-morphology. The latter species, originally described from the USA, was reported from Japan (Imai 1938), and supposed to be a disjunct species between western North American and East Asian (Redhead 1989). Recently, specimens similar to *C. tomentosus* collected from Japan were studied and described by Miller & Aime (2001) as *C. pseudotomentosus* based on their morphological and molecular data. In comparison with *C. pseudotomentosus*, *C. tomentosus* has much longer spores, narrower cystidia, and frequent clamp connections in the basal mycelium (Miller 1964). We studied a collection of *C. tomentosus* collected from Oregon, USA (HKAS 19311). The spores [100/3/1] are (16)18–23(25) × 6.5–8.5 µm; the cystidia are (160)170–220(245) × (14)15–19(22) µm; and clamp connections are frequent on the hyphae in the basal mycelium. Xie et al. (1986), Mao (1998), Mao et al. (1993), and Yu & Liu (2005) reported *C. tomentosus* from China. Study on Chinese collections deposited in HKAS showed that most collections labeled *C. tomentosus* are in fact *C. pseudotomentosus*. It seems to be true that *C. tomentosus* is distributed in western North America while *C. pseudotomentosus* in East Asia (Miller and Aime 2001, Miller 2003, Yang 2005).

Gyroporus longicystidiatus is characterized by its brownish orange pileus, relatively short tubes and long cheilocystidia (Nagasawa 2001). It is mostly similar to *G. castaneus* (Bull.) Quél. phenetically. However, the latter has relatively smaller cheilocystidia (26–55 × 5–8 µm), longer tubes up to 10 mm and chestnut brown basidiocarps. Moreover, there are much more clamp connections in the pileipellis and stipitipellis of *G. castaneus* than in *G. longicystidiatus*.

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MYCOTAXON

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Aphyllophoraceous wood-inhabiting fungi on *Fagus sylvatica* in Italy

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Abstract — 166 species representing 84 genera of aphyllophoraceous fungi growing on *Fagus sylvatica* in Italy are listed. *Steccherinum robustius* is reported as new to Italy, while many species are considered rare in Italy, e.g. *Antrodiella ichnusana, Crustomyces subabruptus* and *Dentipellis fragilis*. The complete annotated specimen list is available on http//www.mycotaxon.com/resources/weblist.html.

Key words — lignicolous fungi, diversity, beech forests

Introduction

In parallel with previous reports on Italian lignicolous fungi (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006, Bernicchia et al. 2007a, b) a list of aphyllophoraceous fungi growing on *Fagus sylvatica* L. (European beech) in Italy is presented. *F. sylvatica* is widely distributed in western Europe, from Southern Scandinavia (below parallel 60° with the exception of two northern and separated localities of Norway in the surroundings of Oslo and Bergen) to northern Sicily and Greece (Parnaso). Towards western part of Europe *F. sylvatica* is present at 5° of longitude W in Cornovaglia, exceeding such limit in Spain (Galizia Mounts). Towards the east *F. sylvatica* reaches Moldavia and sometimes it crosses the Dnestr River. It is also present in eastern Crimea (Tutin 1964) (Figure 1). In Italy *F. sylvatica* belongs to the mountain belt, corresponding to the subatlantic belt. The European beech is dominant but mixed with *Abies alba* Mill., *Taxus baccata* L., *Acer pseudoplatanus* L., *Fraxinus*

Figure 1. Map of approximate distribution of of *Fagus sylvatica* in Europe

excelsior L., *Ulmus glabra* Huds., *Sorbus aucuparia* L., *Populus tremula* L., etc. In Alp valleys *F. sylvatica* is mixed with *Picea abies* (L.) H. Karst., *Pinus sylvestris* L. and *Larix decidua* Mill. In the mountainous broad-leafed forest along the ridges of Italian Apennine, *F. sylvatica* is the most important forestry species (Tutin 1964, VV.AA. 2005).

In Italy the optimal elevations are 600–1300 m in the Alps and elsewhere (including Sicily) 1000–1700 m. Depending on climates, *F. sylvatica* woods of Gargano (Apulia), Latium and Tuscany range from 400 to 500 m in elevation. In Sicily *F. sylvatica* woods are restricted in a vegetational belt ranging from 100 to 2200 m along the major mountain systems (Madonie Mts., Nebrodi Mts., Pelortitani Mts. and Etna volcano).

Materials and methods

During the last 25 years, fungi have been collected in the most representative regions of Italy where *Fagus sylvatica* occurs. A list and map of all 67 collection localities are available on the web Checklist. Samples were taken to the laboratory for microscopical examination; identifications followed Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Kõljalg (1995), Ryvarden & Gilbertson (1993, 1994) and Bernicchia (2005). All specimens are kept in Herbarium HUBO, except for the PAL/Mic collections (with provisional numbers) deposited in the Herbarium Mediterraneum (PAL). The list is partially referred to Onofri (2005) and the nomenclature to Donk (1984), Parmasto (1997), Hjortstam (1998), Kirk et al. (2001) and CBS (2007).

Results

166 species of 84 different genera of aphyllophoraceous wood-inhabiting fungi were collected during the field investigation. The species are listed in alphabetic order; the number of the locality is given in brackets and it is followed by herbaria number. Additional notes on distribution or frequency are given for most of the species. *Steccherinum robustius* (J. Erikss. & S. Lundell) J. Erikss. is new to Italy. Rare or infrequent species include *Antrodiella fissiliformis* (Pilát) Gilb. & Ryvarden, *A. ichnusana* Bernicchia et al., *Ceriporia excelsa* (S. Lundell) Parmasto, *Ceriporiopsis pannocincta* (Romell) Gilb. & Ryvarden, *Crustomyces subabruptus* (Bourdot & Galzin) Jülich, *Datronia stereoides* (Fr.) Ryvarden, *Dentipellis fragilis* (Pers.) Donk, *Stereum insignitum* Quél., *Tyromyces wynnei* (Berk. & Broome) Donk and *Vuilleminia coryli* Boidin et al.

Species more common on coniferous substrata than on deciduous wood include *Dacryobolus sudans* (Alb. & Schwein.) Fr., *Hyphodontia breviseta* (P. Karst.) J. Erikss., *Oligoporus caesius* (Schrad.) Gilb. & Ryvarden, *Phaeolus schweinitzii* (Fr.) Pat., *Resinicium bicolor* (Alb. & Schwein.) Parmasto.

While many of these species can grow on other substrata, some typically fruit on *Fagus*, including *Antrodiella fissiliformis*, *Datronia stereoides*, *Dentipellis fragilis*, *Hericium cirrhatum* (Pers.) Nikol., *Inonotus hastifer* Pouzar, *I. nodulosus* (Fr.) P. Karst., *Ischnoderma resinosum* (Schrad.) P. Karst., *Meripilus giganteus* (Pers.) P. Karst., *Plicaturopsis crispa* (Pers.) D.A. Reid, *Phanerochaete filamentosa* (Berk. & M.A. Curtis) Burds., *Polyporus varius* (Pers.) Fr., *Trametes gibbosa* (Pers.) Fr., and *Tyromyces wynnei*. The last mainly grows on litter, probably connected with roots.

Conclusions

Fagus sylvatica is widely distributed in Italy, often mixed with *Abies alba* and some broad-leaved trees. The mycobiota of *F. sylvatica* showed a high diversity in Italy with 166 species recorded, compared to other substrata; 203 species on *Pinus* spp. (Bernicchia 2007b), 190 species on *Abies alba* (Bernicchia 2007a), 126 species on *Castanea sativa* (Mayrhofer et al. 2001), 105 species on *Juniperus* spp. (Bernicchia 2000) and 52 species on *Arbutus unedo* (Pérez Gorjón et al.

2006). In Italy, fallen branches and logs of beech are often removed from the habitat because of their economic value, which reduces the potential fungal biodiversity on *Fagus*.

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New records of rust fungi for Pakistan

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Abstract — *Puccinia graminis* var. *stakmanii* and *Puccinia striiformoides* (= *P. striiformis* var. *dactylidis*) are described and illustrated as new records for the Pakistan fungus flora.

Key words — *Poaceae, Bromus japonicus, P. pseudostriiformis*

Introduction

Pakistan is floristically a rich country and more than 6,000 higher plants are known from this area (Stewart 1982). However, it is still uredinologically poorly known. Until now, only 21 genera and approximately 400 species of rust fungi are known from Pakistan (Ahmad et al. 1997, Sultan et al. 2006), corresponding to a ratio of circa 7%, thus reinforcing the observations of Hennen & McCain (1993) that rust species are about 5-25% as numerous as plant species. These figures indicate that the number of rust species reported for this area is far less in relation to the vegetation, and a total rust flora between 300 to 1500 species could be expected for Pakistan.

During a survey of rust flora of Pakistan, two species of *Poaceae*, *Bromus japonicus* and *Lolium perenne* were found infected with *Puccinia graminis* var. *stakmanii* and *Puccinia striiformoides* (= *P. striiformis* var. *dactylidis*) respectively. These rust fungi are new records for Pakistan.

Materials and methods

During the survey of rust fungi of Pakistan, infected plants were collected from Khanspur, North Western Frontier Province (NWFP). An attempt was made to collect healthy plants along with inflorescence or fruits for accurate identification. Host plants were identified by comparing them with specimens in the herbarium, Department of Botany, University of the Punjab, Lahore (LAH).

Free hand sections of infected portions of material and spores were mounted in lactophenol. Semi permanent slides were prepared by cementing cover slips with nail lacquer (Dade & Gunnell 1969). Preparations were observed under a NIKON YS 100 microscope and microphotographed with the help of digipro-Labomed. Drawings of spores and paraphyses were made by using a Camera Lucida (Ernst Leitz Wetzlar Germany). Spore dimensions were taken by an ocular micrometer (Zeiss Eye Piece Screw Micrometer).

Enumeration of taxa

1: *Puccinia graminis* var. *stakmanii* A. L. Guyot, Massenot & Saccas ex Z. Urb., Česká Mykol. 21: 14 (1967) **(Figs. A-B)**

Spermogonia and aecia not seen. Uredinia intermixed with telia, dark blackish brown, amphigenous. Urediniospores 14–23 × 20–36µm, ovoid to ellipsoid or subglobose, wall 2–3µm thick at side, up to 6µm at apex, brown to chestnut brown, echinulate, the echinula are about half the diameter on the spore equator, germ pores 3–4, equatorial. Pedicel brown, 6–7 × 50µm.

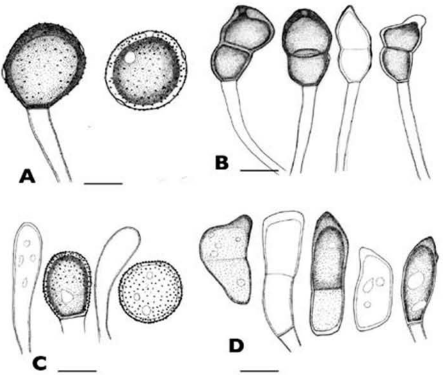
Telia amphigenous, black, 0.09–0.14 × 0.06–0.3mm. Teliospores oblong to ellipsoid, constricted at the septum, attenuated below, chestnut brown, 16–24 × 30–52µm; germ pore 1 in each cell, wall up to 3µm thick at side; apex conical, 4–9µm thick. Pedicel light brown, persistent, 6-8 × 86µm.

> **Material examined:** On *Bromus japonicus* Thunb. Pakistan, North Western Frontier Province (NWFP), Khanspur-Ayubia, at 2575m, 20th September, 2006. NSA # 311061(LAH).

The black stem rust, *P. graminis* Pers., is a common heteroecious species with species of *Berberidaceae* as aecial hosts and members of the *Poaceae* as telial hosts. Cummins (1971) lists 77 host genera of *Poaceae* (primarily in subfamily *Pooideae* but also a few in the subfamily *Panicoideae*) containing species that harbor *P. graminis*.

Puccinia graminis and *P. graminis* subsp. *graminicola* Z. Urb. have previously been recorded on *Triticum aestivum* L. and *Bromus japonicus* from Swat state, Miana; on *Agropyron semicostatum* Nees. from Miana; on *Agrostis munroana* Aitch. & Hemsl. from Kaghan valley; on *Hordeum vulgare* L. from Faisalabad, and on *Cynodon dactylon* Pers. from Quetta (Ahmad 1956b).

P. graminis var. *stakmanii* is here reported for the first time from Pakistan and is an addition to the rust flora of this country.



Figs. A-B: *Puccinia graminis* var. *stakmanii* **(A).** Urediniospores **(B).** Teliospores. **C-D:** *Puccinia striiformoides.* **(C).**Urediniospores with paraphyses **(D).** One and two celled teliospores.
Scale bar: For A, B, C & D= 10µm.

2: *Puccinia striiformoides* M. Abbasi, Hedjar. & M. Scholler,
Rostaniha 5(2): 75 (2005). (Figs. C-D)
= *P. striiformis* var. *dactylidis* Manners, Trans. Brit. Mycol. Soc. 43: 65. 1960.

Spermogonia and aecia unknown. Uredinia mostly on the adaxial surface, yellow to yellowish brown, 0.05–0.06 × 0.2–0.3mm. Urediniospores globose-subglobose or ovoid, hyaline to light yellow, echinulate, 16–21 × 19–24µm; wall 1.5–2µm thick; germ pores up to 8, scattered, obscure. Paraphyses intermixed, abundant, hyaline, cylindric to clavate, 3–5µm thick and up to 50µm long.

Telia amphigenous or mostly abaxial, black, striate, covered by the epidermis, loculate, 0.09–0.15 × 0.03-0.04mm, surrounded by a few paraphyses. Teliospores mostly two-celled but one-celled teliospores are also common. Two-celled teliospores are mostly oblong-clavate or often ellipsoid, 13–24 × 29–49µm, light golden to clear chestnut brown, often paler basally, smooth; germ pore

1 per cell, obscure; wall 1.5–2µm thick at the sides, 3–6µm thick apically, apex truncate, pointed or obliquely conical, not or slightly constricted at septa, base attenuated; pedicel short, up to 8µm long, but mostly less than 7µm. One-celled teliospores 15–20 × 17–30µm, clavate to ellipsoid or often angular, light golden to clear chestnut brown, smooth; wall thickness up to1.5–2µm, apex truncate, pointed or obliquely conical, up to 3–6µm thick; pedicel very short. Paraphyses clavate, few, chestnut brown, 5–5.5µm wide and up to 47µm long.

Material examined: On *Lolium perenne* L., Pakistan, North Western Frontier Province (NWFP), Khanspur-Ayubia, at 2575m, 20th September, 2006. NSA # 20706 (LAH).

P. striiformis, the cause of yellow rust or stripe rust, is a species forming uredinia and telia on various species of *Poaceae*. It is assumed to be heteroecious, but the aecial host is not known. Previously, two varieties — *P. striiformis* var. *striiformis* and *P. striiformis* var. *dactylidis* — were accepted by most authors. Abbasi et. al. (2004) introduced a three-species system based on molecular and morphological features that included:

P. striiformis Westend. s. *str.* mainly on tribe *Triticeae*,
P. pseudostriiformis M. Abbasi et al. on *Poa pratensis* (tribe *Poeae*), and
P. striiformoides on *Dactylis glomerata* (tribe *Poeae*).

The rust fungi already reported on *Lolium* L. include *Puccinia coronata* Corda var. *coronata*, *P. striiformis* var. *striiformis*, *P. brachypodii* var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene, *P. graminis* subsp. *graminicola*, *P. hordei* G.H. Otth and *P. recondita* Roberge ex Desm. (Cummins 1971).

Ahmad (1956a) reported *P. recondita*, *P. coronata* and *P. striiformis* on *Lolium perenne* and *L. persicum* Boiss. & Hohen.

P. striiformoides is a new record from Pakistan. Previously *Dactylis glomerata* was the only reported host of *P. striiformoides*; *Lolium perenne* is now established as a second host for the species.

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New records of *Ascomycota* from Brazil

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Abstract — The taxonomic study of filamentous fungi isolated from the rhizosphere of melon (*Cucumis melo* cv. Gold Mine) plantations treated with different combinations of organic composts reveals five species — *Chaetomium convolutum*, *C. ochraceum*, *C. trigonosporum*, *Thielavia fragilis* and *T. microspora* — documented for the first time in Brazil. Keys to all known Brazilian species of *Chaetomium* and *Thielavia* are also provided.

Key words — ascomycetes, taxonomy

Introduction

During the last decade, melon culture in the Brazilian semiarid northeastern region came to be regarded as an option for short-term investment in sales for national and international markets (Nachreiner et al. 2005). Many types of organic residues have been applied while developing this horticulture in the San Francisco Valley in Petrolina, Pernambuco, Brazil. Little, however, is known of the effects of these composts on the soil microbiology, mainly on filamentous fungi.

The purpose of the present taxonomic work was to study filamentous fungi isolated from the rhizosphere in melon (*Cucumis melo* L. cv. Gold Mine) plantations treated with different combinations of organic composts, which included composted leaves of *Pennisetum purpureum* Schumach., coconut fibre, goat manure — all of which were or were not supplemented with inorganic potassium sulphate. Five species isolated (i.e., *Chaetomium convolutum*, *C. ochraceum*, *C. trigonosporum*, *Thielavia fragilis*, *T. microspora*) constitute first reports of these taxa for Brazil.

Materials and methods

Soils were collected from cultivated melon (*Cucumis melo* cv. Gold Mine) rhizospheres in semiarid land from Brazil (S 09°32´09´´ and W 40°55´28´´). This area was fertilized with combinations of organic composts from *Pennisetum purpureum* leaves, coconut fibre, and goat manure. These organic composts were either supplemented with inorganic potassium sulphate or allowed to compost without added chemical. Each soil sample consisted of three replicates from each melon rhizosphere.

Fungi were isolated using a serial dilution technique. 25 g per soil sample was suspended in 225 ml of sterilized distilled H_2O (dilution 1:10); 10 ml of the first suspension was added to 990 ml of sterilized distilled H_2O (dilution 1:1000), of which 1 ml was poured into Petri dishes containing Sabouraud Agar supplemented with chloramphenicol (500 mg L^{-1}). Triplicates of the plates were stored at room temperature (~28 °C). Fungal growth was monitored for 72 h. Filamentous fungus species were identified based on macroscopic and microscopic characteristics according to Ames (1961), Corlett (1966), Arx (1975), and Arx et al. (1986).

Taxonomy

Species descriptions

Chaetomium convolutum Chivers, Proceedings of the American Academy of Arts and Sciences 48: 85 (1912)

Perithecia ostiolate, subglobose or egg-shaped, 242-285 x 250-268µm, light brown and clothed with relatively few, loose, wide-spreading hairs. Terminal hairs forming a broadly spreading head, black, regularly and thickly covered with minute spines and globular projections, irregularly and obscurely septate, straight below, spirally coiled above, the convolutions open and of large diameter below, 8-10 in number, but toward the tip are constantly and evenly decreased in diameter and becoming more and more closely appressed. Lateral hairs comparatively few in number, septate, graceful, tapering, straight, yellow at the base, minutely roughened, about 4.0-5.0µm in diameter, tapering and fading to a long, hyaline, frequently collapsed tip. Asci club-shaped, 8-spored, 42.5 x 7.5µm. Ascospores, when young colorless with granular contents, when mature pale dull-olive, ovate or almond-shaped, bluntly pointed at either end, slightly apiculate, 8-8.5 x 6.0-6.25µm.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with composted *Pennisetum purpureum* leaves, goat manure, coconut fibre, and inorganic potassium sulphate.

Known distribution: Egypt, Germany, India, Israel, Kenya, Russia, Spain, Taiwan, U.K., U.S.A. and (with this paper) Brazil.

NOTES: *Chaetomium convolutum* may be recognized by the very long terminal hairs with loosely spirally coiled ends, drooping with 8-10 turns. Among related species, *C. subspirale* differs by producing barrel-shaped perithecia, slender terminal hairs, and spirally coiled, short, often thread-like tips that give a fuzzy appearance while *C. pulchellum* produces barrel-shaped perithecia and medium coarse terminal hairs that coiled above in large loops that narrow to blunt tips.

Chaetomium ochraceum Tschudy, American Journal of Botany 24: 475 (1937)

Perithecia ostiolate, globose, about 333-400µm in diameter, overall color green to yellow-green when young, graying with age, lightly attached to the substratum. Terminal hairs narrow throughout their length, light colored, yellow-green with variations when young, smooth, nonseptate, irregularly sinuous, kinky or loosely coiled, interwoven into a large, dense, compact head. Lateral hairs similar but shorter, less sinuous, irregular and appressed. Asci clavate, 8-spored. Ascospores dark olive-brown, ovoid or faintly apiculate at both ends, 7.5 x 5.5µm.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with composted coconut fibre, goat manure, and potassium sulphate.

Known distribution: U.S.A. and currently also in Brazil.

NOTES: *C. ochraceum* is recognized by the ochraceous mycelium, the extremely fine, sinuous and slender unbranched terminal hairs that intertwine to form a dense compact head, and the small ascospores. It differs from *C. globosum* by the presence of ascospores varying from subglobose to lemon-shaped, not exceeding 10.5µm long. *C. olivaceum* has distinctly longer (up to 16µm), more uniformly shaped ascospores and wavy, terminal hairs; *C. circinatum* has longer (up to 15µm), ovoid to lemon-shaped ascospores and long, robust terminal hairs with circinate (2-3 times recurved) tips up to 7.5µm in diameter.

Chaetomium trigonosporum (Marchal) Chivers, Memoirs of the Torrey Botanical Club 14(3): 166 (1915)

Basionym: *Bommerella trigonospora* Marchal, Bulletin de la Société Royale de Botanique de Belgique 24: 164 (1885).

Perithecia ostiolate, globose to subglobose to somewhat elongated, 249.6 x 160µm, black, seated on mats of hyphae which are olive-yellow to olive brown, at maturity producing long, slender, straight or curved, black spore columns. Terminal hairs straight, unbranched, dark rich olive, regularly septate except near the tips, smooth or only slightly and obscurely roughened, at base about 4.0µm in diameter, at tip pale yellow or colorless, without septa. Lateral hairs rather numerous, comparatively short, spine-like, tapering, below, dark olive-brown, minutely roughened, conspicuously and evenly septate, smooth, colorless near tip. Asci narrowly and irregularly club-shaped, 8-spored. Ascospores greenish, when mature rich olive-yellow to dark olive-brown, in face view irregularly triangular, 7.5-10 x 5.0-6.5µm.

Habitat: *Cucumis melo* cv. Gold Mine rhizosphere.

Known distribution: Belgium, Canada, Japan, U.S.A. and currently also in Brazil.

NOTES: *Chaetomium trigonosporum* may be recognized by the short, stiff and spine-like terminal hairs and triangular ascospores. *C. brevipilium* is differentiated by its lemon-shaped ascospores, short terminal hairs tufted about the ostiole, and elongated, barrel-shaped perithecia. Other similar species include *C. homopilatum* with lemon-shaped ascospores, evenly distributed short terminal hairs, and broadly vase-shaped perithecia; *C. seminudum* with almond-shaped ascospores up to 10µm long, 230µm tall vase-shaped perithecia; and *C. minutum* with up to 8.5µm long, depressed, ovoid ascospores and vase-shaped perithecia that are up to 125µm tall.

Key to the species of *Chaetomium* in Brazil

1. Terminal hairs distinctly branched 2
1. Terminal hairs unbranched 8

2. Terminal hairs dichotomously branched 3
2. Terminal hairs not dichotomously branched 4

3. Terminal hairs all of one type .... *C. indicum* Corda
3. Terminal hairs of two types .... *C. funicola* Cooke

4. Terminal hairs typically branched at right angles .... *C. spinosum* Chivers
4. Terminal hairs not branched at right angles 5

5. Terminal hairs coiled 6
5. Terminal hairs not coiled, flexuous 7

6. Coiled hairs intermingled with other types; perithecia vase-shaped, up to 750µm tall, the upper portion of markedly elongate cells; ascospores ovoid to globose, under 7µm long .... *C. caprinum* Bainier
6. Coiled hairs not intermingled with other types; perithecia broadly ovoid, often with blunt, pointed base; ascospores ellipsoid, up to 7.4µm long, often containing an elliptical refractive area .... *C. bostrychodes* Zopf

7. Asci linear-cylindrical; terminal hairs ribbon-like, somewhat twisted, undulate .... *C. senegalense* L.M. Ames
7. Asci club-shaped; terminal hairs of one type, with large crystals and projections appearing at random, undulating or with occasional spiral coils frequently branching .... *C. nigricolor* L.M. Ames

8. Terminal hairs straight, wavy or arcuate 9
8. Terminal hairs coiled or contorted 13

9. Terminal hairs straight, slightly curved or wavy 10
9. Terminal hairs undulate to arcuate with occasional branched tips .... *C. ochraceum*

10. Terminal hairs short, stiff and spine-like or very long 11
10. Terminal hairs not stiff and spine-like 12

11. Ascospores triangular ....*C. trigonosporum*
11. Ascospores lemon-shaped .... *C. homopilatum* Omvik

12. Terminal hairs slightly recurved at base, tips incurved, not dense ..... .*C. aureum* Chivers
12. Terminal hairs slender, straight or wavy ....*C. globosum* Kunze

13. Terminal hairs uniformly coiled or contorted 14
13. Terminal hairs with 4-7 close spirals accompanied by a few long, flexuous hairs, forming a relatively compact head .... *C. brasiliense* Bat. & Pontual

14. Perithecia egg-shaped .... *C. convolutum*
14. Perithecia subglobose 15

15. Ascospores fusiform, up to 16µm long .... *C. fusiforme* Chivers
15. Ascospores cymbiform, less than 13µm long 16

16. Species produces a yellowish pigment that is soluble in water; terminal hairs strongly curved, slender, not bulbous at base, 1-3 spiral convolutions at tips .... *C. trilaterale* Chivers
16. Species produces a copper-colored pigment that is insoluble in water; terminal hairs stiff, bulbous at base, heavily incrusted with copper-colored crystals arcuate from base, terminating in 1-2 spiral convolutions at tips .... *C. cupreum* L.M. Ames

Thielavia fragilis (Natarajan) Arx, Studies in Mycology 8: 8 (1975)
Basionym: *Chaetomidium fragile* Natarajan, Proceedings of the Indian National Science Academy, Part B. Biological Sciences 37(3): 124 (1972) ['1971']

This species has spherical, light brown ascomata, composed of flattened, brown textura epidermoidea. The ascomata may be smooth or covered with some very long, brown, 2.5µm wide hairs with hyaline ends; asci clavate, 22.5-25 x 7.5-10µm; the ascospores are rather irregular in shape, but are often nearly clavate or obovate, rounded at one end, attenuated and provided with a distinct germ pore at the other, 12.5 x 6.5µm in size.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with organic composted *Pennisetum purpureum* leaves, goat manure, and potassium sulphate.

Known distribution: India, Korea and currently also in Brazil.

NOTES: This species may be recognized by the usually setose ascomal wall, clavate asci, and obovate to nearly clavate ascospores. The similar *T. variospora* has variably shaped, irregular ascospores 9-15 x 5-9µm in size and smooth ascomata.

Thielavia microspora Mouch., Bulletin Trimestriel de la Société Mycologique de France 89: 300 (1973)

Colonies grayish-brown, aerial mycelium composed of hyaline or brownish, septate, sometimes verrucose hyphae; ascomata spherical, non-ostiolate, 50-200µm in diameter, composed of brown, flattened cells (textura epidermoidea); asci obovate or ellipsoidal, evanescent, 8-spored, 15-25 x 10-15µm; ascospores broadly ellipsoidal, at one end with a rather distinct germ pore, at the other end often slightly apiculate, brown, when mature, 8-10 x 5.5-6.5µm; chlamydospores present.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with organic composted coconut fibre, goat manure, and potassium sulphate.

Known distribution: Egypt, Kuwait and currently also in Brazil.

NOTES: This species may be recognized by the smooth or tomentose ascomata, usually smaller ellipsoidal ascospores, and ellipsoidal conidia that are often present. The similar *T. terrestris* can be separated by its dark brown ascomal wall, usually ovate ascospores measuring 5.5-7 x 4-5.5µm, and clavate, obovate or pyriform conidia with truncate bases. *T. australiensis* characters include a light brown ascomal wall, 6-8 x 5-6µm ascospores that are often triangular in planar view, and conidia absent or not.

Key to the species of *Thielavia* in Brazil

1. Germ pore of the ascospores apical; ascomata smooth;
    ascospores varying in size 2
1. Germ pore of the ascospores subapical; ascomata smooth;
    ascospores 6-11 x 5–7µm .... *T. coactilis* Nicot

2. Wall of the ascomata brown 3
2. Wall of the ascomata hyaline or bright (old occasionally light brown)
    .... *T. basicola* Zopf

3. Ascospores fusiform or ellipsoidal, 13-18µm long
    .... *T. terricola* (J.C. Gilman & E.V. Abbott) C.W. Emmons
3. Ascospores ovate, clavate, ellipsoidal or irregular, usually shorter than 14µm 4

4. Ascospores 9-14 x 6-8µm, obovate, clavate or irregular .... *T. fragilis*
4. Ascospores usually smaller. 5
5. Ascospores 8-10 x 5-7µm, ellipsoidal.. .... *T. microspora*
5. Ascospores 5-8 x 5-6µm, obovate or pyriform .... *T. terrestris* (Apinis) Malloch & Cain

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The identity of *Lecanora carpathica* (*Lecanoraceae*) described from Slovakia

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Abstract—*Lecanora carpathica* Zahlbr., described on material from Malé Karpaty Mts. in Slovakia, is shown to be an illegitimate younger homonym of *Lecanora carpatica* Zschacke, which is a synonym of *Immersaria cupreoatra*. Zahlbruckner's material is shown to belong to *Lecanora allophana*.

Key words—nomenclature, Western Carpathians, lichens, diversity

Introduction

The Checklist of Lichens of Slovakia provides a chance to encounter the name *Lecanora carpathica* Zahlbr. in the recent lichenological literature. This binomial was included both in its first (Pišút et al. 1993) and the latest versions (Pišút et al. 1998). Zahlbruckner used this name for two sorediate specimens that he collected in the Malé Karpaty Mts., Slovakia, in 1913 (Zahlbruckner 1914).

In his detailed description of the species, Zahlbruckner noted that *L. carpathica* resembled *Lecanora hagenii* (Ach.) Ach. but differed in more robust, K+ yellow thallus covered with soralia, smaller apothecia and spores, and I+ violaceous-blue reaction of hymenium. The aim of the present study is to evaluate the taxonomy of *L. carpathica*.

Materials and methods

The study is based on Zahlbruckner's original material (W) comprising two specimens with identical label data, as well as the type of *Lecanora carpatica*

Zschacke (B). One of Zahlbruckner's original specimens was subjected to thin-layer chromatography following the methods of Culberson & Kristinsson (1970), Culberson (1972), and Culberson & Johnson (1982). Standard spot test reagents used were Pd, K.

> **Specimens examined**—*Lecanora carpathica* Zahlbr., Mag. Bot. Lapok 12: 295-296 (1914). Type: Ungarn, Pressburger Komitat: an den Ahornen unterhalb des Kammes des Rachsturm [=Vápenná Mt., eventually Roštún Mt.; alt. 752 m]. 9.913 [= Sept. 1913]. A. Zahlbruckner. (W 1913-10287, holotype; W without number, isotype – TLC T. Tønsberg 2645/18). – *Lecanora carpatica* Zschacke., Mag. Bot. Lapok 11: 301-302 (1912). Type: Ostkarpaten: Korongis, 13.7.1910 Zschacke (B 60 0131092, holotype). – Specimen used for comparison: *Lecanora allophana* f. *sorediata*, Norway: Buskerud, Ringerike, Norderhov Church, 60°08'N, 10°16'E (ED50), alt.: 100 m, on *Acer platanoides*, 1990.07.14, T. Tønsberg 13297 (BG-L36800).

Results and discussion

A short description of the type material of *Lecanora carpathica* Zahlbr.: Thallus crustose, grey-white to grey with rimose cracked surface, K+ yellow, sorediate; soralia pale, rounded and flat, K+ yellow. Apothecia rare, scattered over the thallus surface, lecanorine, 0.3–0.4 mm in diam.; thalline margin finely crenulate to entire, sessile; disc concave to flat, dark brown. Hypothecium colourless. Epihymenium red-brown, 80–90 µm high. Asci of *Lecanora*-type, 8-spored. Spores simple, colourless, ellipsoid, 7–8.5 × 3.5–5 µm.

Chemistry of thallus and apothecia: atranorin and two to three terpenoids as in *Lecanora allophana* Nyl.

The morphological, anatomical and chemical characteristics of Zahlbruckner's *L. carpathica* proved to be identical to those of *Lecanora allophana* Nyl. (including its sorediate form f. *sorediata*). Therefore the name *Lecanora carpathica* is reduced to synonymy with *Lecanora allophana*. *L. allophana* is characterized by containing the terpenoids denoted Lgr-1 and Lgr-2 (Brodo 1984). Morphologically similar species include *Lecanora impudens* Degel., which produces atranorin and the impudens unknowns (terpenoids) of Tønsberg (1992), and *L. expersa* Nyl., which contains atranorin and 1-2 unidentified fatty acids (Tønsberg 1992)

The substratum preferences of *L. carpathica* conform apparently well with those of *Lecanora allophana*. *Lecanora allophana* and also *L. impudens* are confined to nutrient rich bark of deciduous trees. Zahlbruckner's material was found on maples in a semi-natural, mixed, deciduous forest. *Lecanora farinaria* Borrer grows on acidic bark of deciduous trees (Tønsberg 1992). *Lecanora expersa* prefers wood and bark of conifers and is known from several European countries, including Slovakia (cf. Palice et al. 2006).

Nomenclature

Kondratyuk et al. (2003) listed *Lecanora carpathica* as potentially occurring in Romania, referring to Moruzi et al. (1967). However, this entry relates to *Lecanora carpatica*. Zschacke described *Lecanora* (sect. *Aspicilia*) *carpatica* from Romania, Rodnei Mts., where it grew on the Corongis Mt. [alt. 1987 m] on mica-schists (Zschacke 1912). In the protologue he mentioned the overall resemblance of this new species with *Lecanora cupreoatra* Nyl. [= *Immersaria cupreoatra* (Nyl.) Calat. & Rambold], from which it is distinguished by a more robust thallus and immersed, aggregated apothecia. Reexamination of the type of *L. carpatica* showed that it is in fact identical with *Immersaria cupreoatra* and accordingly we reduce it to synonymy with this species. The medulla shows a positive reaction with I, the apothecial margin is crypto-lecanorine, the hypothecium ± pigmented, the ascospores simple, the spore size [given by Zschacke (1912) as 15-17 × 6-7 µm] is 20 × 10 µm, and the ascospore wall is not amyloid (cf. Calatayud & Rambold 1998).

We regard the epithets „carpatica" and „carpathica" as being merely orthographic variants; both epithets refer to the area where the two taxa were collected, i.e., the Carpathian Mountains. Applying ICBN Art. 53.3 (McNeill et al. 2006), *Lecanora carpathica* Zahlbr. is a younger and illegitimate homonym of *L. carpatica* Zschacke. Further, *Lecanora carpathica* Zahlbr. is a synonym to *Lecanora allophana* and *Lecanora carpatica* Zschacke is a synonym of *Immersaria cupreoatra*.

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A new endophytic ascomycete from El Eden Ecological Reserve, Quintana Roo, Mexico

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Abstract—During a preliminary survey to report the biodiversity of endophytic fungi associated with leaves of some woody plants from El Eden Ecological Reserve in Mexico, a new fungus was isolated from *Callicarpa acuminata* leaves. Cultures of this fungus on PDA form a white floccose colony with a reddish-brown reverse and a mycelium that develops by 90° angle branches and intertwining of hyphae to form rope-like strands and coils. In addition, this endophytic fungus does not form reproductive structures. Based on morphological and DNA sequence analyses, this fungus is proposed to be a member of the *Pleosporaceae (Pleosporales)* and has not been previously described. *Edenia* gen. nov. is described and illustrated to accommodate *E. gomezpompae*.

Key words—angiospermous trees, fungal biodiversity, taxonomy, tropical forests, *Verbenaceae*

Introduction

Many plants develop endosymbiotic associations with microscopic fungi (endophytes) that colonize symptomlessly the living internal tissues of plants and function as mutualists or commensals (Stone et al. 2000). Other endophytic fungi are latent-infecting fungi; they are antagonistic pathogens capable of causing a minimal level of damage to the host when the latency period ends, thus causing characteristic disease symptoms (Sinclair & Cerkauskas 1997).

Endophytic fungi constitute a resource of undescribed biological diversity and a source of valuable genetic diversity with immediate practical biotechnological applications.

The number of fungal species described worldwide is around 80,060 (Kirk et al. 2001). Of these, only about 7,000 species are recorded from Mexico (Guzmán 1998) even though the country is considered the fourth most megadiverse of the world. Clearly little is known about the biodiversity and ecology of microfungi in Mexico, particularly endophytic fungi from tropical forests. El Eden Ecological Reserve is located in one of the more remote and particularly biodiverse biogeographical zones of Mexico, and the fungal endophytic associations with plant communities in El Eden are unknown. During the past two years a biodiversity project to study endophytic fungi associated with some trees of the secondary forest of El Eden was undertaken including an examination of their secondary bioactive products. In this study, we are describing a new endophytic ascomycete that does not form fruiting structures. Some endosymbiotic fungi do not form spores to aid the species in propagation and dissemination, which makes them difficult to identify morphologically (Bayman et al. 1998). To resolve this taxonomic problem, naming fungi based only on DNA sequence data is accepted by the present code of Botanical Nomenclature (Seifert et al. 1995, Taylor et al. 1999). We describe the new genus *Edenia* gen. nov. to accommodate the new species *Edenia gomezpompae* based on a combination of morphological and DNA sequence data.

Materials and methods

Study area

El Eden was founded as a private ecological reserve in 1990 by botanist Arturo Gómez-Pompa for educational and research activities. The Eden Ecological Reserve consists of 3,700 acres and is located in the State of Quintana Roo in the northeastern part of the Yucatán Peninsula of Mexico, at 21° 36', 20° 34' N and 87° 06', 87° 45' W. The region is covered by several ecosystems: 1) a medium semideciduous dry tropical forest dominated by the chicle tree *(Manilkara zapota)*, the chacá *(Bursera simaruba)*, tropical cedar *(Cedrela mexicana)*, and ramón *(Brosimum alicastrum)*, and this forest is the habitat of the spider monkey, jaguar, and many other notable vertebrates 2) low deciduous secondary forest mainly composed of *Leguminosae* and *Polygonaceae* trees, such as *Piscidia piscipula*, *Lysiloma bahamense*, *Acacia cedilloi*, and *Coccoloba* spp. 3) swamp forest 4) savanna 5) microcenotes and cenotes and 6) other wetlands dominated by cattail marsh or sawgrass. The reserve has a mean annual temperature of 24°C, an altitude of 5-10 m, and receives 140-2000 mm of precipitation annually (Gómez-Pompa et al. 2003).

Isolation, description and preservation

Asymptomatic, healthy leaves were collected from *Callicarpa acuminata* Humb. et al. *(Verbenaceae)* from the semideciduous dry tropical forest. This species was selected based on a previous chemical study by Anaya et al. (2003) in which they obtained 5 compounds with moderate biological activity against some phytopathogenic fungi and test plants. A strong surface sterilization protocol was applied to *C. acuminata* leaves (Rodrígues 1994). The complete, intact leaves were immersed in ethanol 75% (1 min), sodium hypochlorite 3.4% available chlorine (10 min), and ethanol 75% (1 min), and then were rinsed with sterilized distilled water and allowed to dry using a sterile absorbent paper. Each surface disinfected leaf was placed separately in a sterile Petri dish sealed with Parafilm and the dishes were transported to the Institute of Ecology at 5 °C and processed after 24 h.

The lamina was cut with the aid of a flame-sterilized scalpel and cork borer into 5 mm diam pieces, and then five discs were plated on potato dextrose agar (PDA: scrubbed and diced potatoes 200 g, dextrose 15 g, agar 20 g Difco, distilled water 1 L) (Hanlin & Ulloa 1988) supplemented with 4g/L streptomycin sulfate, and 5 mg/L Cyclosporine A (Dreyfuss 1986). The Petri dishes were incubated at 25°C under 24 h dark conditions. Each different isolate was transferred into a culture tube with PDA for further studies. Among the fungi recovered was an interesting isolate named C1c. This fungus was inoculated onto Petri dishes (9 cm diam) with PDA, V8 agar, corn meal agar (Difco), and water agar (agar 20 g Difco, distilled water 1L). We attempted to induce formation of reproductive structures by placing on the agar small pieces of sterilized bark and leaves from *C. acuminata*. Colony colors referred to with the letter M are from Kornerup &Wanscher (1978) color standard.

The morphology of this fungus was examined using light microscopy, fluorescent microscopy, and scanning electron microscopy (Goh & Hanlin 1994). Photomicrographs were taken with an Olympus BX60, Nikon Epifluorescence Eclipse E600 and Jeol JSM 5410-LV microscopes, respectively. For the fluorescent microscopy, fungal cell walls were stained with 0.1% w/v calcofluor (Sigma) according to Kuck et al. (1981). For preservation, a living culture of this new endophytic ascomycete was stored in liquid nitrogen vapor in cryoprotectant (10% (v/v) glycerol in distilled water), at -80 °C in 15% glycerol and at 4 °C in sterile distilled water. Dried cultures have been deposited in the J. H. Miller Mycological Herbarium (GAM) of the University of Georgia and in the fungal collection of Herbario Nacional de México (MEXU) of the UNAM under the accession numbers GAM 16175 and MEXU 25346, respectively.

Molecular procedures

Nuclear ribosomal DNA internal transcribed spacer (ITS) regions (ITS1-5.8S rDNA-ITS2) of strain C1c were amplified and sequenced using primers ITS5 and ITS4 and analyzed as previously described (Glenn et al. 1996). Nucleotide-nucleotide BLAST (megablast) search of the 555 bp amplicon sequence against the nr database of NCBI (www.ncbi.nlm.nih.gov) suggested strain C1c was a member of the *Pleosporaceae (Pleosporales)*. This was confirmed by performing BLAST searches using just the ITS1 (149 bp) and ITS2 (155 bp) sequences individually to avoid confounding results from the highly conserved 5.8S rDNA sequence.

Taxonomic description

Edenia M.C. González, Anaya, Glenn, Saucedo & Hanlin, **gen. nov.**
MycoBank #510872

> *__Coloniae__ in agaro decocto tuberorum (PDA), celeriter crescentes, primo albae, deinde pallide roseae, reversum rubro-brunnea vel brunneum, velutinae vel floccosae. __Mycelium__ sterilibus, ex asexual et sexual sporae vel sporiferous structura ignota. __Hyphae__ hyalinae, leptodermica, laeves, septatae, saepe ramificatione in angulis 90° plerumque, flexuosae, convolventes, fila funiformia et spiras formantes.*
>
> **Etymology:** Eden + L. suf. -ia, referring to the name of the ecological reserve where the fungus was found.

Colonies on PDA, fast growing, at first whitish, later becoming pinkish white, reverse reddish-brown to brown, velvety to floccose. **Mycelium** sterile, asexual and sexual spores and sporiferous structures unknown. **Hyphae** hyaline, thin-walled, smooth, septate, frequently developing by 90° angle branching, intertwining and forming rope-like strands and coils.

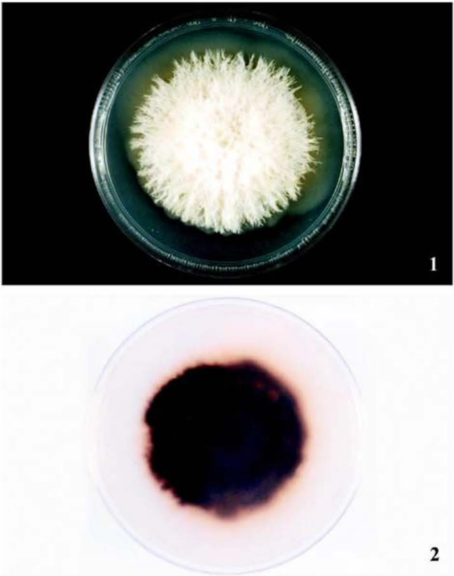
Teleomorph unknown. Sequence data suggest a relationship to *Pleosporaceae (Pleosporales).*

Edenia gomezpompae M.C. González, Anaya, Glenn, Saucedo & Hanlin,
anam. sp. nov. **Figs. 1-10**
MycoBank #510944, GenBank #EF565744

> *__Coloniae__ in agaro decocto tuberorum (PDA), celeriter crescentes 30-35 mm diametro in 7 diebus 25 °C, primo albae, deinde pallide roseae [M 7A2], reversum rubro-brunnea vel brunneum [M 9F], velutinae vel floccosae. __Mycelium__ sterilibus, ex asexual et sexual sporae vel sporiferous structura ignota. __Hyphae__ hyalinae, leptodermica, laeves vel undulatae, septatae, 0.6-2.5 µm diametro, saepe ramificatione in angulis 90° plerumque, flexuosae, convolventes, fila funiformia 4-11 µm diametro et spiras formantes 20 µm diametro.*
>
> *__Teleomorpha__ ignota. Data sequentia regionis ITS (ITS1-5.8S rDNA-ITS2) Edenia (GenBankea accederem # EF565744) affinitatem Pleosporaceae suggerunt.*
>
> **Etymology:** The epithet gomezpompae refers to the last name of Arturo Gómez-Pompa, an eminent plant ecologist, who has contributed notably to conservation and management of the biodiversity of Mexican tropical forests.

Colonies on PDA, fast growing, attaining 30-35 mm diam in 7 d at 25 °C, at first whitish, later becoming pinkish white [M 7A2], reverse reddish-brown to brown [M 9F8], velvety to floccose. **Mycelium** sterile, asexual and sexual spores and sporiferous structures unknown. **Hyphae** hyaline, thin-walled, smooth to undulate, septate, 0.6-2.5 µm diam, frequently developing by 90° angle branching, intertwining and forming rope-like strands 4-11 µm diam and coils 20 µm diam.

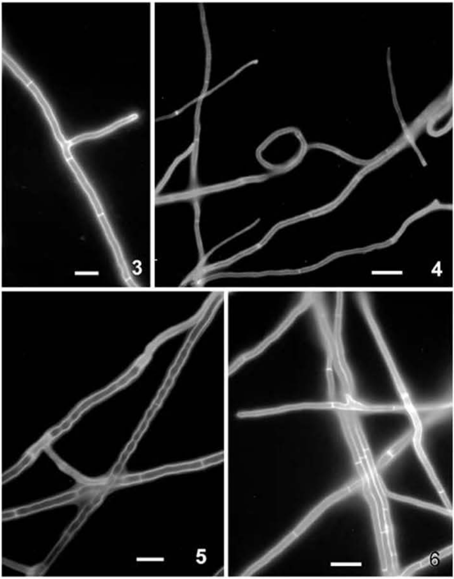
Teleomorph unknown. Sequence data of the ITS regions (ITS1-5.8S rDNA-ITS2) regions of *Edenia* (GenBank accession # EF565744) suggest a relationship to *Pleosporaceae.*



Figs. 1, 2. *Edenia gomezpompae*. 1. Colony appearance on PDA after 14 days at 25°C. 2. Typical reddish-brown pigmentation of culture reverse.

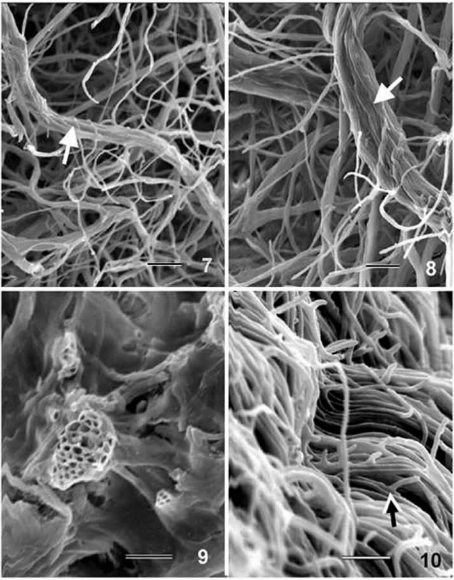
Habitat. Anamorphic ascomycete endophytic within living leaves of *Callicarpa acuminata*.

> **SPECIMENS EXAMINED — MEXICO. QUINTANA ROO: Isla Mujeres Municipality, EL** EDEN ECOLOGICAL RESERVE (87°11'W 21°13'N,), from leaves of *Callicarpa acuminata*, May 2002, *A Saucedo-García, AL Anaya*. (HOLOTYPE MEXU 25346, ISOTYPE GAM 16175).



Figs. 3-6. *Edenia gomezpompae*. 3. Smooth, septate hypha, with characteristic 90° branching developing. 4. Hyphae showing variation in width and coil formation. 5. Undulate hyphae and 90° branch. 6. Rope-like strands and intertwining hyphae.

Bars 3-6 = 10 µm. All photomicrographs taken with fluorescent microscopy.



Figs. 7-10. *Edenia gomezpompae*. 7-8. A rope-like strand that exhibits strong cohesion and intertwining of hyphae (arrows). 9. Transverse section of rope-like hyphal structures immersed in agar medium, showing lumina and hyphal-walls. 10. Surface colony showing the characteristic 90° branches vertically oriented (arrow). All photomicrographs taken with scanning electron microscopy. Bars 7-8 = 20µ, 9-10 = 10µm.

Discussion

Little is known of the biodiversity and ecology of endophytic fungi in the tropical forests, particularly for those fungi that do not produce reproductive structures in culture. Traditionally, these species are not identified even though they could be new taxa, important ecosystem members, and/or new sources of biotechnological applications. Classical methods of identifying fungi based on morphological characters of reproductive structures are of limited value in identifying fungal endophytes that do not produce these structures, although this is the key to conducting and communicating further basic or applied studies of fungi. At the present time, the use of solid molecular methods involving DNA sequence analysis permits us to identify fungi that might otherwise remain unidentified or undescribed.

Based on phenotypical and molecular analyses, the new endophytic fungus from *C. acuminata* in Mexico has a unique combination of characteristics, including the colony texture and color, hyphal morphology, and a chemical profile that includes three new naphthoquinone spiroketals that will be described elsewere. Analysis of the ITS sequence data (GenBank accession # EF565744) indicated the fungus belongs to the *Pleosporaceae (Pleosporales)*, but no GenBank accession was identified that would indicate either genus or species. The accessions having the greatest similarity were AY303602 and AY303611 from two isolates obtained from soil sheetings of the termite species *Macrotermes subhyalinus* and *Odontotermes nilensis* (each had 98% identity with strain C1c; E values = 0.0). Therefore, the new genus *Edenia* is proposed to accommodate the new species *E. gomezpompae.*

Edenia gomezpompae hyphae form 90° branches and intertwining rope-like hyphal strands and coils that look similar to those of *Muscodor albus,* another endophytic ascomycete that does not form reproductive structures (Worapong et al. 2001). The development of those structures suggests a possible adaptation to the endophytic habitat. Mycelial branching morphology is involved with the ability to colonize the host. Probably, the function of sparse 90° branched mycelium is host exploration, whereas the greater abundance of 45° branched mycelium is nutritional resources capture. Mycelial strands and cords formed by endophytic fungi probably have the same function as mycorrhizal fungi, gathering nutrients for the host. Development of hyphal coils can be related to the formation of resistant structures such sclerotia, early stages of development of fruiting bodies and other sporulating fungal structures (Moore et al. 2005, Müller & Krauss 2005). Observations of *E. gomezpompae* and *M. albus,* in planta are needed to compare their hyphal morphology.

The ecological functions of fungi as endophytes, pathogens, and saprobes in the tropics compared to other climates are likely to be similar in some regards, however, tropical ecosystems probably have a higher biological and functional diversity (Hyde 1997, Van Bael et al. 2005). For example, a particularly interesting fungal association in tropical forests is the fungus that lives in association with termites (Kendrick 1992). The fungus-infected termites build soil biogenic structures named soil runways (soil sheeting) made of soil particles cemented with salivary secretions covering the food source composed of dead plant pieces collected on the soil surface (Bagine 1984). *Macrotermes subhyalinus* and *Odontotermes nilensis (Macrotermitinae, Termitidae, Isoptera)*, two main species of fungus-growing termites from semi-arid savanna of Senegal, East African, build soil sheeting structures. When these litter-feeding termites use *Acacia holosericea* leaf litter, the inorganic nitrogen available to plants increased significantly (Deouda et al. 2004).

The ecosystem where *E. gomezpompae* was isolated includes the litter-feeding termite *Nasutitermes mexicanus* (*Nasutitermitinae, Termitidae, Isoptera*) and *Acacia cedilloi*, an ant-acacia described from the State of Quintana Roo, Mexico (Rico-Arce 1994). The implications of these ecosystem similarities are unknown; however, it does suggest a link between the mycobiota of termite sheetings and leaf fungal endophytes. Much remains to be discovered regarding the fungal community structure and dynamics of the endophytic fungi in the El Eden Ecological Reserve of Mexico.

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Changbai wood-rotting fungi 15. *Henningsomyces leptus* sp. nov.

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Abstract — *Henningsomyces leptus* (*Basidiomycota*) is described as a new species. It is similar to *H. candidus* in hyphal structure and basidiospores dimensions. However, the new species differs from *H. candidus* by its longer and thinner tubes, its hyphae at tube-mouth (dissepimental edge) that are shortly branched, and the branches that taper sharply towards the end.

Key words — China, taxonomy, wood-inhabiting fungi

Introduction

An investigation on wood-inhabiting fungi in the Changbaishan Nature Reserve of Jilin Province, northeastern China, was made during August of 2005, and two specimens with tubular fruiting bodies were collected on rotten wood of *Picea*. Morphological characters suggest these two collections belong to *Henningsomyces* Kuntze and represent a new species, *Henningsomyces leptus,* described in the present paper.

The microscopic routine used in the study was presented by Dai (2004). In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = quotient of the mean spore length and the mean spore width (L/W ratio). Sections were studied at magnification up to ×1000 by using a Nikon E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube.

Descriptions

Henningsomyces leptus Y.L. Wei & Y.C. Dai, **sp. nov.**

MycoBank MB 510860 Fig. 1

Carpophorum annuum, tubulum, 1.2–1.8 mm in longitudum, gregariae; facies pororum bubalinum; pori rotundi, 0.1–0.15 mm in diam; subiculum nullum. Systema hypharum monomiticum, hyphae generatoriae fibulatae vel sine fibulis, 2.9–4 µm in diam. Basidiosporae subglobosae, hyalinae, 4.8–6.1 × 4.2–5.2 µm.

Type — China. Jilin Province, Antu county, Changbaishan Nature Reserve, on rotten wood of *Picea*, 28.VIII.2005 *Dai 7071* (holotype in IFP, isotype in H).

Etymology. — *leptus* (latinised Gr.): referring to the thin and delicate tubes.

Fruitbody. — Basidiocarps annual, resupinate, up to 20 cm long and 8 cm wide, soft, watery, buff to pinkish buff when fresh, consisting of individual tubes that grow gregariously; becoming a little bit brittle, yellowish brown, and strongly cracked upon drying. Tubes cylindric, without subiculum, 1.2–1.8 mm in length, 0.1–0.15 mm in diam, tube wall thin; dissepiments incurved, entire.

Hyphal structure. — Hyphal system monomitic; generative hyphae bearing both clamp connections and simple septa, negative in both Melzer's reagent and Cotton Blue; tissues unchanged in KOH.

Tubes. — Tramal hyphae hyaline, thin- to slightly thick-walled, rarely branched, slightly flexuous, subparallel along the tubes, 2.9–4 µm in diam. Cystidia and cystidioles absent. Basidia clavate with four sterigmata and a basal clamp connection or simple septum, 15–21 × 5–7.5 µm. Hyphae at tube-mouth (dissepimental edge) shortly branched, and the branches tapering sharply towards their ends.

Spores. — Basidiospores subglobose, hyaline, thin-walled, smooth, bearing a large guttule, negative in Melzer's reagent and Cotton Blue, (4.5–)4.8–6.1(–6.3) × (3.8–)4.2–5.2(–5.4) µm, L=5.31 µm, W=4.67 µm, Q=1.1–1.17 (n=60/2).

Additional specimen (paratype) examined. — China. Jilin Province, Antu county, Changbaishan Nature Reserve, on rotten decorticated trunk of *Picea*, 25.VIII.2005 *Dai 6969* (IFP, H).

Discussion

Species of *Henningsomyces* and *Rectipilus* Agerer represent a group of cyphellaceous fungi characterized by a soft and tubular fruiting body. These two closely related genera are members of the *Schizophyllaceae*. The main difference between the two genera is the hyphal characteristic of the tube-mouth (dissepimental edge): hyphae are finely branched in *Henningsomyces*, but unbranched in *Rectipilus*.

Henningsomyces was established by Kuntze, and the key character of the genus is its basidiocarps consisting of soft cylindrical tubes that are separated but closely

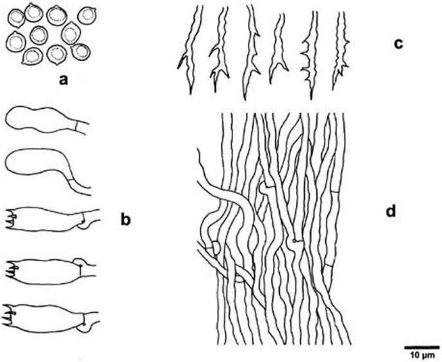

Fig. 1. Microscopic structures of *Henningsomyces leptus* Y.L. Wei & Y.C. Dai (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from tube-mouth (dissepiment edge). —d: Hyphae from tube.

packed. The length of tubes in *Henningsomyces* is 0.1–2 mm. The genus has a monomitic hyphal structure mostly with clamp connections and occasional simple septa. Basidiospores in the genus are subglobose, hyaline, and negative in Melzer's reagent and Cotton Blue. Seven species have been reported in the genus: *H. candidus* (Pers.) Kuntze, *H. minimus* (Cooke & W. Phillips) Kuntze, *H. mutabilis* Agerer, *H. patinaceus* Agerer, *H. puber* (Romell ex W.B. Cooke) D.A. Reid, *H. pulchellus* Sacc. and *H. separatus* Gilb. & Hemmes (Agerer 1973, Gilbertson et al. 2001).

According to the descriptions in Agerer (1973) and Breitenbach & Kränzlin (1986), both *H. candidus* and *H. leptus* share similar hyphal structure and dimensions of subglobose basidiospores. However, *Henningsomyces leptus* has longer and thinner tubes (1.2–1.8 mm in length and 0.1–0.15 mm in diam), and its basidiocarps are pinkish buff when fresh, while tubes are shorter and thicker in *H. candidus* (0.5–1 mm in length and 0.2–0.4 mm in diam) and basidiocarps of the species are white when fresh. In addition, hyphae from the tube-mouth (dissepimental edge) in *H. candidus* are dendrohyphidia-like (Fig.

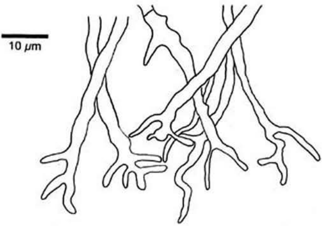

Fig. 2. Hyphae from tube-mouth (dissepiment edge) in *Henningsomyces candidus* (Pers.) Kuntze (drawn from *Penttilä 14911*).

2), in contrast to hyphae that are shortly branched with branches that taper sharply towards the end in the new species. Thus far, *Henningsomyces leptus* is known from rotten wood of *Picea* in northeastern China associated with a white rot.

Other specimens examined. — *Henningsomyces candidus*. Finland, Etelä-Häme, Tavastia australis, Lempäälä, Kahamäki, wood of *Betula*, 26.IX.2004 *Unto 3533* (H). Pohjois-Häme, Lieksa, Ruunavaara, fallen trunk of *Betula*, 7.X.2003 *Penttilä 14911* (H). Pohjois-Savo, Savonranta, Raatelampi, rotten wood of *Populus*, 8.IX.1990 *Kotiranta 8882* (H). China, Yunnan Province, Xianggelila County, Qianhu Mountain, on fallen trunk of *Abies*, 1.IX.2006 *Yuan 2094* (IFP).

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Notes on *Navisporus*: *N. terrestris* and *N. floccosus* from Brazil

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Abstract — *N. terrestris* is collected for the second time, and *N. floccosus* is reported as new to Brazil. A world key to the accepted species of *Navisporus* is provided.

Key words — *Polyporaceae*, taxonomy, neotropics

Introduction

Navisporus is a tropical genus proposed by Ryvarden (Ryvarden & Johansen 1980) based on a new combination on *Trametes floccosa* Bres. believed to have been collected in Tanzania (Ryvarden 1983). The genus can be distinguished by its cinnamon, pale brown to brown context, dimitic hyphal structure with unbranched, strongly dextrinoid skeletal hyphae and clamped generative hyphae, absence of gloeopleurous hyphae, and non-dextrinoid, navicular to fusiform basidiospores. *N. floccosus* was also reported from Kenya, Somalia, and South Africa (Ryvarden 1983), Venezuela (Ryvarden & Iturriaga 2001), and Mexico and Cuba (Torres-Torres et al. 2007).

N. sulcatus (Lloyd) Ryvarden, based on *Trametes sulcata* Lloyd from Brazil (Ryvarden 1983), has been reported from Brazil several times by Rajchenberg & Meijer (1990), Ryvarden & Meijer (2003), and Torres-Torres et al. (2007) as well as from the French Antilles (David & Rajchenberg 1985), USA (Gilbertson

& Ryvarden 1986), Paraguay (Popoff & Wright 1998), and Cuba (Decock & Herrera 2000).

The type specimen of *N. ortizii* S. Herrera & Bondartseva described from Cuba (Bondartseva & Herrera 1989) was re-examined by Decock & Herrera (2000), who found it to be conspecific with *Perenniporia martius* (Berk.) Ryvarden and so excluded from *Navisporus*.

Ryvarden (2001) described *N. africanus* Ryvarden from Zaire, and Ryvarden & Iturriaga (2003) described *N. perennis* Ryvarden & Iturr. from Venezuela. Recently, Gibertoni et al. (2004) described *N. terrestris*, the only *Navisporus* species with stipitate basidioma and also the only member of the genus to be found on soil. *N. terrestris*, previously known only from the type specimen, has now been collected for a second time from the Brazilian semi-arid region. Lastly, a recent collection of another *Navisporus* in the city of Recife is the first report of *N. floccosus* for Brazil.

The descriptions of *N. terrestris* and *N. floccosus* below are based on the recent Brazilian collections and will expand what is known about the genus in Brazil. They precede an amended world key to *Navisporus*.

Material and methods

This study was based on the type collection and specimens from the herbaria URM and HUEFS (Holmgren et al. 1990) respectively. Basidiomata were analysed macro- (shape, size, colours, hymenial surface) and micromorphologically (presence/absence and measures of sterile structures and basidiospores). Microscopical observations were made from slide preparations stained with 1% aqueous phloxine and 5% KOH and Melzer's reagent (Ryvarden 1991). Colour designation was according to Watling (1969).

Taxonomy

Descriptions

Navisporus terrestris Gibertoni & Ryvarden, Syn. Fung. 18: 48, 2004.

Basidiomata terrestrial, perennial, pileate, central to laterally stipitate, flat to slightly infundibuliform, cartilaginous to tough when dry; pilei circular, 1.5-5.5 diameter; stipe 0.4-1.5 cm in diameter, 05-1.0 cm high above the ground, up to 2.5 cm under the ground, cigar brown (16) to snuff brown (17). Abhymenial surface glabrous, slightly sulcate in radial zones, concentrically zonate, cinnamon (10), fulvous (12), bay (19) and/or buff (52). Margin incurved or not when dry. Hymenial surface poroid, fulvous (12) to snuff brown (17), pores round to angular, 2-3/mm, dissepiments slightly thick, tubes concolorous with the context, up to 0.3 cm thick. Context up to 0.3 cm thick, homogeneous, thin, fulvous (12) to buff (52). Hyphal structure dimitic; generative hyphae hyaline, thin-walled, clamped, 2.7 µm in diam.; skeletal hyphae pale brown, thick-walled, 3.6-13.5 µm in diam., dextrinoid. Basidia clavate, 18-20 x 8-9 µm (collapsed in type species). Basidiospores navicular to cylindrical, hyaline, smooth, slightly thick-walled, 9-12(-13) x 3.6-5.0 µm, IKI-.

Examined collections – BRAZIL. Rio Grande do Norte State: Baia Formosa Municipality, Reserva Particular do Patrimônio Natural (RPPN) Senador Antônio Farias, Mata Estrela (06°22'10"S, 35°00'28"W), 07.2001, on soil near to *Caesalpinia echinata*, col. Gibertoni (URM77580, holotype), isotype in O; Bahia State: Senhor do Bonfim Municipality, Serra da Maravilha, Fazenda do Élson (10°24'31"S, 40°12'54"W), 7.2005, on soil, col. Vasconcellos-Neto, Gusmão, A. Cardoso, D. Cardoso & Santos (HUEFS 105829).

Distribution: Known only from Brazil.

Remarks: *N. terrestris* had been so far only known from the type locality. The above description of this taxon is based on the type specimen and also on a recently collected specimen from the countryside of Bahia State, in an area of seasonally dry tropical forest known as Caatinga. This new collection, which was also found on soil, differs macroscopically only slightly from the type material by their flat, smaller and paler basidiomata.

Navisporus floccosus (Bres.) Ryvarden, Prelim. Polyp. Fl. E. Afr. (Oslo): 443, 1980.

Basidiomata annual, sessile, pileate, broadly attached, applanate to triquetrous, pilei up to 19 x 17 x 12 cm, tough to woody when dry, light-weighted. Abhymenial surface glabrous, azonate, slightly scrupose, clay buff (32) to buff (52). Margin obtuse. Hymenial surface poroid, hazel (27), clay buff (32) to buff (52), pores round to angular, 2-3/mm, dissepiments thin, tubes concolorous with the context, up to 1.5 cm thick. Context up to 6 cm thick, floccose to cottony, concentrically zonate, buff (52). Hyphal structure dimitic; generative hyphae hyaline, thin- to thick-walled, clamped, 2.5-7 µm in diam.; skeletal hyphae hyaline, thick-walled, 3-6 µm in diam., dextrinoid. Basidia clavate, 18 x 9 µm. Basidiospores navicular, cylindrical to sub-cylindrical, hyaline, smooth, slightly thick-walled, (10-)12-16(-18) x 5-6 µm, IKI-.

Examined collections – BRAZIL. Pernambuco State: Recife Municipality, Campus of the Universidade Federal de Pernambuco, parking of the Centro de Ciências da Saúde (08°03'00"S 34°56'30"W), 02.2004, on log of *Clitoria fairchildiana*, col. Gibertoni (URM78846).

Distribution: Known from Somalia, Kenya and South Africa (Ryvarden 1983), Venezuela (Ryvarden & Iturriaga 2001), Mexico and Cuba (Torres-Torres et al. 2007), and probably from Tanzania (Ryvarden 1983). It is recorded for the first time in Brazil.

Remarks: The basidiospores are slightly longer (viz., (10-)12-16(-18) x 5-6 µm) than those reported by Ryvarden (1983) (viz., 12-15 x 5-6 µm) and Torres-

Torres et al. (2007) (viz., 11.2-13.6 x 5.6-7.2) and are always hyaline, contrary to what was observed by Torres-Torres et al. (2007). These authors also reported the presence of a very thick and black crust, which was observed neither by us and nor by Ryvarden (1983). Zones not originally noted by Ryvarden (1983) were also observed in the context by Torres-Torres et al. (2007).

World key to the accepted species of *Navisporus*

1. Basidiomata stipitate, on soil .... *N. terrestris*
1'. Basidiomata sessile to effused reflexed, on dead wood 2

2. Context with a black zone, basidiospores 5-6 µm wide .... *N. sulcatus*
2'. Context without black zone, basidiospores 2-7.2 µm wide 3

3. Pores 1-2 per mm .... *N. africanus*
3'. Pores 7-8 per mm 4

4. Context up to 8 cm thick, basidiospores (10-)12-15(-18) µm long ...... *N. floccosus*
4'. Context up to 1 cm thick, basidiospores 7-8 µm long .... *N. perennis*

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Paecilomyces purpureus sp. nov., a new entomogenous fungal species from China

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Abstract — A new entomogenous fungus, *Paecilomyces purpureus* sp. nov. was isolated from larvae of *Lepidoptera* in Guiyang Forest Park, Guizhou, China. The new species is described and illustrated and its relationships to other allied species are briefly discussed. This fungus is characterized by having purple synnemata and small subglobose to fusiform conidia. Morphological characters and ITS-5.8S rDNA sequence comparisons strongly support the establishment of the fungus as a new species in the genus *Paecilomyces*.

Key words — mitosporic fungus, classification, molecular identification

Introduction

Some entomogenous members in the genus *Paecilomyces* always produce synnemata on infected host insects. These fungi are *P. cicadae* (Miq.) Samson, *P. coleopterorum* Samson & H.C. Evans, *P. farinosus* (Holmsk.) A.H.S. Br. & G. Sm., *P. ghanensis* Samson & H.C. Evans, *P. lilacinus* (Thom) Samson, *P. ramosus* Samson & H.C. Evans, *P. tenuipes* (Peck) Samson, *P. amoeneroseus* (Henn.) Samson, *P. cateniobliquus* Z.Q. Liang and *P. fumosoroseus* (Wise) A.H.S. Br. & G. Sm (Samson 1974, Liang 1981). Of these, *P. lilacinus* is the only one producing purple synnemata on infected insect (Samson & Evans 1977). In this paper, we report a new species *P. purpureus* in the genus *Paecilomyces*, which can infect insect and produce purple synnemata on host.

Materials and methods

Sample collection and strain isolation

Strain GZUIFR-GZSL-5 was isolated from an infected larva of Lepidoptera collected in the Forest Park of Guiyang City, Guizhou Province. The infected

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Table 1. Fungi used in the study with their GenBank accession numbers

Species	Gen Bank. No.
Akanthomyces pistillariiformis	AJ786552
Beauveria parasitica	BPU35035
Cordyceps brittlebankisoides	AJ309333
C. sinensis	DQ121377
Epichloe glyceriae	L07136
Hirsutella minnesotensis	DQ345591
H. thompsonii	AF293844
H. rhossiliensis	DQ345590
H sinensis	AJ309353
Metarhizium flavoviride	AF139852
Neotyphodum occultans	AB237154
Paecilomyces amoeneroseus	AY624168
P. cateniobliquus	AF368799
P. cicadae	AB085887
P. farinosus	AY618240
P. fumosoroseus	AB086629
P. javanicus	AB099944
P. lilacinus	AF368804
P. marquandii	AB099511
P. nostocoides	AB104884
P. tenuipes	AF368808
P. verticillutus	DQ836182
Polycephalomyces ramosus	AJ786598
Verticillium suchlasporium	AJ303053
Morchella esculenta	AJ543741
P. purpureus (this work)	EF640809

insect collected from the field was first washed several times using sterile water in order to remove soil and other debris. Several bits of endosclerotium were scraped from the washed infected insect and transferred to the Martin's plates. Cultures were incubated at 26°C until they formed colonies. The cultures of uncontaminated other microbes were transferred onto Sabouraud's slants and stored in the Institute of Fungus Resources, Guizhou University.

Strain identification

The strain studied was transplanted on Czapek agar. After incubation at 26°C for 14 days, the strain was identified based on colony characters, conidiogenous structures and biological characters according to Brown & Smith (1957) and Samson (1974).

DNA extraction

Taq enzyme and dNTP were bought from Shanghai Sangon, an Agarose Gel DNA Purification kit ver. 2.0 was bought from the TRKARA Company.

The strain GZUIFR-GZSL-5 used for the molecular identification was incubated on Czapek agar. The fresh sporulating cultures were used for DNA extraction according to Tigano-Milani et al. (1995), and then DNA extrcted was stored at -20°C.

PCR and ITS rDNA sequencing

The internal transcribed spacer (ITS) region including the 5.8S rDNA was amplified by polymerase chain reaction (PCR) using a pair of primers ITS5 (5'- GGT GAG AGA TTT CTG TGC -3') and ITS4 (5'-TCC TCC GCT TAT TGA TAT GC-3'). After a first denaturation step at 94 °C for 5 min, the amplification reaction was performedfor 35 cycles with denauration at 94°C for 40 s, annealing at 49°C for 40 s, and extension at 72°C for 1 min; followed by a final extension step at 72°C for 10 min. The PCR products were purified using the Agarose Gel DNA Purification kit version 2.0 (TAKARA Company) according to the manufacturer's protocol and were sequenced with the above primers at Beijing Sunbiotech Co. Ltd. The sequence of ITS1-5.8S-ITS2 rDNA region of strain GZUIFR-GZSL-5 was submitted to GenBank (accession number: EF640809).

Phylogenetic analysis

The reference sequences used are listed in Table 1. Multiple sequence alignment was carried out with Bioedit (Hall 1999) and Clustal X (Thompson et al. 1997) programs.

Cladistic analysis using the neighbor-joining method was performed with the MEGA version 3.1 (Kumar et al. 2004). Confidence values for individual branches were determined by bootstrap analysis (1000 replications).

Results and discussion

Taxonomy

Paecilomyces purpureus Z.Q. Liang & Y.F. Han **sp. nov.** **Fig. 1**

MycoBank MB 510901

25°C, vinaceae in centro; reserso purpurae. Synnemata vinacea. Mycelium ex hyphis, hyalinis, laevibus, 0.6-2.4 µm crassis compostum. Conidiophora erecta, hyaline, laevia, simplica, verticillis e 2-3 phialidibus. Phialides e basi cylindrica vel inflata in collum longum angustatae, aliquando graciles. Conidia monocellula, hyalinea, subglobosa, 1.5-1.8 µm diam vel fusiformia, facientia divergentes, catenas exsiccates.

Holotypus *GZUIFR-GZSL-5 isolatus e larvis lepidopterorum, regio Guiyang, Guizhou Provinica, Sina, VII, 2006, HAN Yanfeng et LIANG Zongqi.*

Fig. 1. A synnema on host (left) and the conidiogenous structures of *P. purpureus*. Bars = 10 µm

Colonies on Czapeck agar growing moderate, attaining a diam of 35 mm within 14 days at 25°C, with a basal felt and a velvety overgrowth of aerial mycelium, vinaceous in the centre; reverse purple. Purple synnemata producing after a longtime cultivation for 10 days. Vegetative hyphae septate, branched, smooth-walled, 0.6-2.4 µm wide. Phialides occurring directly on the aerial hyphae or giving rise to whorls of 2-3 phialides on the simple conidiophores, consisting of swollen basal portion, ellipsoidal or cylindrical, sometimes in awl, 9-21 × 0.6-1.8 µm, tapering abruptly into a long neck. Conidia 1-celled, smooth-walled, hyaline, subglobose to fusiform, 1.5-1.8 µm in diam.

Strain studied: GZUIFR-GZSL-5, isolated from an infected lepidopteron larva collected from the field of Forest Park, Guiyang City, Guizhou, China, by Han Yanfeng & Liang Zongqi in July, 2006.

In mitosporic fungi, in addition to *Paecilomyces*, the important entomogenous fungi forming synnemata on hosts are *Hirsutella* Pat., *Tilachlidium* Preuss, *Hymenostilbe* Petch, *Akanthomyces* Lebert, *Polycephalomyces* Kobayasi and *Stilbella* Lindau. The conidiogenous structures common to these stilbellaceous entomogenous fungi are the phialides that scatter to moderately crowd over the synnemata, arise mostly as lateral cells from the outer hyphae or less frequently

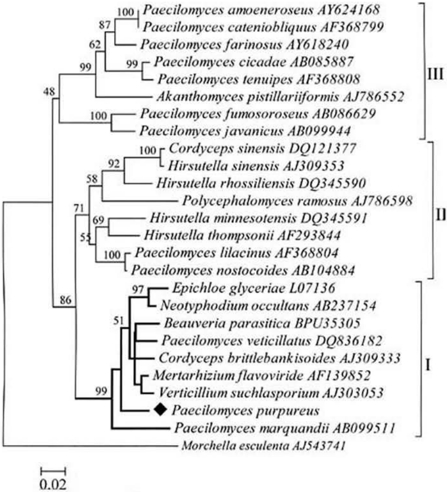

Fig.2. Phylogenetic tree, using the NJ method of representatives of *Paecilomyces* spp. and other allies inferred from analysis of the ITS1-5.8s-ITS2 rDNA region. Bootstrap values calculated from 1000 replicates are given at the branches.

as terminal cells at the ends of the hyphae. The lower portions of the phialides are narrow ovoid or ellipsoid, abruptly narrowed at the apices into slender long necks like those in *Hirsutella*. The conidia of *Hirsutella* do not form chains and are always covered by a persistent mucus layer. The phialides of the entomogenous species of *Polycephalomyces* are definitely awl-shaped and their conidia always aggregate in a globose droplet with a mucus layer. The genus *Hymenostilbe* is distinguished in several important aspects, for example, the phialides are not inflated at the base and are polyblastic at the upper part, and the conidia are single with little or no mucus. *Akanthomyces* has phialides with or without short necks and catenulate conidia with no mucus. The synnemata of *Tilachlidium* and *Polycephalomyces* are ramose and the cylindrical conidiogenous cells always terminate in the hyphae of the synnemata, in ball (Mains 1951, Samson et al. 1981). Although the fungus *P. purpureus* GZUIFR-GZSL-5 also produced definite synnemata on host in nature, the conidiogenous cells did not arise as lateral cells from the outer hyphae of synnamata, and the lower portions of the phialides are inflated, ovoid or ellipsoid, abruptly narrowed at the apices into slender, long necks. Conidia are single without a mucus layer and form dry, divergent long chains. By all appearances, *P. purpureus* GZUIFR-GZSL-5 did not related to these stilbellaceous entomogenous genera.

In the genus *Paecilomyces*, the following species, *P. cicadae*, *P. coleopterorum*, *P. farinosus*, *P. ghanensis*, *P. ramosus* and *P. tenuipes*, produce bright white- or pale yellow-coloured synnemata; *P. amoeneroseus*, *P. cateniobliquus* and *P. fumosoroseus* has red-hued synnemata. They differ distinctly from *P. purpureus* sp. nov. with violet-colored synnemata. Samson et al. (1977) reported that *P. lilacinus* formed purple-colored synnemata on an infected adult of stinkbug *Aethus* sp. Whoever, when *P. lilacinus* was cultivated on the artificial medium, its conidia were ellipsoidal to fusiform (2.5-3.0 × 2.0-2.2 µm), slightly roughened (Samson 1974), not like those of *P. purpureus*, which produced smaller (1.5-1.8 µm diam), smooth-walled, subglobose to fusiform conidia. The differences of morphological characters supported the establishment of *P. purpureus* as a new species in the genus *Paecilomyces*.

Molecular identification

A BLAST search through GenBank was performed by using the ITS sequence of *P. purpureus* as the query. The close matches with the maximal sequence identities of 90-94% included *Epichloe glyceriae* Schardl & Leuchtm, *Neotyphodium occultans* C. D. Moon et al., *Metarhizium flavoviride* W. Gams & Rozsypal, *Beauveria parasitica* (G.L. Barron) Arx, *Verticillium suchlasporium* W. Gams & Dackman, *Cordyceps brittlebankisoides* Z.Y. Liu et al. and *P. verticillatus* Z.Q. Liang et al. The ITS sequences of these species and other related species of *Paecilomyces* and other synnematous entomogenous fungi Were retrieved from GenBank for phylogenetic analysis. The fungus *Morchella esculenta* (L.) Pers. was included as an outgroup.

Three clades were recognized from the phylogenetic tree. The new species *P. purpureus* was grouped in Clade I together with the species having 90-94% nucleotide similarities with the new species in the ITS sequences (Fig. 2). In this clade, *Epichloe glyceriae* is a species in *Clavicipitaceae*, whose anamorph is a thallic endophyte *Neotyphodium* Glenn et al. in grass (Kirk et al. 2001, Ren & Gao 2004). *B. parasitica* is a synonym of *Tolypocladium parasiticum*

G.L. Barron which is an anamorph of an ascomycete in *Hypocreales*, which is characterised by forming *Paecilomyces*-like phialides and solitary conidia. *M. flavoviride* is an anamorph of the ascomycete in *Nectriaceae*, *Hypocreales*, and is characterized by forming cylindrical phialides with a very short neck. The teleomorph of *Verticillium suchlasporium* is also an ascomycete in *Hypocreales*. Members in the genus *Verticillium* are characterized by their conidiophores with verticillate ramification and awl phialides producing solitary conidia which always aggregating into heads. The fungus *P. purpureus* was differentiated from the closely related mitosporic species phylogenetically by forming a separating branch in Clade I.

With the exception of two species *P. lilacinus* and *P. nostocoides* M.T. Dunn forming purple colonies, Clade II is composed of four *Hirsutella* species and one *Polycephalomyces* species. Clade III is composed of the *Paecilomyces* species producing synnemata and *A. pistillariiformis*. The phylogenetic analysis supported the establishment of *P. purpureus* as a new species in genus *Paecilomyces*.

Acknowledgements

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MYCOTAXON

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The ecology and chorology of myxomycetes in Turkey

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Abstract—Myxomycete collections obtained between 1957–2006 from 18 floristic squares and 260 localities in Turkey represent 216 taxa from 39 genera and 12 families in the *Myxomycota*. The specimens were collected from 37 substrates including coniferous trees (six), broadleaf trees (30), and one highly decayed substrate that could not be identified. *Arcyria cinerea* was one widespread species found in 11 different floristic squares on 13 differing substrates. *Arcyria cinerea*, *A. incarnata*, *Fuligo septica*, and *Lycogala epidendrum* were reported from all elevations of the study area. A complete report is available at

http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon07-061.pdf

Key words—Turkish myxobiota, slime molds, biodiversity

Introduction

The area of study includes 260 localities within 18 explored (out of 29 total) floristic squares (Figure 1). This wide area encompasses three phytogeographic regions: Euro-Siberian, Irano-Turanian, and Mediterranean. These three regions have special ecological features and form a biologically diverse area. Turkish myxomycete collections are associated with 37 different substrates including coniferous and broadleaf trees, broadleaf trees, plus one that could not be determined due to the high degree of decay. Our complete report summarizes ecological data reported by previous papers on myxomycetes.

Materials and methods

We have compiled a list of all literature published on Turkish myxomycetes from Lohwag's first report on these organisms in 1957 to 2006. The studies include (in chronological order) Lohwag (1957, 1964), Sümer (1982), Harkönen & Uotila (1983), Gücin & Öner (1986), Härkönen (1988), Ergül (1993a, b, 1997, 1998), Ergül & Gücin (1993, 1994, 1995, 1996), Lado (1994), Gücin & Ergül (1995), Gün (1995), Ergül & Dülger (1998, 1999, 2000a, b, c, 2002a, b, c), Kaya & Demirel (1998), Yağız (1998, 2003), Ocak (2001), Yağız

Figure 1. Map of the study area in Turkey.

et al. (2002), Ocak & Hasenekoğlu (2003a, b, 2005), Pekşen & Karaca (2003), Yağız & Afyon (2003, 2005, 2006a, b), Oran (2003), Oran & Ergül (2004), Ergül & Oran (2005), Demirel (2005), Sesli & Denchev (2005), Ergül et al. (2005a, b), and Demirel et al. (2006), and Oran et al. (2006). These studies were conducted in the following 18 floristic squares: A1-9, B1-4, B8-9, and C1-3. Information is given on substrate types and localities. Type of taxon, epithet, reference, substrate type, elevation, and floristic square designation are presented for each collection. Taxa and author citations are listed according to Hernandez-Crespo & Lado (2006) and Kirk et al. (2004).

Results

Studies on Myxomycetes in Turkey between 1957 and 2006 cite 216 taxa representing 39 genera. The taxa are distributed among 12 families: *Arcyriaceae* 19, *Ceratiomyxaceae* 1, *Clastodermataceae* 2, *Cribrariaceae* 18, *Dianemataceae* 4, *Didymiaceae* 17, *Echinosteliaceae* 10, *Liceaceae* 20, *Physaraceae* 42, *Reticulariaceae* 9, *Stemonitidaceae* 46, and *Trichiaceae* 28. All taxa are listed in alphabetical order in the full checklist posted at http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon07-061.pdf

Discussion

Data pertaining to families, substrate, elevation, and floristic squares were summarized in graphs. The elevations were divided into five elevation groups. These are 1: Sea level-500 m, 2: 501-1000 m, 3: 1001-1500 m, 4: 1501-2000 m, and 5: 2001 m or over.

A total of 216 myxomycete taxa were identified from 260 localities (sites) within 18 floristic squares throughout Turkey. The squares with the greatest number of myxomycete taxa are A2 (131, with 64 sites), A4 (69, with 50 sites), A7 (67, with 31 sites) and C3 (66, with 25 sites). The data suggest that the number of taxa collected is directly proportional to the number of collection localities. This further suggests that additional sites would increase numbers of taxa in the floristic squares with the fewest numbers of taxa, such as A6 (1, from 1 sites) and B9 (2, from 1 sites).

Arcyria cinerea, collected from in 11 different floristic squares, is the most widespread species in Turkey. In abundance, this species is followed by *Physarum auriscalpium* (10 squares), *Arcyria pomiformis* (9 squares), *Echinostelium minutum*, *Badhamia macrocarpa* and *Perichaena corticalis* (8 squares each). These widespread taxa might well be more adaptable to different ecological conditions.

In Turkey, myxomycetes occur between sea level and 2000 meters or above but are most prevalent in the 0–500 m zone. Findings from this study show that the areas closer to sea level exhibit the highest level of biological diversity. At the same time, myxomycete diversity is higher in the 1001–1500 m zone than in adjacent zones below and above. In Turkey, broadleaf woods dominate the 501–1000 m zone and coniferous woods dominate the 1501–2000 m zone, while the two forest types are intermixed in the 1001–1500 m zone. The number of myxomycetes decreases rapidly above 2000 m where ecological factors are less favorable. *Arcyria cinerea*, *A. incarnata*, *Fuligo septica*, and *Lycogala epidendrum* were, however, recorded at all elevations of the study area.

Among 37 substrates cited, six are coniferous associated, 30 are broadleaf associated, and one substrate could not be determined due to its high degree of decay. The percentages of the myxomycete taxa from the most common substrates are: unidentified woody material 42.1%, *Pinus* spp. 38.8%, *Picea* sp. 23.1%, *Quercus* spp. 19.9%, *Fagus* spp. 12.5%, *Abies* spp. 11.6%, *Salix* spp. 11.1% and *Platanus* sp. 8.3%. These percentages indicate that the coniferous substrates are more suitable for the development of myxomycete taxa. The most widespread species, *Arcyria cinerea,* fruited on 13 different substrates with the also widespread *Arcyria pomiformis* found on 11 and *Macbrideola cornea* and *Perichaena corticalis* both found on 10 different substrates.

The posted checklist cites 216 taxa as compared to 888 myxomycetes worldwide (Stephenson 2006). The percentages of Turkish myxomycete taxa compared to total world taxa are *Arcyriaceae* 40%, *Ceratiomyxaceae* 25%, *Clastodermataceae* 40%, *Cribrariaceae* 41%, *Dianemataceae* 31%, *Didymiaceae* 10%, *Echinosteliaceae* 71%, *Liceaceae* 29%, *Physaraceae* 22%, *Reticulariaceae* 38%, *Stemonitidaceae* 22%, and *Trichiaceae* 27%. Overall, 24% of the world's known myxomycetes have been reported from Turkey and 39 of the world's 59 myxomycete genera are represented in Turkey. The following genera have not yet reported from Turkey: *Arcyriatella, Barbeyella, Brefeldia, Calonema, Colloderma, Cornuvia, Diacheopsis, Dictydiaethalium, Elaeomyxa, Kelleromyxa, Lepidoderma, Leptoderma, Listerella, Minaketella, Paradiachea, Physarella, Physarina, Prototrichia, Stemonaria*, and *Willkommlangea*.

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MYCOTAXON

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Taxonomic studies of *Alternaria* 10: two new species and a new record from China

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Abstract — Two new species, *Alternaria lactucicola* on *Lactuca sativa*, and *Alternaria rhaponticicola* on *Rhaponticum uniflorum*, are described. *Alternaria lactucicola* is characterized by producing filiform and 2-branched conidial beaks. *Alternaria rhaponticicola* produces filiform and unbranched conidial beaks. *Alternaria cirsinoxia* is reported as a new record from China. The three species were collected from *Asteraceae*.

Key words — *Cirsium*, hyphomycetes

Alternaria lactucicola X. Sun & T.Y. Zhang, sp.nov. Fig. 1

MYCOBANK MB 510926

Maculae ellipticae vel irregulares, saepissime confluentes, griseo-brunneae. Caespituli amphigeni. Conidiophora solitaria, flavor-brunnea, non ramosa, erecta vel curvata, septata, 62–117 × 5.5–8 μm. Conidia solitaria, brunnea, obclavata vel elliptica, 7-11 transverse septata, 1-4 longitudinaliter vel oblique septata, (distincte constricta) 64–97 × 17–25 μm (av. 79.1 × 21.6 μm) sine rostris. Rostra pallide brunnea vel subhyalina, septata, 56–131.5 × 2.5–5.5 μm (av. 98.4 × 3.6 μm), non ramosa vel ramosa.

Leaf spots elliptic or irregular, often confluent, grayish brown. Fruiting amphigenous. Conidiophores solitary, yellowish brown, unbranched, straight or curved, septate, 62–117 × 5.5–8 μm. Conidia solitary, brown, obclavate or ellipsoid, body with 7-11 transverse septa, 1-4 longitudinal or oblique septa, slightly constricted at septa, central 1-2 septa often slightly darker than others, 64–97 × 17–25 μm (av. 79.1 × 21.6 μm) excluding beaks. Seventy-five percent of conidia with unbranched beaks, and twenty-five percent of conidia with

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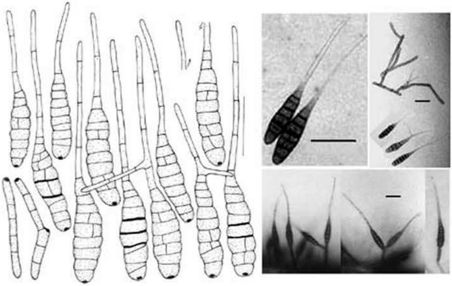

Fig.1 *Alternaria lactucicola*. Left: Conidia and conidiophores ex natural substrate. Upper right: Conidia and conidiophores ex culture on PCA; Lower right: Sporulation pattern (PCA 7d.). (All above ex HSAUP$_{03}$ 0122, Bars=50µm)

2-branched beaks, pale brown to subhyaline, septate, 56–131.5 × 2.5–5.5 µm (av. 98.4 × 3.6 µm).

Colonies on PCA circular, dark brown in central area, and yellowish brown in outer area; A pale yellow pigment often diffused into medium. Sporulation on PCA sparse, on PCA-filter paper, sporulation moderate, conidiophores solitary or fasciculate, branched, straight or curved. Conidia solitary, size and shape similar in both type specimen in nature and in PCA culture.

Holotype: on leaf spots of *Lactuca sativa* L., Yakeshi, Neimenggu Uygur Autonomous Region, 2003, Coll. T.Y.Zhang, HSAUP$_{03}$0122 (=ZTY$_{03}$0122). Dried ex-type cultures on PCA and PCA-filter paper in *HSAUP$_{03}$0122.*

About 32 *Alternaria* species have been described on or isolated from plants of *Asteraceae*. Simmons (1997) segregated them into a small-spored group, an *A. sonchi* group, an *A. helianthi* group, and a group whose conidia have filiform conidial beaks. The latter group includes 19 species. *Alternaria lactucicola* with 2-branched beaks can be easily distinguished from the other 12 species with unbranched-beaks. Among the remaining seven species with branched beaks, *A. lactucicola* differs from four species with 2–4 branched beaks (i.e., *A. carthami* S. Chowdhury, *A. cichorii* Nattrass, *A. cirsinoxia*, *A. scorzonerae* (Aderh.) Loer.) and *A. danida* E.G. Simmons, which has more complex secondary branches. *Alternaria lactucicola* resembles *A. protenta* E.G. Simmons and *A. calendulae*

Ondřej in having 2-branched beaks. However, *A. protenta* has larger (80–104 × 17.5–20.8 µm) conidial bodies than *A. lactucicola*, and *A. calendulae* has longer (136–160 × 2–4 µm) beaks and fewer (1–2) longitudinal septa than the new taxon.

In addition to the above species, some additional species of *Alternaria* have been reported on *Lactuca*. The principal characteristic of *A. lactucicola* is that the conidia are produced singly and have a simple or 2-branched conidial beaks. The other *Alternaria* species reported on *Lactuca*, — *A. alternata* (Fr.) Keissl., *A. lactucae* Meng Zhang & T.Y. Zhang, and *A. tenuissima* (Kunze) Wiltshire — all produce conidia that are often catenulate and have short beaks. The differences between *A. lactucicola* and *A. brassicae* (Berk.) Sacc. and *A. dauci* (J.G. Kühn) J.W. Groves & Skolko are also conspicuous: *A. brassicae* conidia have cylindrical beaks while those in *A. dauci* are longer (usually up to 2.5-5 times the overall length of the conidium) than those of the new taxon.

Alternaria rhaponticicola X. Sun & T.Y. Zhang, **sp. nov.** Fig. 2

MycoBank MB 510927

Maculae orbiculares, ellipticae vel irregulares, atro-brunneae, concentrice zonatae, 3-8mm diam. Caespituli imprimis epiphylli. Conidiophora solitaria, erecta, infuscata, recta vel curvata, ramosa vel non ramosa, septata, 21.5–94 × 4–5.5 µm. Conidia solitaria, obclavata, flavor-brunnea vel brunnea, 6-10 transverse septata, 3-6 longitudinaliter vel oblique septata, constricta, centro transverse septata incrassata, 43.5–67 × 15–25 µm (av.57.4 × 19.4µm), sine rostris. Rostra filiformia, infuscata vel subhyalina, septata, 106–273 × 2.5–3.5 µm (av. 185.9 × 2.7 µm).

Leaf spots circular, elliptic or irregular with concentric rings, dark brown, 3-8 mm in diam. Fruiting mainly epiphyllous. Conidiophores solitary, branched or unbranched, yellowish brown, straight or curved, 21.5–94 × 4 –5.5 µm. Conidia solitary, yellowish brown to brown, obclavate to long obclavate, body with 6-10 transverse septa, 3-6 longitudinal or oblique septa, slightly constricted at septa, central mainly septa often thicker and darker than others, some conidia with verrucose surface, 43.5–67 × 15–25 µm, (av. 57.4 × 19.4 µm) excluding beaks. Beaks filiform, pale brown to subhyaline, septate, 106–273 × 2.5–3.5 µm, (av. 185.9 × 2.7 µm).

Colonies on PCA effuse, pale gray to pale brown, with well-developed aerial mycelium, densely velvety, reverse black. Sporulation on PCA moderate, conidiophores solitary, branched or unbranched, straight or curved. Conidia solitary, obclavate or ellipsoid, conidium body in culture (av. 82.7 × 30.5 µm) is a little larger than that in field specimens. Conidial beaks subulate or filiform, filiform beaks 90–189 × 2.6–4.5 µm (av. 157.7 × 3.1 µm).

Holotype: on leaf spots of *Rhaponticum uniflorum* (L.) DC., Taian, Shandong Province, 2005, Coll. X. Sun, HSAUP$_{65}$3709 (=SX05-008). And dried ex-type cultures on PCA and PCA-filter paper in HSAUP$_{65}$3709.

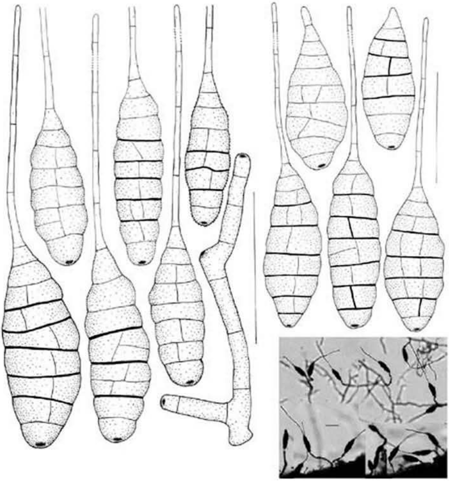

Fig.2 *Alternaria rhaponticicola*. Left: Conidia and conidiophores ex natural substrate. Upper right: conidia ex culture on PCA, Lower right: Sporulation pattern (PCA 7d.). (All above ex HSAUP$_{05}$3709, Bars=50μm)

Among the previously described *Alternaria* species, twelve have simple and unbranched beaks and occur on plants of *Asteraceae*. *A. helianthinficiens* E.G. Simmons, *A. argyroxiphii* E.G. Simmons & Aragaki, *A. steviae* Ishiba et al., *A. agerati* Sawada ex E.G. Simmons and *A. zinniae* M.B. Ellis all appear to produce secondary sporulation (and occasionally produce 2-conidium chains), while the conidia of *A. rhaponticicola* are solitary, without secondary sporulation either in nature or in culture on PCA. Conidium length range is similar in *A. rhaponticicola* and *A. readeri* (G. Winter) Neerg., but conidium body length/width ratios in *A. rhaponticicola* are ca. 3:1, while *A. readeri* has l/w ratios near

4-6:1. *A. rhaponticicola* is easily distinguished from the other species by its conidial size: the conidia of *A. tagetica* S.K. Shome & Mustafee, *A. blumeae* E.G. Simmons & Sontirat and *A. nattrassii* E.G. Simmons are longer (exceeding 100 µm), and the conidia of *A. enydrae* S.A. Khan & M. Kamal and *A. neergaardii* B.S. Mehrotra & Narain are smaller than those of the new taxon, additionally, the beaks of *A. neergaardii* are wider (3.5–7 µm). The differences between *A. rhaponticicola* and *A. carolinaeana* Unamuno are notable, in that the conidial beaks of the latter are sturdy and short.

Of all the above species, *Alternaria rhaponticicola* somewhat resembles *A. zinniae* and *A. neergaardii* in conidial size, however, the new taxon can be separated from the other two species, because the central mainly septa of A. *rhaponticicola* are often thicker and darker, and some mature conidia have subulate beaks.

Alternaria cirsinoxia E.G. Simmons & K. Mort., Mycotaxon 65: 72, 1997.

Specimen examined: HSAUP$_{03}$0177(=ZTY$_{03}$0177), on leaf spots of *Cirsium setosum* (Willd.) M. Bieb., Yichun, Heilongjiang Province, Coll. T.Y. Zhang, 2003.

This species is a new record for China.

Acknowledgments

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MYCOTAXON

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Two new records of the genus *Tulostoma* from Tunisia

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Abstract—Two species of the genus *Tulostoma* are newly recorded for the Tunisian mycobiota, namely, *T. amnicola* and *T. berteroanum*. They were described and illustrated based on their morphological characteristics.

Key words—gasteromycetes, taxonomy, *Tulostomataceae*

Introduction

The genus *Tulostoma* Pers. is a member of a large group of gasteromycetous fungi, which is characterized by having a more or less globose spore-sac with a small apical mouth upon a stem that rapidly expands after the onset of basidiospore maturation (Wright 1987, Sesli et al. 2000). Ripening of the spore-sac takes place hypogeously; when the expanding stipe exposes it above the soil surface, the gleba is already a powdery mass (Wright 1987). This genus prefers temperate, subtropical to tropical xeric habitats with scarce rainfall and with nutritionally poor soils such as the Mediterranean (Binyamini & Wright 1986, Moyersoen & Demoulin 1996), subarid to arid regions (Sesli et al. 2000, Baseia & Milanez 2002), coastal sand dunes (Andersson 1950, Asai 2004), and deserts (Long & Ahmad 1947, Wright 1987). Wright (1987) monographed the genus, for which Kirk et al. (2001) currently cite 79 species.

Tulostoma has been intensively studied in South Africa (Bottomley 1948), West Asia (Long & Ahmad 1947, Shvarcman & Filimonova 1970), Europe (Calonge

1998, Calonge & Demoulin 1975), North America (White 1901, Coker & Couch 1928), Latin America (Wright et al. 1972, Wright 1987) and Oceania (Cunningham, 1944). The *Tulostomataceae* are, however, poorly documented in North Africa, including Tunisia, an ecologically and mycologically diverse area located in the central part portion of this region (Alsheikh & Trappe 1983, Pacioni 1984). Although *T. brumale* Pers., *T. caespitosum* Trab., and *T. nanum* (Pat.) J. E. Wright were hitherto recorded for Tunisia (Patouillard 1892a, b, 1897, 1908; Wright 1987), this genus has not yet been comprehensively studied in this country.

During our floristic investigations of macromycetes of Tunisia undertaken during March to April of 2007, we collected two *Tulostoma* species that we identified as *T. amnicola* and *T. berteroanum*. These new records for Tunisian mycobiota are described here based on our morphological observations.

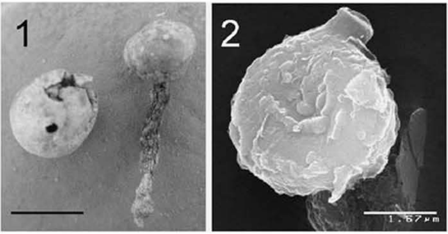
Materials and methods

The materials examined in this study are deposited in the Mycological Herbarium of the National Museum of Nature and Science, Tokyo, Japan (TNS). Macroscopic characters were described by observations on fresh or dried materials. For light microscopic (LM) observations, free-hand sections of gleba and peridium were mounted in water, 3% (w/v) KOH and 1% cotton-blue lactophenol on glass slides. Forty randomly selected basidiospores were measured under a light microscope at 1000x magnification. The surface features of basidiospores were also observed by scanning electron microscopy (SEM). For SEM, gleba were dusted onto specimen holders attached with double-sided adhesive tape and then coated with platinum-palladium with an E-1030 Ion Sputter Coater (Hitachi, Tokyo, Japan). They were examined with a S-4200 SEM (Hitachi, Tokyo, Japan) operating at 20.0 kv.

Taxonomy

Tulostoma amnicola Long & S. Ahmad, Farlowia 3: 243, 1947. (Figs. 1-2)

Spore-sac globose to subglobose, 8–10 mm in diameter, firmly attached to the stem. **Exoperidium** hyphal, forming a very granular sandy sheath at the base of the spore-sac, more or less deciduous. **Endoperidium** pale gray to ochraceous, not smooth. **Mouth** tubular, small, 0.5–1.0 mm in diameter, slightly prominent. **Socket** conspicuous, separated. **Gleba** pale brown to ochraceous, powdery at maturity. **Stem** ochreous to dark brown, uneven, 15–30 × 1–1.5 mm, slightly rugose, slightly bulbose at the base. **Capillitium** disjointable, 3.0–5.5 µm thick, septate, thick-walled, hyaline to subhyaline, the lumen scant or solid, septa hyaline and scarcely broadened. **Basidia** not observed. **Basidiospores**



Figs. 1-2. *Tulostoma amnicola*. **1:** Mature basidiomata. **2:** SEM image of basidiospore. *Bars* **1:** 10 mm, **2:** 1.67 µm (from TNS-F-15659).

subglobose, ovoid to slightly elliptical, 3.3–4.2 µm in diameter, apiculate, smooth under LM, but slightly verruculose under SEM, thick-walled, brown to ochreous, with a short pedicel up to 0.8–1.0 µm long.

Habitat: Solitary or caespitose on sandy soil, among grasses of arid steppe.

Known distribution: Tunisia (Kasserine, new record) and India.

Material examined: Tunisia, Gouvernorat de Kasserine, Near Fériana, along the road to Gafsa (N35.10.19, E08.07.09), March 28, 2007, T. Kasuya, TNS-F-15659.

Notes: The Tunisian specimen of *T. amnicola* is macro- and microscopically nearly identical with the original and earlier descriptions of this species (Long & Ahmad 1947, Wright 1987) with the exception of surface features of basidiospores. Wright (1987) described surface features of basidiospores of *T. amnicola* under SEM as appears with some uneven minute grains. In Tunisian material, we recognized the slightly verruculose surface of the basidiospores under SEM. However, all other morphological features were identical with those of *T. amnicola*.

Tulostoma amnicola is characterized by its hyphal exoperidium, tubular mouth and almost smooth, small (3.3–4.2 µm in diameter) basidiospores. There are three known species having hyphal exoperidium, tubular mouth, and almost smooth or minutely verruculose basidiospores: *T. brevistipitatum* B. Liu et al., *T. evanescens* Long & S. Ahmad, and *T. mohavei* Lloyd. Of these, *T. mohavei* is morphologically very similar to *T. amnicola*, but it differs in having larger (3.9–5.4 × 3.6–5.4 µm) basidiospores and unevenly thickened capillitial walls (Wright 1987). The other two species are clearly distinguished from *T. amnicola* by their short stem and larger basidiospores (5.4–6.1 × 4.3–5 µm in *T. brevistipitatum* and 4.6-6.1 µm in diameter in *T. evanescens*; Long & Ahmad 1947, Liu & Du 1978, Wright 1987). *Tulostoma fusipes* Har. & Pat. and *T. meristostoma* Long also have a hyphal exoperidium and almost smooth basidiospores. *T. fusipes,* however, differs from *T. amnicola* in having a circular mouth and inconspicuous socket and larger (4.6–6.1 µm diam) basidiospores (Wright 1987). *Tulostoma meristostoma* is distinguished from *T. amnicola* by its plane, irregularly lacerate, mouth and larger (4–4.7 µm diam) basidiospores (Long 1944, Wright 1987).

Tulostoma amnicola, originally described from India (Long & Ahmad 1947), was hitherto known only from the type locality and considered an endemic species (Wright 1987). However, it has probable wide distribution in arid habitats of temperate to subtropical areas of West Asia to North Africa.

Tulostoma berteroanum Lév., Ann. Sci. Nat. ser. 3, 5: 166, 1846. (Figs. 3-4)

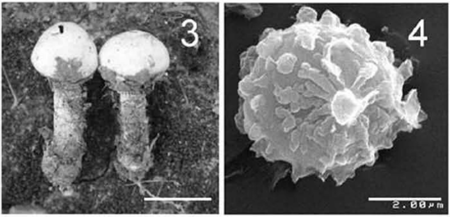
Spore-sac globose to subglobose, 5–10 mm in diameter, firmly attached to the stem. **Exoperidium** membranous, surface dark brown, within whitish, attached at the base of the spore-sac, more or less deciduous at maturity. **Endoperidium** slightly furfuraceous to smooth, ashy white to pale ochraceous. **Mouth** smooth to fimbriate, small to irregular, 0.5–2.0 mm in diameter, not prominent. **Socket** inconspicuous. **Gleba** pale brown to ochraceous, powdery at maturity. **Stem** brown to dark brown, uneven, 1–30 × 1.5–3.0 mm, rugose, slightly bulbose at the base. **Capillitium** disjointable, 2.0–4.5 µm thick, septate, branched, thick-walled, hyaline to pale yellow, septa hyaline and scarcely broadened. **Basidia** not observed. **Basidiospores** subglobose, ovoid to slightly elliptical, 3.3–4.5 µm in diameter, apiculate, minutely asperulate under LM, asperulate to verruculose under SEM, thick-walled, pale brown, with a short pedicel up to 0.5–1.0 µm long.

Habitat: Gregarious on subarid soil, among grasses of garigue.

Known distribution: Tunisia (Le Kef, new record) and South America (Bolivia, Brazil, Chile, Argentina).

MATERIAL EXAMINED: Tunisia, Gouvernorat de Le Kef, Near Nebeur (N36.36.07, E08.07.67), March 27, 2007, T. Kasuya, TNS-F-15660.

Notes: The Tunisian specimen of *T. berteroanum* is macro- and microscopically nearly identical with the earlier descriptions of this species (Wright 1977, 1987) with the exception of mouth features. Wright (1977, 1987) described mouth of this species as mammose to scutellate when young. We could not recognize a mammose to scutellate mouth in the Tunisian material, which was those are completely mature specimen. However, all other morphological features were identical with those of *T. berteroanum.*



Figs. 3-4. *Tulostoma berteroanum*. 3: Mature basidiomata. 4: SEM image of basidiospore. *Bars* 3: 10 mm, 4: 2 µm (from TNS-F-15660).

Tulostoma berteroanum was identified based on its membranous exoperidium, fimbriate mature mouth and slightly asperulate to verruculose, small (3.3–4.5 µm diam) basidiospores. This species is often confused with *T. cyclophorum* Lloyd (Wright 1977). *T. cyclophorum*, however, is distinguished by its tough, tenaciously covering endoperidium when young and almost reticulate, numerous anastomosed crests on the basidiospore surfaces. There are five known species having membranous exoperidium and minutely asperulate to verruculose basidiospores: *T. macalpinianum* Lloyd, *T. gracilipes* J.E. Wright, *T. parvissimum* Long & S. Ahmad, *T. pulchellum* Sacc., and *T. subfuscum* V.S. White. Of these, *T. gracilipes* is morphologically very similar to *T. berteroanum* but differs in having a fibrillose to fimbriate mouth and slightly larger (3.9–5.1 µm diam, Wright 1987) basidiospores. *Tulostoma parvissimum* and *T. macalpinianum* are clearly distinguished from *T. berteroanum* by their tubular or fibrillose mouths and larger basidiospores (5-6.8 µm diam in *T. macalpinianum*; 4.3–5.4 µm diam in *T. parvissimum*; Long 1946, Wright 1987). *Tulostoma pulchellum* and *T. subfuscum* also differ from *T. berteroanum* in their more densely verruculose, larger basidiospores (4.5–6 µm diam in *T. pulchellum*; 4–5.7 µm diam in *T. subfuscum*; White 1901, Binyamini & Wright 1986, Wright 1987).

Tulostoma berteroanum, originally described from Chile (Léveillé 1846), was hitherto known only from South America (Wright 1977, 1987; Baseia & Milanez 2002). However, it has probable wide distribution in the subarid habitats of temperate to subtropical areas of the world.

Acknowledgments

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MYCOTAXON

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New species of *Bartalinia* and *Septoriella* from the Altai Mountains (Russia)

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Abstract – *Bartalinia goniolimonis* sp. nov. (on leaf spots of *Goniolimon speciosum*) and *Septoriella viciae* sp. nov. (on leaf spots of *Vicia unijuga*), from montane forests and steppes of the Altai Mountains of Russia, are described, illustrated, discussed and compared with similar species of anamorphic fungi producing appendaged conidia on the same and closely-related host plants. New keys to the genera of *Bartalinia* and *Septoriella* are provided.

Key words – cellular appendages, coelomycetous fungi, systematics, West Siberia

Introduction

Siberia is characterized by a high level of biodiversity: the fungi associated with its plants are therefore likely to be similarly varied. Microfungi of the region are still, however, very inadequately studied. For one of the most interesting areas, the Altai Mountains (West Siberia, Russia), about 215 species of plant pathogenic and saprotrophic conidial fungi have been recorded to date. Recent field work there revealed a number of interesting leaf-inhabiting coelomycetes with appendage-bearing conidia. In the present work, two of these, which appear to be new, are described, illustrated, discussed and compared with similar species on the same and closely-related host plants.

Materials and methods

During a field trip in late August 2000 to the northern part of the Altai Mountains (Republic of Altai, West Siberia, Russia), leaves of *Goniolimon speciosum* (L.) Boiss. (*Limoniaceae* Ser., a segregate of the *Plumbaginaceae*

Juss.) and *Vicia unijuga* A. Braun (*Leguminosae* Juss.) bearing leaf spots were collected from natural sites in the districts of Chemal and Shebalino, along the rivers of Katun' and Sema. Collections were examined with an MBI-3 stereo light microscope with Carl Zeiss oculars and lens, which was also used to produce habit drawings of the fungi observed on the leaf spots. Photographs of their microscopic features were taken with a Nikon Coolpix 4300 digital camera attached to an Olympus BH-2 compound microscope. Specimens were deposited in the Mycological Reference Collection (forming part of KW) in the Department of Mycology, M.G. Kholodny Institute of Botany, Ukraine.

Taxonomic description

Two anamorphic fungi with appendage-bearing conidia were collected on leaves of *Goniolimon speciosum* and *Vicia unijuga* respectively. Their study resulted in the recognition of two new taxa. They are formally described and typified below.

Bartalinia goniolimonis Andrian. & Minter, **sp. nov.**

MycoBank MB510586 **Figs. 1-2**

Fungus ad Bartaliniam, genus coelomycetum, pertinens, speciebus ab aliis differt non solum obclavata ob conidia sed etiam quod conidio in quoque (licet septa quattuor habeat) cellulam medianam inferiorem et cellulis superioribus et cellula inferiori valde grandiorem habet. Conidiomata stromatica, 100–115 × 80–90 µm, unilocularia, et sin paraphysibus; cellulae conidiogenae sin colore, ampulliformes vel cylindricae, (2.5–) 3.0–5.5 × 3.0–4.0 µm, holoblasticae, nonnullae unica proliferatione percurrenti et enteroblastica vix visibili indutae; conidia plerumque pallide olivacea, (15–) 18–20 (–22) × (3.2–) 3.5–4.0 (–4.5) µm, oblonga vel fusiformia ad elliptica, vel plusminusve obclavata, leviter 2- ad 4-septata et quoque in septo constricta, cum cellula secunda (licet septa quattuor habeat conidium et ex basi ad apicem enumerantur cellulae) longissima, et apicali cum cellula paene sin colore; appendiculus apicalis ipsa ex cellula exoriens sin septo intercalario nec colore, tribus indutus ramis unico ex loco exorientibus, (5–) 10–13 × 0.5–1.0 µm; appendiculus basalis sin ramis, lateralis, 3–5 × 0.5–0.8 µm.

Holotypus: in foliorum vivorum Goniolimonis speciosi maculis, Asia, Russia, Respublica Altai, Paroecia Chemal, ad ripas Katuni fluminis, in declinationibus stipae; 30-08-2000, ***KW 33092****.*

Habit on living leaves, with lesions developing on leaves of all ages. *Leaf spots* orbicular or irregular, tending to be wide and covering about half the leaf, 5–15 mm across in the narrowest part, grayish to dark brown, dry, with the centre bearing conidiomata, without a distinct margin; delimitation of the spots from intact leaf tissues formed by a broad, poorly defined pale brown margin with a pinkish halo up to 2–3 mm wide, sometimes followed by a 1–2 mm wide yellowish halo; lesions covering leaf surface between veins, delimited by the central vein. *Conidiomata* stromatic, on both sides of the leaf, discrete, aggregated in the centre of the spot; circular when viewed from above, covered by leaf epidermal

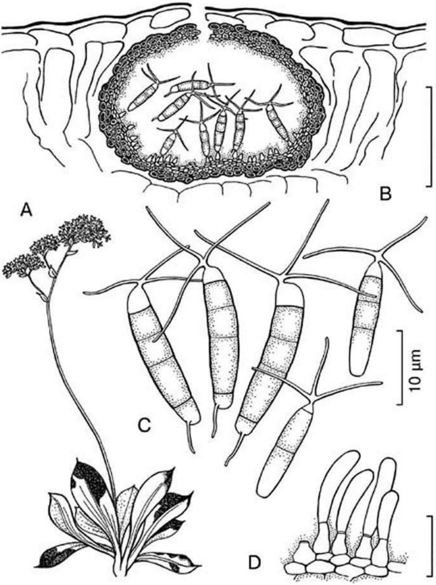

Figure 1. ***Bartalinia goniolimonis***
A. Infected *Goniolimon speciosum*, leaves with lesions. B. Vertical cross section of conidioma.
C. Conidia. D. Conidiogenous cells with forming conidia.

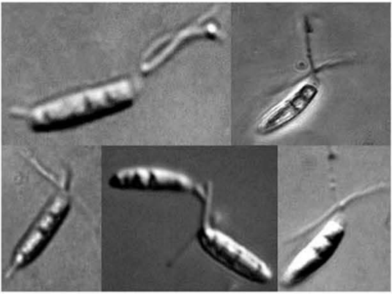

Figure 2. *Bartalinia goniolimonis*
Photomicrographs of conidia (x 1000).

tissue, semi-immersed or immersed, erumpent, brown, subglobose or flat-subglobose, opening by a split in the centre of the apical wall, 100–115 × 80–90 µm, unilocular, without paraphyses, with a wall 10–12 µm thick, composed of 3–5 layers of small *textura angularis* and *textura globulosa* being pale brown internally and more coloured in the outer parts. *Conidiophores* composed only of conidiogenous cells. *Conidiogenous cells* colourless, ampulliform or cylindric to flat-globose, (2.5–) 3.0–5.5 × 3.0–4.0 µm, discrete, smooth, arising from cells lining the inner layer of the conidiomatal cavity, holoblastic, some with one obscure percurrent enteroblastic proliferation, conidial scars inconspicuous, unthickened. *Conidia* colourless to light olivaceous, apical cell and all appendages almost colourless, usually in a light olive-coloured matrix, (15–) 18–20 (–22) × (3.2–) 3.5–4.0 (–4.5) µm, straight or slightly curved, oblong-elliptical to fusiform-elliptical or cylindrical, sometimes tending to be obclavate, barely tapered and rounded at the apex, truncate and rounded at the base, without guttules, smooth, usually very delicately 2- to 4-septate, more often unequally 4-septate, continuous or slightly constricted at the septa; when five-celled, with the two apical cells and the basal cell shorter than the longest basal median cell; bearing an apical colourless appendage with three branches which arise from 1 point, not separated from the cell by a septum, attenuated, flexuous, (5–) 10–13 × 0.5–1.0 µm; basal appendage unbranched, lateral, offset, fine, 3–5 × 0.5–0.8 µm.

Etymology: from the name of the host plant genus *Goniolimon* Boiss.

Disease: leaf spot, brown leaf blotch. Causing leaf drying.

Hosts: *Goniolimon speciosum* (*Limoniaceae*) [Type host].

Geographical distribution: ASIA – RUSSIA; Republic of Altai; Chemal district; along the river of Katun', steppe slopes, 30 August 2000 [Type, **KW 33092**].

The other coelomycetous fungus collected in Altai has minute gelatinous appendages at both ends of the conidia. The appearance of this fungus is described in the following paragraph.

Septoriella viciae Andrian. & Minter, **sp. nov.**

MYCOBANK MB510587 Fig. 3

Fungus ad Septoriellam, genus coelomycetum, pertinens, speciebus ab aliis differt non solum ob macroconidia filiformia et angustiora sed etiam angustiora ob microconidia. Conidiomata pycnidialia, brunnea, globosa vel subglobosa, 134–180 (–200) µm diam., unilocularia, tenuibus cum parietibus; paries ipse 10–13 µm crassus; ostiolum circulare, centrale, 30–35 µm diam., parietis in regione crassiori; cellulae conidiogenae duabus cum formis, vel "macro" vel "micro", et conidia duabus in formis producentes; cellulae macroconidiogenae sin colore, breve-cylindricae ad ampulliformes, (3.5–) 4.0–4.5 × 2.5–3.0 µm, holoblasticae, percurrentibus saepius cum proliferationibus enteroblasticis quorum in quibusque novum parietum aedificat apex novus, et conidia septo anteriori quaeque tanto delimitantur ut generatur crassitudo minuta cellulae conidiogenae cuiusque in apice; macroconidia pallide-olivea vel pallide brunnea, (33–) 48–55 (–60) × 2.0–2.5 µm, saepius ratione longitudinis amplitudinis respectu plusminusve 21.7:1, recta vel flexuosa, paulum crassiora regione in apicali, 3- ad 5-septata, appendiculis gelatinosis modo pilleorum extracellularibus ambobus in terminis induta; appendiculi ipsi postea cupulati, 1.0–3.0 µm; cellulae microconidiogenae sin colore, pyriformes ad subglobosae, 3.0–3.5 × 2.5–3.0 µm; microconidia sin colore, (2.5–) 3.0–4.5 × 1.5–1.8 µm, aseptata, ovoidea vel elliptica, nonnumquam inaequilateralia.

*Holotypus: in foliorum vivorum Viciae unijugae maculis, Asia, Russia, Respublica Altai, Paroecia Shebalino, ab vico Nizhnie Kumaly haud procul, in declinationibus stipae; 29-08-2000, **KW 33089**.*

Habit on living and fading leaves, during the second part of growing season. *Leaf spots* appearing on living leaves as pale greenish yellow spots with indistinct fuzzy margins; later lesions turning into yellow or pale brownish-yellow areas, on the leaf edges or in the central part of the leaf along the principal vein, numerous, irregular, 3–4 mm across and 3–8 mm long in their largest dimension, with fuzzy margins; developing lesions resulting in irregular dead patches at the edges, sometimes with narrow, 0.5 mm, distinct, sometimes elevated, brown margin, limited by principal leaf veins. *Conidiomata* pycnidial, on both leaf surfaces, numerous, separate, immersed in host tissue then semi-immersed, brown, globose or subglobose, 134–180 (–200) µm diam., in external appearance circular when viewed from above; at first entirely covered by a thin layer of leaf epidermis, most often near the surface, later protruding and gradually breaking degraded and collapsed epidermal cells or moving leaf stomata apart; the irregular shape of conidiomata sometimes depending on pressure of surrounding leaf tissues; unilocular, thin-walled, with a wall 10–13 µm thick, composed of 2–3 layers of *textura angularis*, loose, varying from brown in the outer parts to colourless internally, upper part composed of dark brown, thick-walled *textura angularis*. *Ostiole* circular, central, 30–35 µm diam., surrounded by blackish brown, thick-walled cells, forming a thickening of the walls. *Conidiophores* absent. *Conidiogenous cells* and *conidia* of two types, distinguished here by the prefixes "macro" and "micro". *Macroconidiogenous cells* colourless, short cylindrical and ampulliform, (3.5–) 4.0–4.5 × 2.5–3.0 µm, discrete or integrated, smooth, arising from the smaller-cell inner layer of the conidiomatal cavity, holoblastic, usually with percurrent enteroblastic proliferations associated with replacement apical wall-building, with secession of each conidium at a progressively higher level, with minute periclinal thickening, sometimes with a indistinct channel. *Macroconidia* light olive or pale brown, (33–) 48–55 (–60) × 2.0–2.5 µm, mean conidia length/width ratio 21.7:1, smooth, in an olivaceous matrix, straight to flexuous or irregularly bent, filiform to fine-cylindrical, obtuse and rounded at the apex, rounded and slightly tapered at the base, guttulate, minutely broader in the upper third, with from 3 to 5 distinct septa, not constricted at the septa, thin-walled, smooth, bearing gelatinous, polar, cap-like extracellular appendages, later cupulate in form, 1.0–3.0 µm. *Microconidiogenous cells* colourless, pyriform to subglobose, 3.0–3.5 × 2.5–3.0 µm, smooth, discrete, indeterminate, arising from cells of the upper part of the conidiomatal cavity, holoblastic. *Microconidia* colourless, (2.5–) 3.0–4.5 × 1.5–1.8 µm, straight or slightly curved, ovoid or elliptical, sometimes unequal-sided, gradually tapered and rounded at the apex, obtuse at the base; thin-walled, smooth, aseptate, guttulate.

Etymology: from the name of the host plant genus *Vicia* L.

Disease: leaf spot, yellowish blight.

Host: *Vicia unijuga* (*Leguminosae*) [Type host].

Geographical distribution: ASIA – RUSSIA; Republic of Altai; Shebalino district; environs of Nizhnie Kumaly village, along the river of Sema, steppe slopes, 29 August 2000 [Type, **KW 33089**].

Discussion

Bartalinia goniolimonis* on *Goniolimon speciosum

No published records were found of leaf-inhabiting coelomycete species with septate, appendage-bearing conidia occurring on members of the genus *Goniolimon*. Two such species of *Pestalotia staticis* Mosk. and *Vasudevella statices*

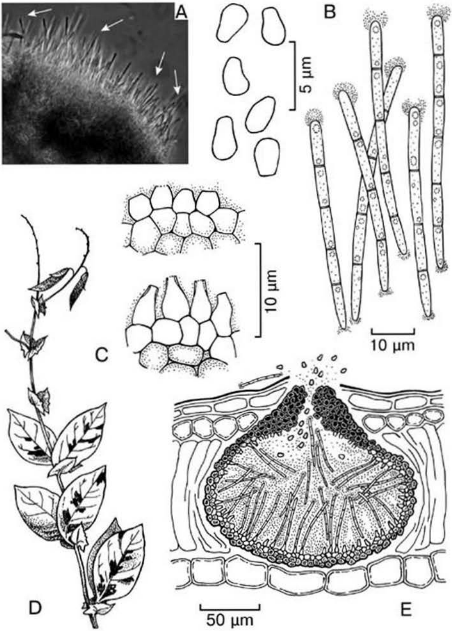

Figure 3. *Septoriella viciae*

(Melnik) Nag Raj (basionym *Kellermania statices* Melnik) have, however, been recorded from other representatives of the *Limoniaceae*, the family in which *Goniolimon* is placed. The salient points distinguishing *B. goniolimonis* from those two species are presented in Table 1.

Table 1. Comparison of conidial morphological characters between coelomycetes producing appendage-bearing conidia and known from leaves of *Limoniaceae* species

COELOMYCETE SPECIES	CONIDIA			APPENDAGES	
	size (μm)	form	number of septa	APICAL branching: size (μm)	BASAL branching: size (μm)
Pestalotia staticis	15–30 × 7–12	fusiform or clavate	4	2–4 (3); 26–33	–
Vasudevella statices	17–27 × 2.5–3.5	fusiform to naviculate	2	single; 5–9	–
B. goniolimonis	15–22 × 3.2–4.5	fusiform-elliptical or cylindrical to subclavate	2–4	3, 5–13	single; 3–5

Pestalotia staticis was recorded on *Limonium gmelinii* (Willd.) Kuntze (syn. *Statice limonium* L.) from Kherson region of Ukraine (Moskovetz 1933). It was neither examined nor reappraised by Nag Raj (1993). We have been unable to find any type material or other reference collections. *Pestalotia staticis* was described in the protologue (Moskovetz 1933) as having unequally coloured, 4-septate conidia, 15–30 × 7–12 μm, with brown second and third cells, colourless apical and basal cells, bearing 3, or sometimes 2 or 4 apical appendages 26–33 μm long. According to Vassiljevsky & Karakulin (1950) appendages can be of uniform or variable length. No information about any basal appendage was provided. Based on those reports, *P. staticis* has much wider and longer conidia and longer apical appendages of variable number than *B. goniolimonis*. It also has a different type of conidial septation, and no evidence of a basal appendage.

Vasudevella statices was described on *Limonium* sp. (syn. *Statice* L.) from Krasnoyarsk, Russia (Melnik 1971). Its conidia differ from *B. goniolimonis* in colour, septation and type of appendages. *Vasudevella statices* has colourless, fusiform, 2-septate conidia with unequally arranged septa, 17–27 × 2.5–3.5 μm, each with a single apical unbranched appendage, 5–9 μm long, and colourless paraphysoids inside pycnidial conidiomata (Melnik 1971). The fungus was studied, well-illustrated and redisposed to *Vasudevella* by Nag Raj (1993).

The fungus on *G. speciosum* is different from both *P. staticis* and *V. statices*, and clearly congeneric with neither. The structure and size of its conidia are

Table 2. Conidial morphological characters: comparison of some *Bartalinia* species with *B. goniolimonis*

SPECIES OF *BARTALINIA*	CONIDIA			APPENDAGES		
				APICAL		BASAL
	size (µm)	form	number of septa	length (µm)	branching	length (µm)
B. ananatis	18–21 × 4	sub-cylindrical to fusiform	4	11–13	3	2.0–5.5
B. dracaenae	16.5–20 × 3	fusiform, sub-cylindrical	4	13–17	(2–)3	+
B. lateripes	16.5–21 × 3.5–4.5	cylindrical to clavate	4	15–21	3	5–11
B. robillardoides (fide Nag Raj 1993)	20–28 × 3.0–3.5	sub-cylindrical	4	15–18	3	3–8
B. robillardoides (fide Morgan-Jones et al. 1972)	19–25 × 4.0–4.5	cylindrical or fusiform	4	10–21	3	5.0–6.5
B. goniolimonis	(15–) 18–20 (–22) × (3.2–) 3.5–4.0 (–4.5)	fusiform-elliptical or cylindrical to obclavate	(2–)4	(5–) 10–13	3	3–5

suggestive, however, of *Bartalinia* Tassi, a coelomycete genus having fusiform to cylindrical, colourless to slightly coloured multi-septate conidia bearing apical, cellular, mainly three-times branched appendage and one basal lateral, offset appendage (Nag Raj 1993).

The species on *G. speciosum* from Altai fits the genus *Bartalinia* in general structure of conidiomata and in having appendaged conidia, but it differs from other known species (Table 2) in having conidia which tend to be obclavate (Fig. 1 C, 2), in some conidial proportions, and in the not always obvious presence of an offset basal appendage (Fig. 2) for all conidia from one conidioma. The most conspicuous feature of *B. goniolimonis*, is the character of mean conidium length/width ratio which is about 4.8:1 to 5:1 and resembles the proportions of *B. ananatis* Li Zeng, Z.D. Jiang & P.K. Chi (4.9:1) and *B. lateripes* (Ellis & Everh.) Nag Raj (5.1:1).

Nevertheless *B. goniolimonis*, in contrast to *B. ananatis* and *B. lateripes*, has conidia with rather unequal septation and size of median cells. In 4-septate conidia, the longest cell, at about 6 µm in length is the second from the base, while the third and fourth are each about 3 µm long, and their mean cell length ratio with that of the second bottom cell is about 2:1. In contrast, *B. lateripes* is characterized by roughly equally sized conidial cells, with lengths varying by not more than 1 µm, and *B. ananatis* is distinguished by a stable number of conidial septa (4), with rather intensively coloured median conidial cells varying from olivaceous to olivaceous brown and with the longest (ie second) conidial cell much less than two times the length of the other median cells.

Conidiogenous cells of *B. goniolimonis* are small, holoblastic, simple or holoblastic with one obscure percurrent enteroblastic proliferation and inconspicuous conidial scars. Thus, some variability was revealed in the structure of conidiogenous cells. Observed characters of conidial development in *B. goniolimonis* fit the concept of *Bartalinia* in the sense of Morgan-Jones et al. (1972).

In a study of *B. robillardoides* Tassi, the type species of the genus, Morgan-Jones et al. (1972) described conidial development as "annellidic with apical percurrent proliferations". Their report of conidiogenous cells with one or two percurrent proliferations was confirmed by Sutton (1980) and was furthermore reflected in later descriptions of *B. ananatis* and *B. dracaenae* P.G. Xi, Z.D. Jiang & P.K. Chi. Using the interpretations and terminology for conidiogenous events proposed by Minter et al. (1982) and Kirk et al. (2001) conidia of *Bartalinia* species can be described as forming holoblastically, with apical wall-building, delimitation by one septum, and schizolytic secession; conidiogenous cells have percurrent enteroblastic proliferations and conidia secede at progressively higher levels.

After further re-examination Nag Raj (1993) accepted *Bartalinia* as a genus with simple conidiogenous cells having conidiogenesis which is "holoblastic by apical wall building in the first conidium and replacement wall-building in subsequent conidia; delimitation by a transverse septum; ... secession schizolytic; proliferation, annellations, apical periclinal thickenings, collarettes ... absent". In a subsequent study of an isolate of *B. robillardoides* cultivated in vitro on artificial media with *Phragmites* segments, Wong et al. (2003) tried to clarify the conidiogenesis ultrastructure of this fungus. Scanning and transmission electron microscopy indicated holoblastic conidial formation, schizolytic secession and rather indeterminate proliferation, though a tiny collarette can sometimes be visible or interpreted on scanning electron micrographs.

Although additional research into *Bartalinia* species morphology and variability of characters is required, it is evident that the pattern of conidial development in *B. goniolimonis* (holoblastic, simple or sometimes with one obscure percurrent enteroblastic proliferation and inconspicuous conidial scars) is entirely compatible with it being disposed in that genus.

Septoriella viciae* on *Vicia unijuga

The features of the fungus found on *V. unijuga* suggest it should be placed in *Septoriella* Oudem. That genus is now briefly reviewed, and the present fungus, *Septoriella viciae*, is compared with its most similar species (see Table 3 below for a summary of salient conidial morphology characteristics).

Table 3. Conidial morphology characters: comparison of some *Septoriella* species with *S. viciae*

SPECIES OF *SEPTORIELLA*	MACROCONIDIA			MICROCONIDIA	
	size (µm)	form	number of septa	size (µm)	form
S. canadensis	36–56 × 2.5–3.0 (3.5)	subcylindrical to clavate; straight or curved	3–4	3.0–4.5 × 2.5–3.0	globose or subglobose
S. halensis	30–43 × 3.5–4.5	fusiform	(5–6) 7	–	–
S. phragmitis	29–46 × 3.0–3.5	fusiform	(3–) 5 (–7)	3.0–4.0 × 2.0–2.5	ovoid to turbinate with truncate base
S. thalassica	59–98 × 2.5–3.5 (4.5)	cylindrical, subcylindrical or acerose; straight, arcuate or curled	3–5	3.0–4.0 × 2.0–2.5	globose, subglobose or pyriform
S. viciae	(33–) 48–55 (–60) × 2.0–2.5	filiform to subcylindrical; straight to flexuous	3–5	(2.5–) 3.0–4.5 × 1.5–1.8	ovoid or elliptical unequal-sided, straight or slightly curved

The generic concept and synonymy of *Septoriella* were discussed by Sutton (1977, 1980) and, later, Nag Raj (1993). Gelatinous, cap-like extracellular appendages of pale brown multiseptate macroconidia formed one at a time on holoblastic conidiogenous cells with schizolytic secession and with production of subsequent conidia by percurrent enteroblastic proliferation at the same or a higher level were adduced to be the distinctive characters of this coelomycete genus. Conidiomata are various from pycnidial to eustromatal, microconidia are observed on some species of the genus.

There are some inconsistencies in reports of conidium ontogeny in *Septoriella*, suggesting that it has not been adequately studied. According to Sutton (1980), conidia form holoblastically. Nag Raj (1993), however, reported that the first conidium develops holoblastically by apical wall building, with percurrent enteroblastic proliferation preceding the production of each subsequent conidium at the same or higher level and very tiny periclinal thickening in collarette zone of conidiogenous cell, secession is schizolytic. This type of conidium ontogeny was also found in the recently described *S. trachycarpa* Joanne E. Taylor, K.D. Hyde & E.B.G. Jones (Taylor & Hyde 2003). Conidiogenous cells of *S. halensis* B. Sutton & Melnik, the other recently described species, have definite periclinal thickening and a distinct channel (Sutton & Melnik 1999), indicating that the conidium ontogeny in that species comprises "percurrent enteroblastic proliferation followed by replacement apical wall-building, with successive conidia seceding at the same level" (Kirk et al. 2001).

The terms "macro-" and "micro-" are usually used to distinguish conidia in *Septoriella* species as larger and smaller conidia are frequently observed in the genus. Various types of macroconidia have been reported for *Septoriella*. Fusiform conidia are found in *S. caroliniana* Nag Raj, *S. halensis, S. phragmitis* Oudem. and *S. trachycarpa*; acerose to elongate-fusiform, multi-septate conidia occur in *S. rockiana* (Petr.) Nag Raj, cylindrical to subcylindrical ones are more characteristic of *S. canadensis* Nag Raj, *S. junci* (Desm.) B. Sutton, *S. restionis* S.J. Lee & Crous, *S. thalassica* (Speg.) Nag Raj and *S. unigalerita* Kohlm. & Volkm.-Kohlm. Microconidial sporulation has been reported in seven of the species studied and accepted in recent years: *S. canadensis, S. caroliniana, S. junci, S. phragmitis, S. rockiana, S. thalassica* (Nag Raj 1993) and the recently described *S. unigalerita* (Kohlmeyer & Volkmann-Kohlmeyer 2000). The presence of microconidia is, however, not universal within the genus: they have not been reported for *S. halensis* (Sutton & Melnik 1999), *S. restionis* (Lee & Crous 2003) and *S. trachycarpa* (Taylor & Hyde 2003).

Septoriella viciae has pycnidial conidiomata with a general structure and clypeus-like thickening (Fig. 3E) similar to those observed in *S. phragmitis* (the type of the genus) and in two other accepted species (*S. trachycarpa* and *S. thalassica*). Conidial development in *S. viciae* is similar to that observed in *S. canadensis* and *S. phragmitis*. Conidiogenous cells are similar to those of most other accepted species of *Septoriella*: conidia-bearing structures are rather small, colourless and lying in a mucoid matrix. Because of that, such characters as minute periclinal thickening and a minute apical channel are not easily determined. *Septoriella halensis*, in comparison, has much more distinct channels and periclinal thickening of its conidiogenous cells, although it differs in the proportions and shape of its conidia, which furthermore are verrucose and have narrow truncate bases, more septa and a darker brown colour (Table 3).

Septoriella viciae produces filiform to fine-cylindrical macroconidia close in general structure to *S. canadensis, S. phragmitis* and *S. thalassica* (Table 3), but the macroconidia differ in proportions from those of all other *Septoriella* species. The mean length/width conidial ratio is 21.7:1 for *S. viciae*, in comparison with mean length/width conidial ratios of 22:1 for *S. thalassica,* 24.5:1 for *S. junci* and 24.6:1 for *S. unigalerita*, the three species with conidia most resembling *S. viciae* in proportions. Although smaller than other species of *Septoriella*, the microconidia of the fungus on *V. unijuga*, most closely resemble *S. canadensis*, *S. phragmitis* and *S. thalassica* (Table 3).

Septoriella viciae has extracellular macroconidial appendages that are characteristic of the genus *Septoriella*. It is not easy to comment on the development of conidial appendages of *S. viciae* with respect to other species of *Septoriella*: these conidial polar appendages can dissolve in water after some period of time (Taylor & Hyde 2003), and the same phenomenon was observed for some conidia in the fungus on *V. unijuga*, though careful examination revealed traces of gelatinous appendages on those conidia.

Conclusions

From the evidence presented, it is clear that *B. goniolimonis* and *S. viciae* from Altai are species new for science. Notes and new keys are provided below for *Bartalinia* and *Septoriella* on the basis of current knowledge of the genera, recently described and new species.

Bartalinia

To date, 19 specific epithets have been combined with the genus *Bartalinia*. Morgan-Jones et al. (1972) redescribed the type species, *B. robillardoides*, known on leaves of *Callistemon speciosus* DC., *Heteropterys chrysophylla* DC. and *Magnolia grandiflora* L. On the basis of the genus definition and revision of the other species by Nag Raj (1993), the genus *Bartalinia* currently numbers 10 accepted species including some described recently: *B. ananatis*, *B. bischofiae* Nag Raj, *B. dracaenae*, *B. goniolimonis*, *B. lateripes*, *B. laurina* (Mont.) Nag Raj, *B. mellea* F. Anderson & Bianchin., *B. pistacina* (J.L. Maas) Nag Raj, *B. robillardoides*, *B. tamarindi* Nag Raj (Nag Raj 1993, Anderson & Bianchinotti 1996, Xi et al. 2000, Zeng et al. 2002).

Thus, members of the genus *Bartalinia* are known on a wide range of host plants from different families and are distributed in locations with high humidity. Although the type of the genus, *B. robillardoides*, was described from Italy, its species are much more widely distributed, with records from the tropics and subtropics as well as from temperate regions (Sutton 1980, Nag Raj 1993). Collection of *B. goniolimonis* on the genus *Goniolimon* from Siberia provides a new temperate location for *Bartalinia*.

The other known names in *Bartalinia* are not well-established and need further study. Two were described as isolates from the atmosphere (*B. bella* (Bat.) Nag Raj) and soil (*B. terricola* Luke & S.U. Devi). The name *B. nervisequa* Tassi has been synonymized with *B. robillardoides* (Morgan-Jones et al. 1972). Three names are now considered to relate to other genera: *B. muehlenbeckiae* M.E.A. Costa & Sousa da Câmara = *Zetiasplozna heteromorpha* (Thüm.) Nag Raj; *B. nolinae* Pollack = *Kellermania nolinae* (Pollack) Nag Raj; *B. themedae* Hansf. = *Libartania themedae* (Hansf.) Nag Raj (Nag Raj 1993), because they differ considerably in morphology from current understanding of the genus *Bartalinia*. The other species under the names of *B. begoniae* Bat., *B. bombacicola* Bat., *B. cunninghamiicola* Ts. Kobay. & J.Z. Zhao and *B. triseptata* Matsush. have not been re-evaluated in the light of Nag Raj's (1993) redefinition of the genus.

Key to accepted species of *Bartalinia*

1 Conidial septa more or less evenly spaced; conidia clavate to subcylindrical ... 2
Conidia have unequal septation, second cell from the base is much longer than third and fourth; conidia subcylindrical to fusiform 5

2 (1) Conidia 3- septate only, apical appendage with 3 branches 3
Conidia 3- or 4- septate, apical appendage with various numbers of branches 4

3 (2) Mean conidial length/width ratio 6:1 .... *B. bischofiae*
Mean conidial length/width ratio 5.7:1 .... *B. tamarindi*

4 (2) Conidia fusiform to clavate, apical appendage with various numbers of branches (2–4) .... *B. pistacina*
Conidia cylindrical to clavate, apical appendage with 3 branches only .... *B. lateripes*

5 (1) Conidia 28–33 µm long 6
Conidia 20–22 µm long 8

6 (5) Conidial apical appendage with 3 branches only .... *B. robillardoides*
Conidial apical appendage with various numbers of branches (from 2 to 4) 7

7 (6) Conidia 3- to 5-septate, with short basal appendage up to 7 µm long, apical appendage with 2–3 branches .... *B. laurina*
Conidia 4-septate only, with basal appendage up to 15 µm long, apical appendage with 2–4 branches .... *B. mellea*

8 (5) Conidia 2- to 4-septate, apical appendage with3 branches ..... *B. goniolimonis*
Conidia 4-septate only, apical appendage with 2 to 3 branches 9

9 (8) Conidial apical appendage with 3 branches, up to13 µm long ...... *B. ananatis*
Conidial apical appendage with 2–3 branches, 13–17 µm long ..... *B.dracaenae*

Septoriella

Of the 20 epithets that have been combined in *Septoriella* to date, the following can be excluded from consideration of the genus. Since pigmented, multiseptate conidia are diagnostic for *Septoriella*, species with colourless conidia of various lengths but that tend to be either very short or rather long (*S. atrata* Sacc., *S. biformis* Sacc., *S. conformis* Sacc., *S. mexicana* Sacc., *S. philippinensis* Sacc., *S. romuleae* Sacc. & Trotter) await redisposition to other generic names; some may be anamorphs of the genus *Phyllachora* Nitschke ex Fuckel. *Septoriella septospora* (Dorog.) Sacc. is now recognized as the conidial state of *Mycosphaerella pini* Rostr. under the anamorphic name *Dothistroma septosporum* (Dorog.) M. Morelet (Evans 1984). *Septoriella striiformis* (Syd. & P. Syd.) Sacc. is now accepted as *Linochorella striiformis* Syd. & P. Syd. (Nag Raj 1993), and *Linochorella* Syd. & P. Syd. itself has been excluded from generic synonyms of *Septoriella* (Nag Raj & DiCosmo 1981). *Septoriella phragmiticola* Sawada was published without diagnosis and is a nomen nudum.

Of the 11 remaining epithets, ten represent species that have been recently described or revised (Nag Raj 1993): *S. canadensis*, *S. caroliniana*, *S. halensis*, *S. junci*, *S. phragmitis*, *S. restionis*, *S. rockiana*, *S. thalassica*, *S. trachycarpa*, and *S. unigalerita*. These ten taxa currently accepted within the genus have been recorded mainly from temperate and tropical regions of the northern hemisphere (Sutton 1980, Nag Raj 1993, Sutton & Melnik 1993, Kohlmeyer & Volkmann-Kohlmeyer 2000, Taylor & Hyde 2003) and are less well represented in the southern hemisphere (Nag Raj 1993, Lee & Crous 2003). They occur on plants from the related monocotyledon families of *Juncaceae* Juss., *Palmae* Juss., *Poaceae* Barnhart (*Gramineae* Juss.) and *Restionaceae* R.Br. *Septoriella viciae* seems to be the first record of a species of *Septoriella* on a member of the *Leguminosae*. If *S. oleae* Sarej. [protologue and specimens not seen] on *Olea europaea* L. from Greece is also a good species of *Septoriella*, the known range of hosts of this fungal genus will also include the other dicotyledon family, the *Oleaceae* Hoffmanns. & Link.

Key to accepted species of *Septoriella*

1	Conidia 7- to 21-septate, mean conidial width 6.0 µm	2
	Conidia 3- to 7-septate	4
2 (1)	Conidia elongate-fusiform, acerose, number of septa more than 15	*S. rockiana*
	Conidia cylindrical or fusiform, number of septa less than 15	3
3 (2)	Mean conidial length shorter than 50 µm	*S. trachycarpa*
	Mean conidial length longer than 50 µm	*S. restionis*

4 (1) Conidial width limits between 3.5–6.0 µm or mean conidial width 3.5 µm 5
Conidial width limits between 2.0–3.5 µm, mean conidial width 2.3–3.2 µm .. 8

5 (4) Conidia cylindrical or acerose, conidial length up to 100 µm 6
Conidia fusiform, verrucose, conidial length less than 50 µm 7

6 (5) Conidia with gelatinous cap at the base, mean length/width ratio 24.6: 1 .... *S. unigalerita*
Conidia with gelatinous cap at both ends, mean length/width ratio 22: 1 .... *S. thalassica*

7 (5) Conidia 3-septate, short, mean conidial length shorter than 20 µm .... *S. caroliniana*
Conidia 5- to 7-septate, mean conidial length greater than than 30 µm .... *S. halensis*

8 (4) Conidia fusiform, mean conidial width 3.2 µm.................. *S. phragmitis*
Conidia other form, mean conidial width about 3.0 µm or less 9

9 (8) Conidia subcylindrical or cylindrical, with constrictions 10
Conidia filiform to subcylindrical, without constrictions, mean conidia width less than 2.5 µm .... *S. viciae*

10 (9) Conidia subcylindrical to clavate, conidial length up to 60 µm, 3- to 4-septate .... *S. canadensis*
Conidia cylindrical, conidial length up to 100 µm, 6- to 7-septate .... *S. junci*

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A new species and two new Chinese records of *Bionectria* (*Bionectriaceae, Hypocreales*)

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Abstract — Based on morphological characters and sequence analysis of the nrDNA ITS region, *Bionectria wenpingii* sp. nov. is described and illustrated. Distinctions between the new species and its closely related taxa are discussed. Two species of *Bionectria* are reported for the first time from China.

Key words — *Bionectria grammicospora, Bionectria pityrodes,* taxonomy

Introduction

Bionectria Speg., typified by *B. tonduzii* Speg. (Spegazzini 1919), remained an obscure genus until Samuels (1988) resurrected it and noted its similarity to the common species *Nectria ochroleuca.* Rossman et al. (1999), who distinguished *Bionectria* from *Nectria* (Fr.) Fr. based on its perithecial pigmentation, morphology and anatomy, and anamorph, transferred *N. ochroleuca* and three additional common species into it. They established the family *Bionectriaceae* Samuels & Rossman. Schroers (2001) presented a molecular phylogenetic analysis that supported separation of *Bionectria* from *Nectria* and monographed the genus, recognizing *Clonostachys* Corda as the anamorph genus for *Bionectria* species. He included forty-four holomorphic or anamorphic species in 6 subgenera in *Bionectria/ Clonostachys.*

Bionectria is characterized by the light orange perithecia that do not become red in 3% KOH and *Clonostachys* anamorphs. *Bionectria* species are often saprobic or fungicolous. Ten species have been reported from China (Zhang

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& Zhuang 2003, Nong & Zhuang 2005, Zhuang & Zhang 2006, Zhuang et al. 2007): *B. apocyni*, *B. byssicola*, *B. gibberosa* Schroers, *B. mellea* (Teng & S.H. Ou) W.Y. Zhuang & X.M. Zhang, *B. oblongispora*, *B. ochroleuca*, *B. pseudostriata*, *B. samuelsii*, *B. sesquicillii*, and *B. tornata* (Höhn.) Schroers.

Recently, three collections from Yunnan and Zhejiang provinces of China were examined. A new species, *Bionectria wenpingii*, and two new Chinese records, *B. grammicospora* and *B. pityrodes*, are reported. Their relationships with some other species of the genus are discussed based on sequence analysis of the nrDNA ITS region.

Materials and methods

For morphological study, the methods of Rossman et al. (1999) and Schroers (2001) were followed. Specimens examined are deposited in the Mycological Herbarium of the Institute of Microbiology in the Chinese Academy of Sciences (HMAS).

For the molecular study, DNA was extracted from mycelium grown on PDA for 1–2 weeks (Wang & Zhuang 2004). Sequences of related fungi were retrieved from GenBank. All material studied is shown in Table 1. Nuclear rDNA ITS1-5.8S-ITS2 was amplified by using the primer pairs, ITS5–ITS4 (White et al. 1990). The PCR reaction mixture (50 μl) consisted of 5.0 μl 10× PCR buffer, 3.0 μl $MgCl_2$ (25 mM), 2.5 μl sense primer (10 μM), 2.5 μl antisense primer (10 μM), 1.0 μl dNTP (10 mM each), 2.5 μl DNA template, 0.5 μl Taq polymerase (5.0 U/μl) (Bio Basic Inc.) and 33 μl ddH_2O. Reactions were performed on the GeneAmp PCR System 2400 (Perkin Elmer) with cycling conditions of denaturation at 95 °C for 5 min, followed by 37 cycles of denaturation at 94 °C for 30 s, annealing at 52 °C for 30 s and elongation at 72 °C for 60 s, with a final extension step at 72 °C for 5 min to complete the reactions. The PCR products were purified by using 3S Spin PCR Product Purification Kit (Shenergy Biocolor for Life Science Co., Ltd.), then sequenced with the same primer pairs as in PCR in both directions with an ABI 3730 DNA analyzer by BGI LifeTech Co., Ltd. The obtained sequences were checked and edited manually by using BioEdit 5.0.9. (Hall 1999).

All sequences were aligned by using ClustalX V.1.8 (Thompson et al. 1997) and visually adjusted where necessary. Maximum parsimony trees were inferred using heuristic search with 1000 replicates of random sequence addition by using PAUP 4.0b10 (Swofford 2002). Gaps were treated as missing data and all characters were equally weighted. Clades were bootstrapped for 1000 replicates with TBR (tree bisection reconnection) branch swapping method. The trees were rooted with *Nectria cinnabarina* and *Nectriopsis sporangiicola*.

Table 1. Materials used in this study

Species	Collection No.	GenBank Acc. No.
Bionectria apocyni (Peck) Schroers & Samuels	CBS 130.87	AF210688
B. aureofulvella Schroers & Samuels	CBS 195.93	AF358226
B. byssicola (Berk. & Broome) Schroers & Samuels	CBS 914.97	AF358252
B. capitata Schroers & Samuels	CBS 218.93	AF358240
B. compactiuscula Schroers	CBS 913.97	AF358245
B. coronata (Juel) Schroers	CBS 696.93	AF210667
B. epichloe (Speg.) Schroers	CBS 101037	AF210675
B. grammicospora (Ferd. & Winge) Schroers & Samuels	CBS 209.93	AF210678
B. grammicosporopsis (Samuels) Schroers & Samuels	CBS 115.87	AF210679
B. kowhai (Dingley) Schroers	CBS 461.95	AF358250
B. levigata Schroers	CBS 948.97	AF210680
B. lucifera (Samuels) Schroers & Samuels	CBS 100008	AF210683
B. oblongispora Schroers	CBS 100285	AF358248
B. ochroleuca (Schwein.) Schroers & Samuels	CBS 193.94	AF210686
B. pityrodes (Mont.) Schroers	CBS 246.78	AF210673
	HMAS 172157	**EF612466**
B. pseudochroleuca Schroers & Samuels	CBS 192.94	AF358238
B. pseudostriata Schroers	CBS 119.87	AF358251
B. ralfsii (Berk. & Broome) Schroers & Samuels	CBS 102845	AF358253
B. rossmaniae Schroers	CBS 210.93	AF358227
	CBS 211.93	AF210665
B. sesquicillii (Samuels) Schroers	CBS 180.88	AF210666
B. samuelsii Schroers	CBS 699.97	AF358236
B. setosa Schroers	CBS 917.97	AF210669
	CBS 834.91	AF210670
B. solani (Reinke & Berthold) Schroers	CBS 101926	AF358230
B. sporodochialis Schroers	CBS 101921	AF210685
B. wenpingii	HMAS 172156	**EF612465**
B. zelandiaenovae Schroers	CBS 232.80	AF210684
	CBS 100979	AF358229
Clonostachys agrawalii (Kushwaha) Schroers	CBS 533.81	AF358241
C. candelabrum (Bonord.) Schroers	CBS 504.67	AF210668
C. chlorina Schroers	CBS 287.90	AF210681
C. divergens Schroers	CBS 967.73b	AF210677
C. intermedia Schroers	CBS 508.82	AF210682
C. miodochialis Schroers	CBS 997.69	AF210674
C. phyllophila Schroers	CBS 685.96	AF210663
C. rhizophaga Schroers	CBS 202.37	AF358225
C. rogersoniana Schroers	CBS 582.89	AF210691
C. rosea f. *catenulata* (J.C. Gilman & E.V. Abbott) Schroers	CBS 154.27	AF358231
C. rosea (Link) Schroers et al. f. *rosea*	CBS 376.55	AF358239
C. solani f. *nigrovirens* (J.F.H. Beyma) Schroers	CBS 142.91	AF358244
C. solani (Harting) Schroers & W. Gam f. *solanis*	CBS 228.74	AF358243
Nectria cinnabarina (Tode) Fr.	NRRL 20484	L36626
Nectriopsis sporangiicola (Samuels) Samuels	CBS 166.74	AF210661

Results and discussion

New species

Bionectria wenpingii J. Luo & W.Y. Zhuang, **sp. nov.**
MycoBank # MB 510960 **Figs. 1–10**

Etymology: The specific epithet refers to the collector of the fungus.

Peritheciis globosis, papillatis, 175–210 µm diam.; ascis clavatis, 8-sporis, 33–44 × 5.5–8.0 µm; ascosporis fusiformibus, uniseptatis, 10.0–13.5 × 2.7–4.0 µm.

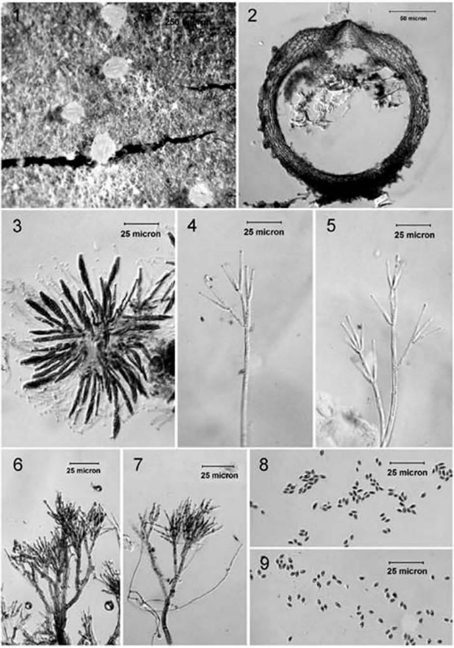
Anamorph: *Clonostachys* sp.

Ascomata perithecial, solitary, on white subiculum, superficial, non-stromatic, globose, 175–210 µm diam., 185–215 µm high, smooth, with a small papilla, collapsing by lateral pinching when dry, pale yellow when fresh and yellowish when dry, not changing color in 3% KOH or lactic acid. Cells of ascomatal surface forming a textura angularis. Ascomatal wall of 2 layers, 19–27 µm thick; outer layer of angular cells, 13–19 µm thick, cells 5.5–13.5 × 4–8 µm; inner layer of elongate cells, 5–8 µm thick. Asci elongate-clavate, 33–44 × 5.5–8.0 µm (n = 20), 8-spored, with an obvious apical ring. Ascospores fusiform, 10.0–13.5 × 2.7–4.0 µm (n = 30), hyaline to yellowish, warted, uniseptate, not or slightly constricted at the septum, 1–3-seriate, warts 0.5–0.7 × 0.2 µm.

Characteristics in culture: Colony grown 7 d on PDA at 24°C under daylight reaching 35 mm diam., reverse pale yellow, surface felty to cottony, pale orange. Conidiophores dimorphic. Primary conidiophores *Verticillium*-like, arising from agar surface or from aerial mycelium throughout the colony, dominating near the margin; stipe 112–150 µm long, 2.7–5.5 µm wide at base; phialides in whorls of 2–4, divergent, straight, cylindrical, slightly tapering towards the tip, 19–29 µm long, 1.5–2.0 µm wide at base, 1.0–1.5 µm wide near aperture (n = 20), each producing a small, hyaline drop of conidia. Secondary conidiophores, penicillate, ter- to quater-verticillate, generally in small pustules or sporodochia, formed on agar surface or arising from strands of aerial mycelium; phialides in whorls of 3–5, divergent, straight, cylindrical, slightly tapering towards the tip, 10.7–17.0 µm long, 1.0–1.5 µm wide at base, ca. 1.0 µm wide near aperture (n = 20). Conidia hyaline, subellipsoid, slightly curved, distally broadly rounded, with a laterally displaced hilum, 3.7–7.5 × 1.5–3.2 µm when formed from primary conidiophores (n = 30), 3.2–5.5 × 2.0–3.2 µm when formed from secondary conidiophores (n = 30). Perithecia not observed in culture.

Holotype: China. Yunnan, Xishuangbanna, on dead leaves associated with *Clonostachys* sp. and *Stachybotrys* sp., 20-X-1999, W.P. Wu & Y. Huang 2792a, HMAS 172156.

Notes: The combination of the perithecial morphology and negative reaction to KOH or lactic acid, and *Clonostachys* anamorph indicates that this is a member of *Bionectria*. This species can be referred to subgenus *Epiphloea*



Figs. 1–9. *Bionectria wenpingii* and its anamorph (HMAS 172156). **1.** Ascomata on natural substrate; **2.** Median section of an ascoma; **3.** Asci with ascospores; **4-5.** Primary conidiophores with conidia; **6-7.** Secondary conidiophores with conidia. **8.** Conidia from primary conidiophores; **9.** Conidia from secondary conidiophores.

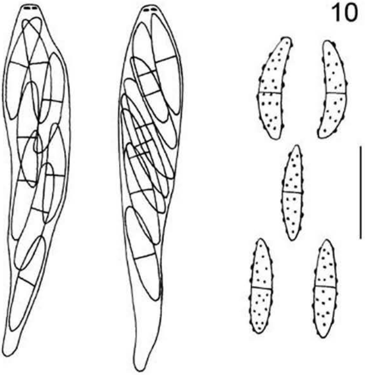


Fig. 10. *Bionectria wenpingii* (HMAS 172156). Asci with ascospores and free ascospores. Scale bar = 10 µm.

Schroers because its perithecia are superficial and not stromatic. It is unusual for subgenus *Epiphloea* that the *Clonostachys* anamorph of our new species is not *Sesquicillium*-like but typical *Clonostachys*.

Bionectria wenpingii is most similar to *B. tornata* in superficial, smooth, and non-stromatic perithecia, as well as the size and shape of ascospores. It differs from the latter in the smaller perithecia (175–210 µm vs. 200–300 µm diam.), thinner perithecial walls (19–27 µm vs. 25–35 µm thick), angular (instead of subglobose) cells in the outer perithecial wall, smaller (33–44 × 5.5–8.0 µm vs. 43.0–52.5 × 7.0–8.5 µm) asci with an obvious (not inconspicuous) apical ring, and a typical *Clonostachys* (instead of *Sesquicillium*-like) anamorph characterized by dimorphic (not monomorphic) conidiophores and much shorter (3.2–7.5 × 1.5–3.2 µm vs. 11–14 × 2.8–3.2 µm) conidia (Schroers 2001).

The new species is also similar to *B. pseudochroleuca* in the smooth-walled perithecia laterally pinched when dry, ascospore shape and ornamentation,

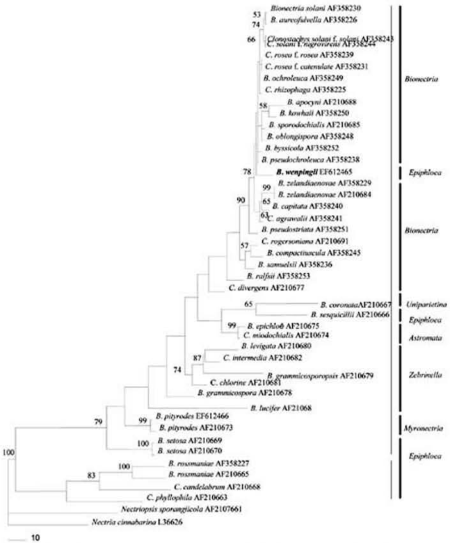


Fig. 11. One of the 308 most parsimonious trees inferred from sequence analysis of rDNA ITS1-5.8S-ITS2 region. Tree length = 737, consistency index (CI) = 0.5834, homoplasy index (HI) = 0.4166, retention index (RI) = 0.6720, rescaled consistency index (RC) = 0.3921. Bootstrap values ≥ 50% from 1000 replicates are noted above internodes. Subgenera of *Bionectria*, indicated on the right, are defined partly on the basis of phenotype. Subg. *Epiphloea* is shown to be paraphyletic.

and the typical *Clonostachys* anamorph. *B. pseudochroleuca* differs in the well-developed stroma, larger perithecia 190–280 µm diam., 3-layered perithecial walls 30–45 µm thick, larger (46–53 × 6.5–7.5 µm) asci, and smaller (8.4–9.4 × 2.8–3.4 µm) ascospores (Schroers 2001).

Relationships of *Bionectria wenpingii* inferred from analysis of ITS sequences

The most parsimonious trees developed from sequence analysis of the ITS region from 45 sequences of 37 species reveal the phylogenetic relationships of *B. wenpingii*. Among the 490 characters investigated, 248 were constant, 82 were parsimony-uninformative, and 160 were parsimony-informative. Fig. 11 illustrates one of the 308 generated trees that recognize two clades. One clade is represented by 32 species belonging to 6 subgenera with 79% bootstrap support. Another clade with weak bootstrap support contains three species of subgenus *Epiphloea*.

Bionectria wenpingii is merged within the 14 teleomorphic and anamorphic species of subgenus *Bionectria* that form a subclade with 90% bootstrap support. These results indicate that the new species is closely related to those of subgenus *Bionectria* with a *Clonostachys* anamorph. Although this placement is consistent with its anamorph, the anatomy of the perithecial wall and the lack of stromal development in *B. wenpingii* are more consistent with placement in subgenus *Epiphloea*. At least as regards *B. wenpingii*, the anamorph appears to predict relationships better than the teleomorph. Members of subgenus *Epiphloea* have *Sesquicillium*-like anamorphs (Schroers 2001). Our results show that subgenus *Epiphloea* as currently defined is not monophyletic. Schroers (2001), who combined *tub*2 and ITS data, found only weak bootstrap support for the new subgenus *Epiphloea*. Evidently *B. wenpingii* is an anomalous *Bionectria* species that casts doubt on the morphological basis of the subgenera proposed for the genus.

New records for China

Bionectria grammicospora (Ferd. & Winge) Schroers & Samuels, Stud. Mycol. 46: 154, 2001.

Material examined: China. Zhejiang, Tianmushan, alt. 800m, on herbaceous stem, 3-XI-2005, J. Luo & W.Y. Li 7630, HMAS 172392.

Notes: This collection extends the known distribution of the fungus from the neotropics and Indonesia (Schroers 2001) to China.

Bionectria pityrodes (Mont.) Schroers, Stud. Mycol. 46: 148, 2001.

Anamorph: *Clonostachys pityrodes* Schroers.

Material examined: China. Yunnan, Xishuangbanna, on dead branches of unidentified plant associated with another ascomycete, 16-X-1999, W.P. Wu & Y. Huang 2718a, HMAS 172157.

Notes: *Bionectria pityrodes* is a common pantropical species, previously known in Asia from Indonesia and Thailand (Schroers 2001, Samuels pers. comm.). This is the first report of the species for China; Xishuangbanna is a tropical area of southern China.

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A new species of *Cylindrosporium*

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Abstract— The anamorphic fungus *Cylindrosporium crataeginum* sp. nov. is described and illustrated from living leaves of *Crataegus tanacetifolia*, *C. monogyna* subsp. *monogyna* and *C. pentagyna* collected in Turkey.

Key words—coelomycetes, *Melanconiales*

Introduction

During studies on the micromycetes of trees and shrubs in Turkey, we observed a species of *Cylindrosporium* that is described here as new. Its identification was ascertained by reference to Vassiljevsky & Karakulin (1950), Švarcman et al. (1971), Sutton (1980), Treigienė & Ignatavičiūtė (1993) and Ignatavičiūtė & Treigienė (1998). The holotype is deposited in the Herbarium of Ahi Evran University, Kırşehir, Turkey.

Material and methods

The plant material was collected from the Küre Mountain National Park in Kastamonu province (Black Sea Region) and Kızılcahamam in Ankara province of Turkey. Specimens of the fungus were taken to the laboratory and microscopically examined with a Leica compound microscope. Sections were hand cut using a razor blade. Host plants were identified using the "Flora of Turkey and East Aegean Islands" (Davis 1982). The author abbreviations of fungi are according to Kirk & Ansell (2004). All examined specimens are deposited in the Ahi Evran University, Arts and Sciences Faculty, Department of Biology, in Kırşehir province of Turkey.

Results

Cylindrosporium crataeginum Erdogdu & Hüseyin, **sp. nov.**
MycoBank mb 511007 Figs. 1–2

Ab Cylindrosporiis ceteris in Rosaceis differt in conidiophoris simplicibus vel ad basim ramosis, 2-septatis, et conidiis (2-)4-8(-11) septatis.

Holotypus—TURKEI, Ankara, Kızılcahamam, in foliis vivis *Crataegi tanacetifoliae* (Lam.) Pers. (*Rosaceae*), 40°36'15"B, 32°31'28"O, alt. 1385 m.s.m, 26-VIII-2005, leg. HUSEYIN (EH 1569). In Herbario Universitatis Ahi Evran (Kırsehir, Turcei) conservatur.

Etymology: The specific epithet is based on the genus name of the host plant *Crataegus*.

Foliicolous. Mycelium immersed, branched, septate, hyaline, 2–2.5 µm wide. Leaf lesions amphigenous, yellow, dark brown when dry, deliquescent, elongate, irregular or irregular circular, 1-3 mm across, scattered, confluent (Fig. 1A). Conidiomata acervulate, on the lower surface, subcuticular, scattered, solitary, pale brown, amber coloured, circular, 160-200 µm diam. (Fig. 1B); conidiomata wall 10–15 µm wide and 3–4 cells thick of pale brownish textura elliptica. Conidiophores hyaline, wall smoth, simple or branched at the base, paralell, 2-septate, erect, straight, formed from the upper pseudoparenchyma, cylindrical, 10–15 × 4.5–5.5 µm. Conidiogenous cells enteroblastic, integrated, smooth, hyaline, cylindrical, 5–6 × 4.5–6 µm. Conidia hyaline, (2–) 4–8 (–11)-euseptate, not constricted, eguttulate, straight or curved, cylindrical, sometimes slightly tapering towards the apex, angusti-obclavate, rounded at the ends or obtuse at the base, (55–) 77–105 × 4–5.5 µm, frequently issuing in small whitish, gelatinous tendrils (Fig. 2A–2B).

Other specimen examined— TURKEY, Kastamonu Prov., Küre Dagları, Pınarbashy, on living leaves of *C. monogyna* Jacq. subsp. *monogyna*, 41°42'8,0"N, 33°09'2,3"E, 1100 m, 26-VIII-2005, Co. ERDOGDU M (ME 1609) and ibid, on living leaves of *C. pentagyna* Waldst. & Kit. ex Willd., 40°42'9,5"N, 33°08'8,1"E, 1035 m, 26-VIII-2005, Co. ERDOGDU M (ME 1573). Deposited in Herbarium of the Ahi Evran University, Kırsehir, Turkey.

Discussion

The new species differs from twenty-five other *Cylindrosporium* species recorded on rosaceous trees and shrubs (Vassiljevsky & Karakulin 1950, Sutton 1980, Treigienė & Ignatavičiūtė 1993, Ignatavičiūtė & Treigienė 1998) appearing most closely related to *Cylindrosporium brevispinum* Dearn., *C. canadense* Vassiljevsky, *C. gei* Farl., *C. kerriae* V.B. Stewart, *C. pruni-tomentosae* Miura and *C. spiraeicola* Ellis & Everh. in structure and morphology of conidiomata, conidiophores, and conidia.

The most significant differences are septate conidiophores that are branched at the base and conidia that are wider, longer and form more septa, 2–11 but predominantly 4–8 (TABLE 1).

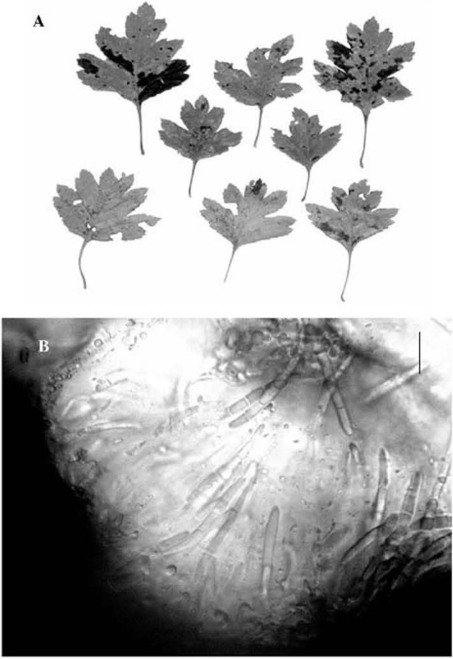

Fig.1. *Cylindrosporium crataeginum.*
A.-leaf spots; B.- vertical section of a conidiomata. Scale bar= 15 µm

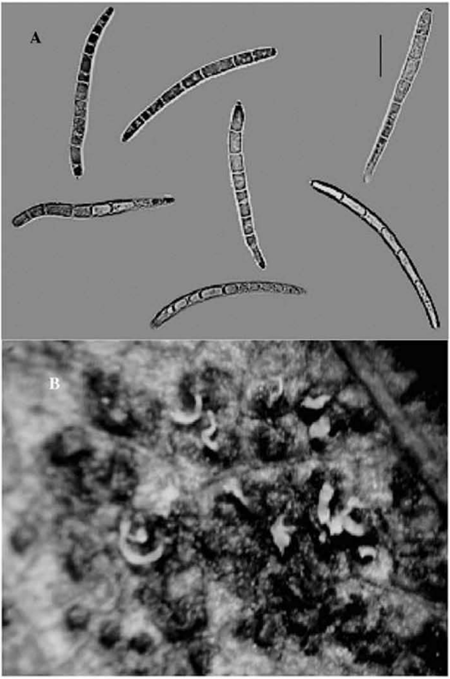

Fig.2. *Cylindrosporium crataeginum:*
A.- natural conidia. Scale bar= 20 µm; B.-gelatinous tendrils. x 25.

Table 1. Comparative analysis of *Cylindrosporium crataeginum* and other *Cylindrosporium* spp. from *Rosaceae*

SPECIES	CONIDIOMATA	CONIDIOPHORES	CONIDIA
C. brevispinum	Hypophyllous, 80–220 µm diam	Filiform, unicellular, 18–30 × 2–2.5 µm	Almost clavate, unicellular or 1–2 septate, 30–90 × 3–4 µm, mostly 45–50 µm long
C. canadense	Hypophyllous, 60–100 µm diam	Hyaline, cylindrical, unicellular, 20–30 × 2.5–3 µm	Filiform, 3-euseptate, up to 120 µm × 3–4 µm
C. gei	Amphigenous	—	Filiform, unicellular, 38–110 µm long
C. kerriae	Amphigenous	—	Filiform, 1-2-euseptate, 40–76 × 3.2–4.8 µm
C. prunifomentosae	Epiphyllous	Simple, unicellular, 10 × 4 µm	Filiform, 3-euseptate, 80–100 × 4 µm
C. spiraeicola	Epiphyllous, 200–500 µm diam	Hyalinae, conical or rod-like, unicellular, 8–16 × 3–4 µm	Broadly obclavate or cylindrical, 1-5 (often 2)-euseptate, 40–90 × 3–4 µm
C. crataeginum	Hypophyllous, 160–200 µm diam	Hyaline, simple or basally branched, 2-septate, 10–15 × 4.5–5.5 µm	Cylindrical, broadly obclavate, 2–11 (predom. 4–8-euseptate, (55–) 77–105 × 4–4.5 µm

Acknowledgments

The authors would like to extend a sincere gratitude to Prof. V.P. Prokhorov (Moscow State University, Russia) for correcting the Latin description and Dr. Paul M. Kirk (CABI Bioscience UK Centre) for linguistic help and critique of the manuscript. We also thank Dr. Shaun Pennycook (Auckland, New Zealand) for critically reading the manuscript and serving as presubmission reviewers and Dr. Lorelei L Norvell (Mycotaxon) for help in preparing of the manuscript for publication.

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New records of *Amanita* section *Amanita* from Garhwal Himalaya, India

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Abstract—Four species of *Amanita* from Garhwal Himalaya are described in detail and illustrated for the first time from India—*A. concentrica, A. rubrovolvata, A. subglobosa,* and one that is not yet named and is given a designating code, "PAK5."

Key words: *Amanitaceae*, China, Japan, Nepal, Pakistan, taxonomy

Introduction

The genus *Amanita* Pers. is represented by at least 50 taxa from India (Bhatt et al. 2003). During the course of our studies on *Amanita* taxa from Garhwal Himalaya, several interesting species have been collected. The present paper provides detailed and illustrated accounts of four *Amanita* species of *Amanita* section *Amanita* collected in Garhwal Himalaya: *A. concentrica, A. rubrovolvata, A. subglobosa* and a species that is known by a provisional code, "*A.* sp. PAK5." The first three were reported from India in brief for the first time by

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Bhatt et al. (2003). The fourth is reported provisionally from northwest Pakistan (Tulloss et al. 2001 and to appear), but never from India.

Materials and Methods

The macroscopic features such as shape, size and colour of the basidiocarps were described from fresh specimens. The dried material was revived in 3% aq. KOH or 10% aq. ammonia and microscopic structures were studied using 2% Congo Red, 2% phloxine or Melzer's reagent, as appropriate. Spores of recent collections of Indian material upon which the descriptions in this paper are based were studied from spore deposits as well as from fresh material. Spores from other collections came from the lamellae of exsiccatae. Colour terminology used is that of the Methuen Handbook of Colour (Kornerup & Wanscher 1978). The specimens have been deposited in the Herbarium, Department of Botany, H.N.B. Garhwal University, Srinagar, Garhwal (GUH). Some duplicate material is deposited in the personal herbarium of Tulloss (RET).

All apiculi of spores are sublateral and cylindric in all species studied, and those character states are omitted from descriptions. Notation used to describe spore data follows Tulloss (2000) and Tulloss & Lindgren (2005). Other methodology follows preferences of the first author. Herbarium codes follow Holmgren et al. (1990), with the exception of HKAS (Herb. Cryptogram. Kunming Inst. Bot., Academia Sinica, Yunnan, China), NHMTU (Natural Hist. Mus. Tribhuvan Univ., Kathmandu, Nepal), and RET.

Taxonomic Part

1. *Amanita concentrica* T. Oda, C. Tanaka & Tsuda, 2002. Mycoscience 43: 81, figs. 1–6. **Figs. 1 (A–E), 2**

PILEUS: 65–140 mm wide, hemispherical at first, convex to planar, slightly uplifted with age, white to yellowish white (3A3), cream to pale yellow (4A3) over disc; *context* white, turning pinkish in half hour after sectioning; *margin* short-striate (striations up to 8 mm long or 0.1±R), decurved, often decorated with fragments of the partial veil; *universal veil* as white to yellowish pyramidal to conic warts, up to 3 × 6 mm, often reduced to floccose remnants towards pileus margin.

LAMELLAE free to seceding, often with decurrent lines on stipe apical region, crowded, white, 5–12 mm broad, edges sometimes finely fimbriate or flocculose; *lamellulae* truncate to subtruncate, plentiful, unevenly distributed (absent between some pairs of lamellae, of diverse lengths (5 to 95% length of lamellae).

STIPE 100–165 × 7–22 mm, white to off white, attenuate upwards to subcylindric, upper part pruinose to finely scaly, lower part with large upward pointing, recurved scales; *context* white; *bulb* 35–56 × 15–36 mm, fusiform to ventricose to napiform, white; *partial veil* superior, membranous, dorsally white, ventrally light brownish to greyish brown, often becoming detached on handling or washed off by rain, often with fragments remaining adherent to pileus margin; *universal veil* on upper part of bulb as thick recurved scales or warts in 2–5 distinct concentric rings, off white to grayish yellow (4B3-4).

Odour indistinct. *Taste* mild.

PILEIPELLIS: 210–300 µm thick, two-layered; *suprapellis* about 115–180 µm thick (filamentous hyphae 0.8–9.5 µm wide, subradially arranged and vertically compacted, gelatinized, thin-walled, branched, colourless, hyaline; vascular hyphae few, 4.5–6.0 µm wide; clamps present); *subpellis* about 90–120 µm thick (filamentous hyphae 1.5–10 µm wide, compactly arranged, hyaline, colourless, thin-walled, branched; vascular hyphae sparse, up to and often 6.5 µm wide; clamps rather common). PILEUS CONTEXT: filamentous hyphae 3.0–14.0 µm wide, thin-walled, branched, interwoven; acrophysalides often up to 40 µm wide, subclavate to narrowly clavate; vascular hyphae rare, up to 6.0 µm wide; clamps present. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w_{cs}}$ = 35–55 µm; *mediostratum* with filamentous hyphae 2.0–7.0 (10.0) µm wide, frequently branched, fairly abundant, with inflated cells subclavate to clavate or subcylindric (40–95 × 8.0–20 µm), with vascular hyphae rare, with clamps present; *lateral strata* with elements diverging at 30°–60° to mediostratum, with filamentous hyphae 3.0–8.0 µm wide, abundant, with inflated cells fusiform to subclavate (30–70 × 10.0–22 µm), with vascular hyphae rare, with clamps rather common. SUBHYMENIUM: 35–50 µm thick, consisting of 2–3 layers of predominantly inflated cells (8.0–20 × 5.0–12.0 µm, mainly ellipsoid to clavate to subclavate to pyriform, occasionally subfusiform or irregularly shaped), with most basidia arising from such inflated cells and only occasionally from partially inflated hyphal segments. BASIDIA: 37–70 × 8.0–14.0 µm, clavate, subclavate, dominantly 4-spored, sometimes 1-, 2-, or 3-spored; sterigmata 2.0–6.0 µm long; clamps rather common. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae 1.5–12.0 µm wide, sparse, branched; acrophysalides 30–160 × 8.0–34 µm; vascular hyphae rare to absent; clamps rare. PARTIAL VEIL: filamentous hyphae 1.5–7.5 µm wide, hyaline, thin-walled, branched; inflated cells subclavate to clavate, cylindric to subcylindric, with irregular fusiform cells (100–195 × 15.0–21 µm); vascular hyphae rare; clamps frequent. UNIVERSAL VEIL: *On pileus*:

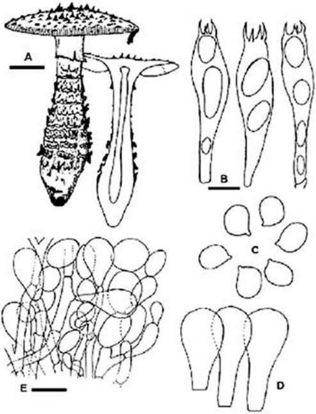

Fig. 1. *Amanita concentrica* (K.C. Semwal 549). A) Basidiome with longitudinal section. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Universal veil elements from pileus, slightly crushed. Key to scale bars for this and subsequent figs.: bar "A" = 2 cm, bar "B" = 10 µm (applies to B, C, and D); bar "E" = 25 µm.

filamentous hyphae 3.0–10.0 µm wide, frequently branched, interwoven; inflated cells subglobose to ovoid to ellipsoid (20–70 × 15.0–55 µm, often in short chains of 3–4) or clavate to broadly clavate cells (32–60 × 13.0–25 µm), abundant to dominant; vascular hyphae rare; clamps present. *On stipe base*: similar to that on pileus, but with filamentous hyphae proportionately somewhat more abundant. MARGINAL TISSUE OF LAMELLAE: filamentous hyphae 2.0–7.0 µm wide, abundant; inflated cells clavate to broadly clavate to pyriform, 22–60 × 10.0–18.0 µm, in short terminal chains of 2 or 3, thin-walled, hyaline, colourless.

Basidiospores: [84/4/4] (6.6) 7.5–10.8 × (5.8) 6.6–8.3 µm, (**L** = 8.1–8. 8 µm; **L'** = 8.4 µm; **W** = 6.6–7.2 µm; **W'** = 6.9 µm; **Q** = (1.10) 1.11–1.28 (1.44); **Q** =

Fig. 2. *Amanita concentrica*, pyramidal universal veil remnants on mature pileus (K.C. Semwal 549).

1.19–1.23; **Q**′ = 1.21), subglobose to broadly ellipsoid, sometimes globose or ellipsoid, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus 0.8–1.6 µm long; contents often monoguttulate; white in deposit.

> *Material examined*: **INDIA**: UTTARAKHAND—Pauri Garhwal - Dandapani, 10.vii.2000 K.C. Semwal 163 (GUH-M 20261); Khirsu, 24.vii.2001 K.C. Semwal 318 (GUH-M 20394); Teka, 11.viii.2001 K.C. Semwal 381 (GUH-M 20453), 23.ix.2002 K.C. Semwal 549 (GUH-M 20622).

Habitat and distribution: Solitary to scattered. On humicolous soil under *Cedrus deodara* (Roxb. ex Lambert) G. Don, *Quercus leucotrichophora* A. Camus, *Myrica esculenta* Buch.-Ham. ex D. Don, *Rhododendron arboreum* Sm. and *Q. glauca* Thunb. *Amanita concentrica* was originally described from Japan (protologue). It is reported also from China (Yang 2005) and Nepal by Tulloss and H. R. Bhandary (see discussion, below) and Tulloss and S. Devkota (pers. corresp.).

DISCUSSION: The present species belongs to *Amanita* section *Amanita* because of its inamyloid basidiospores and bulbous stipe base. Within this section, the present species belongs in the clamp-bearing group phenetically close to *A. muscaria* (L. : Fr.) Lam. Within the latter group, *A. concentrica* is characterized macroscopically by its medium to large, white to yellowish white fruit bodies decorated with many pyramidal warts on the pileus, and distinct concentric rings comprising numerous recurved scales on the lower stipe and on the upper part of the stipe's bulb. The present species is well within the circumscription of the protologue of *A. concentrica*.

Additional material of this species was examined by Tulloss yielding the following supplementary data:

Basidiospores: [70/3/2] (7.0) 7.2–10.8 (15.5) × (5.8) 6.5–9.5 (11.0) µm, (**L** = 8.2–9.2 µm; **L'** = 8.8 µm; **W** = 7.1–8.1; **W'** = 7.6 µm; **Q** = (1.07) 1.08–1.29 (1.35); **Q** = 1.14–1.20; **Q'** = 1.16).

Additional material examined: **INDIA**: UTTARAKHAND—Garhwal - Adwani, 19.ix.1992 V.K. & R.P. Bhatt s.n. (GUH M-19943; RET). **NEPAL**: CENTRAL DEVELOPMENT REGION—Bagmati Zone - Bhaktapur Distr., Nala (10 km NE of Bhaktapur City, E of Kathmandu), 18.viii.1989 H.R. Bhandary s.n. (NHMTU (n.v.); RET).

Habitat and distribution for Nepal: In groups in forests of *Castanopsis tribuloides* A. DC., *Quercus glauca*, and *Schima wallichii* (DC.) Korth.

In Nepal, according to H. R. Bhandary (pers. corresp.), this species is very abundant and well-known in the area around Nala. It suggests to the local people the spiny fruit of the Devil's Apple (in the Newari language, *dhatur muka:*). They apply the same name to *A. concentrica*. The ":" is a nasal sound similar to the final sound in French words ending in "-ment."

Superficially, *A. concentrica* looks very similar to some amyloid-spored species such as *A. cokeri* (E.-J. Gilbert & Kühner) E.-J. Gilbert, *A. eijii* Zhu L. Yang, *A. virgineoides* Bas and other white or whitish members of *Amanita* section *Lepidella*.

The authors of the present species differentiate it from *Amanita muscaria* var. *alba* Peck noting the latter differs in having a less elongated bulb with universal veil remnants usually not on the tips of recurved scales and more restricted to the lower stipe and uppermost portion of the stipe's bulb and having larger, broadly ellipsoid to elongate basidiospores—according to Jenkins (1977), (7.9) 9.4–12.0 (14.1) × (6.3) 7.8–8.3 (9.4) µm, with a **Q** range of 1.19–1.69 and **Q'** of 1.41.

Color illustrations from our Uttarakhand material can be found on-line (Tulloss 2007a).

This is the first extended description of Indian material of the present species.

2. *Amanita rubrovolvata* S. Imai, 1939. Bot. Mag. (Tokyo) 53: 392.

Fig. 3 (A–E)

PILEUS: 25–70 mm wide, hemispherical at first, then convex, becoming campanulate, and finally plane, shiny, viscid when wet, dark red to vivid red (10A8 to 9A8 to 8B8) to reddish orange (7A–B8) over disc, becoming paler

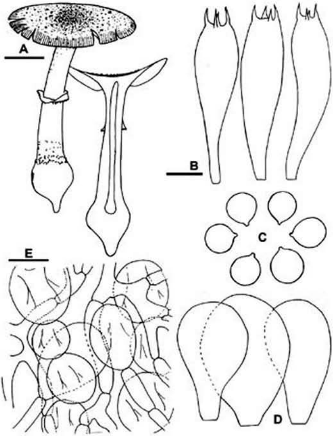

Fig. 3. *Amanita rubrovolvata* (K.C. Semwal 557). A) Basidiome with longitudinal section. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Elements of universal veil from pileus, slightly crushed.

towards margin—orange-red to orange (8A8–5A7); *context* white to lemon yellow, reddish just below pileipellis, 3–5 mm thick above stipe; *margin* distinctly striate (0.4–0.45R), non-appendiculate; *universal veil* as pulverulent-floccose to mealy or farinose warts and small patches, randomly distributed, orange-red to yellowish red to deep orange (8A8 to 6A8).

LAMELLAE: free, close, yellowish white to cream (4A2–3), 3–6 mm broad, sometimes with edges finely fimbriate; *lamellulae* truncate, unevenly distributed (scarce or absent in some sectors), of diverse lengths (15 to 50% length of lamellae).

STIPE: 60–110 × 3–12 mm, central, cylindric or slightly tapering upwards, covered with light orange-yellow appressed fibrils, with ground colour yellow to yellowish orange or reddish yellow (3A5, 4A6–7); *context* white to yellowish, loosely stuffed to hollow; *bulb* 13–25 × 6–22 cm, globose, subglobose to obpyriform; *partial veil* superior to median, membranous, pendant, persistent, thin, creamy to yellowish orange (4A3–8), edges orange-red to vivid red; *universal veil* on apex of bulb as pulverulent-floccose, felted, small patches or in mealy to flocculent layer, forming 2 to 3 incomplete concentric rings on upper bulb, sometimes appearing as narrow free incomplete limbs, reddish orange to yellowish orange (4A8 to 7A8) to vivid red, often leaving floccose to mealy remnants in substrate during collection.

Odour and *taste* not recorded.

PILEIPELLIS: 45–90 µm thick; *suprapellis* about 25–50 µm thick, comprising subradially arranged, thin-walled, branched, gelatinized, hyaline, subcolourless to light straw-yellow hyphae 1.5–6.0 µm wide, with clamps lacking; *subpellis* about 20–40 µm thick, comprising compactly arranged, densely interwoven, thin-walled filamentous hyphae 2.0–8.0 µm wide, with vascular hyphae few, up to 6.0 µm wide, with clamps lacking. PILEUS CONTEXT: filamentous hyphae up to 7.0 µm wide, thin-walled, hyaline, branched; acrophysalides often up to 16.0 µm wide, subclavate to clavate or ellipsoid; vascular hyphae 3.0–4.5 µm wide; clamps lacking. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w}_{cs}$ = 30–40 µm; *mediostratum* with filamentous hyphae 2.0–5.0 µm wide, fairly abundant, branching, with inflated cells intercalary, long ellipsoid to clavate or subclavate to fusiform or subfusiform, 18.0–46 × 10.0–22 µm, with vascular hyphae rare; *lateral stratum* diverging at angle of 30° to mediostratum (filamentous hyphae 2.0–7.0 µm wide, fairly abundant; inflated cells fusiform to subfusiform, 15.0–35 × 10.0–20 µm; vascular hyphae rare or absent; clamps lacking). SUBHYMENIUM: 11.0–27 µm thick, with inflated-ramose arrangement comprising subglobose cells, 3.0–14.0 × 1.5–11.0 µm, often 2 to 3 in chains, with basidia arising from these cells; clamps lacking. BASIDIA: 26–52 × 9.0–19.0 µm, clavate, hyaline, thin-walled, 4-spored, sterigmata often up to 5.0 µm long; clamps lacking. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae branched, thin-walled, 1.5–2.0 µm wide; acrophysalides 93–287 × 23–50 µm; vascular hyphae few, 3.0–7.0 µm wide; clamps lacking. UNIVERSAL VEIL: *On pileus*: filamentous hyphae 1.5–10.0 µm wide, thin-walled, branched; inflated cells fairly abundant, globose to subglobose to ellipsoid, 18.0–60 × 11.0–50 µm, often in short terminal chains of 3 to 4, with few clavate to subclavate cells, up to 55 × 35 µm; vascular hyphae rare; clamps lacking. *On stipe base*: similar to that on pileus, but with proportionately more frequent filamentous hyphae. PARTIAL VEIL: filamentous hyphae 1.5–7.0 µm wide, abundant to fairly abundant, branched; inflated cells terminal, clavate to subclavate, 28–70 × 11.0–19.0 µm; clamps lacking. MARGINAL TISSUE OF LAMELLAE: filamentous hyphae 2.0–6.0 µm wide, thin-walled; clavate to pyriform cells dominant, 19.0–54 × 13.0–32 µm, terminal, single or in chains of 2 to 3.

BASIDIOSPORES: [76/2/2] (6.6) 7.5–9.1 (10) × (5.8) 6.6–8.3 (10) µm; (**L** = 7.8–8.2 µm; **L′** = 8.0 µm; **W** = 7.0–7.8 µm; **W′** = 7.4 µm; **Q** = 1.0–1.12 (1.25); **Q** = 1.05–1.10; **Q′** = 1.07, globose to subglobose, sometimes broadly ellipsoid, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus small; contents often monoguttulate; deposit white.

Material examined: **INDIA**: UTTARAKHAND—Pauri Garhwal - Chobattakhal, 28.ix.2002 K.C. Semwal 557 (GUH-M 20630); Khirsu, 23.ix.1999 K.C. Semwal 063 (GUH-M 20231).

Habitat and distribution: Solitary to scattered, sometimes gregarious. On humicolous soil, under *Quercus leucotrichophora, Rhododendron arboreum* and *Myrica esculenta*. Originally described from Japan (protologue), also reported from Malaya (Corner & Bas 1962), China (Yang 1997, 2005), Korea (Kim et al. 1993), and Nepal (Adhikari et al. 1994) (in *Castanopsis-Schima* forest as well as with *Quercus*).

DISCUSSION: The present species in its macro- and microscopic details agrees well with the description of *A. rubrovolvata* given by Yang (1997). It is a very widely distributed *Amanita* species from eastern Asia and fairly common in the forests of Garhwal Himalaya. It was earlier reported as *A. muscaria* var. *flavivolvata* (Singer) Dav. T. Jenkins from Himachal Pradesh (Kumar et al. 1990; Bhatt et al. 2003).

Additional collections of this species were examined by Yang (pers. corresp.) and Tulloss and yielded the following supplementary data:

Basidiospores: [137/6/6] (6.0) 6.7–8.8 (12.5) × (5.5) 6.4–8.0 (10.4) µm, (**L** = 7.0–8.5 µm; **L'** = 7.8 µm; **W** = 6.6–7.7 µm; **W'** = 7.2 µm; **Q** = (1.02) 1.03–1.15 (1.34); **Q** = 1.06–1.10; **Q'** = 1.08).

Extralimital material examined: **CHINA**: PROV. YUNNAN—Pingbian - Daweishan, 4.vii.1992 Z.L. Yang 1887 (HKAS 32511). **INDIA**: HIMACHAL PRADESH—Shimla - Narkanda, Hattoo Peak, 18.viii.1986 T.N. Lakhanpal & A. Kumar s.n. (HPUB 4359 (n.v.); BPI 71986, as "*A. muscaria* var. *flavivolvata*"). **JAPAN**: HONSHU—Nagakano-ken - Togakushi-Kôgen, 4.x.1976 T. Hongo 5566 (*herb.* T. Hongo). Shiga-ken - Ôtsu-city, Ishiyama-dera, 6.vii.1953 T. Hongo 692 (*herb.* T. Hongo). **NEPAL**: CENTRAL DEVELOPMENT REGION—Bagmati Zone - Bhaktapur Distr., Nala (10 km NE of Bhaktapur City, E of Kathmandu), n.d. H.R. Bhandary 2046 (RET); Kathmandu Distr., Shivapuri, n.d. H.R. Bhandary 2047 (RET). No locale, purchased in market, 23.vii.1994 H.R. Bhandary 2029 (RET).

Habitat and distribution: Solitary to scattered to subgregarious. China: At 1100–3500 m elev. With *Castanopsis* and *Lithocarpus*. India (Himachal Pradesh): At 2700 m elev. Under *Quercus dilatata* Royle and *Pinus wallichiana* A.B. Jacks. Japan: At 1000± m elev. In forest of *Castanopsis cuspidata* (Thunb.) Schottky or in *Larix* forest. Nepal: In forest of *C. tribuloides*, *C. indica* (Roxb. ex Lindl.) A. DC., and *Eurya acuminata* DC.

Color illustrations of this species (including material from Uttarakhand) can be found on-line at (Tulloss 2007c). This is the first report in detail for India of the present species under its correct name.

3. *Amanita subglobosa* Zhu L. Yang, 1997. Biblioth. Mycol. 170: 18, Abb. 5–9. **Fig. 4 (A–E)**

PILEUS: 60–130 mm wide, hemispherical at first, convex to plano-convex, then plane with age, leather brown to tan (6E5-6) over disc, brown to brownish orange (6D6 to 5C4) to greyish orange (5B3) away from disc, pale orange (5A3) towards extreme margin; *context* 4–6 mm thick above stipe, soft, white; *margin* tuberculate-striate, with striations 15–23 mm long (0.35±–0.5±R), nonappendiculate; *universal veil* as white to dirty white small pyramidal to irregularly conic warts, reduced to flocculence towards margin.

LAMELLAE: free to seceding, close to moderately distant, white to cream, 9–15 mm broad; *lamellulae* truncate, plentiful, of at least 4 lengths (20 to 50% length of lamellae).

STIPE: 100–185 × 10–20 mm, white, tapering upwards, slightly expanded at apex, more or less floccose-fibrillose or with reflexed squamules below annulus, sometimes pruinose; *context* white, soft, solid at first, becoming stuffed or hollow with age; *bulb* whitish, subglobose to pyriform, 24–46 × 14–26 mm; *partial veil* median to inferior, pendant, white to yellowish white, with brown to light brown edge; *universal veil* as "rolled-collar" or short limb or covered with white, floccose to mealy volval remnants sometimes forming 2–3 concentric rings on uppermost part of bulb.

Odour and *taste* not known.

PILEIPELLIS: 40–100 µm thick; *suprapellis* 30–70 µm thick, gelatinized, made up of subradially and compactly arranged, thin-walled, branched, subcolourless or straw-yellow to yellowish brown filamentous hyphae 1.5–8.5 µm wide; *subpellis* about 20–30 µm thick, made up of radially arranged, thin-walled, colourless to light straw yellow, clamped, filamentous hyphae 3.0–10.0 µm wide, with vascular hyphae often up to 13.0 µm wide. PILEUS CONTEXT: filamentous, thin-walled, frequently branched hyphae 1.5–10.0 µm wide; acrophysalides plentiful, clavate to cylindric, often up to 30 µm wide; vascular hyphae few, up to 8.0 µm wide; clamps rather frequent. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w_{cs}}$ = 55–100 µm; *mediostratum* comprising abundant filamentous hyphae 1.5–5.0 (8.0) µm wide, thin-walled, branched, with long ellipsoid to subclavate inflated cells, 65–85 × 15.0–25 µm, with vascular hyphae 4.0–7.0 µm wide; *lateral stratum* comprising fusiform to clavate or subclavate cells, 40–70 × 15–30 µm, with abundant filamentous hyphae 3.0–7.0 µm wide, diverging at an angle of 30°–60° to mediostratum, with clamps rather frequent. SUBHYMENIUM: 15–38 µm thick, with inflated branching cells 8.0–19.0 × 4.0–15.0 µm, with globose to ovate cells often up to 10.0 µm wide, and with ellipsoid cells, 13.0–20 × 8.0–12.0 µm, with all cell types in chains of 2–3 (4); basidia arising from these cells and sometimes from slightly inflated hyphal segments. BASIDIA: 38–65 × 7.0–15.0 µm, clavate, thin-walled, 4- and rarely 2-spored, with sterigmata 4.0–6.0 µm long; with basal septa clamped. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae thin-walled, branched, straw yellow, 3.0–12.0 µm wide; acrophysalides 130–370 × 13.0–48 µm; vascular hyphae not observed. UNIVERSAL VEIL: *On pileus*: consisting of globose to irregularly globose cells 28–50 µm wide, with subglobose to broadly ellipsoid cells 18.0–42 × 9.0–35 µm, with both types of cells often in chains of 3–4, with long-ellipsoid to clavate or broadly clavate, pyriform to fusiform cells 33–110 × 14.0–45 µm, with filamentous hyphae 2.0–7.0 µm wide, thin-walled, branched, often clamped, with vascular hyphae 3.0–6.0 µm wide. *On stipe base*: composed of abundant to fairly abundant filamentous hyphae 2.0–8.0 µm wide, thin-walled, frequently branched, mixed with less frequent globose to subglobose cells (20–60 × 20–55 µm), broadly clavate to clavate cells (22–50 × 10.0–22 µm), and ellipsoid cells (28–45 × 13.0–20 µm). PARTIAL VEIL: filamentous hyphae 1.5–7.0 µm wide, abundant to fairly abundant, thin-walled, branched; inflated cells clavate to subclavate, 55–100 × 8.0–25 µm, with occasional globose to irregularly subglobose cells, 28–45 × 20–40 µm. MARGINAL TISSUE OF LAMELLAE: inflated cells, 21–30 × 9.0–16.0 µm, broadly clavate, thin-walled, hyaline.

Basidiospores: [75/2/2] 7.5–10 (10.8) × (5.8) 6.6–8.3 (9.1) µm; (**L** = 8.7 µm; **L'** = 8.7 µm; **W** = 6.9–7.4 µm; **W'** = 7.2 µm; **Q** = 1.11–1.37 (1.50); **Q** = 1.16–1.26; **Q'** = 1.21), broadly ellipsoid to ellipsoid, sometimes subglobose, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus up to 1.6 µm long; contents usually with single refractive guttule; deposit white.

Material examined: **INDIA**: UTTARAKHAND—Pauri Garhwal - Nagdev, 5.vii.2000 K.C. Semwal 151 (GUH-M 20255), 25.viii.2002 K.C. Semwal 511 (GUH-M 20581).

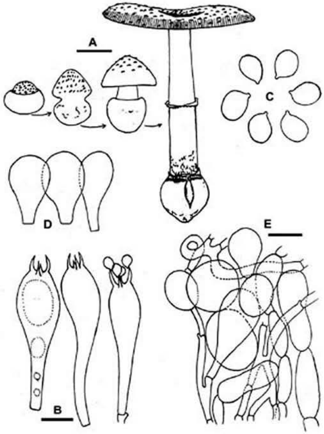

Fig. 4. *Amanita subglobosa* (K.C. Semwal 511). A) Basidiome and its development from a late stage primordium. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Elements of universal veil from pileus, slightly crushed.

Habitat and distribution: Solitary to scattered; growing on humicolous soil, under *Cupressus torulosa* D. Don, *Cedrus deodara*, and *Quercus leucotrichophora*. *Amanita subglobosa* was originally described from China and seems to be quite common in many parts of that country (Yang 1997, 2005).

DISCUSSION: The anatomic details of this species match rather closely with those of *A. subglobosa* (protologue), except the annulus is median to inferior and the basidiospores are relatively smaller in the populations from Garhwal Himalaya, India (possibly due to impact of collecting or drying on the exsiccata). Additionally, Yang (1997) describes brown vacuolar pigment in the pileipellis and universal veil elements. He describes incrustations on hyphae in some tissues. Brownish pigmented and incrusted hyphae were not found in the

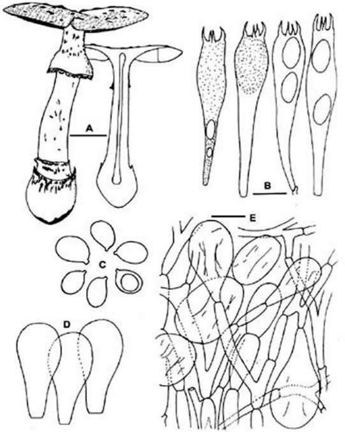

Fig. 5. *Amanita* sp. PAK5 (K.C. Semwal 502). A) Basidiome with longitudinal section. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Elements of universal veil from pileus, slightly crushed.

above described specimens. Yang (pers. corresp.) suggests that these latter two characters might be lost due to gelatinization of the pileipellis and adjacent portions of volval remnants on the pileus. We are faced with a question for which there is no present answer: What is the range of variation of the characters in question within *A. subglobosa*? While we are looking for more collections to justify our identification, we have decided to follow the suggestion of the species' author—treat our cited material under the name *A. subglobosa*.

Color illustrations of the present species (including material from Uttarakhand) can be found on-line at (Yang 2007). The present species is described here in detail for the first time from India.

4. *Amanita* sp. PAK5 **Fig. 5 (A–E)**

PILEUS: 50–95 mm wide, hemispheric at first, becoming convex to plano-convex and finally plane, slightly depressed at centre, greyish yellow (4B–C3) to pale yellow or cream (2A3, 4A3–4), somewhat brownish orange (5C5) over disc, viscid when wet; *context* 3–6 mm thick above stipe, soft, white; *margin* tuberculate-striate, with striations 5–18 mm long (0.2–0.3R), non-appendiculate; *universal veil* as small, randomly arranged, floccose-felted to cottony patches, sometimes as irregularly pyramidal warts over disc, whitish to dirty white or yellowish white, adnate to detersile.

LAMELLAE: free, crowded to close, white to pale cream, 3–8 mm broad; *lamellulae* truncate, of at least 5 lengths (25 to 50% length of lamellae).

STIPE: 80–160 × 9–15 mm, usually tapering upward, apex slightly expanded, white to yellowish white, ornamented with very few appressed fine fibrils above partial veil, more or less fibrillose below it; *context* whitish to light lemon yellowish, soft, fibrous; *bulb* 22–40 × 14–20 mm, subglobose to ovate, whitish; *partial veil* superior to median, pendant, thick, with upper surface whitish to yellowish, with lower surface light brownish orange with a golden yellowish edge; *universal veil* short, appressed-limbate, sometimes in form of floccose or felted patches or warts near apex of basal bulb, white to pallid.

Odour indistinct. *Taste* mild.

PILEIPELLIS: 100–180 µm thick; *suprapellis* $60^{\pm}$–$110^{\pm}$ µm thick (filamentous hyphae 1.5–7.0 µm wide, gelatinized, subradially arranged to interwoven, thin-walled, branched; vascular hyphae up to 7.0 µm wide, clamps rare); *subpellis* $40^{\pm}$–$70^{\pm}$ µm thick (filamentous hyphae 2.0–8.0 µm wide, subradially and compactly arranged, thin-walled; vascular hyphae rare, up to 6.5 µm wide; clamps rare). PILEUS CONTEXT: filamentous hyphae often constricted at septa, 2.0–10.0 µm wide, thin-walled, branched, with hyphal tip cells inflated; acrophysalides clavate to narrowly clavate, often up to 30 µm wide; vascular hyphae rare, up to 7.5 µm wide; clamps rare. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w_{cs}}$ = 40–60 µm; *mediostratum* with filamentous hyphae 2.0–5.0 µm wide, branched, thin-walled, fairly abundant, with inflated cells often up to 45 × 15 µm and long-ellipsoid to cylindric, with vascular hyphae rare, with clamps present; *lateral stratum* with filamentous hyphae fairly abundant to abundant, 3.0–7.0 µm wide, frequently branched, diverging at 30°–60° to central stratum, with long ellipsoid to subfusiform inflated cells often up to 35 × 15.0 µm, with clamps rather common. SUBHYMENIUM: 46–60 µm thick, comprising inflated-branching cells (11.0–18.0 × 7.0–10.0 µm), with subglobose to globose cells up to 20 µm wide, and with partially inflated hyphal segments, with basidia arising from all cell types. BASIDIA: 43–66 × 8.0–13.0

µm, clavate, 4- and sometimes 2-spored; sterigmata up to 7.0 µm long; clamps rare. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae 1.5–5.0 µm wide; acrophysalides clavate to long-cylindrical, 79–300 × 19.0–37 µm; vascular hyphae up to 14.0 µm wide; clamps rare. PARTIAL VEIL: filamentous hyphae 2.0–8.0 µm wide, abundant, branched; inflated cells subglobose to broadly clavate to subclavate, 20–55 × 7.0–17.0 µm; vascular hyphae scattered up to 8.0 µm wide; clamps not observed. UNIVERSAL VEIL: O*n pileus*: filamentous hyphae 3.0–9.0 µm wide, thin-walled, branched; clamps rare; inflated cells fairly abundant, ellipsoid to subglobose to ovoid (35–70 × 25–42 µm, often in short chains) and clavate to broadly clavate to cylindric (30–85 × 9.0–24 µm); vascular hyphae few; clamps present. *On stipe base*: similar to material on pileus, except having proportionately more abundant, densely interwoven, filamentous hyphae. MARGINAL CELLS OF LAMELLAE: inflated cells clavate to broadly clavate or ellipsoid, 22–42 × 9.0–20 µm, terminal, single or in chains of 2 to 3; filamentous hyphae abundant to scattered, 2.0–6.0 µm wide, thin-walled, subcolourless to colourless.

BASIDIOSPORES: [105/3/2] (6.6) 7.5–10.0 (10.8) × (4.5) 5.8–7.5 (8.3) µm; (**L** = 8.1–8.8 µm; **L´** = 8.4 µm; **W** = 5.9–6.8 µm; **W´** = 6.4 µm; **Q** = (1.10) 1.12–1.50 (1.57); **Q** = 1.28–1.37; **Q´** = 1.31), broadly ellipsoid to ellipsoid, sometimes subglobose, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus 0.8–1.6 µm long; contents usually as single refractive guttule; deposit white.

> *Material examined*: **INDIA**: UTTARAKHAND—Pauri Garhwal - Nagdev, 5.vii.2002 K.C. Semwal 150 (GUH-M 20354), 23.viii.2002 K.C. Semwal 502 (GUH-M 20571).

Habitat and distribution: Solitary to gregarious. Growing under *Cedrus deodara* and *Cupressus torulosa*.

DISCUSSION: This species is assignable to *Amanita* section *Amanita* because of its combination of inamyloid basidiospores and a bulbous stipe base. We have used a provisional code introduced for a Pakistani taxon (Tulloss et al. 2001) and expanded upon with some taxonomic detail by Tulloss et al. (to appear). *Amanita* sp. PAK5 can placed with the gemmatoid taxa of section *Amanita* because of its membranous universal veil limb that arises from the stipe's bulb and its rarity of basidial clamps.

Among southern and eastern Asian taxa, *A.* sp. PAK5 macroscopically and (as far as is known to date) microscopically resembles *A. altipes* Zhu L. Yang et al., described from China; but the latter differs in having a friable yellow universal veil not leaving a membranous limb at the stipe base and much broader, globose to subglobose spores—(7.5) 8.0–10.0 (11.5) × (7.0) 7.5–9.5 (10.0) µm, (**Q** = 1.0–1.14 (1.20); **Q'** = 1.07 ± 0.04) (Yang et al., 2004). The ranges of spore width in the two taxa overlap only minimally.

The east Asian *A. parvipantherina* Zhu L. Yang et al. (=*A. pantherina* var. *lutea* W.F. Chiu) differs from the present species by its stipe bulb's bearing flocculose to granular remnants of the universal veil, its darker pileus having more pronounced shades of brown, its production of smaller basidiomes, its having larger spores—[360/14/7] (8.0) 8.5–11.5 (13.5) × (6.0) 6.5–8.5 (9.0) µm, (**Q** = (1.13) 1.22–1.54 (1.62); **Q'** = 1.38 ± 0.10), etc. (Yang 1997, 2005; Yang et al. 2004).

European taxa that most require comparison with the present species are *A. eliae* Quél. and *A. gemmata* (Fr.) Bertill. sensu lato; the most similar North American taxon is *A. russuloides* (Peck) Sacc. All three of these taxa have a membranous or submembranous, irregularly limbate volva on the stipe's basal bulb or at the stipe's base.

Amanita eliae differs from the present taxon by its pileus color (eventually becoming "rosé fauve"), its growth habit with much of the stipe buried in the substrate, and its spore size and shape—(based on 80 spores) (10) 10.5–13 (15) × (6) 6.5–9 µm, (**Q** = (1.25) 1.28–1.86; **Q** = 1.43–1.58 (Neville & Poumarat 2004). Migliozzi & Camboni (2000) provide similar measurements based on an unstated number of measurements made from an Italian (Prov. Roma) collection: 10.5–12.5 (13.5) × (5.7) 6.3–8.4 µm, (**Q** = 1.49–1.67; **Q** = 1.56). From material of southern France, Tulloss has obtained the following spore data for *A. eliae*: [75/3/3] (9.0) 9.2–14.1 (16.0) × (5.4) 5.5–8.5 (10.0) µm, (**L** = 10.1–12.3 µm; **L'** = 11.4 µm; **W** = 6.5–7.4 µm; **W'** = 6.9 µm; **Q** = (1.24) 1.32–2.07 (2.32); **Q** = 1.58–1.80; **Q'** = 1.66).

> *Extralimital material examined (A. eliae)*: **FRANCE**: DORDOGNE—St. Michel-de-Montaigne, 18.vi.1998 F. Massart 98015 (herb. Massart; RET). GIRONDE—Pessac, 9.iv.2001 F. Massart 01002 (herb. Massart; RET). LES LANDES—Onesse, 12.v.1996 F. Massart 96017 (herb. Massart; RET).

Amanita gemmata sensu lato may eventually prove to be a "cluster" of species. The species is illustrated by Neville & Poumarat (2004) as having minimal or no marginal striations in material that appears to be mature or close to it. The species is widely reported to have a weak partial veil that is often absent at maturity. The color described in the caption of the lectotype plate is "jaune d'orée" (Neville & Poumarat 2004; Tulloss 2005); however, at present European authors treat the species as a variable one with the pileus yellowish tan in Norway, orange to yellow or yellow with a red-orange disc in France, and nearly white in some material Tulloss has received from Turkey. Unfortunately, there appears to be a typographical error in the spore data of Neville & Poumarat (2004). Tulloss' spore measurements from European material yield

[76/4/4] (7.7) 8.8–11.2 (11.5) × (5.6) 6.3–8.3 (9.3), (**L** = 9.3–10.5 µm; **L'** = 10.0 µm; **W** = 6.9–7.8 µm; **W'** = 7.5 µm; **Q** = (1.12) 1.20–1.50 (1.67); **Q** = 1.29–1.39; **Q'** = 1.35)—proportionately larger than the spores of *A.* sp. PAK5.

> *Extralimital material examined (A. gemmata)*: **NORWAY**: AKERSHUS—Frogn. Trollskogen Drobäk, 11.viii.1962 P. Wåge s.n. (O). VESTFOLD—N of Larvik, ix.1992 S. Hanson s.n. (O). **SPAIN**: CANARY ISL.—La Palma, summer.2001 R.M. Dähncke s.n. (*in herb.* R.M. Dähncke; RET). **U.K.**, ENGLAND—Berks - Egham, Windsor Great Pk., 18.x.1986 foray member s.n. (K).

Amanita russuloides was subject of a type study by Jenkins (1977, 1978). Its spore size and shape do not differ greatly from those of the present taxon (Jenkins 1978; Tulloss unpub. data), and the marginal striations of its pileus are similarly tuberculate. Its pileus is paler yellow than that of *A.* sp. PAK5; and, as its name indicates, the habit of the *A. russuloides* basidiome can suggest that of a *Russula* species. Its partial veil is white and usually lost by maturity. It is possible that further work may show *A. russuloides* and *A.* sp. PAK5 to be sister taxa.

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MYCOTAXON

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Six new smut fungi (*Ustilaginomycotina*) from Australia

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Abstract — Six new smut fungi, *Sporisorium rarum* (type on *Eulalia aurea*), *S. vermiculum* (type on *Sarga plumosa*), *S. xerofasciculatum* (type on *Xerochloa laniflora*), *Tilletia xerochloae* (type on *Xerochloa laniflora*), *T. yakirrae* (type on *Yakirra majuscula*) and *Ustilago lunata* (type on *Triodia longiceps*), are described and illustrated from central and western Australia. Keys are provided for the smut fungi on *Sarga* and *Xerochloa*.

Key words — new species, taxonomy, *Tilletiales*, *Ustilaginales*

Introduction

Many new and unusual smut fungi have been discovered in remote parts of tropical Australia in recent years (Shivas & Vánky 2003, 2005, 2007a, b, Shivas et al. 2006, Vánky et al. 2006a). During a survey in April 2007 for smut fungi on native grasses in central and north-western Australia, 129 specimens representing 39 species of smut fungi, including five new species on *Poaceae*, were collected. Two new species occurred on *Xerochloa* as well as one on each of *Eulalia*, *Sarga* and *Yakirra*. Further, an unidentified smut fungus on a specimen of *Triodia*, held in herbarium PERTH, was found to represent an undescribed species. These six species are herein described and illustrated.

Six species of smut fungi, all in the genus *Sporisorium* Ehrenb. ex Link, have been recorded on the andropogonoid grass *Eulalia* Kunth (tribe *Andropogoneae*, subtribe *Saccharinae*) (Vánky 2000, Vánky et al. 2006b). Of these, only *Sporisorium eulaliae* (L. Ling) Vánky and the following new species have been found in Australia.

Taxonomy

Sporisorium rarum **R.G. Shivas, McTaggart & Vánky, sp. nov.**

MycoBank # MB510983 Figs 1, 3-4

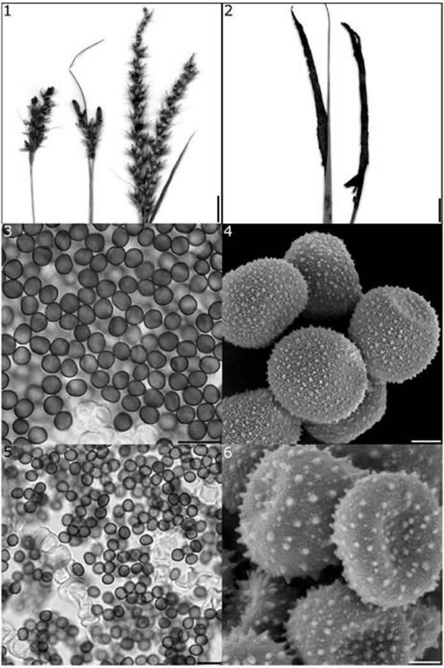
Holotypus in matrice Eulalia aurea *(Bory) Kunth (Poaceae), Northern Territory, Glen Helen Gorge, 23°43′47″S, 132°50′35″E, alt. ca. 600 m, 22.IV.2007, leg. A.R. McTaggart, J.R. Liberato, M.D.E. et R.G. Shivas (BRIP 49134). Isotypus HUV 21451.*

Etymology: derived from the Latin *rarus* meaning rare.

Sori in omnibus spiculis inflorescentiae factae ex organis internis floralibus, ovoidei-ellipsoidei, 1,0-2,5 x 1,0-1,5 m, saepe cum reliquiis involucrorum floralium sicut brevium acutorum apicum in parte distali, partim celatorum involucris externis floralibus et tectorum peridio ravido-brunneo. Fieri potest ut sori fiant ex duabus vel plurimis spicularum distalium, deinde ut sint irregulariter lobati, usque ad 9 m longi et 2 m lati. Peridium maturum ab apice rumpitur et interdum fissura longitudinali, patefaciens fuscam, semi-agglutinatam-pulveraceam massam sporarum globosarum, sporarum et cellularum sterilium cingentium simplicem, crassam columellam tam longam quam sorus. Sporae globosae forma et magnitudine variabiles, 40-125 µm longae, factae decies vel centies ex sporis laxe coniunctis quae facile secedunt. Sporae maturae singulares, globosae vel ellipsoideae-subpolyedrice irregulares, 7,0-9,5 x 6,5-9,0 µm, flavidae-brunneae; paries planus, ca. 0,5 µm crassus, in LM subtiliter, punctatus-verruculosus, facies sporarum levis, in SEM densius, paulum echinulata, inter spinas dense, minute verruculosa. Cellulae steriles singulares, binatae vel in gregibus parvis, irregularibus, persistentibus, cellulae singulares globosae, ellipsoideae vel irregulares, rotundatae in pagina libera, complanatae in paginis laterum contactorum, 6-16 (-20) µm longae, hyalinae-flavae colore, cum nonnullis guttis olei in quaque cellula, paries 0,8-1,5 µm crassus.

Sori in all spikelets of an inflorescence comprising the inner floral organs, ovoid to ellipsoidal, 1.0–2.5 × 1.0–1.5 mm, often with remnants of floral envelopes as short acute tips on their distal part, partly hidden by the outer floral envelopes and covered by a greyish brown peridium. The sori may comprise two or several of the distal spikelets, then may be irregularly lobed, up to 9 mm long and 2 mm wide. At maturity the peridium ruptures from its apex and sometimes by a longitudinal split, exposing the blackish brown, semi-agglutinated to powdery mass of spore balls, spores and sterile cells surrounding a simple, stout, narrowing columella the length of the sorus. **Spore balls** variable in shape and size, 40–125 µm long, composed of tens to hundreds of loosely connected spores which readily separate. **Spores** when mature single, globose or ellipsoidal to subpolyhedrally irregular, 7.0–9.5 × 6.5–9.0 µm, yellowish brown; wall even, ca. 0.5 µm thick, in LM finely, moderately punctate-verruculose, spore profile smooth, in SEM moderately densely, low echinulate, between the spines densely, minutely verruculose. **Sterile cells** single, in pairs or in small, irregular, persistent groups, single cells globose, ellipsoidal or irregular, rounded on the free surface, flattened on the contact surfaces, 6–16 (–20) µm long, hyaline to yellow tinted, with a few oil drops in each cell, wall 0.8–1.5 µm thick, smooth.

Host and distribution: Known only from the type specimen on *Eulalia aurea* in the Northern Territory.



Figs 1, 3–4. *Sporisorium rarum*. 1. Host symptoms (bar = 1 cm) 3. Spores and sterile cells under light microscope (bar = 20 µm). 4. Spores under SEM (bar = 2 µm). **Figs 2, 5–6.** *Sporisorium vermiculum*. 2. Host symptoms (bar = 1 cm). 5. Spores and sterile cells under light microscope (bar = 10 µm) 6. Spores under SEM (bar = 1 µm).

Sporisorium rarum has much smaller spores than *S. eulaliae*, which has spores that measure 9.5–15.0 × 8–12 µm. *S. rarum* is most similar to *S. guangxiense* L. Guo, which occurs in China on *Eulalia pallens* (Hack.) Kuntze. The spores of *S. rarum* are more regular, larger, and have thinner, more uniform spore walls than the spores of *S. guangxiense*, which are variable in shape and size, measure 4–7(–8) × 5.5–9 µm, with an unevenly thick, spore wall measuring 0.5–1(–1.5) µm.

Five species of smut fungi have been recorded on the andropogonoid grass *Sarga* Ewart (tribe *Andropogoneae*, subtribe *Arthraxoninae*) (Vánky & Shivas 2001). A further species is described and a key provided for the smut fungi on *Sarga*.

Sporisorium vermiculum R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510984 **Figs 2, 5-6**

Holotypus in matrice Sarga plumosa *(R. Br.) Spangler, (Poaceae), Western Australia, Lake Campion, 17°49'10"S, 122°44'26"E, alt. ca. 30 m, 8.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49748). Isotypus HUV 21456.*

Etymology: derived from the Latin *vermiculus* meaning a small worm in reference to the chains of sterile cells.

Sori totam inflorescentiam delentes, 7-12 cm x 1,5-3,5 mm, primo tecti crasso, brunneo peridio quod irregulariter rumpitur, patefaciens fuscam pulveraceam massam sporarum et cellularum sterilium cingentium simplicem, crassam columellam tam longam quam sorus. Sporae singulares, globosae, subglobosae-ellipsoideae, 4,5-5,5 x 4,5-5,0 µm, flavidae-brunneae; paries planus, ca. 0,5 µm crassus, minute verruculosus; facies sporarum levis. Cellulae steriles plerumque in catenis longis usque ad 250 µm longis, cellulae singulares variabili forma et magnitudine, globosae, ellipsoideae, plerumque irregulares, duobus lateribus complanatis, 5-12(-15) µm longae, hyalinae, interdum subhyalinae, colore flavido, contento homogeneo; paries 0,5-1,0 µm crassus, levis.

Sori destroying the whole inflorescence, 7–12 cm × 1.5–3.5 mm, initially covered by a thick, brown peridium which ruptures irregularly exposing the dark brown, powdery mass of spores and sterile cells surrounding a simple, stout, tapering columella as long as the sorus. **Spores** when mature single, globose, subglobose to ellipsoidal, 4.5–5.5 × 4.5–5.0 µm, yellowish brown; wall even, ca. 0.5 µm thick, minutely verruculose; spore profile smooth. **Sterile cells** mostly in chains up to 250 µm long, single cells of variable shape and size, globose, ellipsoidal, usually irregular with two flattened sides, 5–12(–15) µm long, hyaline, occasionally subhyaline with pale yellow tint, content homogeneous; wall 0.5–1.0 µm thick, smooth.

Additional specimens examined (paratypes). — On *Sarga plumosa* [*Sorghum interjectum* Lazarides, *Sorghum plumosum* (R. Br.) P. Beauv.], Western Australia: 70 km E of Broome, 7.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley & R.G. Shivas* (BRIP 49750); Kununurra, 13.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. & R.G. Shivas* (BRIP 49767).

Host and distribution: Occurs on *Sarga plumosa* across northern Western Australia.

Sporisorium vermiculum lacks spore balls and has small spores, which indicates similarity with *Tranzscheliella* Lavrov. *S. vermiculum* is one of six smut fungi that infect *Sarga* in Australia. It has very small spores as does *Sporisorium ryleyi* Vánky & R.G. Shivas, which infects individual ovaries. *S. vermiculum* is distinctive in that it destroys the whole inflorescence and has long chains of sterile cells. Long, rather uniform chains of sterile cells are typical for members of the genus *Franzpetrakia* Thirum. & Pavgi (comp. Vánky, 2002: 66-67), which differs from *Sporisorium*, i.a., in having typically reticulate spores.

Key to the smut fungi on *Sarga*

1a. Sori destroying the entire inflorescence 2
1b. Sori in the ovaries or spikelets 3

2a. Spores 4.5–5.5 µm long .... ***Sporisorium vermiculum***
2b. Spores 5.5–9.0 (–10) µm long .... ***Ustilago porosa*** Langdon

3a. Sori in hypertrophied ovaries
.... ***Macalpinomyces ewartii*** (McAlpine) Vánky & R.G. Shivas
3b. Sori in the spikelets 4

4a. Spores darker on one side
.... ***Sporisorium wynaadense*** (Sundaram) Vánky & R.G. Shivas
4b. Spores not darker on one side 5

5a. Spores 4.5–6.5 (–7.0) µm long .... ***Sporisorium ryleyi***
5b. Spores 8–11 µm long, with a light germ pore
.... ***Sporisorium australasiaticum*** Vánky & R.G. Shivas

Only one smut fungus, *Ustilago xerochloae* Vánky & R.G. Shivas, has been reported on the panicoid grass *Xerochloa* R. Br. (tribe *Paniceae*, subtribe *Spinificinae*), which contains three species, two of which are Australian endemics (Macfarlane 1992). During our survey we collected a *Sporisorium* sp. and a *Tilletia* sp. on *Xerochloa laniflora*, which are both described as new species. A key is also provided for the smut fungi on *Xerochloa*.

Sporisorium xerofasciculatum R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510985 Figs 7, 9-10

Holotypus in matrice Xerochloa laniflora *Benth. (Poaceae), Western Australia, inter Halls Creek et Kununurra, 18°03'51"S, 127°48'04"E, alt. ca. 400 m, 11.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49682). Isotypus HUV 21453.*

Etymology: derived in part from the host *Xerochloa* and the Latin *fasciculus* meaning a small bundle in reference to the filiform columellae.

Sori inflorescentias monadis delentes, facti ex omnibus (1-4) spiculis et rhacidi lanata, bracteas florales intactas relinquentes, visi corpus cylindraceum, saepe curvum, 10-25 x 2-5 mm, ultra spatham coreaceam protrudentes, peridio firmo cano tecti quod irregulariter rumpitur, patefaciens massam fuscam pulveraceam laxarum sporarum globosarum et sporarum cingentium plurimas (plures quam decem) columellas longas filiformes. Sporae plerumque globosae, subglobosae, ellipsoideae vel parum subpolyedrice irregulares, 5,5-10,5 x 5-9 µm, flavidae-brunneae; paries ca. 0,5-0,8 µm crassus, densius verruculosus; facies sporarum levis-subtiliter serrulata. Cellulae steriles singulares, gregibus irregularibus, ordinibus vel fasciculis catenarum, cellulae singulares, globosae, ellipsoideae, elongatae, irregulares lateribus complanatis, 6,5-11,0 µm, hyalinae; paries ca. 0,5 µm crassus, levis.

Sori destroying the unit inflorescences, comprising all (1–4) spikelets and the woolly rachis, leaving intact the floral bracts, appearing as a cylindrical, often curved body, 10–25 × 2–5 mm, protruding beyond the coriaceous spathe, covered by a thick, grey peridium, which ruptures irregularly exposing the blackish brown, powdery mass of loose spore balls, spores and few sterile cells surrounding numerous (more than 10), long, filiform, columellae. **Spores** when mature single, globose, subglobose, ellipsoidal to subpolyhedrally slightly irregular, 5.5–10.5 × 5.0–9.0 µm, yellowish brown; wall even to slightly uneven, 0.5–0.8 µm thick, finely, moderately densely verruculose; spore profile smooth to finely serrulate. **Sterile cells** single, in irregular groups, in rows or fascicles of chains, single cells globose, ellipsoidal, elongated, irregular with flattened sides, 6.5–11.0 µm, hyaline; wall ca. 0.5 µm thick, smooth.

Additional specimens examined (paratypes). — On *Xerochloa barbata* R. Br., Western Australia: 5 km SE Broome, 28.III.1996, *A.A. Mitchell* (BRIP 26806b); Broome, 8.IV.2007, *A.R. McTaggart, T.S. Marney, M.J. Ryley & R.G. Shivas* (BRIP 49739b); Derby, 9.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. & R.G. Shivas* (BRIP 49724b).

Hosts and distribution: Occurs on *Xerochloa barbata* and *X. laniflora* in northern Western Australia.

Sporisorium xerofasciculatum differs from *Ustilago xerochloae*, which has sori without columellae and larger spores (8–14 × 7–13 µm).

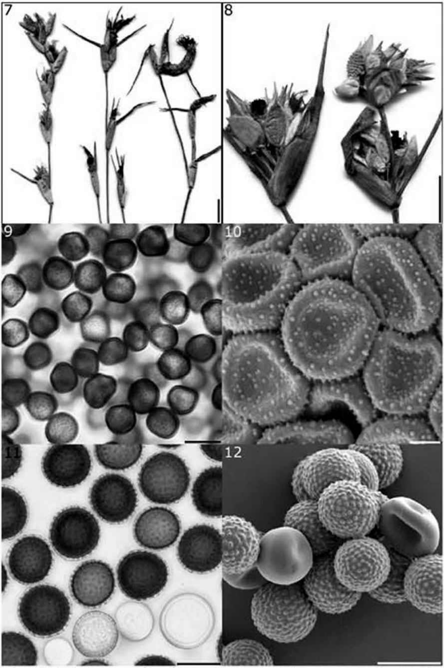
Tilletia xerochloae R.G. Shivas, McTaggart & Vánky, sp. nov.

MycoBank # MB510986 Figs 8, 11-12

Holotypus in matrice Xerochloa laniflora *Benth. (Poaceae), Western Australia, inter Broome et Derby, Cockatoo Ck, 17°44'29"S, 123°34'42"E, alt. c 50 m, 8.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49744a). Isotypus HUV 21455.*

Etymology: derived from the host plant *Xerochloa*.

Sori in aliquibus ovariis in inflorescentia, ellipsoidei-citriformes, 2-3 x 1,5-2,0 mm, plerumque celati involucris floralibus, virides immaturi, fusci-nigri maturi, longitudinaliter secedentes ab apice et ita patefacientes massam nigram pulveraceam sporarum mixtarum cellulis sterilibus. Sporae globosae, subglobosae, raro late ellipsoideae, 21-28(-30) x 21-27 µm, brunneolae-castaneae vel etiam subopacae; paries 2,5-3,0 µm crassus (cum



Figs 7, 9–10. *Sporisorium xerofasciculatum*. 7. Host symptoms (bar = 1 cm). 9. Spores under light microscope (bar = 10 µm). 10. Spores under SEM (bar = 2 µm). **Figs 8, 11–12.** *Tilletia xerochloae*. 8. Host symptoms (bar = 5 mm). 11. Spores and sterile cells under light microscope (bar = 20 µm). 12. Spores and sterile cells under SEM (bar = 20 µm).

> *ornamentis), densius, manifeste, subechinulatus, qui ab aspectu superficiali maculas rotundatas vel paulum irregulares, atriores patefacit, ca. 1-1,5 µm diametro, 8-13 per sporam diametro, ab aspectu mediano opticali spinas 1-1,5 µm altas, 36-48 in sporarum ambitu patefacit, in vagina hyalina inclusas quae spinarum apicem aequat vel paulum excedit. Cellulae steriles, globosae, subglobosae, raro late ellipsoideae vel subpolyhedraliter paulum irregulares, 12-50 µm longae, subhyalinae-brunneolae; paries 1,5-6 µm crassus, 2-3(-4)-stratus, levis vel vestigialibus ornamentis, raro hyalina papilla vel etiam vestigio angusto myceliali.*

Sori in some ovaries of an inflorescence, ellipsoidal to lemon-shaped, 2–3 × 1.5–2.0 mm, mostly hidden by the floral envelopes, green when immature, dark brown to black at maturity, splitting longitudinally from the apex to expose the black, powdery mass of spores intermixed with sterile cells. **Spores** globose or subglobose or rarely broadly ellipsoidal, 21–28(–30) × 21–27 µm, pale to dark chestnut brown or even subopaque; wall 2.5–3.0 µm thick (incl. ornamentation), moderately densely, prominently, low-echinulate which in surface view appear as rounded or slightly irregular, darker spots, ca. 1–1.5 µm diam., 8–13 in spore diam., in optical median view appearing as 1–1.5 µm high spines, 36–48 on the spore circumference, embedded in a hyaline sheath equalling or slightly exceeding the top of the spines. **Sterile cells** globose, subglobose, rarely broadly ellipsoidal or subpolyhedrally slightly irregular, 12–50 µm long, subhyaline to pale yellowish brown; wall 1.5–6 µm thick, 2–3(–4)-layered, smooth or with trace of ornamentation, rarely with a hyaline papilla or also a narrow mycelial remnant.

> **Additional specimens examined (paratypes).** — On *Xerochloa imberbis* R. Br. (*Poaceae*), Western Australia: Cockatoo Ck, 8.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.E., M.D.E. & R.G. Shivas* (BRIP 49741a).

Hosts and distribution: Occurs on *Xerochloa imberbis* and *X. laniflora* in northern Western Australia.

Tilletia xerochloae is the only species in the genus that has been described on *Xerochloa*, although one other species, *Tilletia opaca* Syd. & P. Syd., occurs in the subtribe *Spinificinae*, on *Spinifex* L. *Tilletia xerochloae* has smaller sori and spores with more regularly shaped, thinner walls, with fewer warts per spore diameter than *T. opaca*, which has sori 10–15 mm long and spores with 10–16 warts per spore diameter.

Key to the smut fungi on *Xerochloa*

1a. Sori with several filiform collumellae .... ***Sporisorium xerofasciculatum***
1b. Sori without collumelae 2

2a. Sori as swellings on the culms or in some spikelets; spores 8.0–12.5 µm long, finely echinulate; sterile cells absent .... ***Ustilago xerochloae***
2b. Sori in some ovaries; spores 21–28(–30) µm long, prominently echinulate; sterile cells present .... ***Tilletia xerochloae***

The only smut fungus reported on the panicoid grass *Yakirra* Lazarides & R.D. Webster (tribe *Paniceae*, subtribe *Paninae*) is *Sporisorium cryptum* (McAlpine) Vánky. A new species of *Tilletia* Tul. & C. Tul. was found on *Yakirra* in Western Australia.

Tilletia yakirrae R.G. Shivas, McTaggart & Vánky, sp. nov.

MycoBank # MB510987 Figs 13, 15-16

Holotypus in matrice Yakirra majuscula *(Benth.) Lazarides & R.D. Webster (Poaceae), Western Australia, 10 km E urbe Kununurra, 15°49'16"S, 128°50'18"E, alt. ca. 50 m, 12.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49762). Isotypus HUV 21457.*

Etymology: derived from the host plant *Yakirra*.

Sori in aliquibus ovariis paniculae, globosi usque late ellipsoidei, 3-4 x 2-3 mm, partim celati involucris intimis floralibus, tecti, brunneo, coriaceo levi peridio, quod longitudinaliter ab apice secedit, patefaciens massam nigram semiagglutinatam-pulveraceam sporarum mixtarum cellulis sterilibus. Superiores fertiles flosculi soli in spicula soros gignunt, spiculae infectae affixae ad pedicellos manent. Sporae globosae, subglobosae vel late ellipsoideae, 15-25 x 15-22 µm, flavidae-fuscae olivaceae brunneae-badiae vel subopacae; paries 2,5-5,0 µm crassus (cum ornamentis), praeditus verrucis cylindraceis, quae ab superficiali aspectu videntur maculae atriores, irregulariter polygonae, 5-11 per sporam diametro, solae vel duae vel pleraeque confluentes, facientes breves, irregulares ordines, ab aspectu mediano opticali 1,5-2,5(-3) µm altos, apice complanato vel paulum simili clavi capiti, 23-41 in sporarum ambitu. Cellulae steriles subglobosae, ellipsoideae-subpolyhedraliter irregulares, 9-40 x 7-30 µm, subhyalinae-flavidae-brunneae; paries 0,5-10,0 µm crassus, multistratus ubi crassus est; levis, verrucosus vel ornamentis rudimentalibus intermediis.

Sori in some ovaries of a panicle, globose to broadly ellipsoidal, 3–4 × 2–3 mm, partly hidden by the innermost floral envelopes, covered by a brown, leathery, smooth peridium which splits longitudinally from its apex, exposing the black, semiagglutinated to powdery mass of spores intermixed with sterile cells. Only the upper fertile floret in a spikelet develop sori, infected spikelets remain attached to the pedicels. **Spores** globose, subglobose or broadly ellipsoidal, 15–25 × 15–22 µm, pale to dark olivaceous brown to dark chocolate-brown or subopaque; wall 2.5–5.0 µm thick (including ornamentation), provided with cylindrical warts, which in surface view appear as darker, irregularly polygonal spots, 5–11 per spore diam., isolated or two or several confluent forming short, irregular rows, in optical median view 1.5–2.5(–3) µm high, with flattened or slightly nail-headed tip, 23–41 on the spore circumference. **Sterile cells** subglobose, ellipsoidal to subpolyhedrally irregular, 9–40 × 7–30 µm, subhyaline to pale yellowish brown; wall 0.5–10.0 µm thick, multilayered when thick, smooth, verrucose or with rudimentary, intermediate ornamentation.

Host and distribution: Known only from the type specimen on *Yakirra majuscula* in Western Australia.

Tilletia yakirrae is the only species of *Tilletia* that has been reported on *Yakirra*.

Four smut fungi, all species of *Ustilago* (Pers.) Roussel, occur on the endemic Australian chloridoid grass *Triodia* R. Br. (tribe *Triodieae*) (Shivas et al. 2006). During an examination of specimens held in herbarium PERTH, a further new species of *Ustilago* was found on *Triodia* from Western Australia.

Ustilago lunata R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MYCOBANK # MB510988 **Figs 14, 17-18**

Holotypus in matrice Triodia longiceps *J.M. Black (Poaceae), Western Australia, Kennedy Range, 24°40'S, 115°05'E, alt. ca. 200 m, 16.VII.1991, leg. E.M. Davison (PERTH 01700537). Isotypi BRIP 49114, HUV 21446.*

Etymology: derived from the Latin *lunatus* meaning crescent shaped in reference to the appearance under light microscopy of the spore wall, which is thicker on one side.

Sori circum caulem floralem et inflorescentiam, longi, cylindracei, ca. 10 cm longi x 1-2 mm lati, sori quoque minuti pustuliformes in apice pedicellorum et base glumarum, in exteriore pagina quoque folii inflorescentiam cingentis; primo tecti membrana argentea oriente ex hospite quae irregulariter rumpitur et sensim frangitur, patefaciens massam sporarum fuscam, primo agglutinatam deinde pulveraceam. Sporae globosae, subglobosae, vel late ellipsoideae, 5,0-7,5- (-8,0) x 4,5-7,0 μm, flavidae-brunneae, paries inaequalis, 0,5-0,8 μm crassus, tenuior in latere pallidiore, sparsim, plane verrucosus-echinulatus irregulares, quod tantum faciem sporarum tangit, praesertim in latere pallidiore.

Sori around the floral stem and inflorescence, long, cylindrical, about 10 cm long × 1–2 mm wide; also minute blister-like sori at the apex of the pedicels and base of the glumes; also on the outer leaf surface of the leaf surrounding the inflorescence; at first covered by a silvery membrane of host origin which ruptures irregularly and flakes away exposing the dark brown, first agglutinated, later powdery mass of spores. **Spores** globose, subglobose or broadly ellipsoidal, 5.0–7.5(–8.0) × 4.5–7.0 μm, yellowish brown; wall uneven, 0.5–0.8 μm thick, thinner on the lighter side, sparsely, evidently irregularly verrucose-echinulate which just affects the spore profile, especially on the lighter side.

Host and distribution: Known only from the type specimen on *Triodia longiceps* in Western Australia.

Ustilago lunata differs from *U. triodiae* Vánky, and also from all other known *Ustilago* species on *Triodia*, by smaller spores that are lighter on one side, and sparsely, evidently verrucose.

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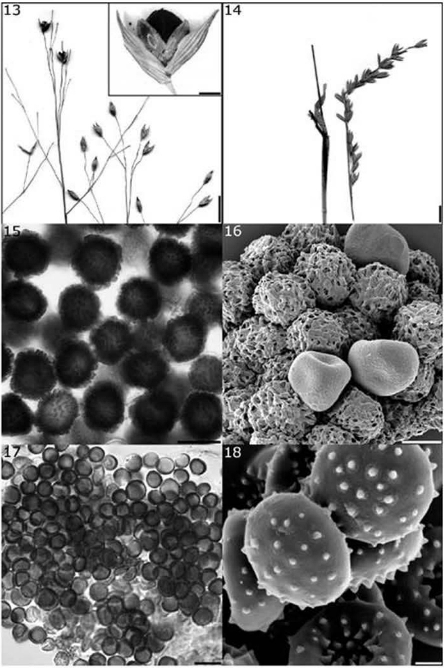

Figs 13, 15–16. *Tilletia yakirrae*. 13. Host symptoms (bar = 1 cm; inset bar = 1 mm). 15. Spores under light microscope (bar = 20 µm). 16. Spores and sterile cells under SEM (bar = 10 µm). **Figs 14, 17–18.** *Ustilago lunata*. 14. Host symptoms (bar = 1 cm). 17. Spores under light microscope (bar = 10 µm). 18. Spores under SEM (bar = 1 µm).

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MYCOTAXON

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Discula betulae comb. nov., correct name for the anamorph of *Gnomonia intermedia*

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Abstract — The anamorph of a widely distributed leaf-pathogen of birch (*Betula* spp.) is commonly known as *Discula betulina*, but this is an illegitimate name based on a superfluous nomen novum. The new combination *Discula betulae* is proposed, based on the earliest available name for this taxon. Nomenclators are presented for this taxon and two illegitimate homonyms of its basionym, and the nomenclatural history of the three taxa is discussed.

Key words — *Gloeosporium betulae, Gloeosporium betuli, Gloeosporium betulinum, Marssonina betulae, Ceuthospora betulae, Phacidium betulinum*

Introduction

In a recent paper, Green & Castlebury (2007) identified *Gnomonia intermedia* as the teleomorph of '*Discula betulina* (Westend.) Arx.' The latter name, under which the anamorph of this widely distributed leaf-pathogen of birch (*Betula* spp.) is universally known, is illegitimate and based on errors that have persisted unchallenged for 140 years. This paper corrects the errors associated with the name, and provides full nomenclators for the three homonymous taxa named as *Gloeosporium betulae*.

Methods

Synonyms of '*Gloeosporium betulae*' and '*Gloeosporium betulinum*' were compiled from the literature, from mycological abstracting publications (e.g. Saccardo 1884), and from web-based mycological databases. The protologues of all names were consulted and any nomenclatural corrections required by the International Code of Botanical Nomenclature (ICBN; McNeill et al. 2006) were applied. Corrected nomenclators were compiled for the three taxa involved.

Results

The correct nomenclators for the three taxa named as *Gloeosporium betulae* are:

Gloeosporium betulae **Westend.**, Bull. Acad. Roy. Sci. Belgique 21: 232, 1854, as '*betuli*'. [Westendorp & Wallays, Herb. Crypt. 20: no. 978, 1854, as '*betuli*'.]
≡ *Gloeosporium betulinum* J.Kickx f., Fl. Crypt. Flandres 2: 94, 1867, nom. nov. superfl.
≡ *Gloeosporidium betulinum* (J.Kickx f.) Petr., Ann. Mycol. 19: 285, 1921, nom. illegit.
≡ *Discula betulina* (J.Kickx f.) Arx, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., 2de Reeks, 51(3): 64, 1957, nom. illegit.

Teleomorph: *Gnomonia intermedia* Rehm, Ann. Mycol. 6: 489, 1908.

Gloeosporium betulae **(Lib.) J.Kickx f.**, Fl. Crypt. Flandres 2: 94, 1867, nom. illegit., non Westend. 1854.
≡ *Leptothyrium betulae* Lib., Pl. Crypt. Arduenna 2: no. 163, 1832.
≡ *Marssonia betulae* (Lib.) Sacc., Syll. Fung. 10: 477, 1892, as '*Marsonia*'.
≡ *Marssonina betulae* (Lib.) Magnus, Hedwigia 45: 89, 1906.
≡ *Marssoniella betulae* (Lib.) Höhn., Hedwigia 62: 50, 1920.

Gloeosporium betulae **Fuckel**, Jahrb. Nassauischen Vereins Naturk. 23–24: 368, 1870, nom. illegit., non Westend. 1854.
≡ *Ceuthospora betulae* Arx, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., 2de Reeks, 51(3): 63, 1957, nom. nov., as '(Fuckel) Arx, comb. nov.'

Teleomorph: *Phacidium betulinum* Mouton, Bull. Soc. Roy. Bot. Belgique 39: 50, 1900.

Discussion

It appears to have been accepted universally, but mistakenly, for 140 years that: (1) the name *Gloeosporium betulae* was validly published by Montagne in 1849; and (2) Westendorp (in either 1854 or 1867) published a taxon named *Gloeosporium betulinum*. Both of these misconceptions appear to have originated from Kickx (1867), the first from an erroneous citation, and the second through misinterpretation of another citation that is correct, although slightly cryptic.

Kickx (1867: 94) gave the erroneous citation "***G. betulae*** Mont. *Ann. des. sc. nat.* tom. 12 (1849), p. 296" for the combination of *Leptothyrium betulae* in *Gloeosporium*. The reference is to Montagne (1849), where Desmazières & Montagne published the new genus, *Gloeosporium*, and a single new species, *G. castagnei*. On p. 296 of Montagne (1849), seven additional taxa (five of them Libert's) were reported to belong in the new genus, but *Leptothyrium betulae* was **not** one of them—moreover, only three of these seven taxa were validly published in *Gloeosporium* (ICBN Art. 33.1), as *G. berkeleyi*, *G. notarisii*, and *G. ribis*. The combination of *Leptothyrium betulae* in *Gloeosporium* was, in fact, not made until 1867, by Kickx himself. The erroneous attribution to Montagne

(1849) has been perpetuated by Saccardo (1881: t. 1028; 1884: 714) and von Arx (1957: 62; 1970: 101), and in the secondary literature.

Kickx (1867: 94) also cited a separate taxon as "*G. **betulinum*** West. (*Betuli*) Not. IV, p. 7 – West. *Herb. crypt.* fasc. 20, n° 978", referring to the name *Gloeosporium betuli* published by Westendorp (1854) and the exsiccata specimens distributed under the same name (Westendorp & Wallays 1854: no. 978). Westendorp's epithet *betuli*, intended as the genitive of the host genus *Betula*, is a grammatical error[*] that must be corrected to *betulae* (ICBN Art. 32.7). Kickx (1867: 95) commented on the danger of confusion between the names *G. betulae* and *G. 'betuli'*, and renamed the latter as *G. betulinum*, presumably thinking that *G. betulae* dated from 1849 and therefore had priority over *G. 'betuli'* 1854. On the contrary, *G. betulae* Westend. 1854 has priority over the illegitimate homonym *G. betulae* (Lib.) J.Kickx f. 1867. Because Westendorp's name is legitimate, Kickx's nomen novum *G. betulinum* is superfluous, and therefore illegitimate and to be rejected (ICBN Art. 52.1). In Saccardo (1884: 715) and von Arx (1957: 64; 1970: 102), *G. betulinum* is referred to the Westendorp exsiccata (which actually uses the name *'betuli'*) and to Kickx (1867). Some secondary sources attribute *G. betulinum* to 'Westend. ex J.Kickx f.', but there is nothing in the text of Kickx (1867) to indicate that the nom. nov. was anything other than Kickx's creation. Both Petrak's (1921) combination *Gloeosporidium betulinum* and von Arx's (1957) combination *Discula betulina* are illegitimate (ICBN Art. 52.1) because the epithet of the type (*Gloeosporium betulae* Westend.) was available and ought to have been adopted. As *Discula* is currently accepted as the appropriate genus for this taxon, a new combination is proposed here:

Discula betulae (Westend.) Pennycook, **comb. nov.**
MycoBank MB 511036
Basionym: *Gloeosporium betulae* Westend., Bull. Acad. Roy. Sci. Belgique 21: 232, 1854, as '*betuli*'.

A third taxon named as *Gloeosporium betulae* by Fuckel (1870) is clearly an illegitimate later homonym of Westendorp's taxon. Consequently, the currently accepted name, *Ceuthospora betulae*, published by von Arx (1957) as a comb. nov. based on Fuckel's name, must be interpreted as a nom. nov. (ICBN Art. 58.1). *Gloeosporium betulae* Fuckel was mistakenly synonymised with *Gloeosporium betulae* (Lib.) J.Kickx f. by Saccardo (1881: t. 1028; 1884: 715).

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[*] Westendorp may have been confused by three earlier names (and their derivatives) in which the orthography *betuli* was used appropriately: *Sphaeria betuli* Pers., Neu. Mag. Bot. 1: 83, 1794; *Peziza betuli* Alb. & Schwein., Consp. Fung. Lusat.: 309, 1805; and *Peziza betuli* Pers., Mycol. Eur. 1: 325, 1822, nom. illegit. For each of these, the epithet is the correct genitive of the epithet of the host, *Carpinus betulus* L. (hornbeam). This also applies to two later names: *Leptothyrium betuli* Oudem., Ned. Kruidk. Arch., 3e Ser. 2: 347 1900; and *Hendersonia betuli* Verpl. & Van den Broecke, Bull. Soc. Roy. Bot. Belgique, 2e Sér., 19: 85, 1936.

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Tremella versicolor, an uncommon species new to south Europe (Italy)

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Abstract — While examining fungi on dead wood, a gelatinous basidiomycete parasitic on *Peniophora cinerea* was found on dead branches of *Tilia platyphyllos*. The fungus was identified as *Tremella versicolor*, a rarely collected and infrequently illustrated species, well characterized by its minute, yellow-red, apothecia-like basidiomes, by growing on *Peniophora* spp., and by mainly relying on conidia for reproduction. Its taxonomy, ecology and host range are discussed.

Key words — *Tremellales*, mycoparasitism, conidial stage

Introduction

The genus *Tremella* (*Basidiomycota, Agaricomycotina, Tremellomycetes, Tremellales, Tremellaceae*; Vizzini 2004, Hibbett 2006) encompasses wood-inhabiting fungi usually characterized by lobate, cerebriform, or circumvoluted gelatinous basidiomes (even if in some species the basidiomes are lacking); 2-4 chambered, longitudinally cruciate-septate not (or only shortly) catenate basidia, basidiospores germinating by budding or repetition; mostly clamped hyphae; a mycoparasitic lifestyle (Bandoni 1987a, 1995; Chen 1998). According to the species, size of the basidiomes ranges from 0.5-2 mm to several centimetres. In some species the basidiomes have a central fleshy core of host hyphae.

In the genus *Tremella* more than 180 species are included, but many doubtful taxa have been described (Diederich 1996, Index Fungorum 2007). Diederich (1996) recognized ca. 50 lichenicolous species and additional, as yet undescribed species (Diederich 2007).

Most (probably all) species of *Tremella* are parasitic on other fungi (Zugmayer et al. 1994, Diederich 1996, Chen 1998, Roberts 1995, 1999, 2001). Often, the *Tremella*-host hyphal interactions can be detected in vitro but they are rare or uncertain in vivo. The biology of some species is still insufficiently investigated and some apparently saprotrophic species may well be connected to cohabiting fungi (Zugmayer et al. 1994). Members of the genus *Tremella* have the largest and most varied basidiomes in *Tremellaceae* and comprise species growing on the hymenophores of aphyllophoroid fungi (mainly *Peniophoraceae* and *Stereaceae*, belonging to the russuloid clade, *Russulales* sensu Miller et al. 2006), in basidiomes of *Dacrymycetales*, on perithecia and/or stromata of *Ascomycota*, as well as on thalli of lichenized *Ascomycota* (lichens). Some species have reduced basidiomes to naked basidia supported by the host sporomes (basidiomeless intrahymenial endoparasitic species) or induce the formation of galls (mycocecidia sensu Vizzini & Girlanda 1997).

Tremella species are considered as haustorial biotroph mycoparasitic fungi (Jeffries & Young 1994); their life cycle depends on living hosts, from which they obtain nutrient resources, without killing or injuring the host cells. The host-parasite interaction is by haustoria, highly characteristic structures, first observed by Olive (1946) in *T. mycophaga* var. *obscura* L.S. Olive (= *T. obscura* (L.S. Olive) M.P. Christ.), consisting of small subglobose cells subtended or not by basal clamps, forming apical, thread-like and irregularly curved outgrowths which are capable of penetrating the hyphae of the host.

A detailed knowledge on the host range of *Tremella* species is currently missing, since for most species the host-parasite interactions have yet to be studied. Members of *Tremella* are usually considered specialists with a more or less narrow host range, although the degree of specificity differs from species to species. Host specificity is likely to be the natural outcome of the parasitic life, in which parasites have to develop highly specific and sophisticated mechanisms to recognize the host, to colonize the host basidiome, to synchronize their life cycle parameters to those of the host, etc. Some *Tremella* species appear to be restricted to one host species, e.g. *Tremella aurantia* Schwein. on *Stereum hirsutum* (Willd.) Pers., *T. karstenii* Hauerslev on *Colpoma juniperi* (P. Karst.) Dennis,, *T. encephala* Willd. on *Stereum sanguinolentum* (Alb. & Schwein.) Fr., *T. subencephala* Bandoni & Ginns on *Aleurodiscus lividocaeruleus* (P. Karst.) P.A. Lemke (Torkelsen 1978, Bandoni & Ginns 1993, Chen 1998, Hauerslev 1999), *T. caloceraticola* Hauerslev on *Calocera cornea* (Batsch) Fr. (Hauerslev 1999), *T. spicifera* Van Ryck. et al. on *Massarina arundinacea* (Sowerby) Leuchtm. (Van Ryckegem et al. 2002) as well as many lichenicolous species (e.g. *T. coccocarpiae* Diederich on *Coccocarpia rottleri* (Ach.) Arv., *T. normandinae* Diederich on *Normandina pulchella* (Borrer) Nyl., *T. lichenicola* Diederich on *Mycoblastus fucatus* (Stirt.) Zahlbr.; Diederich 1996). Others appear to be parasitic on several species within the same host genus, e.g. *T. versicolor* on *Peniophora* spp. (Bandoni & Ginns 1993, Roberts 2001), *T. nashii* Diederich on

Usnea spp. (Diederich 2007), or on species of two or more closely related host genera, e.g. *T. lobariacearum* Diederich & M.S. Christ. (on *Lobaria* spp., and on *Pseudocyphellaria* spp.; Diederich 1996), *T. mesenterica* Retz., *T. mesenterella* Bandoni & Ginns and *T. brasiliensis* (Möller) Lloyd (on *Peniophora* spp. and *Stereum* spp.; Zugmaier & Oberwinkler 1995, Bandoni & Ginns 1998).

Conidia are produced by many *Tremella* species, but few data are available on conidiogenesis patterns in this genus. Conidia formation often precedes and accompanies basidial development. Conidiogenesis is generally blastic and most species form terminal single conidia, catenate conidia or a few successive conidia (in a sympodial pattern). In *T. mesenterica* conidia are produced on hyphae in pure culture (Bandoni & Ginns 1998). Similar conidia precede development of basidia in hymenia of *T. mesenterica, T. brasiliensis, T. aurantia, T. spicifera* and other species. In endoparasitic intrahymenial taxa such as *T. obscura, T. occultifuroidea* Chee J. Chen & Oberw., conidia and basidia are typically present together on the same generative hyphae (Chen et al. 1999). Conidia are also regularly present in the hymenia of basidiomes of some species, e.g. in *T. roseotincta* Lloyd, *T. taiwanensis* Chee J. Chen (Bandoni 1987a, Chen 1998), or make up the predominant phase (*T. caloceraticola, T. versicolor*; Hauerslev 1999, Roberts 2001). Conidial states are also known in mycoparasitic genera close to *Tremella*: sporophores of *Cuniculitrema polymorpha* R. Kirschner & J.P. Samp. (Kirschner et al. 2001) and *Trimorphomyces papilionaceus* Bandoni & Oberw. (Bandoni & Oberwinkler 1983) are usually composed mainly or entirely of conidiogenous cells and conidia; *Tremellina pyrenophila* is an entirely conidial tremellaceous taxon described by Bandoni (1987b).

During a survey of wood-inhabiting fungi of an urban river park, "Cascina Le Vallere", a green area near Turin (Italy), a tiny, inconspicuous species of *Tremella* Pers., growing on *Peniophora cinerea* (Pers.) Cooke, was recorded and subsequently identified as *T. versicolor*. An exhaustive literature search has shown this taxon to be very localized and rare in Europe and North America (or perhaps overlooked, due to its minuscule size), and new to Italy. An illustrated description and some notes on distribution, ecology and host range of the species are provided.

Materials and methods

Basidiomes were examined both macro- and microscopically with a stereo microscope (Leica MZ12) and a compound microscope (Leica DM4500B) respectively. Photographs were taken using a Leica DFC320 digital camera mounted both on the compound and stereo microscope. The description of the microscopic features is based on dried specimens. Dried basidiomata were rehydrated in 3% NaOH, and then sectioned. Sections were mounted in distilled water, and in lactic acid plus acid fuchsine. The conidiophores and conidia were best observed in distilled water with Nomarski differential interference contrast illumination at 630 x. For conidia, basidia, and other structures at least 30 individuals were measured. All examined material has been deposited and kept at MUT, Mycotheca Universitatis Taurinensis, Dipartimento di Biologia Vegetale, Università di Torino, Italy. Herbarium abbreviations follow Holmgren et al. (1990).

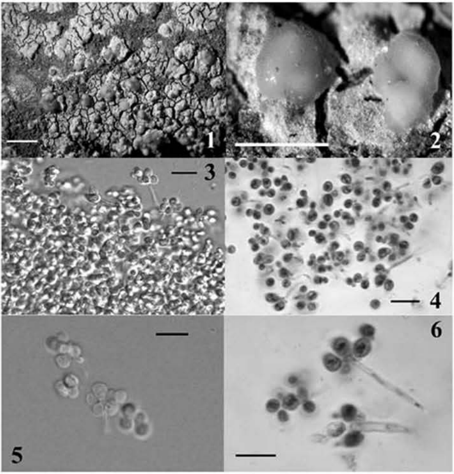
Taxonomic part

Tremella versicolor Berk. & Broome,
Ann. Mag. Nat. Hist., ser. 2, 13: 406, (1854) (Figs. 1-6)

Basidiomata 0.5-2.5 mm wide, at first irregularly pustulate-pulvinate (dacrymycetoid) to discoid (resembling the apothecia of *Orbilia*, *Pulvinula*, or the disc-like perithecia of *Hydropisphaera peziza* (Tode) Dumort.) then becoming inflated, complicate, slightly tremelloid, cerebriform or lobate. By confluence the fructifications can form irregular masses reaching 5-6 mm or more in extent. Surface smooth or somewhat rugose; gelatinous yellowish, orange-red when moist, becoming tough gelatinous on drying, horny and brownish-red (Figs. 1, 2). Hyphae in a dense gelatinous matrix, not forming a well defined context, scattered, 1.5-3 µm in diam., thin-walled, with clamp connections at almost all septa. Haustoria very rare. No well recognizable inner core of host *Peniophora* hyphae was observed. The whole basidioma consists of troops of deciduous erect conidiophores (conidiogenous cells), thin- to slightly thick-walled, 5-18 x 3-5 µm, apically giving rise to 3-7 slightly apiculated, pointed ovoid conidia (blastoconidia), 3.5-5 (6) x 2.5-4(5) µm, thin-walled, generally with a basal clamp, sometimes budding (Figs. 3, 4). Conidia are released in clusters, glomerules (Figs. 5, 6), often with a ribbon-like 2-8 µm long, abruptly tapering vestigial appendage of their subtending conidiophore. Probasidia often lacking, in small deciduous clusters localized below the thick outer layer of conidiophores and conidia, subglobose-ovoid to stalked-clavate, (10) 14-30 (34) x 8-11(-18) µm, at the base of the stipe (subtending hyphae) often slightly wider, seemingly developing out of the attached conidia, 2-4 chambered; few epibasidia (sterigmata) seen, sometimes developing an abortive blastospore-like element. Basidiospores were not observed.

Ecology: basidiomata gregarious, parasitic on hymenophores of *Peniophora cinerea* growing on dead branches of *Tilia platyphyllos* Scop.; in moist and foggy habitat.

Material examined: 19/7/2004, Parco delle Vallere, Moncalieri (Turin, Italy), leg. et det. A. Vizzini, MUT n° HE28; ibidem, 21/10/2005, MUT n° HE41.



Figs. 1–6. *Tremella versicolor*. Fig. 1. Discomycete-like to cerebriform basidiomes on *Peniophora cinerea*. Fig. 2. Young *Dacrymyces*-like to slightly lobate basidiomes. Figs. 3–4. Conidial stage with conidiophores and clusters of conidia (Fig. 3 as Nomarski photo; Fig. 4 in Lactic acid plus acid Fuchsin). Figs. 5–6. Detached clusters of conidia with vestigial ribbon-like remnants of conidiophores (Fig. 5 as Nomarski photo; Fig. 6 in Lactic acid plus acid Fuchsin).

Scale bars 1 = 5 mm; 2 = 2 mm; 3–6 = 10 µm.

Discussion

T. versicolor is macroscopically well characterized by small orange-red disc-like basidiomes growing on *Peniophora* species, and microscopically in being almost entirely conidial; conidia are typically released in clusters, glomerules, with vestigial remnants of deciduous conidiophores.

The geographical distribution of reports of *T. versicolor* is very localized. *T. versicolor* is probably not uncommon, but due to its inconspicuous size it has easily gone unnoticed, and so is a species that has to be searched for deliberately. It is known from England and Northern Ireland in the UK (Roberts 2001, Legon & Henrici 2005), Belgium (Van de Put 1998), Denmark (Heilmann-Clausen 2007; one collection by Spooner, preserved at K, P. Roberts, pers. comm.), Norway (The Herbarium, Oslo, 2007), and The Netherlands (Veerkamp 2001). Bandoni & Ginns (1993) also reported *T. versicolor* from North America, along the west and east coasts of the United States (Oregon, North California, and North Carolina). It occurs on a wide range of *Peniophora* species, on dead branches of several species of broadleaved trees and shrubs, often in relatively cool, moist and foggy habitats.

The species was originally described from England (Berkeley & Broome 1854), where it was found rather frequently in the nineteenth century (27 collections preserved at K), but then disappeared for more than 100 years. It seems that no one looked for it. In the last ten years it has been recollected many times (18 English collections at K) and is probably relatively widespread (P. Roberts, pers. comm.).

Bandoni & Ginns (1993), reviewing *Tremella* species growing on corticioid *Basidiomycetes*, pointed out that the species concept of *T. versicolor* has been somewhat confused; they noted that some European collections on *Aleurodiscus* spp., determined as *T. versicolor*, should be referred to *Tremella subencephala*. This species, parasitic on *Aleurodiscus lividocaeruleus* (= *Acanthophysium lividocaeruleum* (P. Karst.) Boidin) is considered very close to *T. versicolor*, but differs by its different host, its growth in more xeric habitats, and by the thick-walled conidia that are released singly. Moreover, the basidiomes show a central core of host hyphae, as well as the presence of mature spore-bearing basidia. *Tremella versicolor* sensu Neuhoff (1936), Pilát (1957), Eriksson (1958), Jülich (1983, 1984) and Wojewoda (1977, 1981) therefore corresponds to *T. subencephala*. *T. versicolor* as described by Raitviir (1967) is a mix between *T. versicolor* and *T. subencephala*. The unidentified *Tremella* species reported by Stork (1920) on *Aleurodiscus amorphus* Rabenh. and described as very close to *T. versicolor*, is in fact *T. mycetophiloides* Kobayasi (fide Bandoni & Ginns 1993).

All the specimens collected in Europe and North America are mainly conidial, consisting of a thick mass of conidia bunches, though some also have immature, abortive basidia (Bandoni & Ginns 1993, Van de Put 1998, Roberts 2001). In Italian specimens, deep inside the basidiome, below the outer conidial layer, I was able to find a few septate basidium-like elements, but generally without epibasidia (sterigmata). No real basidiospores were found in our specimens (sometimes rare immature blasto-basidiospores, resembling elements reported from *Sirobasidium* spp. and *Sirotrema* spp. (Bandoni 1986) were observed), nor in several collections studied by Bandoni & Ginns (1993), Van de Put (1998), and Roberts (2001). It seems that this *Tremella* species mainly reproduces asexually.

The conidiophores of *T. versicolor*, apically bearing clusters of conidia, are deciduous and they appear to be the chief propagules (disseminules) of the fungus. The presence of deciduous conidiophores and of clusters, glomerules, of conidia is a unique character within the genus *Tremella*, though occasionally found among other mitosporic fungi. These propagules (as well as the rare deciduous clusters of immature-abortive basidia) may well be an adaptation for water film dispersal, as postulated for deciduous basidia of *Tetragoniomyces uliginosus* (P. Karst.) Oberw. & Bandoni (Oberwinkler & Bandoni 1981), growing on wet decaying leaves and branches.

The anamorphic state of *T. versicolor* looks quite similar to *Hormomyces peniophorae* P. Roberts (Roberts 1997), an imperfect fungus reported growing on *Peniophora lycii* (Pers.) Höhn & Litsch., characterized by lacking clamp connexions, terminal tremelloid haustorial cells apparatus, simple conidiophores apically producing 2-4 blastoconidia (4-5 x 2.5-3 µm) which are released singly.

In the Italian specimens, the second clamp-less conidial stage (synanamorph) described by Van de Put (1998) from old basidiomes of *T. versicolor* was not detected. It may be a hyphomycetous contaminant or a *Cladobotryum*-like mycoparasite.

In *T. versicolor* the predominance of the conidial, anamorphic stage may be a form of adaptation to its parasitic way of life. In tremelloid species two macro-micromorphological trends, probably driven by events of degenerative evolution (evolution by simplification, reduction, phenomena typical of many highly-specific parasitic organisms), can be highlighted: 1) a miniaturization-simplification of the basidiomes (endocarpic-intrahymenial species); 2) a gradual loss (e.g. *T. versicolor*, *T. caloceraticola*, *Trimorphomyces papilionaceus*, *Tremellina pyrenophila*, *Cuniculitrema polymorpha*) or modification of the basidial (meiotic) phase (e.g. *Sirobasidium* spp., *Tetragoniomyces uliginosus*).

T. versicolor occurs, as previously noted, on *Peniophora* species. *Peniophora* has been subdivided into several subgenera (Eriksson 1978, Boidin 1994) based on macro-microscopical features. Successive infrageneric subdivisions inferred from molecular analyses performed using ITS sequences (Hallenberg et al. 1996) are slightly different from earlier subdivisions based on morphological characters alone. It is interesting that the host-range of *T. versicolor* seems to support these DNA-based groups to some extent; it mirrors the natural phylogenetic relationships of the species of *Peniophora*. Actually, almost all

European collections of *T. versicolor* (Van de Put 1998, Roberts 2001, Legon & Henrici 2005; Italian collections; P. Roberts, pers. comm.) were reported on *Peniophora* species referable to the *P. cinerea* phylogenetic group as delimited by Hallenberg et al. (1996) (including *P. cinerea*, *P. nuda* (Fr.) Bres., *P. pseudonuda* Hallenb., *P. violaceolivida* (Sommerf.) Massee, *P. lycii*, *P. laeta* (Fr.) Donk). The close relationship between biotroph parasitic fungi and their host is regarded as a result of coevolutionary events. The host range of these fungi is mostly restricted to groups of related species. Therefore, these fungi may serve to describe host phylogenies (Scholler 1998). *T. versicolor/Peniophora* spp. is a simple example of host specificity used as taxonomic marker, of a mycoparasitic fungus exploited as fungal taxonomist.

As regards the infrageneric subdivisions of the genus *Tremella*, morphological and molecular phylogenetic evaluations performed by Chen (1998) yielded five groups in the genus *Tremella*, namely: the *aurantia* group, *foliacea* group, *fuciformis* group, *indecorata* group, and *mesenterica* group. Up to now no DNA sequences of *T. versicolor* have been published or are reported in online genebanks and databases (but sequencing of this species is being undertaken in our Department).

Based on morphological features only, *T. versicolor* is suggested by Chen (1998) to belong to the *aurantia* group, a quite heterogeneous complex of species characterized by growing on basidiomycetous fungi, moderately loose hymenial and subhymenial structures, abundant haustoria, and by host hyphae always inter-mixing in the inner parts of the sporophores of the parasites. However, these subdivisions are here considered very provisional because too few taxa have been investigated sufficiently, and more species have still to be studied and sequenced. An increased taxon sampling, in order to improve phylogenetic inference, is needed.

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Descolea flavoannulata and its ectomycorrhiza from Pakistan's Himalayan moist temperate forests

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Abstract — During the exploration of biodiversity of mushrooms and ectomycorrhizas from Himalayan moist temperate forests of Pakistan, *Descolea flavoannulata* was found associated symbiotically with *Abies pindrow*. Both fungus and ectomycorrhizas are characterized morphologically and anatomically. *D. flavoannulata* ectomycorrhizas are monopodial-pinnate to monopodial-pyramidal, age from cream to brown, and produce enormous white to light brown hyphae that surround the infrequently found tips and sometimes give them a cottony appearance. Plectenchymatous mantle is present in all layers and the outer mantle hyphae sometimes form rings on the surface. Capitate cystidia are observed in the outer mantle layer. Clamps present in mantle hyphae, rhizomorphs and emanating hyphae. Rhizomorphs arise from restricted points. Both fruit bodies and ECM are new records for Pakistan

Key words — macromycetes, silver fir

Introduction

Himalayan moist temperate forests of Pakistan vary from a mixture of coniferous trees, *Abies pindrow* (Royle ex D. Don) Royle, *Cedrus deodara* (Roxb.) D. Don, *Pinus wallichiana* A. B. Jacks., *P. roxburghii* Sarg., *Picea smithiana* (Wall.) Boiss., and *Taxus wallichiana* Zucc. to an intermixture of evergreen and deciduous broad leaved trees such as *Aesculus indica* Wall. ex Cambess., *Acer acuminatum* Wall., *Quercus dilatata* Lindl. ex. Royle, *Q. incana* Roxb., and *Populus ciliata* Wall. The rainfall is 1000–1750 mm and there is snowfall in winter (November–February) maintaining the soil moisture (Champion et al. 1965).

Silver fir *(A. pindrow)* is common and gregarious in these Himalayan forests up to 3100 m, usually on the north aspect in light (sandy), medium (loamy) or heavy (clay) and acidic to neutral moist soils (Champion et al. 1965). Silver fir wood is light, soft, not very durable, and used for house interiors, cases, furniture, water troughs and fuel (Core et al. 1979, Usher 1984).

During summer months, from July to September, with elevated rainfall and higher temperature, macrofungal fruiting bodies fruit in the coniferous forests. Most of these macromycetes associate with trees forming ectomycorrhizas (ECM). A high diversity of ectomycorrhizal fungi associate with *A. pindrow* (Iqbal et al. 1996). In order to determine the ecology of ECM-forming macromycetes, it is first necessary to identify them (Agerer 1999).

In Pakistan, research is currently in progress regarding the biodiversity of mushrooms and ECM (particularly with conifers; cf. Niazi et al. 2006, Muzna Zahoor et al. 2004, Kazmi et al. 2004, Afshan et al. 2003, Khalid & Niazi 2003).

Descolea (Singer 1950) is mostly a southern hemisphere fungal genus. It is thought to have co-evolved with the ectotrophic genus *Nothofagus* and has been reported as ectomycorrhizal with members of the *Pinaceae* (*Abies, Larix, Pinus*) and *Fagaceae* (*Quercus, Lithocarpus, Castanopsis*) (Horak 1971, 1980, Yokoyama et al. 1979).

The genus *Descolea* is represented by about eight species (*D. antarctica* Singer, *D. alienata* E. Horak & Desjardin, *D. flavoannulata*, *D. gunnii* (Massee) E. Horak, *D. maculata* Bougher, *D. pretiosa* E. Horak, *D. recedens* (Cooke & Massee) Singer, *D. rheophylla* (Bertault & Malençon) Malençon), which have been reported as ectomycorrhizal with conifers as well as broad leave trees (Bougher & Malajczuk 1985, Agerer 1987-2002, 2006).

Outside the southern hemisphere, *D. flavoannulata* is widely distributed in Indian sub-continent, China and Japan (Yokoyama et al. 1979, Yang 1998). It has been reported to form ECM with different hosts (Watling & Abraham 1992, Yang 1998, Yokoyama et al. 1979) but its ECM has never been described (Roman et al. 2005)

The aim of the present work is to describe the morphological and anatomical features of the ECM formed between *D. flavoannulata* and *A. pindrow* and to report on the fungal species.

Materials and methods

Sampling and Identification

The study area is located in the range of Murree hills and falls in Himalayan moist temperate forests of Pakistan. The sampling was carried out in Northern West Frontier Province (NWFP), Khanspur-Ayubia at an elevation of 2135m from sea level. The area is dominated by *A. pindrow* intermixed with a few *P. wallichiana* and deciduous trees along with herbaceous understory vegetation. The maximum temperature during summer varies from 10.7 to 18C. The average rain fall is about 600 mm while average humidity is 57%. The soil is clay with high organic matter content (Hussain 1995).

In this region, the peak fruiting season of macrofungi is from July to September. Intensive sampling of ECM was done along this period by taking soil cores of 15 x 10cm exactly beneath the basidiocarps found under pure strands of *A. pindrow*. The field data of basidiocarps (site, habitat, association etc.) was annotated.

The soil samples with roots, together with basidiocarps were placed in polythene bags with a few fresh leaves to keep the specimen fresh, leaving the samples as undisturbed as possible and transported to the laboratory. Samples were examined under stereomicroscope to detect hyphal connections of basidiocarps to ECM as described in Agerer (1991).

ECM were carefully placed in water to clean off soil particles and characterized morphologically under the stereomicroscope. Lactic acid, 15% KOH, Meltzer's reagent were used to study the specific colour changes.

Microscopic Analysis

The microscopic description of the ECM follows the terminology of Agerer (1991, 1999). Mantle views (outer & inner), emanating elements and illustrations were documented with the help of a camera lucida. Thin, hand-made, transverse and longitudinal sections were made to study the depth of Hartig net.

The epigeous basidiocarps were analyzed macroscopically (colour, lamellae, shape, etc.) and microscopically (basidia, basidiospores, cystidia etc.) following Reid's (1984) methodology. Voucher specimens were deposited in the Herbaria, Department of Botany, University of the Punjab, Lahore, Pakistan (LAH) and in the Herbarium of Cryptogams of the Chinese Academy of Sciences (HKAS).

Results

Description of the basidiome

Descolea flavoannulata (Lj. N. Vassiljeva) E. Horak,
Persoonia 6:246, 1971 (Fig. 1A, B)

Pileus 4–9 cm in diam. Spherical-subglobose or conical-campanulate to convex, then expanded and obtusely umbonate or almost plane; surface dry; not viscid, brown to yellowish brown to cinnamon brown with dark brown tinge over the centre of the pileus, covered with small, floccose, cream to yellow, with irregular patches or remnants of universal veil, 1–3 mm diam., randomly distributed but crowded towards centre, margins striate. ***Lamellae*** adnate, crowded to sub-distant, brown, incomplete to complete, brown to dark brown then rusty cinnamon. ***Stipe*** (5-)6-10(-14) cm long, 1-2 cm thick, ochreaceous yellow,

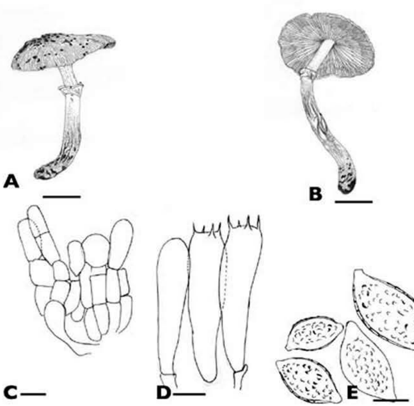

Fig 1 (A-B). Habit of *Descolea flavoannulata*. (C). Pilipellis (D). Basidia (E). Basidiospores. Bar (for A &B) =2cm, (for C-E) = 20µm

paler above the annulus, towards the base with fibrillose, more or less striated, slightly bulbous base, often with fragments of universal veil as rudimentary volva. ***Annulus*** thick, rather large and ample yellow, membranous, distinctly striated on upper side, some time rolled upwards on stipe, 0.8 x 1.5 cm, firmly attached with stipe.

Basidiospores (Fig. 1E) lemon shaped to amygdaliform rust brown, verrucose, with smooth and distinct perispore, germ pores absent. [20/1/1] (9.4–)10–14 (–16) × (5.4–)6–8(–9) µm. L=11.54 µm, W=7.14 µm; Q= (1.14–)1.21–1.96 (–2.0) µm, Q=1.61µm. monoguttalate or multiguttulate. ***Basidia*** (Fig. 1D) clavate, (10–) 12–14 × (20–)30–45(–50) µm, bisterigmate to tetrasterigmate, sterigmata 1.5–3 × 5–10 µm. Cystidia, clavate, thin walled, smooth, hyaline, crowded, 8–14 × 30–35 µm. Pilipellis (Fig. 1C) composed of 3–5 layers of sub-globose-ovoid to ellipsoid cells. Subcutis of somewhat radially arranged hyphae, cylindric, 2.5–5.5 µm wide. Clamps common. Hyphae of universal veil on pileus are radially to subradially arranged, septate, 4–8 µm wide, sometimes with incrusting pigments. Cheilocystidia clavate, thin-walled, 30–41 × 9–15 µm. Caulocystidia long, with swollen head, thin walled, 4–8 × 35–55 µm.

Habitat and Distribution — on ground, scattered, solitary, under *A. pindrow*. Pakistan, at 2400-2580m elev. in Himalayan moist temperate forests, 12/VIII/2006.

Specimen Examined: Pakistan: N W Frontier Province. Hazara Distt. Khanspur-Ayubia, 12/VIII/2006, A.R.Niazi #ARN-12086 (LAH, HKAS 51967).

Description of ECM

Morphological characters (Fig. 2A)

Ectomycorrhizal system infrequently found, hydrophobic, monopodial-pinnate to monopodial-pyramidal, up to 7.5mm long, axis 0.9mm diam. *Unramified ends* straight to bent, 2.5–4mm long, 0.5mm diam., cream to brown, very tip brown, dark brown when gets older. Mantle surface of smooth but somewhere with granular appearance because of cystidia and silvery due to air trapped among hyphae, host tissue slightly visible under the sheath. ***Rhizomorphs*** infrequent, connecting distinctly to the mantle surface, white to cream in young ECM turning light brown-brown when gets older, hairy when fully developed, entangled, rounded to flat in cross section, branched, mostly dichotomous, up to 1–2mm thick, up to 3mm at branching points,hyphae entangled to each other, difficult to separate. ***Emanating hyphae*** white, dark brown when get old, abundant on few tips, giving a cottony appearance. Sclerotia not observed.

Anatomical characters of mantle in plan views (Fig. 2B, C)

Mantle plectenchymatous in all layers. Lacking laticiferous hyphae. ***Outer mantle layers*** not gelatinous, loosely plectenchymatous with net like arrangement of hyphae (type B, Agerer 1987–2002), few hyphae forming ring like structures, hyphae delicate, irregularly ramified, sometimes long dichotomies also observed, 1.5–2µm diam., cell walls 0.2–0.6µm thick, smooth surface; clamps frequent, simple anastomosis observed, hyphae frequently septate, hyphal cell (16–)22–28(–34)µm long, consistently cylindrical in shape, capitate cystidia present, develop with the age of the ECM, 3–5 × 30–45µm. ***Inner mantle layer*** densely plectenchymatous. Hyphae with smooth surface, colourless and straight cells septate and netlike arrangement of hyphal bundles (type A; Agerer 1987–2002). Hyphae with smooth surface, colourless and straight, up to 2.8µm in diam., hyphal cells 20–36 µm length, cell walls 0.2–0.5 µm thick; simple anastomosis observed among hyphae, clamps observed but not frequent. *Very tips* with the same structures as in the lateral parts.

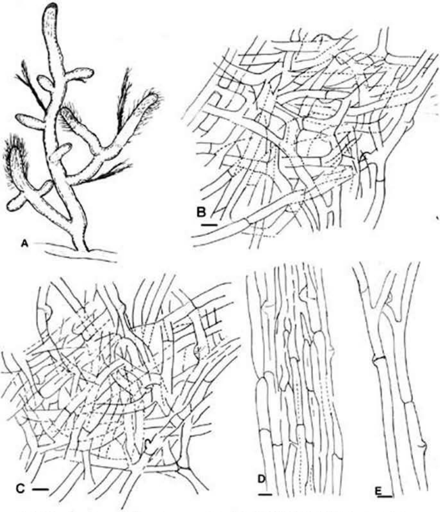

Fig 2. *Descolea flavoannulata* ectomycorrhiza. (A). ECM (Habit). (B) Outer mantle layer. (C) Inner mantle layer. (D) Internal view of rhizomorph. (E) Emanating hyphae. Bar (for A) =20mm, (for B-E) = 10µm.

Anatomy of mantle in cross section; mantle appears thick as hyphal aggregations, plectenchymatous throughout forming a distinct sheath, (30–) 40–50(–55)µm thick, different layers discernible, cortical cells with Hartig net in 2–3 rows, mostly 2 rows reaching endodermis, hyphae frequently ramified. *Anatomy of mantle in longitudinal section*; plectenchymatous hyphae entangled, running parallel towards root length, different layers discernible. Cortical cells with Hartig net in 2–3 rows, Hartig net in section around cortical cell in 1–2 rows, roundish to cylindrical, 2–3µm thick, frequently ramified.

Anatomical characters of emanating elements (Fig. 2D, E)

Rhizomorphs undifferentiated (type B, Agerer 1991); margins rather smooth; hyphae compactly arranged and of uniform diameter, branched. Hyphae smooth, entangled and jointed, cells 20–28µm length, 2.8–4.8µm diam., walls 0.5–0.7µm thick, frequently septate, clamps rare, compactly woven hyphae and sometime fused with each other without any particular type of anastomosis type, simple anastomosis also observed. ***Emanating hyphae*** smooth, thick 3.5–4.6µm diam., cell walls thick, up to 0.8–1.0µm, hyphae dichotomously ramified, septate with well developed clamps, clamps may be at septa formation or somewhere else. Cystidia absent. Chlamydospores not observed.

Chemical reactions; 15% KOH & lactic acid, no reaction. Meltzer's Reagent, light blue.

Voucher specimen: ectomycorrhizas under *A. pindrow* in the Herbarium of Botany Department, P.U.Lahore, Pakistan, A.R Niazi # ARN-12086E (LAH).

Discussion

The genus *Abies* has been reported as ectomycorrhizal and there exists a high diversity of ECM within its rhizosphere (Iqbal et al. 1996, Agerer 1987–2002). In the present study, we report the field ECM of *D. flavoannulata* with *A. pindrow* for the first time in Pakistan.

Descolea flavoannulata is the first representative of this genus for Pakistan (Ahmad et al. 1997). It has been reported as ectomycorrhizal (Watling & Abraham 1992, Yang 1998, Yokoyama et al. 1979) but a detailed morphological and anatomical description of its ECM does not exist. Moreover, it is known that *D. flavoannulata* is usually associated with some different host genera; *Quercus* and *Tilia* in Siberia, *Castanopsis, Quercus, Larix* and *Pinus* in Japan, and *Quercus* in Korea. Similar mycorrhizal associations as those reported here for *D. flavoannulata* have also been reported for *D. pretiosa* in India where it is associated to *Abies, Picea, Pinus* and *Taxus* (Horak 1971).

The field ECM of *D. antarctica* with *Nothofagus alpina* (Poepp. & Endl.) Oerst. from South America (Palfner 1998) and the synthesized ECM of *D. maculata* with *Eucalyptus* seedlings (Bougher & Malajczuk 1985) have already been reported.

The ECM of *D. flavoannulata* reported in this work resemble closely the ECM of *D. antarctica* and synthesized mycorrhizae of *D. maculata* due to monopodial pinnate to monopodial pyramidal type of ramification with light brown to brown colour. Also, the mantle in plan view has a plectenchymatous hyphal arrangement in outer and inner mantle layers and the presence of cystidia (Agerer 2006).

However, there exist many differences between the ECM of *D. flavoannulata* and *D. antarctica*. The main difference regards the occurrence of rhizomorph in the ECM of *D. flavoannulata*. They are whitish to cream, branched and originate from the restricted points of the mycorrhizal system in *D. flavoannulata* but in *D. antarctica* are unreported or absent (Agerer 1987–2002). The ring-like arrangement of mantle hyphae in ECM of *D. flavoannulata* also differentiates the morphotypes of both species.

Both *Descolea* species are associated with different host trees from different families, i.e. *D. flavoannulata* is associated with *A. pindrow* from *Pinaceae* belonging to conifers while *D. antarctica* with *N. alpina* from *Nothofagaceae*, which is a broad leaved family from different ecological regions. The host plant genus is also the most important component of this partnership to determine the habit and Hartig net of ECM; the minor component may be the fungus (Pillukat & Agerer 1992).

Descolea flavoannulata sporocarps are reported for the first time in Pakistan and its ECM for the first time in the mycorrhizal literature.

Acknowledgments

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The genus *Peniophora* in Israel (highlighting the variability of *Peniophora quercina*)

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Abstract—A form new to science, *Peniophora quercina* f. *merulioides*, is described for the subarid region of the Middle East, grown on *Quercus calliprinos* wood and characterized by a merulioid hymenophore. Analysis of its spore variability shows an overlapping size and shape with the type. Both *Peniophora quercina* and *P. cinerea* are recorded for the first time for Israel.

Key words—Mediterranean, corticioid fungi, *Peniophoraceae*

Introduction

The genus *Peniophora* (*Peniophoraceae, Russulales*) includes branch-inhabiting species having xerophilous fruitbodies with sulpho-positive gloeocystidia and lamprocystidia in many species. Fruitbodies are annual to perennial, resupinate, and orbicular with inrolled to totally prostrate margins. The usually even hymenophore is wart-like in orbicular fruitbodies, where it appears papillate due to the confluence of individual basidiomata; in some species the hymenophore produces raduloid processes. Maximum species diversity of *Peniophora* can be found in boreo-nemoral and semiarid areas of the Northern Hemisphere (Jülich & Stalpers 1980, Hallenberg & Parmasto 1998, Boidin et al. 1991, Yurchenko 2000).

In his study of Israeli *Aphyllophorales*, Binyamini (1982, 1983) recorded five species of *Peniophora*: *P. incarnata*, *P. lycii*, *P. meridionalis*, *P. polygonia*, *P. pithya*, some of which were described in "Larger Fungi of Israel (*Ascomycotina* and *Basidiomycotina*)" (Binyamini 1984: 112–114). Czederpiltz et al. (2004) later recorded a sixth species, *P. pini*, from pine forests near Jerusalem.

Peniophora quercina belongs to the group of species characterized by basidiomata having inrolled margins (*P. rufomarginata*, *P. limitata*, etc.). It is widely distributed associated with oaks in North America and Eurasia (Breitenbach & Kränzlin 1986) but until now has not been reported for Israel. During our research into aphyllophoroid fungi of Israel, we found this species commonly occurring in *Quercus calliprinos* forests in the Golan Heights and Upper Galilee. Surprisingly, we found a deviant hymenophore shape of *Peniophora quercina*, which is considered as new for this genus.

Also, during our research we have repeated finds of *P. lycii*, *P. incarnata*, *P. polygonia* and recorded a new find of *P. cinerea*.

Material and methods

Morphological characteristics of our specimens were examined using a light/dark field microscope (Carl Zeiss Axiostar 1122-100). In all 30 spores from each specimen were measured; 5% of the measurements from the end of each size variation range were placed in parentheses. Potassium hydroxide solution 10% (KOH) and medicinal iodine were used for microscopical analyses. A map showing the natural regions of Israel (Fig. 1) demonstrates the species distributions. Specimens analyzed have been deposited in the herbarium of the Institute of Evolution at the University of Haifa (HAI), Israel.

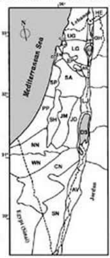

Fig. 1. Accepted abbreviations for nature regions of Israel: AP – Akko Plain; AV – Arava Valley; BS – Beit Shean Valley; CC – Carmel Coast; CG – Coast Galilee; CM – Carmel Mount; CN – Central Negev; DS – Dead Sea Area; EP – Esdraelon (Yizre'el) Plain; GH – Golan Heights; GM – Gilboa Mount; HE – Hermon Mount; HP – Hula Plain; JD – Judean Desert; JM – Judean Mts.; LG – Lower Galilee; LJ – Lower Jordan Valley; NN – Northern Negev; PP – Philistean Plain; SA – Samaria; SH – Shefela; SN – South Negev; SP – Sharon Plain; UG – Upper Galilee; UJ – Upper Jordan Valley; WN – Western Negev (Feinbrun-Dothan & Danin 1998).

Taxonomic descriptions

Peniophora quercina (Pers.) Cooke, Grevillea 8(45): 20 (1879). FIG. 2

= *Thelephora quercina* Pers., Syn. Meth. Fung. (Göttingen): 573 (1801).
= *Lichen carneus* Willd., Fl. Berol. Prodr.: 358 (1787).
= *Auricularia corticalis* Bull., Champ. 6: tab. 436, fig. 1 (1790).
= *Peniophora pezizoides* Massee, J. Linn. Soc., Bot. 25: 141 (1889).
= *Stereum tuberculosum* Velen., České Houby 4–5: 762 (1922).
= *Thelephora agglutinata* Pers., Mycol. Eur. (Erlanga) 1: 134 (1822).

Icon.: Eriksson et al. (1978): Fig. 487, 488, 530b; Breitenbach & Kranzlim (1986): fig. 153; Krieglsteiner (2000): Fig. 128.

Basidiocarp perennial, resupinate, initially wart-like, then with radial cordons prostrating over tree bark, finally confluent into irregularly shaped patches with inrolled free margin, up to 0.3–1 mm thick and several cm in extent. **Hymenial surface** even to slightly tuberculate, finally sometimes cracked, hard and brittle (dry specimen), violaceous-gray with pinkish tints. **Margin** adnate and thinning outwards in young basidiocarps, tapped with thin orange zone, inrolled upwards in larger patches. **Abhymenial surface** brown to nearly black.

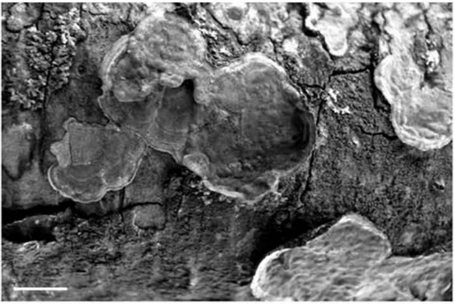

Fig. 2. *Peniophora quercina* (HAI 0102): basidiocarps.
Scale bar = 5 mm.

Hyphal system monomitic. **Hyphae** with clamps, hyaline to brown-colored, moderately branched, slightly thick-walled, up to 4 μm across; contextual hyphae dense with subparallel arrangement, brown-colored near the substrate; subhymenium composed of strongly agglutinated vertical brown-colored hyphae. **Lamprocystidia** abundant in the hymenium, conical, strongly encrusted and thick-walled, 45–70 × 8–15 μm, encrusted parts 15–40 μm long. **Basidia** 25–50 × 4–5 μm, subcylindrical to narrowly clavate, with 4 sterigmata and a basal clamp. **Basidiospores** suballantoid to allantoid, hyaline, smooth, thin-walled, 7.8–10.8(–10.9) × (2.9–)3–3.5(–3.6) μm, non-amyloid.

General distribution and habitat: The typical substrate for the species is dead, attached, or fallen branches, usually of *Quercus* and *Fagus*, but also it can be found on other deciduous trees; agent of white rot. Its general distribution includes: **Europe** (England, Ireland, Norway, Sweden, Germany, Switzerland, Austria, France, Spain, Italy, Belgium, Poland, Romania, Bulgaria, Estonia, Hungary, Belarus, Ukraine, Russia); **Asia** (Israel, Azerbaidzhan, Armenia); **North America** (USA, Canada); **Southern Hemisphere** (New Zealand).

Note: Despite its variability, *Peniophora quercina* can be easily distinguished by its even to slightly tuberculate hymenophore, constant pink-violaceous-grayish color of hymenial surface, inrolled margin, and its host preference (*Quercus* species). It can be confused with *P. rufomarginata* (Pers.) Bourdot & Galzin, which has smaller spores, more strongly pigmented hyphae, and inhabits *Tilia* wood.

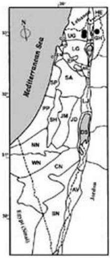

Fig. 3. Distribution of *Peniophora quercina* in northern part of Israel.

SPECIMENS EXAMINED: **ISRAEL.** GH, Massada forest, *Quercus calliprinos* and *Q. ithaburensis* forest, on branches of *Q. calliprinos*, 07.03.2007, leg. & det. D. Țura, I. Zmitrovich et V. Malysheva (HAI 0101). – UG, Mt. Meron, *Quercus calliprinos* forest, on branches of *Q. calliprinos*, 09.03.2007, leg. & det. D. Țura, I. Zmitrovich et V. Malysheva (HAI 0102). – UG, Meron forest, mixed *Pinus halepensis* and *Quercus calliprinos* forest, on branches of *Q. calliprinos*, 09.03.2007, leg. & det. D. Țura, I. Zmitrovich et V. Malysheva (HAI 0103). – **AZERBAIDZHAN.** *Peniophora quercina* subsp. *caucasica* Parmasto: Hatsmas, Hudat, on branches of *Quercus longipes*, 29.10.1981, leg. & det. E. Parmasto ex Fungi Caucasici, Isotypus (LE 208001). – **ARMENIA.** Noiemberiam, Kochp, on branch of *Quercus macranthera*, 13.09.1962, leg. & det. E. Parmasto ex Corticiaceae URSS II (LE 35727; TAA 16200). – **RUSSIA.** Samara Region, Zhiguli, Bakhilova Polyana, lime forest, on fallen branch of *Quercus robur*, 27.08.2003, leg. & det. I. Zmitrovich & V. Malysheva (LE 227742). – **AUSTRIA.** Mt. Hermannskogel, prov. Wien, on dry branch of *Quercus robur*, leg. K. Rechinger, det. F. Höhnel ex *Cryptogamae exsiccatae editae a Museo Hist. Natur. Vindobonesi* No 320 (LE 35729). – **ESTONIA.** Kingissepa, reserve "Loode tammik", oak forest, on dead branch of *Quercus robur*, 25.09.1981, leg. & det. E. Parmasto ex Fungi Estonici, No 1004086 (LE 35731). – **SWEDEN.** Västergötland, Göteborg, St. Änggården "Naturparken", on dead branches of *Quercus robur*, 03.1937, leg. & det. T. Nathorst-Windahl ex *Fungi exsiccate suecici, praesertim Upsaliensies*, No 156 (LE 35387). – Åryds, Tjärö, Kalven, on branch of *Quercus* sp., 14.06.1975, leg. & det. I. Nordin ex *Flora Suecica*, No. 6053 (LE 35730). – **NORWAY.** Vestfold, Tjølling, on fallen branches of *Quercus robur*, 27.04.1969, leg. & det. G. Gulden ex *Plantae Norvegicae a Museo Botanico Universitatis Osloensis distributae* (LE 35732).

Peniophora quercina* f. *merulioides Ţura, Zmitr. & Wasser, **f. nov.** FIGS. 4, 5

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A typo superficiis hymenialis merulioideis differt.

HOLOTYPE: **ISRAEL.** UG, Mt. Meron, *Quercus calliprinos* forest, on branches of *Q. calliprinos*, 09.3.2007, leg. & det. D. Ţura, V.F. Malysheva and I.V. Zmitrovich (HAI 0104).

Basidiocarps resupinate, scattered in small and larger patches on tree bark, 0.4–3 cm long and 0.2–1.5 cm across, of hard consistency (dry specimen). **Hymenial surface** merulioid (Fig. 4), hard, violaceous-gray with pinkish tints. **Margin** in young fructifications finely fimbriate, whitish, thinning outwards whereas the margin of larger patches inrolled upwards, some loosening from the substrate leaving attached only a short rounded base. **Abhymenial surface** brown to nearly black. **Hyphal system** monomitic. **Hyphae** with clamps, hyaline to brown-colored, moderately branched, slightly thick-walled, up to 4 µm across; contextual hyphae densely packed with subparallel arrangement, brown-colored near the substrate; subhymenium composed of strongly agglutinated brown-colored vertical hyphae. **Lamprocystidia** (Fig. 5) abundant in the hymenium, conical, strongly encrusted and thick-walled, 45–70 × 8–15 µm, encrusted part 15–40 µm long. **Basidia** 25–50 × 4–5 µm, cylindrical to narrowly clavate, with 4 sterigmata and a basal clamp. **Basidiospores** suballantoid to allantoid, hyaline, smooth and thin-walled, (8.8–)8.9–10.3(–10.5) × (2.9–)3–3.5(–3.6) µm, nonamyloid.

Table 1. The spore variability of *Peniophora quercina* and *P. quercina* f. *merulioides*

Specimen	Limits of spore size variability (µm)	Spore length average (µm)	Spore width average (µm)	Spore quotient (Q)
P. quercina	7.92–10.89 × 3–3.5	8.76	3.22	2.72
P. quercina f. *merulioides*	8.91–10.3 × 3–3.5	9.25	3.24	2.85

The merulioid hymenophore

A review of Russian and East European specimens of *P. quercina* has shown that deviant meruloid forms occasionally occur alongside non-merulioid fruitbodies. In particular, merulioid forms are found in Estonian exsiccates (Fungi Estonici, No 1004086). As far as we know, Corner (1971) was the last researcher to discuss the merulioid phenomenon. Because we did not find any information concerning corticioid *Russulales* related to this subject, some notes are proposed here.

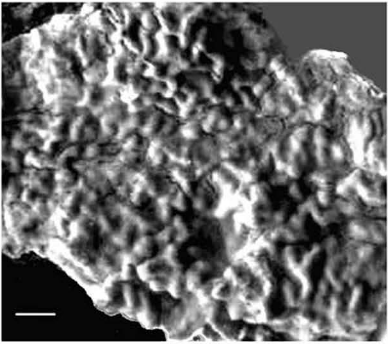

Fig. 4. *Peniophora quercina* f. *merulioides* (HAI 0104): the merulioid hymenophore. Scale bar = 1 mm.

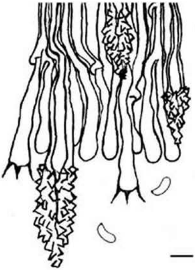

Fig. 5. *Peniophora quercina* f. *merulioides* (HAI 0104): subhymenium and hymenium with strongly encrusted lamprocystidia among clamped basidia. Scale bar = 10 µm.

First of all, similar to other corticioid lineages, merulioid development is connected with resupinate growth form (i.e., prostrate fructification having free margin). The second interesting similarity is that all merulioid taxa have significantly smaller species numbers compared to related taxa with smooth hymenophores (compare *Byssomerulius* to *Phanerochaete*, *Merulius* to *Phlebia*, and *Ceraceomyces* to *Athelia*). There are some species that produce merulioid hymenia when fresh but which become smooth when dry (e.g., *Serpulomyces borealis*, *Serpula sororia*, and some specimens of *Phanerochaete sanguinea*). All these facts rather confirm Corner's idea about the relic nature of merulioid hymenium versus smooth one. The stipe loss that accompanied the gain of branching by resupinate pleurotoids has resulted in certain 'rationalizations' (i.e. economic simplifications) of sporophore construction that have evolved through incorporation of orthotropic hymenophoral processes into the plagiotropic mycelial matrix. In such conditions, the hymenial protuberances become more or less smooth (Zmitrovich & Wasser 2004). The presence of such a merulioid form within the russuloid lineage suggests the need for a comparative study of *Peniophora* and pleurotoid (cyphelloid, aleurodiscoid) *Russulales*.

Key to *Peniophora* species of Israel

1a. Dendrohyphidia present. 2
1b. Dendrohyphidia absent. 4

2a. No lamprocystidia. Basidiocarp adnate, with clearly delimited prostrate
margin. Hymenium even to warted, reddish but powdered by white
pruina. Hyphae clamped, 3–7(–8) μm wide. Dendrohyphidia hyaline,
richly encrusted, forming a dense matrix. Gloeocystidia not abundant,
40–100(–120) × 10–20(–25) μm. Basidia 30–40 × 4.5–5.5 μm.
Basidiospores 9–12 × 2.5–4.2 μm. .... ***P. polygonia***
(Pers.) Bourdot et Galzin, Hymenomyc. France: 320 (1928);
[*Thelephora maculaeformis* Fr. (1815); *Th. colliculosa* Hoffm. (1796)].

Note: In Israel the fungus grows on *Eucalyptus* and *Cercis* branches, whereas in boreal zone it prefers *Populus tremula* branches.

2b. Lamprocystidia present 3

3a. Basidiospores 9–12 × 3.5–5 μm. Basidiocarp totally prostrate, adnate,
margin inconspicuous. Hymenium even to papillate, pruinose, whitish,
grayish, rarely with violaceous tints. Hyphae clamped, 3–5 μm wide.
Dendrohyphidia hyaline, with scarce incrustations. Gloeocystidia
mostly lacking. Lamprocystidia 25–35 × 10–25 μm. Basidia 25–40 ×
4–7 μm .... ***P. lycii***
(Pers.) Höhn. et Litsch., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt.1 116: 747 (1907);
[*Corticium bupleuri* Roum. (1882); *C. friesii* Grognot (1863); *C. caesium* Bres. (1892)].

Note: This is the most common *Peniophora* species in Israel, growing on branches of many leaf trees.

3b. Basidiospores 6–9 × 2–3(–3.5) µm. Basidiocarp totally prostrate, adnate, margin inconspicuous. Hymenium even or obscurely papillate, creamy, then cinnamomeous. Hyphae clamped, 3–5 µm wide. Gloeocystidia lacking. Lamprocystidia 35–50 × 8–20 µm. Basidia 25–45 × 4.2–5.5 µm. Restricted to *Quercus* wood.. . . . . ***P. meridionalis***

Boidin, Bull. trimest. Soc. mycol. France 74(4): 455 (1958).

4a. Basidiocarps of salmon-orange tints. Q ≤ 2.5. Hymenium papillate to secondarily even, pinkish, salmon-colored or orange (sometimes brown in old specimens). Hyphae clamped, 3–5 µm wide. Gloeocystidia 50–250 × 8–20 µm. Basidia 30–45 × 5–6.5 µm . . . .***P. incarnata***

(Pers.) P. Karst., Hedwigia 28: 27 (1889);
[*Thelephora fallax* Pers. (1801); *Th. lateritia* Chaillet (1822);
Peniophora aemulans P. Karst. (1889)].

4b. Basidiocarps dull colored, of grayish-violet-brownish tints. Q ≥ 2.5 5

5a. On gymnosperms 6

5b. On angiosperms 7

6a. Basidiocarp totally prostrate, adnate, margin adnate, delimited. Hymenium even, grayish or reddish gray, then brownish-violaceous. Hyphae clamped, 3–6 µm wide. Gloeocystidia 50–75 × 8–10 µm. Basidia 20–35 × 4–6 µm. Basidiospores 5.5–7.5 × 2–3 µm . . . . ***P. pithya***

(Pers.) J. Erikss., Symb. bot. Upsal. 10(5): 45 (1950); [*Corticium plumbeum* Fr. (1874)].

6b. Basidiocarp discoid with clearly delimited free margin, initially orbiculate, then confluent into small stereoid clusters. Hymenium mostly uneven, at first reddish, then violaceous to brownish, creamy near the margin. Hyphae clamped, gelatinized, 3–10 µm wide. Gloeocystidia 30–60 × 10–20 µm. Lamprocystidia 20–35 × 5–7 µm. Basidia 30–40 × 5–6 µm. Basidiospores 7–9 × 2.5–3.3 µm . . . . ***P. pini***

(Schleich. ex Fr.) Boidin, Revue Mycol., 21: 123 (1956).

7a. Margin totally prostrate, pruinose Hymenium even, creamy gray to mouse-gray, in some cases with weak violaceous tinge. Hyphae clamped, 2–4 µm wide. Gloeocystidia absent. Lamprocystidia 15–30 × 7–10 µm. Basidia 20–35 × 5–6 µm. Basidiospores 7–10 × 2–3.5 µm. On a wide range of deciduous trees . . . . ***P. cinerea***

(Pers.) Cooke, Grevillea 8: 20 (1879);
[*Thelephora tiliae* Pers. (1822);
Corticium fumigatum Thüm. (1876). Fig. 6.]

Fig. 6. A portion of hymenium of young *Peniophora cinerea* collected from UG, Israel.
Scale bar = 10 µm.

7b. Margin rolling up. Almost exclusively on *Quercus*. 8

8a. Hymenium even or tuberculate .... ***P. quercina*** **f.** ***quercina*** (see p. 386)

8b. Hymenium folded, of merulioid appearance ***P. quercina*** **f.** ***merulioides*** (see p. 389)

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