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MYCOTAXON

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A contribution to the rust flora (Uredinales) of southern Africa, with an emphasis on South Africa*

MECHTHILDE MENNICKEN & FRANZ OBERWINKLER

info@systbot.uni-tuebingen.de
Lehrstuhl für Spezielle Botanik & Mykologie
Botanisches Institut, Universität Tübingen
Auf der Morgenstelle 1, D-72076 Tübingen, Germany

Abstract—Six new rust species are described: *Puccinia rocherpaniana* on *Helichrysum tricostatum*, *P. pteroniae* on *Pteronia divaricata*, *Uredo tarchonanthi* on *Tarchonathus littoralis*, *Uredo aspalathi* on *Aspalathus laricifolia*, *Uromyces silksvleyensis* on cf. *Bartholina burmanniana*, and *Uromyces quaggafonteinus* on *Ehrharta calycina*. Rust species newly recorded from the western provinces of South Africa and/or on new host plants are: *Aecidium elytropappi* on *Elytropappus rhinocerotis* and *Leysera gnaphalodes*, *Aecidium dielsii* on *Lebeckia* sp., *Miyagia pseudosphaeria* on *Sonchus* cf. *oleraceus*, cf. *Phakopsora pachyrhizae* on *Psoralea pinnata*, *Puccinia polycampta* on *Chlorophytum crassinerve* and on *Trachyandra* sp., *P. kalchbrenneri* var. *kalchbrenneri* on *Helichrysum cochleariforme*, *P. ursiniae* on *Ursinia anthemoides*, *P. granularis* on *Pelargonium grossularioides*, *P. menthae* on *Mentha* cf. *longifolia*, *P. hordei* on *Bromus pectinatus*, *P. polypogonis* on *Polypogon monspeliensis*, *P. stonemaniae* on *Thesium* cf. *strictum* and on *T. viridifolium*, *Uredo* sp. on *Salsola* cf. *zeyheri*, *Uromyces chaetobromi* on *Chaetobromus dregeanus*, *Uromyces ehrhartae-giganteae* (= *Uredo ehrhartae-calycinae*) on *Ehrharta calycina* and on *E. villosa*, *Uromyces holci* on cf. *Holcus setiger*, on *Karroochloa* cf. *schismoides*, on *Schismus barbatus* and on *Tribolium echinatum*.

Keywords—Biodiversity, Namibia, rust fungi, taxonomy.

Introduction

Up to 400 rust species (Crous, Phillips & Baxter 2000; Doidge 1950) and about 20.000 species of higher plants (Acocks 1953) are known from South Africa. If it is true that rust species are about 5-25% as numerous as plant species (Hennen & McCain 1993), a total rust flora of about 1.000 to 5.000 species could be calculated. Thus, it is likely that a lot more rust species are yet to be found in South Africa.

In the pilot phase of the BIOTA (Biodiversity Monitoring Transect Analyses) Southern Africa project extensive collections of rust fungi were made in the western parts of South Africa and in Namibia. For our first results, we describe six new rust species and we report the first recording of several rust species for South Africa and for Namibia. Furthermore, known rust fungi are shown to have extended host ranges, than currently accepted.

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* Part 216 in the series „Studies in Heterobasidiomycetes" from the Botanical Institute, University of Tübingen.

Materials and methods

The examined specimens were mostly collected in the South African BIOTA-observatories by the first author and Markus Göker between 17.XI.2001–03.XII.2001 and by the first author between 02.IX.2002–30.IX.2002. The 13 BIOTA-observatories in South Africa were set up along a transect, parallel to the N7, from Cape of Good Hope to Richtersveld. Each observatory has one km^2. The specimens collected in the course of this study as well as some additional specimens from herbaria were studied as we performed freehand sections and scrape mounts of infected plant material. The samples were heated in "Hoyer's fluid" (Cunningham 1972) and subsequently examined with a Carl Zeiss microscope with bright field and phase contrast.

With the exception of pycnio- and basidiospores, 25 spores of each occurring spore state were measured. If only one collection of a rust species was available 50 spores of each present spore state were measured. The same was done with type collections. If a spore state is put in parentheses, measurements were not available. The reasons for that are either too small a number of spores or strong alterations of spores that had already germinated.

The cells of the peridium were also examined. In our line drawings, which show the cells as optical sections, the outer wall of the cells is on the left hand side, the inner wall on the right hand side. All specifications with the prefix 'circa' are based on measurements of less than 25 cells.

For the determination of the rust fungi the encyclopaedic publications of Doidge (1927, 1928, 1939, 1941, 1948a, 1948b, 1950) and Cummins (1971) were mostly consulted. In addition, we checked a lot of further publications concerning the rust flora of Africa which are available via internet under http://www.mycology.uni-tuebingen.de/databases/rust-literature/.

Results

The rust species are listed in alphabetical order referring to the host family and to the host genus, respectively. The following abbreviations are used: 0 = spermogonia = pycnia; I = aecia; II = uredinia; III = telia; IV = basidia.

ANTHERICACEAE – *CHLOROPHYTUM* & ASPHODELACEAE – *TRACHYANDRA*

Puccinia polycampta Syd. (Sydow 1924: 236). (Fig. 1)

Type on *Chlorophytum* sp. (as *Anthericum* sp.) South Africa, Western Cape Province, Stellenbosch, IX.1923, leg. L. Verwoerd No. 1260, (Langbaan No. 1270).

Pycnia unknown. Aecia not seen.

Uredinia amphigenous on leaves, sparse in the middle of concentric groups of telia, supepidermal, roundish or ellipsoid in outline, up to 2 mm diameter, dark brown to black, long covered by the epidermis which ruptures lately but always partly veiled, pulverulent, surrounded by mahogany-red leaf spots. Urediniospores subgloboid, ovoid or ellipsoid, 23–38 x 19–30 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–2 µm thick, yellowish to hyaline, germ pores inconspicuous, 8 to 13, scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, separate or scattered in longitudinal deformed concentric groups, up to 1 cm diameter, partly surrounding one uredinium, subepidermal, dark reddish-black, long covered by the epidermis which ruptures lately but always partly veiled, single sori compact, surrounded by mahogany-red leaf spots, loculated by a well developed stroma of dark mahogany-brown, palisade-wise paraphyses. Teliospores in general bicellular, variable in shape and size, ellipsoid, clavate, oblong or irregular in outline, rounded, acuminate or flattened at the apex, rounded or attenuate at the base, slightly constricted at the septum, 38–65 x 18–30 µm, spore wall smooth, occasionally with longitudinal surface ridges, about 1–2 µm thick at the sides, about 2–8 µm thick at the apex, brown to (pale) chestnut-brown, germ pores obscure, pedicel persistent, up to 20 µm long, often truncate short below of the attachment, thin-walled, collapsing, reddish-brown to hyaline. Mesospores and tricellular spores present.

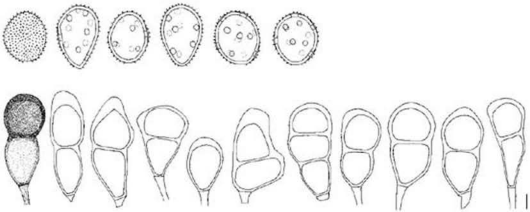

Fig. 1: *Puccinia polycampta* on *Chlorophytum crassinerve*. Uredinio- and teliospores (RSA 146). Scale bar = 10 µm.

Specimens examined:

- On *Chlorophytum crassinerve* (Bak.) Oberm. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.2'', E 17° 32' 45.1'', 11.IX.2002, leg. M. Mennicken No. RSA 146, II III (PREM, M).
- On *Trachyandra* sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.2'', E 18° 18' 23.3'', 19.IX.2002, leg. M. Mennicken No. RSA 187, II III (PREM, M).
- On *Trachyandra* sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.9'', E 18° 18' 24.0'', 19.IX.2002, leg. M. Mennicken No. RSA 195, II III (PREM, M).

Specimen not examined because of the scantiness of the infection:

- On *Trachyandra* sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.0'', E 18° 18' 40.1'', 21.IX.2001, leg. M. Mennicken No. RSA 18, III (PREM).

Our collections agree well with the diagnosis of *Puccinia polycampta* even if the spectrum of spore measurements is wider in our collections. Sydow (1924) stated for the urediniospores 24–27 x 20–25 µm and for the teliospores 36–44 x 18–24 µm. *Chlorophytum crassinerve* is a new host plant and *Puccinia polycampta* seems to be new to the rust flora of the Northern Cape Province.

ASTERACEAE - *HELICHRYSUM*

Puccinia kalchbrenneri De-Toni 1888: 645 **var. *kalchbrenneri*.** (Fig. 2)

Lectotype on *Helichrysum nudifolium* Less. South Africa, near Somerset East, Promont, leg. P. MacOwan.

Syn. *Puccinia helichrysi* Kalchbrenner & Cooke 1880: 21. Type on *Helichrysum petiolatum* D. Don, South Africa, No. 35.
Anamorph. *Uredo lepisclinis* Thümen 1877: 410. Type on *Helichrysum nudifolium*. South Africa, near Somerset-East, Promont, 1876, leg. P. MacOwan No. 1239.

Pycnia, aecia, and telia not seen.

Uredinia mostly abaxial on leaves, and on stems, sparse, separate or scattered in irregular groups, roundish to ellipsoid, small, up to 0.5 mm wide, yellowish-brown, exposed, pulverulent. Urediniospores globoid, subgloboid, or ovoid, 22–28 (–31) x 20–25 (–27) µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1–2 µm thick, bright yellow to hyaline, germ pores inconspicuous, 5 to 9, scattered, without papillae.

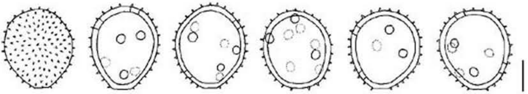

Fig. 2: *Puccinia kalchbrenneri* var. *kalchbrenneri* on *Helichrysum cochleariforme*. Urediniospores (RSA 196). Scale bar = 10 µm.

Specimen examined:

- On *Helichrysum cochleariforme* DC. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 25.6'', E 18° 18' 32.8'', 19.IX.2002, leg. M. Mennicken No. RSA 196, II (PREM, M).

Our collection conforms well with the description of the uredinia and urediniospores of *Puccinia kalchbrenneri* given by Gjærum (1998): "Uredinia hypophyllous, yellowish brown. Urediniospores (21–) 25–33 x 17–25 (–29) µm, globoid, subgloboid or obovoid, sometimes irregular, wall 1 µm thick, finely echinulate". *Helichrysum cochleariforme* seems to be a new host plant.

Puccinia rocherpaniana Mennicken & Oberw. sp. nov. (Fig. 3)

Pycnia et aecia ignota. Uredinia adaxialia, subepidermalia, vulpina, usque ad 1 mm diam., mox nuda, pulverulenta. Urediniosporae subgloboideae, ovoideae vel ellipsoideae, interdum angulatae, 25–35 (–38) x 21–30 µm, pariete echinulato, aureo-fusco vel olivaceo, 2–3 µm crasso, 3–6 poris germinationis dispersis. Telia adaxialia, subepidermalia, nigra, usque ad 1 mm diam., mox nuda, compacta vel pulvinata. Teliosporae bicellulares, obovoideae, ellipsoideae, clavatae vel oblongae, apice rotundato, acuto vel applanato, base rotundata vel attenuata, medio leviter constrictae, 36–69 µm x 21–37 µm, pariete laevigato, brunneo vel castaneo, lateraliter 1–2.5 µm crasso, apicaliter 4–14 µm crasso, poro germinationis cellulae superioris apicali, cellulae inferioris juxta septum posito, pedicello dilute aureo-fusco vel hyalino, usque ad 65 µm longo. Mesosporae numerosae, ellipsoideae vel oblongae, apice acuto vel rotundato, base attenuata vel rotundata, 30–46 x 17–26 µm, pariete laevi, brunneo vel castaneo, lateraliter 1–2 µm crasso, apicaliter 3–11 µm crasso, poro germinationis apicali.
In foliis *Helichrysi tricostati* (Thunb.) Less. (Asteraceae).

Pycnia and aecia unknown.

Uredinia adaxial on leaves, subepidermal, sparse, separate or scattered, roundish in outline, small, up to 1 mm wide, foxy red, exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid or ellipsoid, sometimes irregularly angular, 25–35 (–38) x 21–30 µm, finely echinulate, spores borne singly on pedicels, spore

wall uniformly about 2–3 µm thick, brownish-yellow to olive-green, germ pores inconspicuous 3 to 6, scattered, with hyaline papillae that are weakly developed.
Telia adaxial on leaves, subepidermal, developing from the uredinia, sparse, separate or scattered, black, exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores in general bicellular, variable in shape and size, obovoid, ellipsoid, clavate or oblong, rounded, acuminate or flattened at the apex, rounded or attenuate at the base, slightly constricted at the septum, 36–69 µm x 21–37 µm, spore wall smooth, about 1–2.5 µm thick at the sides, about 4–14 µm thick at the apex, brown to chestnut-brown, paler towards the base and the apex, germ pores apical and just below the septum, pedicel persistent, up to 65 µm long, thin-walled, mostly collapsing, brownish- yellow to hyaline. Mesospores common, ellipsoid to oblong, acuminate or roundish at the apex, attenuate or roundish at the base, 30–46 x 17–26 µm, spore wall smooth, about 1–2 µm thick at the sides, about 3–11 µm thick at the apex, brown to chestnut-brown, paler towards the base and the apex, germ pore apical, pedicel similar to the bicellular teliospores.
On the leaves of *Helichrysum tricostatum* (Asteraceae).
Etymology. Named after the habitat, where the first collection was made, Rocherpan Nature Reserve.

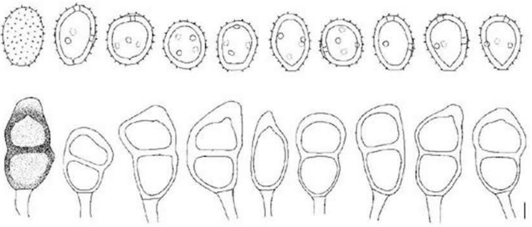

Fig. 3: *Puccinia rocherpaniana* on *Helichrysum tricostatum*. Uredinio- and teliospores (RSA 136). Scale bar = 10 µm.

Specimens examined:

- On *Helichrysum tricostatum*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 27.0'', E 17° 32' 40.1'', 11.IX.2002, leg. M. Mennicken No. RSA 136, II III (Holotype PREM, Isotype M).
- On *Helichrysum tricostatum*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 26.9'', E 17° 32' 40.1'', 26.XI.2001, leg. M. Mennicken No. RSA 52, II III (Paratypes PREM, M).
- On *Helichrysum tricostatum*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 33.3'', E 18° 18' 36.3'', 21.XI.2001, leg. M. Mennicken No. RSA 21, II III (Paratypes PREM, M).
- On *Helichrysum tricostatum*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 24.4'', E 18° 18' 47.9'', 21.XI.2001, leg. M. Mennicken No. RSA 22, II III (Paratypes PREM, M).

- On *Helichrysum tricostatum*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.3'', E 18° 18' 24.7'', 19.IX.2002, leg. M. Mennicken No. RSA 198, II III (Paratypes PREM, M).

As far as could be established, there are five known *Puccinia* and one *Uredo* species on the host genus *Helichrysum*:
The autoecious, macrocyclic *Puccinia kalchbrenneri* (see above) differs from *Puccinia rocherpaniana* in having smaller, thinner-walled urediniospores: "20–30 x 19–26 µm" (Pole Evans 1915), "(21–) 25–33 x 17–25 (–29) µm, … wall 1 µm thick" (Gjærum 1998), and narrower, thinner-walled teliospores having a thinner apex and short, often fragile pedicels: "40–73 x 15–23 µ, rarely up to 27 µ broad, the majority being 40–57 x 15–22 µ, epispore smooth, delicate, thin, pale except of the apex where it is thickened (up to 10 µ) and chestnut brown; … pedicel short, deciduous" (Doidge 1927), "42–66 x 21–27 µm, … walls pale brown, 1 µm thick, apically darker brown, up to 7 µm thick. Pedicels up to 30 µm long, often deciduous" (Gjærum 1998).
Puccinia kalchbrenneri var. *valida* Doidge 1927: 58 differs from *Puccinia rocherpaniana* in having smaller, thinner-walled urediniospores (see above) and in having narrower teliospores (50–80 x 18–24 µ) with a deep chestnut brown colouration at the apex. The urediniospores of *Puccinia kalchbrenneri* var. *valida* are similar to those of *Puccinia kalchbrenneri*.
Puccinia macowani G. Winter (Winter 1885: 255) and *Puccinia pienaarii* Pole-Evans (Pole Evans 1915: 643) are autoecious, probably demicyclic rust fungi. *Puccinia macowani* differs from *Puccinia rocherpaniana* in having longer and smaller teliospores "60–90 x 19–25 µ" (Doidge 1927). The epispore of the teliospores of *Puccinia pienaarii* is up to 10 µm thick, and has "irregular longitudinal or reticulate ridges or flanges (these is only visible when the spore is dry)" (Doidge 1927).
Puccinia lagenophorae Cooke 1884: 6, which infects several *Helichrysum* species in Australia (Shivas 1989), is autoecious and demicyclic.
Uredo humbertii Maire 1934: 646, described from Madagascar, has bigger urediniospores (40–42 x 34–36 µm).
The attributes of *Puccinia rocherpaniana* are not suitable to any other *Puccinia* species on Asteraceae cited in Doidge (1927). Therefore, the rust fungus is described as new.
The host genus *Helichrysum* belongs to the tribe Gnaphalieae (Herman et al. 2000). With ± 600 species, *Helichrysum* is widespread in Africa (244 species in southern Africa) and Madagascar, as well as in Europe, Asia and Australia.

ASTERACEAE - *LEYSERA*

Aecidium elytropappi Henn. (Hennings 1898: 294). (Fig. 4)
Type on *Elytropappus rhinocerotis* Less. South Africa, 'West-Capland', in the hills behind Bot Rivier, XI.1896, leg. R. Schlechter (B 70 0007271).
Pycnia unknown.
Aecia aecidioid, seriate on stems, covering the whole stem surface over several centimeters, often causing minor hypertrophies of the stems, without leaf spots surrounding aecia, aecial cups conical to cylindrical, erumpent, circa 200–450 µm diameter, up to 1 mm long, spore mass freshly orange to yellow, bleaching in the herbarium to cream-white, surrounded by a recurved, irregularly and deeply frayed peridium. Peridium

freshly orange to yellow, bleaching in the herbarium to cream-white, cells of the peridium medium connected, outer wall finely striate, circa 14–16 µm wide, inner wall verrucous, circa 4–7 µm wide. Aeciospores angular globoid, subgloboid to ovoid, 19–27 x 14–22 µm, spore wall about 1–2.5 µm thick, up to 4 µm thick in the edge with the only germ pore, without papillae, finely verrucous, hyaline.

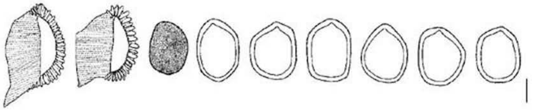

Fig. 4: *Aecidium elytropappi* on *Leysera gnaphalodes*. Peridium cells and aeciospores (RSA 200). Scale bar = 10 µm.

Specimens examined:

- On *Elytropappus rhinocerotis*. South Africa, 'West-Capland', in the hills behind Bot Rivier, XI.1896, leg. R. Schlechter, I (Type B 70 0007271).
- On *Leysera gnaphalodes* (L.) L. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 33.3'', E 18° 18' 37.0'', 21.XI.2001, leg. M. Mennicken No. RSA 25, I (PREM, M).
- On *Leysera gnaphalodes*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 27.0'', E 18° 18' 32.2'', 19.IX.2002, leg. M. Mennicken No. RSA 200, I (PREM, M).

Aecidium elytropappi is denoted on *Elytropappus rhinocerotis* from the Eastern and Western Cape Province in South Africa (Crous, Phillips & Baxter 2000) and on *Stoebe kilimandsharica* O. Hoffm. from Kilimanjaro in Tanzania (Henderson 1972). As far as could be established, *Leysera* is a new host genus. All three known host genera belong to the Gnaphalieae (Herman et al. 2000).

ASTERACEAE - *PTERONIA*

Puccinia pteroniae Mennicken & Oberw. sp. nov. (Fig. 5)

Pycnia et aecia ignota. Uredinia amphigena, subepidermalia, vulpina, usque ad 1 mm diam., mox nuda, pulverulenta. Urediniosporae subgloboideae, pyriformes, ellipsoideae vel oblongae, saepe angulatae, (28–) 33–41 (–48) x 21–33 (–36) µm, pariete echinulato, aureo-fusco, lateraliter (1.5–) 2–2.5 (–3) µm crasso, apicaliter 2–4 µm crasso, 2–4 poris germinationis aequatorialibus. Telia amphigena, subepidermalia, nigra, usque ad 1 mm diam., mox nuda, pulverulenta. Teliosporae bicellulares, subgloboideae, ellipsoideae vel cylindraceae, apice rotundato, base rotundata, medio leviter constrictae, 41–58 (–65) x (28–) 30–40 (–43) µm, pariete laevi, lateraliter 3–6 µm crasso, apicaliter usque ad 9 µm crasso, bilaminato, strato exteriore tenui, luteo-porphyreo, strato interiore atro-porphyreo, poro germinationis cellulae superioris ± apicali vel subapicali, cellulae inferioris ± juxta septum posito, pedicello inflato, dilute aureo-fusco vel hyalino, usque ad 95 µm longo.
In foliis *Pteroniae divaricatae* (Berg.) Less. (Asteraceae).

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, subepidermal, sparse, separate or arranged in irregular groups, single sori round, elliptic or irregular in outline, small, up to 1 mm wide, foxy red, early exposed, pulverulent, surrounded by the torn epidermis, with slightly yellowed and/or brightened leaf spots surrounding uredinia. Urediniospores variable in shape and size, subgloboid, pyriform, ellipsoid or oblong, often somewhat angular, (28–) 33–41 (–48) x 21–33 (–36) µm, echinulate, echinulation coarsely meshed, spores borne singly on pedicels, spore wall about (1.5–) 2–2.5 (–3) µm thick at the sides, about 2–4 µm thick at the apex, golden-brown, germ pores conspicuous, 2 to 4, mostly 3, equatorial, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, subepidermal, developing from the uredinia, sparse, separate or in irregular groups, single sori roundish or irregular in outline, small, up to 1 mm wide, mostly smaller, black, early exposed, pulverulent, surrounded by the torn epidermis, with slightly yellowed and/or brightened leaf spots surrounding telia. Teliospores bicellular, subgloboid, ellipsoid or cylindrical, rounded above and below, slightly constricted at the septum, 41–58 (–65) x (28–) 30–40 (–43) µm, spore wall smooth, about 3–6 µm thick at the sides, up to 9 µm thick at the apex or over the germ pore, bilaminate, outer layer usually thin-walled, forming preferentially in the range of germ pores large, papilla-like swellings, pale and yellowed mahogany-coloured, inner layer ± uniformly thick-walled, mahogany-coloured to deep mahogany-coloured, germ pore in the upper cell ± apical or 1/3 of the distance from the apex to the septum, in the lower cell below the septum or 1/3 of the distance from the septum to the base, pedicel persistent, up to 95 µm long, not collapsing, short below the attachment with cylindrical, stripe-like inflation, outer margins of the swelling diffusing in Hoyer's fluid, brownish-yellow to hyaline, sometimes obliquely inserted.

On the leaves of *Pteronia divaricata* (Asteraceae).

Etymology. Named after the host plant, *Pteronia divaricata*.

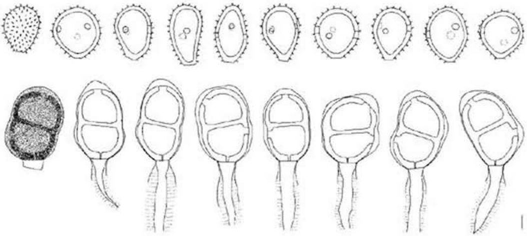

Fig. 5: *Puccinia pteroniae* on *Pteronia divaricata*. Uredinio- and teliospores (RSA 174). Scale bar = 10 µm.

Specimens examined:

- On *Pteronia divaricata*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 43.0'', E 18° 26' 26.1'', 18.IX.2002, leg. M. Mennicken No. RSA 174, II III (Holotype PREM, Isotype M).
- On *Pteronia divaricata*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 24.7'', E 18° 18' 34.7'', 19.IX.2002, leg. M. Mennicken No. RSA 189, II III (Paratypes PREM, M).
- On *Pteronia divaricata*. Namibia, Bezirk Lüderitz, 35 km N of Rosh Pinar (Route to Aus), 2-4 km west of the route, 29.X.1983, leg. B. Leuenberger, Th. Raus & Ch. Schiers No. 3248, II (B 10 9009304).

- On cf. *Pteronia* spec. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 24.5'', E 18° 18' 35.5'', 19.IX.2002, leg. M. Mennicken No. RSA 194, II III (PREM, M).

The host genus *Pteronia*, which belongs to the Astereae, occurs with 70 species mainly in Namibia, Botswana, and South Africa. A few species are extending into Zimbabwe and into Australia (Herman, Retief, Koekemoer & Welman 2000).

As far as could be established, there is no known rust fungus either from the genus *Pteronia* or a similar known rust fungus from other genera of the family Asteraceae in southern Africa or in Australia. Therefore, the rust fungus is described as new.

ASTERACEAE - *SONCHUS*

Miyagia pseudosphaeria Jørst. (Jørstad 1961: 78).

Anamorph. *Aecidium sonchi* Johnst.

Syn. *Puccinia pseudosphaeria* Mont.

Syn. *Puccinia sonchi* Rob. in Desmaziéres 1849: 274. Lectotype on *Sonchus arvensis*, France, autumn.

Syn. *Puccinia pseudo-sphaeria* Mont.

Anamorph. *Aecidium sonchi* Westend. (Westendorp 1861: 649). Type on *Sonchus oleraceus*, Belgium, near Courtrai (HCB No. 1160).

Syn. *Uromyces sonchi* Oudem.

Syn. *Uromyces puccinioides* Fautrey & Rolland in Roumeguére 1893: 25. Type on *Sonchus arvensis*, France, VIII.1892, leg. F. Fautrey.

Syn. *Puccinia tagananensis* Magnus 1901: 297. Type on *Sonchus radiatus* Ait. Teneriffa, near Tagana, VII.1900, leg. Bornmüller.

Syn. *Peristemma sonchi* (Rob.) Syd. (Sydow 1921: 175).

Syn. *Peristemma pseudosphaeria* (Mont.) Jørst. (Jørstad 1956a: 280).

Pycnia and telia not seen. Aecia unknown.

Uredinia amphigenous on leaves, subepidermal, separate or scattered in irregular groups, yellowish pustules small, up to 1 mm wide, long covered by the epidermis, opening through an apical pore, later gaping, pulverulent, spots surrounding pustule up to 2 mm wide, often discoloured violet, not clearly margined on the host leaf. Paraphyses numerous, peripherally surrounding the sori, cylindrical to subclavate, marginally thicker at the apex, pale brown at the base, chestnut-brown at the apex, thick-walled. Urediniospores borne singly on pedicels, ovoid, ellipsoid to oblong ellipsoid, 26–40 x 15–24 µm, echinulate, spore wall about 2–5 µm thick, hyaline, germ pores obscure, only visible in optical sections by the reduced thickness of the spore wall, scattered and probably numerous, without papillae.

Specimens examined:

- On *Sonchus* cf. *oleraceus* L. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 2'3 52.5'', E 18° 16' 49.2'', 08.IX.2002, leg. M. Mennicken No. RSA 125, II (PREM, M).
- On *Sonchus* cf. *oleraceus*. South Africa, Western Cape Province, BIOTA-observatory at Riverlands, S 33° 29' 27.7'', E 18° 35' 25.9'', 19.XI.2001, leg. Markus Göker No. RSA 16, II (PREM, M).
- On *Sonchus* cf. *oleraceus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 42.2'', E 18° 16' 28.4'', 18.IX.2002, leg. M. Mennicken No. RSA 173, II (PREM, M).

Sonchus cf. *oleraceus* is one of the earliest weeds introduced into South Africa from Europe, having been recorded at the Cape as early as 1685 (Bromilow 2001). As far as could be established, *Miyagia pseudosphaeria* is new to the rust flora of South Africa.

ASTERACEAE - *TARCHONANTHUS*

Uredo tarchonanthi Mennicken & Oberw. sp. nov. (Fig. 6)

Pycnia, aecia et telia ignota. Uredinia abaxialia, subepidermalia, aurantiaca vel ochracea vel cremeo-alba, usque ad 0.2 mm diam., immersa, exposita, pulverulenta, paraphysibus peripheralibus cylindraceis, clavatis, capitatis vel irregularibus, incurvatis, septatis, dilute aureo-brunneis, usque ad 100 µm longis, circa 7–19 µm latis, pariete basali circa 0.5–1 µm crasso, apicali incrassato usque ad 4 µm. Urediniosporae subgloboideae, ovoideae, ellipsoideae, pyriformes vel oblongae, 26–41 (–45) x 17–26 µm, pariete echinulato, dilute aureo-fusco vel hyalino, 1–3 µm crasso.
In foliis *Tarchonanthi littoralis* P.P.J. Herman (Asteraceae).

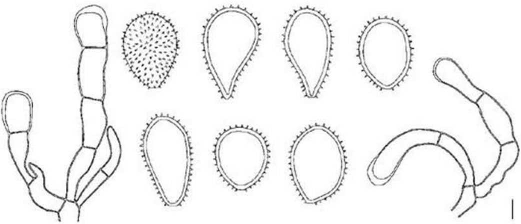

Fig. 6: *Uredo tarchonanthi* on *Tarchonanthus littoralis*. Paraphyses and urediniospores (Holotype RSA 220). Scale bar = 10 µm.

Pycnia, aecia, and telia unknown.
Uredinia abaxial on leaves, scattered, subepidermal, freshly orange and conspicuous, bleaching in the herbarium to ochraceous or cream-white and very inconspicuous as a result of the cream-white, hairy tomentum covering the abaxial leaf surface, single sori strongly immersed, up to 0.2 mm diameter, exposed, pulverulent, surrounded by numerous, mostly incurved paraphyses, paraphyses cylindrical, clavate, or capitate, often irregularly in outline, 1– to 3–septate, up to circa 100 µm long and circa 7–19 µm wide near the apex, wall of the paraphyses about 0.5–1 µm thick basally, up to 4 µm thick near the apex, yellow-brown to hyaline. Urediniospores sessile, subgloboid, ovoid, ellipsoid, pyriform or oblong, 26–41 (–45) x 17–26 µm, grossly echinulate, echinulation closely meshed, spore wall uniformly about 1–3 µm thick, very pale brownish-yellow to hyaline, germ pores obscure, occasionally visible in optical sections, scattered and probably numerous, without papillae.
On the leaves of *Tarchonanthus littoralis* (Asteraceae).
Etymology. Named after the host plant, *Tarchonanthus littoralis*.

Specimen examined:

- On *Tarchonanthus littoralis*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, 23.IX.2002, leg. M. Mennicken No. RSA 220, II (Holotype PREM, Isotype M). Infected with the hyperparasite *Eudarluca caricis* (Biv.) O.E. Erikss.

The genus *Tarchonanthus* forms together with the genus *Brachylaena* the tribe Tarchonantheae and is restricted to Africa, Madagascar and associated islands (Herman, Retief, Koekemoer & Welman 2000). Doidge (1927) described the rust fungus *Uredo brachylaenae* on several *Brachylaena* species in Natal, Transvaal, and Cape Province in South Africa. *Uredo brachylaenae* resembles *Uredo tarchonanthi* in several details like the peripheral, septate paraphyses, and the obscure germ pores. It differs from *Uredo tarchonanthi* in having smaller spores (18–23.5 x 15–17 µm) with a thinner-walled epispore (about 1 µm), and in having "minutely and rather sparsely verruculose-echinulate" spore wall. We examined the type specimens of *Uredo brachylaenae* (Holotype PREM 2525, Paratype PREM 1821, and Paratype PREM 982). Although the urediniospores often have larger dimensions than stated in Doidge (1927), they do not reach the values of our measurements. Furthermore, the echinulate spore wall of *Uredo brachylaenae* is uniformly about 1–1.5 µm thick, the sori are not immersed but superepidermally developed, and the arrangement of the paraphyses is more consolidated in the lower parts of the sorus. Therefore, *Uredo tarchonanthi* is described as new.

ASTERACEAE - *URSINIA*

Puccinia ursiniae R.G. Shivas (Shivas 1991: 379). (Fig. 7)

Type on *Ursinia anthemoides* (L.) Poir. Western Australia, Burns Beach Road, Wanneroo, 20.X.1985, leg. R. G. Shivas (PERTH 791873).

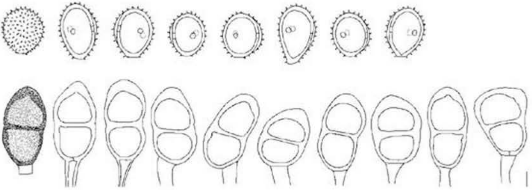

Fig. 7: *Puccinia ursiniae* on *Ursinia anthemoides*. Uredinio- and teliospores (RSA 14). Scale bar = 10 µm.

Pycnia and aecia unknown.

Uredinia mostly amphigenous on leaves, rarely on stems and on peduncles, scattered, single sori round to elliptic in outline, small, up to 1 mm diameter, cinnamon-brown, early exposed, pulverulent, surrounded by the torn epidermis, without leaf spots surrounding uredinia. Urediniospores subgloboid, pyriform, ellipsoid or obovoid, 27–38 x 21–26 µm, echinulate, spores borne singly on pedicels, spore wall about 1.5–2.5 µm thick at the sides, about 2–4 µm thick at the apex, golden-brown to pale brown, germ pores inconspicuous, 3, equatorial, with hyaline papillae that are largely developed.

Telia amphigenous on leaves, on stems, on peduncles and on involucral bracts, (partly) developing from the uredinia, scattered or confluent, single sori on the leaves and on the involucral bracts round to ellipsoid, up to 1 mm diameter, on the stems and the peduncles ellipsoid to oblong, up to 2 mm long, early exposed, cushion-like, pulverulent, surrounded by the torn epidermis, without leaf spots surrounding telia. Teliospores bicellular, ellipsoid or cylindrical, rounded, slightly apiculate or flattened at the apex, rounded or attenuate at the base, not or slightly constricted at the septum, 37–63 x 24–34 µm, spore wall verrucous, with spaced cavities, about 1.5–3 µm thick at the sides, about 5–10 µm thick at the apex, chestnut-brown, germ pore in the upper cell apical, in the lower cell just below the septum, pedicel persistent, up to 120 µm long, thin- or thick-walled, in general not collapsing, hyaline, sometimes obliquely inserted.

Specimens examined:

- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 26' 05.8'', E 19° 02' 18.5'', 18.XI.2001, leg. M. Mennicken No. RSA 9, III (PREM, M).
- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 26' 01.2'', E 19° 02' 09.8'', 21.IX.2002, M. Mennicken No. RSA 209, II III (PREM, M).
- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Riverlands, S 33° 29' 19.1'', E 18° 35' 20.2'', 19.XI.2001, leg. M. Mennicken No. RSA 14, II III (PREM, M).
- On *Ursinia anthemoides*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 17.2'', E 18° 18' 46.5'', 21.XI.2001, leg. M. Mennicken No. RSA 24, (II) III (PREM, M).

The genus *Ursinia*, which belongs to the Anthemideae, occurs with 39 species in southern Africa and Ethiopia. It is widespread, and especially prominent in Northern Cape (Namaqualand), Western Cape, and the Eastern Cape (Herman et al. 2000). *Ursinia anthemoides* has been introduced in Australia and "has become a weed of roadsides and waste places on a variety of soils extending throughout the south-western region of the State" (Marchant et al. 1987 in Shivas 1991).

Our collections agree well with the diagnosis of *Puccinia ursiniae* given by Shivas (1991). The type collection is from Western Australia, but Shivas (1991) checked the possibility that *Puccinia ursiniae* was indigenous to South Africa. He found that eight of 26 herbarium specimens of *Ursinia anthemoides* received from South Africa were infected with *Puccinia anthemoides*. The oldest South African specimen of *Ursinia anthemoides* infected with *Puccinia ursiniae* was collected in the year 1885.

CHENOPODIACEAE - *SALSOLA*

Uredo sp. (Fig. 8)

Pycnia, aecia and telia unknown or not seen, respectively.

Uredinia amphigenous on the elongated leaves of spherical, small, up to 1.5 cm wide, gall-shaped concrescences, subepidermal, scattered, irregularly rupturing pustules up to 1 mm wide, roundish or elliptic, cinnamon-brown, without spots surrounding pustules, early exposed and surrounded by the torn epidermis. Urediniospores subgloboid, pyriform, ellipsoid or terete, 24–32 (–34) x 19–24 (–26) µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–2.5 µm thick, golden to pale chestnut-brown, germ pores 3 to 6, scattered, with hyaline papillae.

Specimens examined:

- On *Salsola* cf. *zeyheri* (Moq.) Bunge. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 42.3'', E 18° 26' 28.4'', 18.IX.2002, leg. M. Mennicken No. RSA 170, II (PREM, M).
- On *Salsola* cf. *zeyheri*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 42.3'', E 18° 26' 30.6'', 18.IX.2002, leg. M. Mennicken No. RSA 182, II (PREM, M).

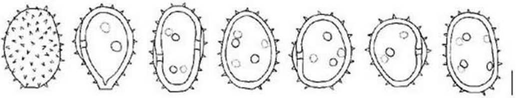

Fig. 8: *Uredo* sp. on *Salsola* cf. *zeyheri*. Urediniospores (RSA 170). Scale bar = 10 µm.

As far as could be established, there is no known South African rust fungus on *Salsola*. Because of the existence of several *Uromyces* species with similar urediniospore dimensions on Chenopodiaceae (Sydow & Sydow 1910) our results are inconclusive.

FABACEAE - *ASPALATHUS*

Uredo aspalathi Mennicken & Oberw. sp. nov. (Fig. 9)

Pycnia, aecia et telia ignota. Uredinia amphigena, subepidermalia, cinnamomea, usque ad 1 mm diam., mox nuda, pulverulenta. Urediniosporae globoideae, pyriformes vel late ellipsoideae, 24–32 x 22–27 µm, pariete echinulato, aureo-fusco, 2.5–3.5 µm crasso, 4–6 poris germinationis dispersis.
In foliis *Aspalathi laricifoliae* Bergius (Fabaceae)

Pycnia, aecia, and telia unknown.
Uredinia amphigenous on leaves, subepidermal, forming small prominent pustules, up to 1 mm wide, roundish or elliptic, irregularly rupturing, cinnamon-brown, without spots surrounding pustules, clearly margined on the host leaves, surrounded by the torn epidermis. Urediniospores borne singly on short pedicels, globoid, pyriform or (broadly) ellipsoid, partially tending to be triangular to pentagonal with broadly rounded edges, 24–32 x 22–27 µm, echinulate, echinulation coarsely and irregularly meshed, spore wall uniformly about 2.5–3.5 µm thick, golden to dark golden-brown, germ pores conspicuous, 4 to 6, scattered, with hyaline papillae.
On the leaves of *Aspalathus laricifolia* (Fabaceae).
Etymology. Named after the host plant, *Aspalathus laricifolia*.

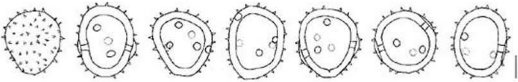

Fig. 9: *Uredo aspalathi* on *Aspalathus laricifolia*. Urediniospores (Holotype RSA 2). Scale bar = 10 µm.

Specimens examined:

- On *Aspalathus laricifolia*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 46.1'', E 18° 23' 36.6'', 17.XI.2001, leg. M. Mennicken No. RSA 2, II (Holotype PREM, Isotype M).
- On *Aspalathus laricifolia*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 40.3'', E 18° 23' 35.5'', 23.IX.2002, leg. M. Mennicken No. RSA 215, II (Paratypes PREM, M).

The genus *Aspalathus*, which belongs to the subfamily Papilionideae and the tribe Crotalarieae is with ± 278 species the largest genus of flowering plants endemic in southern Africa (Germishuizen 2000). The center of distribution is in the Western Cape but extends into KwaZulu-Natal.

As far as could be established, only microcyclic rust fungi have been described on *Aspalathus* so far: *Uromyces bolusii* Massee 1901: 168 (Type on *Aspalathus pachyloba* Benth., South Africa, Montagu Bath, leg. Bolus No. 7597), and *Uromyces ventosa* (as *Teleutospora ventosa*) Syd. (Sydow 1924: 235) (Type on *Aspalathus* sp. (as *Borbonia* sp.), South Africa, Stellenbosch, VIII.1923, leg. A. V. Duthie No. 1246).

FABACEAE - *LEBECKIA*

Aecidium dielsii Henn. (Hennings 1904: 34). (Fig. 10)

Type on *Crotalaria* sp. South Africa, Clanwillian, 1900, leg. Diels No. 1145 (B).

Pycnia unknown.

Aecia aecidioid, amphigenous on leaves, on flowers, and on stems, covering the whole stem surface over several centimeters, often causing hypertrophy of the stems, without spots surrounding aecia, aecial cups reduced to salient, erumpent pustules, circa 400–500 µm diameter, spore mass orange, yellow to cream-white, peridium exserted, slit right to the base in narrow segments, yellowish to cream-white, up to 2.2 cm long, cells of the peridium medium connected, oblong, outer wall striate, circa 3–7 µm wide, inner wall inconspicuously striate, circa 1.5–3 µm wide. Aeciospores angular globoid, subgloboid, ellipsoid to oblong, 22–33 x 18–26 µm, spore wall about 2–4 µm thick, up to 5.5 µm thick in one edge, finely verrucous, yellowish to hyaline, germ pores normally invisible, partly visible in optical sections, probably scattered and numerous, without papillae.

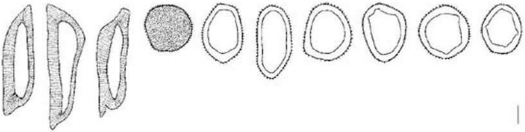

Fig. 10: *Aecidium dielsii* on *Lebeckia* sp. Peridium cells and aeciospores (RSA 185). Scale bar = 10 µm.

Specimen examined:

- On Lebeckia sp. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.9'', E 18° 18' 23.1'', 19.IX.2002, leg. M. Mennicken No. RSA 185, I (PREM, M).

Our collection agrees well with the diagnosis of *Aecidium dielsii*. As far as could be established, *Aecidium dielsii* is known only from the type collection on *Crotalaria* sp. Thus, *Lebeckia* could be proven as a new host genus. Both host genera belong to the tribe Crotalarieae in Papilionoideae (Germishuizen 2000).

FABACEAE - *PSORALEA*

cf. ***Phakopsora pachyrhizae*** Syd. & P. Syd. (Sydow & Sydow 1914: 108).

Type on *Pachyrhizus angulatus* Rich. Formosa, Taihoku, 25.XII.1913, leg. Y. Fujikuro No. 37.
For synonyms and figures see Ono, Buriticá & Hennen (1992).

Pycnia and aecia unknown. Telia not seen.

Uredinia amphigenous on leaves, subepidermal, separate or scattered, pustules small, up to 0.25 mm diameter, roundish, pale brown, opening through a central aperture, pulverulent, not clearly margined on the host leaves, spots surrounding pustule up to 1 cm wide, roundish or irregularly in outline, discoloured brown to dark brown, not clearly margined at the host leaves, single sori surrounded by paraphyses arising from peridioid pseudoparenchyma, also with hymenial paraphyses, paraphyses cylindrical to clavate, up to 45 µm long and up to 12 µm wide apically, wall of the paraphyses thin at the sides, up to 11 µm thick at the apex, pale golden to hyaline. Urediniospores subgloboid, obovoid, pyriform to ellipsoid, 20–28 (–32) x 13–18 µm, echinulate, spore wall uniformly about 1 µm thick, pale yellowish-brown to hyaline, germ pores rather obscure, probably 2 to 8, scattered or ± equatorial, without or with hyaline papillae that are very weakly developed.

Specimen examined:

- On *Psoralea pinnata* L. South Africa, Western Cape Province, Kirstenbosch Botanical Garden, 29.IX.2002, leg. M. Mennicken No. RSA 221, II (PREM, M).

According to Ono, Buriticá & Hennen (1992), *Phakopsora pachyrhizi* infects a wide range of Leguminosae in Austro-Asia and Africa. Without teliospores *Phakopsora pachyrhizi* can not be delimited from *Phakopsora meibomiae* (Arthur) Arthur 1917: 509 (Syn. *Phakopsora psoraleae* Jackson 1931: 346. Type on *Psoralea glandulosa* L. Bolivia, Sorata). *Phakopsora meibomiae* attacks several Leguminosae in the New World. Because of the geographic origin of our collection from South Africa, we refer to this rust fungus as *Phakopsora pachyrhizae*. As far as could be established *Psoralea* seems to be a new host genus for *Phakopsora pachyrhizi*.

GERANIACEAE - *PELARGONIUM*

Puccinia granularis Kalchbr. & Cooke in Kalchbrenner 1882: 22.

Type on *Pelargonium* sp. South Africa, P. Natal, No. 10.

Anamorph. *Aecidium pelargonii* Thüm. (Thümen 1877: 411). Type on *Pelargonium alchemilloides* Willd. South Africa, Boschberg near Somerset-East, Promont, XI.1876, leg. MacOwan.

Anamorph. *Uredo pelargonii* Thüm. (Thümen 1878: 355). Type on *Pelargonium alchemilloides*. South Africa, Boschberg near Somerset-East, Promont, XI.1876, leg. MacOwan.

Syn. *Puccinia pelargonii* (Thüm.) P. Syd. & Syd. (Sydow & Sydow 1904: 469).

Pycnia, aecia, and telia not seen.

Uredinia abaxial on leaves, separate, scattered or in irregularly crowded groups, reddish-brown, forming round or irregular shaped sori on indefinite leaf spots, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid, or ellipsoid, 24–29 x 21–24 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 2.5–3.5 µm thick, golden-brown, germ pores 2 (to 3), equatorial, without papillae.

Specimen examined:

- On *Pelargonium grossularioides* (L.) L'Hér. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 26' 03.2'', E 19° 02' 23.5'', 18.XI.2001, leg. M. Mennicken No. RSA 10, II (PREM, M).

Our collection agrees well with the description of *Puccinia granularis* given by Doidge (1927). In South Africa one collection of *Puccinia granularis* on *Pelargonium grossularioides* is known from the Western Cape Province, University of Cape Town grounds, 31.IV.1934, leg. J.P.H. Acocks No. 2443 (Jørstad 1956b). This collection is not mentioned in Crous, Philip & Baxter (2000).

LAMIACEAE - *MENTHA*

Puccinia menthae Pers.

For synonyms see Sydow & Sydow (1904).

Pycnia, aecia, and telia not seen.

Uredinia abaxial on leaves, on stems, subepidermal, pale cinnamon-brown, separate, scattered, or arranged in irregular or concentric groups, single sori roundish, ellipsoid, or irregularly in outline, up to 1 mm diameter, first covered by the epidermis, early exposed, pulverulent, surrounded by the torn epidermis, mostly with yellowed, brightened or browned leaf spots surrounding uredinia. Urediniospores globoid, subgloboid, or ellipsoid, 22–29 x 18–22 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1–2 µm thick, pale golden-brown to hyaline, germ pores inconspicuous, 2 to 3, ± equatorial, occasionally one additional apical germ pore, with hyaline papillae that are weakly developed.

Specimen examined:

- On *Mentha* cf. *longifolia* (L.) L. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 53.8'', E 18° 16' 51.5'', 08.IX.2002, leg. M. Mennicken No. RSA 127, II (PREM, M).

Puccinia menthae, which is known from the provinces Gauteng and KwaZulu-Natal in South Africa (Crous, Phillips & Baxter 2000), seems to be new to the rust flora of Northern Cape.

ORCHIDACEAE - *BARTHOLINA*

Uromyces silksvleyensis Mennicken & Oberw. sp. nov. (Fig. 11)

Pycnia, aecia et uredinia ignota. Telia in foliis, plurimum abaxialia, raro adaxialia vel in petiolis, subepidermalia, nigro-brunnea, usque ad 1.2 mm diam., epidermide diu tecta, pulverulenta. Teliosporae unicellulares, globoideae, subgloboideae vel ellipsoideae, apice rotundato, leviter acuto vel leviter applanato, base rotundata vel leviter attenuata, 26–36 x 23–29 (–33) µm, pariete laevigato, castaneo, lateraliter 0.5–1.5 µm crasso, apicaliter 3–4 (–5) µm crasso, poris germinationis inconspicuis, pedicello dilute aureo vel hyalino, usque ad 35 µm longo.

In foliis cf. *Bartholinae burmannianae* Ker-Gawl. (Orchidaceae).

Pycnia, aecia, and uredinia unknown.

Telia abaxial on leaves, occasionally adaxial, on petioles, scattered in confluent groups which can cover the whole leaf surface, subepidermal, single sori roundish, ellipsoid or irregularly in outline, up to 1.2 mm diameter, dark chocolate-brown to black, long covered by the epidermis which ruptures lately but always partly veiled, compact, pulverulent, without leaf spots surrounding telia. Teliospores unicellular, globoid, subgloboid to ellipsoid, often somewhat angular and irregularly, occasionally broader than long, rounded, slightly flattened, or slightly acute at the apex, rounded or slightly atten-

uate at the base, 26–36 x 23–29 (–33) µm, spore wall smooth, about 0.5–1.5 µm thick at the sides, about 3–4 (–5) µm thick at the apex, becoming progressively thicker from the base towards the apex, widest thickness not inevitably in the opposite of the pedicel, often obliquely displaced, chestnut-brown, germ pore obscure, probably apical, pedicel persistent, up to 35 µm long, thin-walled, collapsing, yellowish to hyaline, sometimes obliquely inserted.
On the leaves and petioles of cf. *Bartholina burmanniana* (Orchidaceae).
Etymology. Named after the neighbouring field name, Silksvley.

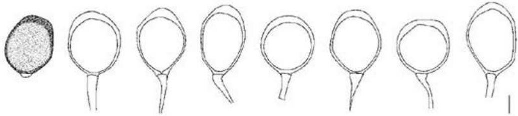

Fig. 11: *Uromyces silksvleyensis* on cf. *Bartholina burmanniana*. Teliospores (Holotype RSA 218). Scale bar = 10 µm.

Specimen examined:

- On cf. *Bartholina burmanniana*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 54.3'', E 18° 24' 03.2'', 23.IX.2002, leg. M. Mennicken No. RSA 218, III (Holotype PREM, Isotype M).

As far as could be established, there is neither a known *Uromyces* species on Orchidaceae in southern Africa nor is there any known *Uromyces* species on the host genus *Bartholina*, which, with two species, is endemic to southern Namibia, and to Northern, to Western and to Eastern Cape (Kurzweil 2000). Therefore, the rust fungus is described as new.

POACEAE - *BROMUS*

Puccinia hordei G.H. Otth.

For synonyms and figures see Cummins (1971).

Pycnia and aecia not seen.

Uredinia mostly adaxial on leaves, creamish-white to ochraceous, subepidermal, forming long streaks between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid, ovoid, pyriform or ellipsoid, 21–33 (–39) x 19–29 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1–2.5 µm thick, pale yellowish, pale brownish to hyaline, germ pores inconspicuous, 10 to 15, scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, mostly abaxial, and on sheaths, dark chocolate-brown to blackish, forming long, confluent streaks between the nerves of the leaves, long remaining covered by the epidermis which later longitudinally ruptures, loculate by brown, palisade-wise paraphyses, compact. Teliospores bicellular, variable in shape and size, ellipsoid, clavate, oblong or irregularly in outline, often angular, rounded, acuminate or flattened at the apex, rounded or attenuate at the base, slightly constricted at the septum, (30–) 36–63 x 17–32 (–36) µm, spore wall smooth or with longitudinal surface ridges, about 1–2 µm thick at the sides, about 3–9 µm thick at the apex, yellow-brown to chestnut-brown, mostly paler towards the base, often paler towards the apex, germ pores obscure, pedicel persistent, up to 20 µm long, often truncate immediately below the attachment, thin-walled, collapsing, yellowish to hyaline, often obliquely inserted. Mesospores and tricellular spores existing.

Specimens examined:

- On *Bromus pectinatus* Thunb. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 47.5'', E 18° 16' 45.3'', 27.XI.2001, leg. M. Mennicken No. RSA 67, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 30.8'', E 17° 33' 11.9'', 11.IX.2002, leg. M. Mennicken No. RSA 137, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 32' 55.7'', 11.IX.2002, leg. M. Mennicken No. RSA 142, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 49.3'', E 18° 16' 43.4'', 27.XI.2001, leg. M. Mennicken No. RSA 69, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Flaminkvlakte 111, S 31° 17' 07.1'', E 18° 35' 46.6'', 06.IX.2002, leg. M. Mennicken No. RSA 116, II (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 48.0'', E 18° 26' 31.4'', 05.IX.2002, leg. M. Mennicken No. RSA 113, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 37.1'', E 18° 36' 14.6'', 07.IX.2002, leg. M. Mennicken No. RSA 118, II III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 30.7'', E 18° 36' 04.0'', 23.XI.2001, leg. M. Mennicken No. RSA 35, III (PREM, M).
- On *Bromus pectinatus*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 28.8'', E 18° 18' 29.9'', 19.IX.2002, leg. M. Mennicken No. RSA 201, II III (PREM, M).

Puccinia hordei agrees well with the description given in Cummins (1971). As far as could be established, there is only one collection of *Puccinia hordei* (on *Bromus pectinatus)* in South Africa (Gjærum 1988). This collection is not mentioned in Crous, Phillips & Baxter (2000). In South Africa the host plant *Bromus pectinatus* is regarded as an exotic plant from Eurasia (Bromilow 2001).

POACEAE - *CHAETOBROMUS*

Uromyces chaetobromi Gjærum 1988: 371. (Fig. 12)

Type on *Chaetobromus schraderi* Stapf. South Africa, Cape Province, Clanwillian distr. (as Chanwillian distr.), 07.XI.1974, leg. Van Breda No. 4302 (Holotype K, Isotype NPPI).

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, subepidermal, cinnamon-brown, forming small elliptic to oblong, later confluent patches between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, subgloboid or ellipsoid, 24–33 x 22–31 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 2–2.5 (–3) µm thick, yellow-brown, germ pores 6 to 12, scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves, subepidermal, blackish, (partly) developing from the uredinia, forming small elliptic to oblong patches, long covered by the epidermis, later-exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores unicellular, 21–31 x 18–27 µm, irregularly in shape, mostly angular globoid, subgloboid to ellipsoid, sometimes broader than long, rounded, acute or flattened at the apex, rounded or attenuate at the base, chestnut-brown, spore wall smooth, about 1–2 µm thick at the sides, about 3–7 µm thick at the apex, germ pore apical, pedicel persistent, up to 55 µm long, thin-walled, collapsing, yellow-brownish to hyaline, often obliquely inserted.

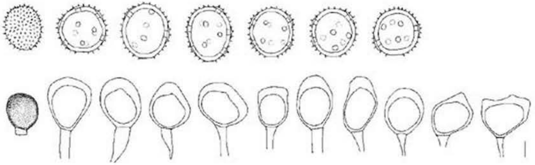

Fig. 12: *Uromyces chaetobromi*. Uredinio- and teliospores on *Chaetobromus dregeanus* (RSA 135). Scale bar = 10 µm.

Specimens examined:

- On *Chaetobromus dregeanus* Nees. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 53.9'', E 18° 16' 49.7'', 08.IX.2002, leg. M. Mennicken No. RSA 126, II (PREM, M).
- On *Chaetobromus dregeanus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 32' 45.4'', 11.IX.2002, leg. M. Mennicken No. RSA 135, II III (PREM, M).
- On *Chaetobromus dregeanus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 40.5'', E 18° 26' 30.5'', 05.IX.2002, leg. M. Mennicken No. RSA 102, II III (PREM, M).

Our collections agree well with the characteristics of *Uromyces chaetobromi* given in the diagnosis (Gjærum 1988). No uredinia but only urediniospores were described from the type collection. The number of germ pores of the urediniospores is wider in our collections (6 to 12) compared to the type collection (7 to 8). As far as could be established, *Uromyces chaetobromi* is only known from the type collection. The type collection is not mentioned in Crous, Phillips & Baxter (2000). *Chaetobromus dregeanus* seems to be a new host plant.

POACEAE - *EHRHARTA*

Uromyces ehrhartae-giganteae Doidge 1927: 207 emend. (Fig. 13)

Type on *Ehrharta thunbergii* Gibbs Russell (= *E. gigantea* Thunb.), South Africa, Mobray, Cape Province, 10.II.1914, leg. Van der Merve No. 7392.

Anamorph. *Uredo ehrhartae-calycinae* Doidge 1948: 907. Type on *Ehrharta calycina* J.E. Sm. South Africa, Stellenbosch, leg. Verwoed, Herb. Stell. Elsenburg Coll. Agric. 41 (34098).

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, mostly adaxial, cinnamon-brown, forming long and narrow, later confluent streaks between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid, pyriform or broadly obovoid, 20–31 x 19–26 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 2.5–4 µm thick, golden to chestnut-brown, germ pores 6 to 8, scattered, with inconspicuous, hyaline papillae that are weakly to broadly developed.

Telia mostly adaxial on leaves, rarely abaxial, on sheaths or stems, dark chocolate-brown, forming patches and long, confluent streaks, exposed, cushion-like, surrounded by the torn epidermis. Teliospores unicellular, 26–43 (–46) x 19–32 µm, tending to be dimorphic with broadly ellipsoid or globoid spores that are mostly more than 25 µm broad and ellipsoid or oblong-ellipsoid spores that are mostly less than 25 µm broad, occasionally asymmetrically angular, golden-brown to chestnut-brown, rounded, flattened or acute at the apex, rounded or attenuate at the base, spore wall smooth, about 1–4 µm thick at the sides, up to 12 µm thick at the apex, germ pore apical, pedicel persistent, up to 170 µm long, not collapsing, yellow-brownish to hyaline, thick-walled, pedicel wall about 1.5–3 µm thick.

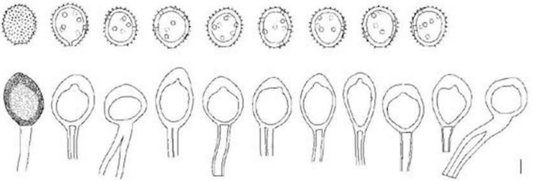

Fig. 13: *Uromyces ehrhartae-giganteae*. Uredinio- and teliospores on *Ehrharta villosa* (RSA 190). Scale bar = 10 µm.

Specimens examined:

- On *Ehrharta calycina*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 26.6'', E 18° 18' 32.0'', 19.IX.2002, leg. M. Mennicken No. RSA 192, II (PREM, M).
- On *Ehrharta villosa* Schult. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 33.8'', E 18° 18' 22.4'', 19.IX.2002, leg. M. Mennicken No. RSA 190, II III (PREM, M).
- On *Ehrharta villosa*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 15.6'', E 18° 18' 37.6'', 21.XI.2001, leg. M. Mennicken No. RSA 20, III (PREM, M).

The urediniospores of our collections agree well with the specifications of *Uredo ehrhartae-calycinae*, which are given in the diagnosis and revised by Cummins (1971): (20–) 22–27 (–29) µm x (17–) 19–21 µm and (4 to) 5 to 8 scattered germ pores. Only the maximum broadness of the urediniospores is 5 µm more in our collections.

Our teliospores coincide with the dimorphic characteristic of *Uromyces ehrhartae-giganteae*, but they reach a larger size than in the diagnosis (Doidge 1927) or in the description of Cummins (1971), respectively. Cummins (1971) scaled up the size of the teliospores given in the diagnosis and specifies for the type: "spores (23–) 26–36 (–38; 40) x (16–) 19–24 (–26) µm".

Summarizing, the deviation in the maximum broadness of the urediniospores and in the size of the teliospores does not justify a new species, all the more so, as the habitats are close-by, and the teliospores were found on a host plant different from the host of the type collection. We assume that our collections belong to *Uromyces ehrhartae-giganteae*, which is synonymous with *Uredo ehrhartae-calycinae*. *Ehrharta villosa* seems to be a new host plant for this rust fungus.

Uromyces quaggafonteinus Mennicken & Oberw. sp. nov. (Fig. 14)

Pycnia et aecia ignota. Uredinia amphigena, subepidermalia, vulpina, mox nuda, pulverulenta. Urediniosporae globoideae vel late ellipsoideae, 26–36 x 24–32 µm, pariete echinulato, luteo-fusco vel dilute castaneo, 2.5–4 µm crasso, 5–9 poris germinationis dispersis. Telia amphigena, subepidermalia, nigro-brunnea, mox nuda, pulvinata. Teliosporae unicellulares, globoideae vel subellipsoideae, apice rotundato, leviter acuto vel leviter applanato, base rotundata, 28–39 x 24–32 µm, pariete laevigato, castaneo, lateraliter 2–4 µm crasso, apicaliter usque ad 12 µm crasso, poro germinationis apicali, pedicello dilute aureo-fusco vel hyalino, usque ad 140 µm longo.
In foliis *Ehrhartae calycinae* J.E. Sm. (Poaceae).

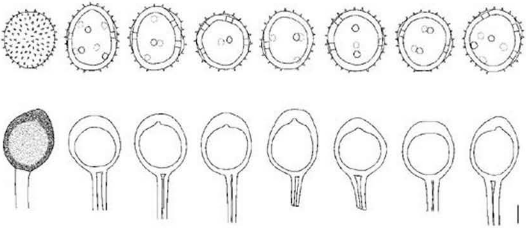

Fig. 14: *Uromyces quaggafonteinus*. Uredinio- and teliospores on *Ehrharta calycina* (Paratype RSA 49). Scale bar = 10 µm.

Pycnia and aecia unknown.

Uredinia amphigenous on leaves, subepidermal, foxy red, forming small, elliptic to oblong, later confluent patches between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid or broadly ellipsoid, golden to pale chestnut-brown, 26–36 x 24–32 µm, echinulate, borne singly on pedicels, spore wall uniformly about 2.5–4 µm thick, germ pores 5 to 9, scattered, with inconspicuous, hyaline or yellowish papillae that are weakly developed.

Telia amphigenous on leaves, subepidermal, dark chocolate-brown, forming small, elliptic to oblong, later confluent patches, between the nerves of the leaves, exposed, cushion-like, surrounded by the torn epidermis. Teliospores unicellular, globoid to subelliptic, rounded, slightly flattened or slightly acute at the apex, rounded at the base, 28–39 x 24–32 µm, chestnut-brown, spore wall smooth, about 2–4 µm thick at the sides, up to 12 µm thick at the apex, germ pore apical, pedicel persistent, up to 140 µm long, not collapsing, brownish-yellow to hyaline, thick-walled, pedicel wall up to 3 µm thick, occasionally obliquely inserted.

On the leaves of *Ehrharta calycina*. (Poaceae)

Etymology. Named after the collection site, Quaggafontein.

Specimens examined:

- On *Ehrharta calycina*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.1'', E 17° 32' 55.6'', 11.IX.2002, leg. M. Mennicken No. RSA 139, II III (Holotype PREM, Isotype M).

- On *Ehrharta calycina*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 25.9'', E 17° 32' 53.0'', 26.XI.2001, leg. M. Mennicken No. RSA 49, II III (Paratypes PREM, M).

Uromyces quaggafonteinus differs from *Uromyces ehrhartae-giganteae* (see above) in the lack of oblong-ellipsoid or asymmetrical angular teliospores. The mean length of the teliospores is shorter, the mean broadness of the teliospores is wider, the echinulation of the urediniospores is coarser and the size of the urediniospores is bigger than in *Uromyces ehrhartae-giganteae*. Only with teliospores a precise determination of these two rust fungi is not possible.

POACEAE - *HOLCUS, KARROOCHLOA, SCHISMUS, TRIBOLIUM*
Uromyces holci Jørst. (Jørstad 1956b: 577). (Fig. 15)

Type on *Holcus setiger* Nees, South Africa, Northern Cape Province, between Pedroskloff and Leliefontein, leg. Drege (S).

Syn. *Uromyces schismi* Jørst. (Jørstad 1956b: 577). Type on *Schismus scaberrimus* Nees, locality unknown "but the collection is obviously from S. Africa, where the host belongs".

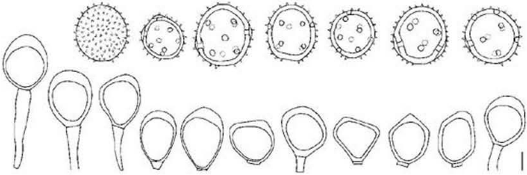

Fig. 15: *Uromyces holci*. Uredinio- and teliospores. Scale bar = 10 µm.

Pycnia and aecia unknown.

Uredinia adaxial on leaves, foxy red, forming patches and stripes between the nerves of the leaves, early exposed, surrounded by the torn epidermis. Urediniospores globoid, broadly ovoid, or broadly ellipsoid, golden to pale chestnut-brown, 21–31 (–34) x 18–28 µm, finely echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–2.5 (–3) µm thick, germ pores 7 to 11, scattered, with hyaline papillae.

Telia adaxial on leaves, blackish, forming small, later confluent patches, early exposed, cushion-like, surrounded by and arched over by the torn epidermis. Teliospores unicellular, variable in shape and size, 19–33 x 15–29 µm, dimorphic with broadly ellipsoid or globoid spores tending to be chestnut-brown and with globoid, ellipsoid or oblong-ellipsoid, asymmetrically angular, variable spores tending to be golden to pale chestnut-brown, spore wall smooth, about 1–3 µm thick at the sides, about 2–8 µm thick at the apex, germ pore apical, pedicel persistent, up to 80 µm long, brownish-yellow, thick-walled and predominantly not collapsing in the chestnut-brown spores, thin-walled and collapsing in the golden to pale chestnut-brown spores.

Specimens examined:

- On cf. *Holcus setiger* Nees. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 17.4'', E 18° 18' 45.3'', 21.XI.2001, leg. M. Mennicken No. RSA 23, II III (PREM, M).
- On cf. *Holcus setiger*. South Africa, Western Cape Province, BIOTA-observatory at Rocherpan Nature Reserve, S 32° 36' 32.5'', E 18° 18' 38.6'', 21.XI.2001, leg. M. Göker No. RSA 26, II III (PREM, M).
- On *Karroochloa* cf. *schismoides* (Stapf ex Conert) Conert & Tuerpe. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 23.0'', E 17° 33' 06.2'', 26.XI.2001, leg. M. Mennicken No. RSA 51, II III (PREM, M).
- On *Schismus barbatus* (Loefl. ex L.) Thell. Namibia, Lüderitz-Süd, Farm Spitzkop LUS, 2716 DC, 25.IX.1977, leg. H. Merxmüller & W. Giess, II III (WIND 46700).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 49.7'', E 18° 16' 44.2'', 27.XI.2001, leg. M. Mennicken No. RSA 66, II (PREM, M).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 22.8'', E 17° 33' 13.0'', 26.XI.2001, leg. M. Mennicken No. RSA 50, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23' 36.2'', E 18° 16' 35.8'', 27.XI.2001, leg. M. Mennicken No. RSA 57, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23' 36.4'', E 18° 16' 37.6'', 27.XI.2001, leg. M. Mennicken No. RSA 58, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Flaminkvlakte 111, S 31° 17' 05.1'', E 18° 35' 48.8'', 23.XI.2001, leg. M. Mennicken No. RSA 30, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 35.4'', E 18° 36' 04.0'', 23.XI.2001, leg. M. Mennicken No. RSA 36, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 27' 40.1'', E 18° 26' 31.6'', 05.IX.2002, leg. M. Mennicken No. RSA 103, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 37.1'', E 18° 36' 14.6'', 07.IX.2002, leg. M. Mennicken No. RSA 119, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Luiperskop 211, S 31° 17' 13.7'', E 18° 36' 14.2'', 07.IX.2002, leg. M. Mennicken No. RSA 120, II III (PREM, M).
- On *Schismus barbatus*. South Africa, Western Cape Province, BIOTA-observatory at Moedverloren 208, S 31° 28' 00.7'', E 18° 26' 25.6'', 26.XI.2001, leg. M. Mennicken No. RSA 104, III (PREM, M).
- On *Tribolium echinatum* (Thunb.) Renvoize (= *Lasiochloa echinata* (Thunb.) Adamson), South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 31.0'', E 17° 32' 35.6'', 11.IX.2002, leg. M. Mennicken No. RSA 141, II III (PREM, M).
- On *Tribolium echinatum* . South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 29.4'', E 17° 33' 05.7'', 11.IX.2002, leg. M. Mennicken No. RSA 144, II III (PREM, M).

Our collections agree well with the range of spore dimensions given in the diagnoses of *Uromyces holci* and *Uromyces schismi*. Dimensions range from 23–29 x 20–24 µm for the urediniospores, and from 17–32 x 15–25 µm for the teliospores. The number of germ pores in the urediniospores of our collection is 7 to 11, noticeably higher than the number given in the diagnoses, where 6 or 7, respectively, scattered germ pores are mentioned. Cummins (1971) listed the number of germ pores as varying from 7 to 9. In his figure one urediniospore has 9 and one urediniospore has 11 germ pores. We hypothesise that *Uromyces holci* has 7 to 11 germ pores in its urediniospores.

As far as could be established, *Uromyces holci* is new to the rust flora of Namibia. *Karroochloa schismoides*, *Schismus barbatus* and *Tribolium echinatum* seem to be new host plants. *Uromyces holci* is the first known rust fungus that infects the grass genera *Karroochloa* and *Tribolium*. Whilst the host genus *Holcus* belongs to the subfamily Pooideae and the tribe Aveneae, the three host genera *Karroochloa*, *Schismus*, and *Tribolium* belong to the subfamily Arundinoideae and the tribe Arundineae (Fish 2000).

POACEAE - *Polypogon*

Puccinia polypogonis Speg. (Spegazzini 1909: 300). (Fig. 16)

Type on *Polypogon monspeliensis*, Argentina, near Lake Muster, Patagonia, XII.1902 (LPS, Isotype PUR).

Anamorph. *Uredo polypogonis* Speg. (Spegazzini 1899: 240). Lectotype on *Polypogon monspeliensis* (L.) Desf. Argentina, Puerto Deseado, 1885/1886.

Pycnia and aecia not known.

Uredinia amphigenous on leaves, mostly adaxial, and on sheaths, foxy red, subepidermal, forming partially confluent stripes between the nerves of the leaves, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores globoid to broadly ellipsoid, golden-brown, 22–29 x 19–27 µm, echinulate, spores borne singly on pedicels, spore wall uniformly about 1.5–3 µm thick, germ pores 6 to 8, with hyaline papillae that are largely developed.

Telia amphigenous on leaves, blackish-brown, subepidermal, (partly) developing from the uredinia, forming small, ellipsoid to oblong patches between the nerves of the leaves, early exposed, compact to cushion-like, surrounded by the torn epidermis. Teliospores in general bicellular, 31–51 x 15–25 (–27) µm, irregularly in shape and size, often oblique, varying from clavate to ellipsoid, occasionally diorchidioid, rounded, apiculate or flattened at the apex, attenuate or rounded at the base, constricted at the septum, brown, spore wall smooth, about 1.5–2.5 µm thick at the sides, about 2 to 9 µm thick at the apex, germ pores apical and just below the septum, pedicel persistent, up to 55 µm long, mostly collapsing, often obliquely inserted, brownish, just below the septum of the lower cell darker tinted. Mesospores commonly developed.

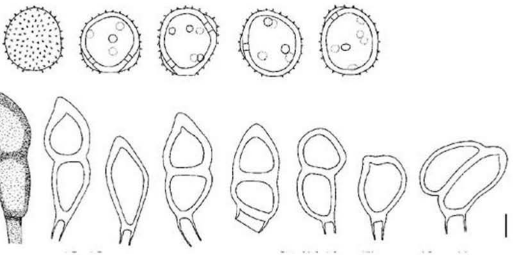

Fig. 16: *Puccinia polypogonis*. Uredinio- and teliospores on *Polypogon monspeliensis* (WIND 41741, WIND 63839). Scale bar = 10 µm.

Specimens examined:

- On *Polypogon monspeliensis*. Namibia, Lüderitz – Süd, Loreleifelsen- und Kupfermine und Umgebung, im Flussbett des Oranje, 2816 BB Oranjemund, 02.X.1977, leg. H. Merxmüller & W. Giess No. 32454, II (WIND 41741).
- On *Polypogon monspeliensis*. Namibia, Nuop Rivier, 3 km nördlich Einmündung in den Oranje, 2817 AA Vioolsdrif, 02.X.1975, leg. W. Giess No. 13837, (II) III (WIND 41744).
- On *Polypogon monspeliensis*. Namibia, Kaokoland Area 2, Skeleton Coast Park, Uniab River, 2013 AA, 50 m, 22.X.1988, leg. C. J. Ward & J. D Ward No. 10480, (II) III (WIND 63839).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Leliefontein 624, S 30° 23' 39.5'', E 18° 16' 40.9'', 27.XI.2001, leg. M. Mennicken No. RSA 60, II III (PREM, M).

- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 49.1'', E 18° 16' 45.2'', 27.XI.2001, leg. M. Mennicken No. RSA 68, II III (PREM, M).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 50.4'', E 18° 16' 45.8'', 27.XI.2001, leg. M. Mennicken No. RSA 70, II III (PREM, M).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Remhoogte 416, S 30° 23' 43.0'', E 18° 16' 43.7'', 27.XI.2001, leg. M.Göker No. RSA 74, II (PREM, M).
- On *Polypogon monspeliensis*. South Africa, Northern Cape Province, BIOTA-observatory at Quaggafontein 478, S 30° 11' 18.4'', E 17° 33' 01.2'', 26.XI.2001, leg. M. Mennicken No. RSA 55, II (PREM, M). This collection is double infected with *Puccinia coronata* Corda (only teliospores).
- On *Polypogon monspeliensis*. South Africa, Western Cape Province, BIOTA-observatory at Elandsberg, S 33° 25' 55.4'', E 19° 02' 14.7'', 18.XI.2001, leg. M. Mennicken No. RSA 7, II (PREM, M).

As far as could be established, *Puccinia polypogonis* is new to the rust flora of Namibia. A South African collection from Saron in the Cape Province by Schlechter in 1890 (Jørstad 1956) is not cited in Crous, Phillips & Baxter (2000). The host plant *Polypogon monspeliensis* was introduced from Europe and Asia and is now naturalised in many parts of South Africa, especially in coastal areas (Bromilow 2001).

SANTALACEAE - *THESIUM*

Puccinia* cf. *stonemaniae Syd., P. Syd & Pole-Evans in Sydow & Sydow 1912: 437. (Fig. 17)

Type on *Thesium* sp. South Africa, Bain's Kloof near Wellington, 21.II.1912, leg. E. M. Doidge.

Anamorph. *Aecidium osyridicarpi* Massee 1911: 225. Type on *Osyridicarpos natalensis* DC. South Africa, Natal, Tabamhlope, leg. Wood No. 527.

Syn. *Puccinia pulvinata* Massee 1911: 224 (nec. Rabh.). Type on *Osyridicarpos natalensis*. South Africa, Natal, Tabamhlope, leg. Wood No. 527.

Syn. *Puccinia osyridicarpi* (Massee) Grove in Wakefield & Grove 1916: 76.

Pycnia not seen.

Aecia aecidioid, amphigenous on leaves and caulicolous, scattered in ± concentric groups up to 5 mm diameter, causing slight hypertrophy, without spots surrounding aecia, aecial cups small cylindrical, circa 250 µm diameter, up to 500 µm long, spore mass pale yellowish to white, surrounded by the irregularly and deeply frayed, orange-yellow to whitish peridium, cells of the peridium firmly connected, outer wall finely striate, circa 12–17 µm wide, inner wall delicately and closely verrucous, circa 4–6 µm wide. Aeciospores angular globoid, subgloboid to ovoid, 23–30 x 22–27 µm, spore wall about 1–1.5 µm thick, inconspicuously finely verrucous, hyaline, germ pores invisible.

Uredinia amphigenous on leaves and on stems, (partly) developing from the uredinia, subepidermal, roundish, ellipsoid or irregularly in outline, up to 1 mm wide, separate or scattered, without spots surrounding uredinia, cinnamon-brown, early exposed, pulverulent, surrounded by the torn epidermis. Urediniospores subgloboid, ovoid or ellipsoid, (26–) 29–37 x 22–30 µm, borne singly on pedicels, spore wall uniformly about 2–3 µm thick, yellowish-brown, noticeable verrucous, germ pores (3 to) 4 to 5, mostly ± equatorial, occasionally scattered, with hyaline papillae that are weakly developed.

Telia amphigenous on leaves and caulicolous, subepidermal, roundish, ellipsoid or irregularly in outline, up to 5 mm diameter, separate or scattered, blackish-brown to black, early exposed, compact to cushion-like, surrounded by the torn epidermis, without spots surrounding telia. Teliospores in general bicellular, obovoid, ellipsoid to oblong, slightly constricted at the septum, 38–48 x 21–31 µm, rounded or subacuminate at the apex, rounded or attenuate at the base, spore wall about 2–4 µm thick at the sides, about 6–9 µm thick at the apex, brown, smooth, germ pore of the upper cell apical, germ pore of the lower cell just below the septum, without papillae, pedicel persistent, up to 100 µm long, thick-walled, mostly not collapsing, yellowish to hyaline, sometimes obliquely inserted. Mesospores occasionally existing.

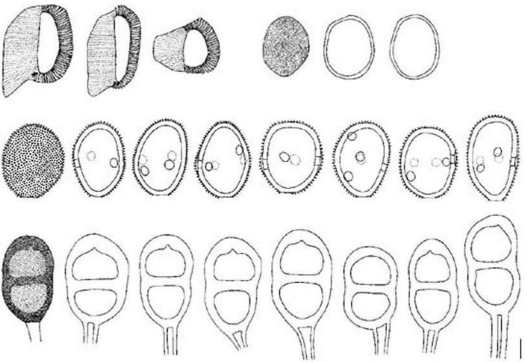

Fig. 17: *Puccinia* cf. *stonemaniae* on *Thesium* cf. *strictum*. Peridium cells and aeciospores (RSA 216), uredinio- and teliospores (RSA 3). Scale bar = 10 µm.

Specimens examined:

- On *Thesium* cf. *strictum* Bergius. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 45.3'', E 18° 23' 36.6'', 17.XI.2001, leg. M. Mennicken No. RSA 3, II III (PREM, M).
- On *Thesium* cf. *strictum*. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 41.1'', E 18° 23' 36.8'', 23.IX.2002, leg. M. Mennicken No. RSA 216, I (PREM, M).
- On *Thesium viridifolium* Levyns. South Africa, Western Cape Province, Cape Peninsula National Park, BIOTA-observatory at Olifantsbos, S 34° 15' 55.1'', E 18° 23' 52.5'', 23.IX.2002, leg. M. Mennicken No. RSA 217, II III (PREM, M).

Our collections do not agree very well with the description of *Puccinia stonemaniae* given in the diagnosis (Sydow & Sydow 1912) and in Doidge (1927). Therefore we use the epithet with the prefix cf. Unfortunately the type collection of *Puccinia stonemaniae* in Berlin got mouldy. Therefore, it could not be examined. *Thesium viridifolium* seems to be a new host plant.

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New species of *Asterina* from Guangdong, China

Bin Song*, Tai-Hui Li, Ya-Heng Shen

binsong@gdas.ac.cn
Guangdong Provincial Key Laboratory of Microbial Culture
Collection and Application; Guangdong Institute of Microbiology
Xianlie Road Central, Guangzhou 510 070,China

Abstract—*Asterina daphniphyllicola* parasitic on *Daphniphyllum macropodum*, *Asterina dinghuensis* parasitic on *Cleistocalyx operculatus*, *Asterina euryae* parasitic on *Eurya acuminata*, and *Asterina myrsinacearum* parasitic on *Myrsinaceae* are described and illustrated as new species.

Key words—*Asterinaceae, Daphniphyllaceae, Myrtaceae, Theaceae*

Introduction

Guangdong Province of China is Mainland China's most southern region. It is close to Hainan Islands, and together they constitute the main tropical and subtropical region of the country. It is an area of abundant and diverse vegetation, characterized by warm, humid weather and frequent rainfall. It has one of the highest levels of fungal diversity of any area in China (Song et al. 2002, 2003). Recently, the first author had the opportunity to restudy the specimens of the asterinaceous fungi deposited in the Herbarium of Guangdong Institute of Microbiology (HMIGD), Guangzhou (China). The study shows that four taxa of the genus *Asterina* occurring in Guangdong are. They are apparently undescribed and are described and illustrated as new species as follows here.

Asterina daphniphyllicola B. Song, *sp. nov.* **Fig. 1**

Similis Asterina daphniphylli sed differt appressoriis et ascosporis brevioribus, appressoriis 10% oppostiis.

Etymology: *daphniphyllicola*, in reference to the host, *Daphniphyllum macropodum*.

Colonies amphigenous, mostly epiphyllous, black, thin, arachnoid to nearly velvety, scattered, up to 5 mm in diameter, sometime confluent. Hyphae brown, sinuous to nearly straight or mostly flexuous, irregularly branching acutely or widely, loosely or densely reticulate, cells mostly 18-30 x 4-5 μm. Appressoria unicellular, alternate to 10% opposite, spreading, straight or bent, ovate, obtuse or narrow at apex, entire to angular, sometime lobate, 7-10 x 5-7 μm. Ascomata scattered to nearly aggregate, black, orbicular to hemispherical, up to 230 μm in diameter, stellately dehiscent at the center, irregularly crenate to short tasseled at periphery, surface cells 2-3 μm wide. Ascospores cylindrical or fusoid, narrow or obtuse at ends, brown, 1-septate, constricted at septum, smooth, 25-33 x 8.5-10 μm.

> **Holotype:** *On leaves of Daphniphyllum macropodum Miq.(Daphniphyllaceae). Nankung Shan, Guangdong Provinice, China. September 17,1992, Y. S. Ouyang and B. Song, HMIGD 32067.*

The new species is closely related to *Asterina daphniphylli* W. Yamam. The main distinguishing characters of *A. daphniphylli* are that the appressoria are longer (9-18 μm), alternate and not opposite, and the ascospores are broader (12-16 μm) (Yamamoto 1956).

Asterina dinghuensis, *sp. nov.* **Fig. 2**

> *Similis Asterina assimilis sed differt appressoriis et ascosporis brevioribus; et a A. claviflori differt ascosporis grandioribus (20-28 x 10.5-12.5 μm).*
>
> Etymology: *dinghuensis*, in reference to the type locality, Dinghu Shan Biosphere Reserve.

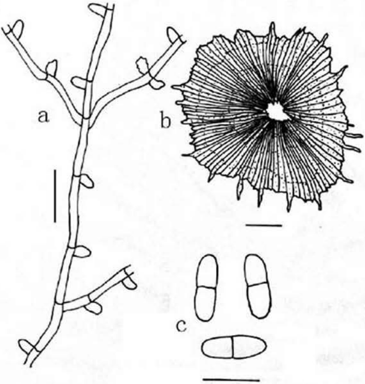
Colonies amphigenous, thin, black, arachnoid or nearly velvety, up to 5 mm in diameter, sometimes confluent. Hyphae brown, sinuous or nearly straight, opposite or irregular branching acutely or obtusely, loosely to closely reticulate, cells mostly 20-45 x 3.8-5 μm. Appressoria unicellular, in alternate or unilateral arrangement, spreading, straight or slightly bent, cylindrical, narrow at apex, entire or sometimes angular, 10-16 x 4-5.5 μm. Ascomata scattered to nearly aggregate, black, orbicular or hemispherical, up to 260 μm in diameter, no apical pore or stellately dehiscent at center, irregularly crenate to shortly tasseled at periphery, surface cells 2-3.5 μm wide. Ascospores nearly ellipsoid to oblong, brown, 1-septate, obtuse, constricted at septum, smooth, 20-28 x 10.5-12.5 μm.

> **Holotype:** *On leaves of Cleistocalyx operculatus (Roxb.) Merr. et Perry (Myrtaceae). Dinghu Shan Biosphere Reserve, Guangdong Province, China. December 14, 1978, G.Z. Jiang, HMIGD 30008.*

The appressoria of this species are unicellular, alternate and not opposite, nearly cylindrical. This species is similar to *Asterina assimilis* Syd., *Asterina claviflori* A. K. Kar et Maity, *Asterina eugeniae* H. S. Yates, *Asterina natalitia* Doidge, and *Asterina rickii* Theiss. (Theissen 1913; Yates 1917; Sydow 1922; Doidge 1942; Kar & Maity 1970). According to their descriptions, the main distinguishing characters for *A. assimilis* are that the ascospores and the appressoria are broader (24-26 x 13-15 μm for the ascospores, 10-17 x 7-9 μm for the appressoria), and for *A. claviflori* that the ascospores are smaller (9.9-13.2 x 6.6-9.9 μm). The main distinguishing characters for *A. rickii* are that the ascospores are narrower (18-22 x 8-9 μm), and for *A. eugeniae* that the ascospores are smaller (20 x 5 μm) and the appressoria are irregular. In addition, the new species differs from *A. natalitia*, which has larger ascospores (30-34 x 12.5-15 μm). Therefore, they can clearly be distinguished from the new species.

The new species is found mixed with *Meliola leptospermi* Hansf. (Hu et al. 1996).

1



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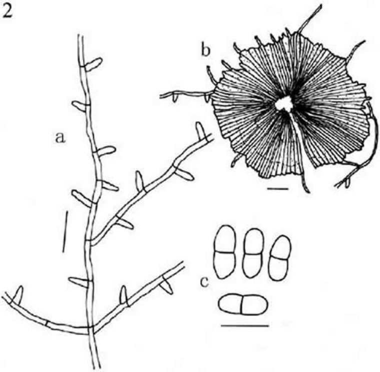


Fig.1 *Asterina daphniphyllicola* (a. hyphae with appressoria; b. ascoma; c. ascospores)

Fig.2 *Asterina dinghuensis* (a. hyphae with appressoria; b. ascoma; c. ascospores) (Bars = 25 μm).

Asterina euryae B. Song, *sp. nov.* **Fig. 3**

Similis Asterina theae sed differt ascosporis et appressoriis minoribus.
Etymology: *euryae*, in reference to the host, *Eurya acuminata*.

Colonies epiphyllous, thin, black, arachnoid to nearly velvety, up to 3 mm in diameter, sometimes confluent. Hyphae brown, nearly straight or curved, branching acutely or obtusely, loosely to closely reticulate, cells mostly 10-25 x 7-8 μm. Appressoria unicellular, in alternate or unilateral arrangement, spreading, straight or bent, globose, mostly angular or sublobate, 12-13 x 11-12.5 μm. Ascomata scattered to nearly aggregate, black, orbicular to hemispherical, up to 240 μm in diameter, stellately dehiscent at the centre, crenate to shortly tasseled at periphery, surface cells 2.5-3.5 μm wide. Ascospores oblong, brown, 1-septate, obtuse, constricted at septum, surface smooth, 30-33 x 11.5-12.5 μm.

Holotype: *On leaves of Eurya acuminata DC (Theaceae). Ruyang County, Guangdong Province, China. December 5, 1995, B. Song, HMIGD 34169.*

The new species is closely related to *Asterina theae* W. Yamam. The main distinguishing characters of *A. theae* are that the ascospores and the appressoria are larger (35-44 x 14-17 μm for the ascospores, 11-18 x 12-17 μm for the appressoria) (Yamamoto 1957).

Asterina myrsinacearum B. Song, *sp. nov* **Fig. 4**

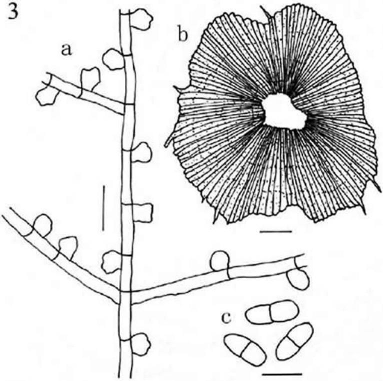
Similis Asterina aphanes sed differt appressoriis grandioribus (10-19 x 8-12 μm) et ascosporis fusoideiis vel subellipsoideiis; et a A. embeliae differt ascosporis grandioribus (17-25 x 10-13 μm).
Etymology: *myrsinacearum*, in reference to the host, *Myrsinaceae indet.*

Colonies epiphyllous, black, thin to nearly dense, arachnoid to nearly velvety, up to 8 mm in diameter, sometimes confluent. Hyphae brown, nearly straight to slightly sinuous, opposite or irregular branching acutely or obtusely, loosely or closely reticulate, cells mostly 17-30 x 3.5-5 μm. Appressoria unicellular, in alternate or unilateral arrangement, less than 1 % opposite, spreading, mostly bent, nearly globose to oblong, 1-3-sublobate or sometimes angular, obtuse at apex, 10-19 x 8-12 μm. Ascomata nearly aggregate to scattered, black, orbicular or hemispherical, up to 130 μm in diameter, stellately dehiscent at the centre, crenate to shortly tasseled at periphery, surface cells 1.8-2.8 μm wide. Ascospores fusoid to nearly ellipsoid, brown, 1-septate, obtuse or narrowed at the ends, constricted at septum, surface smooth, 17-25 x 10-13 μm.

Holotype: *On leaves of Myrsinaceae indet. Yangchun County, Guangdong Province, China. September 1986, H. Hu, HMIGD 34437.*

The new species is closely related to *Asterina aphanes* Petr., *Asterina ardisiae* Hansf., and *Asterina embeliae* Hansf. (Sydow & Petrak 1929; Hansford 1943, 1954). The main distinguishing characters of *A. aphanes* are that the appressoria are smaller (6-8 x 7-8 μm), and the ascospores are oblong-clavate. The main distinguishing characters of *A. ardisiae* are that the appressoria are cylindrical (8-14 x 6-8 μm), attenuate at apex, and the ascospores are oblong. The new species differs from *A. embeliae* in the latter having larger ascospores (26-28 x 13-15 μm).

3



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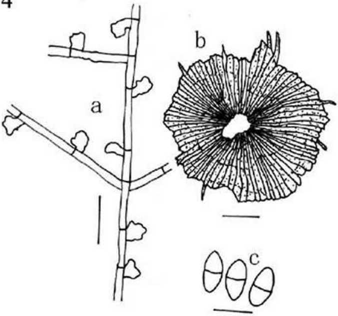

Fig.3 *Asterina euryae* (a. hyphae with appressoria; b. ascoma; c. ascospores) **Fig.4** *Asterina myrsinacearum* (a. hyphae with appressoria; b. ascoma; c. ascospores) (Bars = 25 μm).

Acknowledgements

The authors wish to thank Prof. Dr. R. D. Goos of Department of Botany, University of Rhode Island (U.S.A.) and Prof. Dr. Richard P. Korf for serving as pre-submission reviewers and for their valuable comments and suggestions. They also acknowledge Prof. S Q Chen of South China Institute of Botany, Academia Sinica, Guangzhou, for identifying the host plants, and Ms. A.L. Zhang for technical assistance. This project was supported by the National Science Foundation of China (no. 30370012), the Natural Science Foundation of Guangdong (020470), the Natural Science Fund for Distinguished Young Scholars from Guangdong Academy of Sciences, and the Foundation of Guangdong Institute of Microbiology.

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Yamamoto W. 1957. The Formosan Species of the *Microthyriaceae* « 2 ». Sci. Rep. Hyogo Univ. Agr. Ser. Agr. Biol. 3:23-32

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Preliminary survey of the *Helvellaceae* from Xinjiang, China

WEN-YING ZHUANG[1]

zhuangwy@sun.im.ac.cn
Key Laboratory of Systematic Mycology & Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

Abstract -- Collections of the *Helvellaceae* from Xinjiang, China were examined. 17 taxa of the genera *Gyromitra*, *Helvella*, *Hydnotrya*, and *Wynnella* are recognized. Among them, *H. cupuliformis* var. *crassa* and *H. jimsarica* are new taxa. *Helvella cupuliformis* var. *cupuliformis* is new to China. Distinctions between the new taxa and their closely related species are discussed.

Key words -- taxonomy, *Gyromitra*, *Helvella*, *Hydnotrya*, *Wynnella*

Introduction

Xinjiang is in the northwest of China. It occupies more than 1/7 of the China mainland territory (Fig. 1). The area is covered with deserts, grasslands, conifer forests, broadleaf trees, and shrubs. The Tianshan Mountains run east-west in the area and separate it into two parts, North Xinjiang and South Xinjiang. Mt. Altay is located in the very north and Mt. Kunlun is at the southwest border. The Junggar Basin lies between Mt. Altay and the Tianshan Mountains. Tarim Basin lies between the Tianshan Mountains and Mt. Kunlun. The huge Taklimakan Desert is in the center of Tarim Basin. The mean annual precipitation varies from 50 mm to 600 mm. The mean annual temperature of flatlands is 6–8C in the north, 10–11C in the south; while that in the mountainous area is around 2.5–5C. Glaciers and snow cover the high peaks all the year round. Forests in Xinjiang mainly consist of *Picea, Larix, Abies, Pinus, Juniperus, Betula, Populus, Hippophae, Salix, Haloxylon, Tamarix, Calligonum, Nitraria*, etc. (Lu & Yan 1989).

A few helvellaceous cup-fungi were previously recorded from Xinjiang (Zhao & Mao 1986; Cao 1988; Cao et al. 1990a, b; Zhang 1990; Mao 1998).

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Recent collections of the Helvellaceae from Xinjiang were studied as were specimens of the group on deposit in the Mycology Herbarium, Chinese Academy of Sciences (HMAS). Thirteen taxa of *Helvella*, 2 of *Gyromitra*, 1 of *Hydnotrya*, and 1 of *Wynnella* are recognized. Xinjiang is rich in *Helvella* taxa and has high species diversity accounting for 40% of the total known species in China (Zhuang 1998). *Helvella costifera*, *H. crispa*, *H. cupuliformis* var. *cupuliformis*, *H. ephippium*, and *H. macropus* are the common species there. *Helvella cupuliformis* var. *cupuliformis* is a new record for China. *Helvella cupuliformis* var. *crassa* and *H. jimsarica* are described as new taxa. *Gyromitra* is also frequently encountered there. Collections of the genus from the eastern Xinjiang are mostly *G. infula*, while those from the west belong to *G. xinjiangensis*. *Hydnotrya* seems not to be widely dispersed. *Wynnella* is possibly common in Xinjiang.

Taxonomy

Gyromitra infula (Schaeff.) Quél., Ench. Fung. p. 272, 1886.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, VIII 1978, on rotten wood, S.X. Sun, H.A. Wen & X.L. Mao 597, HMAS 39333; Tianchi, alt. 1900 m, 31 VII 2003, on rotten wood, mycological team WYZ 4603, 4604, HMAS 86061, 86060; Jimsar, alt. 1700 m, 1 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4659, HMAS 86057; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4692, 4693, HMAS 86059, 86058; Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4731, 4732, HMAS 86056, 86055; Altayshan, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4820, HMAS 86054; Altayshan, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4829, HMAS 86049.

Gyromitra xinjiangensis J.Z. Cao, L. Fan & B. Liu, Acta Mycol. Sin. 9: 105, 1990.

Specimens examined: CHINA. Xinjiang, Hejing, 1 VIII 1958, on rotten wood, L.W. Xu 132, HMAS 27863; Tuomuerfeng, 11 VII 1978, on the ground, S.X. Sun, H.A. Wen & X.L. Mao 760, HMAS 39091; Tuomuerfeng, 11 VII 1978, on rotten wood, S.X. Sun, H.A. Wen & X.L. Mao 598, HMAS 39334; Xinjiang, VIII 1994, on rotten wood, J.Y. Wang 310, HMAS 71869; Yining, Qapqal, alt. 2000 m, 13 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4894, 4905, HMAS 86048, 86047; Xinyuan, Nalati, alt. 2200 m, 15 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4964, 4968, HMAS 86046, 86053; Xinyuan, Gongnaisi, alt. 2170 m, 16 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4981, HMAS 86052.

Notes: This species is very similar to *Gyromitra infula* in gross morphology but different from the latter in the ascospore surface morphology, spore guttulation, and fruitbodies with a relatively short stipes (Cao et al. 1990a).

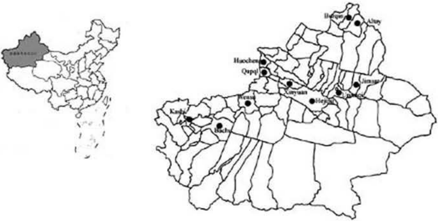
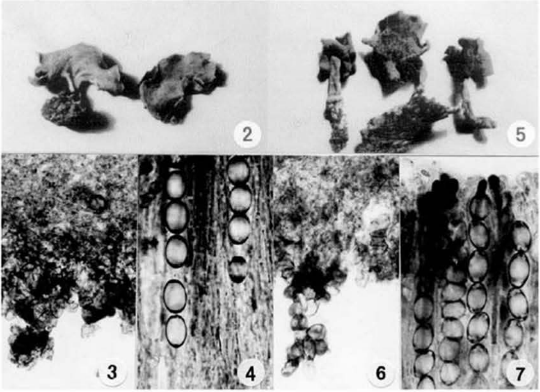


Fig. 1 Map of China showing location of Xinjiang (left), map of Xinjiang showing collecting sites of the helvellaceous fungi (right).



Figs. 2-7 Morphology of *Helvella* spp. Figs. 2-4 *Helvella cupuliformis* var. *crassa* (paratype): 2. Dried fruitbodies, x0.75; 3. Ectal excipular structure, x165; 4. Ascospores, x330. Figs. 5-7 *Helvella jimsarica* (holotype): 5. Dried fruitbodies, x0.4; 6. Ectal excipular structure, x165; 7. Ascospores, x330.

Helvella acetabulum (L.) Quél., Ench. Fung. p. 275, 1886.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, 27 VI 1977, on the ground, H.A. Wen & X.L. Mao 53, HMAS 38329; Tuomuerfeng, 29 VI 1977, on the ground, H.A. Wen & X.L. Mao 56, HMAS 38129; Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4614, HMAS 86051; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4649, HMAS 86050.

Helvella atra Holmskj. : Fr., Beata Ruris Otia Fungis Danicis Impensa 2: 47, 1799.

Specimens examined: CHINA. Xinjiang, Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4695, 4727, HMAS 86045, 86044.

Helvella costifera Nannf., in Lundell & Nannfeldt, Fungi Exsic. Suec. Praes. Upsal. Fasc. 41-42: 37, no. 2061, 1953.

Specimens examined: CHINA. Xinjiang, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4600, 4616, HMAS 86043, 86042; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4638, 4661, HMAS 86041, 86040; Jimsar, alt. 1700 m, 2 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4662, 4667, 4669, 4679, HMAS 83506, 83507, 83508, 83509; Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4684, HMAS 83510; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4864, 4865, HMAS 83511, 83512.

Helvella crispa (Scop.) Fr., Syst. Mycol. 2: 14, 1822.

Specimens examined: CHINA. Xinjiang, Jimsar, alt. 1700 m, 2 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4666, HMAS 83513; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4697, 4696, HMAS 83514, 83550; Altayshan, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4821, 4822, HMAS 83515, 83516; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4867, HMAS 83517; Yining, Qapqal, alt. 2000 m, 13 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4898, HMAS 83518.

Helvella cupuliformis Dissing & Nannf., Sv. Bot. Tidskr. 60: 326, 1966. var. **cupuliformis**

Specimens examined: CHINA. Xinjiang, 15 VII 1978, on the ground, S.X. Sun, H.A. Wen & X.L. Mao 421, HMAS 38330; 23 VII 1977, on the ground, H.A. Wen & X.L. Mao 137, HMAS 38331, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4605, 4606, 4618, HMAS 83519, 83520, 83521; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4646, HMAS 83522.

Helvella cupuliformis var. **crassa** W.Y. Zhuang, var. nov. Figs. 2–4

Ab *Helvella cupuliformis* var. *cupuliformis* ascosporis crassis, 18–21 x 12.5–15 µm differt.

Pileus discoid, 1.5–5.5 cm in diam., hymenium surface grayish brown to grayish, receptacle surface pubescent, pale gray, stipe terete, short, nearly smooth, beige; ectal excipulum of textura angularis, 115–130 µm thick excluding pustules, outermost cells thin-walled, hyaline, club-shaped, 18–31 x 7.5–20 µm; medullary excipulum of textura intricata, hyphae hyaline, 2.5–5 µm wide; subhymenium not clearly defined; hymenium 230–245 µm thick; asci subcylindrical, 8-spored, J– in Melzer's reagent, 18–20 µm wide; ascospores broadly ellipsoid, uniguttulate, 18–21 x 12.5–15 µm; paraphyses somewhat enlarged at apex, 4.5–6 µm wide at apex.

Holotype: CHINA. Xinjiang, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4615, HMAS 83523. Paratype: Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4648, HMAS 83524.

Notes: The new variety is very similar to *Helvella cupuliformis* var. *cupuliformis* in gross morphology and anatomic structure but differs significantly in the large fruitbodies and much wider ascospores (18–21 x 12.5–15 µm *vs.* 18–20 x 11.5–13 µm) (Dissing 1966).

Helvella elastica Bull., Herb. France Pl. 242, Figs. A, B, D-E, 1785.

= *Helvella xinjiangensis* J.Z. Cao, L. Fan & B. Liu, Acta Mycol. Sin. 9: 186, 1990.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, 27 VII 1978, X.L. Mao *et al.* 447, HMAS 38353 (holotype of *H. xinjiangensis*); Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4641, HMAS 83525; Mt. Altay, alt. 1250 m, 9 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4835, HMAS 83526.

Notes: Significant distinctions were not found between the holotype of *Helvella xinjiangensis* and *H. elastica* (Dissing, 1966, Cao *et al.*, 1990b).

Helvella ephippium Lév., Ann. Sci. Nat. Ser. 2, 16: 240, 1841.

Specimens examined: CHINA. Xinjiang, Hejing, 2 VIII 1958, on the ground in woods, L.W. Xu 153, HMAS 27866; Tuomuerfeng, 15 VII 1978, on the ground in woods, X.L. Mao *et al.* 423, HMAS 38354; Tianchi, alt. 1900 m, 31 VII 2003, on soil, fungus collecting team, WYZ 4601, HMAS 83527; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4639, HMAS 83528; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4870, HMAS 83529; Yining, Qapqal, alt. 2000 m, 13 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4923, HMAS 83530.

Helvella jimsarica W.Y. Zhuang, sp. nov. Figs. 5-7

Ab *Helvella elastica* apotheciis lignicola, grandiebus, superficiebus receptaculo pustulatis, pubescens vel villosis, subhymeniis tennuibus differt.

Pileus discoid to somewhat saddle-shaped, up to 5.5 cm in diam. and 8 cm high when fresh, hymenium surface beige to brown when fresh and dark brown when dry, receptacle surface pubescent to villose, often with minute pits observed when dry, light grayish brown to grayish brown when fresh and grayish cinnamon when dry, stipe terete, with a pubescent to villose surface, beige when fresh and straw-colored to grayish beige when dry; ectal excipulum of textura angularis, 75–100 µm thick excluding the pustules, pustules 25–80 µm high, outermost cells thin-walled, club-shaped, (12–)15–38 x 7.5–21 µm, arranged in chains to give rise to the pustules; medullary excipulum of textura intricata, 330–600 µm thick or thicker, hyphae hyaline, 3–7.5 µm wide; subhymenium *ca* 50 µm thick; hymenium 250–280 µm thick; asci subcylindrical, 8-spored, J– in Melzer's reagent, 13–16.5 µm wide; ascospores ellipsoid to broadly ellipsoid, some with warts on surface, uniguttulate, uniseriate, 16.5–21 x 10–13 µm; paraphyses enlarged to 6–7 µm wide at apex.

Holotype: CHINA. Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on rotten wood, W.Y. Zhuang & Y. Nong 4660, HMAS 83531. Paratype: CHINA. Xinjiang, Jimsar, alt. 1700 m, 1 VIII 2003, on plant debris, W.Y. Zhuang & Y. Nong 4640, HMAS 83532.

Notes: The hymenium surface color of *Helvella jimsarica* when fresh resembles that of *Helvella elastica*, but the surfaces of receptacle and of stipe are entirely different from those in *H. elastica*. The new species is characterized by the very large fruitbodies up to 5.5 cm in diameter and 8 cm high, pubescent to villose receptacle surface light grayish brown to grayish brown, with minute pits on surface when dry, as well as its occurrence on rotten wood and plant debris.

Helvella lacunosa Afz. : Fr., Kgl. Vet.-Akad. Nya Handl. 4, p. 303, 1783.
= *Helvella sulcata* Afz. Kgl. Vet.-Akad. Nya Handl. 4, p. 305, 1783.

Specimens examined: CHINA. Xinjiang, Tuomuerfeng, on the ground in woods, 24 VII 1977, X.L. Mao 158, HMAS 38355; Jimsar, alt. 1700 m, 1 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4628, 4642, HMAS 83533, 83537; Jimsar, alt. 1700 m, 2 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4663, 4678, HMAS 83534, 83535; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4694, HMAS 83536.

Notes: HMAS 83537 is somewhat different from other collections. The gross morphology of the fungus is very similar to that of typical *Helvella lacunosa*. It is distinguished from Nordic (a), British (b), and other Chinese (c) collections in wider asci [15–20 µm *vs.* 13–16 µm (a), *ca* 18 µm (b), and 15–18 µm (c) wide], larger ascospores [18–21.5 x 11.5–14.5 µm *vs.* 15–17.1 x 9.5–12 µm (a), 17–20 x 11–13 µm (b), and 15–20 x 11.5–13 µm (c)], and lack of a well-developed subhymenium (Dissing 1966, Dennis 1978). Since spore sizes of specimens from the different geographical areas do not differ clearly, the above distinctions are treated as variations currently unworthy of taxonomic rank. The morphology of HMAS 83537 is described as follows.

Pileus saddle-shaped, 2–5 µm wide and 4.5–9 µm high, hymenium surface grayish brown, receptacle surface paler and smooth to slightly pubescent, stipe robust, with longitudinal furrows, pale grayish to nearly black when dry; ectal excipulum of textura angularis, 130–155 µm thick, cells thin-walled, forming a palisade outer layer, 20–38 x 13–20 µm; medullary excipulum of textura intricata, 280–380 µm thick or thicker, hyphae hyaline, 2–5 µm wide; subhymenium not clearly recognized; hymenium 305–325 µm thick; asci subcylindrical, (4–)8-spored, J– in Melzer's reagent, 15–20 µm wide; ascospores broadly ellipsoid, uniguttulate, uniseriate, 18–21.5 x 11.5–14.5 µm; paraphyses enlarged at apex, 5–7.5(–8) µm wide near apex and 3–3.5(–4) µm wide below.

Helvella macropus (Pers. : Fr.) P. Karst., Not. Sällsk. F. Fl. Fenn. Förh. 11: 224, 1870.

Specimens examined: CHINA. Xinjiang, Tianchi, alt. 1900 m, 31 VII 2003, on the ground, mycological team WYZ 4617, HMAS 83538; Jimsar, 1700 m, 1 VIII 2003, on duff, W.Y. Zhuang & Y. Nong 4626, HMAS 83539; Jimsar, 1700 m, 2 VIII 2003, on duff, W.Y. Zhuang & Y. Nong 4674, HMAS 83540; Burqin, Hemuxiang, alt. 1100 m, 5 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4698, HMAS 83541; Guozigou, alt. 1800 m, 11 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4851, 4868, 4869, HMAS 83542, 83543, 83544.

Helvella phlebophora Pat. & Doass., in Pat., Tab. Anal. Fung. 5: 208, 1886.

Specimen examined: CHINA. Xinjiang, Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4774 , HMAS 83545.

Helvella spadicea Schaeff., Fung. Icon. 3, Tab. 283, 1772; l.c. 4: 112, 1774.
= *Helvella leucopus* Pers., Mycol. Eur. 1: 213, 1822.

Specimens examined: Bachu, VI 1985, on the ground, C. Gao 1661, HMAS 50932; Bachu, V 1986, Anon. 1904, HMAS 53650; V 1987, on the ground I broadleaf forest, Z.Y. Zhao, HMAS 57640; Kashi, on the ground in broadleaf forest, Q. Ji, HMAS 72884.

Notes: The fungus was previously recorded in the Chinese literature as *Helvella leucopus* (Mao 1998).

Hydnotrya cerebriformis Harkn., Proc. Calif. Acad. Sci. 3, 1: 266, 1899.
Specimen examined: CHINA. Xinjiang, Xinyuan, Nalati, alt. 2200 m, 15 VIII 2003, on the ground, W.Y. Zhuang & Y. Nong 4954, HMAS 83546.

Notes: According to Zhang (1990), the fungus was also collected in Qitai County in the east of Xinjiang.

Wynnella auricula (Schaeff.) Boud., Hist. Class. Discom. Eu. p. 51, 1907.
≡ *Elvela auricula* Schaeff., Fung. Bavar. Ind. p. 103, 1774.
= *Wynnella atrofusca* (Beck) Svrcek, Ceska Mykol. 17: 45, 1963.
≡ *Otidea atrofusca* Beck, flora Herstein S. A. p. 131, 1885.
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Notes: The fungus has been found in North America, Europe, and China (Seaver 1928, Dissing 1966, Eckblad 1968, Hansen & Knudsen 2000). It obviously has north temperate distribution. It was previously collected from Mt. Guancen in Shanxi Province, Urmuqi in Xinjiang, and Mt. Yulong in Yunnan (Cao 1988).

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Genetic variability in tropical and temperate populations of *Trapeliopsis glaucolepidea:* Evidence against long-range dispersal in a lichen with disjunct distribution

ZDENĚK PALICE* & CHRISTIAN PRINTZEN**

**palice@ibot.cas.cz*
Institute of Botany, Academy of Sciences of the Czech Republic
CZ-25243 Průhonice, Czech Republic

***christian.printzen@senckenberg.de*
Forschungsinstitut Senckenberg, Abt. Botanik/Paläobotanik
Senckenberganlage 25, D-60325 Frankfurt am Main, Germany

Abstract—The squamulose lichen *Trapeliopsis glaucolepidea* displays a widely disjunct distribution in Europe, East Africa, tropical America, and New Guinea. Using ITS sequences from 38 European and 31 Latin American individuals, we compared the genetic variability within and among populations of this species. Specifically, we addressed the questions whether recurrent genetic exchange occurs between Latin America and Europe, whether there are signs of historical long-range dispersal, whether genetic variability is higher in tropical than in temperate populations, and whether the separation of *T. glaucolepidea* and *T. percrenata* is supported by genetic characters. Intercontinental gene flow seems to be absent and there are also no signs of historical long-range dispersal. Two deviating haplotypes from Europe might belong to an unrecognized species or indicate the presence of paralogous ITS sequences. But our dataset does not support separation of *T. glaucolepidea* and *T. percrenata* based on morphological characters. More thorough sampling efforts and more sequences are necessary to make more detailed inferences on the phylogeography of *T. glaucolepidea*.

Key words—genetic diversity, lichenized fungi, nuclear DNA, Ecuador, Czech Republic

Introduction

Phylogeography provides powerful tools for the study of historical biogeography, dispersal biology, and speciation in various organismal groups (e.g. Avise 2000, Templeton 1998, 2001). Since direct observations are impossible inferences about a species' history can only be made based on genetic data. Population genetics of lichens is still largely unexplored and thus most questions concerning the dispersal, biogeography or speciation of lichens are still unanswered (Printzen & Ekman 2002). Especially the wide disjunctions of many lichen species as compared to other organisms, such as phanerogams are still unexplained. Fragmentation of formerly coherent distributional ranges and long-range dispersal were both invoked as explanations. Some of the first published studies on infraspecific genetic variability of lichens concentrated on biogeographical questions, but came to deviating conclusions. Printzen et al. (2003)

inferred that the North American-European disjunction of *Cavernularia hultenii* was due to the postglacial fragmentation of a circumarctic distributional area, while Högberg et al. (2002) concluded that European populations of *Letharia vulpina* were the result of long range dispersal from North America. In this study we try to provide data on the genetic variability of another lichen species, this time with a peculiar tropical-European disjunction.

Trapeliopsis glaucolepidea (Nyl.) G.Schneider (*Ascomycotina*, *Agyriales*) is a widespread squamulose lichen. Outside Europe, it is reported from higher elevations (mostly above 3000 m) in the tropics: East Africa (Swinscow & Krog 1988), Central & Southern America (Sipman 1999) and Papua New Guinea (Aptroot & Sipman 1991). A few additional unpublished collections exist from montane areas in Asia and a middle-montane region in South America (Palice, unpubl.). No North American records are known so far. In Colombia (Cleef in sched., cf. Sipman et al. 2000) and Ecuador (Palice, pers. obs.) *T. glaucolepidea* appears to be one of the most prominent cryptogamic components of the wet high-páramo – a mountain ecosystem characteristic for the Northern Andes. It grows mainly on naked peat, soil, dry grass tussocks, decaying rosettes of *Asteraceae*, *Apiaceae* and other kinds of plant debris. More rarely, it may be found on rocks or bark covered by mosses or decaying wood. In Europe, the species is best developed in the British Isles, where it preferably occupies open moorland areas at higher elevations. In continental Europe, *T. glaucolepidea* prefers boreal coniferous forests, but also occurs in humid mixed/deciduous forests. Within one locality the species may grow on different substrates: soil, wood, shaded rock and plant debris. The most favoured substrate is relatively freshly exposed, naked peat, e.g. among roots of upended trees. It may also grow epiphytic at the bases of trees (Hafellner 2002).

T. glaucolepidea is a morphologically variable species. Andean and European populations differ in thallus size and in the production of apothecia. In general, the tropical specimens are larger (forms with small squamules are very rare) and more frequently fertile. Well developed tropical individuals can form large palmate squamules exceeding 1 cm in diameter. The best developed specimens from W-European moorlands are morphologically rather similar to average individuals from the tropics forming characteristic grey squamules c. 1-4 mm broad with bluish-grey labriform marginal soralia. Wood-inhabiting European specimens, on the other hand, may have squamules of the breadth only 0.3-1.0 mm. As they may produce soralia at a very early stage it can be difficult to distinguish squamules at all. In Central Europe, a continuum of intermediate forms between the extremes occurs. Thalli of smaller shade forms often lack the bluish tinge and the soralia are pale green to creamy white. Richly fertile specimens are only sparsely sorediate or the soredia are missing completely. The tropical material and the upland specimens from the British Isles have comparatively large apothecia, often above 1 mm in diameter while the specimens from forests produce the apothecia more rarely and they are usually smaller, rarely exceeding 1 mm in diameter. The above mentioned morphological differences apparently reflect environmental conditions, such as light, humidity, character of substrate (texture, decay rate, disturbance of surface) and perhaps also intra- and interspecific competition with other organisms.

Small specimens from decaying wood in West/Central European woodlands are usually called *Trapeliopsis percrenata*. Based on statements on Scandinavian material (cf. Muhr 1986), observations from Bohemia and the respective herbarium material, Palice (1999) concluded that *T. percrenata* is conspecific with *T. glaucolepidea*. In the South American páramo, sorediate specimens and richly fertile individuals without soralia occur. Their status is often difficult to assess. In addition to sparsely sorediate forms of *T. glaucolepidea*, non-sorediate specimens with potential affinities to the African *T. haumanii* or the Australasian *T. colensoi* (indicated by ITS data not included in the current study) might be present.

This study attempts a preliminary answer on three main questions. (1) Is there evidence for recurrent or historical genetic exchange between Latin American and European populations of *T. glaucolepidea*? (2) Are there differences in the genetic diversity of tropical vs. temperate populations. (3) Is there evidence that morphologically different specimens (previously referred to *T. glaucolepidea* and *T. percrenata*) really belong to two different species. Particularly with regard to this last question, but also in order to capture as much of the genetic diversity of *T. glaucolepidea* as possible, our sampling tries to cover the complete morphological variability of European and Latin American *T. glaucolepidea*.

Materials and Methods

Sampling

We sampled 38 European and 31 Latin American individuals of *T. glaucolepidea* (Append. 1) trying to cover the morphological variation of this species. For the comparison of genetic variability in tropical and temperate populations, we sampled several specimens from nearby populations in approximately equal areas of Ecuador (as a hypothetical diversity center) and the Czech Republic. In Ecuador, we chose four closely situated populations at Volcán Chíles, prov. Carchi (E1, n=17), a population in the NP Llanganates, prov. Napo/Tungurahua (E2, n=7), and one in the NP Podocarpus, Loja prov. (E3, n=4) for more intensive sampling. In the Czech Republic two populations in the NP Šumava, S-Bohemia (C1, n=12) and the NP České Švýcarsko, N-Bohemia (C3, n=7) were selected (Tab. 3, cf. Append. 1). The size of the populations varies somewhat within our dataset but was chosen so that the most distant collections from one population are not situated more than 50 km from each other. Only specimens that were clearly assignable to *T. glaucolepidea* were sampled, ITS sequences of non-sorediate specimens were only included when they belonged to one of the "sorediate" haplotypes.

DNA-sequencing

DNA was extracted from the vegetative lichen thalli using the NucleoSpin® Plant Kit (Macherey Nagel) according to the manufacturer's protocol. In order to minimize contamination by other fungi – when feasible – younger thalli were used, and cortex and soralia were cut-off. PCR amplification of the internal transcribed spacer of the nuclear ribosomal DNA repeat (ITS) was performed in 50 μL volumes containing 3-4 μL DNA, 5 μL 10 x reaction buffer, 2.5 mM $MgCl_2$, 1 mM dNTPs, 1 U *Taq* (MBI Fermentas), and 0.8 μM each of the primers ITS 1 F-5′ (Gardes & Bruns 1993) and ITS 4-3′ (White et al. 1990). Cycling conditions were as follows: initial denaturation at 94°C (4'), 6 cycles of a touch-down PCR with 94°C (1'), 62°C (-1°C per cycle) (1'), 72°C

(1'45"), 34 cycles with 94°C (30"), 56°C (30"), 72°C (1'45"), and a final extension of 72°C (10'). PCR products were purified with the QIAquick™ PCR purification kit (QIAGEN). Purified PCR-products were sequenced by GATC Biotech AG (Konstanz, Germany). Both strands were sequenced for new haplotypes. In all other cases (except when sequence chromatograms were of poor quality) only one strand was sequenced. One sequence of every observed haplotype was deposited in GenBank (access. numbers AY600064-AY600082).

Data Analysis

An alignment of 69 ITS sequences was calculated with the program ClustalW as implemented in the software BioEdit (Hall 1999) and manually adjusted. In order to display the phylogenetic relationships within the dataset, a haplotype network was calculated under the 95% parsimony probability criterion (Templeton et al. 1992) using the software TCS version 1.06 (Clement et al. 2000) with gaps treated as a 5th character state. Root probabilities (outgroup weights) were calculated for each haplotype according to the heuristic algorithm introduced by Castelloe & Templeton (1994) and according to the modified algorithm by Cassens et al. (2003). Parameters of genetic diversity were calculated using DNASP version 3.99 (Rozas & Rozas 1999). Parameters were calculated for the two European and three Ecuadorian populations from which four or more individuals were sampled (Tab. 2). In addition, genetic diversity within Europe and Latin America respectively was estimated on the basis of all sampled specimens. As estimators of genetic diversity, we calculated haplotype diversity h (Nei 1987) and nucleotide diversity Pi (π). All calculations were performed on two different datasets: one containing all sampled haplotypes and one excluding the deviating European haplotypes H1 and H2 (see below). DNASP ignores positions with gaps, and consequently pools haplotypes that only differ by indels. In order to calculate correct haplotype diversity indices, we recoded positions 12, 13, 18 and 140 of our alignment. Haplotype diversity indices of populations were compared using a two-tailed t-test as described in Zar (1999; equations 8.62 and 8.65) and significance values obtained by an internet application (URL: http://home.clara.net/sisa/signif.htm). The calculation of nucleotide diversity was performed on the original alignments without recoding. Because of multiple hits at positions 69, 90, 113 and 353 of the alignment we used the Jukes and Cantor correction (Jukes & Cantor 1969) to calculate Pi (π). We used an analysis of molecular variance (AMOVA, Excoffier et al. 1992) to partition the total genetic variance of our sample into components due to differences within populations, among populations within continents (Europe and Latin America), and among continents using Arlequin version 2.001 (Schneider et al. 2001). For this analysis we used the same five populations as for the calculation of genetic diversity. Again, calculations were performed on the two datasets outlined above.

Results

The complete aligned dataset is 530 bp long and contains 48 polymorphic sites. Nineteen haplotypes can be distinguished (Tab. 1). The cladogram in Fig. 1 consists of two clades that are not connected to each other under the 95% parsimony probability criterion. The two haplotypes H1 and H2 are separated from the rest of the network by at least 21 mutational steps. This distance is almost as large as the minimum distance

Table 1: ITS haplotypes of *Trapeliopsis glaucolepidea* and their frequencies in different geographical areas. Only polymorphic sites are listed, with their respective base numbers in the alignment. Sites with multiple hits are in bold face. Sites that were recoded for the calculation of haplotype diversity are denoted by asterisks.

	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	**1**	1	1	1	1	1	1	1	1	1	1	3	3	3	**3**	3	3	3	3	3	3	4	4	4	4	4	4		
	0	0	1	1	1	1	3	4	4	4	5	5	**6**	7	7	7	8	8	8	**9**	9	**1**	2	3	3	4	4	6	6	7	7	8	0	2	5	**5**	6	7	7	8	8	9	0	3	4	6	8	8		
Haplotype	1	7	2	3	4	8	6	3	7	9	2	4	**9**	0	1	5	4	6	7	**0**	8	**3**	3	0	1	0	6	2	9	2	6	3	8	6	1	**3**	9	5	6	2	3	4	2	6	7	0	0	1	**Latin America**	**Europe**
			*	*		*																				*																								
H 03	C	G	T	C	C	-	T	T	C	T	C	T	**T**	C	C	C	C	T	-	**T**	C	**T**	A	C	T	-	A	A	G	-	T	-	T	C	C	**G**	T	C	C	C	G	G	A	T	G	T	T	C	0	1
H 04	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	.	0	7
H 05	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**G**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	G	.	.	.	.	.	0	5
H 06	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**G**	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	G	.	.	.	.	.	0	1
H 07	.	.	.	.	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	**A**	.	.	.	.	.	.	G	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	0	13
H 08	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	T	.	.	.	.	T	T	**C**	.	T	T	.	.	.	G	C	.	.	-	.	1	0
H 09	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	T	.	.	G	C	.	.	-	-	1	0
H 10	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	A	.	-	-	3	0
H 11	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	7	0
H 12	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	A	G	C	.	.	-	-	1	0
H 13	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	**C**	T	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	.	G	C	.	.	-	-	1	0
H 14	.	.	.	.	.	.	.	C	.	.	T	.	**C**	.	.	.	.	.	.	**C**	.	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	.	G	C	.	.	-	-	1	0
H 15	.	.	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	**C**	.	.	.	.	.	.	.	.	T	.	C	.	.	T	.	**C**	C	.	.	.	.	.	G	C	.	.	-	-	3	0
H 16	.	.	-	-	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	9	0
H 17	.	.	-	.	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	2	0
H 18	.	.	-	.	.	C	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	**T**	.	.	.	.	.	.	G	C	.	.	-	-	1	0
H 19	.	A	.	.	.	.	.	.	.	.	T	.	**C**	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	T	.	**C**	.	.	.	.	.	.	G	C	.	.	-	-	1	0
H 01	T	A	.	.	.	.	C	.	T	C	T	C	-	-	-	T	A	C	G	**C**	.	**C**	G	.	.	.	.	.	T	A	C	A	C	T	.	**C**	.	.	.	.	A	.	G	C	.	C	-	-	0	10
H 02	T	A	.	.	G	.	C	.	T	C	T	C	-	-	-	T	A	C	G	**C**	.	**C**	G	.	.	.	.	.	T	A	C	A	C	T	.	**C**	.	.	.	.	A	.	G	C	.	C	-	-	0	1
Σ																																																	**31**	**38**

between our two unconnected clades. More specifically, the genetical differences do not coincide with the supposed morphological differences between *T. glaucolepidea* and *T. percrenata*. Alternatively, these distant haplotypes could also represent paralogous ITS sequences. In the context of the present study we were unable to check for paralogs and hence conducted all of our analyses on two datasets, one including and one excluding H1 and H2. Excluding H1 and H2 reduces the number of polymorphic sites to 30.

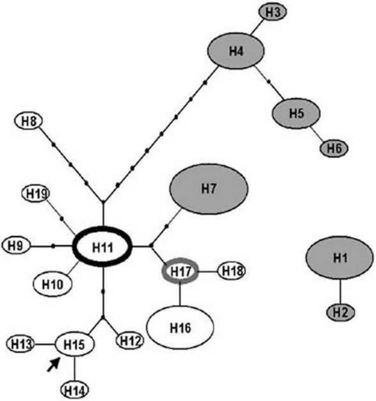

Fig. 1: Haplotype network of 69 ITS sequences from *Trapeliopsis glaucolepidea*. Ovals represent haplotypes sampled by us. The size of each oval is proportional to the number of sampled individuals of that haplotype. A line represents one mutational step. Black dots represent haplotypes not present in the sample. Haplotypes H1-H7 (grey) occur exclusively in Europe, H8-H19 (white) only in Latin America. The subnetwork consisting of haplotypes H1 and H2 is not connected to the main network under the 95% parsimony probability criterion. The minimum distance between both subnetworks is 21 steps. The black arrow indicates the probable connection between H1 and the large subnetwork. Bold marginal lines indicate alternative rooting positions of the large subnetwork: grey according to the algorithm by Castelloe & Templeton (1994), black according to the modified algorithm by Cassens et al. (2003).

Fig. 1 shows that Latin America and Europe do not share any haplotypes. However, the haplotypes from each continent do not form mutually monophyletic lineages. The European haplotype H7 clusters among the Latin American haplotypes close to the oldest – i.e. most interior – haplotypes of the network. The ancestral haplotype inferred by the algorithm of Castelloe & Templeton (1994) is the Ecuadorian H17 near the periphery of the cladogram. However, it has recently been emphasized that this algorithm is problematic when intermediate haplotypes are missing from the dataset or when the frequency of haplotypes is unequal over the geographical range of a species

(Cassens et al. 2003, Printzen et al. 2003). In our case the high outgroup weight of H17 is entirely due to the frequency of its immediate neighbour, H16, in the Ecuadorian population E1 (see below). With the modified algorithm by Cassens et al. (2003), by far the highest outgroup weight is assigned to H11 in the center of the network, which also occurs in Ecuador.

The genetic diversity indices for European and Latin American populations are summarized in Tab. 2. Two trends are obvious from the table. Firstly, the number of haplotypes is considerably higher in Latin America (12) than in Europe (5 or 7, including H1 and H2). Haplotype numbers differ also between single populations from different continents. Secondly, the inclusion of the deviating haplotypes H1 and H2 grossly inflates the nucleotide diversity but has relatively little effect on haplotype diversity. Although Latin America has a much higher number of haplotypes, the haplotype diversity is not significantly higher than for Europe (Tab. 3). It becomes significant only when H1 and H2 are removed from the European sample. A direct comparison of single Latin American and European populations indicates that only one European population (C3) displays a significantly lower diversity than the Latin American populations (Tab. 3).

Table 2: Number of observed haplotypes and diversity indices for two European and three Ecuadorian populations of *T. glaucolepidea*, all Latin American populations and European populations including and excluding the deviating haplotypes H1 and H2.

Population	**N**	**No. of haplotypes**	**Haplotype diversity**	**π(JC)**
Czech Rep. 1 (excl. H1-2)	12	4	0.636	0.0231
Czech Rep. 1 (excl. H1-2)	5	3	0.700	0.0015
Czech Rep. 3	7	2	0.286	0.0011
Ecuador 1	17	6	0.779	0.0015
Ecuador 2	7	5	0.857	0.0022
Ecuador 3	4	4	1.000	0.0038
Europe (incl. H1-2)	38	7	0.781	0.0205
Europe (excl. H1-2)	27	5	0.689	0.0096
Latin America	31	12	0.862	0.0036

The fact that no haplotypes are shared between Europe and Latin America is reflected by the high percentage of genetic variation between the continents. According to the results of the AMOVA (Tab. 4) all three hierarchical layers (among continents, among populations within continents and among individuals within populations) contribute more or less equally to the total genetic variance of our sample when H1 and H2 are included. When these haplotypes are excluded more than 70% of the total genetic variance is due to differences between the continents.

Morphological differences between the specimens are apparently not associated with genetic differences in the studied gene. Our results corroborate the opinion that *T. glaucolepidea* and *T. percrenata* are conspecific (Palice 1999). The ITS-sequences of British samples representing typical *T. glaucolepidea* are identical to some sequences from small, wood/peat-inhabiting morphotypes from Belgium, the Czech Republic, Germany, Poland and Sweden ("typical" *T. percrenata*).

Table 3: Comparison of haplotype diversity indices and significance of results according to a two-sided *t*-test. Significant differences (at the 0.05 level) are found between Latin America and Europe excluding H1 and H2, and Czech Rep. 3 and three Ecuadorian populations.

Population	Latin America	Ecuador 1	Ecuador 2	Ecuador 3
Europe (incl. H1-2)	0.14	-	-	-
Europe (excl. H1-2)	0.02 *	-	-	-
Czech Rep. 1 (incl. H1-2)	-	0.34	0.25	0.13
Czech Rep. 1 (excl. H1-2)	-	0.74	0.56	0.31
Czech Rep. 3	-	0.04 *	0.03 *	0.02 *

Discussion

The fact that there are no shared haplotypes among the two continents and the results of the AMOVA provide strong evidence against recurrent genetic exchange between Latin American and European populations of *T. glaucolepidea*. This is in line with the results of Printzen et al. (2003) who concluded that there is no evidence for recurrent gene flow between Western and Eastern North American and European populations of *Cavernularia hultenii*. However, it is still controversial, whether rare dispersal events in the distant past can account for the wide disjunctions displayed by many lichens. Recently, Högberg et al. (2002) reported evidence for a North American origin of European populations of *Letharia vulpina*. Their inference of long range dispersal is based on the fact that there is higher genetic variability in North America than is observed in European populations of *L. vulpina*. According to Högberg et al. (2002) the low diversity in European populations is best explained by a historical population bottleneck that was in turn the results of a founder event after long range dispersal from North America to Europe. A similar result – relatively low genetic diversity in European as compared to American populations – was reported by Printzen et al. (2003) and is also found here. We hesitate, however, to infer historical long range dispersal on the basis of these data. Low genetic variability in certain populations can be explained by population bottlenecks (Nei et al. 1975). However, there may be alternative explanations to a founder event through long range dispersal for such a bottleneck. Most boreal and temperate species of the Northern Hemisphere underwent pronounced population bottlenecks and changes of genetic diversity during the Pleistocene glaciations (e.g. Hewitt 1996, 1999, Soltis et al. 1997, Taberlet et al. 1998). These bottlenecks could have been more pronounced in Europe with its east-west extending mountain ranges than in North America. Their effects on tropical Latin American populations will certainly have been different from those on temperate European populations. The fact that European and Latin American haplotypes of *T. glaucolepidea* do not even form monophyletic lineages, would make it necessary to assume at least two independent events of historical long range dispersal, or to assume a very ancient dispersal event with subsequent lineage sorting between the continents. In our opinion, the data currently available on the genetic diversity of lichens is by far too poor which makes such assumptions largely speculative.

Table 4: Results of the AMOVA including the five populations Czech Rep. 1-2 and Ecuador 1-3 based on the total dataset and the dataset excluding haplotypes H1 and H2 (in **bold**).

Source of variation	d. f.	Sum of squares	Variance components	Percentage of variation
Among groups	1 **1**	77.421 **73.793**	2.32643 Va **4.07732 Va**	32.58 **73.16**
Among populations within groups	3 **3**	56.172 **14.338**	1.98713 Vb **0.55365 Vb**	27.62 **9.96**
Within populations	41 **34**	117.179 **31.079**	2.85801 Vc **0.91408 Vc**	39.73 **16.45**
Total	45 **38**	250.196 **118.667**	7.19361 **5.55712**	

It appears from our data that the number of haplotypes is higher in the tropics than in Europe. There is also a trend to higher haplotype diversity, however, direct comparisons between European and Latin American populations are mostly insignificant. These results reflect the fact that most Latin American haplotypes have only been collected once and should not be overinterpreted. Most of our tropical samples originate from only a small area. If some of the rare haplotypes are more common in other tropical areas, a more comprehensive sampling and sequencing effort would probably lead to a higher haplotype diversity in the tropics as could be expected from the number of haplotypes alone.

Nucleotide diversity Pi (π), however, is not necessarily affected in the same way. The pairwise, average distance between sequences depends largely on the distance between the most common haplotypes in a sample. In our case, the genetic distance between the most common European haplotypes (H1,) H4 and H7 is much larger than the distance between any of the Latin American haplotypes. We therefore conclude that nucleotide diversity is not a useful measure of genetic diversity, when comparing populations from different regions with non-overlapping haplotype composition.

Because closely related lichen species may be difficult to distinguish morphologically, species delimitations are often controversial in lichenology. For example, while some recent floras and checklists treat *T. glaucolepidea* and *T. percrenata* as different (Foucard 2001, Purvis et al. 1992, Søchting & Alstrup 2002), others suggest that both are identical (Hafellner & Türk 2001, Santesson et al. 2004, Vězda & Liška 1999). If morphological differences between species were associated with genetical differences, this would support the presence of two species instead of one. However, in our present dataset, morphologically different individuals often belong to the same haplotype, and morphologically similar ones are spread over the haplotype network.

A related question that has repeatedly been discussed in recent times is whether genetically differentiated populations of lichens form cryptic species (Grube & Kroken 2000, Kroken & Taylor 2001). The fact that European and Latin American populations are apparently isolated from each other could indicate the presence of two cryptic species. However, we caution against the over-use of the term "cryptic species" for every instance of genetic differentiation. Reproductive isolation may be a prerequisite for the formation of species but does not, in itself, constitute speciation. More genetical data from a broader range of markers and a more complete sampling over a wider geographical range would be necessary to assess the species status of temperate and tropical populations of *T. glaucolepidea*. At present, there is no evidence for cryptic speciation in our dataset.

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Appendix 1: Populations sampled for this study

Country	Haplotype(s)	Coordinates (WGS 84)	Collector (Herbarium)	N
Scotland	H7	56°40-45'N, 03°34-44'W	B.Buryová (hb. Palice 6962, 6975)	2
Ireland	H7	51°48'N, 09°27'W	J.Halda & Z.Palice (hb. Palice 8063b)	1
Netherlands	H5	52°15'N, 05°40'E	A.Aptroot 48260 (hb. Palice)	1
Belgium	H7	50°27-30'N, 06°06' E	B. & P. v.d.Boom 28370, 31546 (hb. Palice)	2
Germany	H1	48°55'N, 13°25'E	J.Halda et al. (hb. Palice 2672)	1
Germany	H7	52°15'N, 14°21'E	B. & P. v.d.Boom 28298 & H.Sipman (hb. v.d.Boom)	1
Germany	H7	50°06'N, 06°40'E	A.Aptroot 59313 (hb. Palice)	1
Sweden	H7	55°54'N, 13°33'E	Z.Palice (hb. Palice 8201)	1
Lithuania	H1	54°32'N, 23°49'E	P.Czarnota (GPN/3117)	1
Poland	H2	53°40'N, 18°15'E	P.Czarnota (GPN/2961)	1
Poland	H1	53°33'N, 17°43'E	P.Czarnota (GPN/3205)	1
Poland	H7	50°49'N, 15°22'E	P.Czarnota (hb. Palice, dupl. ex GPN/3345)	1
Poland	H7	49°10'N, 20°05'E	P.Czarnota (GPN/2894)	1
Czech Rep. - **C1**	H1, H4, H5, H6	48°41-55'N, 13°50'-14°03'30"E	Z.Palice (hb. Palice 1481, 1601, 4212, 4850, 5094, 5101, 6818, 7036, 8630, 8631, 8632, 8633)	12
Czech Rep. - **C2**	H7	49°05'N, 13°31-34'E	Z.Palice, O.Peksa (hb. Palice 6551, 8629)	2
Czech Rep. - **C3**	H4, H5	50°53-54'N, 14°23-25'E	Z.Palice (hb. Palice 5808, 5814, 5831, 6832, 6834, 8605, 8606)	7
Czech Rep. - **C4**	H3, H7	49°38-40'N, 15°53'-16°04'E	Z.Palice & O.Peksa (hb. Palice 8066, 8067)	2
Ecuador - **E1**	H9, H10, H11, H16, H17, H19	00°48-49'N, 77°55-57'W	Z.Palice (hb. Palice 2312, 2323, 3065a, 3065b, 3255, 8494, 8495, 8496, 8497, 8499, 8503, 8505, 8507, 8508, 8509, 8515, 8519)	17
Ecuador - **E2**	H11, H15, H16, H17, H18	01°07-17'S, 78°19-21'W	Z.Palice (hb. Palice 4336, 4348, 8504, 8511, 8512, 8513, 8524)	7
Ecuador - **E3**	H12, H13, H14, H15	04°08-11'S, 79°06-10'W	Z.Palice (hb. Palice 2707, 3149, 3578, 3781)	4
Ecuador - **E4**	H15	01°41'S, 78°27'W	Z.Palice (hb. Palice 3203)	1
Ecuador - **E5**	H16	00°18'S, 78°12'W	Z.Palice (hb. Palice 2234)	1
Costa Rica	H8	09°34'N, 83°45'W	H.Sipman 11792 (B)	1

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New and rare rust fungi *(Uredinales)* from Anatolia (Turkey) - 2

ZELIHA BAHCECIOGLU

zbahcecioglu@inonu.edu.tr
Inönü University, Pharmacy Fac.
Malatya, Turkey

HALVOR B. GJAERUM

plantevernet@planteforsk.no
Norwegian Crop Research Institute, Høgskoleveien 7,
N-1432 Ås, Norway

Abstract—Twenty-two rust taxa are reported from Anatolia in Turkey. Three of them are described as new species, *Phragmidium sarcopoterii* on *Sarcopoterium spinosum*, *Puccinia onosmaticola* on *Onosma molle* and *Uromyces dorystoechadis* on *Dorystoechas hastata*. *Puccinia tepperi* on *Phragmites australis* is reported for the first time outside Australia while four other taxa are reported for the first time in Turkey: *Ochropsora ariae* on *Anemone blanda*, *Frommeëlla tormentillae* on *Potentilla* sp. and *Puccinia constricta* on *Teucrium orientale*. Some new hosts for previously known species in Turkey are reported.

Key words—microfungi, new taxa, parasite

Introduction

As Bahcecioglu & Gjærum (2003) have previously observed, Turkish mycota is rich in microfungi. Some research has been done, e.g. by Karel (1958) and Henderson (1959, 1961, 1964), but there is still much to do.

Materials and methods

The material presented here was collected in the years 1995-2002 in the following provinces: Ağrı, Anamur, Antalya, Bitlis, Erzincan, Erzurum, Gümüshane, Kahramanmaras, Malatya, Ordu and Sivas. Spores were mounted in lactophenol. The host names follow the Flora of Turkey and Aegean Islands by Davis (1968 – 1985) and Davis et al. (1988). After identification of the rusts the material is preserved in the herbarium of Inönü University.

Frommeëlla tormentillae (Fuckel) Cummins & Y. Hirats. – Illustrated genera of rust fungi. Rev. ed., p. 120, 1983.

Syn. *Frommea obtusa* (Fuckel) Arthur. – Bull. Torrey Bot. Club 44: 503, 1917.
On *Potentilla* sp. (Rosaceae).

Gümüşhane. Zigana Pass, 1950-2000 m, 12. Aug. 2001, Z. Bahcecioglu 3228, II+III.

Uredinia hypophyllous, pale yellow with a few clavate, thin-walled paraphyses. Urediniospores 19-22 x 16-20 µm, subgloboid, ellipsoid or obovoid, walls 1 (-1.5) µm thick, hyaline, finely echinulate with 3-4 indistinct pores. Telia hypophyllous, brown. Teliospores 54-84 x 27-32 µm, cylindric or clavate, 3-6-celled, mostly 5, with one pore in each cell, walls brown, smooth, at side 4-5 µm thick, apically thickened to 4.5-6.5 µm, mostly rounded, but often with a short papilla. Pedicels persistent, equal to the length of the spores, hyaline but tinted near the spore, collapsing.

As *Frommea obtusa,* this rust has been reported on many species of *Potentilla* in Europe and the Americas, more rarely in Africa and Australia. In Asia it is reported from Armenia, India and Siberia. *Frommeëlla* is a new genus in the Turkish rust flora.

Ochropsora ariae (Fuckel) Ramsb. – Trans. Brit. Mycol. Soc. 4: 337, 1915.
On *Anemone blanda* Schott & Kotschy. (Ranunculaceae).

Malatya. Beydağı. Bürücek hill, 2000 m, 01. May. 1995, Z. Bahcecioglu 179, 0+I.

Pycnia epiphyllous, type 7. Aecia amphigenous, mostly hypophyllous, covering the whole leaf, cupulate, peridium white. Aeciospores in chains, 14-20(-23) x 14-17 µm, ellipsoid or globoid, often somewhat angular, walls c 1 µm thick, densely and finely verrucose, hyaline.

This rust species, systemic in the rootstocks and host alternating with species of *Sorbus*, occurs on many species of *Anemone* from Europe to China and Japan. Woronow (1910) and Durrieu (1968) reported *A. blanda* as a host for this rust from Caucasus and Greece, respectively, both as *O. sorbi* (Oud.) Dietel. *Ochropsora* is a new genus to the rust flora of Turkey.

Phragmidium sarcopoterii Gjærum & Bahcecioglu, *sp. nov.* (Fig. 1).
Etymology: from *Sarcopoterium*, a genus in Rosaceae.

Pycnia, aecia et uredinia ignota. Telia hypophylla, atrofusca cum paraphysibus clavatis vel cylindricis, pariete 1-1.5 µm crasso, hyalino. Teliosporae 47-80 x 31-39 µm, (3-)4-5(-6)- cellularis, cylindraceae, ad basem leviter dilatatae, ad apicem rotundatae, papillis hyalino vel apiculato verrucoso usque ad 15 µm longo, pariete 4-4.5 µm crasso, ad apicem 4.5-5.5µm incrassato, verrucis disperso, hyalino, quaque cellula poris duobus, cellulae apicalis raro tribus instructis, pedicello persistente, usque ad 90 µm longo, vulgo deorsum incrassato, hyalino.

Pycnia, aecia and uredia not seen. Telia hypophyllous, blackish brown with clavate to curved paraphyses, walls hyaline, 1-1.5 µm thick. Teliospores 47-80 x 31-39 µm, (3-)4-5(-6)-celled, cylindric, slightly wider at base, apically rounded with a low, hyaline papilla or often with a warted, abrupt apiculus up to 15 µm long, walls 4-4.5 µm thick, brown, apically thickened to 4.5-5.5 µm, with scattered, hyaline warts, each cell with 2 pores, apical cells rarely with 3 pores. Pedicels up to 90 µm long, generally swelling at base, hyaline.

Holotype: Z. Bahcecioglu 2674 (Inönü), Turkey, Anamur, Between Anamur and Gazipaşa, Kaledran village, 50 m, 28. May. 2000, on *Sarcopoterium spinosum* (L.) Spach. (Rosaceae). Isotype in NCRI.

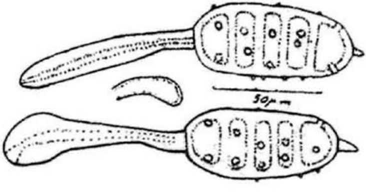

Fig. 1. *Phragmidium sarcopoterii* . Teliospores and paraphyses from type.

The teliospores in the present specimen differ from those in *Phr. sanguisorbae* (DC.) J. Schröt. ssp. *mediterranea* D. M. Henders. in having thicher walls with scattered warts and often an apiculus and with pedicels longer than the spores.

Phr. sanguineum (DC.) J. Schröt. has been reported on the present host from Libya, Greece and Israel. The ssp. *mediterranea* is reported from Spain to Greece.

Puccinia calcitrapae DC. – Fl. Fr. 2: 221, 1805.

Syn. *P. echinopis* DC. – Fl. Fr. 5: 57, 1815.
On *Echinops galeticus* Freyn. (Asteraceae).
Sivas. İmranlı, Saruhan village, 2000 m, 16.Aug. 2002, Z. Bahcecioglu 3352, (II+) III.
On *Echinops melitenensis* Hedge & Hub.- Mor.
Sivas. Gürün, Gökpınar, 1400 m, 16. Aug. 2002, Z. Bahcecioglu 3326, (II+) III.

Uredinia not seen, but some spores have been found in the telia. Urediniospores 26-34 x 26-31 µm, ellipsoid or subgloboid, walls 1.5-3 µm thick, slightly thickened basically, yellowish brown, echinulate with 3 equatorial pores. Telia amphigenous, mostly hypophyllous, black, small, round, often in rings around a central sorus. Teliospores 33-43(-46) x 23-27 µm, cylindrical, ellipsoid or obovoid, walls 3 µm thick, apically rarely thickened up to 4.5-5 µm, apically rounded, flattened or attenuate, verruculose, brown, upper pore apical or subapical, lower pore somewhat depressed. Pedicels short, hyaline.

P. echinopis is widespread in Central and South Europe through Asia to China, but not in more tropical areas. In Africa it is reported from Morocco, Algeria and Sudan. From Turkey it has been reported as *P. echinopis* on many species of *Echinops* as *E. heldreichii* Boiss., *E.* aff. *viscosus* DC. (Henderson 1961) and *E. melitenensis* Hedge & Hub.- Mor. and *E. purgans* Trautv., *E. ritro* L. (Bahcecioglu & Isiloglu 1996, Bahcecioglu & Yildiz 2001). For other asteraceous genera serving as hosts for this rust see e.g. Henderson (1964). *P. echinopis* is now recognized as a race or a f. sp. of *P. calcitrapae* s. lat.

Puccinia caricina DC. s. lat. – Fr. Fl. 5: 60, 1815.

On *Carex* sp. (Cyperaceae).

Ordu. Between Ordu and Aybastı, 1500-1600 m, 17. Aug. 2001, Z. Bahcecioglu 3325, II+III.

Uredinia hypophyllous, oblong, often confluent, covered by epidermis which later cracks, brown. Urediniospores 27-33 x 17-25 µm, subgloboid, ovoid or obovoid, walls 1.5-2.5 µm thick, yellow, echinulate, with 3 equatorial pores, covered by low, hyaline papillae. Telia mainly hypophyllous, oblong, often confluent, covered by epidermis which later cracks, dark brown. Teliospores 47-65 x 15-22 µm, clavate, slightly constricted, apically rounded or obtuse, walls brown, in lower cells about 1 µm thick, in upper cells 1.5 µm thick, apically thickend up to 10 µm, smooth, upper pore apical, lower near septum. Pedicels persistent, pale brown, up to 25 µm long.

P. caricina is reported from all continents, common on many species of *Carex* in Europe, but also in Asia and in the Americas, more rarely in Africa and Australia. The first report of this rust from Turkey was given by Magnus (1903) who reported it as *P. caricis* (Schum.) Rebent. on *C. hirta* L. Later Henderson (1964) and Bahcecioglu & Gjærum (2003) reported it on *C. hordeistichos* Vill., Henderson also on *C. sylvatica* Huds.

Puccinia chaerophylli Purton. – Midland Flora 3: 303, 1821.

On *Chaerophyllum macrospermum* (Sprengel) Fisch. & Mey. (Apiaceae).

Gümüşhane. Zigana Pass, 1600 m, 12.Aug.2001, Z. Bahcecioglu 3219, II+III.

Uredinia hypophyllous, rounded or oblong, yellowish brown. Urediniospores 21-27 x 20-23 µm, subgloboid or ellipsoid, walls 1.5-2.5 µm thick, pale yellow or yellowish brown, echinulate with 3 equatorial pores covered by low, hyaline papillae. Telia amphigenous, mostly hypophyllous, blackish brown. Teliospores 23-36 x 17-25 μm, ellipsoid or obovoid, often irregular, rounded at both ends or apically obtuse or attenuate below, slightly constricted, walls 2-2.5 μm thick, reticulate, yellowish brown to brown, upper pore apical, lower pore subequatorial. Pedicels hyaline, short.

P. chaerophylli is common in Europe and Asia except in tropical areas, rare in Africa. In Turkey it has previously been reported on *Anthriscus nemorosus* (Bieb.) Sprengel (Tamer & Öner 1978), *Chaerophyllum byzantinum* Boiss. (Gjærum 1996) and *C. bulbosum* L. (Bahcecioglu & Yildiz 1996). *C. macrospermum* is a new host for this rust.

Puccinia constricta (Lagerh.) Bubák. – Centralbl. f. Bacteriol., Parasitenk., Infektionskrankh. II. Abt. 9: 919, 1902.

On *Teucrium orientale* L. (Lamiaceae).

Kahramanmaraş. Göksun, Ahmetcik village, 1300 m, 08. Aug. 2001, Z. Bahcecioglu 3187, III.

Telia on leaves and stems, dark brown. Teliospores 39-48 x 20-31 μm, ellipsoid, upper cells mainly slightly wider than the lower ones, slightly constricted, rounded in both ends or apically slightly attenuate, walls 1-1.5 μm thick, in upper cells gradually thickened to 7 μm, brown, in lower cells slightly paler. Pedicels up to 65 μm long, pale brown, collapsing.

Guyot & Massenot (1952) separated the rusts on *Teucrium* in two groups, one with pale to reddish brown telia mainly on leaves, the other with blackish brown telia mainly on stems, but also on leaves. In the latter group they recognized *P. constricta, P. istriaca* P. Syd. & Syd. and *P. polii* Guyot. They found *P. majoricensis* Maire similar to *P. polii* which is the younger name of these two, but they kept them under *P. polii*. Petrak (1953) and Jørstad (1962) used *P. majoricensis* with *P. polii* as a synonym.

P. majoricensis has longer teliospores than both *P. constricta* and *P. istriaca* which hardly can be separated that way as they overlap. However, *P. constricta* has pedicels equal to the length of spores while *P. istriaca* has short pedicels. Our specimen has teliospores whose pedicels are equal or even longer than the spores. We have therefore placed it under *P. constricta* which is known in Central Europe from France to Romania and Bulgaria and also in Caucasia. It is new to the rust flora of Turkey.

Puccinia hieracii Mart. var. **piloselloidarum** (Probst) Jørst. – Kgl. Norske Vidensk. Selsk. Skr. 1935, 38: 27, 1936.

On *Pilosella* x *auriculoides* (A. F. Lang) Sell & West. (Asteraceae).

Erzincan. Kemaliye, Sırakonaklar village, 1300 m, 24. Jun. 2000, Z. Bahceciolglu 2924, II+III.

On *Pilosella verruculata* (Link) Sojak.

Erzincan. Kemaliye, Sırakonaklar village, 1600 m, 24.Jun.2000 m, Z. Bahcecioglu 2936, II+III.

Uredinia hypophyllous, brown. Urediniospores 27-31 x 23-29 μm, subgloboid, ovoid or obovoid, walls 1.5-2.5 μm thick with two pores slightly superequatorial, brown, echinulate. Telia hypophyllous, brown. Teliospores 35-46 x 22-27 μm, ellipsoid or obovoid, somewhat irregular, some spores slightly constricted, walls 2-2.5 μm thick, brown, finely verruculose, upper pore subapical, the lower pore equatorial, pedicels hyaline, short, mostly broken near the spore.

P. hieracii, living on species of many asteraceous genera, is a complex species of which some races or forms have been described as species or varieties, all with two pores more or less superequatorial. *P. hieracii* var. *piloselloidarum* is bound to the *Pilosella* and morphologically characterized by Urediniospors with slightly superequatorial germ pores.

P. hieracii is reported from Turkey by e.g. Magnus (1903), Henderson (1961, 1964) and Bahcecioglu and Yildiz (2001) while Tamer et al. (1987) published the variety on *Pilosella x auriculoides*

Puccinia lapsanae Fuckel. – Jahrb. Nass. Ver. Nat. p. 13, 1860.

On *Lapsana communis* L. (Asteraceae).

Sivas. Kızıldağ Pass, 2100 m, 14. Aug. 1996, Z. Bahcecioglu 1134, II+III; Erzincan. Kemaliye, Sırakonaklar village, 1600 m, 24. Jun. 2000, Z. Bahcecioglu 2941, II+III; Gümüşhane. Torul, between Zigana village and Zigana Pass, 1600 m, 08.12.2001, Z. Bahcecioglu 3225, II+III.

Uredinia and telia amphigenous, brown, small, often confluent. For the specimens 1134 and 2941 urediniospores 22-26 x 16-22 μm, globoid or subgloboid, walls 1-1.5 μm thick, pale brown, verruculose with 2 equatorial pores. Teliospores 27-35 x 22-25(-27) μm, ellipsoid or obovoid, walls 1.5 - 2(-2.5) μm thick, brown, upper pore apical, lower equatorial. Pedicels short, hyaline, deciduous.

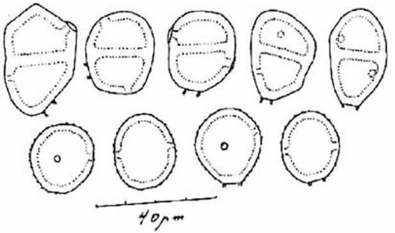

Fig. 2. *Puccinia lapsanae*. Telio- and urediniospores from specimen Z. Bahcecioglu 3225.

In the specimen 3225 uredinio- and teliospores have slightly thicker walls and the teliospores (Fig. 2) are often more irregular than in the two other specimens studied. Henderson (1964) mentioned that in S. W. Asia teliospore-walls often are slightly thickened compared to the normal, probably correlated with the regional arid conditions. However, for describing the fungus on No. 3225 e. g. as a new variety we think more material is necessary.

P. lapsanae is common in Europe, but seems to be rare in the other continents. Bahcecioglu & Isiloglu (1996) and Bahcecioglu & Yildiz (2001) reported it on *L. communis* and *Jurinea consanguinea* L. from the Malatya province.

Puccinia libani Magn. – Verh. Zool.-Bot. Ges. Wien 1: 442, 1900.

On *Prangos pabularia* Lindl. (Apiaceae).

Sivas. 32 km from Gürün to Pınarbaşı, 1800 m, 06. Jun. 1997, Z. Bahcecioglu 1686 m, I+III.

Pycnia not seen. Aecia epiphyllous in long groups, peridial cells rhomboid, 23-39 x 15-20 μm, inner walls verrucose, outer walls smooth, both 6-6.5 μm thick. Aeciospores 21-35 x 19-25 μm, ellipsoid or subgloboid, walls less than 1 μm thick, densely verruculose, hyaline. Telia epiphyllous, round or oblong, often confluent or connected with the aecia, dark brown. Teliospores 56-72 x (23-)28-35 μm, clavoid, somewhat constricted at septum, walls about 1 μm thick, apically thickened up to 11 μm, apically rounded or truncate, reddish brown or brown, basically yellowish brown, smooth, upper pore apical, lower pore obscure. Pedicels tinted, short. One-celled spores occur.

The rust is known from Greece and Lebanon east to Kazakhstan. Lindroth (1902) made the first record of this rust in Turkey on *P. uechtritzii* Boiss. & Hausskn. Henderson (1959, 1964) added *P. ferulacea* Lindl., *P. lophoptera* Boiss. and also *Peucedanum pisidicum* Boiss. *P. pabularia* is a new host for this rust.

Puccinia onosmaticola Gjærum & Bahcecioglu, *sp. nov.* (Fig. 3).

Etymology: from *Onosma*, a genus in Boraginaceae.

Pycnia, aecidia et uredinia ignota. Telia hypophylla, dispersa, parva, pulverulenta, brunnea. Teliosporae 22-34(-39) x 17-22 μm, ellipsoideae, ad basem raro attenuatae, pariete 3-4 μm crasso, laeve, brunneo, poro superiore subapicali, poro inferiore aequatorio instructis, pedicello brevi, pariete tenui, leviter tinto.

Pycnia, aecia and uredinia not seen. Telia hypophyllous, scattered, small, pulverulent, brown. Teliospores 22-34(-39) x 17-22 μm, ellipsoid, rarely obovoid, rounded at both ends or rarely attenuate at the base, walls 3-4 μm thick, smooth, brown, upper pore subapical, lower equatorial. Pedicels short, slightly tinted.

Holotype: Z. Bahcecioglu 2054 (Inönü), Turkey, Sivas, Gürün, Gökpınar, 1500 m, 18. Jul. 1998, on *Onosma molle* DC. (Boraginaceae). Isotype in NCRI.

The teliospores of this species are shorter with evenly thick walls and the lower pore equatorial while teliospores in *P. onosmatis* Gjærum & Bahcecioglu are thickened apically and with the lower pore near septum.

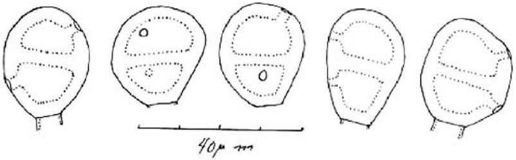

Fig. 3. *Puccinia onosmaticola*. Teliospores from type.

Puccinia pulvinata Rabenh. – Hedwigia 10: 20, 1871.

On *Echinops ritro* L. (Asteraceae).
Sivas. Gürün, Suğul valley, 1400 m, 02. Oct. 2002, Z. Bahcecioglu 3426, II+III.
On *Echinops* sp.
Anamur. Between Anamur and Gazipasa, 50 m, 28. May. 2000, Z. Bahcecioglu 2673, (II+)III.

Uredinia hypophyllous, yellowish brown. Urediniospores 37-45 x 34-39 μm, subgloboid, walls 2-3 μm thick, yellowish brown, apically thickened up to 4.5 μm, at the base up to 4 μm, echinulate, 3-4 equatorial pores covered by wide, hyaline papillae. Telia amphigenous, pulverulent, dark brown. Teliospores 50-63 x 31-39 μm, ellipsoid or ovoid, walls 2-4(-4.5) μm thick, apically thickened up to 5.5 μm, brown, paler above the apical pore, lower pore equatorial, very finely verruculose, easiest to see on dry spores. Pedicels at least up to 130 μm long, in the literature given up to 190 μm (Kapsanaki-Gotsi 1986). One-celled spores occur.

P. pulvinata has been reported scattered from Morocco and Algeria east to Iran and Pakistan. From Turkey it has been reported on *E. heldreichii* Boiss. (Magnus 1903) and on *E. viscosus* DC. (Henderson 1964). *E. ritro* seems to be a new host for this rust species. Other Turkish hosts are *Jurinea depressa* C. A. Mey. var. *pinnatiseta* Boiss. and *J. pontica* Hausskn. & Freyn. (Henderson op. cit.) and *Acantholepis orientalis* Less. (Gjærum 1996).

Puccinia recondita Roberge ex Desm. – Bull. Soc. bot. Fr. 4: 798, 1857.

On *Cerinthe minor* L. (Boraginaceae).

Sivas. Taşlıdere, 1300 m, 03. Jun. 1997, Z. Bahcecioglu 1531, 0+I.

On *Myosatis lithospermifolia* (willd.) Hornem. (Boraginaceae).

Sivas. Divriği, Höbek village, 1300 m, 02.06.1997, Z. Bahcecioglu 1484, 0+I.

Pycnia epiphyllous, type 4, and aecia in groups around the pycnia, peridia white, peridial cells 35 x 10-20 μm, outer walls 8-10 μm thick, striate, inner walls 2-3 μm, verrucose. Aeciospores 25-33 x 21-29 μm, subgloboid, ovoid or ellipsoid, often somewhat angular, walls hyaline, c 1 μm thick, finely verrucose, pores scattered, obscure.

These aecial stages most likely belong to the aggregate species *P. recondita* which has its aecial stage on species of different genera of Boraginaceae, Balsaminaceae, Hydrophyllaceae and Ranunculaceae. From Turkey it has been reported as *Aecidium asperifolii* Pers. under *P. rubigo-vera* (DC.) Winter on *Nonnea macrocarpa* Boiss. & Heldr. and on *Anchusa angustissima* C. Koch by Magnus (1891) and as *P. agropyri* Ell. & Ev. on *Clematis cirrhosa* L. by Bremer et al. (1952). Henderson (1959, 1964) reported it as *A. asperifolii* on *Moltkia caerulea* (Willd.) Lehm. and under *P. recondita* on *Clematis orientalis* L. If belonging to *P. recondita* s. lat. *Cerinthe* and *Myosotis* are new host genera for this rust in Turkey.

Puccinia serpylli Lindr. – Acta Soc. Fauna Flora Fennica 26: 10, 1904.

On *Thymus fallax* Fisch. & Mey. (Lamiaceae).

Ağrı. Eleskirt, Tahir mountain, 2400 m, 21.Jul..2000, B. Yildiz 14853, III; Bitlis. Tatvan, Nemrut mountain, 1750 m. 17.Jul. 2000, B. Yildiz 14802 , III.

On *Thymus fedtschenkoi* Ronninger.

Bitlis. Tatvan, Nemrut mountain, 1750 m, 17. Jul. 2000, B. Yildiz 14796, III.

On *Thymus kotschyanus* Boiss. & Hohen.

Bitlis. Tatvan, Nemrut mountain, 1750 m, 17. Jul. 2000, B. Yildiz 14801, III.

Telia hypophyllous, blackish brown, round or ellipsoid, scattered or in small groups, pulverulent. Teliospores 39-53 x 22-29 μm, ellipsoid or obovoid, mostly rounded apically, constricted at septum, walls 1-1.5 μm thick, apically thickened up to 8 μm, smooth, brown. Pedicels up to 115 μm long, thin-walled, hyaline but tinted near the spore, persistent.

P. serpylli is microcyclic. It has been found scattered on a few species of *Thymus* from Finland and Kola in Russia to Mongolia. Henderson (1959) reported it on *P. kotschyanus* from Turkey, and it has also been reported on the same host from Iran (Petrak 1953). *T. fallax* is a new host for the rust.

Henderson (op. cit.) pointed out the similarity to *P. stipina* Tranz. f. sp. *thymi-stipae* Kleb. and indicated it might has been derived from this longcyclic species, alternating between *Thymus* (0+I) and *Stipa* (II+III).

Puccinia stipae Arthur var. stipina (Tranzschel) H. C. Green & Cummins. – Mycologia 50: 21, 1958.

Syn. *Puccinia stipina* Tranzschel – Trav. Mus. Bot. Acad. Imp. Sci. St. Petersb. 7: 114, 1909 (nom. nud).

On *Thymus kotschyanus* Boiss. & Hohen. (Lamiaceae).

Malatya. Arapkir road, Karayaollari bakımevi, 26. Jun. 1999, 1100 m, B. Yildiz 14356, I.

Pycnia amphigenous, type 4. Aecia hypophyllous, in dense groups. Peridia white, long, peridial cells polygonal, 20-40 x 10-12 μm, outer walls up to 8 μm thick, striate, inner walls up to 2 μm, verrucose. Aeciospores 21-27 x 16-19 μm, subgloboid, oblong or ellipsoid, often irregular, walls 1.5-2.5(-4) μm thick, sometimes unevenly thickened, verrucolose, yellowish brown, pores obscure.

P. menthae Pers. has also been reported with aecia on *Thymus,* but its aeciospore-walls are hyaline.

This taxon is host-alternating between species of *Stipa* (II+III) and species of many lamiaceous genera. On *Thymus* spp. the aecial stage is fairly common in Central and South Europe, but it seems to be very rare in Asia, reported only from Kazakhstan. Tamer et al. (1990) and Güven & Tamer (1993) published it from Turkey. *T. kotschyanus* is a new host for this taxon.

Puccinia tepperi F. Ludw. – Zeitschr. Pflanzenkr. 2: 132, 1892.

On *Phragmites australis* (Cav.) Trin. ex Steudel. (*Poaceae).*

Malatya. 15 km from Malatya to Sivas, 900 m, 19. Jun. 2002, Z. Bahcecioglu 3332, III.

Telia amphigenous, confluent, densely covering large areas of the leaves, brown. Teliospores 43-70 x 21-26(-30) μm, obovoid, ellipsoid or more rarely fusiform, slightly constricted, walls 2.5-4.5 μm, apically thickened to 8.5 μm, yellowish brown, apically paler, smooth, upper pore apical, the lower near septum. Pedicels persistent, thick-walled, not collapsing, up to 220 μm long. It differs from *P. moriokaensis* S. Ito and *P. invenusta* P. Syd. & Syd. on the same host, respectively, wider and longer teliospores.

P. tepperi is macroscopically separated from other species of *Puccinia* on *Phragmites* as the teliospores are confluent in large, compact groups adaxially on the leaves.

This fungus is so far known only from to the type locality, Grange in South Australia. Cummins (1971) when examining the type (S), found two urediniospores. We have seen none.

Trachyspora intrusa (Grev.) Arthur. – Manual of the rusts in United States and Canada, p. 97, 1934.

On *Alchemilla barbatiflora* Juzep. (*Rosaceae*).

Gümüşhane. Zigana Pass, 1600 m, 12. Aug. 2001, Z. Bahcecioglu 3215, III.

On *Alchemilla mollis* (Buser) Rothm.

Sivas. Şerefiye, Armutcayırı village, 1500 m, 16. Aug. 2002, Z. Bahcecioglu 3343, III.

Telia hypophyllous, sori small, surrounded by the epidermis, often confluent, brown. Teliospores 23-35(-43) x (18-)22-27 µm, globoid, obovoid or oblong, walls 2-2.5 µm thick, upper part coarsely verrucose, lower part smooth or nearly so, brown. Pedicels hyaline, 1-septate, upper cells shorter than the lower ones, deciduous.

This rust is widespread in the northern hemisphere. From Turkey it has previously been reported as *T. alchemillae* (Pers.) Fuckel on *A. acutiloba* Stev. by Maire (1906) and as *Uromyces alchemillae* (Pers.) Fuckel on *A.. vulgaris* L. by Magnus (1891). As *A. intrusa* it was published by Henderson (1964) on *A. vulgaris* L. agg., by Tamer et al. (1989) on *A. pseudo-castalini* Juzep. and Bahcecioglu (2004) on *A. holocycla* Rothm.

Uromyces dorystoechadis Gjærum & Bahcecioglu, *sp. nov.* (Fig. 4).

Etymology: from *Dorystoechas*, a genus in *Lamiaceae*.

Pycnia, aecidia et uredinia ignota. Telia hypophylla, parva, dispersa, fusca. Teliosporae 28-31 x 27-30 µm, globoideae, subgloboideae, ellipsoideae vel globoideae-angulares, pariete 3.5-4 µm crasso, fusco, laeve, poro apicalis. Pedicella usque ad 240 µm longi, hyalini.

Pycnia, aecia and uredinia not seen. Telia hypophyllous, small, scattered, dark brown. Teliospores 28-31 x 27-30 µm, globoid, subgloboid or ellipsoid, rarely globoid-angular. Walls evenly 3.5-4 µm thick, dark brown, smooth, pore apical. Pedicels up to 240 µm long, hyaline.

Holotype: Zeliha Bahcecioglu 2892b (Inönü), Turkey, Antalya, Kemer – Göymük, Değirmendere, 50 m, 29. May. 2000, on *Dorystoechas hastata* Boiss. & Heldr. ex Benth. (Lamiaceae). Isotype in NCRI.

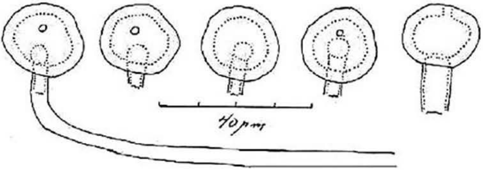

Fig. 4. *Uromyces dorystoechadis* Teliospores from typ.

To our knowledge no rust has previously been described on this genus. It differs from other *Uromyces* species on lamiaceous hosts having teliospores with evenly thickened walls, the others are thickened apically.

Uromyces fallens (Arthur) Kern ex Barth. – Handb. N. Amer. Ured. p. 61,1928.

On *Trifolium pratense* L. (*Fabaceae*).

Gümüşhane. Zigana Pass, 1600 m, 12. Aug. .2001, Z. Bahcecioglu 3221a, II.

Uredinia amphigenous, round, coalescent, brown. Urediniospores (17-)22-30 x 20-24 μm, subgloboid, ellipsoid, obovoid, often somewhat irregular, walls (1.5-)2-2.5 thick, yellowish brown, 3-5(-6) pores scattered or 2-4 equatorial and one apical, echinulate.

This rust is widespread, occurring on many species of *Trifolium*, but seems to be new to the rust flora of Turkey. Cummins (1977) recognized it as a variety of *Uromyces trifolii-repentis* Liro, *U. trifolii-repentis* var. *fallens* (Arthur) Cummins.

Uromyces punctatus J. Schröt. – Abh. Schles. Ges. Vaterl. Cult. Nat. Abh. 1869-72, 1870.

On *Astragalus densifolius* Lam. (*Fabaceae*).

Erzincan. Kemaliye, Sırakonaklar village, 1600 m, 24. Jun. .2000, Z. Bahcecioglu 2942, III.

Uredinia mostly epiphyllous, round or oblong, on stems in long streaks, pale brown. Urediniospores 22-29 x 20-23 μm, obovoid, subgloboid, often angular, walls 1.5-2 μm thick, pale brown with 3-4 pores , when 3 often equatorial, with low, hyaline papillae, echinulate. Telia as the uredinia, but blackish brown. Teliospores 21-28 x 17-20 μm, ellipsoid, obovoid or somewhat irregular, walls 1-1.5 μm, dark brown, verrucose, verrucae often in lines, pore apical, often with a low, hyaline papilla. Pedicels short, hyaline, deciduous.

U. punctatus has been recorded on more than one hundred species of *Astragalus* (Gjærum 1991) and occurs also on species of *Oxytropis*. *A. densifolius* is a new host for this taxon which is often recognized as a race of *U. pisi* (DC.) Otth (cfr. Henderson 1964). Henderson (1961) reported this rust on *A. gummifer* Lab. and *A. sp.* from Turkey.

Uromyces scleranthi Rostr. – Bot. Tidsskr. 21: 40, 1897.

Syn. *Urom. alsines* Tranzschel. – Ann. Mycol. 5: 547, 1907.

On *Minuartia hamata* (Hausskn.) Mattf. (Caryophyllaceae).

Malatya. 10 km from Malatya to Arapkir, 1600 m, 24. Jun. 2000, Z. Bahcecioglu 2910, III.

Telia hypophyllous, blackish brown. Teliospores 20-25 x 15-21 μm, subgloboid, ellipsoid or obovoid, often somewhat irregular, walls 1.5-2 μm thick, pale brown, apically slightly thickened with a wide, hyaline cap over the apical pore, finely verrucose. Pedicels hyaline, deciduous.

The size of the teliospores in this specimen corresponds fairly well to what is given in the diagnosis, but they have slightly thinner walls.

On species of *Minuartia (Alsine)* this rust has been reported from Bulgaria, Russia (Crimea) and Iran. Bahcecioglu (2001) reported it from Turkey on *M. meyeri* (Boiss.) Born. and *M. hamata*. On *Scleranthus* spp. it has been reported from Denmark, France, Hungary, Russia and Australia.

Zaghouania phillyreae Pat. – Bull. Soc. Myc. Fr. 17: 187, 1901.

On *Phillyrea latifolia* L. *(Oleaceae)*.

Antalya. 3 km from Antalya to Gebiz, 100 m, 22. May. 2000, Z. Bahcecioglu 2687, I.

Pycnia not seen. Aecia on stems, amphigenous on malformed, thickened leaves, pustulate, covered by epidermis, orange, peridium short. Aeciospores 18-25 x 15-19 μm, subgloboid or ellipsoid, walls 2-2.5 μm thick, hyaline, alveolate-reticulate.

Z. phillyreae has been reported on *Phillyrea* in South England (cult.) and in the Mediterranean from Morocco, Algeria and Portugal to Israel. On species of *Osmanthus* it has been reported from China and Japan. Zaghouania is a new genus in the Turkish rust flora.

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A new species of *Pseudobaeospora* from California

DENNIS E. DESJARDIN

ded@sfsu.edu
Department of Biology, San Francisco State University
1600 Holloway Ave., San Francisco, CA 94132 USA

Abstract – *Pseudobaeospora stevensii* sp. nov. is described from cypress and redwood forests in northern California. Diagnostic features include dark brown basidiomes lacking violet colors, conspicuous cheilocystidia, clamp connections, and tissues that turn olive to grass green or bluish green in alkaline solution. Notes on type studies of several temperate North American species referable to *Pseudobaeospora* are provided.

Key words – agarics, Basidiomycetes, taxonomy

Introduction

The genus *Pseudobaeospora* was established by Singer (1942, 1963) to accommodate *Baeospora oligophylla* Singer, a small, violet species described from the Altai Mountains of central Asia (Singer 1938). Since then, numerous species have been described in or transferred to *Pseudobaeospora*. The generic circumscription was redefined recently by Bas (2002, 2003), wherein he provided a key, full descriptions and illustrations of all known European species. Very few species attributable to *Pseudobaeospora* have been described or reported from temperate North America, and a critical study of North American taxa has not been published. It should be noted that all reported North American *Pseudobaeospora* form violet-colored basidiomes that do not discolor (red, green, blue or yellow-green) in KOH solution.

Recently, an undescribed species with basidiomes that lack violet or purple colors and that turn olive to grass green or bluish green in KOH solution was discovered in northern California, USA. The new species is associated with Monterey cypress (*Cupressus macrocarpa* Hartw. ex Gord.) and redwood (*Sequoia sempervirens* (D. Don) Endl.), two tree species endemic to coastal California. The species is described below and compared with phenetically similar taxa. Color terms and notations are from Kornerup and Wanscher (1978). Spore statistics include: x, the arithmetic mean of the spore length by spore width (± SD) for n spores measured; Q, the quotient of spore length and spore width in any one spore, indicated as a range of variation in n spores measured; Q_m, the mean of Q values.

Pseudobaeospora stevensii Desjardin sp. nov. Figures 1-7

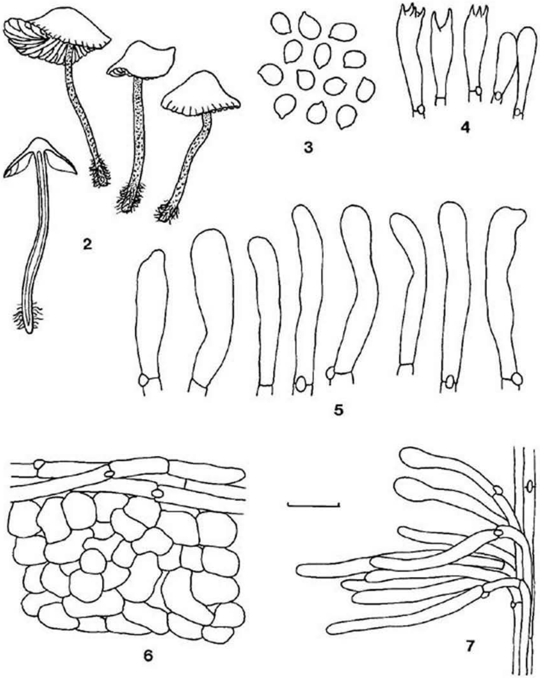
Pileus 4-20(-26) mm latus, obtuse conicus vel campanulatus, siccus, glabrus vel subrugosus, brunneus vel obscure castaneus, 3% KOH ope azureo-viridis. Lamellae subliberae, angustae, brunneae vel pallide aurantiobrunneae. Stipes 20-35 X 1-3 mm, cylindricus, siccus, apicaliter ex furfuraceo scabrosus, basin versus squamulis brunneis vel aurantiogriseis instructus, basaliter albidulostrigosus. Colores violacei desunt. Basidiosporae 3.2-4 X 2.8-3.2 µm, ovoideae, subglobosae vel late ellipsoideae, leves, hyalinae vel pallide stramineae (in aqua), forte dextrinoideae, haud metachromaticae, membrana subincrassata instructae. Basidia 4 spora. Cheilocystidia 27-38 X 3.5-8 µm, cylindrica vel clavata, hyalina, tenuitunicata. Pleurocystidia nulla. Pileipellis ex hyphis cylindricis appressisque, 3-8(-10) µm diam. cutem formantibus, haud gelatinosis, membrana dextrinoidea, hyalina vel brunnea (pigmento intraparietali vel incrustato) instructis. Hypodermium subcellulare, haud gelatinosum. Caulocystidia 40-80 X 4-7 µm, cylindrica vel clavata. Fibulae praesentes. Caro 3% KOH ope olivacea vel azureo-viridis. Ad frustula dejecta sub Cupresso et Sequoiae. USA (California). Holotypus hic designatus: A.W. Wilson #133 (SFSU).

Etymology: Named in honor of Fred Stevens who discovered the new species and who has been instrumental in documenting the fleshy fungi of California.

Pileus (Figs. 1-2) 4-20(-26) mm diam, obtusely conical to campanulate, sometimes broadly campanulate at maturity with uplifted margins; margin even to striate or short-sulcate in age; surface dry, glabrous, smooth to wrinkled; when young disc dark brown to dark reddish brown (8-10F5-7) with a slightly paler reddish brown margin (8-9D5-7), in age becoming paler overall to light brown (7D5-6) or retaining a dark brown margin (5-8F8), lacking any violet or lavender tones; drying dark brown (7F5-8) overall; 3% KOH on pileus surface turning bluish green. **Context** 0.5-1 mm thick, pallid. Odor fungal. Taste slightly acrid and peppery. **Lamellae** subfree, close with 3-4 series of lamellulae, broad (3-4.5 mm), convex to ventricose, brownish orange (7C5) to brown (7D4-5), lacking violet or lavender tones; drying brown (7D-E5). **Stipe** 20-35 X 1-3 mm, central, cylindrical, fistulose, dry, apex furfuraceous to scabrous, squamulose elsewhere, base covered with long, strigose, off-white to pale orangish white (5-6A-B2) hairs; apex brown (7E7-8), base dark brown (7F7-8), with greyish orange (6B3) to pale brownish grey (6C3) squamules.

FIG. 1. Basidiomes of *Pseudobaeospora stevensii* (AWW 133– Holotype). Scale: Twice natural size. A color photograph of this specimen may be viewed at www.mykoweb.com.

Basidiospores (Fig. 3) 3.2-4 X 2.8-3.2 μm [x = 3.45 ± 0.26 X 3.0 ± 0.1 μm, Q = 1.1-1.3, Q_m = 1.14 ± 0.08, n = 25 spores), ovoid to subglobose or broadly ellipsoid with an eccentric hilar appendage, smooth, hyaline to pale yellow in H_2O, strongly dextrinoid, non-metachromatic, with relatively thick walls. **Basidia** (Fig. 4) 16-20 X 4.5-5 μm, clavate, 4-spored, rarely 2-spored, clamped. **Basidioles** (Fig. 4) clavate. **Cheilocystidia** (Fig. 5) common, lamellar edge sterile or heteromorphous with clusters of cheilocystidia, 27-38 X 3.5-8 μm, cylindrical to narrowly clavate or irregular in outline, hyaline, thin-walled, greenish in 3% KOH. **Pleurocystidia** absent. **Pileipellis** (Fig. 6) two-layered: suprapellis a thin (up to 30 μm thick) cutis of appressed, radially arranged, cylindrical hyphae 3-8(-10) μm diam, with repent to erect, cylindrical to clavate or fusoid terminal cells; walls non-gelatinous, dextrinoid, hyaline to brown in H_2O and 3% KOH; pigment intraparietal and incrusting; suprapellis overlaying a well-developed subpellis. **Subpellis** (Fig. 6) composed of inflated to irregular or puzzle-like hyphae (subcellular) 6-24 μm diam, forming a layer up to 100 μm thick; hyphae non-gelatinous, dextrinoid, hyaline to pale yellowish brown in H_2O, olive to grass green or bluish green in 3% KOH, pigment intraparietal. **Pileus trama** of interwoven, elongated, cylindrical hyphae 2.5-6 μm diam, non-gelatinous, weakly dextrinoid, hyaline to yellow in H_2O, vaguely green in 3% KOH.



FIGS. 2-7. *Pseudobaeospora stevensii* (AWW 133– Holotype). 2. Basidiomes. 3. Basidiospores. 4. Basidia and basidioles. 5. Cheilocystidia. 6. Pileipellis and hypodermium. 7. Caulocystidia. Scale bar: 2 = 10 mm; 3-5 = 10 μm; 6-7 = 20 μm.

Hymenophoral trama regular; hyphae 3-9 µm diam, similar to those in pileus trama. **Stipe tissues** monomitic. **Stipitipellis** a cutis of repent hyphae with clusters of erect caulocystidia; cortical hyphae 2.5-4 µm diam, non-gelatinous, dextrinoid, hyaline to pale brown in H_2O, olive to green in 3% KOH; medullary hyphae 2.5-10 µm diam, similar to cortical hyphae. **Caulocystidia** (Fig. 7) common, 40-80 X 4-7 µm, cylindrical to narrowly clavate, similar to the cheilocystidia, hyaline, thin-walled. **Clamp connections** present in all tissues.

Habit, habitat and distribution – Scattered to gregarious in leaf litter under Monterey cypress (*Cupressus macrocarpa*) or rarely under redwood (*Sequoia sempervirens*). Aug.-Dec. California.

> **SPECIMENS EXAMINED** – UNITED STATES. CALIFORNIA: Marin Co., Audubon Canyon Ranch, Galloway Canyon, 11 Dec. 1979, *C. Calhoun 79-1255*. San Mateo Co., San Bruno, Skyline College campus, 1 Sept. 2001, coll. by F. Stevens, *AWW 133* (Holotype); same location, 26 Aug. 2001, *Stevens 8-26-01*; same location, 10 Sept. 2001, *Stevens 9-10-01*. All specimens deposited in SFSU.

Commentary – *Pseudobaeospora stevensii* is characterized by basidiomes that are dark brown overall (lacking any violet, lilac or lavender colors), and have very small, dextrinoid basidiospores, a two-layered pileipellis (with filamentous suprapellis and subcellular subpellis), 4-spored basidia, conspicuous narrowly clavate cheilocystidia and caulocystidia, and abundant clamp connections. It has been collected only in association with cypress and redwood in California. Within the genus *Pseudobaeospora*, the new species is unusual in forming dark brown basidiomes with tissues that turn olive to grass green or bluish green in 3% KOH. This microchemical reaction is reminiscent of that exhibited by a number of *Gymnopus* species allied with *G. alkalivirens* (Singer) Halling (cf. Halling 1979, 1981, 1990), and *Leucoagaricus* species (E. Vellinga, pers. comm.). Bas (2002, 2003) reports five other alkaline-virescent species of *Pseudobaeospora*; *viz*., *P. dichroa* Bas, *P. pallidifolia* Bas, A. Gennari & Robich, *P. pyrifera* Bas & L.G. Krieglst., *P. jamonii* Bas, Lalli & Lonati, and *P. mutabilis* Adamcík & Bas. The latter five species differ from *P. stevensii* by the following features. *Pseudobaeospora dichroa* differs in forming basidiomes with purplish brown to violet pilei and lamellae, lacks the two-layered pileipellis, and more importantly has a KOH reaction that is initially red, fading to yellowish green in time (Bas 2002, 2003). *Pseudobaeospora pallidifolia* differs in forming violet brown pilei with white to pinkish cream lamellae, larger basidiospores (4.5-6 X 3-4.5 µm), lacks cheilocystidia and lacks the two-layered pileipellis (Bas et al. 1997; Bas 2003). *Pseudobaeospora pyrifera* differs in forming dark purplish to vinaceous brown or pinkish brown pilei, reddish violaceous lamellae, a dark reddish brown stipe, has broader cheilocystidia (up to 13 µm diam.), and also lacks the two-layered pileipellis (Bas and Krieglsteiner 1998; Bas 2003). *Pseudobaeospora jamonii*, shares with *P. stevensii* the two-layered pileipellis, narrowly clavate cheilocystidia and small basidiospores, but differs significantly in forming greyish purple to violaceous brown pilei, lilac to yellowish grey lamellae, a lilac to purplish brown stipe, has a paler green KOH reaction, and is associated with *Alnus*, *Fraxinus*, *Fagus*, *Corylus* and *Picea* (Bas et al. 2002; Bas 2003). *Pseudobaeospora jamonii* is known at present only from northwestern and central Italy. *Pseudobaeospora mutabilis* differs in forming dark violaceous grey-brown pilei with pinkish grey margins, violet lamellae, broadly clavate cheilocystidia 7-11(-18) µm in diam., and a hymeniform pileipellis of erect chains of inflated cells. The latter species is associated with *Molinia*, *Frangula* and *Betula* and is known at present only from the type locality in Slovakia (Adamcík and Bas 2002; Bas 2003).

Notes on North American *Pseudobaeospora* – Few species of *Pseudobaeospora* have been reported from temperate North America. Coker (1929) reported *Prunulus syringeus* Murrill from North Carolina. It was described originally from Jamaica, and is now known as *Pseudobaeospora murrillii* E. Horak (1964; a new name, non *Pseudobaeospora syringea* Singer). Smith (1947) mentioned this species (as *Mycena syringea* (Murrill) Murrill) and suggested that it was similar to *Tricholoma microsporum* Ellis, which he collected in Michigan, New York, Ontario and California. Although Smith studied the type specimen of *Pr. syringeus* (NY), the holotype packet is now empty so I was unable to obtain any microscopic data (pers. obs.). I have collected numerous specimens of what Coker (1929) called *Pr. syringeus* from North Carolina, Tennessee and other areas in the Appalachian Mts., and the latter species forms deep violet basidiomes with abundant clamp connections, no cheilocystidia, has a cutis-type pileipellis of hyphae 5-12 µm diam, lacks a subcellular hypodermium, and does not discolor in KOH. Whether this is the same species as that from Jamaica cannot be determined at present. The type of *Tricholoma microsporum* was distributed as part of the Ellis and Everhart, North American Fungi Exsiccata, as #2003, from Newfield, New Jersey. I have studied several representative specimens (K, NY, SFSU) and this species forms violet basidiomes with a thin cutis-type pileipellis that overlays a subcellular hypodermium, has dextrinoid basidiospores 4-5 X 3.5-4.5 µm, lacks cheilocystidia, lacks clamp connections, and does not discolor in KOH. Clearly, it is distinct from *Pr. syringeus* sensu Coker.

Agaricus fuscolilacinus Peck (1886) was described from the Adirondack Mts. of New York, and was reported to form watery-brown to lilac-brown, glabrous pilei, close, adnexed, brownish lamellae, and a brown stipe with pruinose apex and white, villose hairs at the base. An analysis of the holotype specimen (NYS!) revealed the following features: *Basidiospores* 4.2-6.8 X 3.2-4 µm [x = 5.2 ± 0.6 X 3.5 ± 0.2 µm, Q = 1.2-2, Q_m = 1.5 ± 0.2, n = 30], ellipsoid to lacrymoid, thick-walled, smooth, inamyloid to weakly dextrinoid. *Basidia* 16-20 X 4-5 µm, 2-spored. *Cheilocystidia* absent. *Pileipellis* a hymeniform layer of broadly clavate cells 12-26 X 7-14 µm, sometimes in chains, thin-walled, subhyaline to pale ochraceous in KOH, inamyloid. *Tramal hyphae* 4-12 µm diam, hyaline, inamyloid, thin-walled, non-gelatinous. *Stipe vesture* a tangled layer of hyaline to pale yellow hyphae 2-5 μm diam, cylindrical, inamyloid, with a few erect, cylindrical to vesiculose caulocystidia. *Clamp connections* present. This species belongs in *Pseudobaeospora* where it is allied with *P. mutabilis*. A formal transfer will not be made until more specimens from the Adirondack Mts. referable to *A. fuscolilacinus* are collected for comparison. The latter species differs from *P. stevensii* in forming larger basidiospores on 2-spored basidia, in lacking cheilocystidia, and in lacking a two-layered pileipellis.

Pseudobaeospora pillodii (Quél.) Wasser was reported from British Columbia, Canada by Redhead (1982). Bas (2003) suggested that Redhead's material may represent *P. oligophylla* (Singer) Singer, a species accepted by Redhead as a synonym of *P. pillodii*. These two taxa differ only subtly in pileipellis anatomy. Nonetheless, both taxa are quite distinct from *P. stevensii* in forming lilac to purple basidiomes that lack cheilocystidia, lack clamp connections, and do not discolor to green in KOH.

Acknowledgments

I would like to thank Dr. Fred Stevens for bringing this new species to my attention and for all of his fine contributions to mycology in California. I thank Andrew Wilson for taking notes on fresh material of the holotype specimen, Dr. Egon Horak for correcting the Latin diagnosis, and Dr. Else Vellinga and Brian Perry for reviewing the manuscript and for providing helpful comments and obscure literature.

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Les pycnides et conidies de *Lecanora vaenskaei* (lichens, *Lecanoraceae*)

Claude Roux

claude.roux21@wanadoo.fr

CNRS, UPRES A 6116, Laboratoire de botanique et écologie méditerranéenne,
Institut méditerranéen d'écologie et de paléoécologie,
Faculté des sciences et techniques de Saint-Jérôme,
FR—13397 Marseille cedex 20, France.

Résumé—La découverte de pycnides sur un spécimen de *Lecanora vaenskaei* permet de compléter la description de cette espèce et de confirmer sa position systématique. Elle est comparée avec les espèces voisines, plus particulièrement *L. achariana*.

Abstract— Discovery of pycnidia on a specimen of *Lecanora vaenskaei* confirms its systematic position. The species description is emended, and the species is compared to related species, especially *L. achariana*.

Resumo—La malkovro de piknidioj en specimeno de *Lecanora vaenskaei* ebligas kompletigi la priskribon de tiu–chi specio kaj konfirmi ties sistematikan lokon. Komparo kun la parencaj specioj, pli speciale *L. achariana*.

Introduction

Lecanora vaenskaei Cl. Roux et Clother Coste, décrit par Roux et al. (1993), est un *Lecanora* saxicole-calcifuge du sud-est méditerranéen français caractérisé par un thalle épilithique vert-jaune clair, formé de granules se transformant en petites squamules ombiliquées courtement lobées, à cortex supérieur et cortex inférieur, et contenant de l'acide usnique et de la zéorine. Les apothécies qui se forment à l'extrémité des lobes des squamules sont typiquement lécanorines et nettement resserrées à la base ou même courtement pédonculées. Par la structure de ses apothécies, *Lecanora vaenskaei* appartient bien aux Lecanoraceae, tout comme des espèces voisines (*L. chaffiniana* Houmeau et Cl. Roux, *L. chlorophaeodes* Nyl., *L. weberi* Ryan) et les *Rhizoplaca* (Roux et al. 1993).

Quoique très détaillée et richement illustrée, la description originale de *L. vaenskaei* est incomplète, puisque ses auteurs n'avaient pas observé de pycnides. Or, en réexaminant un spécimen (Roux n° 21429), j'ai eu la chance d'y découvrir quelques pycnides typiques, riches en conidies, dont l'observation microscopique a permis de compléter la description de l'espèce et de confirmer sa position systématique. Ce spécimen est choisi comme épitype.

Méthodes

Les coupes et préparations microscopiques ont été réalisées à main levée et observées dans l'eau et le bleu coton au lactophénol, avec un microscope photonique (grandissement maximal de × 1500) muni d'un dispositif de contraste interférentiel. Les dessins ont été réalisés avec l'aide d'un tube à dessin. Le seul spécimen disponible étant ancien, les mesures ont été effectuées dans l'eau, sur du matériel mort.

Lecanora vaenskaei Cl. Roux et Clother Coste

in Roux, Coste, Ménard, Bellemère et Bricaud, *Can. J. Bot.*, **71:** 1660-1671 (1993). France, Provence, Var, Le Muy, la Roquette, 500 mà l'ouest de la chapelle ruinée, sur une surface rocheuse de brèche non calcaire, périodiquement inondée. Alt. 110 m. 1992/10/29. Holotype MARSSJ; isotypes MARSSJ, GZU, H.

Épitype: France, Provence, Var, Roquebrune-sur-Argens, rocher de Roquebrune, partie E, près du chemin, sur une surface rocheuse de brèche non calcaire. Alt. 60 m. 1992/05/21. MARSSJ, Herbier C. Roux n°21429.

Pycnides complètement enfoncées dans le thalle (situées dans la couche algale), entièrement incolores, subglobuleuses, d'environ 0,25–0,3 × 0,2–0,25 mm, simples (uniloculaires). Les coupes ne passant pas par l'ostiole celui–ci n'a pu être observé, mais il n'est pas saillant puisque non visible au stéréomicroscope. La pycnide (fig. 1) est délimitée par une mince paroi incolore de 5–10 μm d'épaisseur, formée de deux couches de cellules globuleuses ou subglobuleuses de 3,5–5,5 × 2,5–4,5 μm de diamètre (lumière de 1–2,5 × 1–2 μm), à paroi épaisse (de 1–2 μm). **Conidiophores** simples ou ramifiés, à cellules de 3–10,5 × 2–3 μm (lumière de 2–9,5 × 1–2 μm, paroi d'environ 0,5 μm d'épaisseur), de type exobasidié (portant la ou les cellules conidiogènes à leur ou leurs extrémités distales). **Cellules conidiogènes** (fig. 1 et 2) longuement ampulliformes, de 6,5–11 × 2,5–3,5 μm (lumière de 5–9,5 × 1–2 μm, paroi de 0,5–1 μm d'épaisseur). **Conidies** (fig. 3) filiformes, modérément courbes, de (16)18–31 × 1 μm (d'après 16 mesures).

Discussion

L'étude de la morphologie et de la structure des pycnides et des conidies de *L. vaenskaei* confirme la parenté de cette espèce avec les *Lecanora* à thalle squamuleux ou placodiomorphe jaune verdâtre à acide usnique, en particulier *L. achariana* A. L. Sm., *L. chaffiniana*, *L. chlorophaeodes* et *L. dispersoareolata* (Schaer.) Lamy. Dans ce groupe d'espèces, *L. chlorophaeodes* et *L. dispersoareolata* s'éloignent le plus de *L. vaenskaei* par l'absence de cortex inférieur même rudimentaire, tandis que *L. chaffiniana* a une ébauche de cortex (Houmeau et Roux 1988) pigmentée de vert noirâtre et *L. achariana*, tout comme *L. vaenskaei*, un cortex inférieur non pigmenté ou pigmenté de brun rouge ou de rose au contact du support, cortex déjà observé par Harmand

(1913: 926). *L. chaffiniana* se distingue également de *L. achariana* et de *L. vaenskaei* par la présence d'acide gyrophorique et l'absence de zéorine.

Bien que Roux et al. (1993) n'aient pas comparé *L. vaenskaei* avec *L. achariana,* c'est pourtant cette espèce qui a le plus d'affinités avec *L. vaenskaei*, notamment par la structure du thalle, la morphologie et la structure des apothécies, par des conidies (Harmand 1913: 927) d'environ 30 *x* 1 µm et par son écologie (sur des surfaces d'écoulements temporaires). *L. vaenskaei* s'en distingue néanmoins (tableau 1) par un thalle nettement plus adhérent au substrat, d'aspect plus granuleux que squamuleux, à lobes beaucoup plus petits, des apothécies terminales, des spores plus larges et l'absence de triterpénoïdes.

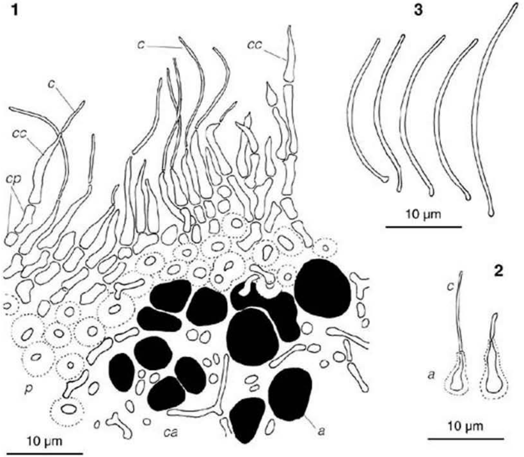

Fig. 1. Structure microscopique de la partie basale d'une pycnide de *Lecanora vaenskaei* d'après une coupe radiale observée dans le bleu coton au lactophénol. *a:* cellule algale; *c:* conidie; *ca:* couche algale (hyphes et cellules algales); *cc:* cellule conidiogène ; *cp*: conidiophore; *p*: paroi de la pycnide formée de deux couches de cellules à paroi épaisse.

Fig. 2. Cellules conidiogènes de *Lecanora vaenskaei,* portant une conidie immature, observées dans le bleu coton au lactophénol. *a:* cellule conidiogène; *c:* conidie.

Fig. 3. Conidies matures de *Lecanora vaenskaei,* observées dans l'eau.

Tableau 1. Caractères distinctifs de *Lecanora vaenskaei* et *L. achariana*

	Lecanora vaenskaei	*Lecanora achariana*
Thalle	nettement adhérent au support, d'aspect plus granuleux que squamuleux, formé de granules ou de petites squamules à lobes de 0,3–0,5 × 0,15–0,3 mm	peu adhérent au support, d'aspect nettement squamuleux, formé de squamules à lobes de 1,5 × 0,5-2 mm
Spores	(9)10-14(17) × 4(4)6-8(9)10 *µ*m	10-15(16) × 4-6 *µ*m
Apothécies	terminales	subterminales
Chimisme	acide usnique, zéorine (Roux et al. 1993)	acide, usnique, zéorine, triterpénoides (Purvis et al. 1992)
Répartition et écologie	région méditerranéenne; étage mésomméditerranéen; thermophile	montagnes d'Europe centrale et septentrionale, de Corse et de Sardaigne; étage montagnard; non thermophile

Spécimen de *Lecanora achariana* examiné: France, Haute-Corse, forêt d'Aïtone, près du foyer de ski de fond, sur une surface subhorizontale de granite très cohérent, soumise à de brefs écoulements périodiques. Alt. 1100 m. 1999/04/19. MARSSJ, Herbier C. Roux (sans numéro).

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Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM, 1992. The lichen flora of Great Britain and Ireland. Natural History Museum Publications et British Lichen Society édit., London, 710 p.

Roux C, Coste C, Ménard T, Bellemère A, Bricaud O, 1993. *Lecanora vaenskaei* Roux et Coste sp. nov. (Lichenes, Ascomycotina), sa position systématique et celle des *Rhizoplaca* (*Lecanorales, Lecanoraceae*). *Can. J. Bot.*, **71:** 1660–1671.

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New and previously unrecorded saxicolous species of *Buellia* s.l. with one-septate ascospores from the Greater Sonoran Desert Region

FRANK BUNGARTZ

bungartz@bsm.mwn.de
Botanische Staatssammlung München
Menzinger Straße 67
D-80638 München, Germany

Abstract—The following species of *Buellia* s.l. from the Greater Sonoran Desert Region are described new to science: *Buellia nashii*, *B. navajoensis*, *B. regineae* and *B. sheardii*. A valid description is provided for *B. lepidastroidea*, a name introduced by Imshaug, but never validly published. *Buellia argillicola* is reported from the Sonoran Region for the first time. A single record of the rare and unusual *B. vilis* is reported from Arizona. *Buellia novomexicana* and *B. fusca* are synonymized with *B. tyrolensis*. Detailed descriptions are provided for all these species. In addition a dichotomous key includes all saxicolous species with one-septate ascospores currently known from the Greater Sonoran Desert Region.

Zusammenfassung–Die folgenden neuen Arten der Sammelgattung *Buellia* s.l. werden aus der Sonoraregion beschrieben: *Buellia nashii*, *B. navajoensis*, *B. regineae* and *B. sheardii*. Eine weitere Art ist *Buellia lepidastroidea*. Diese Art wurde bereits von Imshaug vorgeschlagen, aber nicht gültig publiziert. Sie wird hier erstmals mit einer gültigen Artdiagnose versehen. *Buellia argillicola* wird erstmals aus der Sonoraregion nachgewiesen. Ein Einzelfund der seltenen und ungewöhnlichen Art *B. vilis* wird aus Arizona gemeldet. *Buellia novomexicana* und *B. fusca* werden mit *B. tyrolensis* synonymisiert. Alle diese Arten sind hier detailliert beschrieben. Darüber hinaus ermöglicht ein dichotomer Schlüssel die Bestimmung aller bisher aus der Region bekannten, saxikolen Arten mit zweizelligen Sporen.

Key Words—taxonomy, lichenized ascomycetes, *Physciaceae*, new species, dichotomous key

Introduction

A revision of the saxicolous species of *Buellia* s.l. with one-septate ascospores from the Greater Sonoran Desert Region currently accepts a total of thirty-one species. Several of these species have never been reported from the area or are not yet described. Descriptions of these new species and records are given here. A complete treatment of the genus will be included in the third volume of the Sonoran Desert Lichen Flora (Nash et al. 2002) but a key to all species is published here to allow identification of all species currently known from this region.

The species described here are not necessarily members of what might be considered the core group of *Buellia* De Not. (Bungartz & Nash 2004c). Traditionally specimens, which are related to *Buellia aethalea* (Ach.) Th. Fr. have been associated with *Buellia* s.str. but the current Botanical Code (Greuter et al. 2000) lists *Buellia disciformis* (Fr.) Mudd, a species with distinct characters of *Hafellia* Kalb, H. Mayrhofer & Scheid., as the type. There is currently some discussion to change this typification, but a proposal by Moberg et al. (1999) is not presently accepted. Until the outcome of this proposal is decided, a broad concept of *Buellia* s.l. is therefore adopted. Taxonomic affinities of the species described, are discussed in more detail within brief notes for each species. The genus concept of *Buellia* is currently in a state of much disarray (Eriksson et al. 2002, Nordin 2000) and the question, which genera will ultimately be recognized should best be addressed using molecular tools to evaluate classical data.

Methods

All specimens were examined with light microscopy using hand- and cryosections. Both conventional bright field microscopy (BF) as well as differential interference contrast (DIC) were used. Selected specimens were also studied with transmission electron microscopy (TEM) according to a protocol described in detail by Bungartz et al. (2002). To improve dehydration and infiltration this protocol has been modified according to Bungartz & Nash (2004a).

All specimens were spot tested and routinely examined with standardized thin-layer chromatography (Culberson & Johnson 1982, Culberson & Kristinsson 1970, Orange et al. 2001, White & James 1985). TLC-Plates were interpreted with the computer program WINTABOLITES (Mietzsch et al. 1994), and scanned for permanent record Egan (2001). In addition a subset of specimens was analyzed by Dr. Jack A. Elix from the Australian National University in Canberra using standardized High Performance Liquid Chromatography (HPLC, Feige et al. 1993). Spores measurements are given according to Nordin (2000). Pigment names follow Meyer & Printzen (2000). Detailed specimen information about all collections deposited at ASU is available at: http//seinet.asu.edu/collections/selection.jsp.

Taxonomic Descriptions

Buellia argillicola de Lesd., Ann. Cryptog. Exot. II: 243 (1929) FIGURE 1

Type: MEXICO. México. San Jerónimo. On volcanic rocks (pebbles embedded in soil) [original label data: Estado de Distrito Federal. San Jerónimo, Sobre Piedra], 19°13'30"N, 100°01'30"W, 2598 m alt., Pedro (Pierre) Lyonett *no. 110* (MEXU! – neotype selected here).

Taxonomic note: No type material from the original collections was found. It can be assumed that de Lesdain's holotype collection, originally located in Dunkerque (France), has been destroyed during the Second World War. The specimen selected as a neotype was collected at the type locality and agrees well with the description in the protologue.

THALLUS (Fig. 1A, B)—Crustose, thin, usually growing in distinct circular patches, subeffigurate, several thalli often confluent, epilithic; continuous to rimose with fine fissures; prothallus distinct, delimiting the thallus as a black outline; thallus surface matt and chalky, dull, usually white, rarely gray, heavily pruinose, phenocorticate; entire thallus filled with an abundance of calcium oxalate (H_2SO_4+ forming clusters of needle shaped crystals).

APOTHECIA—Lecideine, (0.3–)0.5–0.8(–1.1) mm in diameter, remaining immersed

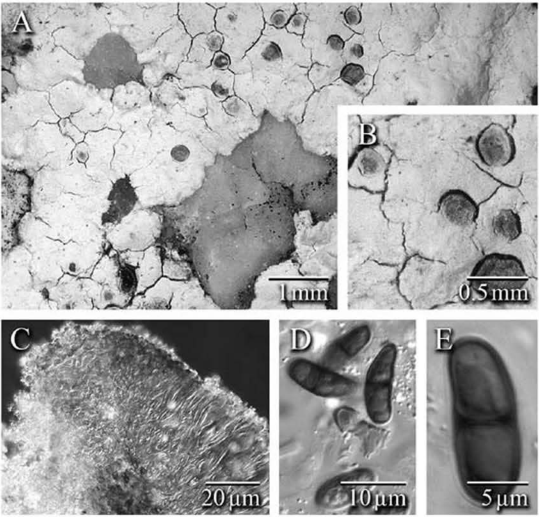

Fig. 1: Light micrographs of *Buellia argillicola* (Nash *12152*).—A. Overview of the rimose thallus.—B. Close-up of the rimose thallus and apothecia.—C. Cross section of the *aethalea*-type exciple.—D. Oblong, ascospores.—E. Ascospore: no septum thickening is present during the spore ontogeny.

to indistinctly adnate; proper margin thick, persistent, not excluded with age, black, usually covered with a dense, fine, white pruina; disc black, plane, not becoming convex with age, usually covered with a dense, fine, white pruina; proper exciple similar to the *aethalea*-type (**Fig. 1C**) *sensu* Scheidegger (1993), i.e. inner exciple almost entirely reduced, hyphae narrow, hyaline, prosoplectenchymatous (*textura oblita*), similar in structure and orientation to the paraphyses, transient with the deep reddish brown hypothecium (*leptoclinoides-brown*, *textura intricata*), outer exciple expanded, globular cells strongly swollen (± *textura oblita*) and moderately carbonized with a brown pigment (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown (cf. *elachista*-brown) pigment cap.

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES** (**Fig. 1D, E**)—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (12.0–)15.0–[16.8]–18.5(–20.0) x (6.0–)6.5–[7.3]–8.1(–9.0) µm ($n = 60$), one-septate, proper septum narrow, not thickening during spore ontogeny, lateral wall thickenings absent [*Beltraminea* (=*Buellia*)-type]; ornamentation rugulate.

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.0–6.5 x 1.0–1.5 µm ($n = 20$).

CHEMISTRY—With the depsidones norstictic, connorstictic, stictic and hypostictic acid and one unknown substance (RF 7, not visible in natural light, UV+ orange). Thallus and medulla K+ faint yellow (yellow solution, but not orange, needle-shaped crystals observed in the microscope), P+ faint yellow, C–, KC–, CK–. UV+ pale white. Thallus and apothecia react amyloid with Lugol's (always test with concentrated Lugol's iodine or in the compound microscope; positive reactions can be very weak!).

SUBSTRATE AND ECOLOGY—The type specimen grows on pebbles embedded in calcareous (HCl+) soil (= *tépetate*), the only known Sonoran specimens grow on limestone (strongly HCl+).

DISTRIBUTION (**Fig. 3**)—Rare, in the Sonoran Desert only known from a single location, originally described from central Mexico.

NOTES—Specimens of *B. argillicola* are superficially similar to *B. subalbula* (Nyl.) Müll. Arg. or *B. venusta* (Körb.) Lettau. The thalli of *B. argillicola* are, however, more continuous and less extensively fissured. Apothecia of *B. argillicola* have a plane disc with a persistent lecideine margin and no thalline collar or veil. Internally the structure resembles the *aethalea*-type but the outer exciple is much more prominent and persistent. Both *B. subalbula* and *B. venusta* have a thin, largely reduced exciple, which usually becomes excluded by the swelling of the disc. In *B. venusta* a thalline collar is common and it can sometimes be present in *B. subalbula*. *Buellia subalbula* is restricted to the coast whereas *B. argillicola* is known from inland localities. *Buellia subalbula* is characterized by a fuscous brown to deeply aeruginose exciple, which always reacts HNO_3+ violet. *Buellia venusta* and *B. argillicola* have no aeruginose exciple pigment. *Buellia venusta* has pluriseptate, *B. argillicola* one-septate ascospores.

REPRESENTATIVE SPECIMEN EXAMINED—MEXICO. **Sinaloa.** Nash *12152* (ASU).

Buellia lepidastroidea Imshaug *ex* Bungartz sp. nov. **FIGURE 2**

Thallus saxicolus, crustaceus, areolatus vel bullato-areolatus, crassus, eburneus, cum hypothallo atero. Apothecia sessilia, lecideina, marginibus propriis exclusis. Excipulum tenuis, fulvum, sine pigmento aeruginoso, carbonaceum. Hymenium interspersum guttae olei. Asci 8-spori. Sporae uniseptae, oblongae vel ellipsoideae, septibus incrassatus, 7–17 x 5-8 µm. Pycnidia urceolata vel globosa. Conidia bacilliformes, 2-7 x 1-2 µm. Thallus atranorina, ± diploicina et ± fulgidina continens. Medulla non- amyloideus.

Type: MEXICO. Baja California. Isla Cedros, ridge crest overlooking western shore and adjacent canyon to the E at the NW corner of the island, 28°22'00"N, 115°15'30"W, ca. 300 m alt., on acidic rock, 19 March 1994, Nash *34458* (ASU! – holotype designated here).

Taxonomic note: The species name was first used by Imshaug (1951) in his dissertation but was never validly published.

THALLUS (Fig. 2A, B)—Crustose, thin to moderately thickened, ± continuous or becoming dispersed, epilithic; areolate to subsquamulose or bullate; prothallus delimiting the thallus margin, distinctly blackened to pale gray, rarely white and indistinct; thallus surface matt and dull, not shiny, usually ivory, rarely beige, epruinose or rarely with a fine pruina, phenocorticate; without Ca-oxalate crystals in the medulla (H_2SO_4–).

APOTHECIA—Lecideine, (0.3–)0.5–0.8(–1.1) mm in diameter, soon sessile; proper margin thin, black, rarely persistent, usually excluded with age; disc black, epruinose, plane, soon becoming convex with age; proper exciple of the *dispersa*-type (**Fig. 2C**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae distinct, not reduced, pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-celled, cells angular, distinctly swollen (*textura angularis*) and usually ± carbonized with various amounts of brown pigments (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, inspersed with oil droplets; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type (**Fig. 2F**). **ASCOSPORES** (**Fig. 2D, G, H**)—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (7.0–) 11.4–[13.2]–15.0(–17.0) x (5.0–)6.0–[6.7]–7.4(–8.0) μm (*n* = 60); one-septate, proper septum briefly thickened but soon becoming reduced during spore ontogeny, lateral wall thickenings absent (± *Physconia*-type); ornamentation absent (not visible in DIC); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 2G, H**) differentiated into smooth, thin perispore (0.06–0.07 μm), narrow intermediate layer (< 0.03 μm), thick proper spore wall (0.34–0.54 μm) and moderately thickened endospore (0.12–0.21 μm).

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 2.0–7.0 x 1.0–2.0 μm (*n* = 41).

CHEMISTRY—With the depsides atranorin and chloroatranorin and the depsidones diploicin, 3-dechlorodiploicin, fulgidin and isofulgidin. HPLC–artefacts: haematommic acid, methyl β-orsellinate (HPLC by J. Elix, Canberra). Thallus and medulla K+ yellow, P+ orange, C–, KC–, CK–. UV+ pale ivory. The thallus medulla and cortex does not react amyloid, apothecia are amyloid in Lugol's (always test with concentrated Lugol's iodine or in the compound microscope; positive reactions can be very weak!).

SUBSTRATE AND ECOLOGY—On a variety of siliceous (HCl–) rock substrates.

DISTRIBUTION (Fig. 3)—Common along the coast of southern California and Baja California.

NOTES—Thalli of *B. lepidastroidea* sometimes vaguely resemble *B. dispersa* or

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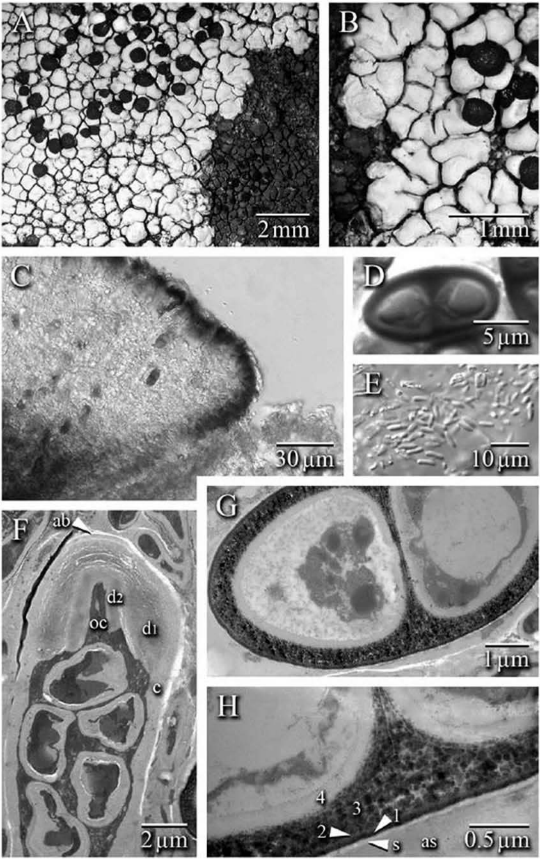
Fig. 2: *Buellia lepidastroidea* (A–E. light micrographs; F–H. TEM micrographs).—A. Overview of the areolate, sublobate thallus with sessile apothecia (Nash *6742a*).—B. Close-up of thallus and apothecia (Nash *6742a*).—C. Cross section through the apothecium with inspersed hymenium (Nash *34458*).—D. Premature ascospore with distinct septal thickening (Nash *34458*).—E. Conidia (Nash *34458*).—F. *Bacidia*-type ascus (Nash *38438*; for designation of the different layers see Bellemère 1994): The a- and b-layer (ab) are barely visible and cannot reliably be distinguished (possibly as a result of fixation artifacts); (c) outer electron opaque c-layer; (d1) d1-layer, i.e. the outer tholus, which is distinctly laminated (in light microscopy this outer part stains deep blue with Lugol's iodine); (d2) d2-layer, i.e. the inner tholus, which is not layered and ± homogeneous (not staining in Lugol's iodine); (oc) ocular chamber .—G. Mature ascospore with reduced septal thickenings (Nash *38438*).—H. Spore wall of a mature ascospore (Nash *38438*): (as) ascus wall; (s) mucilaginous sheath; (1) perispore; (2) intermediate layer; (3) proper spore wall; (4) endospore.


A
2 mm
B
1 mm
C
30 µm
D
5 µm
E
10 µm
F
ab
d2
oc
d1
c
2 µm
G
1 µm
H
4
3
2
1
s
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0.5 µm

B. nashii. *Buellia lepidastroidea* is, however, strictly coastal and characterized by oil droplets in the hymenium. This inspersion is usually distinct, especially if thick apothecial sections are treated with 5% KOH. In thin sections, oil inspersion may be less conspicuous but nevertheless always present. Thalli growing close to the seashore and subject to spray often show more exuberant growth than sheltered thalli. Their thallus areoles become strongly inflated and apothecia thus appear "stalked".

The North American specimens fit well into the concept of Imshaug's *B. lepidastroidea* and the species is described here to validate the name Imshaug first introduced for this species. The species belongs to a group of taxa with indistinct *Physconia*-type ascospores, a *dispersa*-type exciple and an oil-inspersed hymenium. This group of species is currently not well understood. *Buellia lepidastroidea* is very similar to European material of *B. excelsa* (Leight.) A.L. Smith. Scheidegger (1993) selected a lectotype for *B. excelsa* but the material could not be found at BM. Specimens identified as *B. excelsa* from Scheidegger's private herbarium have a more distinctly brown thallus, contain only atranorin, not diploicin or fulgidin and were collected at high altitude, not close to the seashore. Scheidegger (1993, p. 349) mentions that the species is distributed "in dunes and in mountains". In the Sonoran Desert Region *B. lepidastroidea* is clearly confined to coastal, maritime habitats and has not been found further inland or at high altitudes. Other taxa in the *Buellia excelsa*-group are *B. boergesenii* Imshaug and *B. jorgensis* Zahlbr. (Chile – M-0061335, Spindler *16158*, det. Follmann). *Buellia conspirans* (Nyl.) Vain. is a saxicolous species similar to *B. boergensii* according to Imshaug (1955). It is currently listed in the North American Checklist (Esslinger 1997) as a synonym of *B. curatellae* Malme. *Buellia curatellae* is, however, a corticolous species with distinct lateral spore wall thickenings. It was transferred by Marbach (2000) into the genus *Hafellia*.

Buellia lepidastroidea is treated here as a distinct species, but a more detailed revision of the *Buellia excelsa*-group is necessary to evaluate the taxa currently included in this group. Because of the oil inspersion in the hymenium, species of the *Buellia excelsa*–group show some affinities to the genus "*Hafellia*". The presence of diploicin and related substances in *B. lepidastroidea* is unusual for *Buellia* s.str. but these substances have been reported from "*Hafellia*". Scheidegger (1993) did, however, not include *B. excelsa* within "*Hafellia*" because the ascospores lack lateral wall thickenings and he did not find diploicin in *B. excelsa*.

Buellia lepidastroidea usually can be easily distinguished from *B.* ("*Hafellia*") *regineae* because of its thinner thallus, with smaller, more dispersed areoles, smaller apothecia and ascospores. Lateral wall thickenings are usually present in spores of *B. regineae*,

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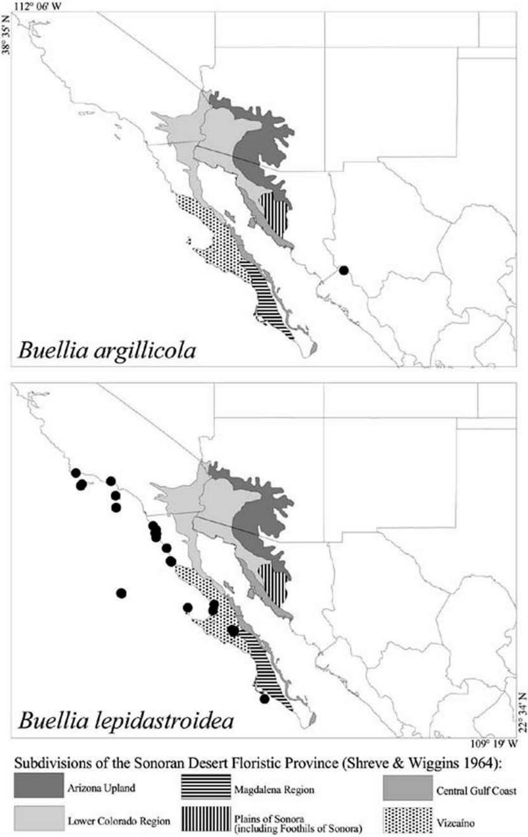
Fig. 3: Distribution of *Buellia argillicola* and *Buellia lepidastroidea* in the Sonoran Desert (Floristic Provinces according to Shreve & Wiggins 1964).


112° 06' W
38° 35' N
Buellia argillicola
Buellia lepidastroidea
22° 34' N
109° 19' W
Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):
Arizona Upland
Magdalena Region
Central Gulf Coast
Lower Colorado Region
Plains of Sonora (including Foothils of Sonora)
Vizcaíno

but less distinct than in *B. leptoclinoides* (see notes on *B. regineae*).

Thalli of *B. lepidastroidea* and *B. excelsa* are very similar to *B. dispersa* and *B. nashii*. All these species also share the same exciple anatomy and have indistinct *Physconia*-type ascospores. The angular thickening of the spore septum, which is characteristic for the *Physconia*-type ascospore, can only very briefly be observed in premature ascospores (Fig. 2D) but becomes soon reduced in mature spores (Fig. 2G & H). *Buellia dispersa* and *B. nashii*, however, do not contain oil droplets within the hymenium.

REPRESENTATIVE SPECIMENS EXAMINED—MEXICO. Baja California. Egan *13790* (OMA); Kalb *24657* (hb. Kalb); Scheidegger *Inv. Nr. 170-189, 71-95, 150-155* (hb. Scheidegger); Weber *L-43033, L-43014, L-43062, L-36575* (COLO); Wetmore *63852, 75765, 72431, 63498, 75873* (MIN); Nash *38242, 34370, 38241, 8688b, 34319, 4916, 34052, 38256, 8730, 25188, 38459, 34358*, Ryan *2136, 21263* (ASU). **Baja California Sur**. Wetmore *72223* (MIN); Marsh *6080*, Nash *8947* (ASU).—**UNITED STATES. California. Los Angeles Co.** Bratt *9799*, Bratt *10219, 11843, 11844* (SBBG); Hasse *Exs. 155* (ASU); Weber *L-42606, L-42823* (COLO). **Santa Barbara Co.** Bratt *7379, 7605* (SBBG). Nash *32646, 33021*, Ryan *31255b, 31270* (ASU). **Washington. Kittitas Co.** Ryan *16838* (ASU).

Buellia nashii Bungartz sp. nov. **FIGURE 4**

Similis Buelliae dispersae sed apotheciae cum pigmento aeruginoso et thallus acida norstictica et connorstictica vel acida stictica continens.

Etymology: The species is named in honor of my Ph.D. supervisor Dr. Thomas H. Nash III.

Type: MEXICO. Coahuila. 3 km W of the paved road, at the Delores sign, 26°00'00"N, 101°00'00"W (estimated coordinates), on volcanic rock, 20 March 1976, Nash *6742a* (ASU! – holotype designated here; one isotype at MEXU, one isotype at US).

THALLUS (Fig. 4A, B)—Crustose, thick, ± continuous or becoming dispersed, epilithic; areolate to subsquamulose; prothallus absent; thallus surface matt and smooth to deeply fissured, dull or ± shiny, usually ivory, beige to deep brown or gray, rarely lead gray, with fine or coarse pruina, rarely epruinose, phenocorticate; with few, or rarely large amounts of Ca oxalate crystals (H_2SO_4+ forming clusters of needle shaped sulphate crystals).

APOTHECIA—Lecideine, (0.4–)0.6–1.1(–1.2) mm in diameter, sessile; proper margin black, thin to thick, usually persistent, rarely excluded with age; disc black, usually epruinose, rarely with white pruina, plane, often becoming strongly convex with age; proper exciple of the *dispersa*-type (**Fig. 4C**) *sensu* Scheidegger (1993), i.e. inner exciple distinct, not reduced, hyphae pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-celled, cells angular, distinctly swollen

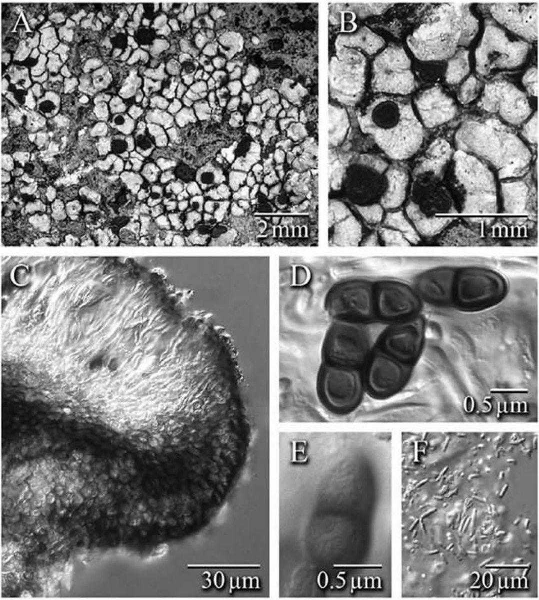


Fig. 4: *Buellia nashii*.—A. Subsquamulose thallus with sessile apothecia (Nash *6724a*).—B. Close-up of thallus (Nash *6724a*).—C. Cross section of an apothecium with *dispersa*-type exciple (Nash *15313b*).—D. Overmature, slightly constricted ascospore with reduced septum thickening (Nash *15313b*).—E. Microrugulate ascospore ornamentation visible at a late stage of the spore ontogeny (Nash *15313b*).—F. Conidia (Nash *15313b*).

(*textura angularis*) and carbonized with various amounts of a brown pigment (cf. *elachista*-brown); small amounts of a diffuse aeruginose pigment present but restricted to the outermost exciple cells (*cinereorufa*-green, HNO_3+ violet); only the brown pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 4 D, E)**—oblong to ellipsoid, rarely constricted with age, with obtuse ends, not curved, (11.0–)12.9–[14.5]–16.1(–19.0) x (6.0–)6.5–[7.3]–8.1(–9.0) μm (n = 60); one-septate, proper septum briefly thickened but very soon becoming reduced during spore ontogeny, lateral wall thickenings absent (± *Physconia*-type); ornamentation microrugulate.

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia (**Fig. 4F**) simple, bacilliform, 5.0–10.0x 1.5–2.0 μm (n = 20).

CHEMISTRY—Typically with the depside atranorin and the depsidones norstictic (forming orange, needle-shaped crystals in the compound microscope) and connorstictic acid. Some specimens do not contain norstictic acid but instead are characterized by stictic and hypositictic acid. Specimens typically react K+ yellow to red (sometimes weak), P+ yellow (sometimes weak), C–, KC–, CK–. UV– (pale). The thallus is not amyloid, apothecia react amyloid in Lugol's (always test with concentrated Lugol's iodine or in the compound microscope; positive reactions can be very weak!).

SUBSTRATE AND ECOLOGY—On a variety of siliceous (HCl–) rock substrates, rarely also on sandstones with small amounts of carbonates (HCl+).

DISTRIBUTION (Fig. 6)—The species is widely distributed throughout the Sonoran Desert Region and adjacent areas, extending into NE Mexico, but absent from low desert elevations.

NOTES—Thalli of *B. nashii* are very similar and almost as variable as those of *B. dispersa* (see the description of morphotype I in Bungartz et al. 2002). The two species nevertheless are reliably distinguished by their chemistry (2'-*O*-methylperlatolic acid in *B. dispersa*, *vs.* norstictic and/or stictic acid in *B. nashii*) and their different exciple pigmentation. No specimen with the chemistry of *B. dispersa* contains any traces of the aeruginose, HNO_3+ violet pigment *cinereorufa*-green. In specimens of *B. nashii* this pigment is always present but usually confined only to the outermost cells of the exciple. Specimens should always be tested with HNO_3 for a reliable identification. Most specimens of *B. nashii* contain norstictic acid and are thus easily distinguished form *B. dispersa* because of the formation of distinct orange, needle-shaped crystals if KOH is applied to apothecial or thallus sections.

REPRESENTATIVE SPECIMENS EXAMINED—MEXICO. Baja California. Nash *26285*, *26320b* (ASU). **Chihuahua.** Nash *13817*, *13766* (ASU). **Coahuila.** Nash *6742c* (ASU).—**UNITED STATES. Arizona. Cochise Co.** Weber *S8831* (COLO). **Coconino Co.** Boykin *2849*, *2674*, Nash *30677*, *4980* (ASU). **Gila Co.** Nash *7386* (ASU). **Graham Co.** Nash *7661* (ASU). **Maricopa Co.** Nash *8411*, *6266*, *9850*, *6659*, *987*, *5011* (ASU). **Mohave**

Co. Nash *7303* (ASU). **Pinal Co.** Nash *6151* (ASU). **Santa Cruz Co.** Nash *39231* (ASU). **Yavapai Co.** Nash *34137*, *34149*, *34188*, *6361*, Ryan *26958* (ASU). **California. Inyo Co.** Ryan *14881* (ASU). **San Diego Co.** Nash *7052* (ASU). **Colorado. San Juan Co.** Nash *17757* (ASU). **Nevada. Lincoln Co.** Ryan *15862* (ASU). **New Mexico. San Juan Co.** Nash *16397*, *16395*, Rankert *117* (ASU). **Utah. Kane Co.** Nash *5071*, *5457*, Nash *6610* (ASU). **San Juan Co.** Nebecker *2800* (ASU). **Washington Co.** Nash *15315* (ASU).

Buellia navajoensis Bungartz sp. nov. **FIGURE 5**

Thallus saxicolus, crustaceus, areolatus vel sublobatus, crassus, eburneus, sine hypothallo. Apothecia immersia vel adnatia, lecideina, marginibus propriis tenuis. Excipulum tenuis, fulvo-caeruleum, pigmentum aeruginosum continens, carbonaceum. Asci 8-spori. Sporae uniseptae, oblongae vel anguste oblongae, septibus incrassatus 13–25 x 6-10 µm. Pycnidia urceolata vel globosa. Conidia bacilliformes, 3-4.5 x 1-1.5 µm. Thallus acida norstictica et connorstictica et substancia xanthonia continens. Medulla amyloideus.

Etymology: The species is named after the Native American Navajos and the type specimens were collected on Navajo Sandstone.

Type: U.S.A. Utah. Kane Co. About 16 km east of Kanab along U.S. Highway 89, in Johnson Canyon near the Kanab Stake Welfare Farm, ca. 1734 m, 37°02'14"N, 112°21'53"W, on Navajo Sandstone, Nebecker *1577* (ASU! – holotype designated here).

THALLUS (Fig. 5A, B)—Crustose, thick, ± continuous, epilithic; areolate to sublobate often forming rosettes; prothallus absent; thallus surface matt and dull, not shiny, usually ivory, beige, rarely with a pinkish tinge, usually strongly pruinose, rarely weak or absent, phenocorticate; entire thallus filled with an abundance of calcium oxalate (H_2SO_4+ forming needle shaped crystals).

APOTHECIA—Lecideine, (0.3–)0.5–1.1(–1.4) mm in diameter, immersed, becoming adnate with age; proper margin black, thin, ± persistent, excluded with age; disc black, usually with a fine white pruina, plane, becoming slightly convex with age; exciple narrow, poorly differentiated, of the *aethalea*-type (**Fig. 5C**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae narrow, hyaline, prosoplectenchymatous (*textura oblita*), often reduced, similar in structure and orientation to the paraphyses, transient with the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*), outer excipular hyphae parallel, moderately swollen (*textura oblita*) and moderately carbonized with various amounts of brown and aeruginose pigments (cf. *elachista*-brown & *cinereorufa*-green), pigmentation ± continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown) and a diffuse, aeruginose pigment (HNO_3+ violet, *cinereorufa*-green).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 5E–I)**—oblong to narrowly oblong, very rarely constricted, with obtuse ends, not curved, (13.0–)16.3–[18.6]–20.9(–25.0) x (6.0–)6.2–[7.1]–8.0(–10.0) μm (n = 60); one-septate, proper septum briefly thickened but very soon becoming reduced during spore ontogeny, lateral wall thickenings absent (± *Physconia*-type); ornamentation microrugulate (to faintly striate); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 5G**) differentiated into smooth to indistinctly cracked, thick perispore (0.30–0.40 μm), narrow intermediate layer (< 0.03 μm), thick proper spore wall (0.35–0.53 μm) and moderately thickened endospore (0.18–0.30 μm).

PYCNIDIA—Rare, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 3.0–4.5x 1.0–1.5 μm (n = 20).

CHEMISTRY—Typically with the depside atranorin and traces of the depsidone norstictic acid. Several xanthones have also been detected with HPLC by J. Elix: 4, 5-dichloronorlichexanthone, arthothelin, thiophanic acid. However, the thallus does not react C+ orange and the UV-fluorescence is only faint, possibly obscured by the large amount of Ca-oxalate pruina on the thallus surface. Thalli usually react K+ yellow, rarely K+ yellow-red (forming orange, needle-shaped crystals if observed in the compound microscope), P ± yellow, C– , KC–, CK–. UV± pale yellow to beige. Thallus and apothecia react strongly amyloid.

SUBSTRATE AND ECOLOGY—On limestone (HCl+ strongly reacting) or sandstone with some traces of carbonates (HCl+ weakly reacting, rarely HCl–).

DISTRIBUTION (Fig. 6)—Currently known only from the U.S.A. (Utah, New Mexico, Colorado, Northern Arizona, California).

NOTES—The thick, pruinose, areolate to sublobate, deeply amyloid thalli of *B.*

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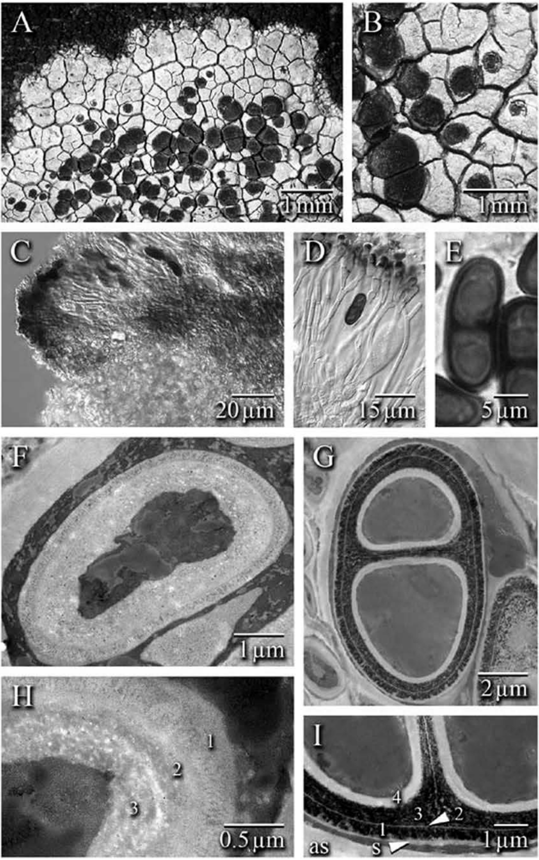
Fig. 5: *Buellia navajoensis.*—A. Overview of areolate thallus (Nebecker *1581*).—B. Close-up of areolate thallus (Nebecker *1581*).—C. Cross section of an apothecium with *aethalea*-type exciple (Nebecker *1581*).—D. Hymenium with asci, paraphyses and one ascospore (Nash *1581*).—E. Mature ascospore: an indistinct septum can be seen in some of the spores (Nash *1581*).—F. Immature ascospore prior to septum formation (Nash *1577* – holotype).—G. Mature ascospore (Nash *1577* – holotype).—H. Wall layers in an immature ascospore: (1) outer layer (perispore and mucilaginous sheath not distinctly differentiated); (2) proper spore wall and (3) endospore beginning to become differentiated (Nash *1577* – holotype).—I. Wall layers in a mature ascospore: (as) ascus wall; (s) mucilaginous sheath; (1) perispore; (2) intermediate layer; (3) proper spore wall; (4) endospore (Nash *1577* – holotype).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navajoensis are very distinct and specimens are not easily confused with other species. Type specimens collected by Nebecker were originally identified as *B. retrovertens* but do not resemble that species. Although the species is very distinct, only a few specimens have so far been collected.

REPRESENTATIVE SPECIMENS EXAMINED—UNITED STATES. ARIZONA Apache Co. Nash *9111* (ASU). **CALIFORNIA. San Bernardino Co.** Nash *10350* (ASU). **COLORADO. Larimer Co.** Ryan *12132* (ASU). **NEW MEXICO. San Juan Co.** Marsh *12* (ASU). **Utah Grand Co.** Ryan *11636* (ASU). **UTAH. Kane Co.** Nebecker *1581*, *1574*, *1580* (ASU).

Buellia regineae Bungartz sp. nov.

FIGURE 7

Thallus saxicolus, crustaceus, areolatus vel bullato-areolatus, crassus, eburneus, cum hypothallo atero. Apothecia sessilia, lecideina, marginibus propriis tenuis. Excipulum tenuis, fulvum, sine pigmento aeruginoso, carbonaceum. Asci 8-spori. Sporae uniseptae, oblongae vel ellipsoideae, septibus incrassatus 11–19 x 5.5-10 µm. Pycnidia globosa. Conidia bacilliformes, 4-5 x 0.5-1.0 µm. Thallus atranorina, gangaleoidina, diploicina, fulgidina et acida haematommica et virensica continens. Medulla amyloideus.

Etymology: The species is dedicated to my sister Regine. The species epithet "*regineae*" also reminds of the superficially similar but not closely related *Buellia capitis-regum* W.A. Weber, which has a similarly "gnarled" thallus surface.

Type: MEXICO. BAJA CALIFORNIA. Isla de Guadalupe, along west coast at "Fondeadero del Oeste" near light, 28°58'50"N, 118°18'50"W, on N-facing cliffs above the ocean, on basalt, *ca.* 80 m alt., 1 January 1996, Nash *38303* (ASU! – holotype designated here).

THALLUS (Fig. 7A, B)—Crustose, distinctly thickened, ± continuous, epilithic; bullate-areolate, thallus surface "gnarled"; prothallus distinct, delimiting the thallus as a black outline; thallus surface smooth (but often eroded in herbarium specimens), matt or ± shiny, usually white to pale ivory, rarely whitish gray, epruinose, phenocorticate; lacking crystals within thallus medulla (H_2SO_4–).

APOTHECIA—Lecideine, (0.3–)0.6–1.1(–1.4) mm in diameter, soon sessile; proper margin thin, black, rarely persistent, soon excluded with age; disc black, epruinose, plane, sometimes ± convex with age; proper exciple of the *dispersa*-type (**Fig. 7C**) *sensu* Scheidegger (1993), i.e. inner exciple distinct, not reduced, hyphae pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-

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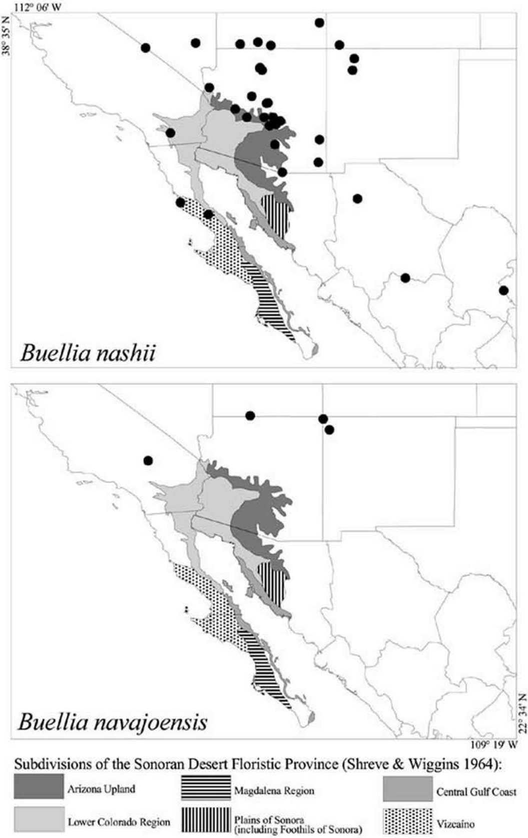
Fig. 6: Distribution of *Buellia nashii* and *Buellia navajoensis* in the Sonoran Desert Region (Floristic Provinces according to Shreve & Wiggins 1964).


112° 06' W
38° 35' N
Buellia nashii
Buellia navajoensis
22° 34' N
109° 19' W
Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):
Arizona Upland
Magdalena Region
Central Gulf Coast
Lower Colorado Region
Plains of Sonora (including Foothils of Sonora)
Vizcaíno

celled, cells angular, distinctly swollen (*textura angularis*) and usually ± carbonized with various amounts of a brown pigment (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, inspersed with oil droplets; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 7D–F)**—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (11.0–)12.8–[14.6]–16.3(–19.0) x (5.5–)6.4–[7.4]–8.4(–10.0) μm ($n = 60$); one-septate, proper septum distinctly and ± persistently thickened during spore ontogeny, lateral wall inconspiciously thickened (± *Callispora*-type); ornamentation absent (not visible in DIC); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 7F**) differentiated into smooth, thin perispore (0.06–0.09 μm), indistinct intermediate layer (< 0.01 μm), moderately thickened proper spore wall (0.26–0.30 μm) and thick endospore (0.23–0.41 μm).

PYCNIDIA—Infrequent, globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.0–5.0x 0.5–1.0 μm ($n = 20$).

CHEMISTRY—The depsides atranorin and chloroatranorin together with various artifacts from hydrolysis of atranorin (chlorohaematommic acid, haematommic acid, methyl-β-orsellinate) have been detected. Other biosynthetically related depsides found in the specimens are: gangaleoidin, norgangaleoidin, chlorolecidioidin, dechlorogangaleoidin. One specimen contains brialmontin 1. The following biosynthetically related depsidones were detected: diploicin, 3-dechlorodiploicin, fulgidin and isofulgidin. One specimen contains virensic acid. (HPLC by J. Elix, Canberra). K+ deep yellow, P+ faintly yellow, C–, KC–, CK–. UV+ bright yellow. The thallus medulla and the apothecia react strongly amyloid.

SUBSTRATE AND ECOLOGY—Growing on siliceous mineral-poor coastal rock (generally HCl–).

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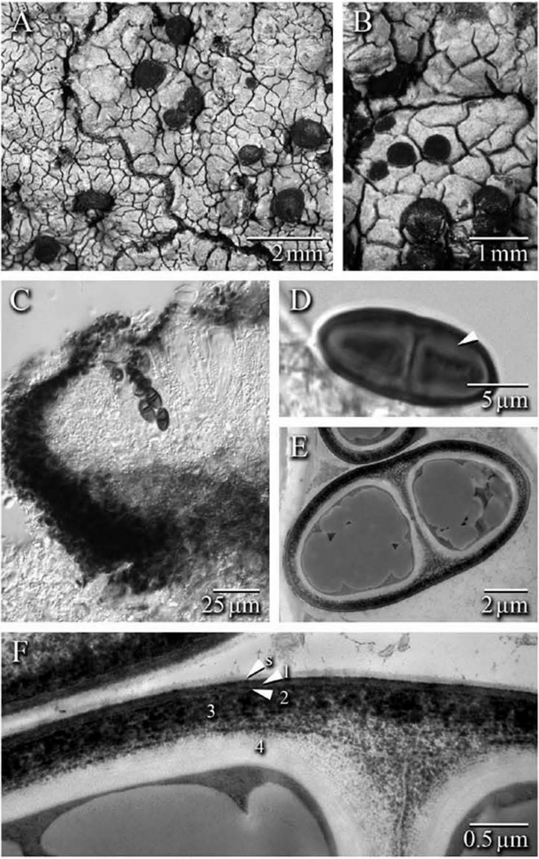
Fig. 7: *Buellia regineae*.—A. Overview of the bullate-areolate thallus outlined by a distinct black prothallus (Wetmore *75787*).—B. Close-up of the thallus (Wetmore *75787*).—C. Apothecium with inspersed hymenium and *dispersa*-type exciple (Wetmore *63682*).—D. Mature ascospore with indistinct lateral wall thickenings (arrow; Weber *Exs. 89*).—E. Mature ascospore (Nash *34319*). — F. Wall layers in a mature ascospore: (s) mucilaginous sheath; (1) perispore; (2) indistinct, narrow intermediate layer; (3) proper spore wall; (4) endospore (Nash *34319*).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DISTRIBUTION (Fig. 9)—Currently known only from the coast of Baja California and southern California.

NOTES—*Buellia regineae* is closely related to a group of species, which are commonly treated within *Hafellia*, a genus described by Kalb (1986) to accommodate species with an oil inspersed hymenium and conspicuous lateral spore wall thickenings. Etayo & Marbach (2003, p. 373) also emphasize that all species of *Hafellia* have "… strongly branched paraphyses (forming an epithecium) …" and typically occur in habitats with high humidity. Most species included in the genus are corticolous. *Hafellia* thus appears very distinct from species related to *Buellia aethalea*, which is often regarded as the core group of the genus *Buellia*.

Unfortunately this concept is currently in direct violation of the Botanical Code as adopted in 1999 in St. Louis (Greuter *et al.* 2000). This currently accepted code lists *Buellia disciformis* as the type of the conserved genus *Buellia*. The listed type clearly belongs to *Hafellia* and was included within that genus by Marbach & Mayrhofer (in Marbach 2000). This transfer is formally invalid because a listed type of one genus (i.e. *Buellia*) cannot belong to another genus (i.e. *Hafellia*). To avoid taxonomic upheaval Moberg et al. (1999) proposed to change the listed type from *B. disciformis* to *B. aethalea*. The majority of lichen taxonomists readily accept the genus *Hafellia* (Birkbeck et al. 1990, Eriksson et al. 2002, Etayo & Marbach 2003, Hafellner & Türk 2001, Kalb 1986, Marbach 2000, Pusswald et al. 1994, Scheidegger 1991, Scheidegger 1993, Sheard 1992, Sheard & Tønsberg 1995). In contrast, Nordin (2000) adopted a very broad concept of *Buellia* suggesting that the proposal to change the listed type will most likely be rejected. Rico et al. (2003) went even further arguing that the acceptance of the most recent code implies that *Hafellia* must be treated as a synonym of *Buellia* s.str. Until a decision on the proposal submitted by Moberg et al. (1999) has formally been reached, species with affinities to *Hafellia* must therefore be included within *Buellia* s.l.

Buellia regineae is closely related to *B. leptoclinoides* (Nyl.) J. Steiner (= *Hafellia leptoclinoides* (Nyl.) Scheid. & H. Mayrhofer *nom. illegit.*). Material of *B. leptoclinoides* was examined for comparison from M and the private herbarium of C. Scheidegger. The specimens have a more distinct lateral wall thickening than *B. regineae*. Nevertheless both species are very similar but the medulla of *Buellia regineae* reacts strongly amyloid and specimens contain fulgidin, isofulgidin and diploicin instead of placodiolic acid. Both species are saxicolous, which is unusual given that the majority of related species appears to be corticolous. Paraphyses of both *B. regineae* and *B. leptoclinoides* are not considerably different from other saxicolous species and a distinct layer on the surface of the hymenium could not be observed (i.e. a distinct epithecium is absent). Thalli growing close to the seashore and subject to spray often have more exuberant areoles and look "gnarled".

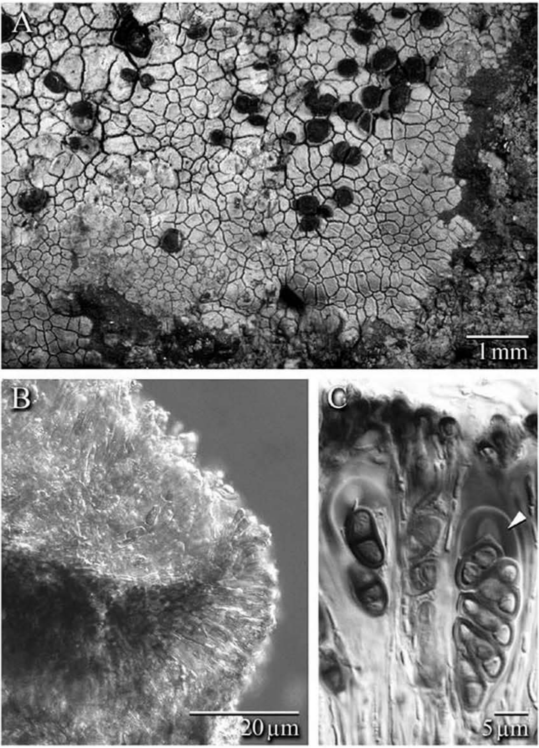

Fig. 8: *Buellia sheardii* (Nash *10086* – holotype). – A. Areolate thallus with sessile apothecia and a black hypothallus. – B. Cross section of an apothecium with *dispersa*-type exciple. – C. Hymenium with *Bacidia*-type ascus (the arrow indicates the characteristic staining of the tholus flanks in Lugol's iodine).

REPRESENTATIVE SPECIMENS EXAMINED—MEXICO. BAJA CALIFORNIA. Nash *26092*, *26093*, *38303* (ASU); Weber *s.n.* (COLO).

Specimens of *B. leptoclinoides* examined for comparison — FRANCE. EASTERN PYRENEES (= DÉPARTEMENT PYRENÉES ORIENTALE). Scheidegger *8480a,b* (hb. Scheidegger); Kalb *Lichenes Neotropici Exs. 372* (M-0061356). ALSACE (= DÉPARTEMENT ALSACE). Suza *s.n.* (M-0061354). **EUROPE.** UNKNOWN LOCALITY. Arnold *s.n.* (M-0051355).

Comment: A specimen selected by Meyer & Printzen (2000) as a reference collection for the pigment *leptoclinoides*-brown (Vezda *Lichenes Selecti Exs. 446*; M-0061353) has been erroneously identified as *H. leptoclinoides*. The specimen in M belongs to *B. saxorum*. The same pigment is nevertheless present in this specimen and it is unnecessary to change the reference collection for this pigment.

Buellia sheardii Bungartz, sp. nov. FIGURE 8

Thallus saxicolus, crustaceus, areolatus, tenuis vel crassus, eburneus, cum hypothallo atero. Apothecia sessilia, lecideina, marginibus propriis crassis. Excipulum crassum, fulvo-caeruleum, pigmentum aeruginosum continens, carbonaceum. Asci 8-spori. Sporae uniseptae, oblongae vel ellipsoideae, septibus angustus, 8–13.5 x 4-6 µm. Pycnidia globosa. Conidia bacilliformes vel fusiformes, 6-9 x 1.0-1.5 µm. Thallus acida norstictica et connorstictica continens. Medulla amyloideus.

Etymology: The species is named to honor Dr. John W. Sheard for his outstanding contributions to the taxonomy of *Rinodina* and *Buellia*.

Type: MEXICO. SINALOA. Topolobampo, near Gulf of California on north-facing hillside, on basalt, ca. 30 m alt., 20 March 1975, Nash *10086* (ASU! – holotype designated here, one isotype at MEXU, one isotype at US).

THALLUS (Fig. 8A, B)—Crustose, thin to moderately thickened, ± continuous, epilithic; areolate; prothallus distinct, delimiting the thallus as a black outline, rarely also between the areoles; thallus surface matt and dull, usually ivory, rarely pale beige, pruinose, phenocorticate; entire thallus with large mineral crystals (*ca.* 40–60 µm in diameter; H_2SO_4–, not forming needles).

APOTHECIA—Lecideine, (0.2–)0.3–0.6(–0.8) mm in diameter, soon adnate to sessile; proper margin prominent, black or rarely masked by grayish remains of necrotic thalline

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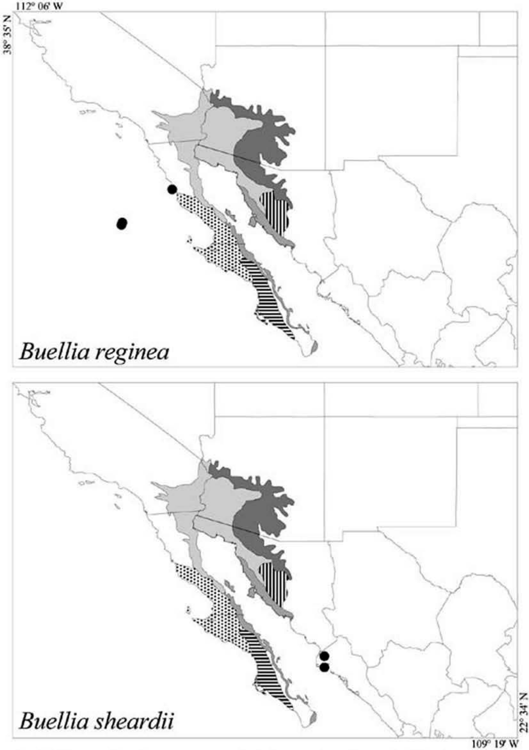
Fig. 9: Distribution of *Buellia regineae* and *Buellia sheardii* in the Sonoran Desert Region (Floristic Provinces according to Shreve & Wiggins 1964).



Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):

- ■ Arizona Upland
- ▤ Magdalena Region
- ■ Central Gulf Coast
- □ Lower Colorado Region
- ▥ Plains of Sonora (including Foothills of Sonora)
- ░ Vizcaíno

material (thalline veil), ± persistent, rarely excluded with age; disc black, epruinose or faintly pruinose, plane, becoming only slightly convex with age; proper exciple of the *dispersa*-type (**Fig. 8B**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae distinct, not reduced, pigmented, prosoplectenchymatous (*textura oblita*), extending from the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*); outer excipular hyphae short-celled, cells angular, distinctly swollen (*textura angularis*) and usually ± carbonized with various amounts of brown and aeruginose pigments (cf. *elachista*-brown and *cinereorufa*-green, HNO_3+ violet), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown) and a diffuse aeruginose pigment (HNO_3+ violet, *cinereorufa*-green).

ASCI (Fig. 8C)—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 8C)**—oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (8.0–)8.8–[10.2]–11.6(–13.5) x (4.0–)4.1–[4.8]–5.5(–6.0) μm (n = 39); one-septate, proper septum narrow, not thickening during spore ontogeny, lateral wall thickenings absent [*Beltraminea* (=*Buellia*)-type]; ornamentation absent (not visible in DIC).

PYCNIDIA—Rare, globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (*sensu* Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform to fusiform, 6.0–9.0 x 1.0–1.5 μm (n = 20).

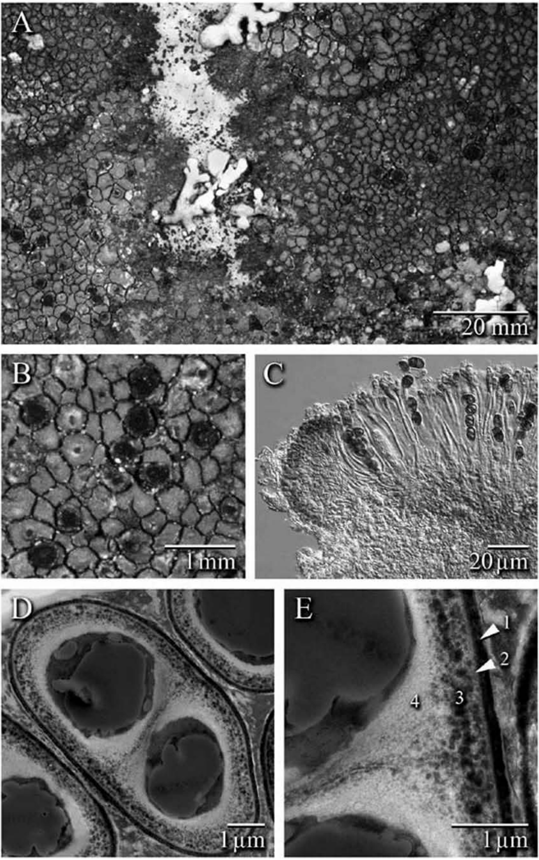
CHEMISTRY—With the biosynthetically related depsides atranorin and chloroatranorin and the depsidones norstictic and connorstictic. Thallus usually K+ yellow to red (orange, needle-shaped crystals forming in the compound microscope), P– or + yellow, C–, KC–, CK–. UV– (dark). The thallus and apothecia react amyloid.

SUBSTRATE AND ECOLOGY—Growing on siliceous mineral-poor coastal rock (generally HCl–).

DISTRIBUTION (Fig. 9)—Currently known only from the coast of Sinaloa, along the Gulf of California (Sea of Cortez).

–>

Fig. 10: *Buellia tyrolensis*.—A. Overview of the areolate thallus with black hypothallus (Nash *10987*).—B. Close-up of the thallus (Nash *10987*).—C. Cross section with *aethalea*-type exciple (Ryan *10987*).—D. Mature ascospore (Bungartz *1575*): The endospore appears considerably thickened in the TEM at this stage of the spore ontogeny although no septal thickening is visible in the light microscope.—E. Wall layers in a mature ascospore: (1) perispore; (2) indistinct, narrow intermediate layer; (3) proper spore wall; (4) endospore (Bungartz *1575*).


A
20 mm
B
1 mm
C
20 µm
D
1 µm
E
1
2
3
4
1 µm

NOTES—Because of the plane apothecia with a ± persistent margin *B. sheardii* superficially resembles *B. disciformis*, which, however, has a rimose-areolate rather than a distinctly areolate thallus, ascospores with median septum thickenings and does not contain *cinereorufa*-green in the exciple.

ADDITIONAL SPECIMEN EXAMINED—MEXICO. Sinaloa. 39 km N of Los Mochis along route 15; 26°07'N, 109°03'W; 60 m, Nash *12088* (ASU).

Buellia tyrolensis Körb., Parerg. Lich.: 187 (1860) FIGURE 10

Type: ITALY. Trentino (= South Tirol). Naifthale bei Meran, *ca.* 46°40'N 11°09'E, 1853, Bamberger *ex* hb. Heufl *s.n.* (UPS – isotype).

Taxonomic note: The "Parerga Lichenologica" was issued in several "Lieferungen" beginning with pages 1-96 in 1859. Pages 97-192 were first published in the following year (1860) with the species description of *Buellia tyrolensis* on page 187. Zahlbruckner (1931) and Scheidegger (1993) both use the spelling "*tirolensis*" and cite page 460 instead of page 187. However, on page 460 (first published in 1865) no species of the genus *Buellia* is treated. According to Articles 60.1 and 60.4 of the code (Greuter et al. 2000) the original spelling with "*y*" as *Buellia tyrolensis* is to be maintained and must not be changed to "*tirolensis*".

= *Buellia buellioides* (Metzler *ex* Arnold) Buschardt, Bibl. Lich. 10: 86 (1979) ≡ *Rinodina buellioides* Metzler in Arnold, Verh. zool. bot. Ges. Wien 23: 112 (1873) *comb. novum pro Buellia fusca sensu* Arnold *nom. illegit.*, Verh. zool. bot Ges. Wien 22: 291 (1872) *Type*: ITALY. Trentino (= South Tirol). On porphyric rocks above Gries near Bozen, 46°31'N, 11°19'60"E [original label data: An Porhyrfelsen oberhalb Gries bei Bozen in Südtirol], 29 August 1872, Arnold *Exs. 495* (M-0061319! – lectotype selected here; M-0061317! – isoletotype). Note: Buschardt (1979) did not specify a type from Arnold's *exsiccati* collection and the specimen with the barcode M-0061319 is therefore selected here as the lectotype.

= *Buellia fusca* (Anzi) Kernst., Zeitschr. Ferdinandeums 35: 306 (1893) ≡ *Buellia spuria* var. *fusca* Anzi, Cal. Lich. Sondr.: 87 (1860). *Type:* ITALY. Lombardia. On silicious rock near Comun Nuovo (San Martino), 46°46'60"N, 11°13'E [original label data: Ad rupes silaceas prope Novum-Comum (S. Martino)], Anzi *s.n.* [Lich. Lang. *no. 195*] (M-0061318!, BERN, UPS, W – isotypes)

= *Buellia novomexicana* de Lesd., Ann. Crypt. Exot. 5(2): 128 (1932). *Type*: not found, probably destroyed in Word War II.

= *Buellia novomexicana* f. *pruinosa* de Lesd., Ann. Crypt. Exot. 5(2): 129 (1932). *Type*: U.S.A. New Mexico. San Miguel Co. Near Las Vegas. Gallinas South Canyon, 34°04'N 107°01'W, on silicious rocks, 1870 m [original label data: New Mexico. Environs de Las

Vegas: Canon Sud, sur roches silicieuses], 14 April 1927, Arsène Brouard s.n. (ex hb. Vezda, STU! – lectotype selected here). Note: Type material of *forma pruinosa* from STU was the only material available. This material is selected here as the lectotype because de Lesdain's holotype collection, originally located in Dunkerque (France), was probably destroyed during the Second World War.

= *Buellia zapotensis* de Lesd., Lichens du Mexique: 26 (1914). *Type*: MEXICO. MICHOACÁN. Morelia. Small hills west of Zapote hill, 19°41'60"N, 101°7'W, 1900 m [original label data: Morelia. lomas à l'ouest de la loma del Zapote, 1900 m], 2 February 1910, Arsène Brouard *3701* (US! – lectotype selected here). Note: The lectotype specimen selected here from a duplicate of the original collection, has a non amyloid medulla (I–) contrary to the protologue.

For additional not verified synonyms see Scheidegger (1993).

THALLUS (Fig. 10A, B)—Crustose, thin to moderately thickened, ± continuous, epilithic; areolate; prothallus conspicuously black, in most specimens strongly developed and growing between the areoles (forming a hypothallus), rarely only surrounding the thallus outline; thallus surface matt and smooth, rarely ± shiny, usually deep brown, rarely olive brown, epruinose, phenocorticate; lacking crystals within the thallus medulla (H_2SO_4–).

APOTHECIA—Lecideine, (0.2–)0.3–0.4(–0.5) mm in diameter, remaining immersed to indistinctly adnate; proper margin prominent, black or masked by grayish remains of necrotic thalline material (thalline veil), usually persistent, rarely excluded with age; disc black, epruinose, rarely with a faint white pruina, plane, rarely becoming slightly convex with age; proper exciple narrow, poorly differentiated, of the *aethalea*-type (**Fig. 10C**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae narrow, hyaline, prosoplectenchymatous (*textura oblita*), often reduced, similar in structure and orientation to the paraphyses, transient with the deep reddish brown hypothecium (*leptoclinoides*-brown, *textura intricata*), outer excipular hyphae parallel, moderately swollen (*textura oblita*) and usually strongly carbonized with various amounts of a brown pigment (cf. *elachista*-brown), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a brown pigment cap (cf. *elachista*-brown).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES (Fig. 10D, E)** — oblong to ellipsoid, usually not constricted, with obtuse ends, not curved, (9.0–)9.4–[10.4]–11.3(–15.0) x (5.5–)5.8–[6.2]–6.7(–8.0) μm ($n = 60$); one-septate, proper septum narrow, not thickened during spore ontogeny, lateral wall thickenings absent [± *Beltraminea* (=*Buellia*)-type]; ornamentation absent (not visible in DIC); septum with septal pore canal, simple pore and undifferentiated pore plug; spore wall (**Fig. 10E**) differentiated into smooth, thin perispore (0.08–0.15 μm), very narrow intermediate layer (< 0.20

μm), thick proper spore wall (0.25–0.50 μm) and thick endospore (0.16–0.68 μm).

PYCNIDIA—Rare to common, urceolate to globose, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.5–7.0x 0.5–1.0 μm ($n = 20$).

CHEMISTRY—The thalli contain the biosynthetically related depsidones norstictic and connorstictic acid and/or the depside 2'-*O*-methylperlatolic acid. Spot test reactions are not distinct on the dark thallus and must be confirmed in the compound microscope. K+ yellow to red (± forming orange, needle-shaped crystals) or K– (no crystals), P– or + faintly yellow, C–, KC–, CK–. UV– (dark). The thallus is not amyloid, but apothecia react amyloid in Lugol's (thallus reactions of the dark thallus should be confirmed in the compound microscope).

SUBSTRATE AND ECOLOGY—On a wide variety of silicieous (HCL-) rock, typically on ± shaded and sheltered boulders and cliffs.

DISTRIBUTION (Fig. 12)—Common and widely distributed in montane areas of the Greater Sonoran Desert Region. The species is also known from Mediterranean Europe, where it appears to be quite rare.

NOTES—Generally no distinct thickening of the spore septum has been observed in any of the specimens examined with the light microscope. Scheidegger (1993) therefore assigned the spores to the *Buellia*-type. Unfortunately these observations do not agree very well with specimens examined with the TEM. In the TEM the endospore appears considerably thickened especially along the spore septum. Currently not enough material has been examined to evaluate this discrepancy between light and electron microscopy.

Scheidegger (1993) distinguished *B. fusca* (with 2'-*O*-methylperlatolic acid) from *B. tyrolensis* (with norstictic acid). Although the majority of specimens examined can be divided into these two chemotypes, some specimens with both norstictic and 2'-*O*-methylperlatolic acid have been found. All chemotypes (only norstictic, only 2'-*O*-methylperlatolic and specimens containing both substances) are morphologically and anatomically identical and show no distinctly different distribution patterns. This situation is surprisingly different from *B. stellulata* (with 2'-*O*-methylperlatolic acid, coastal, non amyloid medulla) and *B. spuria* (with norstictic acid, inland, amyloid medulla), where the same lichen substances clearly denote two distinctly different species.

REPRESENTATIVE SPECIMENS EXAMINED—EUROPE. ITALY. TRENTINO (= SOUTH TIROL). Arnold *s.n.* (M-0061312, M-0061314, M-0061316); Doppelbaur *10288* (M-0061320); Metzler *s.n.* (M-0061313, M-0061321). LIGURIA. Sbarbaro *s.n.* (MSC-40629,

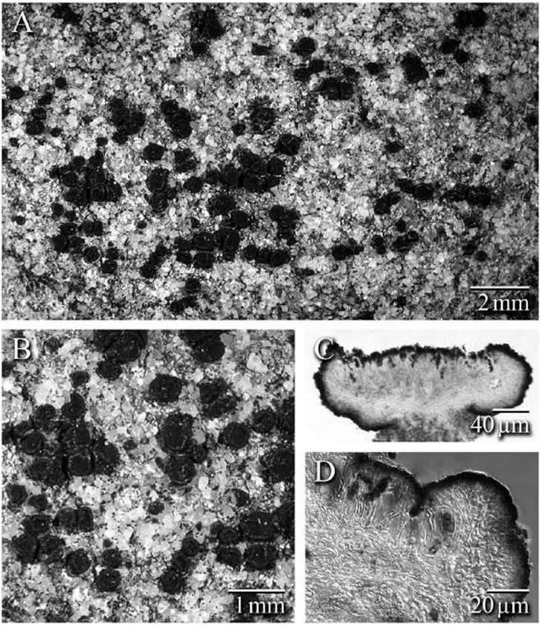


Fig. 11: *Buellia vilis*. — A. Overview of the chasmolithic thallus (Hertel *40242*). — B. Close-up of chasmolithic thallus (Hertel *40242*). — C. Cross section of an apothecium (Marsh *116*). — D. Cross section of an apothecium with *vilis*-type exciple (Marsh *116*).

M-0061315). **SPAIN.** Almeria. Scheidegger *Inv. Nr. 8640* (hb. Scheidegger).—**NORTH AMERICA. MEXICO.** Baja California Sur. Nash *12758*, *39833*, *40016* (ASU). Chihuahua. Nash *31198*, *36099*, *36545*, *36677*, *37521*, *37837*, *13508b*, *13720* (ASU). Sonora. Nash *25500*, *25611*, *37942*, *12519* (ASU); Nash *11959* (MSC-335429). **UNITED STATES.** Arizona. **Cochise Co.** Hertel *40053a* (M); Lehto *s.n.*, Nash *3703*, *3740*, *3742*, *3821*, Ryan *10961*, *10978*, *10782* (ASU); Weber *s.n.*, *S8782*, *S8782*, *Exs. 408* (COLO); Weber *8782* (MSC-40696); Shushan *8782* (MSC-40696); Shushan *S-8782* (M-0061367). **Gila Co.**

Nash *7400b* (ASU). **Graham Co.** Nash *36043* (ASU). **Pima Co.** Darrow *1448* (ASU); Hertel *39915* (M-0061399); Nash *27406a*, *4090*, *4146*, Ryan *20310* (ASU). **Santa Cruz Co.** Darrow *477*, *821*, Nash *25242*, *25243*, *25355*, *25774*, *13011*, *7161* (ASU); Scheidegger *Inv. Nr. 31-39* (hb. Scheidegger); Schramm *196*, Zschau *s.n.* (ASU). **COLORADO. Colorado Co.** Shushan *8185* (MSC-40707). **MISSOURI. Taney Co.** Wetmore *69088* (MIN). **NEW MEXICO. Doña Ana Co.** Nash *7922* (ASU). **San Miguel Co.** Nash *16048* (ASU). **Sierra Co.** Nash *7116* (ASU). **Soccoro Co.** Shushan *S-6932* (M-0061365). **SOUTH DAKOTA. Custer Co.** Wetmore *10175* (MSC-70750). **TEXAS. Brewster Co.** Nash *15037a* (ASU); Wetmore *18488b*, *19391* (MIN, M-00613161); Anderson *S-18696* (M-0061366); Wetmore *19417* (MSC-374082); Anderson *18696* (MSC-45835); Shushan *18696* (MSC-45835).

Buellia vilis Th. Fr., Kgl. Vetensk. Akad. Handl. 7(2): 44 (1867) **FIGURE 11**

Type: NORWAY. SVALBARD (= SPITSBERGEN). On western sea-shore rocks. [original label data: ad saxa litore occidentali], Nordenskjöld *s.n.* (UPS? - type not seen).

Taxonomic note: Type material of Th. Fries at UPS may be lost and a neotype may have to be selected. Scheidegger (1993) also did not see the type. The protologue and the descriptions in Leighton (1868) and Steiner (1907) are, however, very detailed and it can be reasonably assumed that the type shows the same characters as described there.

A specimen from Körber's "Typenherbar" in L is annotated as *B. vilis* (L-0065286). This specimen, however has hyaline, non-septate ascospores and possibly belongs to *Lecidella*.

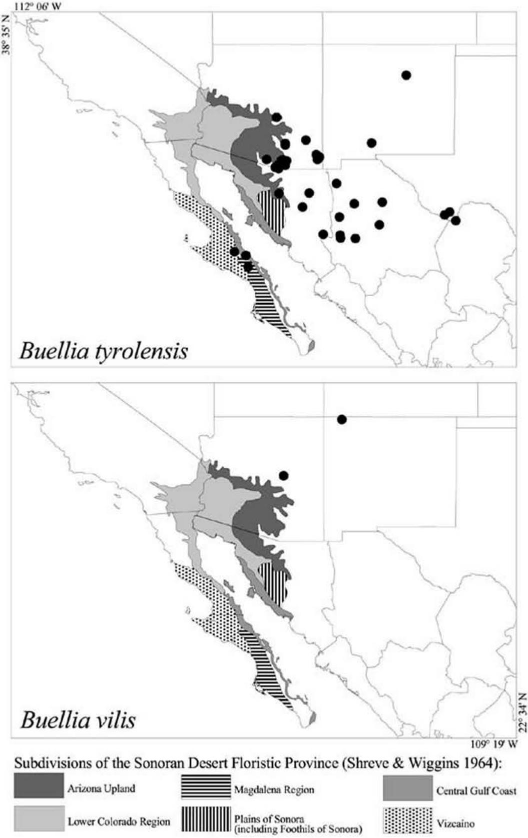
Buellia vilis is *not* closely related to *B. notabilis* Lynge even though the protologue and a description of *B. notabilis* by Thomson (1997) suggest otherwise. A "kleptotype" specimen of *B. notabilis* at MSC has a distinctly epilithic, areolate, gray thallus with a non-amyloid medulla (I-). The lecideine apothecia of this specimen are sunken between the areoles. Because of a *Lecanora*-type ascus and hyaline hypothecium, *B. notabilis* may better be placed into *Rinodina*.

For synonyms of *B. vilis* see Scheidegger (1993).

THALLUS—(Fig. 11A, B) Crustose, thin, discontinuous, hidden, chasmolithic; i. e. forming inconspicuous, poorly delimited granules between the mineral grains of the substrate; prothallus absent; thallus surface matt and dull, not shiny, usually pale gray, rarely pale brown, epruinose, phenocorticate; lacking crystals within thallus medulla (H_2SO_4–).

→

Fig. 12: Distribution of *Buellia tyrolensis* and *Buellia vilis* in the Sonoran Desert Region (Floristic Provinces according to Shreve & Wiggins 1964).


112° 06' W
38° 35' N
Buellia tyrolensis
Buellia vilis
22° 34' N
109° 19' W
Subdivisions of the Sonoran Desert Floristic Province (Shreve & Wiggins 1964):
Arizona Upland
Lower Colorado Region
Magdalena Region
Plains of Sonora (including Foothils of Sonora)
Central Gulf Coast
Vizcaino

Accepted name	Recent Synonym(s)	References
B. aethalea		Bungartz & Nash (2004c). The Bryologist, in press.
B. argillicola		current article
B. badia	*B. turgescens*	Bungartz & Nash (2004b). The Bryologist 107:21-27.
B. christophii		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. concinna	*B. semitensis*	Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. dispersa	*B. retrovertens*	Bungartz Scheidegger & Nash (2002) Bibl. Lich. 82: 19-35.
B. eganii		Bungartz & Nash (2004c). The Bryologist, in press.
B. halonia		Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. lacteoidea		Bungartz & Nash (2004c). The Bryologist, in press.
B. lepidastroidea		current article
B. mamillana	*B. glaziouana*, *B. thomae*	Bungartz, Elix & Nash (2004b). The Bryologist, in press; Weber (1986). Mycotaxon 27:451-497.
B. nashii		current article
B. navajoensis		current article
B. paniformis		Weber (1971). The Bryologist 74:185-191.
B. prospersa	*Amandinea lecideina*	Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. pullata		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. regineae		current article
B. ryanii		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562
B. sequax	*B. saxicola*	Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562, Scheidegger (1993). Lichenologist 25:315-364.
B. sheardii		current article
B. spuria		Bungartz & Nash (2004c). The Bryologist, in press.
B. stellulata		Bungartz & Nash (2004c). The Bryologist, in press.
B. subaethalea		Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. subalbula	*B. maritima*	Bungartz & Nash (2004a) Bibl. Lich. 88:49-66.
B. subdisciformis		Scheidegger (1993). Lichenologist 25:315-364.
B. tergua		Bungartz, Nash & Ryan (2004a). Can. J. Bot. 82: 540-562.
B. tesserata	*B. fimbriata*, *B. cerussata*	Rico et al. (2003). Lichenologist 35:117-124
B. trachyspora		Bungartz, Elix & Nash (2004b). The Bryologist, in press.
B. tyrolensis	*B. novomexicana*, *B. fusca*	current article
B. uberior		Scheidegger (1993). The Lichenologist 25:315-364, Scheidegger (1987). Botanica Helvetica 97:99-116.
B. vilis		current article

Table 1: References to detailed descriptions of all species known from the Sonoran Desert Region, including recent synonyms.

APOTHECIA—Lecideine, (0.2–)0.5–1.1(–1.2) mm in diameter, soon sessile; proper margin thin, black, usually persistent, rarely excluded with age; disc black, epruinose, plane, ± becoming slightly convex with age; proper exciple of the *vilis*-type (**Fig. 11C, D**) *sensu* Scheidegger (1993), i.e. inner excipular hyphae hyaline (reacting strongly I+ blue), prosoplectenchymatous, loosely interwoven (*textura intricata*), transient with the hyaline hypothecium (reacting strongly I+ blue, *textura intricata*), outer excipular hyphae parallel, thin (*textura oblita*) and usually very strongly carbonized with large amounts of a dull brown-red to blackish pigment (*atra*-red, HNO_3+ deep purple), pigmentation continuous with the epihymenium; hymenium hyaline, not inspersed; paraphyses simple to moderately branched, apically swollen, with a deep brown to black pigment cap (*atra*-red, HNO_3+ deep purple).

ASCI—8-spored, clavate, *Bacidia*-type. **ASCOSPORES**—oblong to ellipsoid, usually constricted (with age), with obtuse ends, not curved, (12.0–)13.1–[14.5]–15.9 (–18.0) x (5.0–)5.7–[6.6]–7.4(–9.0) µm (n = 60); one-septate, proper septum narrow, not thickened during spore ontogeny, lateral wall thickenings absent [*Beltraminea* (=*Buellia*)-type]; ornamentation absent (not visible in DIC).

PYCNIDIA—Very rare, unilocular, at maturity almost entirely occupied by densely branched conidiophores; conidiogeneous cells mostly terminal, rarely also intercalary (cf. conidiophore-type V *sensu* Vobis 1980); pycnidial ontogeny similar to the *Umbilicaria*-type (sensu Vobis 1980 and Vobis & Hawksworth 1981); conidia simple, bacilliform, 4.5–7.0x 0.5–1.0 µm (n = 20).

CHEMISTRY—No substances found with TLC. All spot tests negative (K–, P–, C–, KC–, CK–). UV– (dark). The thallus hyphae react very strongly amyloid like the hyphae in the apothecium (even if tested with low iodine concentrations!).

SUBSTRATE AND ECOLOGY—According to Scheidegger (1993) typicallly found on small pebbles in exposed habitats. The specimens from Arizona and New Mexico were found on sandstone.

DISTRIBUTION (Fig. 12)—The species appears to be extremely rare in the Sonoran Desert Region and is probably restricted to montane to subalpine or even alpine habitats. A single record is currently known from the Mogollon Rim in Arizona. A second specimen, deposited at ASU has been collected at 1768 m elevation outside the Sonoran Region in New Mexico (Rankert *116*).

NOTES—*Buellia vilis* has frequently been reported from the North American Southwest but almost all reports are erroneous and based on misidentifications of *B. sequax* (Nyl.) Zahlbr. (see Bungartz et al. 2004a). Until recently, no single specimen was known from the area (Bungartz & Nash III 2004b). *Buellia vilis* is very isolated even within an expanded genus concept of *Buellia* s.l. because of the unique exciple type characterized by a pigment not found in any other species. The species may best be placed in a monotypic genus but the genus concept in *Buellia* is currently not well resolved and the introduction of new genera may only contribute to further confusion.

REPRESENTATIVE SPECIMENS EXAMINED—AUSTRIA. Tirol. Arnold *s.n.* (M-0061300). **FRANCE. Hautes Pyrenées.** Scheidegger *Inv. Nr. 8056*, 8383, *8498*, *8501* (hb. Scheidegger). **ITALY. Trentino (= South Tirol).** Arnold *s.n.* (M-0061301, M-0061302). **UNITED STATES. Alaska. North Slope Co.** Fryday *8279* (MSC). **Arizona. Cocinino Co.** Hertel *40242* (M). **New Mexico. San Juan Co.** Rankert *116* (ASU).

Key

Saxicolous species of *Buellia* s.l. with one-septate ascospores in the Sonoran Desert Region

1 Thallus parasitic on other lichens **2**

Thallus not parasitic **3**

2(1) Thallus deep brown, bullate-areolate to distinctly squamulose, parasitic on a variety of lichen genera including *Xanthoparmelia*, *Acarospora* and *Dimelaena*, medulla KC–, C– (without secondary metabolites or traces from the host lichen), spore ornamentation indistinct .... ***B. badia*** (Fr.) A. Massal.

Thallus light gray to dark gray, areolate, forming distinct insular patches in *Schaereria fuscocinerea*, medulla KC+ fleeting pink, C+ fleeting pink (medulla with gyrophoric acid), spore ornamentation striate .... ***B. uberior*** Anzi

3(1) Thallus C+ orange, KC+ orange (with xanthones) **4**

Thallus C–, KC– (with or without xanthones) **5**

4(3) Thallus granular to minutely bullate, not areolate; prothallus absent; spores with ± tapered ends, frequently curved and crescent-shaped, rarely not curved and ± citriform; exciple brown (HNO_3–); montane to subalpine .... ***B. concinna*** Th. Fr.

Thallus thick, areolate, usually with a distinct black prothallus along the margin; spores ellipsoid to oblong, with obtuse ends, not curved; exciple aeruginose (HNO_3+ violet); coastal .... ***B. halonia*** (Ach.) Tuck.

5(3) Inner exciple distinctly paraplectenchymatous, formed by large, leptodermatous, ± isodiametric cells; outer exciple very strongly carbonized (small, globular cells barely discernible, even in thin microtome sections); spores with a coarsely rugulate to areolate ornamentation (clearly visible at 400x); rare, subtropical; in the Sonoran Desert Region currently known only from Sinaloa and Chihuahua, Mexico .... ***B. trachyspora*** Vain.

Inner exciple not paraplectenchymatous, formed by mesodermatous hyphae;

outer exciple moderately to strongly carbonized (individual cells discernible, at least in thin microtome sections); spores smooth or ornamented but not coarsely areolate (ornamentation, if present, barely visible at 400x); more widely distributed 6

6(5) Thallus with a chalky consistency, containing large amounts of Ca-oxalates (clusters of sulphate needles in H_2SO_4); cortex roughened, often strongly pruinose; substrate usually calcareous, (HCl+) 7

Thallus not chalky, without Ca-oxalates (H_2SO_4–), cortex smooth but sometimes obscured by fine pruina; substrate usually not calcareous (HCl–) **11**

7(6) Medulla amyloid (I+ blue) **8**

Medulla not amyloid (I-) **9**

8(7) Thallus thin, rimose (finely fissured), subeffigurate; bright white; without xanthones; apothecia with thick, persistent, lecideine margin; spores rugulate, oblong to ellipsoid; spore septum not thickening during ontogeny ....
.... ***B. argillicola***

Thallus thick, distinctly areolate (cracked) to sublobate; ivory, pale beige or with faint pinkish tinge; containing xanthones; apothecia with thin, ± reduced lecideine margin; spores microrugulate to faintly striate, oblong to narrowly oblong, spore septum soon, but only briefly thickening during ontogeny ....
.... ***B. navajoensis***

9(7) Thallus rimose to rimose-areolate, ± continuous, usually delimited by distinctly blackened, rarely pale prothallus; apothecia immersed to adnate; exciple narrow, often reduced to few hyphae similar in structure and orientation to the paraphyses, end cells distinctly swollen, with fuscous brown pigment cap and diffuse, aeruginose pigment (HNO_3+ violet), diffuse pigment extending across epihymenium; species restricted to coastal habitats ....
.... ***B. subalbula*** (Nyl.) Müll. Arg.

Thallus areolate to subsquamulose, rarely sublobate, ± continuous to dispersed, not delimited by prothallus; apothecia soon sessile; exciple distinct, strongly developed, inner hyphae pigmented, mesodermatous, extending from reddish brown hypothecium, outer hyphae moderately swollen with fuscous pigment cap, aeruginose pigment absent (HNO_3–) or restricted to outermost exciple cells; widely distributed throughout the Sonoran Desert Region **10**

10(9) Outermost exciple with small amounts of diffuse aeruginose pigment (HNO_3+ violet); thallus usually K+ orange to red (orange, needle-shaped crystals), rarely K+ yellow or K– (no crystals); with norstictic and/or stictic acid .... ***B. nashii***

Outermost exciple cells without diffuse aeruginose pigment (HNO_3–); thallus K– or K+ yellow (no crystals); with 2'-*O*-methylperlatolic acid .... ***B. dispersa*** A. Massal.
(**Note:** A revision of this morphologically variable species group using both classical and molecular data is currently in progress. For a distinction of three morphotypes see Bungartz et al. 2002)

11(6) Thallus indistinct, chasmolithic to endolithic, dispersed granules hidden among mineral crystals or entirely hidden **12**

Thallus distinct, epilithic, establishing a ± continuous crust on the substrate surface **14**

12(11) Spores with ± persistent septum thickenings; thallus pale yellow or whitish, containing xanthones (UV± pale to bright yellow or orange); conidia filiform; restricted to coastal habitats .... ***B. prospersa*** (Nyl.) Riddle
(**Note:** Specimens of *B. prospersa* are usually distinctly epilithic but rarely have a poorly developed and ± discontinuous thallus, which may appear chasmolithic, see Bungartz et al. 2004a)

Spores without septum thickening; thallus absent or white to pale gray, without xanthones (UV– or UV± pale but not bright yellow or orange); conidia bacilliform; not restricted to coastal habitats **13**

13(12) Thallus endolithic to chasmolithic; hyphae strongly amyloid (I+ blackish blue); hypothecium and inner exciple hyaline, outer exciple strongly carbonized with blackish red pigment (HNO_3+ deep purple); spores broadly oblong to ellipsoid; in the Sonoran Region currently known from a single locality (along the Mogollon Rim) .... ***B. vilis***

Thallus chasmolithic; hyphae not amyloid (concentrated I–); hypothecium deep reddish brown, outer exciple weekly carbonized with a brown pigment (HNO_3–); young spores narrowly oblong, becoming ellipsoid with age; common throughout the Sonoran Region .... ***B. sequax***

14(11) Hymenium inspersed with oil droplets (especially in KOH) **15**

Hymenium not inspersed **16**

15(14) Medulla not amyloid (I–); thallus ± continuous to dispersed, apothecia small, usually < 0.8 mm (rarely up to 1.1 mm) in diameter; spores 7–17 x 5–8 μm, with distinct septum thickening but no lateral wall thickenings .... ***B. lepidastroidea***

Medulla amyloid (I+ blue); thallus ± continuous, not becoming dispersed; apothecia large, up to 1.5 mm in diameter; spores 11–19 x 5.5–10 μm, with distinct septum thickening and inconspicuous lateral wall thickenings .... ***B. regineae***

16(14) Thallus granular-areolate to verrucose; each spore cell covered by a broad, darkened band .... ***B. subaethalea*** de Lesd.

Thallus not granular or verrucose, but sometimes bullate or subsquamulose to squamulose; spore cells not covered by darkened bands **17**

17(16) Thallus areolate to squamulose or sublobate; apothecia soon sessile; hypothallus absent **18**

Thallus rimose to areolate, not subsquamulose or sublobate; apothecia immersed, becoming sessile with age; usually with a distinct, black hypothallus, rarely hypothallus absent **21**

18(17) Thallus deep "chocolate" brown, epruinose; forming bullate to subsquamulose areoles or distinct squamules; juvenile thalli frequently parasitic, but becoming independent with age; secondary metabolites absent (or traces from the host lichen) .... ***B. badia***

Thallus not deep brown (ivory, pale brown, olive brown or dark gray); with or without pruina; never parasitic; with various secondary metabolites **19**

19(18) Thallus with diploicin, pale brown to tawny yellow ("*isabelline*") and shiny, rarely with whitish pruina, forming strongly swollen, bullate areoles ("bread-loaves"); epihymenium of immature apothecia shedding a thin epinecral layer when emerging through the thallus surface, exciple of young apothecia with a thin thalline collar, which is soon shed; coastal, rare (currently known only from Guadelupe Island and few localities on the Baja peninsula) ....
.... ***B. paniformis*** W.A. Weber

Thallus without diploicin, areolate to subsquamulose or sublobate; epihymenium not covered by epinecral surface layer, not emerging with a thalline collar; common and widely distributed throughout the Sonoran Region **20**

20(19) Outermost exciple always with small amounts of diffuse aeruginose pigment (HNO_3+ violet); thallus usually K+ orange to red (orange, needle-shaped crystals), rarely K+ yellow or K– (no crystals); with norstictic and/or stictic acid .... ***B. nashii***

Outermost exciple cells without aeruginose pigment (HNO_3–); thallus K– or K+ yellow (no crystals); with 2'-*O*-methylperlatolic acid .... ***B. dispersa***

21(17) Exciple deep brown, without aeruginose pigment (HNO_3–) **22**

Exciple and epihymenium olive brown or bluish green, rarely fuscous brown, always with an aeruginose pigment (HNO_3+ violet) **29**

22(21) Spore septum distinctly thickened during some stages of the ascospore ontogeny **23**

Spore septum not thickened during the entire ascospore ontogeny **25**

23(22) Apothecial disc deep brown, blackening with age; young apothecia lecanorine, becoming lecideine with age (i.e. thalline margin darkening and excluded by expansion of proper exciple), medulla amyloid (I+ blue, test carefully on thin thalli!) .... ***B. mamillana*** (Tuck.) W. A. Weber

Apothecial disc deep black, not brown; young apothecia lecideine; medulla not amyloid (I–) **24**

24(23) Thallus thin, ± continuous, pale yellowish, ivory or yellowish green, containing xanthones; all spot test reactions negative; apothecial margin thin, indistinct; exciple narrow, reduced to a few leptodermatous hyphae similar in structure and orientation to the paraphyses (*aethalea*-type); outer exciple cells strongly inflated, carbonized by a brown pigment cap; spores smooth to microrugulate; septum thickening ± persistent; conidia filiform .... ***B. prospersa***

Thallus moderately thickened, continuous, pale beige to pale brown; without xanthones, usually with atranorin and norstictic acid (K+ yellow to orange, forming crystals, P+ yellow), rarely also with gyrophoric acid (C+ pink, fleeting); apothecial margin thick, prominent; exciple broad, not reduced, of mesodermatous interwoven hyphae similar in structure to the hypothecium, outer exciple cells barely inflated, brown pigmentation ± evenly distributed throughout (*leptocline*-type); spores microrugulate to rugulate; septum thickening soon reduced; conidia bacilliform to fusiform .... ***B. subdisciformis*** (Leight.) Vain.

25(22) Hypothecium hyaline; apothecia remaining immersed between areoles, disc ± irregularly deformed by adjoining areoles; with lecanoric acid (C+ fleeting pink, KC+ fleeting pink or C–, KC–); subalpine to alpine, rare, known from San Francisco Peaks and White Mountains (Arizona), Lake Peak and Sierra Blanca Peak, (New Mexico) .... ***B. eganii*** Bungartz

Hypothecium reddish brown; apothecia emergent; disc circular, not deformed; without lecanoric acid (C–, KC–); coastal or more widely distributed montane species **26**

26(25) Thallus pale gray to white, not beige or deep brown; spores distinctly rugulate; with divaricatic acid and biosynthetically related substances........................... .... ***B. tesserata*** Körb.

Thallus deep brown to olive brown, rarely pale; spores smooth or microrugulate; no divaricatic acid or related substances **27**

27(26) Thallus distinctly areolate, thin to moderately thickened, deep brown to olive brown; with distinct black hypothallus delimiting the thallus and often extending between the areoles, inland .... ***B. tyrolensis***

Thallus rimose to rimose-areolate, thin, not olive, usually deep brown, rarely pale brown; without a hypothallus, coastal and inland **28**

28(27) Premature spores with evenly thickened wall, ± globose, becoming ellipsoid with age; margin prominent, thick, rarely excluded; outer exciple > 20 μm wide in cross section, conidia bacilliform .... ***B. christophii*** Bungartz

Spores of all stages thin-walled, ellipsoid to oblong; lecideine margin thin, usually excluded; outer exciple < 20 μm in cross section; conidia filiform .... ***B. pullata*** Tuck.

29(21) Medulla (at least in parts) amyloid (I+ blue).. **30**

Medulla not amyloid (I–).. **34**

30(29) Medulla K–, KC+ pink and C+ pink (gyrophoric acid), rare .... ***B. uberior*** (**Note**: In the Sonoran region only parasitic material on *Schaereria fuscocinerea* has so far been observed. The species is keyed out here, because non-parasitic type material of *B. malmei* Lynge from Novaya Zemlya (arctic Russia) is anatomically, morphologically and chemically identical and possibly a rare form of *B. uberior* that develops independent thalli.)

Medulla K+ orange to red (orange, needle-shaped crystals), KC– and C–; with norstictic acid **31**

31(30) Young spores with distinct septum thickening, medulla strongly amyloid, even if tested on thallus surface (I+ blackish blue), apothecia remaining immersed, not emerging from thallus, often deformed by adjoining areoles, rarely with a thalline veil; differentiated into distinct, hyaline subhymenium gradually merging into pale to deep reddish brown hypothecium ....
.... ***B. lacteoidea*** de Lesd.

Young spores without septum thickening, medulla amyloid, but reaction obscured if tested on thallus cortex (I+ blue), apothecia immersed to sessile, deformed or not, with or without thalline veil, hypothecium not differentiated from subhymenium, but sometimes hyaline **32**

32(31) Apothecia soon sessile, with thick and prominent lecideine margin; rarely with thalline veil; inner excipular hyphae broad, radiating from deep reddish brown hypothecium, with a narrow, hyaline transition zone and distinctly swollen, pigmented outer exciple cells (*dispersa*-type); conidia > 5 μm long, ± fusiform .... ***Buellia sheardii***

Apothecia immersed to adnate, with thin lecideine margin, young apothecia usually with distinct thalline veil; inner excipular hyphae thin, ± reduced and hyaline, not distinctly radiating from the hypothecium, similar in structure and orientation to the paraphyses, with moderately swollen, pigmented outer exciple cells (*aethalea*-type); conidia < 5 μm long, ± bacilliform **33**

33(32) Thallus with atranorin and norstictic acid; apothecia initially immersed, becoming sessile, circular, not deformed, young apothecia frequently with thalline veil, hypothecium reddish brown throughout; montane, common .... ***B. spuria*** (Schaer.) Anzi

Thallus with norstictic acid only, no other substances; apothecia immersed, not becoming sessile, without thalline veil, often deformed ("comma-shaped"); hypothecium hyaline throughout (at least in all specimens from the Sonoran Region); montane, rare .... ***B. aethalea***

34(29) Apothecia remaining immersed, not emerging, often deformed ("comma-shaped"), rarely circular; all Sonoran specimens with hyaline to pale brown hypothecium; with norstictic acid only, K+ orange to red (orange, needle-shaped crystals); inland .... ***B. aethalea***

Apothecia initially immersed, emerging, not deformed; hypothecium dark reddish brown; norstictic acid absent, K+ yellow (no crystals forming) or K–; coastal **35**

35(34) Thallus white to dark gray, not olive or brown; with atranorin and 2'-*O*-methylperlatolic acid; K+ yellow; young apothecia immersed, but not aspicillioid, becoming adnate to sessile, usually emerging with thalline veil .. .. ***B. stellulata*** (Taylor) Mudd

Thallus brown or olive gray; no secondary metabolites detected; K–; young apothecia immersed, appearing aspicillioid ("bursting through the thallus surface"), becoming adnate to sessile with age, rarely with remains of necrotic material attached to margin (indistinct thalline veil) **36**

36(35) Thallus reddish brown ("leather-colored"), rimose, not delimited by distinct hypothallus, exciple deeply aeruginose, ascospores 10–15 x 6–9 μm; conidia 4–7 μm .... ***B. tergua*** Bungartz

Thallus olive gray to brownish olive, distinctly areolate in the center, with intermediate undifferentiated transition zone along the margin, rising from distinct black, arachnoid hypothallus, exciple fuscous brown, ascospores 9–13 x 4–8 μm; conidia 2-5 μm .... ***B. ryanii*** Bungartz

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Cumminsiella mirabilissima on *Mahonia aquifolium* in Turkey

ELŞAD HÜSEYIN

elsadhuseyin@hotmail.com
Gazi University, Kırşehir Arts and Sciences Faculty
Kırşehir, 40100, Turkey

Abstract—*Cumminsiella mirabilissima* on *Mahonia aquifolium* is reported for the first time from Turkey. The morphological features of this fungus are described and illustrated.

Key Words—Rust fungi, *Pucciniaceae,* microscopical features, Anatolian Peninsula

Rust symptoms have been observed on *Mahonia aquifolium* (Pursh) Nutt. growing in the Campus of Kırşehir Arts and Sciences Faculty and Japan Garden (Central Anatolia). The causal agent of this disease has been identified as *Cumminsiella mirabilissima* (Peck) Nannf. [= *Cumminsiella sanguinea* (Peck) Arthur, = *Uropyxis sanguinea* Arthur] (Gäumann 1959; Wilson & Henderson 1966; Kuprevich & Uljanishchev 1975; Ellis & Ellis 1987; Cummins & Hiratsuka 2003). The description drawn up from our Turkish materials. The collections concerned are characterized by the following microscopical features:

Leaf spots bilateral. On the upper surface reddish, on the lower surface brown, minute occasionally. *Spermogonia* epiphyllous and very seldom hypophyllous. *Aecia* hypophyllous, sometimes on petioles and veins, in groups, pale-brown; *aeciospores* angular-globoid or globoid, (17.5–) 22–25 x (15–)17.5–20(–22) μm; wall very finely echinulate, pale-yellow, uniformly 1 μm thick. (Fig. 1 A). *Uredinia* hypophyllous, very rarely epiphyllous, scattered or in small groups, minute, compact, chestnut-brown; *urediniospores* obovoid, almost fusiform or ellipsoid, (27.5–)32.5–35(–38) x (15–)17–20 μm; wall 2–2.5 μm thick, finely warted, yellow gold, with 2 equatorial pores; pedicels colorless, weak, easily broken down. (Fig. 1 B). *Telia* hypophyllous, not very numerous, cushion-shaped, powdered, rarely confluent, chestnut-brown; *teliospores* two celled, ellipsoid or oblong-ellipsoid, rounded at both ends, constricted at the septum, (27.5–)30–35 x 20–22.5 μm; wall 3–5 μm thick, brown-chestnut, of 3 layers: first layer innermost, smooth; second – average, warty; third – outermost, weakly noticeable, cuticularised layer; wall with 2 equatorial pores in each cell; pedicels hyaline, easily broken down with spore from substrate, sometimes oblique attached, swollen at the base, 65–90 x 6–9 μm. (Fig. 1 C).

Autoecious and macrocyclic species.

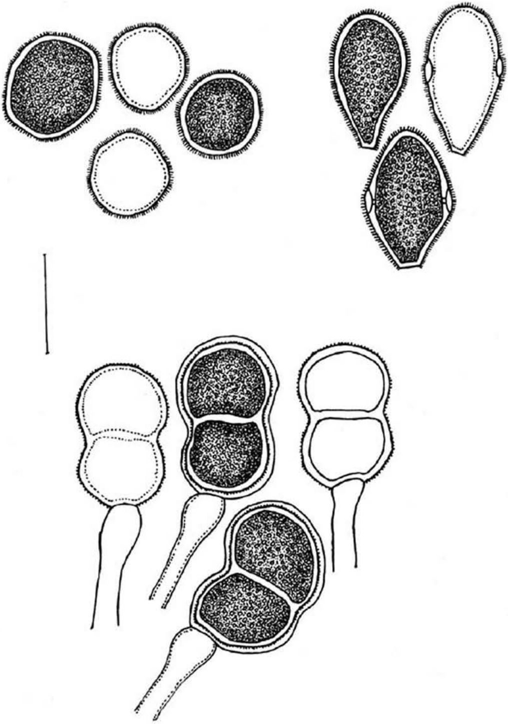

Fig. 1. *Cumminsiella mirabilissima:* A. *Aeciospores;* B. *Urediniospores;* C. *Teliospores.* Scale bar = 20 μm.

SPECIMENS EXAMINED: Turkey, Kırşehir Prov., Gölhisar, Petlas, Campus of Gazi University Kırşehir Arts and Sciences Faculty, on *Mahonia aquifolium* (Pursh)Nutt., 39° 4' 53" N, 34° 12' 30" E, 1235 m a.s.l., 17-IV-2002, E.Hüseyin (EH 1141); Kırşehir Prov., Kaman, Çağırkan, Japan Garden, on *Mahonia aquifolium*, 39° 19' 22" N, 33° 43' 12" E, 1400 m a.s.l., 20-IX-2002, E.Hüseyin (EH 1142).

The specimens are deposited in the Herbarium of the Gazi University, Kırşehir Arts and Sciences Faculty, Kırşehir, Turkey.

Cumminsiella mirabilissima is known on *Mahonia aquifolium* from Europe (Wilson & Henderson 1966; Kuprevich & Uljanishchev 1975; Denchev 1995), Central and North America (Farr & al. 1995).

Before our investigations 290 species from 13 genera of rust fungi were reported from Turkey (Tamer & al. 1998; Kirbag, Civelek & Huseyinov 2001; Huseyin & Kirbag 2003). There are no records of the genus *Cumminsiella* Arthur in these publications. This is the first report of genus *Cumminsiella* and *C. mirabilissima* from Turkey.

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MYCOTAXON

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Interesting taxa of *Meliolaceae* in HMAS, China

BIN SONG* & TAI-HUI LI

binsong@gdas.ac.cn
Guangdong Provincial Key Laboratory of Microbial Culture
Collection and Application; Guangdong Institute of Microbiology
Xianlie Road Central, Guangzhou 510 070,China

Abstract—This paper gives an account of five meliolaceous fungi in the Herbarium Mycologicum Instituti Microbiologici, Academiae Siniae (HMAS), China. Of these, *Appendiculella malaisiae* and *Meliola sawadae* are described and illustrated as new species.

Key words—*Capparaceae, Meliolales, Moraceae*

Appendiculella malaisiae B. Song, *sp. nov.* **Fig. 1**

Similis Appendiculella tonkinensis et A. tonkinensis var. cecropiae sed differt appressoriis brevioribus et ascosporis brevioribus et latis.

Etymology: *malaisiae*, in reference to the host species, *Malaisia scandens*.

Colonies amphigenous, black, nearly velvety, scattered, up to 6 mm in diameter, rarely confluent. Hyphae brown, nearly straight, alternately branching, closely reticulate, cells mostly 25–45 *x* 6-8 μm. Appressoria in alternate or unilateral arrangement, spreading, nearly straight or bent, 22–37 μm long; stalk cells cuneate to cylindrical, 7.5–22 μm long; head cells nearly ellipsoid, entire or nearly lobate, 15–17 *x* 13–15 μm. Phialides mixed with appressoria, opposite or alternate, scattered, ampulliform, 20–28 *x* 5.5–7.5 μm. Mycelial setae absent. Perithecia scattered or nearly aggregate, black, globose, verrucose, up to 220 μm in diameter, larviform appendages mostly 6-9, brown, transversely striate, conoid to mammillate, attenuate upwards, obtuse to nearly acute at apex, straight to slightly curved, projecting up to 20–45 μm, 20–35 μm broad at base. Ascospores brown, cylindrical, obtuse or nearly acute at ends, 4–septate, constricted at septum, 43–45 *x* 12–13 μm.

Holotype: *On leaves of Malaisia scandens (Lour.) Pl. (Moraceae). Lianchang County, Zhanxian, Hainan Province, China. August 8, 1956, G.Z. Jiang. HMAS 20689.*

So far, four taxa of *Appendiculella* occuring on members of the family Moraceae, namely *Appendiculella echinus* (Henn.) Höhn., *A. echinus* var. *domingensis* Hansf., *A. tonkinensis* (P. Karst. & Roum.) Toro, and *A. tonkinensis* var. *cecropiae* (F. Stevens) Hansf. have been found from Brazil, Guiana, Panama, San Domingo, and the Asian tropical region (Toro 1927; Hansford 1961). The main distinguishing characters of *A.*

echinus and *A. echinus* var. *domingensis* are that their ascospores are all wider (15-18 μm for *A. echinus* and 17–18 μm for the variety), their larviform appendages are also longer (up to 180 μm for *A. echinus* and 80 μm for the variety); and of *A. tonkinensis* and *A. tonkinensis* var. *cecropiae* are that their appressoria are shorter (14–22 μm for *A. tonkinensis*, 13-20 μm for the variety), their ascospores are shorter and broader (37–43 *x* 15-16 μm for *A. tonkinensis*, 32–35 *x* 14–15 μm for the variety); in addition, the ascospores of *A. tonkinensis* are fusoid, allowing easy distinction from the new species.

This is the first record of the genus *Appendiculella* parasitic on the genus *Malaisia*.

Armatella longispora W. Yamam., Sci. Rep. Hyogo Univ. Agr. Ser Agr. Biol. 3:19. 1957

On leaves of *Cinnamomum comphora* Sieb.(*Lauraceae*). Tianjin River, Sichuan Province, China. September 29, 1956, HMAS 20688.

This species was recorded from Taiwan, Guangdong, and Anhui in China (Hu et al. 1996).

Asteridiella malloticola (W. Yamam.) Hansf., Sydowia 10:49. 1956

On leaves of *Mallotus apelta* (Lour.) Muell.-Arg. (*Euphorbiaceae*). Xinglong, Hainan Province, China. July 3, 1956, S. J. Han, HMAS 33462.

This species was recorded from Taiwan, Guangdong, and Yunnan in China, and is also distributed in India and the Philippines.

Meliola champereiae Syd. & P. Syd., Ann. Mycol. 12:540. 1914

On leaves of *Champereia manillana* Merr. (*Opiliaceae*). Chishui,Taizhong, Taiwan Province, China. November 29, 1928, K. Sawada, HMAS 05100.

This species was recorded from Taiwan in China, and is also distributed in the Philippines (Hu et al. 1999).

Meliola sawadae B. Song, *sp. nov.* **Fig. 2**

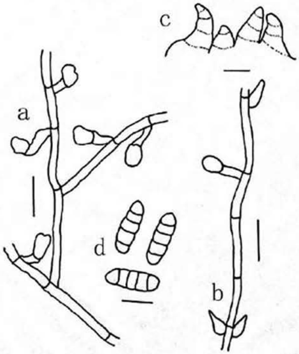
Similis Meliola balakrishnanii, M. capparidicola et M. capparidis sed differt ascosporis grandioribus.

Etymology: *this species is named in honour of the Kaneyoshi Sawada, collector of the type, a mycologist of Japan, for his outstanding contributions to study on the fungi.*

Colonies amphigenous, mostly hypophyllous, black, velvety, scattered, up to 4 mm in diameter, rarely confluent. Hyphae brown, nearly straight, oppositely branching, closely reticulate, cells mostly 20–35 *x* 7–8.5 μm. Appressoria in opposite or alternate arrangement, spreading, straight or bent, 17-25 μm long; stalk cells cuneate to cylindrical, 2.5-6 μm long; head cells nearly oblong, entire, 12–20 *x* 7.8–11 μm. Phialides mixed with appressoria, opposite or alternate, scattered, ampulliform, 16–21 *x* 6.5–8.2 μm. Mycelial setae scattered, black, simple, straight to slightly curved, acute or sometime obtuse at apex, up to 300 μm long, 7.5–8.9 μm broad at base. Perithecia aggregate, black, globose, verrucose, up to 160 μm in diameter. Ascospores brown, nearly ellipsoid or oblong, obtuse or nearly acute at ends, 4-septate, constricted at septum, 25–30 *x* 10–13 μm.

Holotype: *On leaves of Capparis kikuchii Hay.(Capparaceae). Taidong, Taiwan Province, China. April 27, 1909, K. Sawada, HMAS 05098.*

1



2

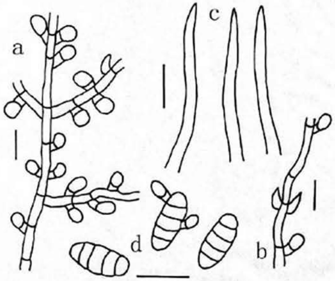


Fig.1 *Appendiculella malaisiae* (a. hyphae with appressoria; b. hyphae with appressoria and phialides; c. larviform appendages; d. ascospores) (Bars=25 μm).

Fig.2 *Meliola sawadae* (a. b. hyphae with appressoria and phialides; c. mycelial setae; d. ascospores and germinating ascospore) (Bars=25 μm).

Four species of the *Meliola* on the family *Capparidaceae*, namely *Meliola balakrishnanii* L. N. Nair & V. P. Kaul, *M. capparidicola* Hosag., *M. capparidis* Hansf. and *M. stixis* B. Song & T. H. Li have been found in India, Uganda and China (Hansford 1961; Hosagoudar et al. 1997; Song et al. 2002). The new species differs the *M. balakrishnanii*, *M. capparidicola* and *M. capparidis*, which have larger ascospores (34–50 μm long and 13–20 μm wide). In addition, the appressoria of *M. stixis* are shorter (11–17 μm) and the head cells are nearly globose or ovate (9–12.5 *x* 8.2–10.8 μm), and the mycelial setae of *M. capparidis* are dentate, distinguishing these from the new species.

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Molecular analyses confirm the relationship between *Stephanospora caroticolor* and *Lindtneria trachyspora*

M.P. MARTÍN[1], S. RAIDL[2] & M.T. TELLERÍA[1]

maripaz@ma-rjb.csic.es
[1]Real Jardín Botánico, CSIC, Plaza de Murillo 2, 28014 Madrid, Spain

[2]Ludwig-Maximilians-University Munich, Department Biology I and GeoBioCenterLMU, Biodiversity Research, Systematic Mycology, Menzinger Str. 67, D-80638 München, Germany

Abstract—The relationship between *Lindtneria trachyspora*, with resupinoid basidiomes, and *Stephanospora caroticolor*, with sequestrate basidiomes, is discussed. Analyses of the ITS1, ITS2 and 5.8 S ribosomal DNA sequences confirm the morphological and chemical affinities established by early authors.

Key words—*Stereales, Russulales, Stephanosporaceae, Lindtneriaceae*, rDNA

Introduction

The taxa included in the family *Stephanosporaceae* Oberw. & E. Horak show sequestrate habit. According to Kirk et al. (2001) and following Hibbett & Thorn (2001), this family is one of the 11 considered in the order *Russulales* Kreisel ex P.M. Kirk, P.F. Cannon & J.C. David. The only species of this family in the Northern hemisphere, *Stephanospora caroticolor* (Berk.) Pat. (Pegler et al. 1993), is very easy to recognize by the bright orange basidiome, the evanescent peridium and the characteristic spores with a peri-appendicular corona.

In the family *Corticiaceae* Herter, all the taxa have a resupinate basidiome and are included in the order *Polyporales*. In agreement with Hjortstam (1987), Kirk et al. (2001) include the species of the genus *Lindtneria* Pilát in this family. During the last year, we have studied different collections of *Lindtneria trachyspora* (Bourdot & Galzin) Pilát and *Stephanospora caroticolor*. Both taxa show the same basidiome colour and the spores have the same morphology. Based on microscopic and ultrastructural characters of both taxa (e.g. strongly sculptured spores), Oberwinkler & Horak (1979) proposed to include *Lindtneria* Pilát and *Stephanospora* Pat. in the same family (*Stephanosporaceae* Oberwinkler & Horak). The close relationship between both genera was also accepted in Jülich (1981), but he proposed the monogeneric family *Lindtneriaceae* Jülich.

The main purpose of this study was to know if molecular data support the hypothesis that *L. trachyspora* and *S. caroticolor* are closely related species.

Material and Methods

MATERIAL EXAMINED—All material is deposited in the herbarium of the Real Jardín Botánico (Madrid, Spain). *Lindtneria trachyspora*.- Germany, Bavaria, Oberbayern, district Bad Tölz-Wolfratshausen, in the valley of the river Isar between Vorderriß and Wallgau, on decayed wood lying on the riverbank, 47 33´north and 11 24´west, 795 m elev., 1/X/1997, leg. et det. S. Raidl (SR413, MA-Fungi 47773); *idem*, 19/X/1998 (SR702, MA-Fungi 47774); *idem*, 22/X/1999 (SR907, MA-Fungi 47775). *Stephanospora caroticolor:* Germany, Bavaria, Oberbayern, district Bad Tölz-Wolfratshausen mixed forest near the Pupplinger Au near Wolfratshausen, 10/X/1999, leg. Prof. W. Steglich (MA-Fungi 47684).

MOLECULAR METHODS—A small quantity (less that 10 mg) of each collection was subjected to molecular analysis of the internal transcribed spacer regions of rDNA (ITS1 and ITS2), including the 5.8S. Total DNA was isolated using E.Z.N.A. Fungal MiniPrep Kit (Omega-Biotech, Doraville, USA) as described in Martín & García-Figueres (1999). Primer pair ITS1F and ITS4 was used to obtain amplifications of both ITS regions, including the 5.8S of the ribosomal RNA gene cluster and small flanking parts of the SSU and LSU genes; primers were described in White et al. (1990). Amplifications were done using Ready-to-Go® PCR Beads (Amersham-Biosciences, UK) as mentioned in Winka et al. (1998). Results of amplifications were assayed from 5µl aliquots by gel electrophoresis of 2% Pronadisa D-1 Agarose (Lab. Conda, Spain). Amplification products were cleaned using the E.Z.N.A. Clean kit (Omega Biotech, USA) and both strands were sequenced separately using primers ITS1F and ITS4 at the Authomatic Sequencing Service (CIB-CSIC, Madrid). Sequence Navigator ™ Sequence Comparison software (Perkin Elmer, USA) was used to identify the consensus sequence from the two strands of each ITS region. The new sequences have been logged in the EMBL database with the Accession Numbers AJ419224 (*Stephanospora caroticolor* MA-Fungi 47686) and AJ419225 (*Lindtneria trachyspora* MA-Fungi 47774). SEQAPP software for multiple sequences was used to compare these sequences. Alignment gaps were marked.

Results and Discussion

MORPHOLOGY—As shown in Fig. 1, the spores in both taxa are globose, spinulose with peri-appendicular corona. *Lindtneria trachyspora* is the only species of this genus in Europe with globose and spinulose spores. Spores of the other two species mentioned in Ryvarden & Gilbertson (1993), *L. leucobryophila* (Henn.) Jülich and *L. flava* Parm., are ellipsoid and warted. Hjortstam (1987) included in his key, a species, *L. pterospora* Reid, with globose spores, but prominent wing-like crests. Oberwinkler & Horak (1979) consider that from the microscopic and ultrastructural point of view *Lindtneria trachyspora* and *Stephanospora caroticolor* are practically indistinguishable.

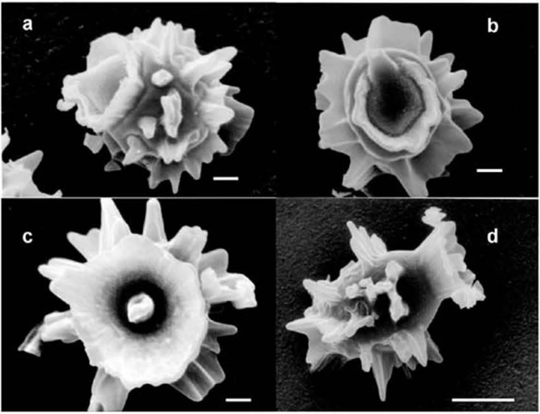

Fig. 1 Spores: a) *Lindtneria trachyspora* MA-Fungi 47773; b) *L. trachyspora* MA-Fungi 47774; c) *L. trachyspora* MA-Fungi 47775; d) *Stephanospora caroticolor* MA-Fungi 47686. (Bar figs 1-3= 1 μm; Bar fig. 4= 5 μm).

MOLECULAR ANALYSIS—The total aligned sequences ITS1-1 and ITS-2, including the 5.8S nrDNA, were 739 base pairs (bp) long, without ambiguous areas (Fig.2). The nucleotide differences among all pairwise comparisons was 37 bp in ITS1 and 31 in ITS2; there were not differences in the 5.8S rDNA gene. In ITS1 15 differences are due to deletions, 16 to transitions and 6 to transversions. In ITS2 the differences are quite similar: 16 deletions, 10 transitions and 5 transversions.

Recently, Steglich and collaborators from the Department Chemie der Universität München (Munich, Germany) have identified and isolated two pigments that give the bright orange colour to the peridium and gleba of *Stephanospora caroticolor* (Hellwig 1999, Lang et al. 2001): stephanosporin (young basidiomes) and 2-chloro-4-nitrophenol (mature basidiomes). From the methanol extractions other compounds were identified: 4-hydroxy-acetanilide (paracetamol), 4-amino-2-chlorophenol and 4-nitrophenol. These authors have found 4-nitrophenol and traces of 2-chloro-4-nitrophenol in the resupinate basidiomes of *Lindtneria trachyspora*. The oxidative transformation of stephanosporin into 2-chloro-4-nitrophenol (fungicide) is a complex enzymatic process. In agreement with Lang et al. (2001), the presence of this compound in *L. trachyspora* and *S. caroticolor* supports the inclusion of both taxa into the same family by Oberwinkler & Horak (1979). The ITS rDNA is highly variable in fungi, even among closely related taxa. Kretzer & Bruns (1997) investigated the secotioid genus *Gastrosuillus* Thiers to clarify its relationships with *Suillus* Mich. ex Gray. The phylogenetic analysis of the unambiguous sites of the alignment allowed them to transfer all known *Gastrosuillus* species to *Suillus*. Ko, Hong & Jung (1997) found that the sequences obtained from eight species of *Trichaptum* Murrill were very variable (e.g. from the 460 ITS1 positions, only 101 were optimally aligned). The alignment among our isolates has no unambiguous parts, and the sequences dissimilarities are not very high (ITS1: 37 positions: ITS2: 31 positions). However, more studies including chemical and molecular methods should be done in the other species of *Lindtneria* and *Stephanospora* to conclude that both genera belong to the same family.

The linkages between sequestrate fungi and epigeal basidiomycetes have been reported many times in the literature (Malençon 1931, Singer 1975). Molecular analyses, mainly from rDNA, give additional evidence of relationship between agarioid/boletoid and sequestrate fungi

(Hibbett et al. 1997). In particular, in the order *Boletales* (Bruns et al. 1989, Baura et al. 1992, Kretzer et al. 1996, Kretzer & Bruns 1997, Johanesson & Martín 1999), *Cortinariales* (Martín & Rocabruna 1999, Martín & Moreno 2001) and *Russulales* (Martín et al. 1999, Calonge & Martín 2000, Miller et al. 2001) these affinities have been established.

In our previous studies in *Cortinariales* (Martín & Rocabruna 1999, Martín & Moreno, 2001) based on morphological, ecological and molecular data, we conclude that the agaricoid basidiomes of *Setchelliogaster rheophyllus* (Bertault & Malençon) Malençon & Moreno (= *Naucoria rheophylla* Bertault & Malençon) and the gasteroid basidiomes of *Setchelliogaster tenuipes* (Setchell) Pouzar (=*Secotium tenuipes* Setchell) are two morphotypes of the same species. Köljalg et al. (1998) in their database of complete ITS and part of the LSU DNA included more than 40 tomentelloid and thelephoric species: parsimony and distance analyses confirmed that a *Tomentella radiosa* (P. Karst.) Rick with a resupinoid basidiome is the same species as *Thelephora terrestris* Ehrh.: Fr.

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          *       *   *** *
TRALIN_2   CATTATCGAATCGTTGAAAC TTGGCTGTCGCTGGCTTTCT CCTTCCTGGGGATCGCATGT
CARSTE_1   CATTATCGAATCGTTAAAAC TTGGCTGTCGCTGGCTCTCT CCTTCTCGAG-ATTGCATGT

                 ** !!                *                                !
TRALIN_2   GCACGCCCATGTTCAAACTT TTCATTTTAACCTCCTGTGC ACTTTTGTGGATCGTGGATG
CARSTE_1   GCACGCTTAGTTTCAAACTT TTCATTCTAACCTCCTGTGC ACTTTTGTGGATCGTGGAAG

                                                     !                  !
TRALIN_2   GATAACACTT-GTCAAAGTA ACATTTGGTTTTGGGGATCG AGAGTCTGCTTTCCCCTACT
CARSTE_1   GATAA-ACTTTGTCAAAGTA ACATTTGGTTTTGGGGATCG C-AGTCTGCTTTCCCCTACA

                     * *                                  *          *
TRALIN_2   ATTTGTCCA-CGGTTCATGT CTTTTTA-CTA--CAAACCA TTAAACAAAAA----CCTAG
CARSTE_1   ATTTGTCCAATGATTCATGT CTTTTTAACTATACAAACCA TTAAATAAAAAATAACTTAG

               *  !  *                                 !*
TRALIN_2   AATGTTTAACGAGTTGGGGA CTTTAGTGACCCTCTCTTAA AAATTTATACAACTTTCAAC
CARSTE_1   AATGCTTTACAAGTTGGG-A CTTTAGTGACCCT-TCTTAA AATCTTATACAACTTTCAAC


TRALIN_2   AACGGATCTCTTGGCTCTCG CATCGATGAAGAACGCAGCG AAATGCGATAAGTAATGTGA
CARSTE_1   AACGGATCTCTTGGCTCTCG CATCGATGAAGAACGCAGCG AAATGCGATAAGTAATGTGA

TRALIN_2   ATTGCAGATTTCAGTGAATC ATCGAATCTTTGAACGCACC TTGCACCCTGTGGTATTCCA
CARSTE_1   ATTGCAGATTTCAGTGAATC ATCGAATCTTTGAACGCACC TTGCACCCTGTGGTATTCCA

                                        !
TRALIN_2   CAGGGTATGCCCGTTTGAGT ATCATTAATTCATCAACTCC AAAACCTTTGTGTTCTTGGT
CARSTE_1   CAGGGTATGCCCGTTTGAGT ATCATTAAGTCATCAACTCC AAAACCTTTGTGTTCTTGGT

            *                               * *   *
TRALIN_2   GTTTGGTCT--GAGGGTCAT TGCAGGCTCTTTGTAAAGCC -GGCTCCCTTTAAATCCATT
CARSTE_1   GCTTGGTCTTTGAGGGTCAT TGCAGGCTCTTTATGA-GTC AGGCTCCCTTTAAATCCATT

                  *                 !      *                  *        !
TRALIN_2   AGCGAGATTTCCCTGTGCTG AACTAGTCTCTCGACGTGAT AGTCTATCTGCGTCAAATGT
CARSTE_1   AGCGAGACTTCCCTGTGCTG AACTTGTCTCTTGACGTGAT AGTCTATCTACGTCAAATTT

           !                       !                            !
TRALIN_2   AGAGTTCTCGTTGGGCTTGC TTCAAATCCGTCCTCTTTGG ACAATCGGAATAAGAGTTGC
CARSTE_1   TGAGTTCTCGTTGGGCTTGC TTCTAATC-GTCCTCTTTGG ACAATCGGAATTAGAGT-GC

            *         *                * !
TRALIN_2   ACATATCTGTGTGCATCCCT CTTTCCAGAACCATTTTGAT CTCAAATCGGGTAGGACTAC
CARSTE_1   ATATAT----GCG---CCCT -TTTC-AAATCCATTTTGAT CTCAAATCGGGTAGGACTAC

TRALIN_2   CCGCTGAACTTAAGCATAT
CARSTE_1   CCGCTGAACTTAAGCATAT
```

Fig. 2 Alignment of the ITS1 and ITS2 sequences, including the 5.8 S rDNA of *Lindmeria trachyspora* (TRALIN-2, AJ419225) and *Stephanospora caroticolor* (CARSTE-1, AJ419224) (*: transitions; !: transversions).

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A new *Neotyphodium* species symbiotic with drunken horse grass *(Achnatherum inebrians)* in China

CHUNJIE LI, ZHIBIAO NAN*
chunjie@lzu.edu.cn, zhibiao@lzu.edu.cn
College of Pastoral Agriculture Science and Technology, Lanzhou University
Gansu Grassland Ecological Research Institute
Key Laboratory of Grassland Argo-Ecosystem, Ministry of Agriculture
Lanzhou 730020, China

and

VOLKER H. PAUL, PETER D. DAPPRICH, YONG LIU
Laboratory for Biotechnology and Quality Assurance
Fachhochschule Südwestfalen, University of Applied Sciences
Soest 59494, Germany

Abstract—A new endophytic fungus has been isolated from *Achnatherum inebrians* collected from Gansu Province, China. The morphological and cultural characters are used to describe the new species, *Neotyphodium gansuense*.

Key Words—taxonomy, new taxon, alkaloids

Introduction

Drunken horse grass (*Achnatherum inebrians* (Hence) Keng) is a perennial bunchgrass, which is so named because it is associated with narcosis of horses grazing on pasture containing the grass. *A. inebrians* is mainly distributed on alpine and subalpine grasslands in Gansu, Xinjiang, Qinghai, Tibet and Inner Mongolia, China (Shi 1997). An endophytic fungus has been found in seeds, leaf sheaths and peduncles of the grass (Bruehl et al. 1994; Miles et al. 1996; Li et al. 1997, 1998; Nan & Li, 2000; Li et al. 2004). Two major ergot alkaloids, ergonovine and lysergic acid amide, have been detected from endophyte infected *A. inebrians* (Miles et al. 1996). Although these alkaloids are known to be toxic to grazing animals (sheep, goats and cattle), the link between endophyte infection in *A. inebrians* and narcosis of grazing animals in China has still to be proved experimentally. The endophyte we obtained from *A. inebrians* differs in several aspects from species already described and we therefore propose it as a new taxon.

**Corresponding author*

Materials and methods

Endophytes were isolated from pieces (5 mm long) of single tillers of *A. inebrians* placed on potato dextrose agar (PDA), as described by Dapprich *et al.* (1996). During incubation, the pieces of tiller tissue were examined periodically with a dissecting microscope (Leica MS5) for the emergence of mycelium. Contaminant fast growing fungi were discarded and uncontaminated pieces of tissue were transferred onto fresh plates of PDA until slow growing fungi appeared from the cut ends of the host tissue pieces. These colonies were later transferred onto fresh plates of PDA as pure cultures.

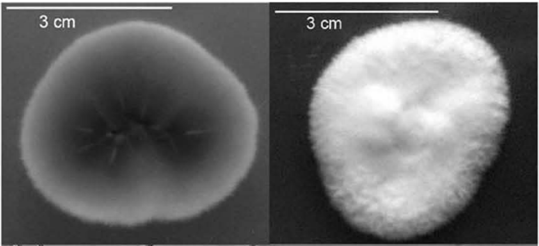
Colony diameters were measured and morphological characteristics were observed weekly. Colonies produced abundant conidia under stress conditions in the medium. Therefore, the central part (c. 1 cm in diameter) of the medium was removed and discarded to promote sporulation from the cut edge of the colony. Fifteen isolates of the fungus were obtained in total. For each isolate, 20 measurements of hyphae, conidiophores, conidia and chlamydospores were made with a light microscope (Leica DMRB).

Taxonomy description

Neotyphodium gansuense C.J. Li et Z.B. Nan *sp. nov.* **Plate 1, 2**

> Coloniae albae, gossypinae, lente crescents, 30 mm diametro aetate 28 dierum ad 22 C in PDA; reverso pallide brunneo vel brunneo. Odor nullus. Hyphae vegetativae hyalinae, septatae, 1.3-2.5 *μ*m latae. Cellae conidiogenae ex hyphis aeriis oriuudae, discretae, solitariae, orthotropicae, determinatae, 7.5-18.8 (med. 13.6) *μ*m longae, 1.3-2.5 *μ*m latae ad basim, 0.8-1.3 *μ*m latae ad apicem. Conidia solitariae, subglobosae, ellipsoidea, semiglobularea, reniformia, hyalina, saepe transversaliter affixa, 3.8-5 X 2.5-3.8 *μ*m. Chlamydosporae globosae vel subglobosae, hyalinae, laterales vel intercalares, 5-10 X 5-8 *μ*m. Telemorphosis ignota.
>
> In culturis ex culmis *Achnatheri inebrians*, in Sunanensi, Gansuensi, Sinico, C. J. Li, Sept. 2002, MHLZU-GS0201, holotypus hic designatus.

Colonies on PDA slow growing, reaching 30 mm diameter in 4 weeks at 22 C, forming a compact, centrally raised, white cottony mass of aerial hyphae. Colony reverse pigmented with pale brown to dark brown central area; fracturing of agar occurs. Odour is absent. Vegetative hyphae hyaline, septate, convoluted, coiled, sinuous, 1.3-2.5 *μ*m wide, in intercellular leaf sheath, pith of peduncle and innermost seed coat. Conidiogenous cell very sparse on PDA, arising solitarily from aerial hyphae, discrete, orthotropic, unbranched, hyaline, sometimes with a basal septum, 7.5-18.8 (mean 13.6) μm long, and gradually tapering from 1.3-2.5 μm wide at the base to 0.8-1.3 μm at the tip. Sporulation is rare on PDA unless the colony is stressed. Conidia solitary, subspherical, short ellipsoid, semiglobular, hyaline, smooth-walled, 3.8-5 x 2.5-3.8 μm, often attached transversely across the conidiogenous cell at the apex. Chlamydospores terminal or intercalary in chains, hyaline, smooth-walled, spherical to subspherical, 5-10 x 5-8 μm. Teleomorph unknown.



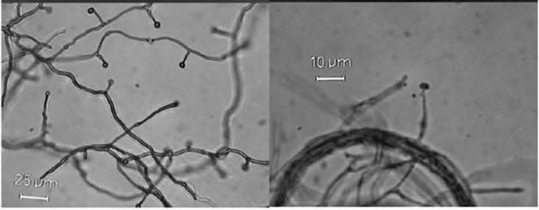


Plate 1 *(top)*. Reverse (*left*) and upper (*right*) view of *N. gansuense* on PDA after six-weeks inoculation at 22 C under continuous dark.

Plate 2 *(bottom)*. Conidiophores and conidia of *N. gansuense* on PDA under a light microscope. *Left:* Unstained with green filter; *Right:* Stained with 0.8% aniline blue.

Isolated from culms and leaf sheaths of plants grown from seeds of *A. inebrians* originally collected from a deer farm in Sunan County, Gansu Province, China in September 2002 by C.J. Li, deposited in Mycological Herbarium of Lanzhou University, China. (MHLZU-GS0201).

Etymology – the endophyte is named after the Gansu Province of China where the host plant is common.

Discussion

Since the establishment of the genus *Neotyphodium* as anamorphs of *Epichloë* and related asexual grass endophytes (Glenn et al. 1996), 14 species have been formally named and one other species tentatively identified (Table 1). *N. gansuense* can be distinguished from these 15 species by differences in the characteristics shown in Table 1. The growth rate of *N. gansuense* (diam. 7.5 mm/week) separates it from the relatively slow growing species (diam. < 4 mm/week) of *N. lolii, N. coenophialum, N. uncinatum, N. aotearoae, N. australiense, N. melicicola, N. chisosum* and *N. occultans* and from the relatively fast growing species (diam. 10 mm/week) of *N. typhinum* and *N. chilense*. *N. gansuense* can be separated from species with a similar growth rate by other characteristics (Table 1). *N. gansuense* has a different colony appearance to *N. huerfanum* and shorter conidiogenous cell and smaller conidia than *N. tembladerae, N. siegelii* and *N. starrii*. In addition, *N. gansuense* differs from *N. starrii* in not having an aculeate conidiogenous cell.

Some *Neotyphodium* species have been isolated from more than one species of host plant, e.g.: *N. tembladerae* in *Festuca argentina, F. hieronymi* and *Poa huecu* (Cabral et al. 1999) and *N. occultans* in *Lolium canariense, L. multiflorum, L. persicum, L. remotum, L. rigidum, L. subulatum* and *L. temulentum* (Moon et al. 2000). Also, some grass species are host for more than one species of *Neotyphodium*, e.g.: *N. aotearoae* and *N. australiense* in *Echinopogon ovatus* (Moon et al. 2002) and *N. uncinatum* and *N. siegelii* in *L. pratense* (Gams et al. 1990; Craven et al. 2001). A second, unidentified endophyte has been isolated from *A. inebrians* originally collected from Xinjiang, China (Bruehl et al. 1994). This endophyte grew slowly, with a paucity of aerial mycelium, forming compact creamy-white to creamy-buff colonies that did not sporulate on PDA or cornmeal agar (CMA) and did not sporulate on PDA or cornmeal agar (CMA) (Bruehl et al. 1994; Miles et al. 1996). It was associated with production of the alkaloids of ergonovine and lysergic acid amide in endophyte-infected *A. inebrians* (Miles et al. 1996). Bruehl et al. (1994) and Moon et al. (2000) suggested that it could be a new species of *Neotyphodium*.

Based on the life cycle categories for *Neotyphodium*-grass associations proposed by White et al. (1993), *N. gansuense* belongs to type III species (sexual stromata not found). Schardl and co-investigators defined morphological, biological and phylogenetic species and identified new species that were the result of apparent hybridization between species of *Epichloë* (Schardl et al. 1994; Moon et al. 2000, 2002; Craven et al. 2001; Schardl & Craven 2003).

Table 1. Comparison of described *Neotyphodium* species

Species (Host)	Growth rate (mm/week)	Colony	Conidiogenous cell (μ)	Conidia (μ)	Literature cited
N. aotearoae (*Echinopogon ovatus*)	<2.2 on PDA at 22C	Tan to brown, raised	Not found	Not found	Moon et al. 2002
N. australiense (*E. ovatus*)	<3.7 on PDA at 22C	Off-white to light tan, rings, raised	Nonseptate, 11-25 x 2	Ellipsoid to lunate 5-7 x 3-4	Moon et al. 2002
N. chilense (*Dactylis glomerata*)	10 on 4% Glucose Agar at 25C	White, cottony,	Nonseptate, 10-30(50) x 1-1.5	Oblong, 3-6 x 1-2	Morgan-J et al. 1990
N. chisosum (*Stipa eminens*)	1.8 PDA at 20C	White, cottony, pulvinate	Septate, 10-30x2-5	Ellipsoid to obovate, 5-9 x 2.5-4	White & Morgan-J 1987a
N. coenophialum (*F. arundinacea*)	2 on PDA at 20C	White felty or cottony	Nonseptate, 12-34 x 1.5-2	Subulate to falcate, 7-11 x 2-3	Morgan & Gams 1982
N. huerfanum (*F. arizonica*)	7 on PDA at 22C	White to yellowish-green, orange, zonate	Septate, 13-25 x 1.5-3	Cylindrical to lunate, 3-4 x 2-2.5	White et al. 1987
N. lolii (*Lolium perenne*)	1.6 on PDA at 20C	Slightly off-white, waxy	Nonseptate, 13.5-65 x 1.5-2	ellipsoid to reniform, 4.7-7 x 1.9-2.5	Latch et al. 1984
N. melicicola (*Melica acemosa*)	<3.7 on PDA at 22C	White, felty, convoluted	Septate, 6-35 x 2.5	Ellipsoid to lunate, 5-8 x 3.5-5	Moon et al. 2002
N. occultans (*L. multiflorum*)	0.6 on PDA at 22C	Off-white to tan, raised	Not found	Not found	Moon et al. 2000
N. siegelii (*L. pretense*)	3.7 on PDA at 24C	White, cottony	Nonseptate, 12-24 x 1.5-3	Navicular to reniform 6-8 x 2.5-3.5	Craven et al. 2001
N. starrii (*F. subulata*)	5 on PDA at 22C	White or slightly tan	Septate, 15-31 x 1.5-2.5	Allantoid, reniform 4-7 x 1.5-3	White & Morgan-J 1987b
N. tembladerae (*F. argentina*)	<7 on PDA at 24C	White, cottony to lanose, elevated to appressed	Septate, 10-31 x 1.5-3.5	Lunate, reniform, 4-10 x 2-4	Cabral et al. 1999
N. typhinum (*Holcus mollis*)	10 on MEA at 20C	White, cottony, tufted	Septate, 14-35 x 1.5-2	Fusiform, lunate, 4.5-8.5 x 2-3	Morgan& Gams 1982
N. uncinatum (*F. pratensis*)	<3 on PDA at 25C	Whitish to rosy buff, raised	Nonseptate, 9-18(25) x 1.5-2	Uncinate 5-13 x 1-2	Gams et al. 1990
N. inebrians (*Achnatherum inebrians*)	0.5 on PDA at 20C	Cream-buff, raised	Not found	Not found	Bruehl et al.1994; Miles et al. 1996
N. gansuense (*A. inebrians*)	7.5 on PDA at 22 C	White, cottony, raised	Septate, 7.5-18.8 x 1.3-2.5 (13.61 x 4.69)	Subspherical, semiglobular, 3.8-5 x 2.5-3.8	Li, Nan et al..

Further work is required to determine whether *N. gansuense* can infect other plant species and molecular phylogenetic work is needed to evaluate the potential hybrid origin of the genome.

Acknowledgements

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MYCOTAXON

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Kuehneola uredinis (Uredinales) on species of *Rubus* in Turkey

ELŞAD HÜSEYIN

elsadhuseyin@hotmail.com
Gazi University, Kırşehir Arts and Sciences Faculty
40200 Kırşehir, Turkey

Abstract— *Kuehneola uredinis* on *Rubus canescens* and *R. caesius* is reported, described, and illustrated for the first time from Turkey.

Key words—*Phragmidiaceae*, microscopical features, morphology, Anatolian Peninsula

Severe disease symptoms have been observed on *Rubus canescens* DC. and *R. caesius* L. growing in the forests of Ege region and Black Sea coast of Anatolian Peninsula. First symptoms appeared at the end of May and the beginning of June and formed as reddish and then pale yellow, pale golden-yellow spots. The causal agent of this disease has been identified as *Kuehneola uredinis* (Link) Arthur [= *Chrysomyxa albida* J.G.Kühn; = *Kuehneola albida* (J.G.Kühn) Magnus] (Gäumann 1959; Wilson & Henderson 1966; Kuprevich & Ulijanizshev 1975; Ellis & Ellis 1987; Cummins & Hiratsuka 2003). The collections concerned are characterized by the following microscopical features:

Spermogonia epiphyllous, subcuticular, gregarious, spheric-depressed, hemispheric, 75–90 μm wide, 35–40 μm high. *Aecia* epiphyllous, subepidermal, roundly, orange-yellow; *aeciospores* globoid, ellipsoid, ovoid, 20–22.5 x (17.5–)18–20 μm; wall colorless 2–2.5 μm thick, dense minute-verrucose (Figure 1 A). *Uredinia* hypophyllous, sometimes on the petioles or caulicolous, scattered, pulverulent, orange-yellow, without paraphyses; *urediniospores* globoid, subellipsoid, (19–)20–23(–27) x 17.5–20 μm; wall pale-yellow, sometimes colorless, 1.5–2 μm thick, dense verrucose or short-thorned; germ pores indistinct, probably 3–4, equatorial (Figure 1 B). *Telia* hypophyllous, scattered, yellowish-whitish; *teliospores* cylindrical, rounded-truncate, often trapezoidal, 18–32.5 x 17.5–25 μm, articulate-dense jointed to clavate or elongate chains, each of 5–13 superposed spores, like multicellular spore; wall colorless or light-yellow, smut, with one germ pore in each spore, 1.5–2 μm thick, to 4 μm thick on apical; pedicel is short and fragile (Figure 1 C).

Autoecious and macrocyclic species.

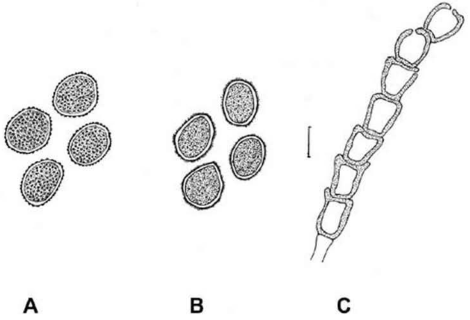

Fig. 1. *Kuehneola uredinis*: ***A.*** – aeciospores; ***B.*** – urediniospores; ***C.*** – teliospores. Scale bar = 15 µm

Specimens examined: Turkey, Rize Prov., Ikizdere, near Tron, on *Rubus caesius* L., 40°42'35" N, 40°36'10" E, 830 m a.s.l., 27-VII-1998, E. Hüseyin, F. Selçuk (EH 1174, FS 0120); Rize Prov., Hemşin, Gidilmişdere, on *Rubus canescens* DC., 41°3'52" N, 40°45'36" E, 1110 m a.s.l., 4-VIII-1999, E. Hüseyin, F.Selçuk (EH 1175, FS 0375); Balıkesir Prov., Ivrindi, Karasu, on *Rubus canescens*, 39°30'58" N, 27° 22'48" E, 31-V-2000, E.Hüseyin (EH 1176).

Herbarium specimens are deposited in the Herbarium of the Gazi University Kırşehir Arts and Sciences Faculty, Kırşehir, Turkey.

Kuehneola uredinis is known on *Rubus caucasicus* Focke, *R. ibericus* Juz., *R. sanguineus* Friv., *R. caesius*, *R. glandulosus* Bell., *R. hirtus* Waldst. & Kit., *R. fruticosus* L. and other species of *Rubus* from Europe, Asia, North America, South Africa and New Zealand (Wilson & Henderson 1966; Kuprevich & Ulijanizshev 1975; Ellis & Ellis 1987; Denchev 1995).

Before our investigations 290 species from 13 genera of rust fungi were reported from Turkey (Tamer & al. 1998; Kırbag, Civelek & Hüseyinov 2001; Hüseyin & Kırbag 2003). There are no records of the genus *Kuehneola* Magnus in these publications. This is the first report of genus *Kuehneola* and *K. uredinis* from Turkey. This fungus was registered on *Rubus canescens* and *R. caesius*.

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Fungi of 'alpine islands' of *Dryas octopetala* in the Carpathians

ANDRZEJ CHLEBICKI
chlebick@ib-pan.krakow.pl
Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46
PL-31-512 Kraków, Poland

MARKÉTA SUKOVÁ
marketa.sukova@nm.cz
Mycological Department, National Museum, Václavské nám. 68
CZ-115 79 Praha 1, Czech Republic

Abstract–39 ascomycete fungi and some anamorphs are reported from the Western and Eastern Carpathians, among them *'Lachnum crystallophorum'*, *Leptosphaeria holmiorum*, *Odontotrema alpinum* and *Urceolella dryadicola*. Analysis of *Dryas*-specific fungi of the Carpathians, Alps, Scandinavia and the Urals shows some similarities between these areas. This indicates that the Carpathian population of *Dryas octopetala* has been influenced by migrational waves of *Dryas*, as much from the west (the Alps), as from the east (the Urals and Scandinavia). The most similar populations were found in the Malá Fatra Mts., Chočské vrchy Mts., Západné (Zachodnie) Tatry Mts., Vysoké Tatry Mts. and Bielanske Tatry Mts. The most distinct and isolated areas is the western part of the Tatry Mts., named the Zachodnie Tatry Mts., which have a greater number of exclusive species and a single endemite, *Melanomma margaretae*. The dispersion of fungi in smaller 'islands' is mostly accidental, resulting from the decline of the host population and the extinction of fungi that follows it.

Key words–arcto-alpine fungi, distribution, mycogeography

Introduction

Dryas octopetala was first reported by Wahlenberg (1814) from the Chočské vrchy Mts. in the Slovakian Carpathians. Later it was reported from the Zachodnie Tatry Mts. (Herbich 1831; Fritze & Ilse 1870; Kotula 1889-1890, Berdau 1890, Sagorski & Schneider 1891), Malá Fatra Mts. (Brancsik 1862; Holuby 1888), Belianske Tatry Mts. (e.g., Krajina 1925; Domin 1925, 1926), Nízke Tatry Mts. (e.g., Trapl 1930; Sillinger 1933) and Svidovets Mts. (e.g., Domin 1929; Klášterský 1930); see also Zahradníková, (1992). More recently Milkina (1995) found a new locality of *D. octopetala* in the Eastern Carpathians (Chornohora Mts.). The biggest plant populations inhabit the Západné (Zachodnie) and Belianske Tatry Mts. Smaller populations where noted in the Malá Fatra Mts., Chočské vrchy Mts., Nízke Tatry Mts. (Krakova hoľa Mt.), Svidovets Mts. and Rarău Mts. Very small relict populations have survived on a single rock wall in the 'Biała Woda' Nature Reserve in the Pieniny Mts. (Kornaś 1958). Other very small populations were noted in the Súlovské vrchy Mts., Bába Mt. in the Nízke Tatry Mts. and the slope of Pop Ivan Mt. and Berbenieskul Mt., both in the Chornohora Mts. The species was widely distributed in the lowlands of Central Europe during the glacial period, as indicated by fossil records of *Dryas octopetala* from Europe reported by Tralau (1961). At present the host plant inhabits only 'island' areas in the mountains.

Fungi – 23 taxa of fungi have been found on *Dryas octopetala* occurring in the Carpathians so far (Velenovský 1934; Sandu-Ville 1967; Sałata *et al.* 1984; Bontea 1985; Eliade 1990; Chlebicki 1995, 2002; Lizoň & Bacigálová 1998; Lizoň & Jančovičová 2000). Of them, *Patinella dryadea* Vel. in fact is a lichenized fungus (Chlebicki 1995; Lizoň & Jančovičová 2000). Moreover, *Rosellinia riminicola* Rehm and *Septoria semilunaris* Johans. seem to be doubtful taxa. Altogether 96 taxa (excluding endophytes) have been noted on the plant. Well known, detailed investigations of the dryadicolous fungi in some populations of *Dryas octopetala* were conducted in Europe (L. Holm 1979; K. Holm & L. Holm 1985, 1993; Graf 1986; Nograsek 1990; Nograsek & Matzer 1991; L. Holm & K. Holm 1993; Chlebicki 1995, 2002). In addition, 63 species of endophytes were noted on plants found in the Alps and the Arctic (Fisher *et al.* 1995; Robinson *et al.* 1998). More investigations were conducted in Arctic Canada (Barr 1959), Greenland (Chlebicki & Knudsen 2001; Chlebicki & Raitviir 2003), the Far East (Vassiljeva 1979, 1987, 1998) and Western Siberia (Chlebicki 1998, 2002)..

Material and Methods

The material gathered by the authors came from the western and eastern parts of the Carpathian Mountains: Tatry Mts., Nízke Tatry Mts., Malá Fatra Mts., Svidovets Mts., Chornohora Mts. and Rarău Mts. In addition, the collections of *Dryas octopetala* in the Czech and Polish herbaria, such as PRC, PR and KRAM, were researched using Rostrup's method. Plants from 248 collections (70 from PRC, 82 from PR, 96 from KRAM) were screened with a Nikon SMZ 1500 dissecting microscope and examined in Zeiss and Olympus BX-51 transmitted light microscopes afterwards. Measurements of anatomical characters were taken from tissues placed in distilled water. The material is deposited in PRC, PR, PRM and KRAM. The Latin names of the orders follow Kirk *et al.* (2001). The phytogeographical division of the Carpathians follows Bertová (1984). The phytogeographical analysis was preformed using the mycogeographical method described by Chlebicki (2002). The species of the genera *Mycosphaerella*, *Eurotium*, *Septoria* and *Stagonospora*, as well as plurivorous species, were excluded from the mycogeographical analysis.

Results

Acanthostigma longisporum (Remler) Réblová & M.E. Barr, Sydowia 52: 264, 2000. *Pleosporales*

This rare species was earlier reported from the Alps and Scandinavia (Nograsek 1990). It was also found in the Western Carpathians on the Polish side of the Zachodnie Tatry Mts. (Chlebicki 1995, 2002).

Cainiella johansonii (Rehm) E. Müll., Sydowia 10: 121, 1957. *Xylariales*

SPECIMENS EXAMINED – Western Carpathians – Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., Plačlivý Roháč [Plačlivé] Mt., ca 1900 m elev., on dead petioles, July 1928, coll.: *J. Dostál*, PRC; Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., on stipules, 24 July 1931, coll.: *J. Dostál*, PRC; (POLAND) – Zachodnie Tatry Mts., Ciemniak Mt., Stoły Rocks, on vein of lower side of leaf, 26 July 2002, coll.: *A. Chlebicki*, KRAM; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on lower side of leaves, 23 September 2003, coll.: *A. Chlebicki & M. Suková*, KRAM, PRM 901048.

Comments – It has not been reported from the Carpathians so far, but it is not a rare species, noted on leaves of *D. octopetala*, *D. integrifolia* and *D. drummondii* (L. Holm 1979; Barr 1959; Spooner 1981; Nograsek 1990; Fisher *et al.* 1995; Chlebicki 1995, 1998, 2002; Vassiljeva 1998; Chlebicki & Raitviir 2003).

Crocicreas dryadis (Nannf. ex L. Holm) S. E. Carp. var. ***dryadis*** Brittonia 32: 270, 1980. *Helotiales*

SPECIMENS EXAMINED – (all collections on lower side of leaves of *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., near hostel, 1 August 1919, coll.: *K. Domin*, PRC; Malá Fatra Mts., Kriváň Mt., 15 July 1920, coll.: *J. Klika*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., 28 June 1925, coll.: *F. Maloch*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., 6 October 2001, coll.: *A. Chlebicki*, KRAM; Chočské vrchy Mts., Veľký Choč Mt., 28 July 1919, coll.: *K. Domin*, PRC; Chočské vrchy Mts., Veľký Choč Mt., '*Dryadetum*' 1550 elev., 10 July 1928, coll.: *P. Sillinger*, PRC; Chočské vrchy Mts., Veľký Choč Mt., 18 June 1937, s. coll. nom., PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Biela skala above Zuberec, ca 1750 m elev.' [ridge between Radové skaly rocky peak (1557 m elev.) and Sivý vrch Mt. (1805 m elev.) on current maps], 15 August 1928, coll.: *J. Dostál*, PRC; Liptovské hole Mts., Bobrovec Mt., 1664 m elev., 12 August 1928, coll.: *J. Dostál*, PRC; Liptovské hole Mts., Plačlivý Roháč [Plačlivé] Mt., 5 August 1928, coll.: *J. Dostál*, PRC; Liptovské hole Mts., Plačlivý Roháč [Plačlivé] Mt., 1800-1900 m elev., 5 August 1928, coll.: *J. Dostál*, PRC; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, 26 July 2002, coll.: *A. Chlebicki*, KRAM; Vysoké Tatry Mts. (SLOVAKIA) – Podtisovky, SSW of Tisovka Mt. in Bielovodská dolina (valley), 18 July 1925, coll.: *I. Klášterský*, PRM 901046; Zámky Mt., 9 July 1925, coll.: *V. Krajina*, PRC; Belianske Tatry Mts. (SLOVAKIA) – Muráň Mt., 1800 m elev., 14 August 1925, coll.: *K. Domin*, PRC; Faixová ridge [ridge with a number of rocky peaks going in ESE direction from Skalné Vráta Mt. to the beginning of Dlhá stěna (rocky wall)], 1550 m elev., 21 July 1928, coll.: *V. Krajina*, PRC; N slope of Muráň Mt., 14 August 1925, coll.: *V. Krajina*, PRC; Belianske Tatry Mts., locality not given, July 1933, coll.: *K. Domin*, *Kettnerová*, *V. Krajina*, PRC; Nízke Tatry Mts.

(SLOVAKIA) – Bába Hill E of village of Lučivná, 4 September 1920, coll.: *K. Domin*, PRC; **Eastern Carpathians** – Svidovets Mts. (UKRAINE), Bliznitsa Mt., July 1918, coll.: *A. Margittai*, PRC.

Comments – Chlebicki (1995, 2002) reported 13 localities of the fungus from the Wysokie and Zachodnie Tatry Mts., as well as from Bliznitsa Mt. (Svidovets Mts.) and Berbenieskul Mt. (Chornohora Mts.), both in the Eastern Carpathians. It can be considered as a common species in the Carpathians, earlier noted in Sweden (L. Holm 1979), Iceland (K. Holm & L. Holm 1984), Austria (Nograsek & Matzer 1991), Bosnia, Herzegovina, Croatia, Finland, Poland, Russia and Slovakia (Chlebicki 1995, 2002).

Crocicreas dryadis (Nannf. ex L. Holm) S. E. Carp. var. ***uniseptata*** Nograsek & Matzer, Nova Hedwigia 53: 451, 1991. *Helotiales*

Apothecia darker than in the type variety, ascospores two-celled 8.8-10.4 x 2.1-2.4 μm.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., on lower side of dead leaves, 2 August 1919, coll.: *K. Domin*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Dolina Rozpadlica' (valley) – at present probably Rozpadlý grúň valley SE of saddle between Krzesanica Mt. and Małołączniak Mt., see Kotula, (1889-1890), 1500 m elev., on lower side of dead leaves, 22 August 1930, coll.: *J. Dostál*, PRC.

Comments – The species was reported from the Alps and Scandinavia (Nograsek & Matzer 1991; Chlebicki 1995), Scotland (Spooner 1981), Iceland (K. Holm & L. Holm 1984) and Novaya Zemlya (Chlebicki 2002).

Crocicreas variabile Nograsek & Matzer, Nova Hedwigia 53: 453, 1991. *Helotiales*

Apothecia cup-shaped, pale olivaceous, ascospores hyaline, four-celled (14)15.5-18.5 x 2-3 μm.

SPECIMENS EXAMINED – (all collections on lower side of leaves of *Dryas octopetala*) **Western Carpathians** – Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., 24 July 1931, coll.: *J. Dostál*, PRC; (POLAND) – Zachodnie Tatry Mts., Mt. Ciemniak, (Stoły Rocks), 10 September 1995, *coll. A. Chlebicki*, KRAM F; Vysoké Tatry Mts. (SLOVAKIA) – 'Bolond-Gero' (?), ca 1800 m elev., July 1926, coll.: *A. Margittai*, PRC; Wysokie Tatry Mts. (POLAND) – Szpiglasowa Pass, 12 September 1995, *coll. A. Chlebicki*, KRAM F; Belianske Tatry Mts. (SLOVAKIA) – 'Distr. Kežmarok, Kopa' (Belianska Kopa) Mt., see Krajina, (1925), 19 June 1924, coll.: *V. Krajina*, PRC.

Comments – An arcto-alpine species, earlier reported from the Alps, Sweden (Nograsek & Matzer 1991), Tatry Mts., Urals and Greenland (Chlebicki 2002).

Didymosphaeria massarioides Sacc. & Brunaud, Michelia 2: 392, 1881. *Pleosporales*

It is a cosmopolitan species, noted on various plants, among them *Dryas octopetala* (Nograsek & Matzer 1991; Atproot 1995). Chlebicki (2002) noted it on *Dryas* wood in the Pieniny Mts. in the western Carpathians.

Discosia strobilina Lib. Pl. Crypt. Ard. exs. 346, 1837. Anamorphic fungus

A species with a wide distribution, noted on various host plants (Subramanian & Chandra-Reddy 1974). More recently Chlebicki (1995) reported two finds from the Zachodnie Tatry Mts. in the Western Carpathians.

Eurotium herbariorum Link : Fr., Systema Mycologicum 3: 332, 1832. *Eurotiales*

Ascomata globose, circular, yellow, ascospores circular, 7.5-9 μm diam. in face view, 4.3-5.8 μm wide in lateral view, with two minutely roughened ridges.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., on both sides of leaves and petioles of *Dryas octopetala*, July 1924, coll.: *S. Trapl*, PRC.

Comments – It is widespread species. Its minute, yellow ascocarps are reported on many products such as cheeses, meats and fruits (Pitt & Hocking 1997). It was sometimes noted on herbarium plants (Dennis 1968). Earlier it was reported from leaves of *D. octopetala* collected in the Zachodnie Tatry Mts. (Chlebicki 2002).

Gnomonia dryadis Auersw., Mycol. Europ. 5/6: 26, 1869. *Diaporthales*

Ascospores hyaline, (13)14.5-17.5(21.5) x 4-7 μm, with cone-shaped (2.5-6.5 μm long) to filiform (8-14.5 μm long) appendages.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., on twig, 3 June 1926, coll.: *J. Klika*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., on twig, July 1900, coll.: *C. Brancsik*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., on twigs, 28 June 1925, coll.: *F. Maloch*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead twigs, 6 October 2001, coll.: *A. Chlebicki*, KRAM; Chočské vrchy Mts., Veľký Choč Mt., 29 May 1926, coll.: *J. Klika*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., on petiole, 24 July 1931, coll.: *J. Dostál*, PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on petiole and stipules, 9 July 1925, coll.: *V. Krajina*, PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on twig, 23 September 2003, coll.: *M. Suková & A. Chlebicki*, PRM 901049; **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei rocks, at 1653 m elev., 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – The appendage seems to be rolled and this is the reason for its cone shape. Appendages of ascospores became filiform and long when immersed in water. The presence of appendages in the Carpathian specimens indicates its Scandinavian origin. The specimens from the Alps are devoid of such appendages (Nograsek 1990). The specimens from the Carpathians possess mostly 8-sporous asci. The 16-sporous asci were present in the single collection from the Nízke Tatry Mts. The species was earlier noted in the Alps, Scandinavia (L. Holm 1979; K. Holm & L. Holm 1985; Nograsek 1990), Canadian Arctic (Barr 1959, 1978), Spitsbergen (K. Holm & L. Holm 1993), Tatry Mts., Pyrenees, Yugoslavia (Chlebicki 1995), Sayan Mts. and Greenland (Chlebicki & Knudsen 2001).

Isothea rhytismoides (Bab. ex Berk.) Fr., Summa Veg. Scand.: 421, 1849. *Phyllachorales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., near hostel, 1 August 1919, coll.: *K. Domin,* PRC; Malá Fatra Mts., Kriváň Mt., on upper side of leaves, 15 July 1920, coll.: *J. Klika,* PRC; Veľký Kriváň Mt., 1400-1600 m elev., 7 August 1967, coll.: *J. Soják,* PR; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on living leaves, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Chočské vrchy Mts., Veľký Choč Mt., 1617 m elev., on upper side of leaves, 10 September 1922, coll.: *F. Maloch,* PRC; Chočské vrchy Mts., Choč (Veľký Choč) Mt., 18 June 1937, s. nom. coll., PRC; Veľký Choč, ca 1600 m elev., 22 August 1941, coll.: *I. Klášterský,* PR; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., Bobrovec Mt., 1664 m elev., 12 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., foot of Plačlivý Roháč [Plačlivé] Mt. in Smutná dolina (valley), ca 1650-1700 m elev., on upper side of leaves, August 1926, coll.: *J. Dostál,* PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on upper side of leaves, 9 July 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts. (SLOVAKIA) – on leaves, 29 August 1919, coll.: *K. Domin,* PRC; Muráň Mt., 1800 m elev., 14 August 1925, coll.: *K. Domin,* PRC; Hlúpy vrch, ca 1900 m elev., July 1938, coll.: *M. Deyl,* PR; **Eastern Carpathians** – Svidovets Mts. (UKRAINE) – Bliznitsa Mt., ca 1875 m elev., 13 July 1932, coll.: *D. Žoſák,* PRC; Chomohora Mts. (UKRAINE) – Černá hora, locality not given, August 1938, coll.: *E. Hadač,* PR; Rarău Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on upper side of leaves, 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – *I. rhytismoides* occurs in the whole range of *Dryas* species (Chlebicki 2002). It was noted in the Tatra Mts., Chornohora Mts. and Svidovets Mts. (Chlebicki 2002). We observed leaves grazed by insects in places covered by fungus ascomata.

'Lachnum crystallophorum' Nograsek & Matzer, Nowa Hedwigia 53: 455, 1991. *Helotiales*

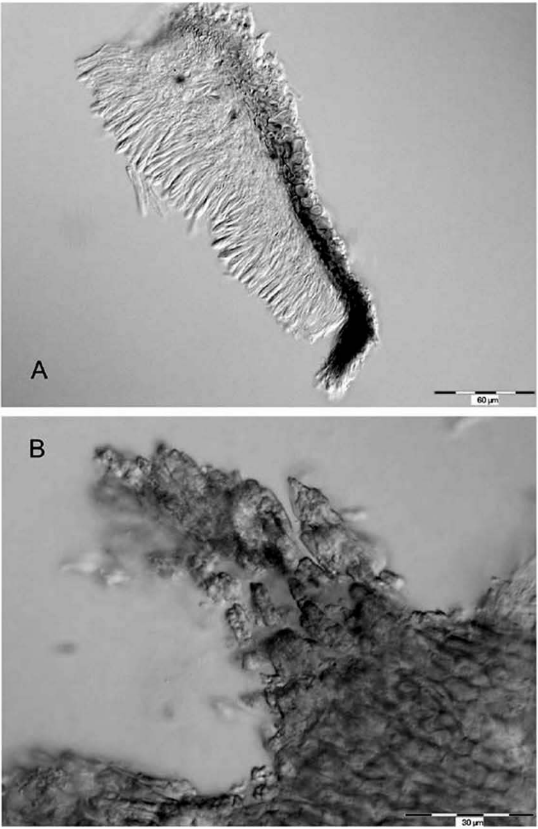
Apothecia minute, short-stalked, covered by scabrous hairs bearing white crystals, hairs in small clusters forming teeth at margin of apothecium, outer excipulum brown, composed of isodiametric (surface layers) to elongated (inner layers) cells, asci 25.5-33 x 4.5-5.5 μm, the asco-apical apparatus IKI red and KOH/IKI blue, ascospores hyaline, one-celled, 6.5-8.5 x 1-1.5 μm, paraphyses filiform, 1-1.2 μm wide (Fig. 1, 2).

SPECIMENS EXAMINED – Eastern Carpathians – Rarău Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on lower side of leaves of *Dryas octopetala,* 4 October 2002, coll.: *A. Chlebicki,* KRAM.

Comments – It is a very characteristic species, with white crystals covering almost all the surface of the hair. Its belonging to the genus *Lachnum* is provisional because of the presence of rounded tips of paraphyses. Previously, it was known only from the Alps (Nograsek & Matzer 1991). Possibly it is a member of the genus *Incrupila* (H.O. Baral, in letter).

Leptosphaeria dryadophila Huhndorf, Illinois Nat. Hist. Surv. Bull. 34: 484, 1992. *Pleosporales*

Fig. 1. '*Lachnum crystallophorum*': A – excipulum in longitudinal section (in lactophenol), scale bar = 40 μm; B – hairs (in water using Nomarski contrast), scale bar = 4 μm; C – margin of apothecium with teeth (in water), scale bar = 30 μm.


A
60 µm
B
30 µm

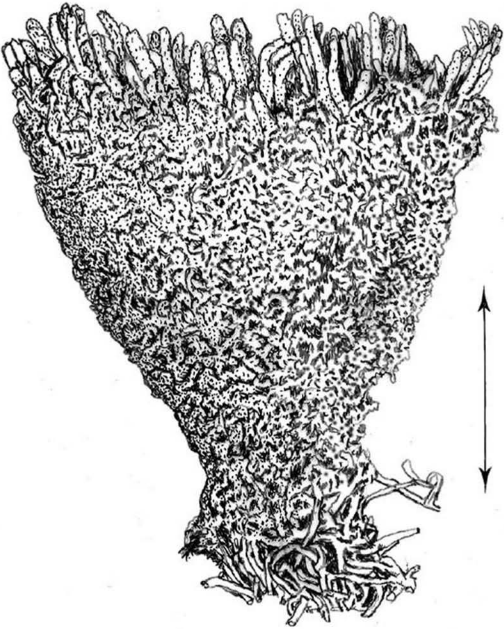


Fig. 2. Apothecium of '*Lachnum crystallophorum*', scale bar = 50 μm

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead hypanthium, 6 October 2001, coll.: *A. Chlebicki*, KRAM; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on previous year's hypanthia, 23 September 2003, coll.: *M. Suková & A. Chlebicki*, KRAM, PRM 901050; **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on dead hypanthium, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – Its occurrence is restricted to the host inflorescences (Fig. 3A). The adult ascomata occur on dead sepals of the previous year's hypanthia and fruits. The fungus was noted in Alaska (Sprague 1955), the Alps (Müller 1950), Greenland, Iceland, Novaya Zemlya, Scandinavia, Spitsbergen (Lind 1910; L. Holm 1957, 1979; Nograsek 1990; K. Holm & L. Holm 1993), Rarău Mts. in the Eastern Carpathians (Chlebicki 1995), Kamchatka (Vassiljeva 1987) and Greenland (Chlebicki & Knudsen 2001). It is more common in the sub-Arctic and the Arctic than in alpine regions.

Leptosphaeria holmiorum Chleb., Mycotaxon 86: 218, 2003. *Pleosporales*

Ascocarps superficial, ostiole ca 40 μm diam, asci tetrasporous, 103-126 x 23-27 μm, ascospores mostly four-celled, olivaceous to light brown, upper median cell darker, distal cells paler, 31.5-42 x 12-12.5 μm (Fig. 3B, 4A).

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., on dead petiole of *Dryas octopetala*, July 1900, coll.: *C. Brancsik*, PRC.

Comments – It is a rare species, known from the Polar Urals, Chukotka Peninsula and the Caucasus (Chlebicki & Raitviir 2003). The Carpathian specimens differ from the type only by the presence of constantly four-celled ascospores. It seems to have been coexisting with *Dryas* for a long time.

Leptosphaerulina dryadis (Starbäck) L. Holm, Bot. Notiser 132: 86, 1979. *Pleosporales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., July 1900, coll.: *C. Brancsik*, PRC; Chočské vrchy Mts., Veľký Choč Mt., on upper side of leaves, 28 July 1919, coll. *K. Domin*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Biela skala' above Zuberec, ca 1750 m elev. [ridge between Radové skaly rocky peak (1557 m elev.) and Sivý vrch Mt. (1805 m elev.) in current maps], on upper side of leaves, 15 August 1928, coll.: *J. Dostál*, PRC; Liptovské hole Mts., Plačlivý Roháč (Plačlivé) Mt., ca 1900 m elev., on petiole, July 1928, coll.: *J. Dostál*, PRC; Liptovské hole Mts., on slope of Jakubina Mt. in Račková dolina (valley), ca 2050 m elev., on petioles and peduncle, July 1931, coll.: *J. Dostál*, PRC; Liptovské hole Mts., 'Dolina Rozpadlica' (valley) – at present probably Rozpadlý grúň valley SE of saddle between Krzesanica Mt. and Małołączniak Mt., see KOTULA. (1889-1890), 1500 m elev., on lower side of dead leaves, 22 August 1930, coll.: *J. Dostál*, PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on peduncle and upper side of leaves, 9 July 1925, coll.: *V. Krajina*, PRC; Belianske Tatry Mts. (SLOVAKIA) – Hlúpy vrch Mt., 1920 m elev., on upper side of leaves, 11 July 1991, coll.: *D. Jalovičiarová*, PRC; **Eastern Carpathians** – Maramureş mountain range (ROMANIA) – NNE of village of Repedea, Mihailecul Mt., 1910-1920 m elev., on lower side of leaves, 30 June 2003, coll.: *M. Suková*, PRM 901043.

Comments – It is a widely distributed species, known from Europe (L. Holm 1979; Nograsek 1990; Chlebicki 1995, 2002), Siberia, Korea (Chlebicki 2002), the Far East in Asia (Vassiljeva 1987), and North America (Barr, in letter). It was also noted in the Zachodnie Tatry Mts. (Western Carpathians), Chornohora Mts. and Rarău Mts. in the Eastern Carpathians (Chlebicki 1995).

Leptosphaerulina pulchra (G. Winter) M.E. Barr, Contr. Inst. Bot. Univ. Montréal 73: 7, 1959. *Pleosporales*

Ascocarps minute, conical, ascospores yellow brown, clavate (Fig. 4B) 19-25 x 8-9 μm.

SPECIMENS EXAMINED – **Western Carpathians** – Nízke Tatry Mts. (SLOVAKIA) – Bába Hill E of village of Lučivná, on dead peduncle of *Dryas octopetala*, 4 September 1920, coll.: *K. Domin*, PRC.

Comments – This arcto-alpine species was reported on various host plants from the genera *Potentilla, Dryas, Erigeron, Helianthemum, Senecio* and *Sieversia* (Barr 1959; Crivelli 1983; Vassiljeva 1998).

Lophiostoma macrostomum (Tode : Fr.) Ces. & De Not., Comm. Soc. Critt. Ital. 1: 219, 1863. *Pleosporales*

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead twigs, 6 October 2001, coll.: *A. Chlebicki*, KRAM; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, on dead twigs, 26 July 2002, coll.: *A. Chlebicki*, KRAM.

Comments – It is a plurivorous species noted on ligneous and herbaceous substrata, reported earlier in the Zachodnie Tatry Mts. (Chlebicki 2002).

Lophiostoma winteri (Sacc.) G. Winter in Rabenh., Krypt.-Fl., 2. Aufl., 1, 2: 297, 1885. *Pleosporales*

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková*, KRAM; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei rocks, at 1653 m elev., on dead twigs of *Dryas octopetala*, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – It is a plurivorous species, reported from Sweden, Spitsbergen, the Alps, Carpathians (Zachodnie Tatry Mts., Rarâu Mts.), Polar Urals and Caucasus (L. Holm & K. Holm 1988; Chlebicki 1995, 2002).

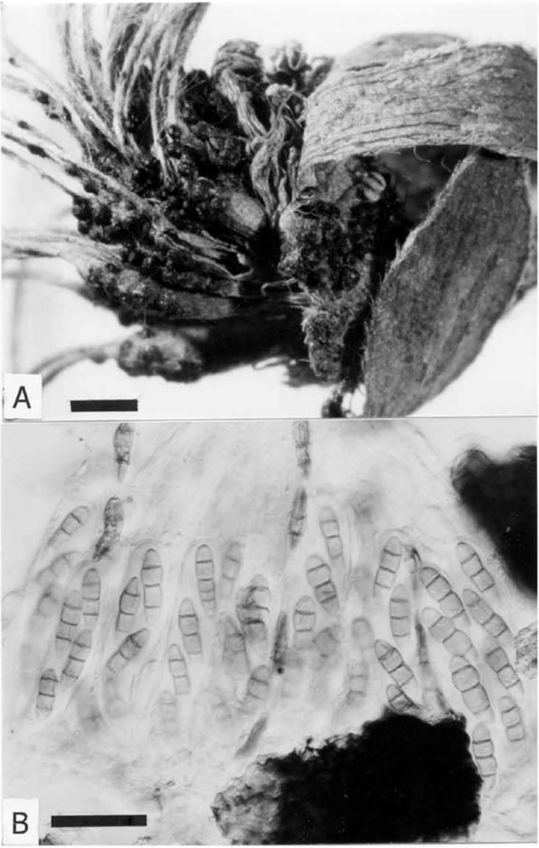
Massarina balnei-ursi (Rehm) K. Holm & L. Holm, Sydowia 38: 142, 1985. *Pleosporales*

Ascocarps black, partially embedded in decorticated wood, asci 110-150 × 10-16.5 μm, ascospores hyaline, 18-24.5 x 5-9.6 μm with gelatinous coating 2 μm thick.

SPECIMENS EXAMINED – **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., on end of broken twig, July 1891, coll.: *J. Wagner*, PRC; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, on dead twigs, 26 July 2002, coll.: *A. Chlebicki*, KRAM; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., on dead twigs, 23 September 2003, coll.: *A. Chlebicki & M. Suková*, KRAM; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on dead twigs, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – This lignicolous saprotroph was reported from the Alps (K. Holm & L. Holm 1985; Nograsek 1990), Sweden (Nograsek 1990), Polar Urals and Yakutia (Chlebicki 2002).

Fig. 3. A – ascocarps of *Leptosphaeria dryadophila* on inflorescence of *Dryas octopetala*, scale bar = 1 mm; B – asci and ascospores *of Leptosphaeria holmiorum*, scale bar = 50μm


A
B

Massarina corticola (Fuckel) L. Holm, Symb. Bot. Upsal. 14, 3: 147, 1957. *Pleosporales*

A plurivorous species, reported also on twigs of *D. octopetala* from the Pieniny Mts., the lowest locality in the Western Carpathians (Chlebicki 2002).

Melanomma margaretae Chleb., Monogr. Bot. 90: 91, 2002. *Pleosporales*

It is tentatively placed in the genus *Melanomma* because of the radiating wall structure and scleroplectenchymatic cells resembling those of *Leptosphaeria*. It was noted in the Zachodnie Tatry Mts. (Chlebicki 2002).

Mycosphaerella octopetalae (Oudem.) Lind, Rep. Sci. Res. Norw. Exp. Nov. Zemlya 19: 12, 1921. *Mycosphaerellales*

Ascocarps partially immersed, scattered, ascospores hyaline, two-celled, 21-24.5 x 8.7-10.3 μm.

SPECIMENS EXAMINED – Eastern Carpathians – Maramureş mountain range (ROMANIA) – NNE of village of Repedea, Mihailecul Mt., 1910-1920 m elev., on upper side of dead leaves of *Dryas octopetala*, 30 June 2003, coll.: *M. Suková*, PRM 901044.

Comments – It is the most common fungus on *Dryas*, see L. Holm, (1979). However, usually empty ascomata or anamorphs of the genus *Asteromella* Pass. & Thüm. were found on the leaves. Its determination was rather impossible.

Mycosphaerella ootheca (Sacc.) Magnus in Dalla Tore, Fl. Tirol 3: 381, 1913. *Mycosphaerellales*

Ascomata immersed, asci saccate, ascospores hyaline with median septa 15-17 x 4.7-5.5 μm (Fig. 4C)

SPECIMENS EXAMINED – Western Carpathians – Nízke Tatry (SLOVAKIA) – Bába Hill E of village of Lučivná, on dead peduncle of *Dryas octopetala*, 4 September 1920, coll.: *K. Domin*, PRC.

Comments – *M. ootheca* described by Saccardo (1882) differs from *M. octopetalae* (Oudem.) Lind. by its somewhat shorter ascospores, 15-16 x 6-7 μm. Tomilin (1979) synonymized *M. octopetalae* and *M. ootheca* with *M. dryadis* (Auersw.) Lindau. *Mycosphaerella ootheca* differs from *M. dryadis* by its somewhat wider ascospores. The shape of the ascospores from the Carpathians differs significantly from these of *M. octopetalae*.

Mycosphaerella punctiformis (Pers.: Fr.) Starbäck, Bihang Kongl. Svenska Vetensk-Akad. Handl. 15 afd. III. nr. 2: 9, 1889. *Mycosphaerellales*

SPECIMENS EXAMINED – (on leaves of *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., 6 October 2001, coll.: *A. Chlebicki*, KRAM; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., Plačlivý Roháč (Plačlivé) Mt., 5 August 1928, coll.: *J. Dostál*, PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková*, KRAM.

Comments – The ascomata of this species are arranged in distinct groups on the leaf surface. It is a plurivorous species (Tomilin 1979), also noted on *Dryas octopetala* in the Alps (Nograsek 1990).

Mycosphaerella cfr ***tassiana*** (De Not.) Johanson, Öfversigt af K. Vetens. Akad. Förh. 1884(9): 167, 1884. var. ***tassiana*** M.E. Barr, Northern Pyrenom. 1: 23. 1957. *Mycosphaerellales*

Ascomata immersed, ascospores hyaline with submedian septa, 11-12(14) x 3-4 μm (Fig. 4D).

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Fatra (SLOVAKIA) – Chočské vrchy Mts., Choč (Veľký Choč) Mt., on leaves of *Dryas octopetala*, 29 May 1926, coll.: *J. Klika*, PRC.

Comments – It is a very common and plurivorous species, noted also on *Dryas integrifolia* Vahl. (Barr 1959; Kobayashi *et al.* 1969).

Odontotrema alpinum (Sacc.) L. Holm, Bot. Notiser 132: 80, 1979. *Ostropales*

Apothecia globose, slightly flattened, with strongly concave hymenium, ascospores hyaline, four-celled, 15-20 x 1.7-2.8 μm (Fig. 4E).

SPECIMENS EXAMINED – Western Carpathians – Belianske Tatry Mts. (SLOVAKIA) – on rocks between Bujačí Mt. and Jatka (Jatky) Mt., 1800-2000 m. elev., on leaves of *Dryas octopetala* among tomentum, 18 August 1967, coll.: *V. Vašak*, PRM 901047 (extracted from PR).

Comments – The species was reported from the Alps (Müller & Arx 1955; L. Holm 1979; Sherwood-Pike 1987) and Kola Peninsula (Chlebicki 2002). Chlebicki & Raitviir (2003) described *Odontotrema alpinum* var. *octopartitum* Raitv. & Chleb., a new variety of the species from Greenland. This last taxon seems to be restricted to *Dryas integrifolia* only. The type variety was also noted on *Geum* in the Alps (Sherwood-Pike 1987). The presence of *O. alpinum* in the Carpathians is noteworthy. It can be considered an old taxon.

Otthia dryadis K. Holm, L. Holm & Nograsek in Nograsek, Bibl. Mycol. 133: 172, 1990. *Dothideales*

Comments – This lignicolous species was reported from the Alps, Scandinavia (Nograsek 1990), Spitsbergen (K. Holm & L. Holm 1993), Zachodnie Tatry Mts. in the Western Carpathians (Chlebicki 1995), the Urals and Taimyr Peninsula (Chlebicki 2002).

"***Patinella dryadea***" Velen., Monographia Discomycetum Bohemiae p. 75, 1934.

Comments – Velenovský (1934) described this taxon on the basis of material from the Tatry Mts. Chlebicki (1995) recognized the type specimen as belonging to the lichenized genus *Lecidella*, see also Lizoň & Bacigálová, (1998) and Lizoň & Jančovičová, (2000).

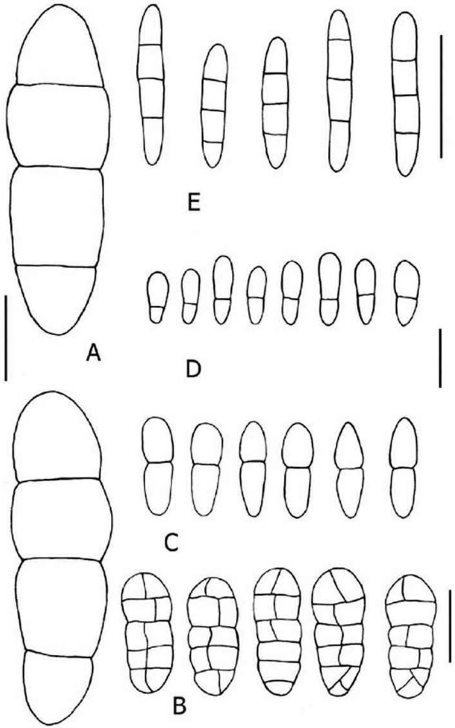


Fig. 4. A – ascospores of *Leptosphaeria holmiorum;* B – *Leptosphaerulina pulchra;* C – *Mycosphaerella ootheca;* D – *Mycosphaerella* cfr *tassiana* var. *tassiana;* E – *Odontotrema alpinum;* all scale bars = 10 μm.

Phaeosphaeria dryadea Nograsek, Bibl. Mycol. 133: 179, 1990. *Pleosporales*

Ascocarps superficial, covered by hairs, hairs brown, up to 190 x 7 μm, with one or several septa, pseudoparaphyses hyaline, septate, 0.8-2.2 μm wide, asci octosporous, cylindrical, (75)85-100 x (12.5)13.5-16.5 μm, ascospores hyaline, 4-celled, 23-27 x 5.5-8 μm.

SPECIMENS EXAMINED – **Western Carpathians** – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., on upper side of leaves and adjacent part of petiole, 3 June 1926, coll.: *J. Klika*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., 28 June 1925, coll.: *F. Maloch*, PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková*, KRAM; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei rocks, at 1653 m elev., on upper side of leaves and petioles, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – A very characteristic species, reported from the Alps (Nograsek 1990), Carpathians (Rarâu Mts.), Polar Urals, Yuzhnyj Urals, Chukotka Peninsula (Chlebicki 1995, 2002) and Greenland (Chlebicki & Raitviir 2003).

Pleospora ascodedicata K. Holm, L. Holm & Nograsek in Nograsek, Bibl. Mycol. 133: 194, 1990. *Pleosporales*

It is known from the Alps and Scandinavia (K. Holm & L. Holm 1985; Nograsek 1990), Western Carpathians (Zachodnie Tatry Mts.), Polar Urals and Yakutia (Chlebicki 1995, 2002). The species was noted in the lowest Carpathian locality of *D. octopetala* in the Pieniny Mts. (Chlebicki 2002).

Pleospora helvetica Niessl, Verhandl. Naturf. Ver. Brünn 14: 191, 1876. *Pleosporales*

Ascocarps setose or bare, ca 200 μm diam., setae 60-100 μm long, ascospores brown, 28-30 x 13-14 μm, surrounded by gelatinous coating 3 μm thick.

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Nízke Tatry (SLOVAKIA) – Bába hill E of village of Lučivná, on upper side of leaves and on petiole, 4 September 1920, coll.: *K. Domin*, PRC; **Eastern Carpathians** – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on upper side of leaves, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – It is a common and plurivorous species, reported also on arcto-alpine hosts.

Pleospora penicillus (J.C. Schmidt : Fr.) Fuckel var. ***ambigua*** (Berl. & Bres.) Crivelli, Diss. ETH. 7318: 75, 1983. *Pleosporales*

SPECIMENS EXAMINED – (on *Dryas octopetala*) **Western Carpathians** – Zachodnie Tatry Mts. (POLAND) – Mt. Kominiarski Wierch, on twigs and leaves of *D. octopetala* and *Rhodiola rosea*, 7 September 1995, coll.: *A. Chlebicki*, KRAM; Mt. Ciemniak, (Stoły Rocks), on hypanthium of *D. octopetala*, 10 September 1995, coll.: *A. Chlebicki*, KRAM F.

Comments – It is a widely distributed species and noted on many host plants.

Protoventuria latispora (M.E. Barr) M.E. Barr, Can. J. Bot. 46: 851, 1968.
Pleosporales

The fungus was noted in the Zachodnie Tatry Mts. and Pieniny Mts. in Poland, see Chlebicki, (2002). It occurs also on ericaceous hosts.

Pseudomassaria islandica (Johanson) M.E. Barr, Mycologia 56: 854, 1964.
Xylariales

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead leaves, 6 October 2001, coll.: *A. Chlebicki*, KRAM; Chočské vrchy Mts., Veľký Choč Mt., '*Dryadetum*' 1550 elev., on petiole and upper side of leaf, 10 July 1928, coll.: *P. Sillinger*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Biela skala' above Zuberec, ca 1750 m elev. [ridge between Radové skaly rocky peak (1557 m elev.) and Sivý vrch Mt. (1805 m elev.) in current maps], on stipules, petiole and upper side of leaves, 15 August 1928, coll.: *J. Dostál*, PRC; Zachodnie Tatry Mts. (POLAND) – Ciemniak Mt., Stoły Rocks, on vein of lower side of leaf, 26 July 2002, coll.: *A. Chlebicki*, KRAM; Vysoké Tatry Mts. (SLOVAKIA) – 'Bolond-Gero' (?), ca 1800 m elev., on upper side of leaf, July 1926, coll.: *A. Margittai*, PRC; Belianske Tatry Mts. (SLOVAKIA) – Faixová Ridge [ridge with a number of rocky peaks going ESE from Skalné Vráta Mt. to the beginning of Dlhá stěna (rocky wall)], 1550 m elev., on stipules and upper side of leaf, 21 July 1928, coll.: *V. Krajina*, PRC.

Comments – *Pseudomassaria islandica* is a common dryadicolous species with an amphi-atlantic distribution, noted on *Dryas octopetala*, *D. integrifolia* and *D. drummondii* (Chlebicki 2002).

Pseudomassaria minor (M.E. Barr) M.E. Barr, Mycologia 56: 856, 1964.
Xylariales

Ascocarp partially immersed, 110-140 μm diam., pale internally, dark externally, apex setose, asci (8)12-16-spored, 38-53 x 11.5-18 μm, ascospores hyaline, two-celled, 9-14 x 4.2-6.5 μm.

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., on dead stipules, 5 September 1967, coll.: *J. Chrtek & B. Křísa*, PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on dead leaves, 6 October 2001, coll.: *A. Chlebicki*, KRAM; Zachodnie Tatry Mts. (POLAND) – Kalacka Turnia (crag), on dead pedicel, 3 September 1954, coll.: *J. Mądalski*, (KRAM F).

Comments – The fungus was noted on leaves of *Dryas octopetala*, *D. drummondii* and *D. integrifolia* (BARR 1959; NOGRASEK 1990; Chlebicki 1995). Chlebicki (1995) observed polysporous asci in Polish material. *P. minor* is known from Canada (Barr 1959), Austria (the Alps), Scandinavia (Nograsek 1990) and the Zachodnie Tatry Mts. (Chlebicki 1995).

Scopinella solani (Zukal) Malloch, Fungi Canadenses, no. 82, 1976.
Sordariales

A rare fungus, noted on plant debris in Canada and Europe (Cannon & Hawksworth 1982), also on *Dryas octopetala* in the lowest locality in the Pieniny Mts. in the Western Carpathians (Chlebicki 2002).

***Septoria* sp.** Anamorphic fungus

Conidiomata black, densely distributed, cone-shaped or globose, widely opened by longitudinal slit in its upper part, conidia hyaline (3)5-8–septate, 50-90 x 1-1.5 μm.

SPECIMENS EXAMINED – Eastern Carpathians – Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on upper side of leaves, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – Very similar fungi, but with shorter conidia (32-42 μm long), were noted in material from the Pyrenees, Carpathians and the Putorana Mts. in Northern Asia (Chlebicki 1995, 2002).

Sphaerotheca volkartii Blumer, Beitr. Krypt.-Fl. Schweiz 7, 1: 115, 1933. *Erysiphales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13' N, 19° 06' E, 1590 m elev., on lower side of leaves of *Dryas octopetala*, 6 October 2001, coll.: *A. Chlebicki*, KRAM.; **Eastern Carpathians –** Rarâu Mts. (ROMANIA) – Pietrele Doamnei Rocks, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – Earlier *Sphaerotheca volkartii* was reported from the Alps (Braun 1987, 1995), Scandinavia (L. Holm 1979), Romanian Carpathians (Sandu-Ville 1967; Eliade 1990; Chlebicki 1995), Pyrenees and Zachodnie Tatry Mts. (Sałata *et al.* 1984; Chlebicki 1995). According to Blumer (1967) it does not follow *Dryas* above 2000 m elev.

Stagonospora sp. Anamorphic fungus

Conidiomata blackish brown, opened irregularly by several valves, wall of conidioma in erumping part (valves) brown, conidia hyaline, four-celled, 19-21 x 1.7-2.0 μm.

SPECIMENS EXAMINED – Western Carpathians – Nízke Tatry Mts. (SLOVAKIA) – Bába Hill E of village of Lučivná, on upper side of leaves of *Dryas octopetala*, 4 September 1920, coll.: *K. Domin*, PRC.

Comments – Anamorphs belonging to the genus *Stagonospora* are usually connected with *Phaeosphaeria* (Leuchtmann 1984).

Stomiopeltis dryadis (Rehm) L. Holm, Bot. Notiser 132: 88, 1979. *Micropeltidaceae* (*Dothideomycetidae* inc. sed.)

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Kriváň Mt., on upper side of leaves, 2 August 1919, coll.: *K. Domin*, PRC; Chočské vrchy Mts., Veľký Choč Mt., on persisting leaf-bases and upper side of leaves, 28 July 1919, coll.: *K. Domin*, PRC; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., 'Dolina Rozpadlica' (valley) – at present probably Rozpadlý grúň valley SE of saddle between Krzesanica Mt. and Małołączniak Mt., see Kotula, (1889-1890), 1500 m elev., on lower side of dead leaves, 22 August 1930, coll.: *J. Dostál*, PRC; Vysoké Tatry Mts. (SLOVAKIA) – 'Bolond-Gero' (?), ca 1800 m elev., on upper side of leaves, July 1926, coll.: *A. Margittai*, PRC; Belianske Tatry Mts. (SLOVAKIA) – 'Distr. Kežmarok, Kopa' (Belianska Kopa) Mt., see Krajina, (1925), on stipules, 19 June 1924, coll.: *V. Krajina*, PRC; N slope of Muráň Mt., 14 August

1925, coll.: *V. Krajina*, PRC; Nízke Tatry Mts. (SLOVAKIA) – Krakova hoľa Mt., 48° 59' 07" N, 19° 37' 59" E, 1730-1750 m elev., 23 September 2003, coll.: *A. Chlebicki & M. Suková*, KRAM; Bába Hill E of village of Lučivná, on twig, 4 September 1920, coll.: *K. Domin*, PRC; **Eastern Carpathians** – Svidovets Mts. (UKRAINE) – Bliznitsa Mt., July 1918, coll.: *A. Margittai*, PRC; Maramureş mountain range (ROMANIA) – NNE of village of Repedea, Mihailecul Mt., 1910-1920 m elev., on upper side of leaves, 30 June 2003, coll.: *M. Suková*, PRM 901045.

Comments – It was earlier reported from the Alps (Rehm 1904; Nograsek 1990), Scandinavia (L. Holm 1979; Nograsek 1990), Canadian Arctic (Barr 1959, 1990), Iceland, the Faroe Islands (L. Holm 1979), Spitsbergen (K. Holm & L. Holm 1993), Pyrenees and Carpathians (Chlebicki 1995). Recently it was noted in some Carpathians ranges such as the Zachodnie Tatry Mts., Vysoké Tatry Mts., Pieniny Mts. and Svidovets Mts. (Chlebicki 2002).

Sydowiella dryadis L.N. Vassiljeva var. ***macrospora*** Nograsek in Nograsek & Matzer, Nova Hedwigia 53: 464, 1991. *Diaporthales*

SPECIMENS EXAMINED – **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on dead twigs, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – *Sydowiella dryadis* var. *macrospora* was earlier noted in the Alps (Nograsek & Matzer 1991), Spitsbergen (K. Holm & L. Holm 1993), Zachodnie Tatry Mts., Svidovets Mts. (Carpathians) and the Urals (Chlebicki 2002).

Synchytrium cupulatum F. Thomas, Botan. Zbl. 29(1): 22, 1887. *Chytridiales*

This parasite occurs on living leaves, petioles, calyces and petals of *D. octopetala* and *D. integrifolia*. It is a rare fungus, so far reported from the Alps, Finland, Iceland, Spitsbergen, Chukotka Peninsula, Greenland, and Somerset Island in the Canadian Arctic (Karling 1964; Savile 1959; Chlebicki 2002; Chlebicki & Raitviir 2003). Bontea (1985) reported the species from the Romanian Carpathians.

Urceolella dryadicola Raitv., Mycotaxon 86: 222, 2003. *Helotiales*

Apothecia sessile, pale yellow, covered with white hairs, spores hyaline, fusoid to clavate-fusoid, aseptate, 7-8 x 1.3 μm, paraphyses filiform, slightly thickened at the top, not exceeding the asci.

SPECIMENS EXAMINED – **Eastern Carpathians** – Rarău Mts. (ROMANIA) – Pietrele Doamnei Rocks, at 1653 m elev., on lower side of dead leaves, 4 October 2002, coll.: *A. Chlebicki*, KRAM.

Comments – The species has been described from Greenland (Chlebicki & Raitviir 2003). The first author found it also in material from the Canadian Arctic gathered by E. Ohenoja.

Wettsteinina dryadis (Rostr.) Petrak, Sydowia 1: 322, 1947. *Pleosporales*

SPECIMENS EXAMINED – Western Carpathians – Fatra (SLOVAKIA) – Malá Fatra Mts., Suchý Mt., upper side of leaves, 3 June 1926, coll.: *J. Klika,* PRC; Malá Fatra Mts., Malý Kriváň Mt., 1669 m elev., 15 May 1921, coll.: *F. Maloch,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., ca 1600 m elev., on upper side of leaves, 28 June 1925, coll.: *F. Maloch,* PRC; Malá Fatra Mts., Veľký Rozsutec Mt., 49° 13’ N, 19° 06’ E, 1590 m elev., on dead leaves, 6 October 2001, coll.: *A. Chlebicki,* KRAM; Západné Tatry Mts. (SLOVAKIA) – Liptovské hole Mts., ‘Biela skala’ above Zuberec, ca 1750 m elev. [probably ridge between ‘Biela skala’ Mt. (1316 m elev.) and Sivý vrch Mt. (1805 m elev.)], on upper side of leaves, 15 August 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., Plačlivý Roháč (Plačlivé) Mt., ca 1900 m elev., on upper side of leaves, July 1928, coll.: *J. Dostál,* PRC; Liptovské hole Mts., foot of Plačlivý Roháč (Plačlivé) Mt. in Smutná dolina (valley), ca 1650-1700 m elev., on petioles, August 1926, coll.: *J. Dostál*, PRC; Vysoké Tatry Mts. (SLOVAKIA) – Zámky Mt., on lower side of leaves (at median furrow and main veins) and on stipules, 9 July 1925, coll.: *V. Krajina,* PRC; Belianske Tatry Mts. (SLOVAKIA) – ‘Distr. Kežmarok, Kopa’ (Belianska Kopa Mt.), see KRAJINA, (1925), on upper side of leaves, 19 June 1924, coll.: *V. Krajina,* PRC; Nízke Tatry (SLOVAKIA) – Bába Hill E of village of Lučivná, on petiole, 4 September 1920, coll.: *K. Domin,* PRC; **Eastern Carpathians** – Svidovets Mts. (UKRAINE) – Coluoirs in Limanovy car, 1650 m elev., 11 July 1931, coll.: *M. Deyl,* PRC.

Comments – *Wettsteinina dryadis* was noted in the Zachodnie Tatry Mts. and Belianske Tatry Mts. (Chlebicki 1995, 2002). It is a widespread species in Arctic and alpine regions, noted on *Dryas octopetala, D. drummondii* and *D. integrifolia* (Shoemaker & Babcock 1987).

Biogeographic connections

No doubt the old host plant metapopulation was widely distributed in the Carpathians during the last glaciation. At present it is divided into separated areas. The sizes of the disjunct ‘islands’ inhabited by the host plant vary greatly. The number of fungus species of these ‘islands’ is distinctly connected with the size of the locality. Movement of fungi between the small host plant populations is very restricted, as indicated by the fungal data. Extinction of mycobiota in these ‘islands’ also is linked to their size, see also MacArthur & Wilson, (1963, 1967). Moreover, some very small host populations are inhabited by plurivorous fungi; the population from the Pieniny Mts. is one example. This distinct process of extinction makes it difficult to identify the origin of the host plant on the basis of mycogeographical analysis. It should be pointed out that *Dryas octopetala* tends to host a great number of arcto-alpine species of fungi (Chlebicki 2002). The presence of some alpine fungus species indicates the connection of Carpathian mycobiota with the Alps: *Crocicreas dryadis* var. *uniseptata*, ‘*Lachnum crystallophorum*’, *Odontotrema alpinum* and *Acanthostigma longisporum*. So far these fungi were noted only in Central Europe, but Carpathian mycobiota possess species known from the Ural Mts. and Asia, such as *Leptosphaeria holmiorum*. Spore appendages of *Gnomonia drydis* are very similar to those from Scandinavia, not those from the Alps. The distribution of such species as *Odontotrema alpinum* and *Pleospora ascodedicata* indicates that there is a connection between the alpine

Table 1. Distribution of fungi in Carpathian 'island' areas*

Fungus	1	2	3	4	5	6	7	8	9	10	11	12	Total
Stomiopeltis dryadis	*	*	*	*	*	*	*	*	*		*		10
Crocicreas dryadis var. dryadis	*	*	*	*	*			*	*	*			8
Isothea rhytismoides	*	*	*	*	*				*	*		*	8
Leptosphaerulina dryadis	*	*	*	*						*	*	*	7
Gnomonia dryadis	*	*	*	*			*					*	6
Wettsteinina dryadis	*		*	*	*			*	*				6
Pseudomassaria islandica	*	*	*	*	*								5
Massarina balnei-ursi	*		*				*					*	4
Crocicreas variabile			*	*	*								3
Leptosphaeria dryadophila	*						*					*	3
Phaeosphaeria dryadea	*						*					*	3
Sphaerotheca volkartii	*		*									*	3
Sydowiella dryadis var. macrospora			*						*			*	3
Cainiella johansonii			*				*						2
Crocicreas dryadis var. uniseptata	*		*										2
Pleospora ascodedicata			*			*							2
Pseudomassaria minor	*		*										2
Acanthostigma longisporum			*										1
Lachnum crystallophorum												*	1
Leptosphaeria holmiorum	*												1
Melanomma margaretae			*										1
Mycosphaerella octopetalae											*		1
Mycosphaerella ootheca								*					1
Odontotrema alpinum					*								1
Otthia dryadis			*										1
Urceolella dryadicola												*	1
Lophiostoma winteri (n)			*				*					*	3
Mycosphaerella punctiformis (n)	*		*				*						3
Eurotium herbariorum (n)	*		*										2
Lophiostoma macrostomum (n)	*		*										2
Pleospora helvetica (n)								*				*	2
Protoventuria latispora (n)			*			*							2
Didymosphaeria massarioides (n)						*							1
Discosia strobilina (n)			*										1
Leptosphaerulina pulchra (n)								*					1
Massarina corticola (n)						*							1
Mycosphaerella tassiana (n)		*											1
Pleospora penicillus v. ambigua (n)			*										1
Scopinella solani (n)						*							1
Together	17	7	25	8	7	6	8	6	5	3	3	12	

***1** Malá Fatra Mts. **2** Chočské vrchy Mts. **3** Západné (Zachodnie) Tatry Mts. **4** Vysoké (Wysokie) Tatry Mts. **5** Belianske Tatry Mts. **6** Pieniny Mts. **7** Nízke Tatry Mts. (loc. Krakova hoľa) **8** Nízke Tatry Mts. (loc. Bába) **9** Svidovets Mts. **10** Chornohora Mts. **11** Maramureş, **12** Rarâu Mts.

(n) fungi non-specific for *Dryas*

mycobiota in Central Europe and in Scandinavia. The presence of the various fungi mentioned earlier indicates that the *Dryas octopetala* population in the Carpathians probably is composed of elements of various origin.

Table 2. Distribution of specific and plurivorous fungi in the Carpathians

Region	Dryas-specific fungi	Plurivorous	Area-specific species	Size of host population area
Malá Fatra Mts.	14	1	1	+++
Chočské vrchy	6	1		++
Západné (Zachodnie) Tatry Mts.	18	7	3	++++
Vysoké Tatry Mts.	8			++
Belianske Tatry Mts.	7		1	+++
Pieniny Mts.	2	4		+
Nizke Tatry Mts. (loc. Krakova hoľa)	6	2		++
Nízke Tatry Mts. (loc. Bába)	4	2		+
Svidovets Mts.	5			++
Chornohora Mts.	3			+
Maramures	3			+++
Rarău Mts.	10	2	2	+++

The fungi can be divided into three groups: 1 – arcto-alpine specific fungi noted in some 'islands'; 2 – rare specific fungi noted in single localities; 3 – fungi non-specific for *Dryas* (Table 1). In almost all 'island' areas, the following *Dryas*-specific fungi were found: *Isothea rhytismoides, Crocicreas dryadis* var. *dryadis, Stomiopeltis dryadis* and *Leptosphaerulina dryadis* (Table 1). Of these, only *Crocicreas dryadis* var. *dryadis* is exclusively a European species. Non-specific dryadicolous fungi (Table 2) were found in the Zachodnie Tatry Mts. (mostly arcto-alpine species) and Pieniny Mts. (mostly plurivorous species). In this last locality the host plant grows at 715 m elev., which is its lowest locality in the Carpathians.

Some connection between particular 'islands' were noted. The presence of *Pleospora ascodedicata* in the Tatry Mts. and Pieniny Mts. only, as well as the presence of *Cainiella johansonii* in the Tatry Mts., Liptovské hole and Nízke Tatry Mts. evidence a connection between these areas in the past. In terms of mycobiota, the 'islands' most similar to each other were the Malá Fatra Mts., Chočské vrchy Mts., Západné (Zachodnie) Tatry Mts., Vysoké Tatry Mts. and Bielanske Tatry Mts. The four big 'islands' possess exclusive species (Table 2). Among them, the Západné (Zachodnie) Tatry Mts. are the most distinct and separated 'island', having a greater number of exclusive species and a single endemite, *Melanomma margaretae*. However the dispersion of the fungi in smaller 'islands' is mostly accidental, the result of the decline of the host plant population and the consequent extinction of fungi.

These data should be augmented with more and wider mycogeographical analyses.

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Four new lichen species from Turkey

Kenan Yazici*
kcagri_1997@yahoo.com
Biology Department, Fatih Education Faculty, Karadeniz Technical University
Trabzon, Turkey

Ali Aslan
aliaslan@atauni.edu.tr
Biology Department, Kazım Karabekir Education Faculty, Atatürk University,
Erzurum, Turkey

André Aptroot
aptroot@cbs.knaw.nl
Centraalbureau voor Schimmelcultures
P.O. Box 85167, NL-3508 AD Utrecht, The Netherlands

Abstract—Four species of lichenized fungi, *Lecidea variegatula*, *Lecidella anomaloides*, *Ramalina subgeniculata* and *Verrucaria compacta*, are newly recorded for Turkey; for each, a taxonomic description, together with habitat and distributional data, is provided.

Keywords— Ascomycetes, Bayburt, Biodiversity, MustafaKemalpaşa

Introduction

Although the lichen flora of Turkey is largely unknown and many regions of this country have yet to be investigated, in recent years there has been a substantial increase in the attention paid to this country (Aslan 2000, Aslan and Öztürk 1994, Aslan et al. 1998, 2002a, b, Gönülol et al. 1995, Öztürk and Kaynak 1999, Öztürk 1990, Özdemirtürk 2003, Yazıcı and Aslan 2002a, b, Yazıcı 1995). John (1996a, b) has reviewed the earlier work and provided an invaluable checklist on which to build our knowledge. The present paper is a further contribution to this work.

Material and methods

Samples were collected from two different stations in Bayburt and Bursa province in July-August 2003. A stereo microscope, a light microscope and the usual spot tests were used in the identification of the samples, together with the following reference books: Clauzade & Roux (1985), Poelt (1974), Purvis et al. (1992) and Wirth (1995). Vouchers have been deposited in the herbarium of the Biology Department, Fatih Education Faculty, Karadeniz Technical University.

Results

Lecidea variegatula Nyl.

Thallus episubstratic, large or small, 1,5-3 mm thick, subsquamulose, areolate; surface yellowish white, brownish yellow, grey or brown; not sorediate, without thalloconidia; areoles/lobes angular or rounded, plane or convex, folded, continuous throughout the thallus, basally not constricted or basally constricted; edges concolorous with the remaining areoles/lobes surface. Ascomata 80-400 per cm^2, 3-9(-1.3) mm in diam., sessile, slightly constricted at the base; disc plane or weakly convex to rarely distinctly convex, black, not pruinose; margin persistent, not flexuose, not pruinose, not umbonate; excipulum 20-50 μm wide, grey, without to with parallel-radiate hyphae, hyphae 3-5 μm wide; hypothecium hyaline; hymenium 25-40 μm high, hyaline to greenish hyaline; epihymenium olivaceous to green to turquoise, HC- to + bluish; ascospores ellipsoid to ellipsoid-cylindrical, (4.5-)5-7.2(-8) μm long, (2-)2.4-2.8(-3.5) μm wide, smooth; conidia (3.5-)4.6-5.1(-6) μm long. Medulla K-, C-, PD-; ascomatal disc C-; excipulum K-, C-; hypothecium K-; epihymenium K-.

On non-calcareous rock (sandstone, rarely with traces of carbonate) in well-lit areas. It is distributed throughout Europe and South America.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on slightly calcareous rock, at 600 m altitude, 39° 53' 00" N, 28° 19' 00" E, 24 August 2003.

Lecidella anomaloides (A. Massal.) Hertel & Kilias

Thallus, thin (0.2 mm thick), crustose, continuous to indistinctly areolate, ± scurfy to ± granular, wide-spreading, pale to dark grey or greenish; hypothallus usually absent (rarely visible at the thallus margin, up to 0.1 mm thick), black. Apothecia sparse or moderately abundant, 0.4-0.7 mm in diam., sessile, flat to slightly convex and slightly constricted at the base; disc plane, black, not pruinose; margin biatorine; excipulum well developed, often wavy, persistent, 50-70 μm thick, mostly opaque, dark brown towards the hypothecium; epithecium green-black to brownish, non-crystalline; hypothecium hyaline, colourless or pale brown, red brown when old and often K+ faintly reddish; hymenium hyaline, not inspersed; paraphyses not (or rarely) distinctly branched, not (or rarely) anostomosing; not (or slightly) thickened; ascospores 8 per ascus, ellipsoid or ovoid, 9-15 x 7-8 μm; conidiophores of Vobis-type III: conidia filiform or curved.

On shaded, often vertical, ± damp, siliceous rocks, often in wooded situations or in sheltered gullies. It is distributed throughout Western Europe, from the Mediterranean northwards, and in North America.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on calcareous rock, at 600 m altitude, 39° 53' 00" N, 28° 19' 00" E, 24 August 2003.

Ramalina subgeniculata Nyl.

Thallus shrubby, 1-5 cm high, generally with numerous branches; lobes up to 2-5 mm wide, longitudinally furrowed, perforate and fenestrate; medulla P-, K-, C- and KC-, without pseudocyphellae and soralia. Apothecia frequent, apical, subapical and lateral, often spurred; ascospores 9-16 x 4-6 μm and quite curved.

On non-calcareous rocks or deciduous trees exposed to light but sheltered against wind; generally found in the Mediterranean area and Madeira.

Bursa: MustafaKemalpaşa, near Suuçtu Cascade, on calcareous rock, at 600 m altitude, 39° 53' 00" N, 28° 19' 00" E, 24 August 2003.

Verrucaria compacta (A. Massal.) Jatta

Thallus dark brown, clearly areolate; areoles contiguous or occasionally solitary, irregular, thick, widening from a narrower base (subumbilicate), and therefore ± easily detatched from rock, mostly ending abruptly but occasionally with a few smaller, flatter marginal areoles, in section appearing compound above but with thick, white, ± continuous medulla; hypothallus not evident; ascomata completely immersed, with small, black nearly invisible ostioles; ascomatal wall colourless except at the mouth; ascospores (9-)11-18 x 6-9(-11)μm.

On calcareous rock in alpine areas of Europe.

Bayburt: Yeniköy, on calcareous rock, at 2500 m altitude, 40° 03' 45" N, 40° 10' 10" E, 2 July 2003.

Discussion

In this study four lichen species are presented, which are new records for the lichen flora of Turkey. In previous work conducted in the region, Yazıcı (1999a) reported 78, Yazıcı (1999b) 231, and Yazıcı and Aslan (2003) 206 lichen species. The climate of MustafaKemalpaşa (Bursa) is mild and cool in summer, being intermediate between continental and cool Mediterranean. Below 400 m the dominant vegetation type is Macchia. Between 400 and 700 m forest appears, especially by streams, mostly *Pinetum, Quercetum* and *Carpinetum*. Large areas have been converted into prairies. MustafaKemalpaşa is rich in fruticose and crustose lichen species. Bayburt has a continental climate with severe winters and hot summers; it is quite poor in terms of forest cover, being very rich in crustose but poor in fruticose lichen species.

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Nectriella guadalupensis and Its *Dendrodochium*-like anamorph (*Bionectriaceae, Hypocreales*): a new species on *Agavaceae*

ANNETTE W. RAMALEY

aramaley@yahoo.com
7 Animas Place
Durango, Colorado 81301

Abstract—*Nectriella guadalupensis* and its *Dendrodochium*-like anamorph are described from dead leaves of *Nolina*. A *Dendrodochium*-like anamorph is new for the genus *Nectriella*.

Keywords—Ascomycotina, *Nolina*, systematics

Introduction

The *Hypocreales* are distributed worldwide but favor tropical and warm-temperate locales. Members of the order exhibit a nutritional status from apparent saprotrophy to biotrophy in some stage of developmental. These fungi are found on a wide variety of biotic substrata including both animals and plants. In addition, several genera or species within a genus occur on lichens or are fungal associates on polypores, mushrooms, discomycetes, ascomycete stromata, and myxomycetes (Rossman et al. 1999).

Farr et al. (1989) list two hypocrealean genera from *Yucca* L., *Hyponectria mohavensis* Bonar, and *Allantonectria yuccae* Earle. No member of the Hypocreales is cited from other members of the Agavaceae commonly found in southwestern deserts in the USA, *Agave* L., *Nolina* Michx., or *Dasylirion* Zucc. *Hyponectria* Sacc. was moved from the *Hypocreales* to the *Phyllachorales, Physosporellaceae* (Barr 1977) and is now placed in the *Xylariales, Hyponectriaceae* (Barr 1990). *Hyponectria mohavensis* was excluded from the genus (Barr 1977), but its proper disposition was not determined. *Allantonectria yuccae* Earle is a synonym of *Nectria miltina* (Mont.) Mont. (Rossman et al. 1999). In addition to the *Yucca* substratum, this fungus has now been collected on *Dasylirion* and *Nolina* (Rossman et al. 1999), and more recently on *Agave* in the USA. Two other members of the *Hypocreales* have been described from leaves of the Agavaceae (Ramaley 2001). *Niesslia agavacearum* A.W. Ramaley, found on *Dasylirion* and less frequently on *Nolina*, is a member of the *Niessliaceae*. *Hyaloseta nolinae* A.W. Ramaley from *Nolina* was tentatively placed in the *Niessliaceae* on morphological grounds despite its having hyaline ascomatal setae. DNA sequencing has shown it is similar to other members of the *Niessliaceae* (Amy Rossman, personal communication).

Nectriella Nitschke comprises 23 species of the *Bionectriaceae* in the *Hypocreales* (Rossman et al. 1999). The genus was redescribed and known species described and illustrated by Lowen (1991) who also removed several lichenicolous species formerly classified as *Nectriella* to *Pronectria* Clem. Additional *Nectriella* species were described, and a key to all the species was provided by Rossman et al. (1999). *Nectriella* is distinguished from other family members by its non-stromatic ascomata, and its immersed to partially erumpent habit in wood, bark, and herbaceous tissues, or rarely, lichens and fungi. Ascospores are 1-septate except in *Nectriella jucunda* (Durieu & Mont.) Sacc., which has aseptate ascospores. *Nectriella pironii* Alfieri & Samuels causes stem galls and cankers in several ornamental plants (Alfieri et al. 1979), whereas other species are saprotrophes. Anamorphs are known for few *Nectriella* species. *Acremonium* Link. or *Acremonium*-like fungi are anamorphs of *N. minuta* Lowen, *N. dakotensis* (Seaver) Lowen (as *N. muelleri* Samuels et al. in Samuels et al. 1984) and an unnamed species (Samuels et al. 1984). *Nectriella pironii* has a sporodochial *Kutilakesa pironii* Alfieri and a hyphomycetous *Acremonium*-like synanamorph (Alfieri & Samuels 1979). In this paper *Nectriella guadalupensis*, on dead leaves of *Nolina micrantha* I.M. Johnst., is described as a new species because it occurs on a novel substratum, the associated anamorph differs from any known for the genus, and the ascospores differ in size and shape from ascospores of any other species. *Nectriella guadalupensis* is similar to other hypocealean fungi in having an association with other fungal species. It is commonly seen with conidiomata of *Piptarthron sp.*, the fungus most often encounterd on *Nolina* leaves, and has also been found adjacent to *Coniothyrium sp.* conidiomata. Ascomata are found adjacent to old conidiomata or even in the mouth of such structures. In addition to these associates, all stages of *N. guadalupensis* are associated with pale orange, *N. guadalupensis*-like hyphomycete hyphae that bear gray to gray-brown dictyospores.

Materials and Methods

To obtain cultures, *Nectriella* ascomata were divested of as much surrounding tissue as possible, rinsed three times in sterile tap water, and cut open to release groups of asci. Droplets containing groups of asci and freed ascospores were placed in drops of sterile tap water on Petri plates of commercial potato dextrose agar (PDA, BBL) + 2% agar (Difco) + ca 2.5 mg L streptomycin, and spread with a sterile glass rod. Germination from free ascospores occurred within 48 h. Germlings were transferred to PDA tubes and maintained at room temperature (RT, 18–22 C) in incident daylight. Sections were cut with a razor blade and mounted in tap water for examination. Measurements were made using an ocular micrometer with 0.8 µm increments. Growth rate was established by touching a sterile needle to conidia in an actively growing culture and stabbing the center of a PDA plate. Plates were wrapped in laboratory film and grown at RT in incident daylight on a tabletop. Each week, colonies were measured to the nearest mm.

Taxonomic Description

Nectriella guadalupensis A.W. Ramaley *sp. nov.* FIGURES 1-6

Ascomata singulares vel pauci-aggregata, immersa in conidiomatibus veteribus fungorum (Piptarthron, Coniothyrium), proxime extra conidiomata fungorum talium, vel in fissura *stomatiphora, obpyriforma 150–200 µm lata, 200–280 (–360) µm elata, dilut-aurantiaca maturitatem; papilla 64–120 (–200) µm, apex expositus, truncatus, canalis ostioli periphysatibus. Peridium 16–24 µm latum, strata externa cellularum crassi-parietibus composita, strata interna cellularum elongatarum tenui-parietibus composita, strata extima ascomatum insularum cellularum bruni-parietibus composita ex hyphis ambientibus formata. Asci cylindrici-clavati, 40–60 (–70) X 6.4–8.8 µm, apex rotundatus. Ascosporae allantoideae vel interdum prope cylindricae, (8–) 9.6–11.2 (–12.4) X 2–2.4 µm, in medio 1-septatae, non constrictae ad septa, hyalinae, laeves.*

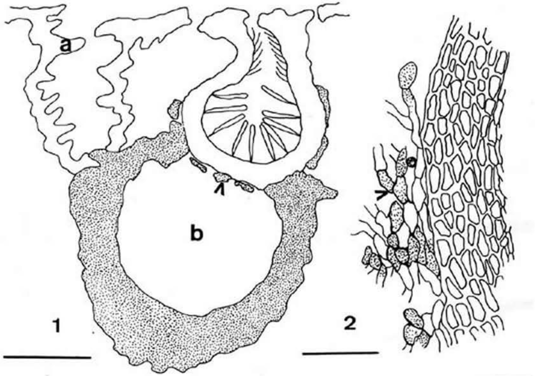
Anamorph: *Dendrodochium*-like

HOLOTYPE: USA. TEXAS: Culberson County, Guadalupe Mountains National Park, 4.6 miles from the highway gate on Williams Ranch Road, 20 October 1999, often associated with other fungi (*Piptarthron*, *Coniothyrium*, undetermined hyphomycete genus) on dead leaves of *Nolina micrantha* I. M. Johnst., Annette Ramaley 9912A, culture CBS 110134 (BPI 842102. Isotype: UC).

Ascomata single or in small groups, immersed in old conidiomata of other genera (*Piptarthron*, *Coniothyrium*), immediately external to such conidiomata, or with anamorph in stomatal cleft of substratum, obpyriform, 150–200 µm broad, 200–280 (–360) µm tall, at maturity pale orange; papilla 64–120 (–200) µm tall, deeper orange than venter, truncate tip exposed, ostiolar canal lined with periphyses. **Peridium** 16–24 µm thick, most layers composed mainly of small, thick-walled cells, a few innermost layers composed of more elongate, thinner-walled cells sometimes present; external to these wall layers, ascomata eventually surrounded, with gaps, by islands of irregularly shaped, brown-walled cells differentiated from hyphae surrounding ascomata. Wall of papilla usually with a few layers of thick-walled, rounded cells externally, and elongate thin-walled cells internally. **Asci** unitunicate,cylindric-clavate, 40–60 (–70) X 6.4–8.8 µm, apex rounded, apical ring not observed, interthecial elements lacking. **Ascospores** allantoid to nearly cylindric, (8–) 9.6–11.2 (–12.4) X 2–2.4 µm, 1-septate in middle, not constricted at septum, hyaline, pale orange en masse, smooth.

Conidiomata sporodochial, narrow at base, broadening toward conidiomatal surface, pale orange when active, ca 160 µm broad, much extended along stomatal clefts of affected leaves up to at least 3 mm, apparently by fusion of adjacent conidiomatal initials, hyphae upright, repeatedly branched, each penultimate cell bearing 2 or 3 conidiogenous cells. Conidiogenesis phialidic, phialides 7.2–9.6 X 2–2.4 µm, lageniform, with short collarette and some periclinal thickening, pale orange. Conidia usually bacillar, 4–7.2 X 1.6 µm, individually hyaline, pale orange in mass, smooth, thin-walled, biguttulate.

Growth in Culture — On PDA, mycelium white to pale orange, tightly appressed to agar, hyphae more widely separated below agar surface. After 1 w, colonies 5–8 mm diam (avg. 6.0 mm), some colonies developing an orange center. After 2 w, colonies 13–16 mm diam (avg. 14 mm), all with bright orange center surrounded by a white marginal ring 4–6 mm broad. Slimy orange central spot somewhat raised, consisting of vegetative hyphae 0.8–1.6 µm diam, hyphae ca 2.5 µm diam bearing expanded, curved conidiogenous cells 2–3.2 X 8–12 µm, and conidia. Orange from accumulated conidia and conidiogenous cells. Conidiogenous cells born laterally on hyphae, or terminally with 2 to 3 conidiogenous cells born on a penultimate cell. Closely spaced branching reminiscent of sporodochia only rarely present in broader hyphae below

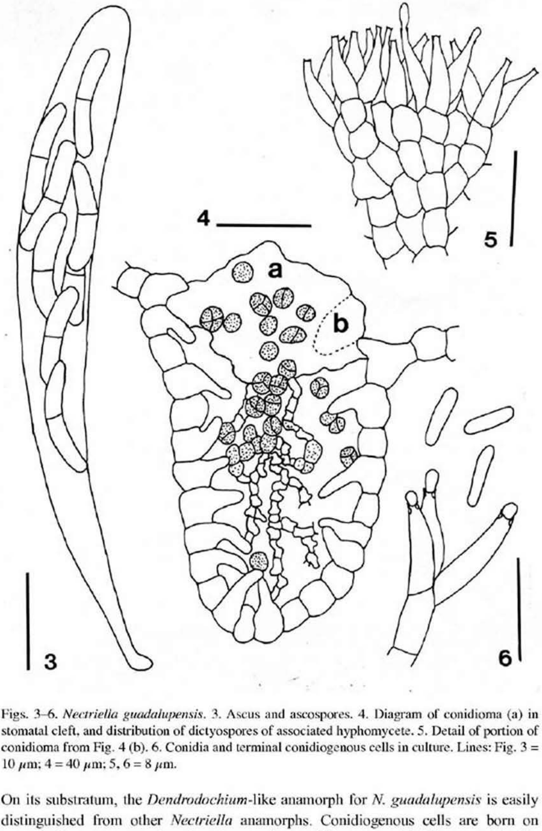


Figs. 1–2. *Nectriella guadalupensis*. 1. Transection of *Nolina* leaf with ascoma in mouth of old *Piptarthron* conidioma. (a), tooth of epidermal cell in stomatal cleft; (b), locule filled with *Nectriella* hyphae; (>), islands of brown-walled cells that develop from hyphae surrounding an ascoma. 2. Wall of ascoma; (>), brown-walled cells in island adjacent to ascoma. Lines: Fig. 1 = 100 μm; 2 = 20 μm.

terminal conidiogenous cells. Conidiogenesis phialidic, phialides with slight periclinal thickening and short collarette. Conidia mostly bacillar 4–6.4 X 1.6 μm, hyaline, smooth, thin-walled, biguttulate. After 4 w colonies 31–34 mm diam (avg. 33 mm). Appearance of colonies much as in young cultures, orange center surrounded by a ring of white hyphae. In older cultures, central orange spots form radii from small orange foci of conidium production which expand and fuse. In addition, hyphae below agar also form conidiogenous cells and conidia.

Discussion

Nectriella guadalupensis is distinguished from other species by its occurrence in the desert, habitat on dead leaves of *Nolina*, a monocot, the allantoid to cylindric ascospores, and the *Dendrodochium*-like anamorph. Other species with monocot substrata include *Nectriella dacrymycella* (Nyl.) Rehm on stems of *Iris* Tourn. *ex* L., *N. exigua* Dennis from *Ammophila* Host., *N. curtisii* (Berk.) Lowen on stems of *Typha* L., *N.paludosa* Fuckel from stems of *Typha* and *Iris*, and *N. minuta* Lowen from dead bamboo culms. Ascomata of *N. exigua*, *N. curtisii*, and *N. minuta* generally remain immersed, as do those of *N.guadalupensis*, but the substrata for these other species are not xerophytic. *Nectriella* ascospores are usually ellipsoid to ellipsoid-fusiform to fusiform. As in *N. guadalupensis*, *N. jucunda*, from stems of *Opuntia* Tourn. *ex* Mill., has allantoid to cylindric ascospores, but they are aseptate and only ca 5.5 μm long.



Figs. 3–6. *Nectriella guadalupensis*. 3. Ascus and ascospores. 4. Diagram of conidioma (a) in stomatal cleft, and distribution of dictyospores of associated hyphomycete. 5. Detail of portion of conidioma from Fig. 4 (b). 6. Conidia and terminal conidiogenous cells in culture. Lines: Fig. 3 = 10 μm; 4 = 40 μm; 5, 6 = 8 μm.

On its substratum, the *Dendrodochium*-like anamorph for *N. guadalupensis* is easily distinguished from other *Nectriella* anamorphs. Conidiogenous cells are born on sporodochia, not separately, as are *Acremonium* conidiogenous cells. These sporodochia lack setae such as those occurring on *Kutilakesa pironii* sporodochia. In addition, *K. pironii* has an *Acremonium* synanamorph that is more common than the sporodochia in cultures as well as in nature. Typical *Dendrodochium*-like sporodochia are lacking in *N. guadalupensis* cultures, but conidium formation has never been observed on separate, upright, *Acremonium*-like conidiophores. The *Dendrodochium*-like anamorph is also distinct from the sporodochial, non-setose genus *Tubercularia* Tode that often has acropleurogenous phialides, conidiomata derived from a pseudoparenchymatous stroma, and rapid, pink growth in culture (Tulloch 1972, Seifert 1985).

The *Dendrodochium*-like anamorph could not be cultivated because few conidia were present, and propagules of many other fungal genera accumulate on the upper surface of the sporodochia on the decomposing leaves. However, the connection of the two states is supported by their organic connection on the host. In addition, conidia are produced on similarly shaped terminal conidiogenous cells that are born in twos or threes on the sporodochia on *Nolina* as well as in cultures from *Nectriella guadalupensis* ascospores.

Acknowledgements

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A host-specific species of *Hypoxylon* from France, and notes on the chemotaxonomy of the "*Hypoxylon rubiginosum* complex"

MARC STADLER [1,2,*] & HARTMUND WOLLWEBER [1]

[1]marc.stadler@t-online.de
Naturwissenschaftlicher Verein (Mycological Section)
& Mycological Herbarium of the Fuhlrott-Museum Wuppertal
In den Birken 73, D-42113 Wuppertal, Germany
[2]Bayer Health Care AG, Pharma Research Europe
P.O. Box 10 17 09, D-42096 Wuppertal, Germany

JACQUES FOURNIER

jacques.fournier@club-internet.fr
Las Muros, F-09420 Rimont, France

Abstract—*Hypoxylon petriniae* sp. nov. is described from a new combination of morphological characters of its teleomorph and anamorph. It was found in France and other countries of Western and Central Europe, mostly colonising *Fraxinus excelsior*. Its status is supported by a chemotaxonomic study by analytical HPLC profiling with diode array and mass spectrometric detection of secondary metabolites in several *Hypoxylon* spp. These analyses revealed the presence of binaphthalene tetrol (BNT) as major stromatal metabolite of *H. petriniae*. This widespread purple stromatal pigment of *Xylariaceae* was not found in *H. rubiginosum*, *H. cercidicolum*, and further, presumably related species. In contrast to *H. rubiginosum* and *H. cercidicolum*, *H. petriniae* was found devoid of mitorubrin. Orsellinic acid and rubiginosins, which are recently identified azaphilone pigments chemically related to mitorubrin were found as common stromatal metabolites of many of the aforementioned taxa, and the occurrence of particular azaphilones appears to be specific for some species. A key to European *Hypoxylon* spp. is provided.

Key words—chemotaxonomy, systematics, secondary metabolites

Introduction

The current study deals with *Hypoxylon rubiginosum* (Pers. : Fr.) Fr. and presumably allied taxa. Miller (1961) had synominised about 60 names with *H. rubiginosum* in his world monograph, but many of them are now regarded as separate species. The work of Ju & Rogers (1996) helped very much to sort out this conglomerate of taxa. The authors gave detailed descriptions of type materials of several species and provided evidence that allowed to discriminate these morphologically related taxa. Nonetheless, the segregation of this "*H. rubiginosum* complex" appears to be still ongoing, as indicated by recent taxonomic treatments.

For example, there is a fungus associated with Fraxinus, which was reported as *H. rubiginosum* (Pers. : Fr.) Fr. var. *cercidicola* (Berk. & M. A. Curtis ex Peck) L. Petrini apud L. E. Petrini & E. Müller, by Petrini & Müller (1986). This variety was listed by Ju & Rogers (1996) among the synonyms of *H. cercidicolum* (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers. According to Ju & Rogers (1996), the latter species was first described from Europe as *H. moravicum* Pouz. (Pouzar 1972). As pointed out by Granmo (1999), both Pouzar (1972) and Petrini & Müller (1986) already showed that *H. moravicum* differs from *H. rubiginosum* and its varieties with respect to teleomorphic and anamorphic characters. The asexual stage of the former species was described by Petrini & Candoussau (1983) as *Hadrotrichum pyrenaicum* Petrini & Candoussau. In contrast, cultures of *H. rubiginosum* var. *cercidicola* ss. Petrini & Müller (1986) were reported to produce an anamorph referable to *Virgariella* S. J. Hughes, which corresponds to the *Virgariella*-like branching pattern as defined in Ju & Rogers (1996). Moreover, the anamorph of this variety differs from that of *H. rubiginosum* ss. str., which forms on malt as well as oatmeal agar a conidiogenous structure of the *Nodulisporium* type ss. Ju & Rogers (1996). Granmo (1999) treated *H. rubiginosum* var. *cercidicola* as "*H. cercidicola* (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers", albeit he explicitly stated that this fungus was not conspecific with *H. moravicum* ss. Pouzar (1972). Notably, Ju & Rogers (1996) described a fungus with morphological similarities to *H. rubiginosum* and a *Virgariella* anamorph from *Fraxinus* in their "Notes to *H. rubiginosum*". They even referred to a previous description of this *Virgariella*-like stage by Greenhalgh & Chesters (1968, as *H. rubiginosum*), but did not relate the similar description of *H. rubiginosum* var. *cercidicola* by Petrini & Müller (1986) to this taxon, for which they provided no new name.

In the current study, various specimens corresponding with the above taxa were collected fresh from France and studied for morphological characters of their teleomorphs and anamorphs. For comparison, some specimens that had been studied by Petrini & Müller (1986), as well as materials from Germany and the type of *H. suborbiculare* Peck were examined. High performance liquid chromatography (HPLC), which recently had revealed consistent species-specific differences in *Daldinia* Ces & de Not. (Stadler et al. 2001a,b), *Hypoxylon* (Mühlbauer et al. 2002; Hellwig et al. 2004) and allied *Xylariaceae* (Stadler et al. 2004) was employed to generate secondary metabolite profiles. Such data were used as surrogate parameters to verify morphological traits. Hence, we report the outcome of this study and erect the new species, ***H. petriniae*** **M. Stadler & J. Fournier**.

HPLC-based data were also correlated with morphological characters and data on KOH-extractable pigments to provide a user-friendly key that should allow specialists as well as amateur mycologists for identification of European *Hypoxylon* spp. This key is thus independent of HPLC-based data and anamorphic characters.

Materials and Methods

Specimens examined – Only those specimens examined for stromatal metabolites by HPLC are listed below. Most of them are representatives selected from an ongoing mycobiotic study on Pyrenomycetes of southwestern France, and several were also used in the concurrent study by Hellwig et al. (2004). Further materials examined by

J.F. and co-workers for morphological characters were listed on the Internet by Fournier & Magni (2004). If not indicated otherwise by acronyms of herbaria (following abbreviations as listed in Holmgren et al. 1990), the specimens are deposited at the mycological herbarium of the Fuhlrott-Museum, Wuppertal, Germany, and also kept in the personal herbarium of J. Fournier.

Albeit a great deal of culturing was involved (indicated as "CULTURED" for the materials in the list below), to verify the taxonomy of these species, not all strains remained viable. Surviving cultures were deposited at CBS (where indicated) and/or at the collection of the Academia Sinica, Taipei, Taiwan and preserved at the Bayer Pharma Research Center, Wuppertal, Germany, on YMG agar slants at 4°C and in liquid N_2.

REMARKS: (*,#): Specimens consisting of (*) two or even (#) three different species growing on the same substrate, which were discriminated by examination of teleomorphic, anamorphic and cultural characters, as well as by HPLC profiling of stromatal extracts. With these materials, extraction and culturing experiments were repeated several times to exclude dependence of results on substrate and environmental factors. – (**) Further materials of these species were previously examined by Mühlbauer et al. (2002) and their HPLC data are considered in the current study. Acronyms of collectors: JF: Jacques Fournier; STMA: Marc Stadler; Ww: Hartmund Wollweber. Materials from ZT were generally included in the study by Petrini & Müller (1986).

Hypoxylon cercidicolum (Berk. & M.A. Curtis ex Peck) Y.-M. Ju & J.D. Rogers: FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*. 20.X.2001, *JF-01129*, CULTURED. – UNITED STATES. New York: SANDLAKE, 1877, corticated wood of *Fraxinus*, C.H. Peck (NYS, TYPE of *Hypoxylon suborbiculare* Peck, nom. illeg.).

H. ferrugineum Otth: **SWITZERLAND: Zürich,** WÄDERSWIL, Autumn 1972, *Sorbus aucuparia* var. *edulis*, J. Anliker as *H. rubiginosum*, det. E. Müller (ZT).

H. fragiforme (Pers. : Fr.) J. Kickx fil.**: **GERMANY. Rheinland-Pfalz Prov.:** KARLSTAL, near TRIPPSTADT, on recently felled trunk of *Quercus robur*, 28.IX.2003, *STMA 03044*, CULTURED, CBS 115276. – dto., twigs of *Fagus sylvatica*, 28.IX.2003, *STMA 03045*, CULTURED, CBS 115275.

H. howeianum Peck**: **FRANCE. Ariège**: RIMONT, Las Muros, *Quercus robur*, 10.VII.1996, *JF-96050*.

H. intermedium (Schwein. : Fr.) Y.-M. Ju & J. D. Rogers: **FRANCE. Ariège:** RIMONT, Las Muros, *Fraxinus excelsior*, 27.VII.2003, *JF-03128*, CULTURED, CBS 115274. **– Pyrénées Atlantiques**: OLORON, Forêt de Bugangue, *Fraxinus*, 15.X.1981, L. & O. Petrini & F. Candoussau, as *H. fraxinophilum* (ZT). **– LIECHTENSTEIN.** GAMPRIN, Rheinau, 27.IX.1986, *Fraxinus*, L. & O. Petrini, as *H. fraxinophilum* (ZT). **– SWITZERLAND. Zurich:** FÄLLANDEN, forest near Benglen, Mülíholz, *Fraxinus*, 02.X.1984, L. Petrini, as *H. fraxinophilum*.

H. julianii L. E. Petrini: **FRANCE: Ariège,** MONTSERON, Roquebrune, decorticated wood of *Salix caprea*, 04.VI.1999, *JF-99112*. – **SWITZERLAND. Graubünden:** SOLAS near FILISUR, *Alnus incana*, 03.IX.1982, L. Petrini (ZT-HOLOTYPE). – dto., *Alnus incana*, 24.IX.1983, L. & O. Petrini (ZT-PARATYPE).

H. laschii Nitschke: **FRANCE. Ariège:** RIMONT, Saurine, *Populus tremula*, 09.VIII.1998, *JF-98096*.

H. petriniae M. Stadler & J. Fournier, sp. nov.: Specimens see taxonomic part **(B)** of Results and Discussion.

H. perforatum (Schwein. : Fr.) Fr.: FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*, 02.IX.2000, *JF-00181*, CULTURED, CBS 115281. – dto., *Rhamnus carthartica*, 27.VII.2003, *JF-03125*. – dto., *Fraxinus excelsior*, 27.VII.2003, *JF-03126*. – dto., *Fraxinus excelsior*, 16.VIII.2003, *JF-03139C'*, CULTURED. – Isère: region of Lac de PALADRU, ca. 0.8 km SE of PALADRU, edge of Marais de la Véronnière, on decorticated fallen branch of *Fraxinus*, 29.VIII.2003, D. Triebel & G. Rambold *G.R.-9571* (M), associated with *H. petriniae*, CULTURED. – Pyrénées Atlantiques: NAY, Saligues de Bourdettes, *Fraxinus*, 12.X.1981, F. Candoussau & L. Petrini as *H. rubiginosum* var. *perforatum* (ZT). – SWITZERLAND. Jura: ST. URSANNE, Col de la Croix, cf. *Carpinus betulus*, 19.VI.1983, L. & O. Petrini, as *H. rubiginosum* var.

perforatum (ZT). – Tessin: Meride, *Fraxinus*, 26.VII.1982, L. Petrini & A.J.S. Whalley, as *H. rubiginosum* var. *perforatum* (ZT).

H. rubiginosum (Pers. : Fr.) Fr.**: FRANCE. Ariège: RIMONT, Las Muros, bark of *Populus tremula*, 21.VIII.1999, *JF-99191*. – dto., *Fraxinus excelsior*, 02.IX.2000, *JF- 00180B**; CULTURED. – dto., 07.IX.2001, decorticated wood of *Ulmus*, *JF 01189*, CULTURED. – dto., *Fraxinus*, 15.VI.2003, *JF- 03100B**, CULTURED. –dto., *Fraxinus excelsior*, 16.VIII.2003, *JF-03139B′*, CULTURED. – USTOU, Cirque de Cagateille, decorticated wood of *Fagus*, 26.VIII.2001, *JF-01173*, CULTURED. – Isère: region of Lac de PALADRU, ca. 0.8 km SE of PALADRU, edge of Marais de la Véronnière, decorticated fallen branch of *Fraxinus*, 29.VIII.2003, D. Triebel & G. Rambold *GR-9575* (M), associated with *H. petriniae* and *H. perforatum*, CULTURED, CBS 115160. – GERMANY. North Rhine Westphalia Prov.: HAAN-GRUITEN, Neandertal, bark and wood of *Fraxinus excelsior*, 16.IV.2003, STMA & Ww, *Ww 4314*, CULTURED. –SWITZERLAND. Graubünden: Station UNTERVAZ, Heurütenen, decorticated wood, 31.VII.1982, L. Petrini & A.J.S. Whalley (ZT). – Bern: Brünigpasshöhe, *Fagus sylvatica*, 18.X.1982, L. Petrini (ZT) – Tessin: SAGNO, San Martino, *Fraxinus excelsior*, 26.VII.1982, L. Petrini & A.J.S. Whalley (ZT) – Zurich: ZURICH, Albisguetli, bark of *Fraxinus excelsior*, 05.XI.1981, T. Sieber, det. L. Petrini as *H. rubiginosum* var. *rubiginosum* (ZT) – UNITED KINGDOM. Devon: MANATON, Becky Falls, Houndtor wood, *Salix*, 21.IV.1982, L. Petrini (ZT).

H. rutilum Tul. & C. Tul.: FRANCE. Ariège: RIMONT, Las Muros, *Prunus avium*, 11.IX.2000, *JF-00291*, CULTURED, CBS 115159.

H. subticinense Y.-M. Ju & J. D. Rogers: **FRANCE. Ariège:** RIMONT, Las Muros, *Populus tremula*, 26.V.1997, *JF 97075*. – dto., ruisseau de Peyrau, *Rhamnus carthartica*, 28.VII.2000, *JF-00135*.

H. ticinense L. E. Petrini: **FRANCE. Ariège:** RIMONT, Las Muros, ruisseau de Peyrau, bark of *Fraxinus*, 02.IX.2001, *JF-01181*. – dto., Las Muros, *Malus silvestris*, 27.VII.2003, *JF-03124*. – dto., *Fraxinus excelsior*, 27.VII.2003, *JF-03129*, CULTURED, CBS 115271.

Microscopic observations of teleomorphic structures were made in water (for studying ascospore morphology), in Melzer's reagent (for testing the amyloidity of ascal apical structures), in aqueous Congo Red, Blue Black Waterman ink or Phloxine (for measurements of ascal stipes), and in 10% KOH for testing the dehiscence of perispore. Measurements of ascospores were taken in water at 1000x magnification. KOH-extractable pigments were obtained as described in Ju & Rogers (1996). Colour codes follow Rayner (1970). The conidiogenous structures and all species treated here are named, following the monograph by Ju & Rogers (1996) and the recent update by Ju et al. (2004), respectively. Microphotographs of ascospores were taken in Melzer's reagent. **SEM** (scanning electron microscopy) of ascospores was carried out as described previously by Stadler et al. (2002). **Microscopic observations of anamorphic structures** were made in water at 400x - 1000x magnification, using phase contrast. For this purpose, cultures were obtained from single ascospores in a similar manner as described by Petrini & Müller (1986), transferring the germinated spores to a yeast-malt glucose (YMG) medium supplemented by antibiotics (Stadler et al. 2001a). For morphological studies, the cultures were grown on malt agar (Petrini & Müller 1986) as well as on Difco Potato dextrose (PDA), YMG and Difco Oatmeal agar (OA) to compare morphological structures to all previous reports. No significant differences regarding the shape and size of conidiogenous structures were seen in the same fungus grown on different media. However, macroscopic characteristics of the culture were influenced by the medium, and to assure conformity with the reports by Ju & Rogers (1996), the photographs shown in Figs. 7 – 8 were taken from OA, the medium generally used by the latter authors.

HPLC analyses of stromatal methanolic extracts were carried out according to Mühlbauer et al. (2002) in two different gradients, using UV-visual detection (**HPLC-**

UV/Vis) with diode array detection (**DAD**) and mass spectrometric detection (**HPLC-MS**) in both the positive and negative electrospray ionisation (**ESI**) mode. Secondary metabolites were identified by matching their retention times (**Rt**), HPLC-UV/Vis and HPLC-MS spectra with external or internal standards of pure compounds that had been obtained previously and concurrently. HPLC data of extracts and pure compounds from previous studies on *Xylariaceae* (Hellwig et al. 2004, Quang et al. 2002, 2004a,b, Stadler et al. 2001a,b, 2004) were also used for comparison. Cultures were propagated on YMG medium, and their extracts analysed on the occurrence of secondary metabolites as described by Stadler et al. (2001a). Some materials from Difco OA plates were also extracted with ethyl acetate or methanol and their extracts analysed for comparison.

Results and Discussion

The results of the current study are divided into a chemotaxonomic and a morphological/taxonomic part, both of which are presented and discussed separately.

A. HPLC-based studies on secondary metabolites

Secondary metabolites have been known to be valuable in the taxonomy of *Xylariaceae* for a long time. For instance the secondary metabolites of cultures are specific for particular genera to some extent (Whalley & Edwards 1995, Stadler et al. 2001a,b, 2004). Stromatal pigment patterns of *Hypoxylon* in particular are known to be species-consistent. They even revealed characteristic differences between taxa that were at times only regarded as "chemical races" of the same species (Whalley & Greenhalgh 1971, Whalley & Whalley 1977), but whose status as separate taxa has meanwhile been established by morphological methods. These early studies dealt with thin layer chromatography (**TLC**), a technique which provides insufficient information, especially if standards of the detected metabolites are not available. HPLC coupled with spectral techniques provides a higher sensitivity and resolution, and the characteristic compounds contained in fungal materials can be safely identified, using only some mg of crude material (Stadler et al. 2004).

In the current study, several *Hypoxylon* spp. were identified and examined as described in Materials and Methods. Methanolic extracts of their stromata were prepared and studied for the occurrence of characteristic secondary metabolites by analytical HPLC as previously described by Stadler et al. (2001a) and Mühlbauer et al. (2002). The results of this HPLC profiling study are summarised in Table 1, the chemical structures of characteristic metabolites depicted in Fig. 1 and some characteristic HPLC-UV chromatograms shown in Fig. 2. In accordance with previous chemotaxonomic studies on other *Xylariaceae*, the results were consistent for all species where several records were examined. The correspondence and synonymy of the species described by Petrini & Müller (1986) with their respective counterparts in the later monograph by Ju & Rogers (1996) was confirmed with one exception (***H. petriniae***, see further below). The specimens obtained from ZT had all been collected prior to 1987, but still showed the same characteristic metabolites as the more recently collected specimens.

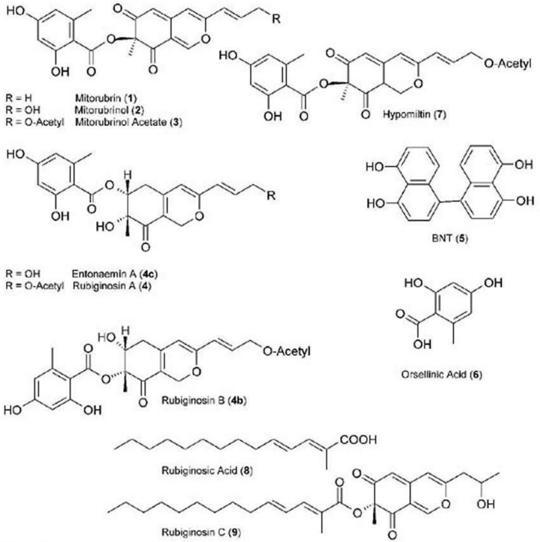


Fig. 1. Secondary metabolites detected in the current study. For distribution of these compounds in stromata of various *Hypoxylon* spp. see Table 2.

In most cases, age of specimens and seasonal aspects mainly affected the yields of secondary metabolites extracted (and thus, the intensity of the HPLC chromatograms) but not the composition of the secondary metabolite profiles themselves. Only very young conidiogenous stromata yielded rather small amounts of the characteristic compounds so long as no ascospores were formed. In such materials (which generally still have a yellowish surface colour), some unknown metabolites were also detected, even complicating the identification of the characteristic metabolites, but these were always present as deduced from HPLC-MS data. The latter technique is more sensitive (Stadler et al. 2004) and was successfully applied to depauperate specimens that had been collected in overmature state. Remarkably, these findings were in contrast to previous studies on *Daldinia* (Wollweber & Stadler 2001), where it had been easier to classify immature stromata at least with regard to their chemotype, since no apparently specific metabolites were observed in young conidiogenous stromata. Nonetheless, if ascospores were found besides the conidial stage, the stromata of the *Hypoxylon* spp. studied generally yielded larger quantities of extractable materials than aged and overmature ones. These findings were again in analogy to *Daldinia*.

The substrate did not apparently have any influence on secondary metabolite production. Even wood from the immediate vicinity of the stromata did not even show traces of those metabolites that were present in the stromata in abundance. This was not surprising, since the characteristic pigments of *Hypoxylon* are located in the outermost parts of the stromata, i.e., in regions that have no contact to the substrate. Hence, species-consistency of metabolite profiles was not only established with *H. rubiginosum*, colonising various hosts, but also, e.g., for an unusual collection of *H. fragiforme* from *Quercus robur* (STMA 03044), which did not differ from those specimens that were found on *Fagus*, the usual host of this species (cf. Mühlbauer et al. 2002, for similar findings on *H. fuscum*).

Among the taxa compared in the current study, ***H. petriniae*** was the only one containing BNT (**5**) as well as orsellinic acid (**6**) and the recently described compound, rubiginosin A (**4** in Fig. 1). The occurrence of the latter metabolite in *H. rubiginosum* (Mühlbauer et al. 2002) and several red- or yellow-pigmented species of *Entonaema* A. Möller (Stadler et al. 2004) had been previously established by comparing retention times (**Rt**) in two different gradient systems, as well as by HPLC-UV/Vis spectra and HPLC-MS characteristics in the positive and negative ESI mode. A typical HPLC chromatogram of *H. rubiginosum* and further species was also depicted in Mühlbauer et al. (2002). As demonstrated concurrently (Hellwig et al. 2004), there are further species of *Hypoxylon* in Asia and New Zealand that contain both compounds **5** and **6** as co-metabolites, but no other European taxon so far shared this feature. For details on the HPLC characteristics and other physico-chemical parameters we refer to these previous papers and to Quang et al. (2004a,b).

Rubiginosin A (**4** in Fig. 1) was still treated as "unknown compound **14**" by Mühlbauer et al. 2002) and now identified from *H. rubiginosum* (Quang et al. 2004b). This metabolite is structurally related to mitorubrins (**1** - **3** in Fig. 1) but the ester bond linking the orsellinic acid moiety to the azaphilone backbone is located at a different carbon atom, while the mitorubrins have a carbonyl group at this position (Quang et al. 2004b). While compounds **1** - **4** were found to co-occur in several *Hypoxylon* spp. (Table 1) as well as in all orange-pigmented species of *Entonaema* (Stadler et al. 2004), rubiginosin A (**4**) was not contained in *H. fragiforme* and *H. howeianum*, (Mühlbauer et al. 2002). As noted in the current study, it also lacked in *H. ticinense*. Additional minor metabolites of this type are the entonaemins (e.g. **4c**). They were reported from a fungus named *Entonaema splendens* (Berk. & M.A. Curtis) Lloyd collected in Japan (Hashimoto & Asakawa 1998), which may actually correspond with *E. cinnabarina* (Cooke & Massee) Lloyd (Stadler et al. 2004). The HPLC-UV and HPLC-MS data point toward their presence as minor metabolites in rubiginosin-containing *Hypoxylon* spp., due to the similar UV spectra and matching molecular masses observed.

Along with the novel fatty acid, rubiginosic acid (**8**) and rubiginosin C (**9**), an unprecedented compound that formally constitutes an ester of this acid with the modified azaphilone moiety of the mitorubrins, were identified as main constituents of *H. rubiginosum* from Germany. While the acid (**8**) was not detected in the current study, rubiginosin C (**9**) was found in several *Hypoxylon* spp. (see Table 2), including several species that also contained rubiginosin A (**4**). Presumably, these types of azaphilones are derived from different biogenetic precursors, and specific enzymes are necessary to modify the azaphilone backbone. There are even indications that further azaphilone esters of fatty acids may be present as specific lipophilic metabolites in various *Hypoxylon* spp., and their identification is currently pending.

All examined specimens of ***H. petriniae*** differed from both *H. rubiginosum* and *H. cercidicolum* by the presence of BNT (**5**) and the absence of mitorubrin (**1**). In contrast to the *H. cercidicolum* specimens (including *H. suborbiculare*), the two other species generally contained rubiginosin A (**4**) as common major metabolite. In *H. petriniae*, mitorubrin (**1**) was apparently replaced by an unidentified compound with rubiginosin-like HPLC-UV/Vis chromophore, which eluted at the same Rt as BNT. At least its characteristic molecular mass and the UV spectrum of mitorubrin were not detected, in contrast to the results obtained from other species. Entonaemin A (**4c**) and rubiginosin B (**4b**), whose structures are depicted in Fig. 1, were not detected in the crude extract and had only been isolated from *H. rubiginosum* in minor quantities after preparative HPLC separation (Quang et al. 2004b). The same work also revealed the presence of daldinin C in trace amounts in the stromata of *H. rubiginosum*, but this compound was also not detected during HPLC profiling of crude extracts.

Apparently, ***H. petriniae*** lacks the ability to produce mitorubrin, but can instead produce rubiginosin A/entonaemin-like azaphilones, rubiginosin C (**9**), and the purple pigment BNT (**5**). The latter compound is most probably responsible for its characteristic purplish to vinaceous stromatal surface colours that lack in, e.g., *H. rubiginosum*. Therefore, ***H. petriniae*** is quite easily distinguished from aforementioned, presumably related species by HPLC profiling. As shown below and in Table 2, these chemical traits are quite in agreement with various data available on the morphology and biology of this fungus. Conceivably, secondary metabolite profiles (and thus characters relating to KOH-extractable stromatal pigments as an important means of differentiation in the current generic concept) provide an important argument against the conspecificity of ***H. petriniae*** with *H. cercidicolum*.

Because ***H. petriniae*** occasionally co-occurs with other taxa on the same substrate, this phenomenon was studied by concurrent extractions and HPLC analyses of portions of stromata representing these different fungi. Albeit the stromata of two different *Hypoxylon* spp. were at times found growing only some centimetres apart from one another, their HPLC profiles were still found characteristic. The portions of the specimen JF-00180A, JF-03100A, JF-03139A and G.R.-9574 representing ***H. petriniae*** always contained BNT (**5**), while their counterparts representing *H. rubiginosum* and/or *H. perforatum* lacked this compound. In all cases, their stromata were found to contain the same metabolites as their counterparts that colonised the woody substrates alone. This was confirmed by repeating extraction and analyses several times for various portions of each specimen, as well as by concurrent culturing experiments.

As shown concurrently by Hellwig et al. (2004), the typical pigment of *H. hypomiltum* Mont., *H. intermedium* and *H. perforatum* is the yellow azaphilone hypomiltin (**7** in Fig. 1). All species found to contain this compound are apparently devoid of mitorubrins and rubiginosins (**1** – **4** and **9**). They can be discriminated without HPLC, since they yield greenish yellow pigments [e.g. amber (47), greenish yellow (16), citrine (13)] in KOH, while those of the species containing mitorubrin and/or rubiginin (cf. Table 1) are orange (7) or reddish brown.

Species of sect. *Hypoxylon* with yellow stromatal pigments in KOH also include *H. macrocarpum* Pouz. (Mühlbauer et al. 2002) and *H. fuscum* (Pers.: Fr.) Fr. (Quang et al. 2004b), both of which were recently found to contain compounds of the daldinin and macrocarpone types, respectively. These metabolites were not detected as major constituents in the species examined here. Neither were daldinal A, previously found as a minor metabolite in *H. fuscum*, and other, yet unknown metabolites of *H. subrutilum* Starb. (Mühlbauer et al. 2002).

In contrast, *H. laschii*, *H. cercidicolum*, *H. julianii* and *H. subticinense* all largely resembled *H. rubiginosum* with regard to their secondary metabolite profiles. While BNT (**5**) was absent, at least one compound of the mitorubrin (**1** - **3**) metabolite family and rubiginosin A (**4**) were always detected as major metabolites. Differences were noted with regard to their lipophilic constituents (i.e., metabolites eluting after mitorubrinol acetate). For instance, *H. julianii* and *H. rutilum* only contained an additional main metabolite **HR1** with Rt = 9.2 min, which was not present in any other species (Fig. 2). This metabolite could not be identified, due to the small quantities of stromatal materials available from these relatively rare species. Yet another, apparently specific metabolite was also found in the extract of *H. ferrugineum* as a co-metabolite of azaphilones. However, the occurrence of this compound should be verified by concurrent studies on type and further authentic material. Albeit we agree with Petrini & Müller (1986) that this specimen showed the typical characteristics of *H. ferrugineum*, it was reported from *Sorbus* rather than from *Tilia*, the usual host of this species (cf. Ju & Rogers 1996). In any case, its metabolite profile was different from that of *H. rubiginosum*. The amount of mitorubrin (**1**) was found particularly high in the freshly collected *H. cercidicolum*, as well as in *H. ferrugineum*, *H. julianii*, *H. laschii* and *H. rutilum*, while these species did not contain much or were even found devoid of the mitorubrin derivatives **2** and **3**. Therefore, it is possible that the latter fungi are not capable of converting mitorubrin into the hydroxylated derivative **2** and its acetate **3**. Likewise, the metabolite profiles of *H. ticinense* and *H. subticinense* differed in the presence of mitorubrinol acetate (**3**) only in the former and rubiginosin A (**4**) in the latter.

As reported previously, high contents of mitorubrinol are also typical of *H. subticinense* and both varieties of *H. subgilvum* (Hellwig et al. 2004). However, the significance of the latter results should be confirmed, based on a larger number of specimens, preferably of different developmental stages. The methodology employed is not quite suitable to establish a quantitative chemotaxonomy, anyway, because the amounts of materials extracted can hardly be standardised.

In any case, the employed HPLC profiling methodology proved perhaps even more valuable than in *Daldinia* (Stadler et al. 2001a,b) because of the apparent high diversity of specific compounds in *Hypoxylon* sect. *Hypoxylon*. Similar methodology could certainly find further application to solve some immanent taxonomic problems in *Xylariaceae* and other fungi, in conjunction with or as a prerequisite for morphological and molecular studies.

Table 1. Occurrence of characteristic stromatal metabolites in European species of *Hypoxylon* sect. *Hypoxylon* as deduced from HPLC profiling.

Species	**Secondary metabolites detected by HPLC analysis**							
	1	**2**	**3**	**4**	**5**	**6**	**9**	**Other or remarks**
H. cercidicolum (France)	++	(+)	–	+	–	(+)	+	unknown metabolites found in *H. suborbiculare* lacking
H. cercidicolum (NYS, *H. suborbiculare*, Type)	(+)	–	–	–	–	(+)	+	unknown metabolites prevailing, possibly artefacts or specific compounds
H. ferrugineum	++	+	(+)	–	–	+	–	characteristic peak at Rt = 7.4 min.
*H. fragiforme**	+	+	+	–	–	+	–	see Mühlbauer et al. (2002)
*H. fuscum**	–	–	–	–	+	–	–	Daldinins, see Quang et al. (2004b)
H. howeianum	+	+	+	–	–	+	–	see Mühlbauer et al. (2002)
H. intermedium	–	–	–	–	–	+	–	Hypomiltin (**7**) and congeners with similar UV
H. julianii	++	–	–	+	–	+	+	Peak **HR1** with Rt= 9.06 min
H. laschii	++	–	–	(+)	–	+	–	
*H. macrocarpum**	–	–	–	–	+	+	–	macrocarpones, see Mühlbauer et al. (2002)
H. petriniae	–	–	–	++	+	(+)	+	
H. perforatum	–	–	–	–	–	+	–	hypomiltin (**7**) and congeners with similar UV
H. rubiginosum	+	–	–	++	–	+	+	rubiginosin (**9**)
H. rutilum	++	–	–	+	–	+	–	Peak **HR1** with Rt= 9.06 min
H. subticinense	+	++	–	+	–	+	+	
H. ticinense	+/++	+/++	+	–	–	(+)	–	

A) SECONDARY METABOLITES: **1**= mitorubrin, **2** = mitorubrinol; **3** = mitorubrinol acetate; **4** = rubiginosin A; **5** = binaphthalenetetrol (BNT); **6** = orsellinic acid; **9** = rubiginosin C; chemical structures see Fig. 1; **HR1**, unknown compound; see Fig. 2.

B) INTENSITY OF PEAKS: **++** = main peak (over 50% of UV absorption of total components at 210 nm); **+** = major component (5-50% UV adsorption of total components at 210 nm); **(+)** = minor components (detected only by HPLC-MS and/or UV adsorption < 5% of total components in extract at 210 nm); **–** = neither detected by HPLC-UV nor by HPLC-MS.

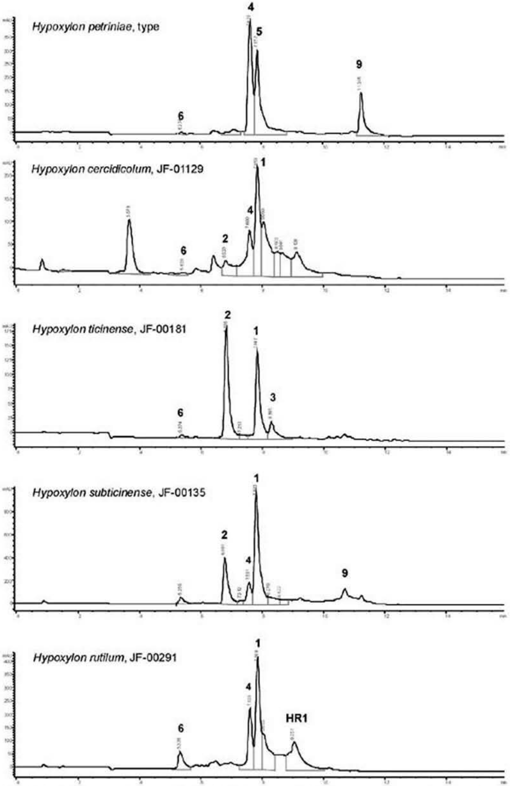


Fig. 2. HPLC-UV chromatograms (210 nm) of stromatal MeOH extracts of some *Hypoxylon* spp. For chemical structures of compounds **1** – **6** and **9** see Fig. 1 and for their HPLC characteristics Mühlbauer et al. (2002) and Quang et al. (2004b). **HR1** = unidentified compound.

Hypoxylon petriniae* M. Stadler & J. Fournier *sp. nov. **FIGURES 3a, 4-5,6a,7-8**

Stromata in ligno *Fraxini* vel (raro) *Populi* decorticato vel corticato, irregulariter effusa vel elongata, applanata, 6-60(-120) mm longa x 3-22(-25) mm lata x 0.3-0.8 mm crassa, margi stromatibus nigri et recti. Externe lilacea, rufobrunnea vel brunneo-vinacea, demum denigrata, superficie leviter rugosa, sine tumulis perithecorium, sub superficie granulis luteo-brunneis conspersa, granulis ferrugineis vel aurantiacis in KOH dissolutis; textura inter perithecia brunnea medullosa, textura sub peritheciis tenua, exigua. **Perithecia** sphaerica vel obovoidea, 0.25–0.5 mm alta x 0.25–0.38 mm diametro. **Ostiola** umbilicata. **Asci** 115-145 μm longitudine tota, 7-10 μm lati; partibus sporiferis 65-85 μm longi, stipitibus 37-64(-72) μm longi. Annulo apicali discoideo, 0.8-1 μm alto x 2.7-3.4 μm lato, in liquore iodato Melzeri cyanescente. **Ascosporae** brunneolae, unicellulares, ellipsoideo-inequilaterales vel leviter falcatae, apicibus angustatis, 8.8-11.5(-13) x 4.8-6 μm, rima germinativa recta, longa in latere convexo praeditae, perisporium in KOH dehiscens, leve, episporium leve.

Etymology: Named for the Swiss mycologist, Liliane E. Petrini.

= ***Hypoxylon cercidicola*** (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers *sensu* A. Granmo, Sommerfeltia 26, 1999. p. 26-28 and Figs. 3A-C, 12, 36]; *non* Y.-M. Ju & J. D. Rogers, A Revision of the Genus *Hypoxylon*, p. 95. 1996.

= ***Hypoxylon rubiginosum*** (Pers.: Fr.) Fr. **var. *cercidicola*** (Berk. & M. A. Curtis ex Peck) L. E. Petrini *apud* L. E. Petrini & E. Müller, Mycol. Helv. 1: 533, 1986. p. 533-534 and Fig. 14].

Stromata (Fig. 3a) on decorticated wood or bark of *Fraxinus* (*excelsior*), or, rarely, *Populus*, elongate to irregularly effused, plane, with inconspicuous perithecial mounds, usually finely wrinkled, 6-60 (-120) mm long x 3-22 (-25) mm broad x 0.3-0.8 mm thick; margins black and linear, surface lilac (54), vinaceous (57) to brown vinaceous (84); yellowish brown, orange (7) to rust (39) granules beneath surface and between perithecia, with KOH-extractable pigments orange (7) or rust (39); the tissue below the perithecial layer inconspicuous, up to 0.4 mm thick, dark brown to blackish.

Perithecia spherical to obovoid, 250-380 μm diam x 250-500 μm high. **Ostioles** umbilicate, on mature stromata surrounded by a ring of white material 50-70 μm diam. **Asci** 115-145 μm total length x 7-10 μm broad, the spore bearing-parts 65-85 μm long, the stipes 37-64(-72) μm long, with apical ring amyloid, discoid, 0.8-1 μm high x 2.7-3.4 μm broad. **Ascospores** (Fig. 5) brown, ellipsoid-inequilateral to slightly falcate, 8.8-11.5(-13) x 4.8-6 μm, M (n=300) = 10.7 x 5.1 μm, with straight germ slit spore-length on the more convex side of the spore; perispore dehiscent in 10% KOH, appearing smooth by L.M., but showing conspicuous transverse striations by SEM (Fig. 6a).

Cultures and anamorph (Figs. 7-8): **Colonies** on 2% Difco Oatmeal agar at ca. 20 °C and under 12h of fluorescent light reaching the edge of a 9 cm Petri dish in 9-11 days, at first whitish, felty, zonate, with diffuse margins, becoming greyish brown when sporulating, reverse brown. Occasionally (see Fig. 7) infertile stromata are observed after 3-4 wk., but no teleomorph is produced. Sporulating regions appearing after 13-15 days of incubation, at first sparsely appearing on the margins of colony, later numerous and scattered over entire surface of colony, greyish brown. **Conidiogenous structure** *Virgariella*-like, conidiophores 80-170 x 2.5-3 μm, hyaline, smooth to finely roughened, containing one or two conidiogenous cells at each terminus. Conidia produced in basipetal sequence from sympodially proliferating conidiogenous cells, which are located exclusively at the apices of conidiophores, never intercalary. **Conidiogenous cells** hyaline, smooth, 25-50 x 2.5-3 μm. Conidia hyaline, smooth or finely roughened, ellipsoid, (6.5-)7-8 x 3-4 μm.

Anamorph on stromata at margins of young stromata or on old stromata, pale yellow to ochraceous, velvety. **Conidiogenous structure** *Virgariella*-like, mostly dichotomously branched, much like the anamorph in culture, conidiophores slightly roughened, up to 95 mm long x 3 μm broad, yellowish to light brown. **Conidiogenous cells** cylindrical, variable in size, 10-30(-35) x 2-3 μm. **Conidia** ellipsoid, (6-)7-8(-8.5) x 3-4 μm, hyaline or yellowish brown.

TYPUS: FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*, 18.V.2001, J. Fournier, *JF 01096* (M, HOLOTYPUS), culture CBS 114746.

FURTHER REPRESENTATIVE SPECIMENS EXAMINED (if not indicated otherwise, those were collected and identified by J. Fournier): FRANCE. Ariège: RIMONT, Las Muros, *Fraxinus excelsior*, associated with *H. rubiginosum*, 02.IX.2000, *JF-00180A*, CULTURED. – dto, *Fraxinus excelsior*, associated with *H. rubiginosum*, 15.VI.2003, *JF 03100A*, CULTURED. – dto, *Populus tremula*, associated with *Hypoxylon perforatum*, *H. rubiginosum* and *Eutypa sparsa*, 16.VIII.2003, *JF-03139A*#, CULTURED, CBS 115158. – dto., 01.X.2003, on bark of *Fraxinus excelsior*, JF-03187, CULTURED, CBS 115272. – RIMONT, Binette, *Fraxinus excelsior*, 26.IV.2000, *JF-00044*. – PRAT COMMUNAL, Loumet, decorticated wood of *Fraxinus excelsior*, 22.VIII.2003, *JF-03151*, CULTURED. – Isère: region of Lac de PALADRU, ca. 0.8 km SE of PALADRU, edge of Marais de la Véronnière, on decorticated fallen branch of *Fraxinus*, 29.VII.2003, D. Triebel & G. Rambold *G.R.-9574* (M), associated with *H. perforatum* and *H. rubiginosum*, CULTURED, CBS 115278. – dto., ca. 11 km NW of VOIRON, region of Lac de PALADRU, Bilieu, ca. 1 km SW of the church of Bilieu, rotten branch of cf. *Fraxinus*, 26.VIII.2003, D. Triebel & G. Rambold *G.R.-9578* (M), CULTURED, CBS 115279. – Morbihan: PLOHARS, Pont du Douar, Forêt de Carnoët, bark of *Fraxinus*, 26.X. 2002, P. Leroy, *JF-02204*, CULTURED. – Vendée: LA TRANCHE sur MER, La Saviniére, *Fraxinus*, 02.VI.2003, *JF 030078*, CULTURED. – AVRILLE, Bois de la Garde, *Fraxinus*, 05.VI.2003, *JF-03091*, CULTURED.– GERMANY. North Rhine Westphalia: WUPPERTAL-APRATH, in mixed forest near hospital "Diakonie Aprath", corticated wood of *Fraxinus*, 28.IX.2003, *STMA 03073*. – dto., WUPPERTAL-LÜNTENBECK, corticated wood of *Fraxinus*, 29.XII.2003, *STMA 04W02*, CULTURED. – SWITZERLAND. Tessin: Morbio Superiore, Val della Credo, 04.IV.1983, L. & O. Petrini, as *H. rubiginosum* var. *cercidicola* (ZT) – UNITED KINGDOM. Wales: RUTHIAN, Llysfair Memorial Wood, *Fraxinus*, 07.II.1981, A.J.S. Whalley 771, det. L. Petrini as *H. rubiginosum* var. *cercidicola* (ZT).

COMMENTS: This species agrees well with previous descriptions of *H. rubiginosum* var. *cercidicola* (Petrini & Müller 1986) and *H. cercidicola* (Granmo 1999). This was even confirmed by authentic materials studied by the former authors collected from Switzerland and Wales, which were kindly provided by the curators of ZT. The anamorph is also in agreement with previous descriptions by Ju & Rogers (1996) and Greenhalgh & Chesters (1968) mentioned in the introduction. Based on these results, we agree with Granmo (1999) that this species is certainly not rare. It probably occurs throughout Europe in the distributional area of *Fraxinus*, and is most likely also present in America (cf. "Notes to *H. rubiginosum*" in Ju & Rogers 1996, for a Mexican *Hypoxylon* sp., sharing these characteristics).

The secondary metabolites of *H. rubiginosum* and ***H. petriniae*** in culture were also studied for comparison, using the method described by Stadler et al. (2001a). While mellein derivatives (Whalley & Edwards 1995) were prevailing in submerged YMG cultures for both species and all cultures examined in the current study, the ethyl acetate extract of a 5 weeks old Difco OA plate of ***H. petriniae*** JF-03091 contained BNT (**5**), which lacked in *H. rubiginosum* and was so far not found in *Xylariaceae* cultures (Stadler et al. 2001a). As *H. rubiginosum* cultures always produced dense yellow pigments in agar culture, it should be worthwhile to examine a larger number of taxa on secondary metabolites produced on Difco OA plates. The most striking differences between *H. petriniae* and *H. rubiginosum* are compiled in Table 2.

Table 2. Main diagnostic characters discriminating *Hypoxylon rubiginosum* from ***H. petriniae***

	H. petriniae	***H. rubiginosum***
Stromatal colour (Rayner 1970)	Lilac (54), vinaceous (57), brown vinaceous (84)	Rust (39), bay (6), sienna (8) dark brick (60)
Margin	Black, linear	Yellow to orange, effused
Perithecial mounds	Inconspicuous	More or less conspicuous, 2/3-1/2 immersed to almost naked
Basal tissue	Up to 0.4 mm thick	0.5-1.5 mm thick
Stromatal shape	Effused	Effused-pulvinate to pulvinate
Perithecia	Up to 500 μm high	Up to 800 μm high
Ascospore dimensions	M = 10.7 x 5.1 μm	M = 10.1 x 4.4 μm
Apical ring dimensions	0.8-1 x 2.7-3.4 μm	0.5-1.5 x 2-2.7 μm
Ascal width	7-10 μm	5.5-8 μm
Ascal stipes	37-64(-72) μm long	60-98 μm long
Anamorph	*Virgariella*-like branching pattern*	*Nodulisporium*-like branching pattern*
Conidiogenous cells	2 μm broad	2.5-3 μm broad
Conidia	5-7.5 x 3.5-4 μm	5-6 x 3-4 μm
Hosts	mostly *Fraxinus* (*excelsior*)	no apparent host specificity (also frequent on *Fraxinus*)
Secondary metabolites	BNT (tetrahydroxybinaththyl) present, mitorubrin absent	BNT absent, mitorubrin present

*as defined in Ju & Rogers (1996)

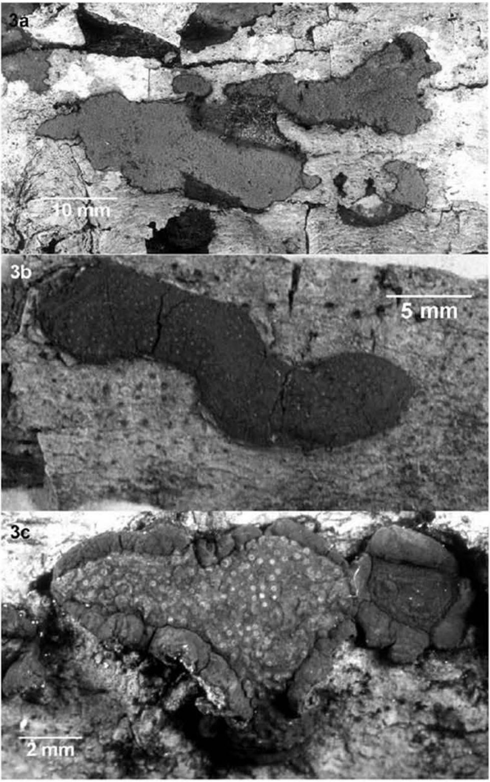
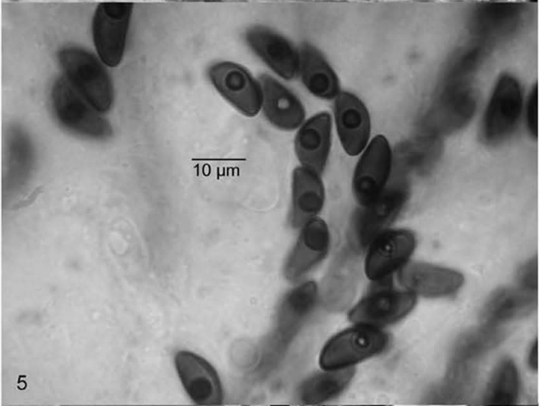


Fig. 3. Stromata of *Hypoxylon* spp. **Fig. 3a**. ***H. petriniae*** (HOLOTYPE-M). **Fig. 3b**. ***H. suborbiculare*** (TYPE-NYS). **Fig. 3c**. *H. cercidicolum*, JF-01129, showing a mature ascigenous stroma (left) as well as immature one (*Hadrotrichum* anamorph, right). Scale is indicated by bars.



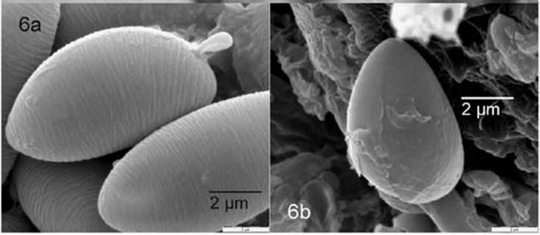
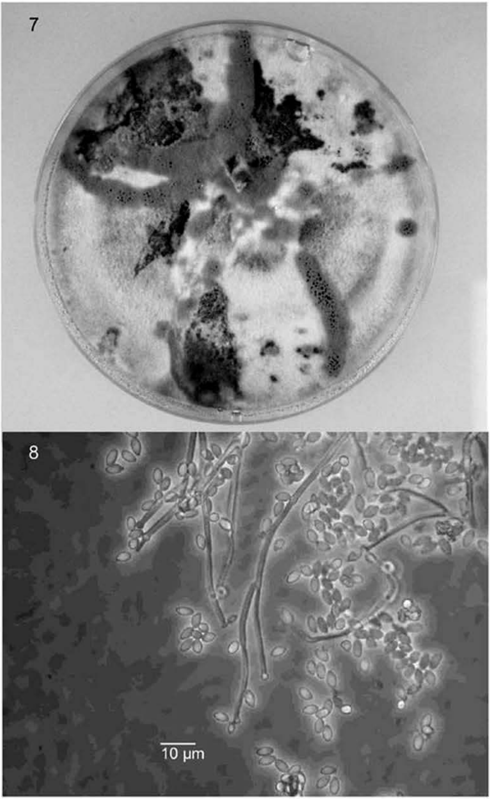


Fig. 4. *H. petriniae*, JF03187, perithecia; **Fig. 5**: *H. petriniae*, ascospores by L.M. (1000x). **Fig. 6.** SEM of ascospores of *Hypoxylon* spp. at 10.000x magnification **Fig. 6a**: *H. petriniae* (from type, M); **Fig. 6b**: *H. cercidicolum* (*H. suborbiculare*, from type, NYS). Scale is indicated by bars.



Figs. 7-8: Culture and anamorph of *H. petriniae*. **Fig. 7**: Culture (ex JF-03091) on OA (diam 9 cm) after 4 wk. **Fig. 8**. Conidiogenous structures of *H. petriniae* (from ex-type culture JF 01096) on OA after 3 wk. Scale is indicated by bar.

Characteristics of the type of *H. suborbiculare*

One task of the current study was exclusion of the conspecificity of *H. cercidicolum* ss. Ju & Rogers (1996) with ***H. petriniae***. The name *H. cercidicoum* goes back to *Diatrype cercidicola* Berk. & M. A. Curtis ex Peck. The etymology of this species is puzzling as it was never recorded from *Cercis* as would be indicated by its name, but the original substrate was identified as *Fraxinus nigra*, an American species of Ash. In the protologue of this fungus, Peck (1873) described a pyrenomycete "*with plane black stromata, 3-4 inches in diam, thin, seated on the inner bark, surrounded by the ruptured epidermis, dotted by the minute depressed or umbilicate at length perforate ostiola, perithecia crowded, elliptical or ovate, spores unequally ovate, colored, 0.004 inches long*". Peck himself subsequently named this fungus *H. suborbiculare* Peck (Peck 1879), creating a later synonym. Peck's type material of *H. suborbiculare* was kindly provided by NYS and studied concurrently. The stromata were much as described by Peck and only examined superficially to save the valuable material. As can be seen by comparison of Figs. 3a -c, their habit was somewhat different from the typical erumpent form of *H. cercidicolum*, which is usually encountered on *Fraxinus* in Europe. Certainly, they both differed from ***H. petriniae***.

In one piece of wood of the NYS specimen, a stroma whose morphological features and metabolite profiles were reminiscent of *H. rubiginosum* was observed. Hence, we suspect that the specimen may constitute a mixed collection comprising two *Hypoxylon* spp. In the remaining parts of the specimen, a homogenous morphology was observed: All stromata were plane, effused but the stromata appeared higher than in ***H. petriniae***, and they lacked the characteristic black margin of the new species. In attempts to observe ascal structures, some water mounts were prepared, but no asci, no apical ring, and only a few ascospores measuring 10-11 x 4-5 μm were seen in the probes. Some of those were prepared for SEM (Fig. 6b).

The HPLC data of this material were not quite conclusive as its extracts contained several peaks that were not observed in recently collected *Hypoxylon* spp. and might therefore constitute artefacts. Only traces of orsellinic acid (**6**) and mitorubrin (**1**) but neither rubiginosin A (**4**) nor BNT (**5**) were detected in the small portion of the material that was extracted for comparison. The metabolite profile differed from those of both *H. rubiginosum* and ***H. petriniae*** and rather appeared more reminiscent of *H. cercidicolum*. A comparison of ascospores of ***H. petriniae*** and the type of *H. suborbiculare* by SEM (Fig. 6) was made. Besides being larger in size, the spores of the new taxon also showed very conspicuous transverse striations on their outermost layer, while those of the type of *H. suborbiculare* appeared almost smooth when observed at the same magnification. These results pointed against the conspecificity between *D. cercidicola* and Petrini's interpretation on *H. rubiginosum* var. *cercidicola* (i.e., ***H. petriniae***) as suggested by Granmo (1999). The correspondence of *H. cercidicolum* with further synonyms proposed by Ju & Rogers (1996), however, remains to be evaluated by such methodology.

Notes on other *Hypoxylon* spp.

The current study confirmed the results of Ju & Rogers (1996), who found that *H. laschii* and *H. perforatum* are different taxa. Both had been segregated from *H. rubiginosum* ss. Miller (1961) as *H. rubiginosum* var. *perforatum* by Petrini & Müller (1986). Their materials came from various hosts, including *Populus*, *Fagus* and *Fraxinus*, while *H. laschii* shows apparent host specificity to *Populus*. *H. laschii* and *H. perforatum* also significantly differ in their secondary metabolite profiles, in agreement with their characteristic stromatal pigments in KOH.

While the morphology of cultures obtained from *H. perforatum* was in full agreement with previous descriptions by Petrini & Müller (1986) and Ju & Rogers (1996), our material of *H. laschii* unfortunately did not yield viable cultures, and studies on the anamorph of this species must therefore await collections of fresh specimens. *H. intermedium* [syn. *H. argillaceum* (Pers.) Nitschke and *H. fraxinophilum* Pouz. fide Ju & Rogers 1996] contained orsellinic acid and the novel azaphilone, hypomiltin. This species thus appears unrelated to the former taxa and further species of the "*H. rubiginosum* complex" as inferred from chemotaxonomic data. In contrast to Ju & Rogers (1996), who had not observed an anamorph in their cultures of *H. intermedium*, the culture of JF-03128 occasionally produced a *Sporothrix*-like anamorph when propagated on YMG agar, but not on OA.

The anamorphic structures were in agreement with those reported by Greenhalgh & Chesters (1968) for this species (as *H. argillaceum*). On OA, the morphology of this culture agreed with that reported for this species by Ju & Rogers (1996). The anamorph of *H. rutilum* was also found in agreement with the description in Ju & Rogers (1996) of a culture made from material of Taiwanese origin, further confirming that this species is present in Europe as well as in Asia.

An updated key to European species of *Hypoxylon*

We found it practical to provide a key to the species of *Hypoxylon* that have so far been encountered in Europe. If found appropriate, particular hosts, habitats and countries of origin will also be keyed out. If not indicated otherwise, ascospore sizes were given according to Ju & Rogers (1996), and detailed descriptions of the status of these taxa can also be found in the latter monograph. Otherwise, (e.g., if the species were described after 1996) the appropriate reference is cited. We also refer to a concurrent update of the monograph by Ju et al. (2004), containing additional information on the genus but not including any further descriptions of European *Hypoxylon* species.

Unlike those in Ju & Rogers (1996) and Ju et al. (2004), our key is not strictly divided into sect. *Annulata* and *Hypoxylon*, but all members of sect. *Annulata* are to be found in Part A and (**An.**) has been added after their Latin names. All taxa keyed out in part B, as well as the remaining species listed in Part A, however, belong to sect. *Hypoxylon*. Colours of stromatal pigments are occasionally deviating from the data given by Ju & Rogers (1996), presumably because more fresh specimens were included here, which tend to yield pigments that may be absent or slightly different in overmature and aged herbarium specimens. Some important parameters of the key are also based on the results of previous treatments of *Hypoxylon* by Petrini & Müller (1986) and Granmo (1999, 2001).

We hope that this key will contribute to an increase in our knowledge about the distribution of presumably rare taxa. Hence, special emphasis is given to characters that can be observed either in the field or upon examination of freshly collected specimens.

Ostioles papillate, opening higher than the stromatal surface *Key* **A**
Ostioles umbilicate or obsolete, opening lower than or at the same level as the stromatal surface *Key* **B**

Key A. Ostioles papillate

A- Ostioles encircled by a conspicuous flattened to slightly concave disc **A1**
A- Ostioles not encircled by a disc **A2**

A1(A)- Perithecial mounds inconspicuous; ascospores 6-8 x 3-3.5 μm, recorded from *Acer*, *Castanea*, *Carpinus* and *Quercus*, in France and Russia
H. stygium (Lév.) Sacc. **var. *annulatum*** (Rehm) Y.-M. Ju & J. D. Rogers (An.)
A1- Perithecial mounds conspicuous; ascospores 11-15 x 4.5-5.5 μm, associated in Southern Europe (Italy, Portugal, Spain) with *Laurus* ***H. michelianum*** Ces. & De Not. (An.)

A2(A1)- Perithecia small, 0.2-0.3(-0.4) mm diam, the tissue below the perithecial layer weakly developed, <0.3 mm thick; stromata effused to pulvinate **A3**
A2- Perithecia larger, 0.4-0.6 mm diam, the tissue below the perithecial layer 0.5-3.5 mm thick; stromata pulvinate to peltate, often constricted at base, often coalescent **A7**

A3(A2)- Mature stromata waxy, with KOH-extractable pigments **A4**
A3- Mature stromata carbonaceous, black, without KOH-extractable pigments [but immature stromata orange, with dark livid (80) to dark vinaceous (82) pigments]. Ascospores 9.5-11.5 x 4-5.5 μm. USA, recently first recorded from France (current study).
H. submonticulosum Y.-M. Ju & J. D. Rogers

A4(A3)- Stromata umber (9), rust (39) or sepia (63), with KOH-extractable pigments orange (7); ascospores averaging less than 20 μm long **A5**
A4- Stromatal surface with vinaceous (57) or purple (35) shades, with KOH-extractable pigments olivaceous (48), greenish olivaceous (90), vinaceous grey (116) or absent; ascospores averaging more than 20 μm long **A6**

A5(A4)- Ascospores averaging more than 15 μm long; 15-18 x 6-7.5 μm, without apparent host specificity ***H. julianii*** L. E. Petrini
A5- Ascospores averaging less than 11 μm long; 7.5-10 x 4-4.8 μm; distribution apparently worldwide, without apparent host specificity ***H. rutilum*** Tul. & C. Tul.

A6(A4)- KOH-extractable pigments greenish olivaceous (90) or with brown tones, ascospores 22-31 x 8.5-11 μm with faint germ slit less than spore-length; distribution boreal (Europe, North America), preferably in glaciated areas, mostly on *Salix*. ***H. macrosporum*** P. Karst.
A6- KOH-extractable pigments pale vinaceous grey (115) to vinaceous grey (116) in fresh specimens or absent in aged specimens, ascospores 18.5-23 x 8-10 μm with conspicuous germ slit spore-length. Frequently on *Ulmus* (France) but also on other hosts ***H. vogesiacum*** (Pers.) Sacc.

A7(A2)- KOH-extractable pigments orange (7) to rust (39); stromata pulvinate, erumpent, apparently restricted to *Populus*, ascospores 8-10 x 3.5-4.5 μm. Recorded from Germany (type locality), Finland, France and USA (Ju & Rogers 1996) ***H. laschii*** Nitschke
A7- KOH-extractable pigments different **A8**

A8 (A7)- Ascospores 6.5-8.5 x 3-4 μm; on *Quercus*, *Castanea*, and *Erica arborea* in western Europe ***H. cohaerens*** (Pers. : Fr.) Fr. var. ***microsporum*** J. D. Rogers & Cand. (An.)
A8- Ascospores larger; on different hosts **A9**

A9(A8)- Apparently restricted to *Fagus*, widespread; ascospores 9-11 x 4-5 μmwith germ slit spore-length ***H. cohaerens*** (Pers. : Fr.) Fr. (An.)
A9- Mainly associated with *Alnus*, *Betula* and *Corylus*, widespread; ascospores 8.5-12 x 3.5-5 μm with germ slit less than spore-length ***H. multiforme*** (Fr. : Fr.) Fr. (An.)

Key B: Ostioles not papillate

B- Stromata hemispherical to almost spherical **B1**
B- Stromata effused to pulvinate **B4**

B1(B)- Stromatal surface vinaceous grey (116), sepia (63) or grayish sepia (106), KOH-extractable pigments pure yellow (14), greenish yellow (16) or citrine (13), ascospores 17-22 x 9-11 µm; restricted to *Fraxinus* ***H. intermedium*** (Schwein.: Fr.) Y.-M. Ju & J. D. Rogers

B1- Stromatal surface rust (39), bay (6), or dark brick (60), KOH-extractable pigments orange (7), ascospores averaging less than 15 µm long **B2**

B2(B1)- Ascal apical ring present, amyloid **B3**
B2- Ascal apical ring absent, monotypic, not recorded since 1867, ascospores 9-11 x 4.5-5.5 µm ***H. commutatum*** Nitschke

B3(B2)- Widespread, mainly on *Fagus*; ascospores 11-13.5 x 5-6.5 µm ***H. fragiforme*** (Pers. : Fr.) J. Kickx fil.
B3- Widespread, on other hosts, rarely on *Fagus*; ascospores 7-9 x 3.5-5 µm ***H. howeianum*** Peck

B4(B)- Stromatal surface with purple (35) or vinaceous (57) colours **B5**
B4- Stromatal surface with orange (7), rust (39), brick (60), or brown colours **B12**

B5(B4)- Ascospores averaging more than 20 µm long **B6**
B5- Ascospores averaging less than 15 µm long **B7**

B6(B5)- KOH-extractable pigments pale vinaceous grey (115) to vinaceous grey (116) in fresh specimens or absent in aged specimens; ascospores 18.5-23 x 8-10 µm with germ slit spore-length (see also **A6**) ***H. vogesiacum*** (Pers.) Sacc.
B6- Boreal distribution, frequently on Salix, KOH-extractable pigments dense, greenish olivaceous (90); ascospores 22-31 x 8.5-11µm with faint germ slit less than spore-length (see also **A6**) ***H. macrosporum*** P. Karst.

B7(B5)- KOH-extractable pigments dilute, livid purple (81) or absent in aged specimens; ascospores 8-11.5 x 4.5-5 µm. Distribution world-wide, recently first recorded from Europe (France, current study) ***H. carneum*** Petch
B7- KOH-extractable pigments orange (7); ascospores 9-13 x 4-5.5 µm, newly erected herein ***H. petriniae*** M. Stadler & J. Fournier
B7- KOH-extractable pigments amber (47), isabelline (65), olivaceous (48), gray olivaceous (107), greenish olivaceous (90), citrine (13) or otherwise with yellow, green or brown tones **B8**

B8(B7)- Perithecia obovoid to frequently tubular, up to 1 mm high; stromatal surface with a metallic shine when mature. Recorded from Central and Western Europe and North America (various hosts). Ascospores 9.5-11.5 x 4-4.8 µm ***H. macrocarpum*** Pouz.
B8- Perithecia spherical to obovoid, not tubular; stromatal surface lacking a metallic shine when mature **B9**

B9(B8)- Ascospores with straight germ slit; ascal stipes shorter than the spore-bearing parts **B10**
B9- Ascospores with slightly sigmoid germ slit; ascal stipes as long as or longer than the spore-bearing parts **B11**

B10(B9)- Ascospores ellipsoid-inequilateral in lateral view, 9-12 x 4-6 μm, perispore dehiscent in 10% KOH. KOH-extractable pigments amber (47), greenish yellow (16) or citrine (13)
H. perforatum (Schwein. : Fr.) Fr.

B10- Ascospores ellipsoid, nearly equilateral in lateral view, often pyriform, 12-15 x 5.5-7 μm, perispore indehiscent in 10% KOH. KOH-extractable pigments olivaceous (48), greenish olivaceous (90), gray olivaceous (127), or olivaceous gray (121). Apparently rare, so far known from USA, Germany and Austria (Mühlbauer et al. 2002).
H. fuscopurpureum (Schwein.: Fr.) M. A. Curtis

B11(B9)- Stromata with pure yellow (14) to luteous (12) granules and greenish olivaceous (90) KOH-extractable pigments; apparently restricted to *Quercus*, with a boreal distribution; ascospores 10-13.5 x 4-5 μm. So far known from France (current study) and Scandinavia (Granmo 1999)
H. porphyreum Granmo

B11- Stromata with sienna (8) or otherwise orange brown granules and KOH-extractable pigments amber (47), isabelline (65), olivaceous (48), gray olivaceous (107), or greenish olivaceous (90); widespread, on Betulaceae and other hosts, but not yet safely recorded from *Quercus*; ascospores 11-16 x 5-8 μm ***H. fuscum*** (Pers. : Fr.) Fr.

B12(B4)- Young stromata with a bright yellow to orange fimbriate margin; perithecia small, 0.1-0.3 mm diam, seated on a well developed black basal tissue **B13**

B12- Young stromata lacking a bright yellow to orange fimbriate margin **B14**

B13(B12)- Ascospores 5-7 x 2.5-3.5 μm, ellipsoid-inequilateral in lateral view. So far recorded from Austria, Croatia, France, Italy, Slovakia and Switzerland (Ripková & Hagara 2003)
H. ticinense L. E. Petrini

B13- Ascospores 8-11 x 4-5 μm, ellipsoid-equilateral in lateral view. So far recorded from France and USA ***H. subticinense*** Y.-M. Ju & J. D. Rogers

B14(B12)- KOH-extractable pigments orange (7) **B15**

B14- KOH-extractable pigments with shades of olivaceous brown **B22**

B15(B14)- Ascal apical ring highly reduced or lacking, inamyloid **B16**

B15- Ascal apical ring present, amyloid **B17**

B16(B15)- Stromata applanate, discoid, encircled with a swollen stellate margin, on bark of *Fraxinus*; ascospores 9.5-12 x 5-6 μm. Central and Southern Europe (Pouzar 1972, Petrini & Müller 1986, as *H. moravicum* Pouz.) and North America (Canada, USA) fide Ju & Rogers (1996). ***H. cercidicolum*** (Berk. & M. A. Curtis ex Peck) Y.-M. Ju & J. D. Rogers

B16- Stromata pulvinate to hemispherical, ascospores 9-11 x 4.5-5.5 μm (rare, see also **B2**)
H. commutatum Nitschke

B17(B16)- Ascospores averaging more than 14 μm long **B18**

B17- Ascospores averaging less than 12 μm long **B19**

B18(B17)- Stromata pulvinate restricted at base, with rust brown to ochraceous brown granules beneath surface; apparently rare, known only from *Tilia* and *Sorbus*; ascospores 14-17 x 6.5-8 μm, Recorded from Europe in Switzerland (Petrini & Müller 1986) and Slovakia (Z. Pouzar, unpublished) ***H. ferrugineum*** Otth

B18- Stromata effused to pulvinate, with red granules beneath surface, recorded from various hosts; ascospores 15-18 x 6-7.5 μm (see also A5) ***H. julianii*** L. E. Petrini

B19(B17)- Perithecia 0.1-0.35 mm diam; recorded from *Salix* in Northern Europe (Granmo 1999), and USA (Ju & Rogers, 1996); ascospores 7-10 x 3-4.5 μm **H. salicicola** Granmo
B19- Perithecia averaging more than 0.4 mm diam **B20**

B20(B19)- Stromata erumpent, pulvinate, small, up to 6 mm diam; on *Populus*; ascospores 8-10 x 3.5-4.5 μm (see also A7) **H. laschii** Nitschke
B20- Stromata non-erumpent, effused to pulvinate, larger **B21**

B21 (B20)- Stromatal surface rust (39) to brick (60), with dull orange granules beneath surface and between perithecia; KOH-extractable pigments orange (7). Widespread, without apparent host-specificity; ascospores brown, 9-13 x 4-5.5 μm **H. rubiginosum** (Pers. : Fr.) Fr.
B21- Stromatal surface vinaceous buff (86), greyish sepia (106) to brown vinaceous (84)with bright yellow granules beneath surface and between perithecia; KOH-extractable pigments hazel (88), sienna (8) to umber (9). Apparently restricted to *Sorbus*, with a boreal distribution; ascospores dark brown, 9.5-12.5 x 4.8-6 μm (Granmo 2001) **H. liviae** Granmo

B22 (20)- Ascospores dark brown, ellipsoid nearly equilateral. Apparently restricted to *Sorbus*; ascospores 9.5-12.5 x 4.8-6 μm (Granmo 2001, see also **B21**) **H. liviae** Granmo
B22- Ascospores medium brown, ellipsoid-inequilateral; without apparent host-specificity **B23**

B23(B22)- KOH-extractable pigments amber (47), greenish yellow (16) or citrine (13); ostioles surrounded by a conspicuous white material on mature stromata; perithecia spherical to obovoid, up to 0.4 mm high (see also **B10**) **H. perforatum** (Schwein. : Fr.) Fr.
B23- KOH-extractable pigments isabelline (65), umber (9), or grayish sepia (106); ostioles lacking white material; perithecia frequently tubular, up to 1 mm high (see also **B8**)
H. macrocarpum Pouz.

Acknowledgments

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MYCOTAXON

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Tuber zhongdianense sp. nov. from China

[1] Xing Yuan He [2] Hai Mei Li [3] Yun Wang*

[1] *hext@iae.ac.cn* [2] *Lihaimei@163.com* [3]*wangy@crop.cri.nz*
Institute of Applied Ecology, Academia Sinica, 72 Wenhua Road,
Shenyang 110015, Liaoning, China

Abstract — A new truffle species is described and illustrated from Zhongdian (Shangri-La), Yunnan province in SW China. This new species is apparently mycorrhizal with *Quercus pannosa*. The relationship of the new species to other closely related species is discussed.

Key words — Ascomycota, *Pezizales*, taxonomy

In October, 2002, the authors visited Zhongdian County, Diqing Tibetan Autonomous Prefecture, Yunnan province, SW China, where three large rivers that run parallel from north to south cut through the southeast rim of the Tibet plateau. Very deep, narrow valleys and magnificent snowy mountains create distinctive vertical climate and vegetation patterns from the tropical valley floors to the glacial mountaintops. Unique plants and wildlife, such as the endemic Yunnan snub-nosed monkey, have been found there. Although *T. indicum* Cooke & Massee, *T. himalayense* B.C. Zhang & Minter, *T. sinense* K. Tao & Liu, *T. gigantosporum* Wang & Z.P Li, *T. pseudoexcavatum* Y. Wang, G. Moreno, Riousset, Manjón & G. Riosset, *T. huidongense* Y. Wang, *T. liui* A.S. Xu, and *T. xizangense* A.S. Xu have been recorded from neighboring areas (Wang & Li 1991; Wang et al. 1998; Wang & Hall 1999; Wang & He 2002; Xu 1999), no *Tuber* species have previously been reported from the Zhongdian region. We describe here both a new species and the first *Tuber* from the region.

Tuber zhongdianense sp. nov. **FIGURES 1-6**

Ascocarpa irregularis, usque ad 15 mm in diam, pallide brunnea, puberula. Peridium bistratum 220 µm crassum, straits doubus: epicutis 60-70 µm crassum, pseudoparenchymatis, subcutis 150-160 µm crassum, prosenchymatis. Pili densi,

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*Corresponding author

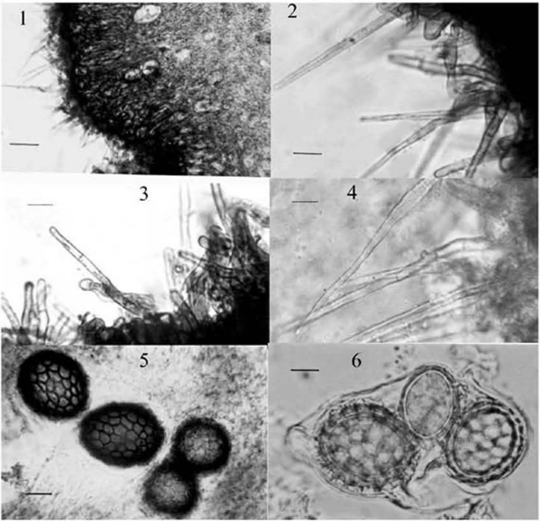
usque ad 95 µm longae, 4-5 µm crassae, unicellularae vel multicellularae. Gleba solida, brunnea, venis albis. Asci sporis 1-2, subglobosae vel irregularae, usque ad 109 x 73 µm. Ascosporae late ellipsoideae, 50-63 x 38-44 µm (ubi 1 spora in quaque asco), 33-44 x 29-38 µm (2-sporae), reticulatae. Habitat in ad terrata sub Quercus pannosa, *alt. 3000m. Yunnan: Zhongdian.*

Etymology: zhongdianense derives from Zhongdian, type locality for the fungus species.

Ascomata irregular and slightly lobed, pale brown, up to 15 mm in diam, puberulent, solid. **Odour** slight. **Peridium** 220 µm thick, composed of two layers; the outer layer complex, 60-70 µm thick, pseudoparenchymatous, composed of vertically arranged globose to rectangular cells, 19-32 x 13-15 µm and thin-walled; scattered large inflated hyaline cells, reaching 50 x 34 µm; the 2-µm thick walls giving rise at the surface to hairs in two layers; one type tall, tapered, reaching 95 x 4-5 µm, 2-3 septate and sometimes with a small teat on the wall, hyaline or yellowish, slightly thick-walled; other hairs short, obtuse, 0-1-2 septate, cylindrical (52 x 4 µm), flask-shaped (10 x 6 µm), obpyriform (19 x 8 µm) or spathulate (16 x 5 µm); the inner layer 150-160 µm thick, composed of 2-4 µm diam, interwoven, colourless hyphae that gradually merge into the gleba tissue. **Gleba** initially whitish, maturing to brown; veins distinct, white, branching and derived from many points on the periphery, some not entirely closed; inter-ascal hyphae colourless, interwoven, thin-walled, sometimes with thin-walled inflated cells, 18 x12 µm. **Asci** 1-2- (rarely 3-4-) spored, reaching 109 x 73 µm overall, walls 2-3 µm thick, colourless, broadly ellipsoid or obovoid (immature asci), oval to oblong (2-spored), pyriform (3-spored), or irregular (4-spored). **Ascospores** broadly ellipsoid, sizes excluding ornamentation 50-63 x 38-44 µm (1-spored asci), 33-44 x 29-38 µm (2-spored asci), or 27-37 x 23-33 µm (3-4-spored asci); walls 2-4 µm thick, brown (brownish yellow when young); reticulate with regular mesh, normally 7-11 meshes long, 6-9 meshes wide [from 5-6 meshes long and 6-7 meshes wide on smaller to 15-16 meshes long and 11-12 meshes long on larger spores], average ornamentation 2 µm high, occasionally to 6-7 µm tall.

Holotype here designated: Zhongdian County (Shangri-La), Diqing Tibetan Autonomous Prefecture, Yunnan province, SW China, alt. 3000 m, under *Quercus pannosa* Hand-Mazz., 15 October 2002, Y. Wang 0299 (IFS).

This species is closely related to other European white truffle species with pseudoparenchymatous peridia with abundant surface hairs, such as *T. borchii* Vittad. *T. rapaeodorum* Tul. and *T. puberulum* Berk. & Broome (Mello et al. 2000; Trappe & Cázares 2000; Astier 1998; Pegler et al. 1993).



Figs. 1-6. Fig. 1. *Tuber zhongdianense* (Wang 0299): Section of peridium showing the two layers and big inflated cells (bar = 20 μm). **Fig. 2.** *Tuber zhongdianense* (Wang 0299): Surface hairs showing the two kinds of hairs (bar = 15 μm). **Fig. 3.** *Tuber zhongdianense* (Wang 0299): Long tapered surface hairs (bar = 10 μm). **Fig. 4.** *Tuber zhongdianense* (Wang 0299): Short obtuse surface hairs (bar = 13 μm). **Fig. 5.** *Tuber zhongdianense* (Wang 0299): Ascospores (bar = 20 μm). **Fig. 6.** *Tuber zhongdianense* (Wang 0299): Ascus and ascospores (bar = 10 μm).

T. zhongdianense differs in having two kinds of hairs – tapered and obtuse (Figs. 2, 3, 4) – and larger ascospores (Figs. 5, 6). This species differs from the similar *T. liui* from Tibet (Xu 1999) in its smaller ascospores with lower ornamentations (Figs. 5, 6). *T. zhongdianense* is also notable for having a pseudoparenchymatous epicutis composed of vertically arranged globose to rectangular cells (Fig. 1). The fact that the ascospores closely resemble those of

T. gigantosporum from the neighboring Sichuan province, also characterized by having very low (2-4 µm tall) ornamentation (Wang & Li 1991), suggests that they may be closely related phylogenetically.

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Book reviews and notices

Compiled by

DAVID L. HAWKSWORTH[1]

The Yellow House, Calle Aguila 12, Colonia La Maliciosa, Mataelpino,
ES-28492 Madrid, Spain.

General

Biodiversity of Fungi: Inventory and monitoring methods. Edited by Gregory M. Mueller, Gerald F. Bills & Mercedes S. Foster. June 2004. Elsevier Academic Press, 200 Wheeler Road, Burlington, MA 01893, USA. Pp. xviii + 777. ISBN 0 12 509551 1. Price US $ 95.

Biodiversity of Fungi is an invaluable book for mycologists that are interested in ecology, taxonomy and conservation. The editors have brought together a series of chapters that describe sampling strategies and ecological principles based on phytosociological and survey practices that are more commonplace in ecology than they are in mycology. These organized and statistically robust survey methods are essential for mycologists to generate high quality quantitative and qualitative data on which to adequately assess the biodiversity and geographic distribution of fungi. Plant and animal ecologists have been doing this type of survey work for years, but mycological foray records have rarely had consistent methodologies. This book is suggesting the way forward and it is my hope that mycologists accept the principles of disciplined foray design strategies, rigorous database construction, and the maintenance of adequate herbarium collections. These thoughts are expanded upon in the introduction by the editors, which sets the scene for the following chapters.

The rest of the book is divided into three parts. Part I consists of six chapters that provide an overview of the methodologies required to adequately evaluate fungal diversity and maintain databases and herbaria. These chapters provide an overview of the fungal kingdom, showing how molecular tools have recently allowed us to reevaluate fungal taxonomy and evolutionary linkages between the 'crown fungi'. We are told that herbaria have been around for over 200 years, but the key elements to compiling, maintaining and disseminating information from a good fungal herbarium is presented to us in detail to remind us of what we should be doing. This advice includes

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[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor (address above) in the first instance. Fax (+34) 91 857 3640; e-mail: myconova@terra.es.

methods of isolation, culture, storage, database development (including examples of record sheet templates), the shipment of fungi around the world (based primarily on USDA APHIS regulations) with a near 'cook book' approach, which reinforces the idea that quality control should be strictly maintained between and within collection forays. John C. Zak and Michael R. Willig's chapter on biodiversity patterns reinforces the statistical issues in any ecological survey work. This chapter does an excellent job of introducing collecting effort functions, explaining richness and diversity measures and introduces the reader to multivariate statistical methods that not only allow us to obtain a good picture of how to identify changes in fungal community structure, but also allows us to relate these changes to environmental variables in a rigorous statistical way. This part of the book concludes with a chapter on molecular methods that assist in verifying morphological identifications of fungi, giving step-by-step procedures of PCR methods and their derivatives.

Part II A of the book consists of four chapters that detail protocols that could or should be adopted to collect, isolate and study fungi from living plants, organic components of soil and wood, those that form lichens, and sequestrate fungi. Each chapter is a mini-treatise discussing some of the biology of the fungal groups that are found associated with these substratum types, followed by methods used to obtain samples and then how to culture the fungal species supported by the substrates. Each of these chapters is well-illustrated with line drawings, monochrome, and colour illustrations, that add value to the text and are just a pleasure to look at. The detail in each chapter varies, partly reflecting the extent of knowledge of each group of fungi or the ecology of that particular substrate. Most chapters discuss basic statistical problems of determining species-effort relationships and design of sampling strategies. An excellent example of this is a series of figures in Chapter 8 showing how different strategies for sampling macrofungi could be determined from preliminary surveys using adaptive cluster sampling. Although mentioned in some chapters, the problem of scaling is given little discussion. If we are to attempt to evaluate the global diversity of fungi we need to be able to make some attempt to statistically address our scaling of discovered diversity at the micro-, local, or landscape level to the regional and global level. This is not a trivial task and some pointers, as in the chapter on lichen-forming fungi, or open admissions of not knowing how to proceed would have been welcomed in the discussions in these chapters, especially as we learn that a 100 000 ha plot of tropical Costa Rican forest vegetation can yield 81 500 plant pathogenic fungi alone.

Part II B consists of seven chapters on the protocols for isolating particular functional groups of microfungi. These include microfungi of wood and plant debris, endophytes, saprotrophic soil fungi, fungi from stressful environments, arbuscular mycorrhizal fungi, yeasts, and fungicolous fungi. Each chapter follows the established format of a discussion of the biology of the fungi, a survey of the fungal species known to be associated with the substrate or environmental condition, and a discussion of the methods adopted to enumerate, identify, culture and store samples of each fungal group. Again, the chapters are richly illustrated with flow diagrams of procedures and photographs of apparatus or specimens.

Part II C discusses the associations of fungi with animals with five chapters looking at the diversity of fungi on insects and other arthropods, nematodes and rotifers, vertebrates, animal faeces, and a surprising chapter on the fungi involved with vertebrate guts and fibre degradation in anaerobic ecosystems. The discussion of arthropod fungal associates goes beyond the pathogenic forms and addresses fungi that are carried by insects and which act as plant pathogens. Gardens of fungi associated with ants and termites are also discussed. In both chapters discussing fungi of invertebrates, the authors address the problems with and methods for obtaining the fungal host animal. Methodologically this doubles the problems involved with sampling as the researcher needs to address statistical concerns of representatively capturing both the animal host and then the fungi that are associated with them.

The final section of Part II (D) takes four chapters to discuss fungi from aquatic habitats, considering freshwater and marine ecosystems, mycetozoans as a special group, and fungi associated with aquatic animals. One surprise was the lack of discussion of fungal pathogens of anurans. Pathogens of fish, crustaceans and molluscs are discussed and, given the recent interest in decline of tropical frog populations linked to fungal pathogens (Lipps 1999; Reed *et al.* 2000), this seemed to be a slight omission from this chapter!

The final section of the book consists of four very useful appendices. The first describes the manufacture and use of moist chambers for the culturing and isolation of fungi; an important technique that is frequently mentioned throughout the book. The second is an annotated recipe book of culture, antibiotic, fixative, staining, mounting and storage media that are used for fungi. The annotations describe their best use for different groups of fungi or different situations. A list of major fungal collections, databases and web sites assures us that there is the potential for cross referencing of material and extant discussions between countries throughout the world on the current knowledge of the diversity of fungi. The fourth appendix gives contact information of vendors of all things associated with mycology, herbarium management and software houses for database management.

The book finishes with a glossary compiled by Frank M. Dugan, which contains many simplistic, but graphic sketches that will be a great asset to those of us who attempt to teach mycology and 89 pages of literature cited. I mention the latter as this represents some 4000 citations to the mycological literature. This vast set of information ensures that any reader of this book will be capable of following-up and digging deeper into specific areas that appeal. This list of references alone makes the book worth while having on my bookshelf.

In the conclusion to their chapter on fungi from stressful environments, John C. Zak and Howard G. Wildman state that it had been difficult to compile standardized sampling strategies or isolation methods due to the varied habitats and life cycles of fungi. They suggest that the parallel use of multiple isolation techniques is the only way to adequately address the heterogeneity of resources in the world, which will yield complete assessments of fungal biodiversity patterns. Only then, they say, can we begin to understand the link between fungal community diversity and ecosystem function. This book is a splendid example of how we may take those steps by seeing the range of methods (procedural, statistical and educational) than need to be compiled to address attempts to understand the fungal community of any given habitat or geographical region. This is a resource book that will be used extensively during the forthcoming years as we attempt to tackle the task of unraveling the complexity of fungal communities and diversity.

This is an excellent book which has appeared at a time when biodiversity discussions are in the forefront of ecologists as a whole. If we are to progress further with understanding the development and function of communities of fungi and, especially if we are to attempt to relate the current knowledge of fungal diversity to fungal and ecosystem functioning, we need to have much more robust data on the actual diversity of fungi at all scales of resolution and improve out knowledge of their functional attributes. This book not only shows us the way to go, but tells us how to do so in a way that will maximize the quality of the data generated. The editors and chapter authors are to be congratulated on producing such a colourful and informative text.

Lips, K. R. (1999) Mass mortality and population declines of anurans at an upland site in western Panama. *Consrvation Biology* **13**: 117-125.

Reed, K. D., Ruth, G. R., Meyer, J. A. & Shukla, S. K. (2000) *Chlamydiapneumoniae* infection in a breeding colony of African clawed frogs (*Xenopus tropicalis*). *Emerging Infectious Diseases* **6**: 196-199.

JOHN DIGHTON
Department of Biology, Rutgers University, Camden, NJ 08102, USA.

Fungi Fimicoli Italici: A guide to the recognition of basidiomycetes and ascomycetes living on faecal material. By Franceso Doveri. May 2004. Associazione Micologica Bresadola, Via A. Volta 46, I-38100 Trento, Italy. Pp. 1104, colour photographs 158, figures *ca* 300. ISBN not indicated. Price: € 110.

This is a remarkable work which will be sought-after by all field mycologists involved in inventory work. I only wish it had been available when I was endeavouring to record dung fungi in the Slapton Ley National Nature Reserve in Devon, south-west England, in the 1970s-80s. This is not the first work to provide keys and(or) descriptions of a wide range of dung fungi (e.g. Bell 1983, Richardson & Watling 1997, Ellis & Ellis 1998), but it is by far the most lavishly illustrated and comprehensive yet to appear on the market.

Here there are detailed accounts and keys or tabulations to over 300 species of basidio- and ascomycetes, but not of their anamorphs, other conidial fungi, mucoralean fungi, nor slime moulds. The individual species entries have full bibliographic information on both accepted names and synonyms, a copy of the original diagnosis (a most welcome feature), and list of collections examined. Accessibility internationally is facilitated by the text being in both English and Italian (printed in a smaller font size).The species descriptions are meticulously prepared as are observations on ecology and occurrence. Notes of additional species described but not known in Italy are often included, as are references to pertinent revisions and other treatments of particular genera or species. But it is the carefully executed drawings of microscopic features, mainly from material freshly collected by the author and various colleagues, and the colour plates, that together make an immediate impact and will be especially valuable in making identifications. The nomenclature appears to have been carefully checked, with even sanctioning citations used correctly and author abbreviations following the Brummitt & Powell (1992) system recommended in the *Code*. What then could have been improved?: the sketches of perithecia, some of which seem to have been rather quickly prepared and would have benefitted from being reproduced at a smaller size. It would also have been helpful if the figures had been numbered, and might have avoided the embarrassment of some replacement figures having to be sent out with the copies (for pp. 203, 626, and 627).

The preparation of the book has clearly been a labour of love, a tremendous achievement for a family doctor and endocrinologist, and has taken 15 years. Further, the author has been in contact with a staggering 77 mycological specialists around the world and has had the support of some 60 colleagues in securing material for study and illustration. The Associazione Micologica Bresadola is renowned for the quality of its publications and their modest cost, and this tradition is maintained with this splendid volume. As many of the fungi have wide distributions and some occur also on other substrata (e.g. *Chaetomium*) or are rarely to commonly found amongst soil isolates, the book should have an international appeal amongst systematic mycologists and fungal ecologists.

Bell, A. (1983) *Dung Fungi: an illustrated guide to coprophilous fungi in New Zealand*. Wellington: Victoria University Press.

Brummitt, R. K. & Powell, C. E. (eds) (1992) *Authors of Plant Names*. Kew: Royal Botanic Gardens.

Ellis, M. B. & Ellis, J. P. (1998) *Microfungi on Miscellaneous Substrates*. 2nd edn. Slough: Richmond Publishing.

Richardson, M. J. & Watling, R. (1997) *Keys to Fungi on Dung*. 2nd edn. Stourbridge: British Mycological Society.

Fungal Life in the Dead Sea. Edited by Eviatar Nevo, Aharon Oren & Solomon P. Wasser. May 2004 ["2003"]. A. R. G. Gantner Verlag Kommandit Gesellschaft, Ruggell. [Distributor: Koeltz Scientific Books, P. O. Box 1360, D-61453 Königstein, Germany.] [Biodiversity of Cyanoprocaryotes, Algae and Fungi of Israel No. 4.] Pp. 361. ISBN 3 906166 10 4. Price: € 89.

The information gained on the mycobiota of the Dead Sea during the last decade has been impressive, but distributed through numerous separate publications. This multi-authored book covers the history of the Sea's scientific exploration, its origins and physico-chemical characteristics, data on the prokaryotes and algae as background, osmoadaptation strategies, and the fungi themselves. This last topic is the reason the book is mentioned here. Data are presented on the 70 species of fungi recovered from the Dead Sea, together with observations on their diagnostic and cultural characteristics and spatial and temporal occurrences. These are arranged systematically by major group and order, but there is no overall key. References to more detailed accounts of the species are, however, provided. Half-tones of some species are included, and there are colour plates showing colony characteristics of selected species. An impressive 17 page list of publications dealing with microorganisms in the Dead Sea, and a comprehensive index, conclude the work.

The systematic section should prove of some value to mycologists endeavouring to identifying cultures from other saline environments and enable them to compare their results with data now brought together on this most unusual habitat.

Los Hongos de El Edén Quintana Roo: Introduccion a la micobiota tropical de México. By Gastón Guzmán. February 2004 ["2003"]. Instituto de Ecologia A.C., Km 2.5 carretera Antigua a Coeatepec 351, Congregación El Haya, Xalapa 91070, Veracruz, México. Pp. xvi + 316, figs 100, col. plates 189. ISBN 970 709 030 8. Price: Not indicated.

The fungi of Mexico remain poorly understood, especially those species that inhabit the tropical forests of the country. Gastón Guzmán has throughout the years worked tirelessly, endeavouring to right this situation.

This work reports the results of an ongoing biodiversity survey of the poorly known fungi of the El Edén Ecological Reserve, a large forested area to the north of the Yucatan peninsula, Guzmán's *Los Hongos de El Edén* presents a valuable insight into the fungi, including lichen-fungi and myxomycetes of the reserve. This volume represents intensive survey work carried out during early June and November 2000, with the collection of some 700 specimens, comprising macromycetes, some micromycetes, lichen fungi and myxomycetes; some 85% of the collections were new records. Not surprisingly therefore, some of the species treated have yet to be assigned formal species level names.

The volume provides a first-rate account of some 140 species which were collected and are described here. These include 100 basidiomycetes, 20 non-lichenized ascomycetes, ten lichen fungi, eight myxomycetes, two straminipiles, and also mitosporic species, mostly with whole-page colour photographs. Towards the end of the book line, excellent line drawings of microscopic features are provided.

As 'El Edén' has been subject to various forms of disturbance, particularly fires, hurricanes, and deforestation, the book highlights some of the common and new fungi that were recorded from either of these affected habitats.

If there were to be any criticism of the book, it would be the quality of some of the photographs. In a world that is increasingly spoilt by very high quality digital and SLR images of fungi, the few of poor quality within this book may be greeted with some disdain. However, this has to be placed in the context of concern to document what has been actually seen on a particular expedition with the equipment being carried and material presenting at the time.

An excellent bibliography is provided, and one would not want to look further for a sound introduction to the tropical fungi of Mexico. I wish it had been to hand when I first visited Xalapa in 1999. Useful tables of the fungi, including lichenized species and myxomycetes collected by Gastón in such habitats in the country are included, with the species treated and illustrated in the book highlighted in bold. Also valuable is a list of herbarium material deposited by Gastón and his collaborators, along with their accession numbers.

Having spent some time myself in the tropical regions of Mexico collecting macrofungi, and also having interviewed the author for *The Mycophile*, it comes as no surprise that Gastón's unique knowledge of such habitats was indispensible in identifying collections from such an area.

In summary, a very useful volume, forging further inroads into our understanding of tropical fungi, their ecological requirements, and their historic cultural uses for medicines or food. The publishing institute is to be congratulated on having the confidence to produce such a detailed record of the fungi of this site, which will be of lasting value.

ANDY S. OVERALL
Flat 2, 39 North End Road, Golders Green,
London NW11 7RJ, UK.

Bolets de Catalunya. Col-Lecció XXII. Edited by the the Societat Catalana de Micologia. 2003. Societat Catalana de Micologia, c/o Institució Catalana de Història Natural, C/ de la Marina 94 1er 4a, ES-08013 Barcelona, Spain. Laminated coloured plates 50. ISSN 0212-3460. Price: Not indicated.

This part continues the format of the last part received by *Mycotaxon* (see *Mycotaxon* **78**: 512-513, 2001) of separate laminated colour photographs with texts on the reverse in both Catalan and Castillion. A huge range of fungi is represented in this installment, which while dominated by agarics also includes resupinates, discomycetes and even a conidial fungus (*Volutella ciliata*). The total number of plates issued in the series is now an amazing 1100, constituting a major aid to identification of fungi in the Iberian Peninsula for those fortunate enough to have complete sets.

Basidiomycetes

Smut Fungi (*Ustilaginomycetes* p.p. and *Microbotryales, Basidiomycota*. By Meike Piepenbring. 2003. New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, NY 10458-5126, USA. [Flora Neotropica Monograph No. 86.] Pp. iv + 292, figs 59, photographs 45, maps 54. ISBN 0 89327 449 6. Price: US $ 58.

The smut fungi of the Neotropics are represented in this book by 227 species in 34 genera. The number of host plant species over which these are distributed is 364; these plants belong to 18 families of angiosperms, especially monocotyledons. About 55 % of the hosts belong to *Poaceae* and 17 % belong to *Cyperaceae*. One new species, two new names, and 12 new combinations are proposed.

This monograph will help mycologists and plant pathologists studying this interesting group of parasitic fungi in the Neotropics. The introductory chapters provide general information, valuable both for students and researchers, on the diversity of smut fungi and their recognition and collection in the field, as well as on life-cycles, morphology, distribution, host plants, molecular research, and systematics.

The main body of the book consists of descriptions, illustrations, and keys to the genera and species. Each species description includes nomenclatural data, information on the development of the sori and their morphology, microscopic features of the spores, including wall ornamentation as seen by LM and SEM, germination of the spores (where there is information), Neotropical hosts, distribution in the Neotropics, specimens examined, and illustrations – photomicrographs of spores, and(or) line drawings of symptoms and diagnostic features. The Neotropical distribution of all 227 species is presented on maps. The plates containing drawings and SEM photographs are of high quality and will be appreciated by all readers. Finally, there are lists of references on the literature on Neotropical smut fungi, a list of the host species, and an index of scientific names.

The suprageneric taxa are presented in accordance with the system of Bauer *et al.* (2001), which in turn was based mainly on Bauer *et al.* (1997). However, I would like to point out that the classification of smut fungi and allied taxa has changed since 2001, and that the system of the *Ustilaginales* in particular has altered radically (*cfr* Kirk *et al.* 2001; Vánky 1999, 2001, 2002 a, b). Piepenbring's concept of *Ustilaginales* is too broad according to these newer systems. I also note that the author uses statistical parameters (means with standard deviation) in the species descriptions, based on measurements of a total number of "at least 20 spores" from each collection; 20 is obviously too small a number to examine statistically and ≥ 35 spores would be prudent.

However, there is no doubt that this monograph will be an essential resource for mycologists, plant pathologists, students, and everyone interested in learning about or naming Neotropical smut fungi.

Bauer, R., Begerow, D., Oberwinkler, F., Piepenbring, M. & Berbee, M. L. (2001) *Ustilaginomycetes*. In *The Mycota*. Vol. VII, part B. *Systematics and Evolution* (D. J. McLaughlin, E. G. McLaughlin & P. A. Lemke, eds): 57-83. Berlin: Springer Verlag.

Bauer, R., Oberwinkler, F. & Vánky, K. (1997) Ultrastructural markers and systematics in smut fungi and allied taxa. *Canadian Journal of Botany* **75**: 1273-1314.

Kirk, P. M., Cannon, P .F., David, J. C. & Stalpers, J. A. (eds) (2001) *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edn. Wallingford: CAB International.

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

Vánky, K. (2001) The emended *Ustilaginaceae* of the modern classificatory system for smut fungi. *Fungal Diversity* **6**: 131-147.

Vánky, K. (2002a) The smut fungi of the world – a survey. *Acta Microbiologica et Immunologica Hungarica* **49**: 163-175.

Vánky, K. (2002b) *Illustrated Genera of Smut Fungi*. 2nd edn. St Paul: American Phytopathological Society Press.

Cvetomir M. Denchev
Institute of Botany, 23 Acad. G, Bonchev Street,
BG 1113 Sofia, Bulgaria.

Illustrated Genera of Rust Fungi. By George B. Cummins & Yasuyuki Hiratsuka. 2003. 3rd edn. American Phytological Society Press, 2240 Pilot Knob Road, St Paul, MN 55121-2097, USA. Pp. ix + 225, figs 142 (53 in colour). ISBN 0 89054 304 6. Price: US $ 65.

It is a pleasure welcome this spiral-bound third edition of this standard work; first published by George Cummins alone in 1959, the second edition appeared in 1983 so an up-date was long overdue. I found the Introduction especially well-done, with discussions of relationships, symptom types (beautifully illustrated in colour), and host restriction. A chapter on morphology, life-cycles and cytology follows, again well-illustrated by line drawings and photographs, with an especially fine page of drawings showing surface features, pore arrangements, and shapes of spores. These two first chapters together provide the nucleus for any class on rusts that has to be taught.

In the main body of the text, 133 genera are treated, 120 of which are holomorphic and 13 anamorphic. These are dispersed through 13 families, and clear keys to families and genera are presented. The generic entries themselves are arranged by family, something I find a little irritating as this means that to locate a particular genus either one has to know the family it is now placed in or look it up in the index.

For each genus, publication details are provided along with page-spreads as well as the pages on which descriptions appear, although more than one of those is cited should that extend over several pages. I was pleased to see "in" citations used correctly, but disappointed that the the dates and places of publication of most sanctioned names are given incorrectly; for example *Aecidium* was validly published by Persoon in 1796 and not 1801. Further, "ex" is used rather than ":" where names have been sanctioned for both generic names and species names cited. This is most unfortunate in such an important and widely used reference work, and it is to be hoped that users will not simply copy these citations or presume they are more authoritative than those, for example, in the *Dictionary of the Fungi* (Kirk *et al.* 2001). For each genus, a description, the name of the type species (with basionyms where appropriate), its host, geographical region, remarks, selected literature references, and first-rate line drawings and(or) light or scanning electron micrographs, are all provided.

Appendices cover general and regional literature, author abbreviations, a glossary, and list of generic names and current dispositions. There is also an index including the names of host plants mentioned.

There has been uncertainty amongst rust specialists with respect to the creation and use of anamorph names in rusts where holomorphs are already known. I was pleased to see a firm and pragmatic line taken here. The authors are opposed to both the introduction and use of separate anamorph names for rust species, and instead use phrases such as "uredinia *Uredo*-type" in the descriptions and do not even give the anamorph binomials for species where they have been introduced. At the same time, there is a key to anamorph generic names, together with brief diagnoses, line drawings, and information on the type species, etc. However, somewhat interestingly the new generic name *Petersonia* is formally introduced here for the aecial stages found in three teleomorphic genera of the *Mikronegeriaceae* -- yet although a binomial in *Petersonia* is used for the type species (*Caeoma sanctae-crucis*) the combination is not validly published here nor mentioned under the main text entry of the pertinent teleomorph genus. There is also mention of an "ined." generic name *Wardia* attributed to "J. F. Hennen & M. M. Hennen" for the uredinial stage of the coffee rust *Hemileia vastatrix* and two other genera, but again the binomial is not mentioned or used in the holomorph entry. I believe that there are lessons here for how the nomenclature of other groups of fungi with pleomorphic life-cycles might be increasingly handled in future, whether or not recently made proposals are adopted (Hawksworth 2004). This work should be studied by all mycologists concerned, involved in, or following the current Art. 59 debates (Gams *et al.* 2003).

In summary, a reference work that should be in all mycological and plant pathological libraries, and to which those enquiring about background information on rusts can be directed with confidence. According to the dates of authors included, George B. Cummins becomes a cenentarian in 2004. I and all mycologists will want to send him our best wishes and express our gratitude for all the major contributions he has made to making sense of the world's rusts over so many years.

Gams, W., Korf, R. P., Pitt, J. I., Hawksworth, D. L., Berbee, M. L., Kirk, P. M. & Seifert, K. A. (2003) Has dual nomenclature run its course? The Article 59 debate. *Mycotaxon* **88**: 493-508.

Hawksworth, D. L. (2004) Limitation of dual nomenclature for pleomorphic fungi. *Taxon* **53**: 596-598.

Kirk, P. M., Cannon, P. F., David, J. C. & Stalpers, J. A. (2001) *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edn. Wallingford: CAB International.

***Tricholoma* (Fr.) Staude, Supplemento.** By Alfredo Riva. 2003. Edizioni Candusso, Vio Ottone Primo 90, I-17021 Alassio SV, Italy. Pp. 201, col. plates 87, figs 17, tables 1. ISBN 88901057 0 4. Price: Not indicated.

This new supplement to the monograph of *Tricholoma* in Europe [*Fungi Europaei* Vol. 3] which was published in 1988 is an update of information from the same author on additional and new taxa, and supplementary information, to those treated in the monograph. Of the 87 taxa treated here, 20 are updates as either new combinations, or new species, varieties, or forms. Taxa that remain unchanged are cited as with "No modification".

The user has to scrawl through the text with an Italian dictionary to decipher the number of new taxa, combinations, varieties, and forms proposed as this is not given within the guidelines at the front of the book. I did find this somewhat frustrating, so for this review I just gave the number of taxa newly treated (as above).

Updating the systematic-taxonomic details remains based upon the conceptual framework of the 1988 monograph, although some of the authors' interpretations have been modified.

The key, is as in the previous monograph, is based upon gross morphological characteristics placing taxa into various colour groups. If you happen to be in the possession of a copy of the *Methuen Handbook of Handbook,* then the amendments made to the key in the supplement will go some way in addressing problems of subjectivity in colour nomenclature. The additionally recognized new species, varieties and forms have been worked into the key along with any new relevant information applicable to previously treated taxa.

New species, combinations, varieties and forms are accompanied by clear line drawings of pertinent microscopic details. Further, the illustrations that graced the previous monograph have now been replaced by superb colour photographs of the taxa *in situ*, and by a few excellent illustrations by J. P. Beati.

Some author citations are missing dates and further information (e.g. *Tricholoma equestre* var. *albipes* Peck), but in the main are in keeping with the 1988 monograph. There is a new bibliography for the supplement, but for the main bibliography of *Tricholoma*, the user will have to refer to the original monograph.

This is an excellent supplement to the monograph of *Tricholoma* in Europe that reflects the author's desire to present new information garnered during the last 15 years. Information collated from more frequent visits to southern territories during the past decade, and collaboration with colleagues who have a special interest in the genus, make this a major contribution to furthering our knowledge of *Tricholoma* in Europe.

ANDY S. OVERALL
Flat 2, 39 North End Road, Golders Green,
London NW11 7RJ, UK.

Rare and Interesting Species of *Psathyrella*. By Eef Arnolds. 10 August 2003. Edizioni Candusso, Vio Ottone Primo 90, I-17021 Alassio SV, Italy. [Fungi non Delineati No. 26.] Pp. 76, col. pl. 8, figs 20. ISSN 1128-6008. Price: € 11.

A welcome addition to the often problematic genus *Psathyrella*, this publication treats 21 species, six of which are described as new here. Descriptions follow the taxonomic arrangement of Kits van Waveren (1985), with respect to the order within the descriptions. All species described, apart from one (*P. granulosa*), are accompanied by excellent watercolour plates. The paintings are based on fresh material collected from an area surrounding the author's house in The Netherlands.

Distinction is drawn between the taxonomic value of the different cystidial types within the genus, and the variation of certain cystidia within a single species. This is a useful aid when approaching microscopic identification of species within this genus. This is helped further by line drawings of the morphological types of cystidia based on the definitions used in the *Flora Agaracina Neerlandica* (Bas *et al.* 1988).

Accompanying each description, are fine, clear line drawings of the important microscopic features applicable to each species. However, the absence of a key of some description is an anachronism, which if included would have been of further help to the user.

In summary, a very clear and useful addition to our further understanding of what is to the field mycologist a confusing and problematic genus.

Bas, C., Kuyper, T. W., Noordeloos, M. E. & Vellinga, E. C. (eds) (1988) *Flora Agaricina Neerlandica*. Vol. 1. Rotterdam: A. A. Balkema.

van Waveren, E. K. (1985) The Dutch, French and British species of *Psathyrella*. *Persoonia, Supplement* **2**: 1-300.

ANDY S. OVERALL
Flat 2, 39 North End, Road, Golders Green,
London NW117RJ, UK.

Osservazioni sul genere *Melanoleuca*. By Robert Fontenla, Mario Gottardi and Roberto Para. 10 August 2003. Edizioni Candusso, Vio Ottone Primo 90, I-17021 Alassio SV, Italy. [Fungi non Delineati No. 25.] Pp. 112, figs 21, col. pl. 40. ISSN 1128-6008. Price: € 14.

Adding to a series of contributions towards our understanding of the genus *Melanoleuca*, this publication presents treatments of 27 species. Nineteen of the species covered herein are complete with full descriptions, explanatory notes of material used, with habitat information as well as additional observations, which with some species include taxonomic notes. Accompanying each species are good quality colour photographs and excellent line drawings of important microscopic features. The remaining eight species, dealt with fully in previous publications, are only provided with new colour iconographs. A newly proposed key, which is simple and easy to use, is included for the subsect. *Exscissae* species currently known in Europe.

Among the 27 species treated, one new species (*M. robusta*) and one new combination are proposed, two species have been neotypified (*M. melaleuca* and *M. robusta*). Further, two species are revealed as present in Europe for the first time, and colour pictures of four species are newly published.

The introduction provides a valuable overview of the macro- and micromorphological features that need to be considered when studying this genus. Further, the section of coloured photographs includes an excellent series of photomicrographs of the various forms of cystidia in certain species, a most helpful inclusion for those studying the genus.

A table showing the taxonomic history of the proposed new species is accompanied by a text providing a useful insight into how species have arrived at their current status. In addition, tables consider other reported species whose status or occurrence in Europe has been challenged.

This is a well-produced and very useful addition to the ongoing contributions of the authors to our knowledge of the genus *Melanoleuca* that will prove to be a very useful tool for all wishing to identify material in or study the genus further.

ANDY S. OVERALL
Flat 2, 39 North End Road, Golders Green,
London NW117RJ, UK.

Synopsis Fungorum No. 18. Edited by Leif Ryvarden. January 2004. FungiFlora, P. O. Box 95, Blinderen, N-0313 Oslo, Norway. Pp. 84. ISBN 82 907724 29 2. Price: NOK 120.

This is a collection of 12 papers, involving six authors, all on wood-inhabiting corticioid and particularly polyporoid fungi from the neotropics, Ethiopia, Japan, and in some cases other tropical areas. Three new genera (*Globuliciopsis*, *Lyothelia*, and *Parvodontia*) and 20 new species are described and five new combinations made. There is also a treatment of tropical *Mycoaciella* species (4 spp.), and keys to non-cystidiate *Mycoacia* species (4 spp.), and neotropical species of *Antrodiella* (15 spp.), *Ceriporiopsis* (12 spp.), *Diplomitoporus* (9 spp.), *Oxyporus* (6 spp.), *Navisporus* (4 spp.), *Polyporus* subgen. *Melanopus* (8 spp.) and subgen. *Favolus* (7 spp.). Numerous line drawings showing diagnostic features of newly described and other species are included. In summary, another significant contribution to our knowledge of tropical, and especially neotropical corticioid and polyporoid fungi.

Ascomycetes

Revision of the Genus *Amphisphaeria*. By You Zhi Wang, André Aptroot & Kevin D. Hyde. January 2004. Fungal Diversity Press, Centre for Research in Fungal Diversity, Department pf Ecology and Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong. [Fungal Diversity Research Series No. 13.] Pp. 168, plates 92. ISBN 962 86765 5 5. Price: US $ 45.

Careful treatments of all names referred to a particular genus are the backbone of taxonomy. With 254 species names referred to it and hitherto no monograph, *Amphisphaeria* was very much a candidate for such arevision. The type material of 170 species has now been examined, and 12 species are accepted in the genus here. Many of the fungi previously placed there proved to be loculoascomycetes and are dispersed through a variety of genera. One new species, one new name, and 27 new combinations are made, only two of which are in *Amphisphaeria*. Genera featuring most strongly are *Arecophila* (5 new combinations), *Didymosphaeria* (3), *Kirschteiniothelia* (5), and *Trematosphaeria* (3). Keys are included not only to the *Amphisphaeria* species but also to those in some of other genera treated in detail (e.g. *Arecophila, Cainia, Ommatomyces*).

Accepted species are described, with details of type and other material examined, and illustrated by photomicrographs showing ascospores, asci, and in some cases the superficial appearance of the ascomata and(or) vertical sections of them. I would have found it helpful to have vertical sections for all species presented, especially those transferred to other genera, as the structures and tissue types are critical in the recognition of, for example, *Kirschsteiniothelia* and *Mycomicrothelia*. For example, I would have particularly liked to see an ascoma section of the species here called *M. lojkae*, which is reported as having the largest ascospores yet described in the genus, especially as no information on the structure of its ascoma is given in the text itself.

Anamorphs are not mentioned, and yet while they are unknown in most species, it would have been of interest to know whether the *Dendryphiopsis* state of *K. aethiops* was present on the names newly synonymized with that species, and if so whether the conidia were in the normal range. I was also intrigued by the exceptionally long-stalked asci figured in *Munkovalsaria donacina* (from the types of two species originally described in *Amphisphaeria*) which make me wonder over the suggested placement in *Dacampiaceae*.

The time to undertake such revisions can be almost open-ended with so many type collections to track down. Inevitably there is a list of some 98 names treated as "untraceable and unexamined species", amounting to more than one third of all referred to *Amphisphaeria*. Scanning through this list, I noted that the types of quite a few would be expected to be locatable (e.g. all species described by Berkeley, Cooke, Fuckel, Höhnel, and Schweinitz) given the time and opportunity to search different herbaria, while others are quite well-known species currently accepted in different genera (e.g. *A. biformis* is *Anisomerdium biforme*, *Amphisphaeria callicarpa* is *Caryospora callicarpa*, *A. pertusa* is *Trematosphaeria pertusa*).

Kevin Hyde is well-known for the high standards of his photomicrographs, and while this reputation is supported by those of the excluded species presented here, those of many of the accepted species are much less crisp and rather grainy. It would also have been good to see the ornamentation or striation in the ascospores of the eight *Arecophila* species accepted more clearly; sadly, these are hardly evident in some of the photographs unless studied with a hand-lens. Otherwise, the book is very well produced.

Such detailed revisions are much-needed as starting points for the identification and naming of fungi, especially when new collections are made in little-studied areas. Having obtained an *Amphisphaeria*-like fungus, hitherto it would have been extremely difficult to progress. Now there is a first port-of-call, and mycologists with packets labelled "*Amphisphaeria* sp." squirrelled away in boxes or drawers will now be able to see if they belong to any of the species treated here. A burst of new activity in describing species in the genus is now to be expected.

***Dothideales* Dictyospóricos/Dictyosporic *Dothideales*.** By Julia Checa. 2004. J. Cramer in Gebrüder Borntraeger Verlagsbuchhandlung, Berlin. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Johannestrasse 3A, D-70176, Germany.] [Flora Mycologica Iberica Vol. 6.] Pp. 162, figs 46. ISBN 3 443 65011 228 49 0. Price: € 58.

It was a pleasure to see an issue of this well-produced series, edited by the Real Jardín Botánico Madrid (Consejo Siperior de Investigaciones Cientificas), devoted to dothideaceous pyrenomycetes with muriform ascospores. Twenty-three genera occurring in the Iberian Peninsula are treated, with keys to both the genera covered and species within those represented by more than one species. Generic and species descriptions are provided, with notes on hosts or substrata and distribution, and pertinent observations. The line-drawings are particularly superb, especially those showing the habit on the natural substratum.

Species reported from the literature are covered even where the material has not been located, but I was unsure why *Dacampia* was missing; three species growing on lichens are known from the Iberian Peninsula (Llimona & Hladun 2001). Where genera include dictyosporous and phragmosporous species (e.g. *Leptosphaerulina*), only the dictyosporpous ones are treated. Full details of types and places of publication of both accepted names and synonyms are included, though it is not always clear whether the types cited have been studied personally by the author. No lists of specimens examined are given, which I found rather surprising in such a work.

I also found it strange in a time when most mycologists have a "whole fungus" approach, not to see anamorphs mentioned at all even under species such as *Pleospora herbarum*. An index to host plants would also have been a welcome addition.

There are the seemingly almost inevtiable nomenclatural slips, for example the repeated citing of places of sanctioning as basionyms with only those bibliographic details and with no mention of the place or date of valid publication of those names. It seems extraordinary that even experienced mycologists cannot get such details correct now 23 years after this aspect of the *Code* was modified. Further, in the case of *Capnodium*, the author citation and place of publication of the genus and type species is given only as "Mont. emend. D. R. Reynolds, Mycotaxon 7(3): 504 [or 505].1978" with no information on the original publication of Montagne. It is unfortunate that the nomenclature was not checked by a specialist as such slips detract from an otherwise painstakingly and well-produced work.

Except for nomenclatural information, the entire text is arranged in two columns, one Spanish and and the other in English. This, along with the fine drawings, makes this a "must-have" for the shelves of all pyrenomycete collectors and specialists. The author should be proud of having generated such a work, and I look forward to further pyrenomycete volumes in the series with similarly splendid drawings.

Llimona, X. & Hladun, N. L. (2001) Checklist of the lichens and lichenicolous fungi of the Iberian Peninsula and Balearic Islands. *Bocconea* **14**: 1-581.

***Hypocrea/Trichoderma* (*Ascomycota, Hypocreales, Hypocreaceae*): Species with green ascospores.** By Priscila Chaverri & Gary J. Samuels. 2003. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [Studies in Mycology No. 48.] Pp. 119, figs 527 (3 pp. colour). ISBN 90 70351 51 X. Price: € 50.

This work continues the critical revisions of *Trichoderma* and its teleomorphs by Gary Samuels and various colleagues, using a combination of careful microscopic observations, cultural characteristics, and molecular data. Here 124 isolates were used in the molecular phylogenetic studies which utilized two genes, the RNA polymerase II subunit and translation elongation factor 1-α., and both neighbour-joining and Bayesian methods of analysis. The results show the species with green ascospores to be nested amongst *Hypocrea* species with colourless ascospores, and in consequence the genera *Chromocrea* and *Creopus* which had been distinguished by this feature are here treated as synonyms of *Hypocrea*.

Separate keys based on teleomorph and anamorph features are provided to the 40 species accepted here, 11 of which are described for the first time, most from recently collected tropical material. In addition, new names are introduced for 12 *Trichoderma* species for which a name in *Hypocrea* was already available and for one *Hypocrea* that already had a named *Trichoderma* anamorph. While in all anamorph/teleomorph pairs the same species epithets are employed, I really wonder why it was considered necessary to introduce two separate names for the eight new species in which both states were known; while allowable under the *Code*, this is surely contrary to the advice given in Rec. 59A.3 that: "Authors should avoid the publication and use of binary names for anamorphs when the teleomorphic connection is firmly established . . . ".

Trichoderma harzianum s. str. (syn. *T. inhamatum*) is confirmed as anamorph of *H. lixii* (for which an epitype has been designated), and eleven teleomorph names are excluded primarily because type material was unavailable or could not be confidently asigned to any accepted species.

Detailed descriptions of the species are provided and accompanied by line drawings of the anamorphs and half-tone photographs of both anamorph and teleomorph (including sections of stromata and details of the tissue types). In addition, colour plates feature entire stromata and colonies on PDA at 25 °C after *ca* 10 days growth. Attention is also drawn to an interactive key to *Trichoderma* species which is available on http//: nt/ars-grin.gov/taxadescriptions/keys/Trichoderma.

This is carefully executed study, showing the value of combining molecular, morphological and cultural approaches, and which is sure to remain the definitive monograph of the green-spored *Hypocrea* species and their anamorphs for many years to come.

Lichen-forming Fungi

Lichen-forming and Lichenicolous fungi of Fennoscandia. By Rolf Santesson, Roland Moberg, Anders Nordin, Tor Tønsberg & Orvo Vitikainen. 2004. Museum of Evolution, University of Uppsala, Norbyvägen 16, SE-752 36 Uppsala, Sweden. [Available through Svenska Botaniska Föreningen, c/o Växtekologiska avd, Uppsala Universitet, Villavägen 14, SE- 752 36 Uppsala, Sweden.] Pp. 359. ISBN 91 972863 6 2. Price (incl.VAT and handling): SEK 321 (Sweden), 445 (Europe), or 480 (elsewhere).

Rolf Santesson's (1993) carefully prepared checklist of the lichens and lichenicolous fungi of Sweden and Norway has become a constant source of reference on current taxonomy, orthography and author citations to those working on lichenized and lichenicolous fungi world-wide. Since that time there have been many changes and additions, and a checklist has also been published for Finland (Vitikainen *et al.* 1997). With the *Nordic Lichen Flora* launched in 1999 (see *Mycotaxon* **75:** 508, 2000), a single checklist covering all of the Nordic countries would be a logical step. The integration now seen here, embracing three countries, is an important step along that road.

The new edition treats 2844 species, of which 430 are lichenicolous and 27 related saprophytes; these figures compare with 2602, 314, and 17, respectively in the 1993 work. Amongst the related saprophytes, I was pleased to note the long-overdue omission of genera such as *Agyrium*, *Leptorhaphis* and *Sarea* which are well-known not to be either lichenized or lichenicolous, but which have traditionally and idiosyncratically continued to be covered in lichen checklists and identification works. Yet in this context, I am unsure why *Stenocybe* is retained. The style is similar to the 1993 work, with synonyms (cross-referenced), notes on habitat or hosts, distributions by province within each country, and key literature references.

Many recently described or resurrected genera, mainly of crustose lichens and lichenicolous fungi, are accepted, including *Pseudosagedia* for the *Porina chlorotica* group which was not taken up by Coppins (2002). However, I did not understand why *Usnea subloridana* was not treated as a synonym of *U. florida* despite the overwhelming molecular evidence (which is referenced), why *Nesolechia* was not accepted as distinct from *Phacopsis*, nor why *Punctelia ullophyllodes* was synonymized with *P. subrudecta*. Such *minutiae* and points for further debate between specialists will always arise in such works, and do not detract from the pivotal and authoritative position this work occupies in European lichenology.

Coppins, B. J. (2002) *Checklist of Lichens of Great Britain and Ireland*. London: British Lichen Society.

Santesson, R. (1993) *The Lichens and Lichenicolous Fungi of Sweden and Norway*. 2nd edn. Lund: SBT-förlaget.

Vitikainen, O., Ahti, T., Kuusinen, M., Lommi, S. & Ulvinen, T. (1997) Checklist of lichens and allied fungi of Finland. *Norrlinia* **6**: 1-123.

Svenska Skorplavar och Svampar som växer på dem. By Tony Foucard. 2001. Interpublishing, Taptogatan 4, S-102 53 Stockholm, Sweden. Pp. 392. ISBN 91 86448 42 0. Price: Not indicated.

Tony Foucard's first book on the crustose lichens of Sweden (Foucard 1990) was the first comprehensive treatment to have appeared since the late nineteenth century and included keys and descriptions of some 1350 species. Since 1990 there have been enormous changes in the taxonomy of crustose lichens, and also a new edition of the standard checklist for Sweden (Santesson 1993). That checklist included lichenicolous fungi, and I was especially pleased to see that Foucard's new book also covered the lichenicolous fungi to be found on crustose lichens. In consequence the length has swelled by some 90 pages and around 1550 lichenized and 200 lichenicolous species are now treated. Overall keys to genera are included, the genera are treated alphabetically, and keys provided to species within the genera. The descriptions of species are detailed, and information on the ecology and distribution is included, but generic descriptions are not provided for all genera, mostly ones treated in the 1990 work. Swedish names are given where they exist, and selected literature is cited under the generic entries.

The detailed treatment of lichenicolous taxa is an especially important feature of the book immediately making it of international appeal. Even though in Swedish, the keys are intelligible with the aid of a modest dictionary. I was especially intrigued to see the key to *Stigmidium* with 15 species all keyed out as a 15-chotomy just by their host lichens – a pragmatic approach reflecting how inadequate is our knowledge of species circumscriptions in that genus. A separate list of lichenicolous species arranged by the lichen host is included and in many cases this will be a helpful short-cut when making identifications. The work would have been even more valuable if lichenicolous fungi occurring on non-crustose hosts could also have been incorporated: perhaps that could be considered in any new edition produced?

A double-column format has been adopted this time, which has facilitated the inclusion of the previously marginal and also additional thumb-nail drawings of, for example, ascus apices and spores. One regrettable difference, however, is the omission of the black and white photographs of 345 species which were an especial feature of the 1990 book, constituting the largest collection ever published of photographs of crustose lichens.

A tremendous achievement, and a work which all who deal with crustose lichens and their associated fungi will want side-by-side with its predecessor within reach of the microscope.

Foucard, T. (1990) *Svenska Skorplavs Flora*. Stockholm: Interpublishing.
Santesson, R. (1993) *The Lichens and Lichenicolous Fungi of Sweden and Norway*. 2nd edn. Lund: SBT-förlaget.

Guía dos Liques de Galicia. By Carlos Pérez Valcárcel, Carmen López Prado & Eugenia López de Silanes Vázquez. December 2003. Baía Edicións, Poligono de Pocomaco, 2ª Avda. Parcela G18 Nave Posterior, ES-15190 A Coruña, Spain. [Guía da Natureza Baía Verde No. 13.] Pp. 408, col. plates. ISBN 84 96128 49 0. Price: € 33.28.

This guide to lichens of Galicia is written in Gallego, the romance language of the region. Galicia, in northwest Spain, has a mild, very humid and temperate climate that favours lichen richness and biodiversity in the region. The publication of this guide fills an important gap in our general knowledge of Spanish lichens. The authors made a study of the Galician lichens and provide numerous drawings and photographs that will enable the general public to learn about and appreciate lichens. The book will be of interest to lichenologists in Spain, while particularly serving the needs of beginners. A notable and especially valuable feature is the treatment of the crustose lichens, which other Spanish guidebooks have usually omitted, and the inclusion of detailed photographs of microscopic preparations. It is also well edited and easy to handle.

The guide covers 87 genera and 317 species considered the most representative of this region, including foliose, squamulose, fruticose, leprose and crustose life forms. A key to genera is provided. Genera are arranged alphabetically, and for each genus there is a detailed description together with colour photographs including ons of microscopic preparations of ascomata and spores, where they are present. Keys to species within different genera are provided, and there is a colour photograph for each species treated. At the beginning of the keys there is an explanation of how to identify a lichen, and how to use the guide which will be very useful for beginners.

The first part is well-illustrated with original drawings and colour photographs, and gives a thorough description of lichen thalli: including different growth forms, thallus structures, reproductive strategies, and other characteristic features such as lichen products. The book continues with a section on lichen uses, with an emphasis on their application as bioindicators of air pollution; quantitative and qualitative methods are explained in detail. It also includes a survey of previous lichenological studies in Galicia, to which the present authors and their colleagues have made outstanding contributions in recent years. A glossary and index to taxa is provided at the end of the book.

The quality and number of illustrations will make this book useful even to those with no knowledge of the Galician language.

Ana Pintado
Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense de Madrid, Plaza de Ramón y Cajal, Ciudad Universitaria, ES-28040 Madrid, Spain

A Monograph of *Enterographa* and *Sclerophyton*. By Laurens B. Sparrius. May 2004. J. Cramer in Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Bibliotheca Lichenologica No. 89.] Pp. 141, figs 58, tables 2. ISBN 3 443 58068 8. Price: € 48.

This monograph, prepared under the supervision of André Aptroot, treats all species hitherto referred to *Enterographa* and *Sclerophyton* (*Arthoniales, Roccellaceae*). No modern account of these mainly tropical genera has hitherto been prepared, and it is good to see them clearly circumscribed, mainly on the basis of differences in ascospore shape and structure, to accommodate 35 and 14 species respectively. In addition *Sclerophytonomyces* is taken up for *S. circumscriptum* on the basis of the wide paraphysoids and pigmented ascospores, but I remain unconvinced that the name can be treated nomenclaturally other than as a synonym of *Sclerophyton*, the original mention of *S. circumscriptum* merely being due to an error over the citation of the type species of *Sclerophyton*, the intention being to introduce an alternative name for the fungal partner of that genus; a new generic name will probably have to be introduced for that species.

Over one third of the species (18) are described as new to science, most of these tropical and Southern Hemsiphere species of *Sclerophyton*. Ten new combinations are proposed, including two additions to *Llimonaea*. The list of excluded and doubtful taxa has 40 entries, many for species treated as belonging to genera such as *Schismatomma* in other recent treatments.

Descriptions are detailed, there are lists of specimens examined, and clear illustrations of ascospores and black and white macrophotographs showing the habits and appearance of the complex and often cerebriform lirellate ascomata.

A worthy addition to the series, and now the first place to go to identify material of these genera.

Myxomycetes

Myxomycetes of Poland: A checklist. By Anna Drozdowicz, Anna Ronikier, Wanda Stojanowska & Eugeniusz Pamek. 2003). W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Biodiversity of Poland Vo. 10.] Pp. 103. ISBN 83 89648 08 3. Price: Not indicated.

This work is divided into the following chapters: Introduction (History of studies on Myxomycetes in Poland, General remarks on the checklist, Detailed remarks on the checklist, Latin nomenclature, Substrate, Notes, Symbols and abbreviations used in the list), List of species, Outline of systematic classification, Index of Latin names, Index of Polish names (with reference to Latin names), Index of author's names, and References.

The book is very well conceived, the chapters are well structured, and all of them are necessary. I would like to highlight the information presented on the substrate of fructifications, and the very useful notes that facilitate the understanding of different taxonomic interpretations by Polish authors.

The number of species of *Myxomycetes* known from Poland according to this checklist is 222, making Poland one of the countries with major myxomycete biodiversity with respect to described Myxomycetes. However, the historical trajectory of its study has been intermittent, but currently we see again a strong and united team of 'myxomycetologists', something necessary in order to standardize studies and criteria.

It is important to observe that in the checklist are some species described as new for science by authors from Poland or which were originally recognized in the country, such as *Diacheopsis pieninica* Krzemien., *Didymium leptotrichum* (Racib.) Massee, *Didymium macrospermum* Rostaf., and *Enerthenema berkeyanum* Rostaf.

The chapter of References is very interesting because there are works cited in it which are difficult to locate in western European and North American libraries, due no doubt to the former political isolation of Poland. Included are references to works of Raciborski and Rostafiński that can be considered fundamental for the taxonomic study of *Myxomycetes*.

I only missed in this checklist the absence of the complete bibliographic citations of accepted taxa and synonyms, information very useful in any taxonomic work.

In conclusion, the information compiled here is exhaustive and provides what will be a much appreciated tool for all students of *Myxomycetes*, both professionals and amateurs. It is a book that we should include in our libraries.

GABRIEL MORENO
Departamento de Biología Vegetal, Universidad de Alcalá, Alcalá de Henares,
ES-28871 Madrid, Spain.

MYCOTAXON

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Penultimate revisions

Lorelei L. Norvell

editor@mycotaxon.com
Pacific Northwest Mycology Service
6720 NW Skyline Boulevard, Portland OR 97229 USA

Revised *Mycotaxon* formatting guidelines

A complete set of the newly revised *Mycotaxon* guidelines will be published in the 2004 October-December issue, 90(2), and posted on www.mycotaxon.com. The new guidelines will condense protocols already covered in *Mycotaxon* 88: 515-526, *Mycotaxon* 89(1): covers 2-3, *Mycotaxon* 89(2): 521, and our website. Below are the most important formatting requirements.

Fonts (General) – Authors **must** obtain permission to use fonts other than Arial [Helvetica], Times [Times New Roman], or Courier (limited to tables where alignment is essential, as in presenting sequence data). Symbol characters (α, β, *μ*m.) should be inserted using the SYMBOLS menu when preparing text in Times New Roman.

Paragraph settings (General) – Authors are encouraged to format paragraphs rather than insert spacer lines or use tab keys to indent (e.g., set spacing at 6-points before, indent first lines by ~1 cm, use hanging indents for literature cited). A formatted MSWord shell setting forth *Mycotaxon*–approved styles is available from the Editor.

The following formats are now required.

Title – *Font:* Arial, 11-point, Bold, **sentence** (not upper or title) case; *Paragraph:* no period (dot) at the end (unless ending with an abbreviation), no indent, center aligned.

Author names – *Font:* Times, 10-point, Roman (regular), Large & small capital; *Paragraph:* no indent, center aligned.

Address information – *Font:* Times, 9-point, Italic; *Paragraph:* no indent, center aligned, no periods at line ends; *Placement:* Email address on top line; Institution/Street on middle line/s; City, Code, Country on bottom line.

Abstract & Key Words headers – *Font:* Arial, 8-point, Bold; *Placement:* on first line preceding text.

Abstract paragraph and Key words list – *Font:* Times, 8-point; *Paragraph:* margins indented ~1cm, no first line indent, fully justified; no period at end of Key words list.

Primary stand-alone subheadings – *Font:* Arial 10-point, Bold/Bold Italic; *Paragraph:* no indent, center aligned.

Secondary stand-alone subheadings – *Font:* Times 10-point, Bold/Bold Italic; *Paragraph:* no indent, left aligned.

Basic Text – *Font:* Times 9- (preferred) or 10-point; *Paragraph:* fully justified (preferred).

Subordinated text – *Font:* Times, 8-point (9-point optional when basic text in 10-point; 7-point optional: preferred in large tables but discouraged in Acknowledgements and Literature cited sections).

Literature cited – *Font:* Times, 8- or 9-point; *Paragraph:* Hanging indent, no line spaces between entries.

Latin scientific names for all taxa up to and including order – *Fonts:* Italic (in the version of the font and style of the sentence or heading containing that name).

Tables – Due to the difficulty of importing complex tables into In-Design, tables are now treated as graphics files. Those submitting MSWord or Rich Text Format electronic manuscripts are asked to submit all but the simplest tables as stand alone EPS or document files during final submission.

Graphic file size – Print resolution in the final publication is 300 dpi and the maximum final print area for a graphic is 11cm wide, 17.5 cm long (without legend). Format high-resolution final graphics files between 300 dpi (line drawings) and 600 dpi (halftone plates). TIF, EPS, and table files should all be scaled to fit the final print area (not page) size.

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Email – Due to increased junk email, authors should always include "Mycotaxon" followed by an appropriate short manuscript title in the email subject header. Authors using spam filters should add <editor@mycotaxon.com> and <llnorvell@pnw-ms.com> to their list of permitted incoming addresses.

Presubmission – When *Mycotaxon* resumes its four volume/year publication schedule in 2005, it will no longer be possible for the Editor-in-Chief to fine-tune each manuscript during the pre-submission period. Authors submitting electronic files for pre-approval are expected to send fully formatted, print-ready electronic files and to implement requested changes themselves. Users of Adobe PageMaker or In Design are encouraged to submit files formatted in those applications. PDF files accompanied by fully formatted MSWord or Rich Text Format files (with graphics removed) can also be used during pre-submission. Those wishing to submit print-quality Adobe PDF files during final submission must be able to insert the masthead font and page numbers after final manuscript approval. Pre-flighting all such files before final submission with Sheridan Press is encouraged.

Final submission is not final until the Editor-in-Chief has received **(i)** ONE (and only* one) manuscript hard copy with all plates, line drawings, and tables in place, **(ii)** a cover letter citing title, number of pages, number of graphics, and addresses (especially email) for **all** coauthors and **both** peer reviewers, and **(iii)** checklists and comments from two peer-reviewers. (Peer-reviewers may email their reviews to the Editor-in-Chief.)

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Electronic files (which may be sent as email attachments) must include (i) a fully-formatted print-ready document file with graphics (including tables) omitted, (ii) separate high resolution TIF or EPS files for each line drawing, phylotree, or halftone, and (iii) DOC, RTF, or EPS files for each table.

ERRATA

VOLUME 87

p. 76, line 32	for: *floccosa*	read: *floccosum*
p. 76, lines 28 & 32	for: *protracta*	read: *protractum*

VOLUME 89

p. 16, line 21,	*for:* subsecc.	*read:* subsect.
p. 55, Abstract, line 11	for: *stuhlmanii*	read: *stuhlmannii*
p. 89, line 7	for: *effususm*	read: *effusum*
p. 102, line 23	*for:* lead,	*read:* led,
p. 102. line 27	*for:* lead	*read:* led
p. 201, text line 6	*for:* the *Amazonia*	*read:* the genera *Amazonia*
p. 212, line 34	for: *Amyocorticium*	read: *Amylocorticium*
p. 212, line 34	for: *Clavariadeplphus*	read: *Clavariadelphus*
p. 212, line 35	for: *Diplotomitoporus*	read: *Diplomitoporus*
p. 243, lines 43-44	for: *atro virens*	read *atro-virens*
p. 321, Introduction line 12	for: *Tricothelium*	read: *Trichothelium.*
p. 335, line 8	*for:* subsec.	*read* subsect.
p. 336, line 5	*for:* sec.	*read* sect.
p. 336, line 8	*for:* insect.	*read:* in sect.
p. 336, line 9	for: *Anthidepas*	read: *Anthipades*
p. 345, line 36	for: *pinetorm*	read: *pinetorum*
p. 355, Abstract, lines 2, 7	for: *moellerii*	read: *moelleri*
p. 357, Keys, couplet 8b	for: ***moellerii***	read: ***moelleri***
p. 358, line 25	for: *ericacea*	read: *ericaea*
p. 360, line 21	for: *Heterobasidium*	read: *Heterobasidion*
p. 363, last line	*for:* □m	*read:* µm
p. 366, species 6	for: *moellerii*	read: *moelleri*
p. 367, line 1	should read: Figure 5. *Psilocybe moelleri*. A. Basidiome. B. Basidiospores. C. Basidia. D. Cheilocystidia.	
p. 368, Remarks, line 3	for: *moellerii*	read: *moelleri*
p. 387, line 19	*for:* Megasporoporia	read: *Megasporoporia*
p. 389, Abstract: italicize *Antrodiella micra, Aphyllphorales, Hymenochaetaceae, A. pallasii,Trichaptum abietinum,* and *Antrodiella*		
p. 399, Abstract line 4	for: *rubro-stipitatus*	read: *rubrostipitatus*
p. 441, Abstract line 8	for: *clasdosporioides*	read: *cladosporioides*
p. 523, add: *Megasporoporia subcaverulosa* Y. C. Dai & Sheng H. Wu, p. 384		

p. 523, add *Parmotrema sampaioi* Paz-Bermúdez & Elix, p. 506

p. 524, line 6 for: *Transcheliella* read: *Tranzscheliella*

p. 524, line 7 *for:* p. 83 *read:* p. 82

p. *ii*, the **Editorial Advisory Board** should read

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All back volumes [except volumes 22, 24, 34(2), 35, 41, and 54, currently out of print] are available at $35 each by surface mail, $55 each by air mail. Volumes 1, 38, 39, 43 and 46 were reprinted in 2001; the original printing of volume 1, part 1 is provided, with parts 2 and 3 reprinted.

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