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Phaeocollybia in western North America 4: Two new species with tibiiform cheilocystidia and Section *Versicolores* reconsidered[1]

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Abstract — Two new phaeocollybias are described from coastal and coastal montane coniferous forests of California, Oregon, and Washington. *Phaeocollybia rufotubulina*, closely related to the gregarious, hollow-stiped *P. californica* and *P. scatesiae*, differs in pileipellis pigments, pseudorhizal branching pattern, and RFLP profile. *P. tibiikauffmanii* differs from the similarly robust, orange-brown, viscid capped *P. kauffmanii* in its thick-walled narrow-necked capitulate cheilocystidia. Phenetic and cladistic analyses of restriction data generated from thirty-seven isolates representing *P. californica*, *P. pseudofestiva*, *P. scatesiae*, *P. spadicea*, *P. radicata*, and the two new species support the existence of a clade characterized by thick-walled tibiiform cheilocystidia. Characters previously used to diagnose Section *Versicolores* are re-examined, and the implied phylogenetic separation of the vernal *P. pleurocystidiata* from the fall-fruiting tibiiform western species is discussed.

Key words — *Agaricales*, Basidiomycota, *Cortinariaceae*, ITS, temperate rainforest

Introduction

As part of a continuing study of the genus *Phaeocollybia* begun in 1991, a large number of fresh specimens (>1,000 collections) from Pacific coastal temperate rainforests of western North America have been examined and compared closely with older dried material (including type specimens). During this research, 160 collections were molecularly analyzed (Norvell 1998ab, 2000, 2002; Norvell & Redhead 2000), new insights into the development and biology of the genus gained (Norvell 1998ab), new morphological characters revealed (e.g., the existence of a universal pellicular veil, different pseudorhizal morphologies, the presence of sarcodimitism, see Norvell 1998ab), and seven new species named (Norvell 2000, 2002; Norvell & Redhead 2000). Two additional undescribed species characterized by large ornamented basidiospores, absence of clamp connections, and narrow-necked thick-walled capitulate tibiiform cheilocystidia are described below. Similarities among western North American phaeocollybias characterized by thick-walled tibiiform cheilocystidia are discussed,

[1]Based in part on material submitted for a doctoral dissertation at the University of Washington, Seattle WA 98195-5325 USA.

and Section *Versicolores* (Smith 1957b; Singer 1970, 1986, 1987; Bandala and Montoya 1994) is reconsidered.

Materials and Methods

Specimen collection and examination, macrochemical tests, DNA extractions, PCR-amplification of the ITS1 + 5.8S + ITS2 rDNA region (henceforth referred to as 'the ITS region'), restriction digests and mapping, and phenetic and cladistic analyses using NTSYS (Rohlf 1993) and Phylip (Felsenstein 1995) were conducted using protocols outlined by Norvell (1998ab, 2000).

Descriptions are based on data taken from both type and other well-documented collections. Morphological and developmental terms (*e.g.* tibiiform diverticula, sarcodimitic tissues, pellicular veil, vertical-monopodial and rhizomorphic pseudorhizae) are explained in Norvell (1998ab). General non-standardized color names in lower case are accompanied by italicized color references. Ridgway (1912) colors are capitalized and abbreviated, with a slash "/" or parentheses separating modifiers of the same base color (*e.g. Mikado /Mars /Verona Brown = Mikado Brown, Mars Brown, Verona Brown; (Pale) Pinkish Cinnamon = Pale Pinkish Cinnamon* and *Pinkish Cinnamon);* bracketed Munsell (1976) alpha-numeric color ranges (*e.g. [2.5Y 6-8/1-4]*) follow Ridgway references. Measurements of anatomical characters were taken from tissues rehydrated in 6% aqueous KOH unless otherwise noted, and basidiospores from the stipe apex were measured when spore prints were lacking. Ranges enclosed in parentheses accompany mean basidiospore dimensions with standard deviations. "L+ll/cm" is the number of lamellae + lamellulae per cm at the pileus "edge" and at the "midpoint" between edge and stipe. "Aerial stipe" refers to the portion of the stipe above the ground; "origin" refers to the pseudorhizal origin at the very base of the basidiome within the substrate.

Herbaria housing cited collections are abbreviated in accordance with Holmgren et al. (1990), with "PNW" representing the Pacific Northwest Mycology Service herbarium. Subscripts denote Randon Fragment Length Polymorphism (RLFP) codes; and asterisks (*) flag Northwest Forest Plan Strategy 1 collections (USDA-USDI 1994, Norvell 1995, Norvell & Exeter 2004) of significance to US governmental forest management policy. Longitudes and latitudes were either converted from Township-Range-Section data obtained from USDI-BLM maps using the TRS2LL computer application (Wefald 1995) or obtained electronically from the Yale Peabody Museum of Natural History GNIS database (YALE). Separate collection dates are not listed for the date-based numbered Norvell (LLN###), Density Management Study (g###), and Chronosequence Study (a###) collections *e.g.* LLN1921116-02$_{ruc1}$ = Norvell *November 16, 1992* collection 2, RFLP code *ruc1*). Collector abbreviations include RLE or Ex (Exeter), LLN (Norvell), SAR (Redhead), and HDT (Thiers). Vegetation abbreviations include ABGR *(Abies grandis)*, ABAM *(Abies amabilis)*, BENE *(Berberis nervosa)*, GASH *(Gaultheria shallon)*, LIDE *(Lithocarpus densicarpa)*, OXOR *(Oxalis oregana)*, PISI *(Picea sitchensis)*, POMU *(Polystichum munitum)*, PSME *(Pseudotsuga menziesii)*, SESE *(Sequoiodendron sempervirens)*, TSHE *(Tsuga heterophylla)*.

Taxonomic Descriptions

Phaeocollybia rufotubulina sp. nov. FIGURES 1-2

Pileus usque ad 60 mm latus, convexo-campanulatus, umbonatus, madidus vel viscidulus, glaber, e rufo rufo-brunneus; caro subaurantia; odor leviter florali vel leviter favaceus; lamellae aurantio-cremeae, fulvo-brunnescentes e sporis; stipes usque ad 12 mm versus apicem, usque ad 180 mm longus cum pseudorhiza tenua racemosa, glaber vel fibrillosus, cum corticem tenuissimo, cavus (tubulosus). Sporae longae, 8.2-10 × 4.5-6 µm, limoniformes, rugulosae cum rostro et apiculo glabro et cum plaga obscura; ixocutis cum suprapelle tenue vel moderato, gelatinosa, cum pigmento aurantio incrustato et subpelle cum pigmento intraparietali et encrustato; cheilocystidia abundans, heteromorpha, tibiiformea et 3 µm lata versus septam cum collo crasse tunicato angusto et cum capitulae usque ad 1.5 µm lata, vel clavata leptoderma, gelatinosa, hyalina. Hyphae desunt in texturis omnibus. Typus ad terram in silvis mixtis: LLN1921116-01ruc1, L. L. Norvell cum G. L. Barron et S. A. Redhead (Jackson State Forest, Mendocino County, California, USA). Holotypus WTU; Isotypi DAOM, PNW.

Etymology: from the Latin *rufus* = "reddish" + *tubulus* = "little pipe"

Selected descriptions and illustrations: Norvell (1998a)—color photographs, line drawings. Norvell (1998b)—black & white photographs, line drawings.

Brief summary — Basidiomes densely gregarious, small to medium, more or less uniformly reddish orange; pilei convex-campanulate, subviscid; young lamellae pale orange; stipes strict, tubular with very thin cortices, matte to polished, pale orange to deep purplish red; pseudorhizae sequential-racemose, cord-like, rhizomorphic. Basidiospores large (~9 × 5 µm), long-limoniform, coarsely warty-rugulose with smooth elongated apical beaks, dark orange amber in KOH; cheilocystidia abundant, slightly heteromorphic, thick-walled, refractive, lageniform/tibiiform, occasionally intermixed with thin-walled, mucronate elements; pileipellis bilaminate with a moderately thin yellowish suprapellis composed of narrow hyphae spirally encrusted with orange to orange-brown pigment overlying a thin brownish-orange subpellis; clamp connections absent. Tissues either negative or very faintly pink (pseudorhizae only) in syringaldazine. Dried pileus colored copper or purplish bronze, with a metallic sheen.

Expanded description — Pileus 15-62 mm broad, convex-umbonate with acute umbo and incurved margin when young, expanding to broadly campanulate with acute to low broad umbo, incurved to straight margin, and incurved edge, glabrous, lubricous to subviscid, opaque, nonstriate, generally bright reddish to brownish orange *(Xanthine / Ochraceous / Apricot Orange, Mars Yellow, Ochraceous Buff)*, often with slightly darker disc and edge *(Sanford's / Dark Orange Brown, Tawny)*, brownish streaks and damaged areas occasionally present, dried pileus metallic, usually copper or winy-reddish bronze. **Context** 3-6 mm thick at the disc, pale orangish cream *(Pale Ochraceous Salmon, Pinkish Buff)*. **Odor** faintly floral (reminiscent of cultivated *Viola*) or like cooked potatoes (similar to *Amanita citrina)*, occasionally sharply farinaceous after cold storage, then developing a green corn odor on warming. **Taste** mild and not distinctive to slightly bitter (reminiscent of raw potatoes). **Lamellae** nearly free, emarginate with a short tooth, ventricose, multi-tiered with 1-3 (young) to 2-6 (mature) lamellulae irregularly interspersed; 2-5 mm broad (mean length : width ratio 3.5), subcrowded (L+ll/cm: edge = 19-23; midpoint = 10-12); color pale orangish cream *(Apricot / Ochraceous Buff)* when young, maturing to foxy brown *(Clay Color, (Ochraceous) Tawny)* with bright rusty orange streaks.

Primordial sheath remnants present as connective fibrils between pileus and stipe (immature) or as occasional, densely scattered, fine, dark reddish brown fibrils on mature stipe apex. **Stipe** central to slightly eccentric; aerial length up to 140 mm, combined length with pseudorhiza up to 180 mm, apex 4-12 mm diam; strict, terete, uniformly equal except for slight bulbous swelling at ground level above sharply attenuating cord-like pseudorhiza, glabrous and smooth or covered with fine short reddish-orange fibrils, dry to lubricous; apex slightly paler than reddish orange pileus when young *(Xanthine Orange, Light Ochraceous Buff, Cinnamon)*, gradually darkening upwards to a dark reddish to purplish brown in age *(Hay's Russet, Kaiser / Liver Brown)*; hollow, cortex 1-1.5 mm thick, brittle, cartilaginous; lumen empty from pileus to rhizomorphic pseudorhiza. **Pseudorhiza** sequential-racemose, rhizomorphic, 1.5-2 mm thick cord of undetermined length (strands up to 55 mm have been retrieved); cortex dark reddish brown *(Liver Brown, Clay Color)*, cartilaginous; medulla dark orange-brown *(Clay Color)*, compact.

Spore print brown (slightly darker than 7.5YR 4/4 [Sayal Brown]).

Basidiospores 9 × 5 ± 0.6 × 0.3 μm (overall range 8.2-10 × 4.5-6 μm), limoniform with a prominent straight to slightly tilted beak in profile, ovate with swollen portion in face view, exosporium thick-walled, coarsely rugulose roughened except over the apiculus and beak, with less ornamented plage visible in oil immersion; dark to deep orange-amber in KOH; inamyloid. **Cheilocystidia** heteromorphic, with thick-walled and thin-walled lageniform, tibiiform, and clavate elements intermixed; mucronate/tibiiform elements occasional to frequent, 17-30 μm long with 3 μm wide ventricose bases below 1-μm wide refractive necks and with/without 1.5 μm diam capituli, containing viscous pale to dark amber contents; thin-walled elements less frequent, moderately inflated or broadly clavate, heavily gelatinized, hyaline, developing long filamentous apical outgrowths in age or in storage. **Pleurocystidia** absent. **Basidia** 4-spored, 25-30 × 5-6 μm with long (to 8 μm) sterigmata, hyaline to pale straw-colored. **Pileipellis** a bilaminate ixocutis; suprapellis 120-200 μm thick, the gelatinous matrix pale orange-yellow and the embedded hyphae long, branched, 2-4 μm wide, highly gelatinized, roughened, and with spirally encrusting and intraparietal yellowish-orange to orange brown pigments; subpellis thick (300-450 μm), hyphae (5) 8-15 μm diam, thick-walled, highly gelatinized, walls orange-yellow to deep orange in KOH. **Stipitipellis** a longitudinal ixocutis, hyphae narrow (2-4 μm diam), cylindrical, thick-walled, highly gelatinized, incrusted with medium to dark orange-amber to orange-red pigments. **Tramal tissues** moderately to highly gelatinized, strongly sarcodimitic in the pseudorhiza and lower stipe with long (95- 200 μm), wide (≤ 20 μm), thick-walled (≤ 3 μm), cylindrical, rigid yellowish "vessel" hyphae supported by less conspicuous, shorter (~20 μm), narrower (4-6 μm), branched, thin-walled (< 0.5 μm), flexuous hyphae; in the pileus both hyphal types also present, but vessel hyphae with thinner (1 μm) walls; in the lamellae central hyphae parallel, 4-6 μm diam, highly gelatinized, slightly thick-walled, with refractive septa and pale amber intraparietal pigments; these giving rise to a compact, 2-6 μm thick subhymenium. **Tibiiform diverticula** abundant on mycelium, primordial surfaces, and pseudorhizal pellis; also frequent on vestiges of pellicular veil on stipe apex. **Clamp connections** absent in mature basidiomes but occasionally present in primordial pellis.

FIGURE 1 *Phaeocollybia rufotubulina* (LLN1921116-01) **1a.** Holotype *in situ* with differentially developed basidiomes in Jackson State Forest, Mendocino County, California (photo by Scott Redhead). **1b.** Suprapellis hyphae with refractive septa and dark orange encrustations (phase contrtast). **1c.** Tibiiform diverticula on stipitipellis (bright field). *Scales = 10 µm.*

Macrochemical reactions — *Syringaldazine* negative to slightly positive (pseudorhiza develops black tinge after 15 minutes and magenta tinge after 60 minutes); *KOH* dark brown on pileus; *$FeSO_4$* slightly greenish on all tissues. **Fluorescence** — (fresh material not checked; dried gills brilliant mustard yellow where mature spores absent. **RFLP profile** (Extensive data for 6 isolates including type) — ITS 690 bp (± 730 bp second band); unique in Xho1 (500-190); EcoR1 (365-325) diagnostic; *also cut* in Cfo1, Hinf1, Nde2, Pal1, and Pvu2; *uncut* in Rsa1, Sal1.

Ecology, range and distribution — Densely gregarious in loose bundles in sandy loam under needle duff in mature mixed forest with an overstory of *Lithocarpus densifolius, Sequoia sempervirens, Pseudotsuga menziesii, Abies grandis* and shrubby understory of *Rhododendron, Vaccinium ovatum,* and *Polystichum munitum*. Uncommon, yet often locally abundant. Known from 13 sites (36 collections) in coastal lowlands from southern Oregon (Lane County) south to Marin County along the north central California coast. October through January.

OTHER SPECIMENS EXAMINED UNITED STATES. CALIFORNIA: **Marin Co.** AUDUBON CANYON RANCH (122.6794°W, 37.19308°N)—05.I.1984 *CCalhoun84-3737* (SFSU as *P. californica*); BOLINAS RIDGE TR NEAR MT TAMALPAIS (122.7847°W 38.095°N)—clustered in soil under oaks in dense mixed conifer-hardwood forest 17.I.1992 *HDT54067* (SFSU as *P. radicata*); **Mendocino Co.** JACKSON SF 'ALEURIA GLEN' ON SF RD 409, 1.5–2 MI FROM 408 (123°46'W 39°20'28"N)—mature LIDE ABAM PSME TSHE SESE 24.XI.1992 *LLN1921124-02ruc3-03,-04,-03,-06,-07,-08ruc6,-09,-10,-24,-27* by/w GLBarron REHalling HDT (WTU, -02 -08 split w PNW); SIMPSON LANE, FORT BRAGG AREA (123.8114°W, 39.4172°N)—duff mixed forest 22.XI.1982 *ASMethven2149* (NY as *P. radicata*); JACKSON SF (123°38'52"W 39°23'33"N)—gregarious humus mixed woods 14.XI.1967 *HDT21575* (SFSU as *P. radicata*), 25.X.1986 *MTSeidl2114* (WTU), mature LIDE ABAM PSME TSHE SESE 21.XI.1992 *LLN1921121-06-ruc9* by REHalling HDT (NY WTU PNW); JACKSON SF NEAR MENDOCINO (123°47'30"W, 39°18'28"N)—soil mature LIDE ABAM PSME TSHE SESE 22.XI.1980 n.c. (*HSC5940* as *P. dissiliens*); JACKSONSF ICT RDS 408/409 'MUSHROOM CORNER' (123°44'W, 39°19'N)—humus dense mixed forest 25.XI.1960 *HDT08477* (SFSU as *P. attenuata*), 11.XII.1965 *HDT14607* (SFSU as *P. attenuata*), 05.XI.1967 *HDT21404* (SFSU as *P. attenuata*), 07.XII.1969 *HDT24452* (SFSU as *P. californica*), 03.XII.1971 *JFAmmirati06222* (MICH as *P. californica*), 31.X.1972 *HDT30427* (SFSU as *P. californica*), 07.XII.1974 *HDT33175* (SFSU as *P. californica*), 02.XI.1975 *HDT35261* (SFSU as *P. californica*), soil SESE ABAM 13.XII.1990 *DEDesjardin5030* (SFSU as *P. californica*), mature LIDE ABAM PSME TSHE SESE *LLN1921117-08-ruc8* w SAR (DAOM PNW WTU); RUSSIAN GULCH SP (123°46'26"W 39°19'59"N)—mature LIDE ABAM PSME TSHE SESE 25.XI.1992 *SAR7454, 7500ruc7* (DAOM PNW); WOODLANDS CAMP (123.7050°W, 39.3156°N)—*04.XII.1971 DEStuntz17100* (WTU); **San Mateo Co.** HUDDART ROADSIDE PARK (122.2947°W 37.4350°N)—duff mixed forest 23.XII.1964 *WJSundberg195* (SFSU as *P. attenuata*); **Santa Clara Co.** SANTA CRUZ MTNS (121°54'W, 37°6'N)—gregarious terrestrial *RAHanks s.n.* (SFSU as *P. attenuata*); **Sonoma Co.** SALT POINT SP (123°18'43"W, 38°34'31"N)—mixed woods 25.XI.1972 *HDT30756* (SFSU as *P. californica*). **OREGON: Lane Co.** FLORENCE (124°5'55"W 43°58'58"N)—*LLN1971031-01* Mt Pisgah show (PNW).

Comments *Phaeocollybia rufotubulina* is easily recognized in the field by its striking reddish-orange color, dense gregarious habit, and strict tubular stipe that splits longitudinally and curls back into a floret when sliced crosswise (similar to a dandelion scape). Long, narrow, heavily rugulose-roughened, dark red-brown spores, moderately thick pileipellis with concentrically dark-encrusted hyphae, and heteromorphic mix of abundant thick-walled tibiiform and thin-walled clavate cheilocystidia characterize the species microscopically. No other *Phaeocollybia* species tested possesses an Xho1 restriction site. *P. rufotubulina* appears coastally restricted to southern Oregon (one

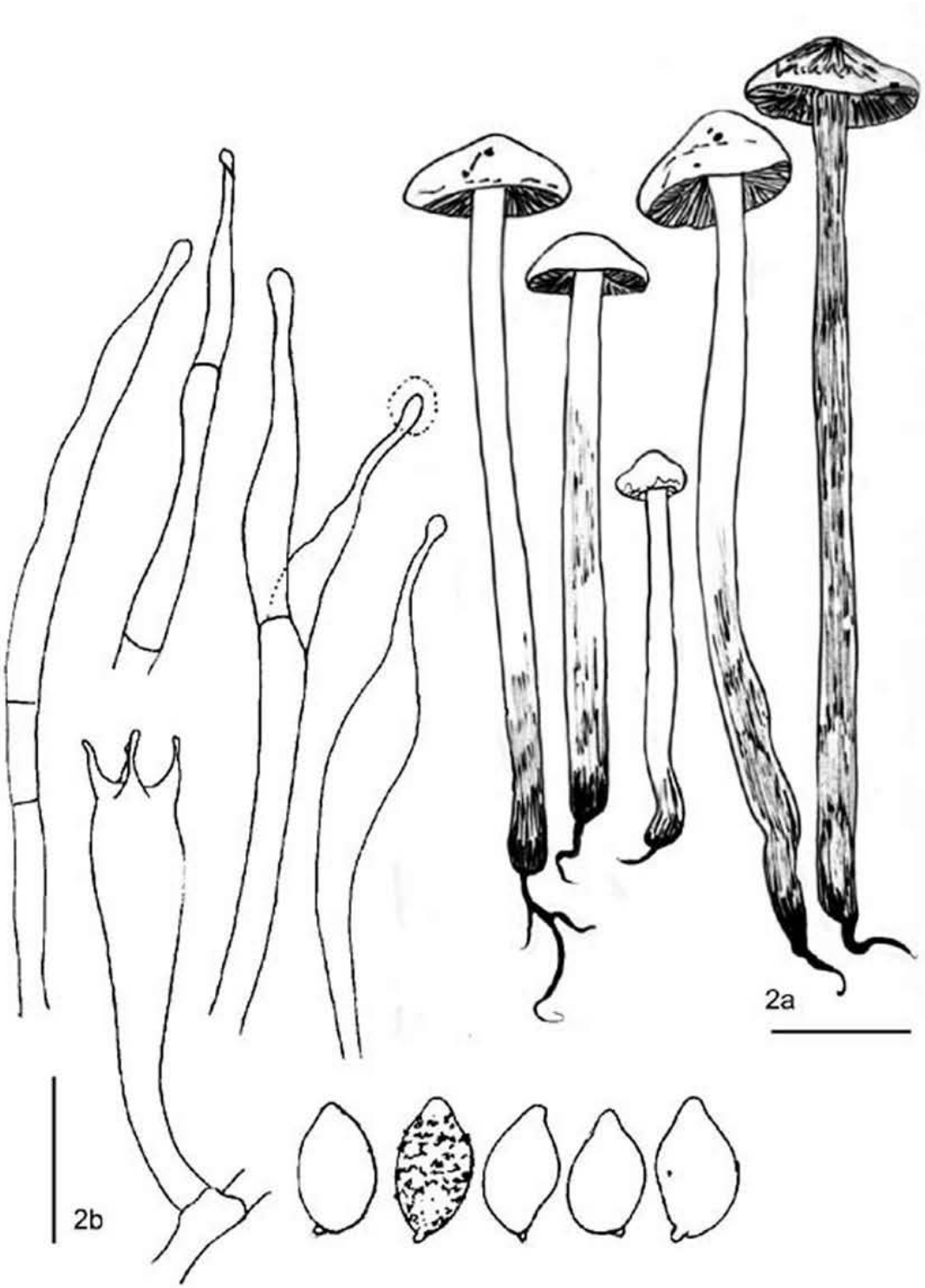

FIGURE 2. *Phaeocollybia rufotubulina* (LLN1921116-01 Holotype WTU; isotypes DAOM, PNW) **2a.** Habit showing sequentially branching cord-like rhizomorphic pseudorhiza. *Scale = 5 cm.* **2b.** Cheilocystidia, basidium, and basidiospores. *Scale = 10 µm.*

collection) and Humboldt, Mendocino, and Marin Counties in California. (For ontogeny and pseudorhizal anatomy, see Norvell 1998b).

A cryptic species previously misidentified as the morphologically similar *Phaeocollybia californica* A.H. Sm., *P. rufotubulina* produces more richly pigmented and strongly ornamented basidiospores, dark orange (not hyaline) concentric encrustations over subtly wider suprapellicular hyphae, a thinner, darker stipitipellis, and more abundant tibiiform cheilocystidia. *P.californica* produces slightly larger, less highly pigmented basidiomes and stipes with thicker cartilaginous cortices lined with long white fibrils

Phaeocollybia rufotubulina and *P. californica* form a complex with another western species, *P. scatesiae* A. H. Sm. & Trappe, previously synonymized with *P. californica* by Horak (1977). All three species share anatomical similarities (basidiospore form and size, cheilocystidia) and possess racemose rhizomorphic pseudorhizae. Molecularly, *P. rufotubulina* is separated by a 10bp length mutation in the ITS region that results in a unique RFLP. *P. californica* and *P. scatesiae*, which have identical RFLP profiles, are differentiated by striking macroscopical and subtle microscopical differences: the densely clustered, highly glutinous *P. scatesiae* basidiomes erupt in fasciculate mounds (usually with scores of tightly clustered basidiomes emanating from single points on subtending rhizomorphic pseudorhizae) rather than in the 'gregarious arcs' of *P. californica*. Additionally, the broadly conic and more sharply umbonate pilei are heavily glutinous and yellowish brown to dark blackish-brown (not subviscid and brownish-orange to orange brown), and the spore prints are a paler brown. Microscopically, *P. californica* is distinguished by its larger, more rounded, darker basidiospores, less abundant cheilocystidia, and 'furred' suprapellicular hyphae (spirally hyaline to pale amber encrusted) with clearly visible, frequently refractive septa. In *P. scatesiae*, the smooth-walled suprapellis hyphae are usually so submerged within a thick gelatinous matrix that individual septa can be seen only with difficulty. *P. scatesiae* is the most widely distributed of the three species, extending from California's Mendocino County the furthest north (to Washington's Olympic peninsula) and farthest inland (to Oregon's Mt. Hood in the Cascades).

Phaeocollybia tibiikauffmanii sp. nov. **FIGURES 3-4**

Pileus usque ad 70 mm latus, conico-campanulatus, umbonatus, viscidus, glaber, fulvus vel brunneo-aurantius; caro crassa, pallida; odor leviter florali vel farinaceus; lamellae subaurantiae, subroseo-brunnescentes e sporis; stipes usque ad 12 mm latus versus apicem, usque ad 230 mm longus cum pseudorhiza attenuata, glaber, farctus, versus apicem lamellis subconcolorus, versus subapicem vinascens. Sporae 7.5–9 × 4.5–5.2 µm, limoniformes, verrculosae vel leviter punctatae cum rostro longo stricto glabro usque ad 1.5 µm et cum apiculo excentrico glabro, cum plaga obscura; ixocutis cum suprapelle subcrassa, gelatinosa, hyalina et subpelle crassa cum pigmento intraparietali, infrequens incrustato; cheilocystidia tibiiformeae cum collo crasse tunicato angusto et capitulae 1.5–3 µm crassae vel infrequens clavata leptosperma hyalina. Hyphae desunt in texturis omnibus. Typus ad terram in silvis mixtis Tsugarum et Pseudotsugarum: L. L. Norvell a2011031ox-01 cum R. L. Exeter (Pedee BLM Reserve Forest Chronosequence transect, Polk County, Oregon, USA). Holotypus OSC; Isotypi WTU, PNW.

Etymology: from 'tibi' (< *tibia* = L. for thigh-bone) relating to its tibiiform (ventricose below and capitate above) cheilocystidia and 'kauffmanii' for its similarity to *P. kauffmanii*.

Selected descriptions and illustrations: Norvell 1998a—color photographs, line drawings; 1998b—black & white micrograP.

Brief summary – Basidiomes solitary to fasciculate, moderately large, slightly farinaceous, deeply rooting; pilei orange tawny to brown, broadly campanulate to reflexed, viscid; young lamellae pale orange yellow to pale buff; stipes slender, pale pinkish cinnamon, stuffed with longitudinally splitting cortex surrounding firm to cottony pith; pseudorhizae vertical-monopodial, frequently fasciculate. Basidiospores medium-sized (8 × 4.5 μm), limoniform, roughened, with prominent, smooth, tapered apical beaks; tibiiform cheilocystidia with refractive, thick-walled necks intermixed with thin-walled lageniform and clavate elements; brownish-orange with diffuse pigments; clamp connections absent. Tissues immediately magenta in syringaldazine. Dried pileus copper-colored, sometimes with deep purple red umbo.

Expanded description — **Pileus** up to 120 mm wide, broadly conic-campanulate with conic to acute low umbo, upturned margin and down-turned straight edge; glabrous, viscid, opaque to slightly hygrophanous, nonstriate; overall brownish orange or foxy brown (*5YR 5/8 – Tawny, Orange Cinnamon*) or with tawny disc and orange cinnamon edge zone, darkening in age (*7.5YR4/2, 10YR 8/4 – Verona, Snuff Brown*). **Context** 4-6 mm at the disc and confluent with stipe pith; color when young pale orangish white (*10YR 9/3*), becoming drab grey in age (*10YR 7/2-6*). **Odor** faintly floral with farinaceous overtones. **Taste** mild, not distinctive. **Lamellae** nearly free, ventricose, thin with ± even edges, polydymous with 3-7 irregularly interspersed tiers, narrow (4-5 mm broad; average length : width ratio = 5.5), close (L+ll/cm = 19 edge, 10 midpoint); color pale orangish buff (*10YR 6-8/6 = Warm Buff*) when young, dull pinkish brown (*5YR 5/6 = Fawn Color*) when mature. **Remnants of primordial sheath** evident as occasional darker fibrillose patches on stipe apex. **Stipe** slightly eccentric, terete, ± equal above, gradually narrowing below toward pseudorhiza; apex 5-12 mm diam, aerial length to 100 mm, combined length with pseudorhiza ≤ 230 mm; glabrous except for darker fibrillose patches, dry, innately longitudinally lined; apex pale to deep pinkish-orange (*7.5 YR 6/5-8; 10YR 7-8/4 = Pinkish Cinnamon, Orange Cinnamon; Warm Buff*), below grading to dull pinkish brown (*5YR 5/6 = Fawn Color*); cartilaginous rind 2 mm thick, splitting longitudinally in age; stipitipith compact fibrillose, orangish white; **Pseudorhizal form** vertical-monopodial, slightly >2/3 overall stipe length, gradually tapering to pointed origin, origin ferruginous to dark brown (*2.5 YR 4/6-8 = Ferruginous, Sanford's Brown*); interior pith firm, brown where water-soaked, otherwise concolorous with stipitipith.

Spore print dull pinkish brown (*Fawn Color, 5YR 4-5/4-6*).

Basidiospores 8 × 4.5 ± 0.3 μm (range 7.5–10 × 4–5.5 μm), limoniform with a protruding beaked apex in profile, fusoid-elliptical in face view, verruculose to punctate roughened except on 0.5-1 μm long beaked apex and eccentric apiculus, suprahilar plage an indistinctly bordered area of lowered ornamentation discernible under oil immersion, orange-amber in KOH, ochraceous in H2O, inamyloid (very young spores still attached to basidia faintly dextrinoid in Melzer's). **Cheilocystidia** abundant, lageniform/tibiiform elements abundant, occasionally diverticulate, necks refractive, thick-walled; capituli usually present; occasional clavate elements intermixed, thin-walled; tibiiform elements 17-32 (50) μm long, branched at or above ultimate and penultimate 2-3 μm diam septa, often swelling above septa to 3-5 μm before narrowing

to 8–15 × 0.5–2 μm necks, necks either thick-walled and refractive or thin-walled, with or without 1.5–3 μm diam capituli, hyaline. **Pleurocystidia** absent. **Basidia** 4-spored, 27–32 × 7–8 μm, hyaline. **Pileipellis** a bilaminate ixocutis; suprapellis 100–120 μm thick, hyphae radially aligned, 2–6 μm diam, highly gelatinized, hyaline, hyphae within the top 50 μm of suprapellis cylindrical, 2 μm diam, closely compacted and collapsed, in lower portion 2–6 μm wide, thin-walled, often inflated, smooth; subpellis 170–200 μm thick, brownish-orange, hyphae 2–8 μm diam, thin-walled, inflated above refractive septa, with diffuse and often encrusting orange pigments, occasional orange oleifers intermixed. **Stipitipellis** hyphae subgelatinized, thin-walled, long, 2–6 μm diam, pale brownish green (diffuse pigments soluble in KOH). **Pseudorhizal pellis** hyphae 2–4 μm diam, gelatinized, dark orange brown. **Tramal tissues** gelatinous, oleifers present throughout; in the pseudorhiza slightly sarcodimitic, "vessel" hyphae infrequent, only slightly thick walled (≤0.5 μm thick), long, 10–20 μm diam; flexuous hyphae abundant, thin-walled, branched, 2–6 μm wide, irregularly inflating; in the stipe and pileus monomitic; in the lamellae hyphae parallel, 65–80 × 3–6 μm, thin-walled, inflated, subgelatinized, hyaline, toward the hymenium narrowing to 2–3 μm diam and giving rise to a rudimentary subhymenium. **Tibiiform diverticula** abundant on mycelium and pseudorhizal pellis, less frequent on fibrillose pellicular remnants on stipe apex, 4–20 × 0.5–1 μm, hyaline. **Clamp connections** absent in all tissues.

Macrochemical reactions—*Syringaldazine* positive (immediately magenta) on all tissues; *KOH* positive (immediately dark brown); *$FeSO_4$* greenish. **Fluorescence**—fresh material not tested; dried lamellae dull yellow orange (one small area in one a brilliant orange yellow)

RFLP profile (Fragmentary data for 1 isolate amplified from outlier Washington collection)—ITS 715 bp; HinfI (395-320) diagnostic, *also cut* in CfoI, EcoR1, NdeI, PvuII; *uncut* in RsaI, XhoI; *data missing* for PalI, SalI.

Ecology, range and distribution: Solitary to closely gregarious in humus under mature second- and old-growth *Tsuga heterophylla, Pseudotsuga menziesii,* and/or *Picea sitchensis* among *Polystichum munitum, Oxalis oregana, Eurhynchium oreganum.* Known from 13 sites (43 collections) in low-lying to montane areas from Oregon's mid-coast to Washington's Olympic peninsula. October to December.

OTHER SPECIMENS EXAMINED UNITED STATES. OREGON: **Benton Co.** *Ex200-283* (PNW); GREEN PEAK BLM DENSITY MANAGEMENT STUDY (123.4551°W, 44.366°N) — PRE-TREATMENT 'CLEARCUT' 2000' 65yo PSME TSHE POMU *g1981124c1-04* LLN RLE TFennell (OSC PNW); 'HIGH RETENTION' 1900' 65yo PSME TSHE POMU *g1991208hx.03* LLN RLE SAR (PNW DAOM), *g2001127hx3* LLN RLE (PNW); KLICKITAT BLM UNIT 3 (TRS: 3s7w21NWSW) — 60yo PSME TSHE GASH 30.X.2000 *Ex200-065* (PNW), 16.XI.2000 *Ex200-252* (PNW); KLICKITAT BLM UNIT 6 (TRS: 3s7w9SWSE) — 50yo PSME TSHE POMU 31X.2000 *Ex200-082,-090* (PNW), 14.XI.2000 *Ex200-187b* (PNW); KLICKITAT BLM UNIT 7 (TRS: 3s7w21NWNE) — 60yo PSME TSHE GASH 30.X.2000 *Ex200-070* (PNW); RUNNING BEAR BLM UNIT (TRS: 13s7w5, 123.5631°W, 44.4686°N) — 200yo PSME TSHE POMU *LLN1981109.108E* RLE (PNW OSC), 6.XI.2000 *Ex200-103* (PNW), 28.X.2002 *Ex2002-16* (PNW). **Lincoln Co.** CASCADE HEAD EF, 100M S TILLAMOOK CO. LINE (123°54'55"W, 45°2'41"N) — late-succ 2nd growth PSME TSHE POMU OXOR *LLN1951109- 19* (WTU PNW); FOGARTY CREEK SP (124.0444°W, 44.8425°N) — mid-succ PISI TSHE *LLN1951109-22* (PNW). **Linn Co.** BLM CASCADE RA KEEL FLATS (TRS: 12s1E23) — PSME BENE POMU 6.XII.1999 *Ex199-BK* by KScott 991206-KF-5-KS1 (PNW OSC). **Polk Co.** MARY'S PEAK RA BLM UNIT (TRS: 9s7w1NENW) — 2000' 200yo PSME TSHE GASH 26.XI.2001 *Ex2001-112,115* (PNW); PEDEE BLM RESERVE CHRONOSEQUENCE STUDY (123.4885°W, 44.7913°N)

FIGURE 3 *Phaeocollybia tibiikauffmanii* (Holotype, a2011031ox-01). Cluster of primarily mature basidiomes excavated in lab to expose origins of vertical pseudorhizae. *Scale = 1 cm.* Inset: Detail showing new primordium (arrow) arising from fungal mass at excavated pseudorhizal origin.

— **50yo** 1900' PSME TSHE POMU 1.XI.2000 *Ex200-091* w LLN (PNW); **150yo** 1770' PSME TSHE POMU *a1981104o1-01 & o2-02-04* LLN RLE CHibbler (PNW), 5.X.2000 *Ex200-045* (PNW), *a2001018o1-15 & o2-25, a2001101o2-30, a2011031o2-03,04,05,06,08 & ox-02, a2011114o1-01,02,03 & ox-01, a2021015o2-01, a2021113o2-01,02,03* LLN RLE (PNW). **WASHINGTON: Clallam Co.** KLAHANIE CMPGRD, OLYMPIC NF (124.3000°W, 47.9613°N) — >250yo PSI TSHE *LLN1921018-04*$_{wps3}$ STrudell (WTU PNW).

Comments A tawny, viscid, conic-campanulate pileus, moderately large size, stuffed tapering stipe, medium-sized punctate-roughened basidiospores, heteromorphic cheilocystidia with thick-walled tibiiform intermixed with thin-walled elements, and lack of clamp connections diagnose *P. tibiikauffmanii*. Its size, pileus color, tapering stuffed stipe, vertical-monopodial pseudorhiza, syringaldazine reactivity, and basidiospore size resemble those of *Phaeocollybia kauffmanii* (A.H. Sm.) Singer, but the presence of thick-walled tibiiform cheilocystidia, differences in pigment topography, and absence of heavily gelatinized, strongly sarcodimitic tissues in the pileal trama clearly separates *P. tibiikauffmanii* from the earlier named species. In the field *P. tibiikauffmanii* is differentiated by its more slender aspect and lack of strongly inrolled pileus edge.

Anatomically, *P. tibiikauffmanii* shares affinities with *Phaeocollybia spadicea* A.H. Sm. and *P. pseudofestiva* A.H. Sm. Young specimens of *P. spadicea* are readily differentiated by their dark to blackish brown pilei lacking orange hues, drab stipes usually covered with recurved, agglutinated, cinnamon-colored fibrillose patches, negative syringaldazine reactivity of the pileus and lamellar tissues, and smaller basidiospores. *Phaeocollybia pseudofestiva* — with similar sized basidiospores, tibiiform cheilocystidia, positive syringaldazine reactivity, pileus shape, and odor — is distinguished by smaller olive-green basidiomes with slightly more prominently beaked basidiospores and lacking thin-walled cheilocystidia.

Molecular data for this species were generated from the single Washington collection, initially thought to represent an orange form of *P. spadicea*. The 715 bp ITS region is much shorter than that estimated for *P. kauffmanii*, and the Cfo1, EcoR1, Hinf1 and Nde2 fingerprints support separation of *P. tibiikauffmanii* from both *P. spadicea* and *P. pseudofestiva*.

Cystidial morphology and Section *Versicolores*

There are two distinct cystidial forms represented in *Phaeocollybia*: thin-walled, ≥2 μm diam, cylindrical / clavate elements versus thick-walled, refractive, narrow-necked (≤ 1 μm diam) lageniform / tibiiform elements. Clémençon does not directly address phaeocollybian cystidia in his treatment of hymenomycete anatomy (Clémençon 1997), but the two cystidial types are similar to those he classifies as lamprocystidia and leptocystidia within the non-secretory alethocystidia. Such cystidial classification is, however, complicated by the fact that most western phaeocollybian cystidia both gelify and appear to serve in a secretory capacity.

A. H. Smith, the first to classify *Phaeocollybia* at the subgeneric level (Smith 1957), divided the genus into two sections — *Phaeocollybia*, for species characterized by thin-walled, clavate cheilocystidia, and *Versicolores*, for species characterized by thick-walled, narrow-necked, lageniform to tibiiform cheilocystidia. After finding

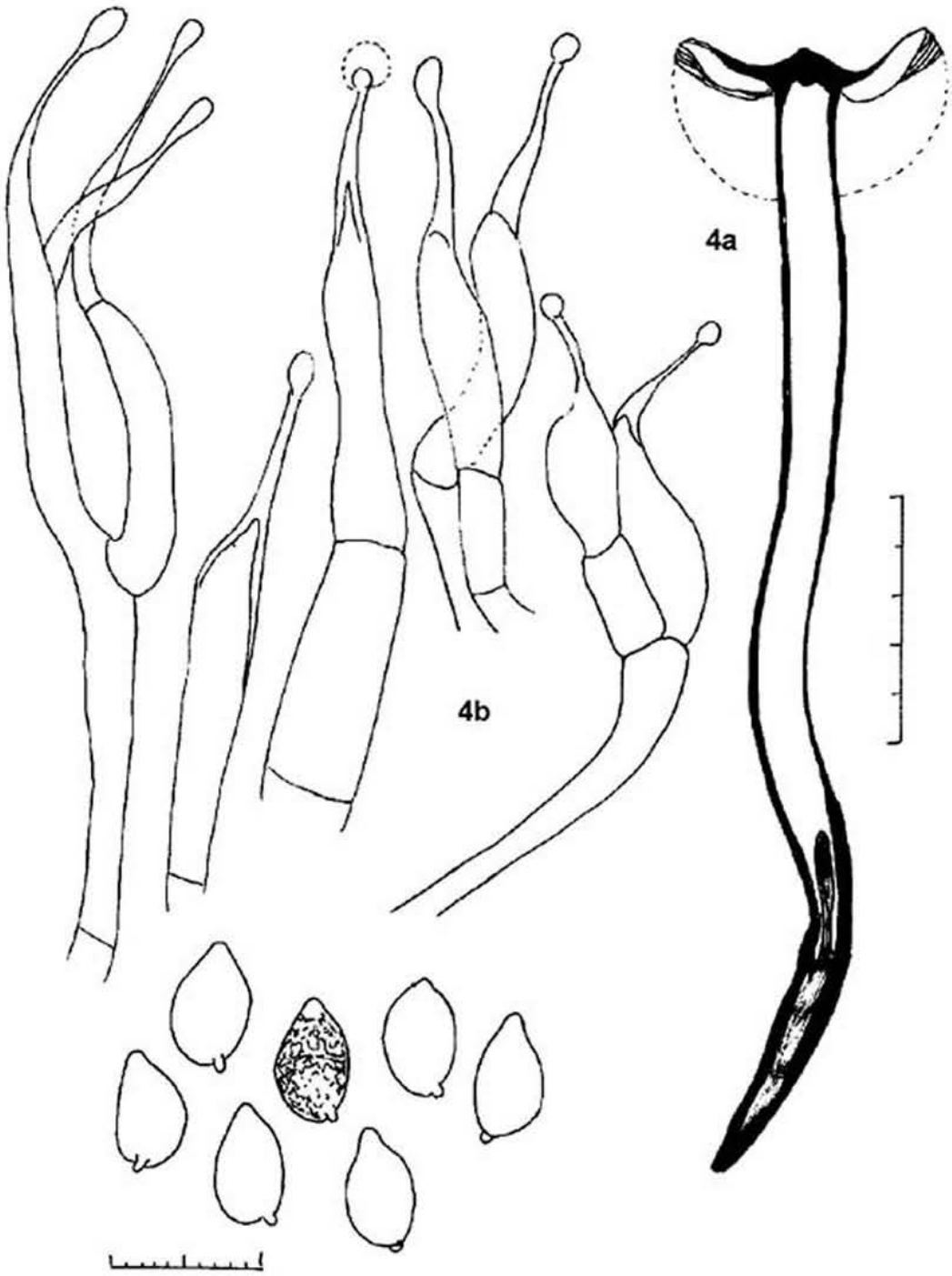

FIGURE 4 *Phaeocollybia tibiikauffmanii* (LLN1951109-19). **4a.** Habit of young basidiome showing lamellar attachment, uplifted pileus, and pseudorhizal form. *Scale = 1 cm.* **4b.** Tibiiform cheilocystidia and basidiospores. *Scale = 10 μm.*

new species from the neotropic western hemisphere, Singer (1970, 1986) revised Smith's sections and added three new ones. Singer separated his sections based on cheilocystidial morphology + basidiospore length + clamp connections:

TABLE 1. *Phaeocollybia* sections sensu Singer 1970, 1986

SECTION	CHEILOCYSTIDIA	BASIDIOSPORE LENGTH	CLAMP CONNECTIONS
Phaeocollybia	clavate to cylindrical	> 6.5 µm	—
Subattenuatae	variable, non-capitate	> 6.5µm	+
Versicolores	acute or apically capitate	> 6.5 µm	—
Radicatae	(sub)capitate	< 6.5 µm	+
Microsporae	variable; oft clavate / cylindrical	< 6.5 µm	—

Most recently, Bandala and Montoya (1994) proposed two subgenera — Subgenus *Phaeocollybia* (with Singer's 'unclamped' sections, *Phaeocollybia, Versicolores,* & *Microsporae*) and Subgenus *Fibulophaeocollybia* (with Singer's 'clamped' sections, *Subattenuatae* & *Radicatae*).

Molecular support for section *Versicolores*

Amplification and enzymatic digestion of the ITS region from 160 isolates representing 27 *Phaeocollybia* species and five out-taxa (Norvell 1998a, 2000, 2002; Norvell & Redhead 2000) revealed nine different ITS lengths within *Phaeocollybia* (Norvell 1998a). Most ITS lengths and restriction fragment length polymorphisms (RFLPs) support morphologically based species hypotheses. Table 2 summarizes ITS lengths, number of restriction sites, and RFLP profiles for eight tibiiform species. Although preliminary cladistic analyses of the data obtained from western North American specimens indicate that taxonomic classification at sectional and subgeneric level is still premature, they do imply at least one monophyletic clade diagnosed by cystidial morphology in *Phaeocollybia*. Seven out of eight species characterized by thick-walled cystidia have isolates with relatively short (<715 bps) ITS regions (TABLE 2). The eighth species (*P. pleurocystidiata*) is, however, characterized by the longer (740 bp) ITS region more commonly found in thin-walled cystidiate species.

While RFLP 'fingerprint' patterns have proved extremely useful for species diagnoses, DNA sequencing should provide more phylogenetically reliable information (*cf.* Norvell 1998a for a discussion of problems associated with inferring phylogenies from RFLP generated data). Cfo1 and EcoR1 RFLP fingerprints for all 160 *Phaeocollybia* isolates show exceedingly subtle differences that are clearly correlated to ITS length variation. EcoR1 halves the ITS regions in *P. californica, P. scatesiae,* and the unallied *P. piceae* A.H. Sm. & Trappe, making the enzyme an effective diagnostic tool, if not a phylogenetically informative one. Hinf1 and Pal1 produce far more informative fingerprints with relatively easily mapped restriction sites. *P. spadicea* isolates have

instantly recognizable RFLP profiles that are unique within the genus (Hinf1) or within the thick-walled clade (Pal1). All isolates within this clade have Pvu2 loci and lack Rsa1 loci. Only *P. spadicea* isolates have Sal1 and only *P. rufotubulina* isolates have Xho1 sites. None of the nine tested enzymes produce data that support separation between the *P. californica* and *P. scatesiae* (both with estimated 700 bp ITS regions), two species that are otherwise clearly anatomically and morphologically distinct.

TABLE 2. RFLP-generated data isolated from tibiiform cystidiate western North American phaeocollybias

Species	ITS	Cfo 1	Eco R1	Hinf 1	Nde 2	Pal 1	Pvu 2	Rsa 1	Sal 1	Xho 1
P. californica *(2)*	700	400 300	350 350	355 345	390	465 140 95	610 90	0	0	0
P. pleurocystidiata *(4)*	740	420 320	390 350	390 350	405	**450** **190** **100**	630 80 30	0	0	0
P. pseudofestiva *(4)*	700	400 300	360 340	365 335	405	440 165 95	605 95	0	0	0
P. radicata *(2)*	710	400 310	380 330	390 320	—	**480** **120** **100**	—	—	0	—
P. rufotubulina *(6)*	**690**	400 290	370 320	365 325	400	435 160 95	600 90	0	0	**1**
P. scatesiae *(9)*	700	400 300	350 350	355 345	390	465 140 95	610 90	0	0	0
P. spadicea *(13)*	710	410 300	375 335	**395** **125** **110 80**	**275**	480 120 110	615 95	0	**1**	0
P. tibiikauffmanii *(1)*	715	405 310	380 335	390 325	410	—	625 90	0	—	0

Numbers in each species cell = number of isolates tested. Numbers elsewhere = fragment lengths (in base pairs) estimated per RE (ITS, Cfo1, EcoR1, Hinf1, Nde2, Pal1, PVU2) or number of restriction sites (Rsa1, Sal1, Xho1). RFLP profiles in gray boxes are unique for the 25 *Phaeocollybia* species tested (Norvell1998a); only the top band is given for Nde2. Isolates not cited elsewhere include *Ph. californica* —HOLOTYPE AHSmith55610cal2 (CA) (MICH); *Ph. pleurocystidiata*—HOLOTYPE LLN1940330-02ple1 (WA), LLN1930516-01ple2 (OR), MTSeidl 914ple3 (CA), DAOM128270ple4 (CA) (DAOM); *Ph. pseudofestiva* —LLN1921116-02pse1* (CA), LLN1921121-01pse6 (CA), LLN1911123-02pse8* (OR), LLN1921123-8pse11(CA); *Ph. radicata*—AHSmith3763rad2 (CA) (MICH); *Ph. scatesiae*—LLN1931104-09sca1 (OR), ISOTYPE KScates1136sca2 (OR), LLN1921104-14sca3 (OR), LLN1921123-01sca4 (CA), LLN1921015-19*sca5 (WA), LLN1921015-16*sca5 (WA), HOLOTYPE AHSmith 79286*sca6 (OR) (MICH11630), LLN1931104-02sca7 (OR), CGoetz33sca9* (OR); *Ph. spadicea*—LLN192.11.02-03spd1 (OR), LLN1931023-06spd2 (OR), LLN1921015-26spd3 (WA), LLN1941106-24spg4 (OR), LLN1931104-04sps4 (OR), LLN1921110-22spd5 (OR), LLN1931104-06sps5 (OR), LLN1931114-07spd6 (OR), LLN1931023-07spd7 (OR), LLN1921120-02sps6 (CA), LLN1931114-13spd8 (OR); LLN1921031-03spd4 (WA), [DAOM] LLN1921015-10sps1 (WA). Four additional *Ph. pseudofestiva* isolates from Washington and British Columbia with subtly different banding patterns were not included in cladistic analyses. Collections at WTU unless otherwise noted.

Morphological characters have been mapped onto an unrooted Fitch-Margoliash + Neighbor-joining consensus tree generated from ITS length and restriction site data from 24 *Phaeocollybia* species and *Stagnicola perplexa* (Orton) Redhead & A. H. Sm. (*Figure 5*). Six out of eight 'tibiiform' Pacific Northwest phaeocollybias—*P. californica, P. pseudofestiva, P. radicata, P. rufotubulina, P. scatesiae,* and *P. spadicea*—occur in one clade. Molecular data for *P. tibiikauffmanii* were too fragmentary to include

in the analyses. The eighth species, *P. pleurocystidiata*, is unique among western phaeocollybias in its possession of abundant thick-walled tibiiform pleurocystidia. Its additionally distinct vernal phenology (exhibited by only one other western species, *P. phaeogaleroides* Norvell) suggests a possible source for genetic isolation from the seven other thick-walled species, all autumnal fruiters.

The four species at the tips of the autumnal 'tibiform' clade in Figure 5 have subtending, branching, cord-like rhizomorphic pseudorhizae and stipes that soon become hollow. Among other western Phaeocollybias, only *Phaeocollybia dissiliens* A. H. Sm. & Trappe and *P. sipei* A. H. Sm. (also hollow stiped) have been confirmed with cord-like pseudorhizae. Both *P. spadicea* and *P. tibiikauffmanii* (as well as the out-lying *P. pleurocystidiata)* produce basidiomes characterized by vertical monopodial pseudorhizae and stipes always stuffed with firm to spongy pith. Somewhat more problematical is placement of *P. radicata*, which is characterized by clamp connections and extremely small ellipsoid spores. Here molecular data, obtained from only one isolate, were fragmentary and conclusions regarding the place of *P. radicata* within the clade must be considered premature.

Restriction site data do support a clade diagnosed by thick-walled morphology (*Figure 5*). Exclusion of the vernal *Phaeocollybia pleurocystidiata* from that clade, however, challenges Section *Versicolores* as circumscribed by both Smith (1957) and Singer (1970, 1986). Inclusion of the clamped *P. radicata* in the clade likewise challenges Section *Versicolores* as revised by Singer (1970, 1986, 1987) and accepted by Bandala and Montoya (1994). Recent phylotrees containing *Phaeocollybia* sequence data (from the ITS region in Rees et al., 2002, and large ribosomal subunit in Moncalvo et al., 2002, and Rees et al., 2003) offer little insight into sectional relationships within the genus. The phylogeny generated by Moncalvo et al. (2002) from 877 homobasidiomycete taxa (including four north temperate phaeocollybias) recognizes the /phaeocollybia clade in 'euagarics incertae sedis'. The phylotree also supports separation of subgenera *Phaeocollybia* and *Fibulophaeocollybia* as defined by Bandala and Montoya (1994), placing the 'clampless' *P. attenuata* & *P. redheadii* (Section *Phaeocollybia*) and *P. jennyae* A. H. Sm. (Section *Microsporae*) apart from the 'clamped' *P. dissiliens* (Section *Radicatae*). Rees et al. (2002) included two southern hemisphere representatives—*P. ratticauda* E. Horak (Section *Microsporae*) and *P. graveolens* B. J. Rees & Syme (Section *Radicatae*)—in their preliminary phylogeny of *Gymnopilus* species and related genera, while Rees et al. (2003) included sequences from the south temperate *P. ratticauda* and north temperate *P. jennyae* in their phylogenetic analyses of 78 species from brown-spored genera. While all three phylogenies imply monophyly for *Phaeocollybia*, the omission of taxa representing sections *Subattenuatae* and *Versicolores* leaves the Smith (1957) and Singer (1970, 1986) sectional hypotheses untested. Given the preliminary nature of current molecular analyses, revision of phaeocollybian subgeneric taxa awaits analysis of sequence data representing all five 'traditional' sections from both hemispheres.

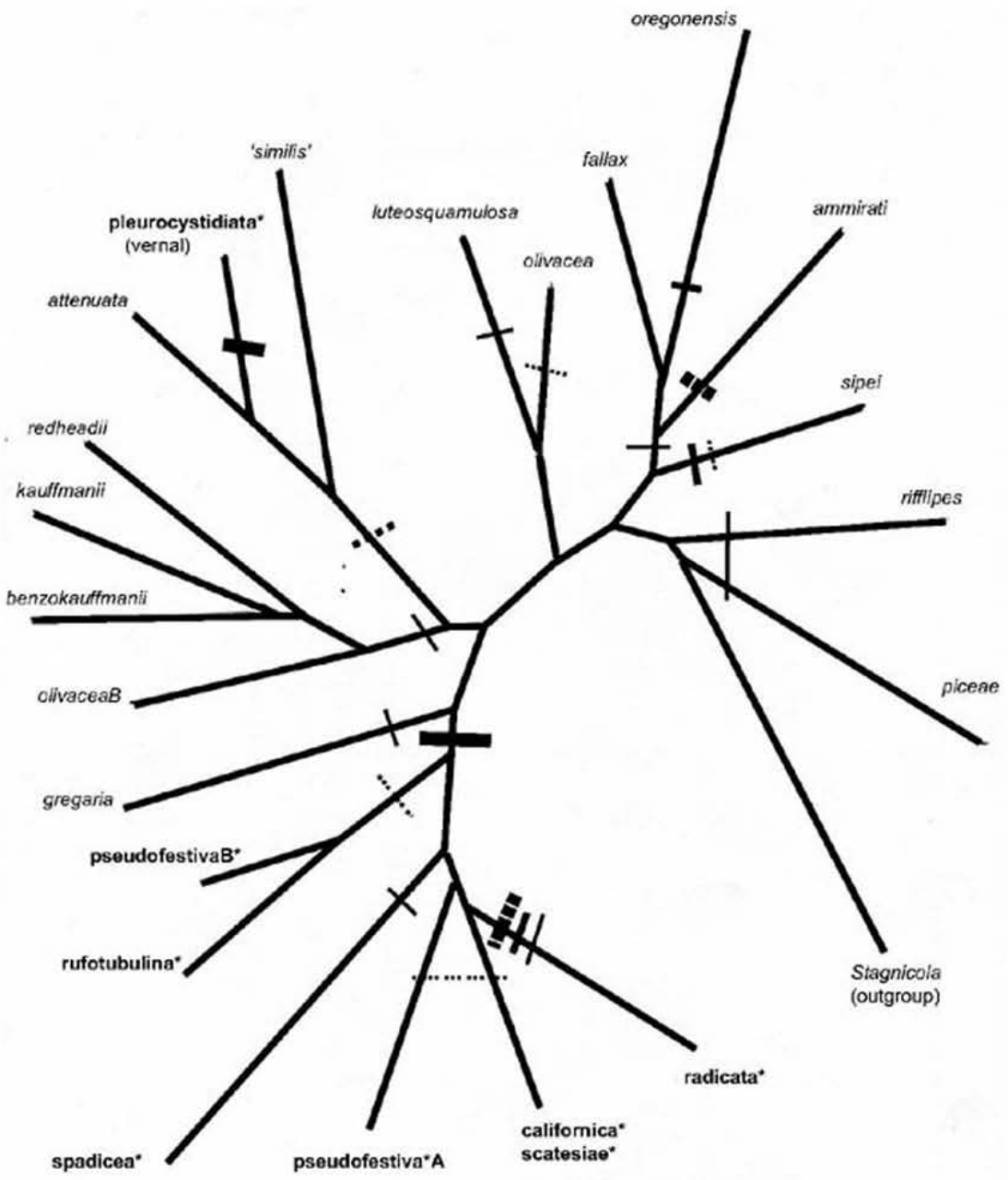

FIGURE 5 Phylogenetic relationships of 8 tibiiform cystidiate species (bold starred) among themselves and 15 other western *Phaeocollybia* species and the outgroup, *Stagnicola perplexa*, are shown in an unrooted consensus tree generated from Fitch-Margoliash + Neighbor trees derived from ITS lengths and estimated Cfo1, Hinf1, Pal1, Pvu2, Rsa1, Sal1 and Xho1 restriction sites in 150 isolates. Important missing Pal1 and Sal1 data from the only representative tested prevented inclusion of *P. tibiikauffmanii* (not shown), while *P. radicata* (shown) was mapped from suspect molecular data. Sectional diagnostic characters noted above include CYSTIDIAL FORM (heavy bar = thick-walled tibiiform cheilocystidia), CLAMP CONNECTIONS (heavy dashed bar), and SPORE MORPHOLOGY (medium solid bar = small ellipsoid punctate). Lines map differing PSEUDORHIZAL MORPHOLOGIES (solid = vertical monopodial; narrow-dashed = racemose; wide-dashed = criniform lateral-monopodial).

Removal of *Phaeocollybia olivacea* from Section *Versicolores*

One final observation should be made with respect to tibiiform cystidia. Smith (1957), noting their rarity in other genera, felt that refractive, thick-walled, narrow-necked cystidia represented a recently derived form in *Phaeocollybia*. Given their morphological similarity to the generically significant tibiiform diverticula that are an integral part of the primordial pellicular sheath (Norvell 1998ab), however, it seems equally possible that such elements are plesiomorphic and thin-walled cheilocystidia are derived. If so, then thin-walled more or less clavate cheilocystidia could be regarded as modified extensions of the central hyphae in the lamellar trama that have evolved to assume the same secretory functions as their refractive, thick-walled antecedents.

While many western phaeocollybias appear to possess only one cystidial type, others (e.g. *P. rufotubulina, P. spadicea, P. tibiikauffmanii)* possess both thick-walled lageniform/tibiiform narrow-necked elements and thin-walled clavate elements. Smith (1957) noted that *Phaeocollybia olivacea* A.H. Sm.—which he described as having thin-walled cystidia—also tends to develop thick-walled 'forerunners'. Bandala and Montoya (1994), who also observed thick-walled elements when they examined the holotype, used this to support their transfer of *P. olivacea* into Section *Versicolores*. My examination of all *P. olivacea* type specimens (Norvell 1998ab), however, uncovered only one specimen bearing heteromorphic cheilocystidia. In that specimen, the far more abundant thin-walled clavate elements were sporadically topped with long thin extensions that were even more rarely capitulate. Thickening of cystidial walls in this specimen was even more rare. I regard the extensions atop the thin-walled elements in this specimen as apical regenerations of innately thin-walled elements—a condition frequently found in old or improperly stored phaeocollybias with thin-walled cheilocystidia (Norvell 1998ab).

Here the infrequent occurrence of thickened walls—again found very rarely in only one type specimen of *P. olivacea*—is more significant than the slightly more numerous presence of narrow-necked (but thin-walled) extensions. In any case, present RFLP data (Norvell 1998a; Figure 5) support exclusion of *P. olivacea* from the thick-walled clade and thus from Section *Versicolores s. a.*

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Trechinothus smardae gen. et comb. nov., un champignon corticioïde à chlamydospores moriformes

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Abstract—*Trechinothus* gen. nov. is proposed to accommodate *Tomentella smardae* recently found again in the Czech Republic and in France. This species is characterized by the echinulate spores with the ornamentation that mostly develops in later stages of spore maturation, the hyphae frequently ampullate at the septa and becoming ochraceous next to the substrate, the absence of any cyanophilous reaction, and the presence of numerous blackberry-shaped chlamydospores in subiculum and on rhizomorphs.

Résumé—*Trechinothus* gen. nov. est proposé pour accueillir *Tomentella smardae*, retrouvé récemment en République Tchèque et en France. Cette espèce est caractérisée par des spores échinulées dont l'ornementation ne se forme entièrement qu'en état avancé de maturation, des hyphes fréquemment ampullacées aux cloisons et qui deviennent ocrées vers le substrat, l'absence totale de réaction cyanophile et la présence de nombreuses chlamydospores moriformes dans le subiculum et sur les rhizomorphes.

Introduction

Un heureux hasard nous a conduits, presque simultanément, à examiner séparément deux récoltes distinctes de l'espèce que nous allons décrire ci-après. L'un de nous (Martini) a eu l'occasion, pour sa part, d'étudier l'holotype de *Tomentella smardae* Pilát, lors d'une visite à l'herbier mycologique de Prague (PRM). Trichies, quant à lui, se voyait confronté à une récolte personnelle dont les caractères lui semblaient alors suffisants pour définir une espèce nouvelle pour la science. La comparaison fortuite de nos observations respectives nous a promptement révélé l'identité spécifique de nos deux spécimens. Dès lors, nous nous sommes appliqués, de conserve, à leur trouver un genre d'accueil satisfaisant.

Ces deux exemplaires montrent un développement quelque peu divergent. Par son basidiome aranéeux, un peu pelliculaire, et ses basides atteignant à peine 25 μm,

l'échantillon français évoque indéniablement la structure de certaines espèces du genre *Trechispora* P. Karst. La récolte-type, par contre, rappelle plutôt *Leptosporomyces fuscostratus* (Burt) Hjortstam par son hyménophore plus consistant, membraneux, fragile et séparable du subiculum; elle produit, par ailleurs, des basides près de deux fois plus longues. Par chance, un troisième spécimen attribué à cette même espèce nous a été aimablement transmis par le professeur Zdeněk Pouzar: son développement, sensiblement intermédiaire entre les deux précédentes, nous a permis de supposer que les différences observées à cet égard n'étaient dues probablement qu'à des états distincts de maturation.

Après un examen comparatif approfondi des taxons génériques et spécifiques montrant le plus d'affinités avec *T. smardae*, nous sommes arrivés à la conclusion qu'aucun des genres publiés jusqu'à ce jour ne convenait pleinement à cette espèce et qu'il fallait envisager la création d'un genre nouveau. En conséquence, nous proposons l'adoption de *Trechinothus* gen. nov.

Méthodes

Le matériel sec a été observé à l'aide d'un microscope binoculaire à un grossissement de x 10 en utilisant une source de lumière halogène à fibres optiques. Les couleurs sont codifiées à l'aide du code couleur de Munsell (1975).

Les observations microscopiques ont été faites à partir de petits fragments prélevés à l'aide d'une aiguille ou d'une lame de rasoir, puis montés dans une solution aqueuse de KOH à 2%, dissociés par pression et finalement remontés dans l'acide lactique à 10%. Les mesures ont toujours été effectuées à un grossissement de x 1250 dans ce dernier milieu, celles des spores sont données sans inclure ni l'apicule ni les ornementations. L'observation de l'ornementation des spores à été faite à x 1875. Nous avons observé le matériel dans le bleu coton, le melzer, le bleu de crésyl, le rouge Congo ammoniacal et la solution potassique de phloxine. Des préparations permanentes ont été faites dans l'acide lactique, après dissociation des prélèvements dans une solution aqueuse de potasse. Les dessins ont été effectués à l'aide d'un microscope Nikon Optiphot muni d'un tube à dessiner.

Description

Trechinothus E. C. Martini et Trichies, gen. nov.

Ab Trechispora P. Karst. differt propter sporas ab initio laeves cum parietibus cito crassioribus, magnitudine ultima circiter pervenienti echinulatas.

Etymologie: contraction de l'élément trechi- (allusion au genre voisin *Trechispora*) et du suffixe nothus (faux, bâtard, hybride).

Type du genre: *Tomentella smardae* Pilát

Trechinothus smardae (Pilát) E. C. Martini et Trichies, comb. nov.

Basionyme: *Tomentella smardae* Pilát, Studia Botanica Čechica 5 (1-2) : 75 et tab. X (1942)

Basidiome athélioïde, d'abord aranéeux, moelleux, faiblement pelliculaire, séparable, puis s'épaississant et alors mieux différencié entre strate hyméniale et subiculum. **Hyménium** au début discontinu, poruleux, blanc, blanchâtre (10YR 8/3), enfin continu, compact, membraneux, crustacé et fragile, jaunâtre pâle (2.5YR 8/4) à faiblement ocré (10YR-2.5Y 7/3-4), mesurant jusqu'a 0.2 mm d'épaisseur, facilement séparable du subiculum par petits morceaux, lisse ou rehaussé de petits collicules hémisphériques épars ou plus rapprochés et mesurant jusqu'à 0.2 mm de diamètre. **Subiculum** lâche, hypochnoïde, de couleur claire dans les parties les moins développées, devenant vite écru (10YR 7/2) à gris brun (10YR 5/2) ou un peu plus ocré. **Marge** peu différenciée, déterminée et nette, ou stérile et aranéeuse, et même fibrilleuse ou byssoïde, blanchâtre à beige clair, parfois épaissie et concolore au subiculum. **Rhizomorphes** fréquents à la base du subiculum et dans le substrat sous-jacent, plus rares à la marge, beige clair, minces, jusqu'à 0.1-0.2 mm d'épaisseur, occasionnellement fusionnés et en éventail, atteignant alors 0.4 mm de diamètre.

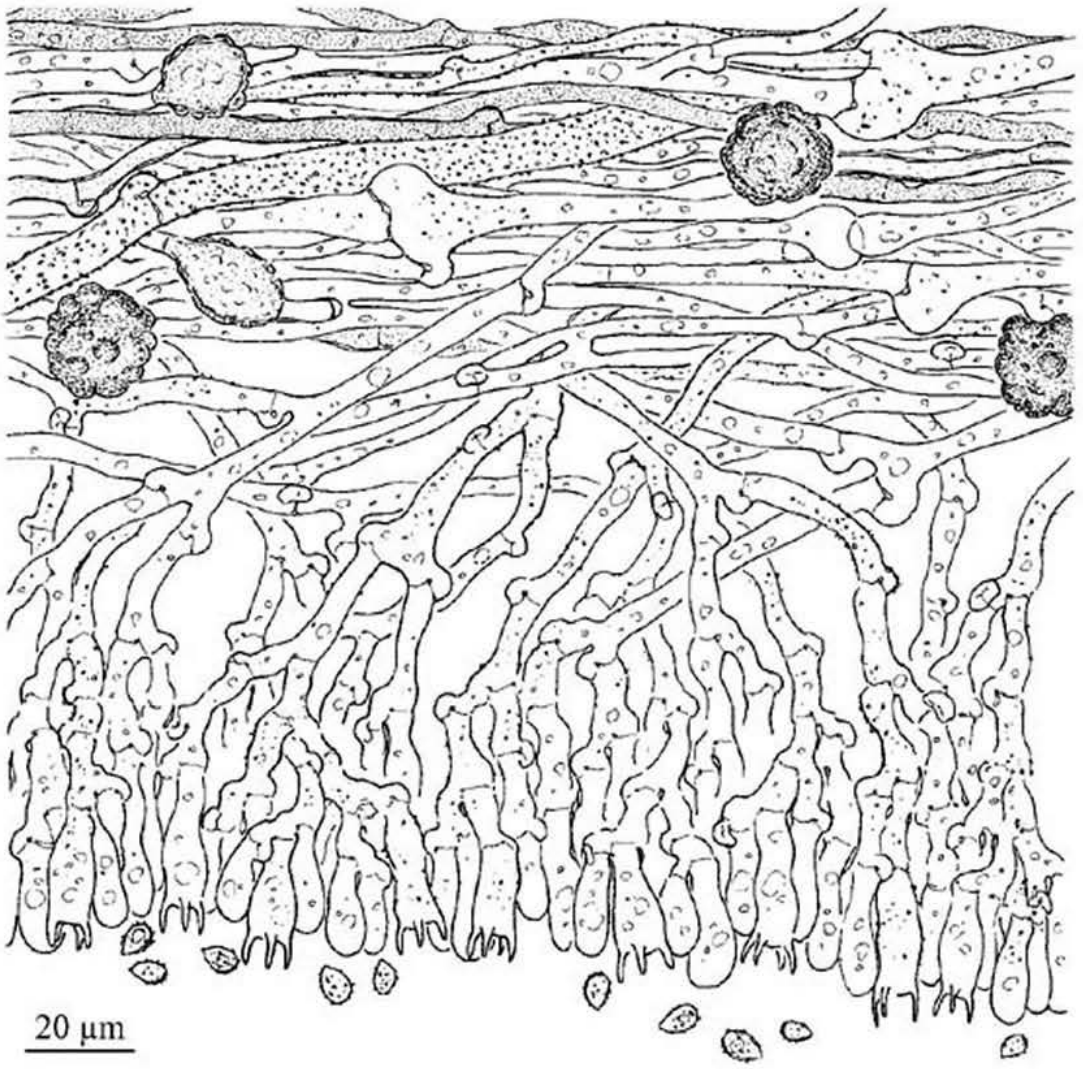

Fig. 1. *Trechinothus smardae*. Section verticale du basidiome, coll. GT 03 092

Chlamydospores facilement visibles au stéréomicroscope comme ponctuations noirâtres dans le subiculum et sur les rhizomorphes.

Système hyphal monomitique. **Hyphes subhyméniales** à articles relativement courts, plus ou moins régulièrement calibrées, mesurant (3) 4-6 (7) μm de diamètre, constamment bouclées aux cloisons, à paroi mince, hyalines, fréquemment ramifiées à partir des boucles, constituant finalement un tissu très compact. **Hyphes subiculaires** très peu cohérentes, à articles généralement longs et de diamètre assez régulier, (2.5) 4-8 (9) μm, mais fréquemment élargies ou nettement ampullacées aux cloisons jusqu'à 13 (18) μm, constamment bouclées, à paroi mince ou un peu épaissie, hyalines ou subhyalines à ocrées. **Rhizomorphes** relativement lâches, avec structure homogène, constitués par un seul type d'hyphes semblables aux subiculaires.

Basides variant sensiblement selon les récoltes: subcylindriques à faiblement claviformes, plutôt trapues et mesurant 15-25 x (5) 7-9 (10) μm dans GT 03 092; subcylindriques à plus nettement claviformes et atteignant 25-40 x 8-10 μm dans PRM 894976; de même forme, voire un peu sinueuses et légèrement plus longues, 30-45 x 8-10 μm dans le type; munies de (2) 4 forts stérigmates à peine arqués mesurant 6-9 μm de longueur et 1.5-2.5 μm de largeur à la base. Basidioles courtement claviformes.

Spores plus ou moins allongées, larmiformes à ovoïdales mais le plus souvent ellipsoïdales, amincies vers l'apicule proéminent, mesurant (5.5) 6-9 (9.5) x 4-6 (6.2) μm, au début lisses ou presque, avec paroi épaissie, ornées à maturité par des aiguillons émoussés ou des verrues régulièrement et assez densément répartis de dimension et de forme assez variables, plus ou moins hémisphériques ou coniques ou subcylindriques, hauts jusqu'à 0.8 (1.5) μm, sans plage lisse sur le côté adaxial, hyalines à faiblement jaunâtres.

Chlamydospores nombreuses dans le subiculum et sur les rhizomorphes, se formant initialement comme cellules ellipsoïdales à globuleuses, sur certaines hyphes assez étroites ou à leur extrémité; d'abord lisses et hyalines mais vite avec paroi épaissie et stratifiée, de couleur jaune à ocre, puis progressivement recouvertes par du matériel résinoïde rouge brun en forme de bulles disjointes ou contigües, de plus en plus grosses, constituant à terme des corps arrondis ou plus rarement ellipsoïdaux, moriformes, de couleur brun foncé, mesurant 18-25 μm de diamètre et jusqu'à 30 (40) x 20 μm pour les exemplaires allongés.

Incrustation: nombreuses hyphes du subiculum et des rhizomorphes (parfois aussi quelques hyphes subhyméniales et quelques basides), fortement à éparsement incrustées par des granules irréguliers, permanents en KOH.

Réactions chimiques: aucun élément cyanophile ni amyloïde.

RÉCOLTES EXAMINÉES — FRANCE, **Meuse**: Billy-sous-Mangiennes, Bois du Blanc Estoc, sur tronc mort cortiqué d'*Alnus glutinosa* et sur la base d'un basidiome vivant de *Ganoderma lipsiense* (Batsch) G.F. Atk., 15.IX.2003, leg. G. Trichies (herb. privé G. Trichies, GT 03 092) — RÉPUBLIQUE TCHÈQUE, **Moravie**: Kuřim, [ad ramulum dejectum putridumque quercinum], 20.X.1941, leg. F. Smarda (**holotype**, PRM 703743); **Bohème centrale**: Karlštejn, in colle Velká hora, declive merid., *Fraxinus excelsior* (ramus iacens) et *Cornus mas* (trunc. vivus), 15.XII.2000, leg. Z. Pouzar (PRM 894976)

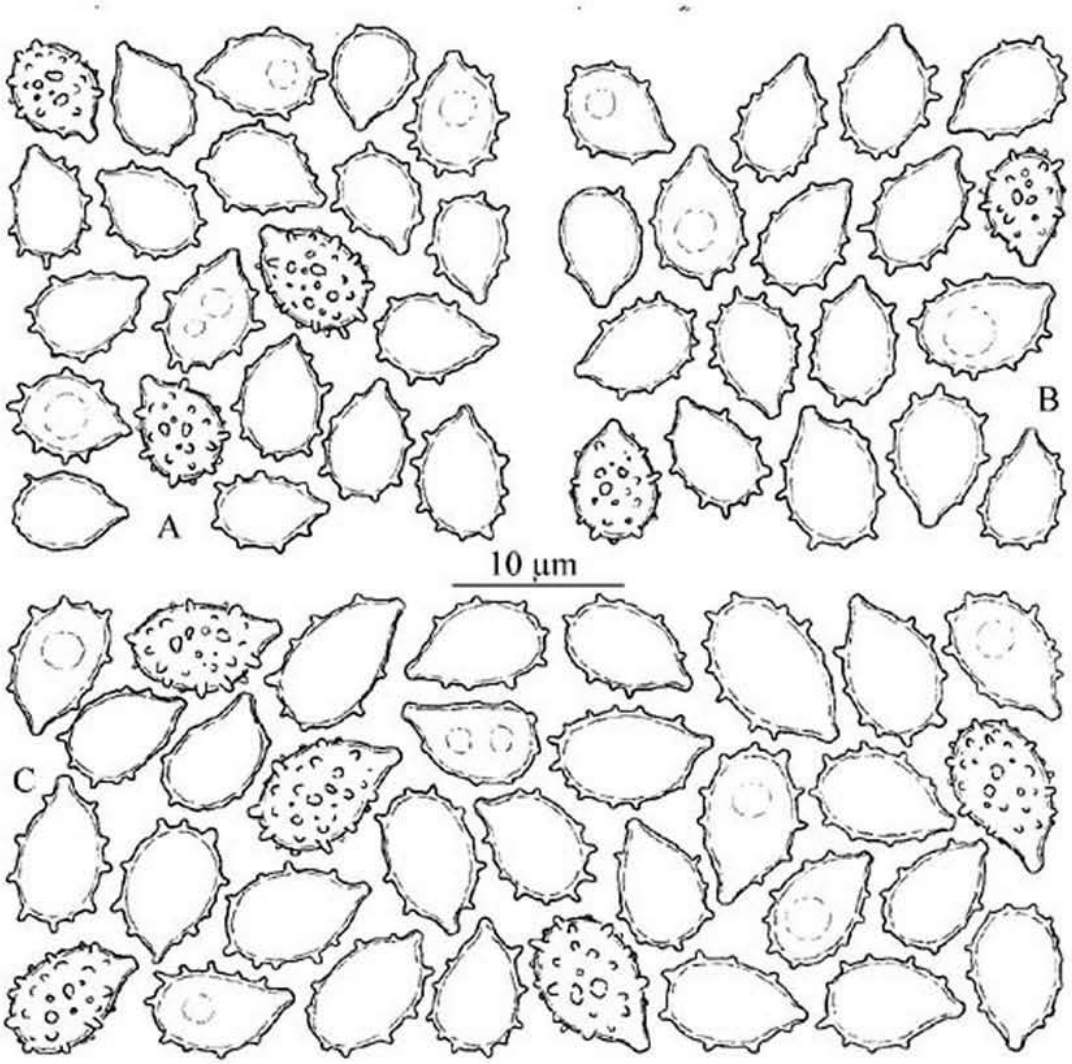

Fig. 2. *Trechinothus smardae*. Spores. **A**. coll. GT 03 092; **B**. coll. PRM 894796; **C**. coll. PRM 703743 (holotype)

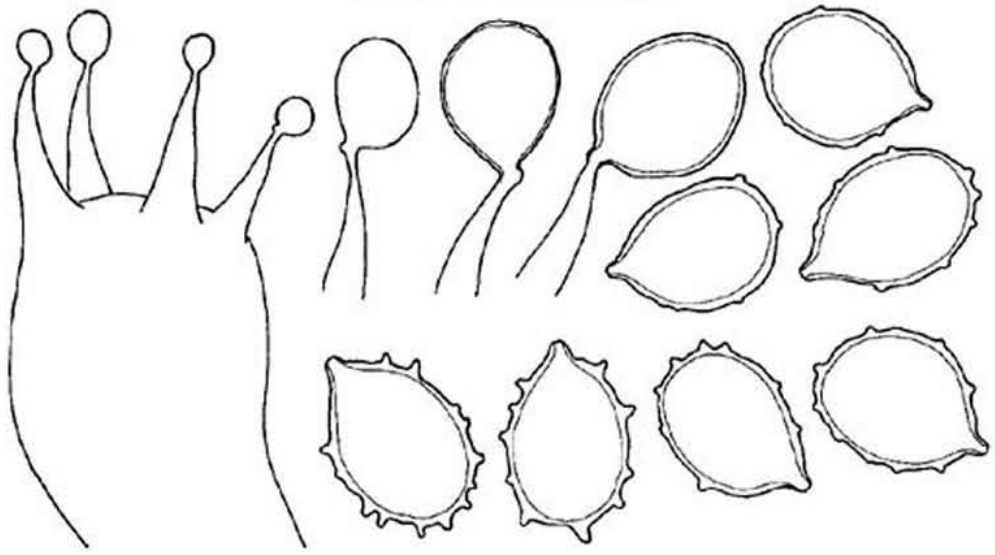

Fig. 3. *Trechinothus smardae*. Ontogenèse de la formation des spores et de son ornementation

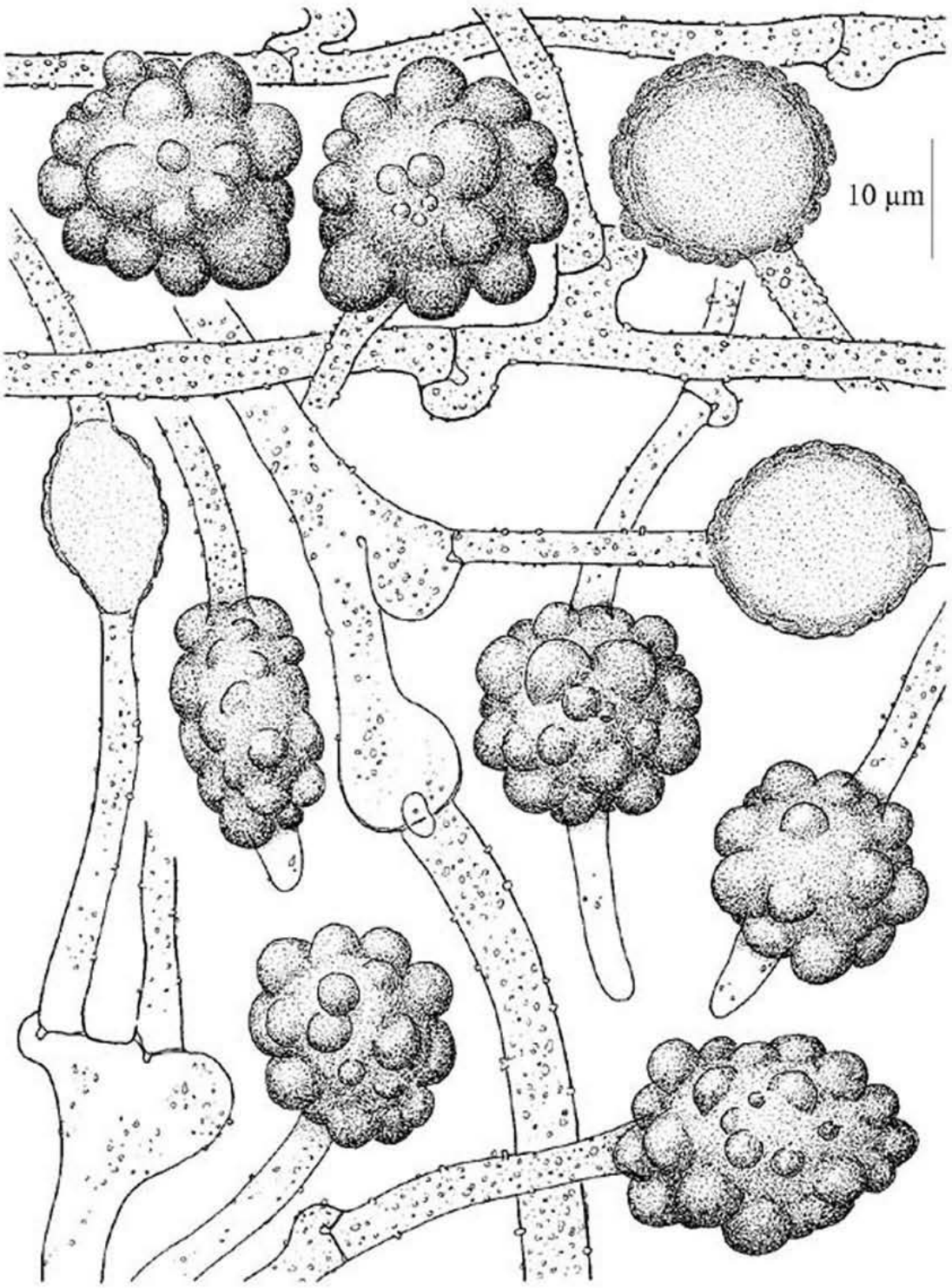

Fig. 4. *Trechinothus smardae*. En haut, trois chlamydospores et hyphes de PRM 703743 (holotype); les autres de la coll. GT 03 092

Discussion

Après la description originale de Pilát, en 1942, nous n'avons pu trouver dans la littérature aucune autre citation de *Tomentella smardae*, hormis une courte note de Liberta (1973) et une autre de Larsen (1974). Le premier auteur mentionne cette espèce, en relation avec *Trechispora polyporoidea* (Berk. & M.A. Curtis) Liberta, qu'il place parmi les espèces exclues de ce genre. Le second la situe aussi à proximité de *Corticium polyporoideum* Berk. & M.A. Curtis (la même note de Larsen se trouve également sur un feuillet daté du 4.IV.1971 et inséré dans l'enveloppe du type de *T. smardae*). Par la suite, ce même *C. polyporoideum* a été transféré dans le genre *Ramaricium* par Ginns (1979) et nous disposons, pour cette espèce, des descriptions de Jülich (1974), de Jung (1987) et de Burdsall (1971) ainsi que des notes de Petersen (1971) qui signalent unanimement des basides pédicellées, une ornementation des hyphes et des spores fortement cyanophile (cette réaction étant plus faible sur les parois correspondantes), des hyphidies dans l'hyménium et enfin, des hyphes basales toujours hyalines et grêles. Nous pouvons donc raisonnablement exclure toute affinité particulière entre *T. smardae* et *R. polyporoideum*.

Trechinothus smardae est un champignon résupiné corticioïde qui concentre certains caractères remarquables mais que l'on peut retrouver aussi, éparpillés çà et là, dans plusieurs autres genres de différentes familles.

En premier lieu, il faut noter la production des nombreuses chlamydospores, phénomène exceptionnel dans les corticiés. Qui plus est, celles-ci ne sont pas de forme banale et nous n'avons connaissance de cellules ornées similaires que dans *Pseudotomentella rhizopunctata*, que Martini et Hentic (2003) viennent de créer, et qui présentent une ornementation craquelée en plaques disjointes. Certaines espèces appartenant à *Sarcodon*, *Hydnellum* et *Phellodon*, produisent également des chlamydospores aux formes singulières et celles de *T. smardae* ne sont pas tellement différentes, à ce point de vue, de celles d'*Hydnellum peckii* Banker dont les bosses sont polygonales et non hémisphériques (Agerer, 1993). Nous sommes intrigués par cette similitude, mais nous n'avons pourtant trouvé aucun autre argument pour établir une quelconque relation de parenté entre *T. smardae* et les *Thelephoraceae* ou les *Bankeraceae*.

Quant aux hyphes ampullacées à de nombreuses cloisons, leur existence est signalée également dans bien d'autres genres qui ne révèlent, dans certains cas, aucun lien de parenté: *Hydnocristella*, *Kavinia*, *Lindtneria*, *Ramaricium*, *Scytinopogon*, *Sistotrema* ou surtout *Trechispora*. Ce caractère est, en tout cas, très intéressant parce que stable dans les espèces qui en sont pourvues. Parfois, la présence de ces hyphes ampullacées aux cloisons se limite aux rhizomorphes ou bien, elles se montrent rares; dans *T. smardae* elles sont manifestement fréquentes, aussi bien dans le subiculum, que dans les rhizomorphes.

Les espèces du genre *Trechispora* sont celles qui révèlent le plus de similitude avec *T. smardae* et nous avons envisagé clairement son rattachement à ce genre. Ainsi, dans *Trechispora*, il n'est pas rare de découvrir aussi des organes asexués comme des blastoconidies ou des arthroconidies; les hyphes ampullacées y sont fréquentes dans

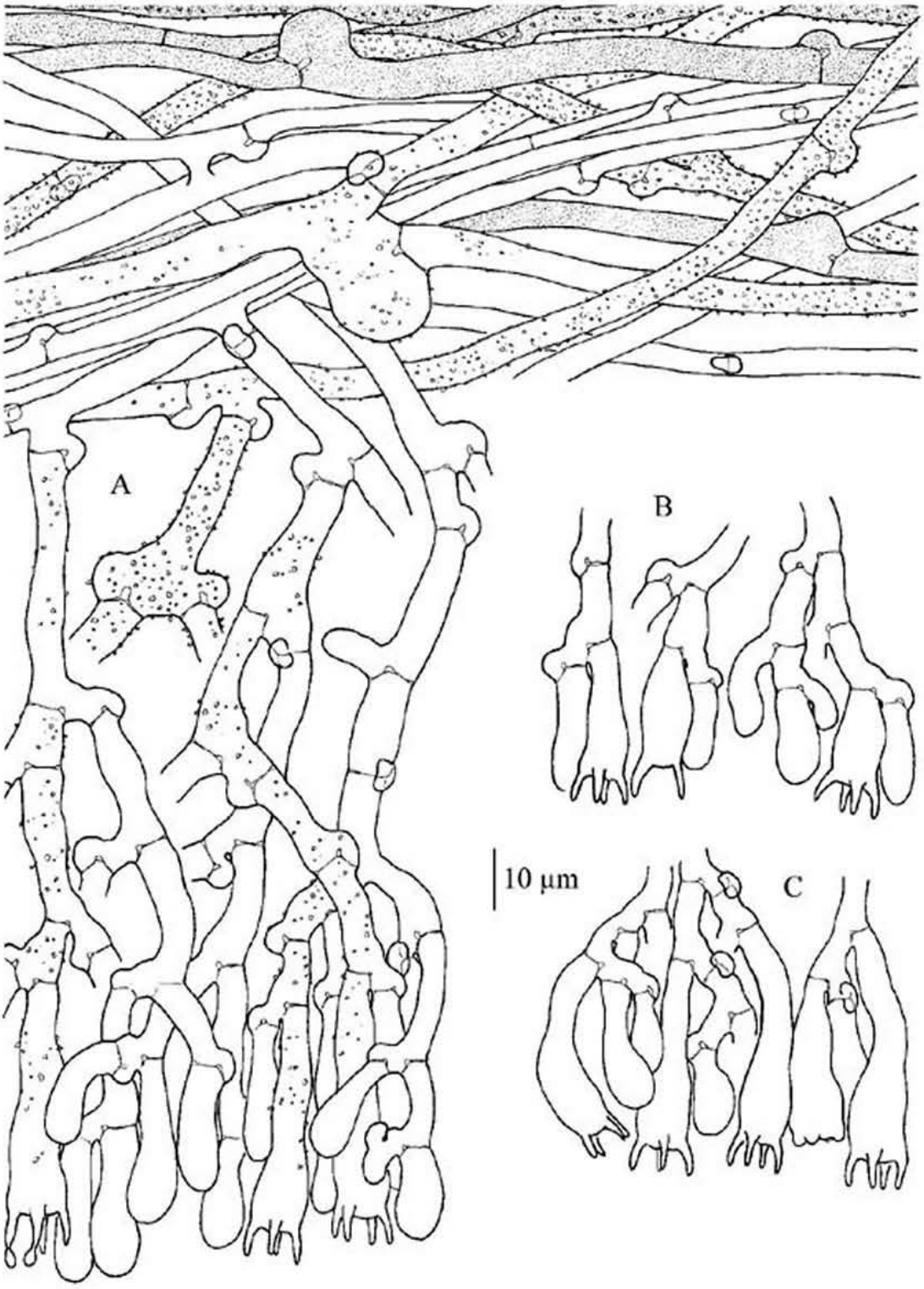

Fig. 5. *Trechinothus smardae*. **A.** Section verticale du basidiome, les hyphes subiculaires finement pointillées sont ocrées, coll. PRM 703743 (holotype). **B.** Basides et hyphes subhyméniales, coll. GT 03 092. **C.** Basides et hyphes subhyméniales, coll. PRM 894976

les rhizomorphes, et les basides ont sensiblement la même forme. Mais les hyphes sont bien plus grêles, les basides normalement plus courtes et les spores beaucoup plus petites, ne dépassant presque jamais 6 μm (ornementation incluse). L'étude minutieuse des spores nous a toutefois amenés à la conclusion que l'ontogenèse de leur ornementation éventuelle est complètement différente. Dans les *Trechispora* ssp. concernés, elle se forme très tôt et peut être observée déjà sur les spores juvéniles encore attachées aux basides et très petites. Larsson (1994: 1167) fait aussi cette constatation: «In a *Trechispora* ornamentation is formed early and can be detected in spores only half the final volume». Dans *Trechinothus*, par contre, c'est la paroi sporique qui s'épaissit d'abord alors que sa surface reste lisse ou presque; l'ornementation ne se forme qu'en état avancé de maturation. Cette évolution nous semble plus proche de celle qu'on observe dans les espèces du genre *Lindtneria*. L'analogie s'arrête pourtant là, car ce dernier possède d'autres caractères distinctement différents de ceux de *T. smardae*. Par exemple, la forte cyanophilie de ses spores dont l'ornementation - par ailleurs nettement dissemblable - présente une couronne crêtée autour de l'apicule qui limite une plage suprahilaire lisse très évidente; mais aussi les basides (et surtout les basidioles) à contenu pluriguttulé pareillement cyanophile; et enfin, la présence seulement exceptionnelle d'hyphes ampullacées aussi typiques aux cloisons, même si des renflements assez considérables s'observent indéniablement le long de certains articles.

Remerciements

Nous tenons à remercier vivement Jan Holec et le personnel de l'Herbier mycologique de Prague (PRM) pour leur aimable hospitalité pendant la visite de l'un de nous (EM), avec une gratitude particulière à l'égard de Zdeněk Pouzar pour l'envoi de son spécimen de *T. smardae*. Nous sommes aussi reconnaissants à René Hentic, Daniel Job et Jean Keller qui ont bien voulu relire ce texte, et à Aureliano Martini pour la traduction de la diagnose en latin.

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MYCOTAXON

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Cladosporium galii sp. nov. on *Galium odoratum* from Poland

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Abstract—*Cladosporium galii* sp. nov. is described and illustrated from living leaves of *Galium odoratum (Rubiaceae)* collected in the Białowieża National Park (Białowieża Forest, Poland). The new species is discussed and compared with morphologically similar *Cladosporium* species.

Key words—mycobiota, mitosporic fungus, Hyphomycetes

Introduction

Cladosporium Link *s. lat.* is one of the largest and most heterogeneous genera of hyphomycetes. A checklist recently published by Dugan, Schubert and Braun (2004) comprises 772 names that have been assigned to *Cladosporium*. The heterogeneity of this genus was discussed by Arx (1983), Morgan-Jones and Jacobsen (1988), McKemy and Morgan-Jones (1990), Morgan-Jones and McKemy (1990) and David (1997). The structure of the conidiogenous loci and conidial hila, examined in detail by David (1997), proved to be a key feature for a more natural classification and circumscription of *Cladosporium*. True *Cladosporium* species are characterized by having 'coronate' conidiogenous loci and hila, i.e., they are more or less protuberant with a central convex dome surrounded by a raised rim (= *Cladosporium* type). This new generic concept was supported by molecular examinations, and the new teleomorph genus *Davidiella* Crous & U. Braun was introduced for species with *Cladosporium* anamorphs (Braun et al. 2003).

The most common, widespread *Cladosporium* species, e.g., *C. herbarum* (Pers. : Fr.) Link, *C. oxysporum* Berk. & M.A. Curtis and *C. cladosporioides* (Fresen.) G.A. de Vries, are saprobic fungi and secondary invaders, but other species of this genus are hyperparasitic or plant pathogenic. A new species, found in Poland on living leaves of *Galium odoratum*, is described, illustrated and discussed in this paper.

Taxonomic Description

***Cladosporium* [subgen. *Cladosporium*] *galii* sp. nov.** FIGURE 1

Differt a C. cladosporioides conidiophoris saepe fasciculatis et nodulosis, (2.5–)4.5–8(–10) µm latis, et conidiis verruculosis, (2.5–)3–6.5 µm latis.

Etymology: epithet derived from the name of the host genus.

Selected descriptions and illustrations: www.mycotaxon.com (2004) — downloadable PDF file

On living leaves, distinct leaf spots lacking, but with pale olivaceous-brown to greyish discolorations. Colonies hypophyllous, rarely epiphyllous, punctiform, in small tufts, scattered, pale to dark brown, sometimes almost blackish. Mycelium internal, subcuticular to subepidermal, immersed, hyphae branched, (3–)4–8(–10) µm wide, septate, with swellings and constrictions, pale to medium brown, smooth, walls slightly thickened, forming loose to somewhat denser stromatic hyphal aggregations, 37.5–82.5(–100) µm diam., composed of swollen, subcircular, ellipsoid to somewhat angular–irregular, thick-walled hyphal cells, (5–)7–16(–20) µm wide, olivaceous to dark brown, smooth. Conidiophores solitary, arising from hyphae or in loose to dense fascicles arising from stromatic hyphal aggregations, erumpent through the cuticle or emerging through stomata, erect, straight or slightly flexuous, unbranched or rarely branched, 25–280 × (2.5–)4.5–8(–10) µm, septate, but only few septa, subhyaline, pale to medium olivaceous-brown, somewhat paler towards the apex, smooth, sometimes minutely verruculose at the apex, walls slightly thickened, usually swollen und somewhat darker at the base, up to 12 µm wide, often with small, head-like, terminal swellings, up to 8 µm wide, with a single or several distinct scars at the apex. Conidiogenous cells integrated, terminal or intercalary, cylindrical or often with small swellings, 18–80 µm long, proliferation sympodial, with a single or few conidiogenous loci, loci protuberant, mostly short cylindrical, (1–)1.5–2.5 µm wide, slightly thickened, darkened–refractive (*Cladosporium* type). Conidia catenate, in simple or branched acropetal chains, sometimes solitary, straight to slightly curved, conidia small, obovoid, ellipsoid, 3–7 × 2–4 µm, smooth, ramo-conidia ellipsoid, fusiform to cylindrical, 6–30(–40) × (2.5–)3–6.5 µm, mostly 0(–2)-, very rarely 3-septate, not constricted at the septa, subhyaline, very pale to medium pale brown, smooth to usually minutely verruculose, walls only slightly thickened, somewhat rounded at the ends, with protuberant hila at one end or both ends, slightly convex, (0.5–)1–2.5 µm wide, with a central convex dome, surrounded by a raised fine rim.

Cladosporium pilicola Richon (Saccardo 1892: 602) was described from France on dry stems of *Galium mollugo*. Type material of this species could not be traced, and other collections are unknown. However, based on the original description, *C. pilicola* is quite distinct from *C. galii* (probably saprobic; conidiophores branched; conidia cylindrical, 1–3-septate).

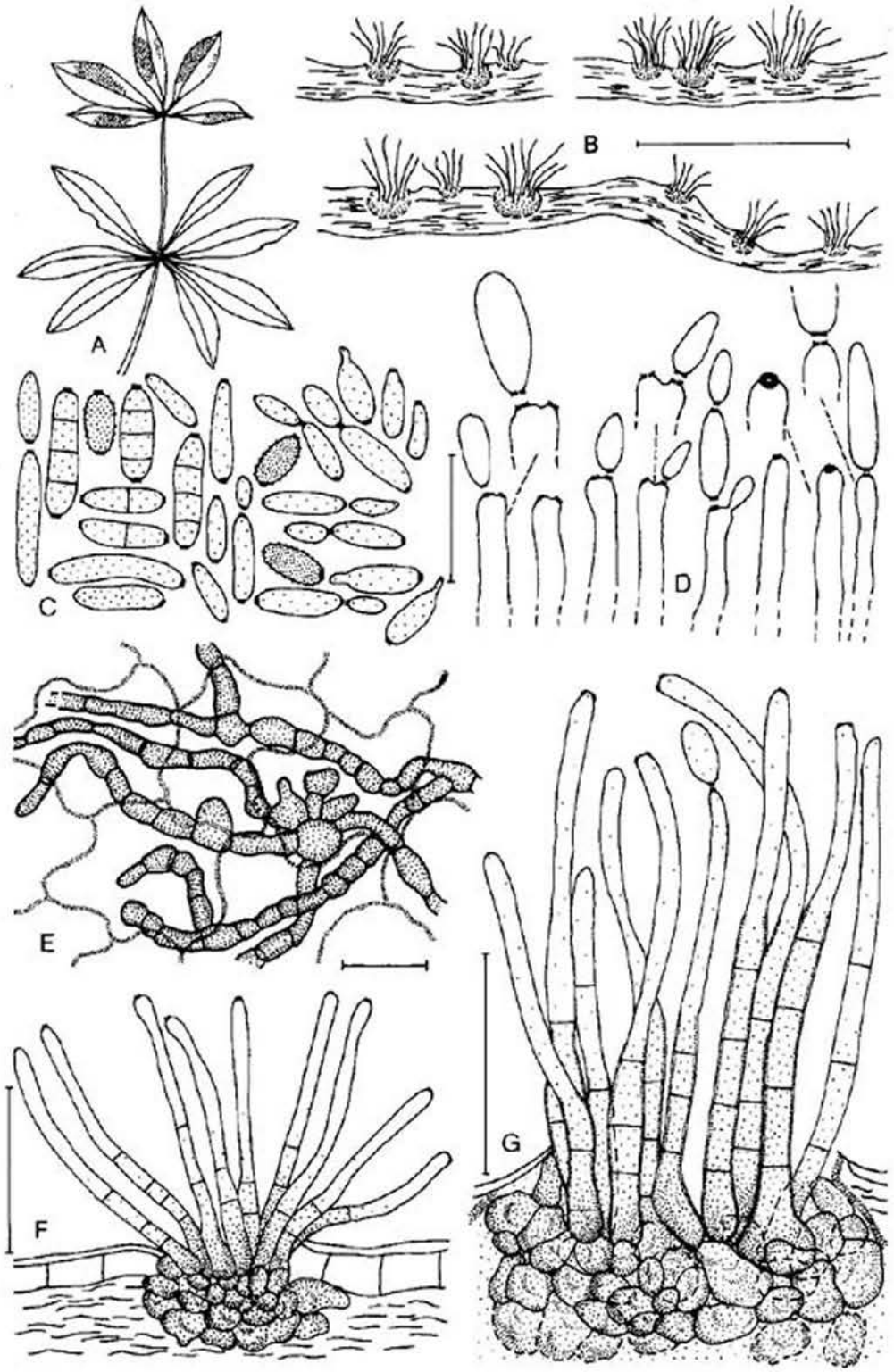

Fig. 1. Morphology of *Cladosporium galii*: A – infected young leaves (orig. size); B – section of the leaves tissues with stromata and conidiophores (bar = 500 μm); C – conidia (bar = 25 μm); D – apices of conidiophores (bar = 25 μm); E – vegetative subepidermal mycelium (bar = 60 μm); F – scheme of a small stroma with conidiophores (bar = 100 μm); G – big stroma and conidiophores (bar = 50 μm).

The common, widespread *Cladosporium cladosporioides* (concept based on Ellis 1971 and Ho et al. 1999) is usually a saprobic fungus or secondary invader on many different plants, but plant pathogenic races may also occur. This species is morphologically close to *C. galii*, but differs in having narrower, cylindrical conidiophores, 2–5.5 μm wide, without swellings, usually formed singly, and usually smooth, narrower conidia, 2–5 μm wide (Ellis 1971, Ho *et al.* 1999).

Nodulose conidiophores are known from some other *Cladosporium* species, e.g., *C. colocasiae* Sawada, *C. herbarum s. lat.* (incl. *C. macrocarpum* Preuss), *C. oxysporum* and *C. variabile* (Cooke) G.A. de Vries (Ellis 1971). The conidia of *C. herbarum s. lat.* and *C. variabile* are coarsely verruculose and wider. In addition, *C. variabile*, confined to *Spinacia oleracea*, is well-distinguished by forming tortuose, spirally twisted aerial hyphae. *C. colocasiae*, a common parasite of *Colocasia* species, has much wider (6–9 μm), smooth conidia, and the widespread saprobic species *C. oxysporum* differs in having very long conidiophores, up to 500 μm or more, and smooth conidia. Various species of *Cladosporium* subgen. *Heterosporium* (Klotzsch ex Cooke) J.C. David tend also to be somewhat nodulose (David 1997), but they are easily distinguishable by having much larger, above all wider, verrucose conidia, which are usually formed singly.

REPRESENTATIVE SPECIMENS EXAMINED – POLAND: Nizina Północnopodlaska, Białowieża Forest, Białowieża National Park, Forest Compartment 342, Permanent plot No 40 of Białowieża Geobotanical Station of Warsaw University, single collection on living leaves of *Galium odoratum* (L.) Scop. (Rubiaceae) in oak-linden-hornbeam forest (*Tilio-Carpinetum*), 26 Sept. 1992, leg. W. Mułenko, [HOLOTYPE – LBLM 8459, ISOTYPE–HAL 1811 (F)].

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MYCOTAXON

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Thozetella buxifolia sp. nov. — a new hyphomycete from Argentina

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Abstract—Current research on fungi growing on decaying leaves in a native xeric forest dominated by *Celtis tala* and *Scutia buxifolia* has uncovered a previously unpublished new species. *Thozetella buxifolia* is described, based on observations on natural substratum.

Key words—imperfect fungi, hyphomycetes, litter

Study area

The native dry forest dominated by *Celtis tala* Gill. ex Planch. and *Scutia buxifolia* Reiss. constitutes the main woodland community of the eastern plains ("Pampa") in Buenos Aires province, Argentina. The forest grows on highly calcareous material derived from sea transgression and regressions in the Quaternary (Cabello & Arambarri 2002).

Reports on the litter fungi of this native woodland have not been published, although there is a previous report on biodiversity of soil fungi (Cabello & Arambarri, 2002). At present, a new representative of the Hyphomycetes isolated from fallen leaves of *Scutia buxifolia* is described.

Introduction

Thozetella O. Kuntze (1891) is a nom. nov. for *Thozetia* Berk. & F. Mueller (in Berkeley, 1881) and was revised by Pirozynski & Hodges (1973) who accepted four species. Subsequently additional species were described by Nag Raj (1976), Holubová-Jechová & Mercado Sierra (1984), Sutton & Cole (1983) and Mercado Sierra et al. (1997) being nine at this moment the described ones. The genus is characterized by aseptate, hyaline, curved conidia, each end with an unbranched setula, phialidic conidiogenesis and integrated conidiogenous cells. Distinctive elements that Pirozynski & Hodges (1973) called microawns (to indicate their morphological similarity to awns of certain *Gramineae*) are formed in conidiomata and these are unique for *Thozetella*.

The type species *T. nivea* (Berk.& Muell.) Kuntze has sporodochial conidiomata as do *T. canadensis* Nag Raj and *T. cubensis* Castañeda et Arnold. *T. effusa* Sutton & Cole forms a flat conidioma with 1-2 cells thick on the outer face from which conidiogenous cells are produced. Whereas in *T. radicata* (Morris) Pirozynski & Hodges, *T. tocklaiensis* (Agnihothrudu) Pirozynski & Hodges, *T. cristata* Pirozynski & Hodges, *T. ciliata* (Castañeda) Hol. Jech. & Mercado, *T. havanensis* Castañeda and *T. buxifolia* Arambarri, Cazau, Cabello & Allegruci the conidiomata are simply synnematal, occasionallly becoming branched towards the apex.

T. effusa Sutton & Cole forms a flat conidioma with 1-2 cells thick on the outer face of which conidiogenous cells are produced. In *T. radicata* and *T. tocklaiensis* the conidiomata are only known from culture. In *T. ciliata* there are not microawns and the synnema has black setae. Pirozynski & Hodges (1973) considered that *T. ciliata*, *T. tocklaiensis* and *T. radicata* are geographical variants or growth forms of the same species.

Taxonomy

***Thozetella buxifolia* sp. nov.** **FIGURE 1 (A-C)**

Etym.: buxifolia, *referring to* Scutia buxifolia *where the fungus was found.*

Synnemata dispersa, superficialia,stromatibus parvis partim superficialibus partim in substrato in mersisoriunda, ex stipite brunneo et massam candidam, conidiorum composita. Stipes conidiophoris numerosis dense fasciculatis, agglutinatis compositus in primis ca 10 µm usque 50 µm long, annulis 1-3 fuscioribus rugosis, massam subglobosam, plerumque ca. 150 x 100 µ m, conidiorum et cellularum sterilium aristiformium. Microaristae irregulatim sigmoideae velfalcatae plerumque torsivae, hyalinae, 25-30 µm (27,5 µm) long, 3-3,5 µm lat. Medio, utrinque angustatae, cum parte destali parietem crassiusculum habenti, verruculosa, cum parte proximali tenui et laevi. Conidiophora septata ramosa, compacta et connata, flavo-brunnea, usque 100 µm long, 1,5-2 µ m lat, phialides terminales, pallidiorus 15-25 x 1,5-3 µm, apice minutum collum ferentis. Conidia lunata vel naviculiformia, apice angustato, base truncata, hyalina, laevia, guttulata 13,5-15 x 2,5-2,7 µm, utrinque solo filiformi, tubulari 10-13 µm long appendice praedita.

Holotypus in foliis putridis Scutia buxifolia, Pta Indio. Magdalena, Prov. Buenos Aires, Argentina. April 2001. LPS 47406.

Synnemata scattered, superficial, arising from small, partly superficial, partly immersed stromatic aggregations of hyphal cells, composed of amore or less elongated, brown stalk bearing a white mass of conidia. Stalk composed of several hundred conidiophores which are closely packed and partly fused together, at first about 10 µm long, forming a flat area with the conidiogenous cells, then up to 50 µm long, ringed by up to three brown transverse ridges or articulations each representing an area of synchronous proliferation of all conidiophores, topped by a subglobose mass, mostly about 150 x 100 µm composed of liberated conidia and microawns. *Microawns* produced from conidiogenous cells and liberated with the conidia, irregularly sigmoid, twisted in two planes, hyaline 25-30 µm (27,5 µm) long, 3-3,5 µm wide tapering at each end, distal half thick-walled, sparse by verruculose, proximal half thin-walled. *Conidiophores* septate, branched proliferating at intervals, pale brown, up to 100 µm long. *Conidiogenous cells* phialidic, cylindrical, each 15-25 x 1,5-3 µm and bearing a single minute collaret at

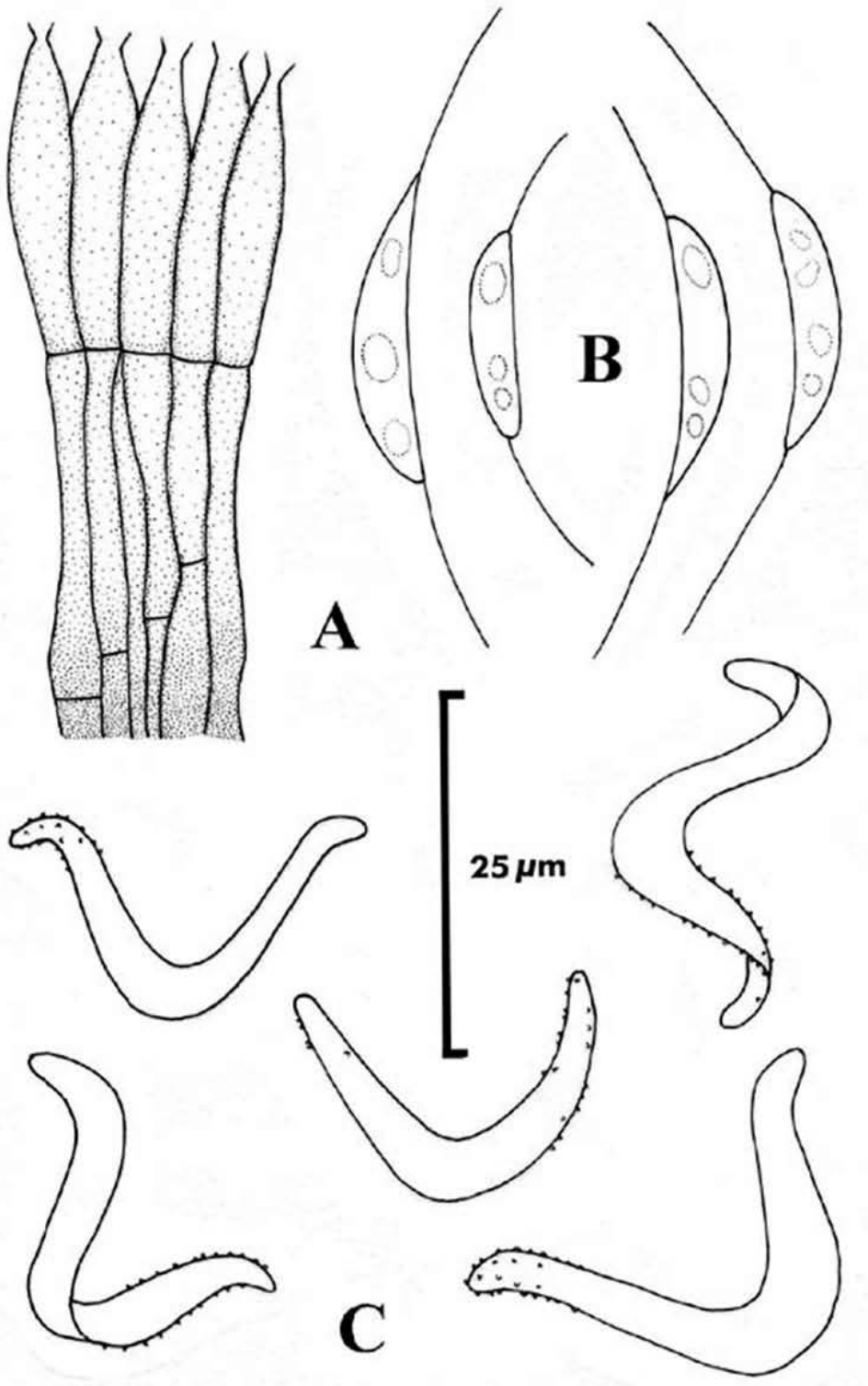

Fig.1. A. Detail of conidiogenous cells, B. Conidium, C. Detail of microawns

the open apex. Conidia hyaline, lunate or naviculate, narrowed at the apex, narrow and truncate at the base, unicellular smooth-walled and guttulate, 13,5–15 x 2,5–2,7 μm provided at each end with a single, filiform appendage 10-13 μm long.

Specimen examined: on leaf litter of *Scutia buxifolia*

T. buxifolia has a close affinity with *T. havanensis* Castañeda and *T. cristata* Pirozynski & Hodges. In *T. havanensis* the synnema is sessile or nearly so and the conidia have both ends fusiform, in *T. buxifolia* the stiped synnema grows with age of the conidiomata and has a ring of proliferating conidiophores as happens in *T. cristata* but differs in the shape and size of the microawns that in *T. cristata* are 40-60 μm long and thick-walled and in *T. buxifolia* many reach 30 μm long, and are sigmoid and thin-walled.

Key to the species of *Thozetella*

A. With microawns produced in different ways,

B. Conidiomata sporodochial

C. Conidiophores compact

D. Microawns L-shaped with the basal arm thin-walled. ***T. nivea***

D.' Microawns of different forms

E. Microawns sigmoid and uncinate smooth ***T. cubensis***

E.' Microawns sickle-shaped or irregularly sigmoid, verruculose on one surface ***T. canadensis***

C'. Conidiophores effuse ***T. effuse***

B'. Conidiomata synnematal

F. Synnema radicant

G. Microawns smooth ***T. radicata***

G'. Microawns verruculose ***T. tocklainensis***

F'. Synnema not radicant

H. Microawns smooth ***T. cristata***

H'. Microawns verruculose

I. Microawns and conidia in a mucoid mass ***T. havanensis***

I'. Microawns and conidia not forming a mucoid mass ***T. buxifolia***

A'. Without microawns. ***T. ciliata***

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MYCOTAXON

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NATS truffle and truffle-like fungi 10: *Pachyphloeus thysellii* sp. nov. (*Pezizaceae*, Pezizomycotina)

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Abstract—An undescribed truffle found on the Fort Lewis Military Reservation near Olympia, Washington, is described as *Pachyphloeus thysellii*. This new species, associated with *Pseudotsuga menziesii*, closely resembles *Pachyphloeus prieguensis* from southern Europe. It differs from the latter in having yellow veins and patches showing among the minute, brown warts on the peridial surface, smaller asci, and a different mycorrhizal host.

Introduction

Integrated research on ecosystem functions in forests of 55 to 65-yr-old *Pseudotsuga menziesii* (Mirb.) Franco at Fort Lewis Military Reservation near Olympia, Washington includes studies of the small mammals that feed on fungi. As hypogeous fungi are a major food base for the small mammals, standing crops of those fungi were monitored at 6-week intervals for nearly 3 years (Colgan et al., 1999). During this time, the genus *Pachyphloeus* was represented by one undescribed species, for which we propose the name *Pachyphloeus thysellii*.

Methods

At each collecting time, 10 plots of $4m^2$ each were raked into mineral soil along each of 16 transects. All specimens found in plots were collected, identified and dried for estimation of standing crops and for herbarium deposit (Colgan et al., 1999). Colors of fresh specimens are in general terms of the author. Specimens were dried with a forced air dehydrator at 49°C (120°F). Microscopic characters were determined from hand sections mounted in 5% KOH, Melzer's reagent, or cotton blue, as indicated. Spore dimensions are based on at least 50 randomly selected spores and do not include ornamentation. Light photomicrographs are from sections mounted in 5% KOH unless

otherwise indicated. For electron microscopy, dried spores were mounted on pegs with double sided tape, coated with gold and examined with an Amray 3000 scanning electron microscope. The holotype and paratypes have been accessioned into the Mycological Herbarium of Oregon State University (OSC).

Taxonomy

Pachyphloeus thysellii sp. nov.
FIGURE 1

Species haec ab Pachyphloeus prieguensis, P. melanoxanthus *et* P. virescens *ob peridio verrucoso-reticulato, brunneo vel fulvo, venis et maculis luteis, et ascis ellipsoideis vel subglobosis. Holotypus hic designatus: OSC 80960.*

Etymology: "thysellii" in honor of the collector of the type specimen, David Thysell, a research botanist with the USDA Forest Service and cooperator on the Forest Ecosystem Project at Fort Lewis

Ascomata subglobose to irregular, 0.8-2 cm in diameter, minutely warty, brown to tawny with yellow veins and patches showing among the warts; texture rubbery, odor mild to slightly onion like, taste not recorded, hard when dried. **Gleba** off-white to yellowish translucent, with white and yellowish alternating veins radiating from a central cavity containing cottony hyphae.

Excipulum (peridium) 200-300 μm thick, with two layers: **ectal excipulum** 150-250 μm thick, brown to pale yellow, compactly arranged, of inflated, brown-walled polygonal cells 35-45 μm broad, the walls ca. 1μm thick; ental **excipulum** 40-60 μm thick, hyaline, of tightly interwoven hyphae 6-8 μm broad, with many cells inflated up to 10 μm, the walls ca. 1μm thick. **Medullary excipulum** (gleba) of hyaline, interwoven, branched hyphae 6-10μm in diam. **Asci** 8-spored, elliptical to reniform or subglobose, 80-110 x 40-60 μm including a short to prominent stem 10-60 x 8-15 μm, hyaline, the walls 1 μm thick, not amyloid, weakly cyanophilic in cotton blue, the spores biseriate or clustered in the asci.

Spores predominantly globose, 12-17 μm broad excluding ornamentation, the walls ± 1 μm thick and hyaline in KOH and Melzer□s reagent but strongly cyanophilic in cotton blue. **Ornamentation** of symmetrical rods ≥2 x 0.7-1 μm tall, cyanophilic; spore wall ±1 μm thick. **Episporium** hyaline, inconspicuous, adherent to the tips of the ornamentation.

Habit, habitat and season – Hypogeous; at 400 ft elevation in 55-65-yr.-old thinned stands of *Pseudotsuga menziesii* (Mirb.) Franco on glacial till, August.

Collection examined – HOLOTYPE here designated: Washington, Thurston Co. Fort Lewis Military Reservation, Hill block, stand 3, in root-rot treatment area, below an excavated wasp nest, Col. D. Thysell. 24 Aug. 1994 (OSC 80960). **PARATYPE:** Washington, Thurston Co. Fort Lewis Military Reservation, Stellar block, stand 1, heavily thinned treatment, Col. Wes Colgan III, 18 Aug. 1993 (OSC 80959)

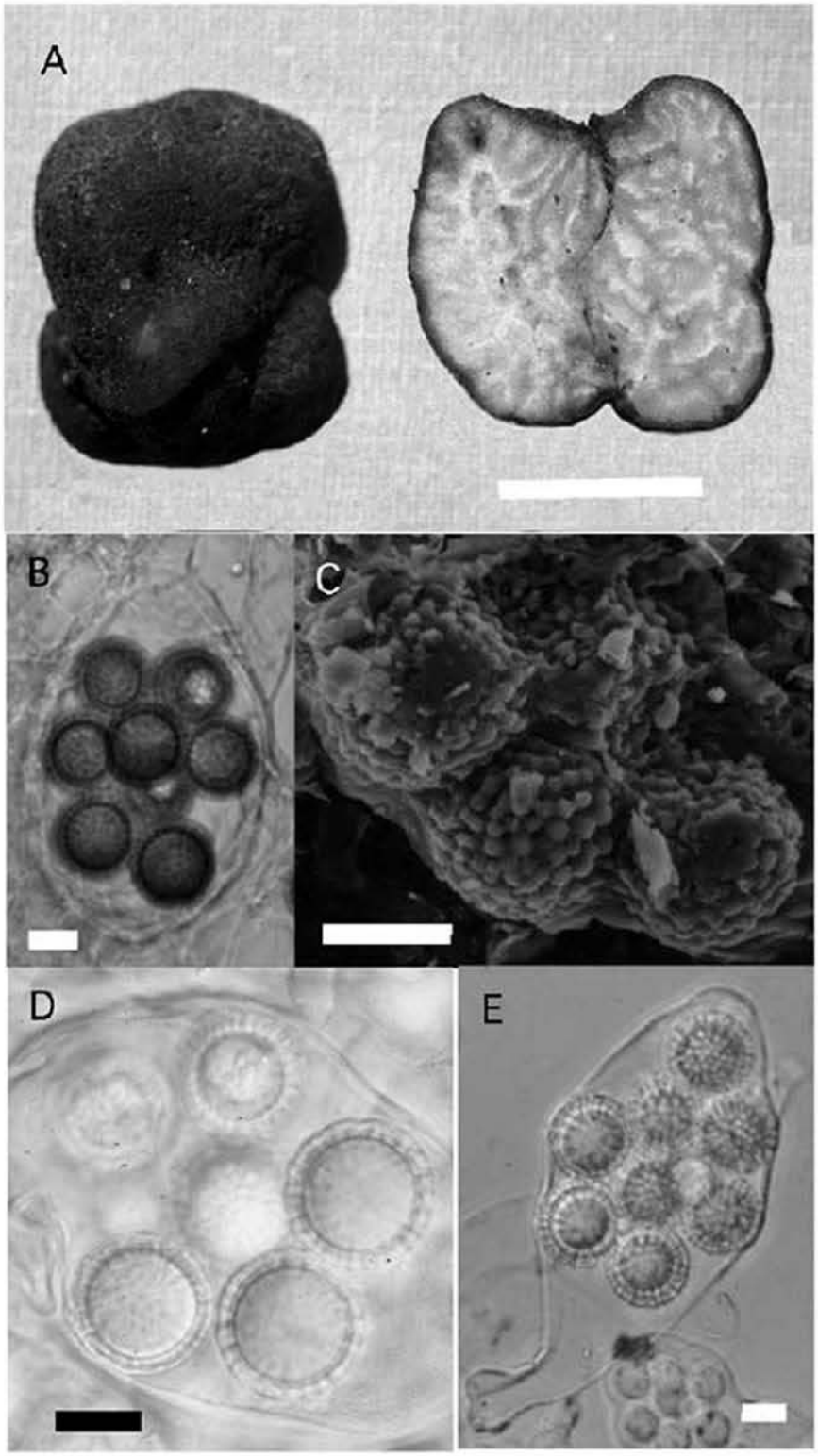

Fig. 1. *Pachyphloeus thyselliі*. A. Sporocarp shown in cross-section showing external surface (left) and gleba (right). Scale bar 1cm (OSC 80960). B. Light micrograph of spores and ascus stained with cotton blue. Scale bar 10μm (OSC 80959). C. Scanning electron micrograph of spores. Scale bar 10μm (OSC 80959). D & E. Light micrographs (Nomarski optics) of spores and asci Scale bar 10μm (D, OSC 80960; E, OSC 80959).

Discussion

Pachyphloeus thysellii is closest to *P. prieguensis* Moreno-Arroyo, J. Gomez & Calonge from southern Europe. That species, however, lacks the yellow veins and patches between the peridial warts, has larger asci, is associated with deciduous trees and occurs in calcareous soils. *P. virescens* Gilkey differs in peridial coloration and structure. *P. thysellii* possesses darkly pigmented angular warts similar to *P. melanoxanthus* (Tul.) Tul. & C. Tul, but the space between the peridial warts is brown rather than yellow and it is associated with deciduous trees.

Acknowledgments

This research was conducted under grants, contracts, and agreements to Andrew B. Carey, Leader, Ecological Foundations of Biodiversity Team, from the USDA Forest Service. Specifically, funding was provided by the U.S. Army, Fort Lewis Military Reservation, the USDA National Research Initiative Competitive Grants Program (Grant No. 9401095) and the USDA Forest Service, Pacific Northwest Research Station.

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MYCOTAXON

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Lactarius in Kumaon Himalaya 3: A new species of subgenus *Lactifluus*

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Abstract—An undescribed *Lactarius* species in subgenus *Lactifluus* has been found in Kumaon, Himalaya. The combination of features with regard to basidiome and latex color, basidiospore form, and thick walled hymenial cystidioid elements distinguish this new species, *L. capitatus*, from its close relative, *Lactarius luteolus* of U.S.A. The basidiomes of the species described here were found growing under *Quercus leucotrichophora* in subtropical deciduous forests.

Key words—macrofungi, *Russulaceae*, taxonomy, India, ectomycorrhizal fungi

Introduction

Critical examination of specimens of *Lactarius* has been carried out in Kumaon, Himalaya. The gathered information allows us to confirm the presence of members of subgenus *Lactifluus* in this Indian region. From the eight taxa of subgenus *Lactifluus* (Burl.) Hesler & A.H. Sm. currently known in India (Das & Sharma 2002), six species including *Lactarius capitatus* described in this communication have been collected from this area.

Materials and Methods

The present communication is based on fieldwork in Kumaon, Himalaya, undertaken periodically during last five years, by two of us (KD & JRS). Macroscopic characters were recorded in fresh specimens. Microscopic study was carried out on dry samples, mounting hand sections of basidiomes in 5% KOH, Melzer's solution, Congo red, Lactophenol-cotton blue and carbol fuchsin. Color terms mentioned follow Kelly & Judd (1955). All line drawings were made by K. Das. Microscopic line drawings were prepared with the aid of a camera lucida at original magnification of 1500x for basidiospores, 1000x for cystidia and basidia, 500x for other microstructures. Density of lamellae (= L/cm) was measured at pileus attachment excluding lamellulae. Basidiospore length excludes the ornamentation height. Basidium length excludes the sterigmata

length. Width of the elements of suprapellis was measured at their apices. For basidiospore dimensions the range observed in the collections is reported based on 25 basidiospores per collection. **RM** corresponds to the range of means of length and width of the collections. **Q** is the range of mean values of coef. Q (length/width ratio of spores). Herbaria housing the cited specimens are abbreviated after Holmgren et al. (1990). Scanning electron microscope (SEM) study was made by L. Montoya following Montoya & Bandala (2003).

Description of the species

Lactarius capitatus K. Das, J.R. Sharma & Montoya *sp. nov.*

Figure 1a-g; 2a-d.

Etymology: After the characteristic capitate microstructures.

Pileus 50–80 mm diam, planoconvexus, siccus leviter depressus in centro, ferrugineus, brunneoaurantiacus, griseoaurantiacus vel griseorufus, margine saepe cinnabarinus, incurvo. Lamellae subdecurrentes, subdistantes, pallide aurantiacus. Stipes 33–63 x 10–18 mm, cylindratus, pileo concolorus. Latex translucido-albus, albo ad griseo-luteo, pallidus griseo-rubescens vel brunnescens. Contextus aurantiacus, brunnescens. Odore piscis similis. Sporae in cumulo albae, (6.4-) 7–8.8 (-9.6) x (5.6-) 6.4–7.8 (-8) µm, globosae vel subglobosae, amyloideae, verrucosae. Pseudocystidia abundantia, cylindrica. Cellulae ad lamellae margine 33–70 x 4.6–7.5 µm, abundantia, capitata, septata. Pileipellis trichodermis, bistrata; elementa suprapellis 20–135 x 5.5–13 µm, capitata et subcapitata; subpellis pseudoparenchymata. INDIA, Uttaranchal, Bageshwar, Loharkhet top, September 15, 2003, leg. K. Das & J.R. Sharma, KD7001 (HOLOTYPUS, BSD; ISOTYPUS, XAL).

Pileus 50–80 mm diam, planoconvex to slightly depressed when mature; pileipellis dry, matted pruinose to velvety, sometimes minutely areolate towards center at maturity, medium reddish to grayish-orange, grayish-red, medium to brownish-orange, often dark red at the edge; margin incurved to decurved, wavy, often crenate. **Lamellae** decurrent, close at first sight but subdistant when excluding the lamellulae (ca 5–6 per cm), light orange to orange-yellow, light to medium reddish-brown after bruising; lamellulae in five different lengths. **Stipe** 33–63 x 10–18 mm, dry, matted, cylindric or slightly tapered towards base, often longitudinally grooved, dry, matted, concolorous to pileus. **Context** solid, pale to light orange-yellow or ochraceous, turning slowly brownish. **Latex** at first whey like, later white to pale buff, droplets turning very slowly to pinkish, finally dark reddish-brown to brown, staining the white paper medium brown. **Odor** spicy to fishy. **Spore print** white.

Basidiospores (6.4-) 7–8.8 (-9.6) x (5.6-) 6.4–7.8 (-8) µm, RM = 7.8–8.3 x 7–7.2 µm, Q = 1.03–1.11, globose to subglobose, ornamentation amyloid, 0.6-0.8 µm high, composed mostly of conical isolated warts, at times connected or somewhat aligned; under SEM the ornamentation appears as subcylindric warts, broadened towards base, apex rounded, isolated or aligned and even interconnected at base level,

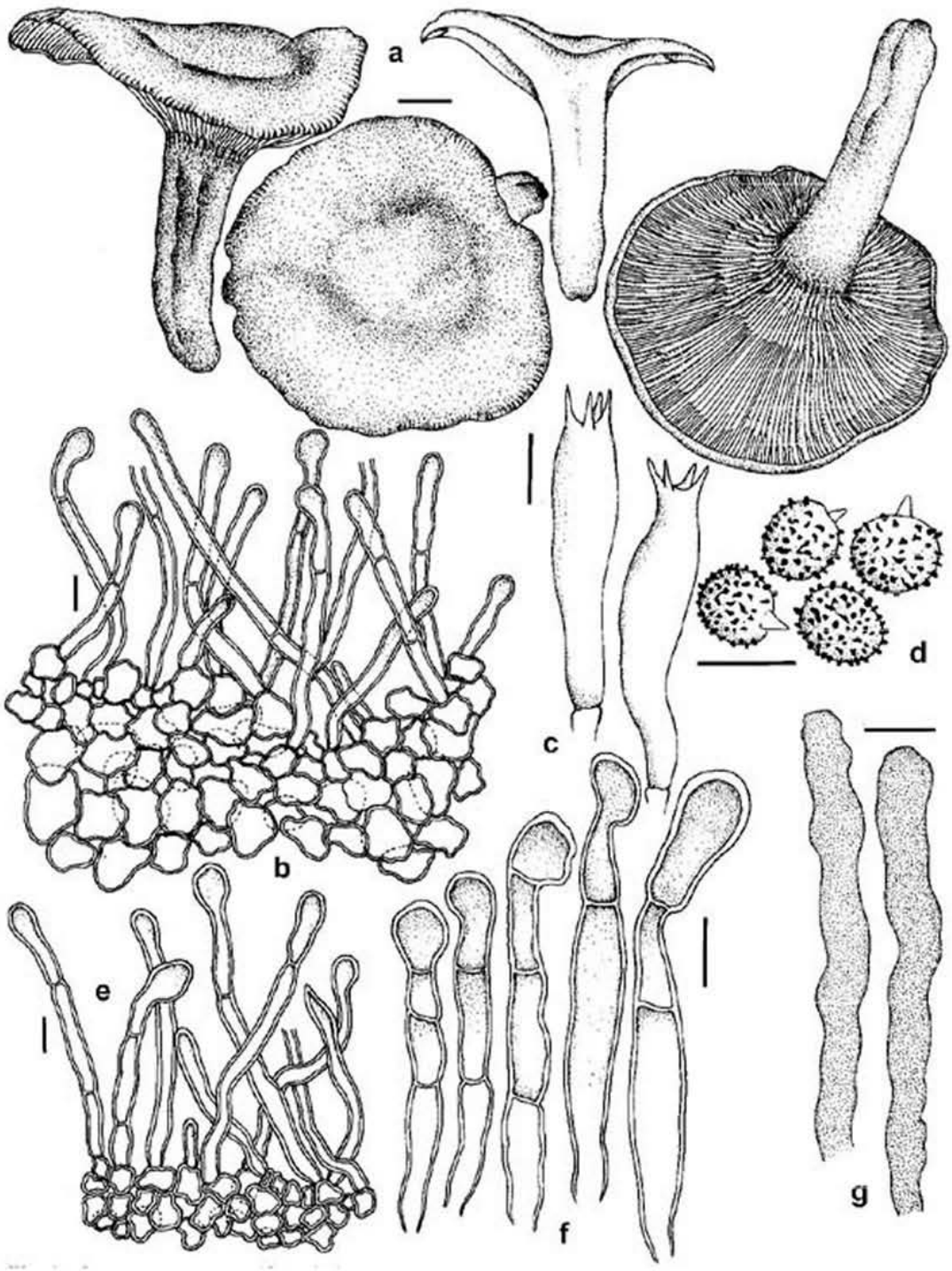

Fig. 1. *Lactarius capitatus* (from holotype). a. Basidiomes. b. Cross-section of pileipellis. c. Basidia. d. Basidiospores. e. Cross-section of stipitipellis. f. Marginal cystidioid elements. g. Pseudocystidia. Bars: a = 10mm; b–g = 10 μm.

at times with rounded, sinuous or truncate ridges; with suprahylar plage. Basidia 34–44 x 8–10 μm, subclavate to clavate, 4-spored; sterigma up to 7.5 μm long. Hymenial cystidioid elements abundant, subcylindric, capitate, septate, wall 0.8-1.6 μm thick, with hyaline or slightly yellowish and dense contents; at lamellae surfaces 38.4-92 x 5.6-8 μm, terminal segments 12-24 x 5.6-8.8 μm; at lamellae margins 33–70 x 4.6–7.5 μm, abundant, often septate, terminal segments 14.4-28 x 4.8-8.8 μm. Pseudocystidia abundant, subcylindric, 4-6.4 μm broad. Pileipellis a trichodermis of two layers, up to 225 μm thick; elements of suprapellis 20–135 x 5.5–13 μm, filamentous, capitate or subcapitate to cylindric, mostly hyaline or with dense yellowish contents, often septate, wall 0.8-1.6 μm thick; subpellis pseudoparenchymatous; cells 7–34 x 6–24 μm, wall 0.8-1.6 (-2.4) μm thick. Hymenophoral trama mostly cellular, sphaerocytes 8-28 μm diam, hyphae 4-4.8 μm thick, laticifers 8-11.2 μm diam, subhymenium thick and cellular Stipitipellis two layered; elements of suprapellis 18–125 x 4–12 μm, capitate or subcapitate to fusiform, often septate, thick walled; wall up to 1 μm broad; subpellis pseudoparenchymatous of subisodiametric cells, 10–20 x 6–14 μm.

Ecology — *Lactarius capitatus* is a rare species forming ectomycorrhizal association with *Quercus leucotrichophora* A. Camus in subtropical to temperate (1900–2200 m) deciduous forests in Kumaon Himalaya.

SPECIMENS EXAMINED -- **INDIA. UTTARANCHAL: Bageshwar**, LOHARKHET TOP, 15.IX.2003, leg. K. Das & J.R. Sharma, KD7001 (**HOLOTYPE**, BSD; isotype XAL); *ibid.*, 15.IX.2003, leg. K. Das & J.R. Sharma, KD7004 (BSD); *ibid.*, 26.IX.1999, leg. K.Das & J.R. Sharma KD1095 (BSD).

ADDITIONAL SPECIMENS EXAMINED -- *Lactarius luteolus* Peck. **UNITED STATES. MASSACHUSSETTS, East Milton**, August, H. Webster *s/n* (**HOLOTYPE**, NYS).

Comments — *Lactarius capitatus* is distinguished in the field by having the pileus and stipe surfaces matted, pruinose to velvety, reddish to brownish-orange, the lamellae and context are pale to light orange-yellow or ochraceous, latex droplets turning slowly to pink and finally dark reddish-brown to brown, and mild spicy odor in the fresh material. Moreover, the verrucose basidiospores and presence of typical capitate to subcapitate thick walled cystidioid elements in the hymenium and suprapellis of both pileus and stipe make the species very distinct.

Lactarius capitatus is closely related to *L. luteolus*. The latter differs in that the basidiomes lack reddish tinges [being buff, white or whitish-buff (Peck 1896, Hesler & Smith 1979)]. Moreover, *L. luteolus* presents white latex droplets staining brown, and as observed in the holotype it has elliptic basidiospores (Q = 1.3) and thin walled or slightly thick walled (0.8 μm thick) marginal cystidioid elements.

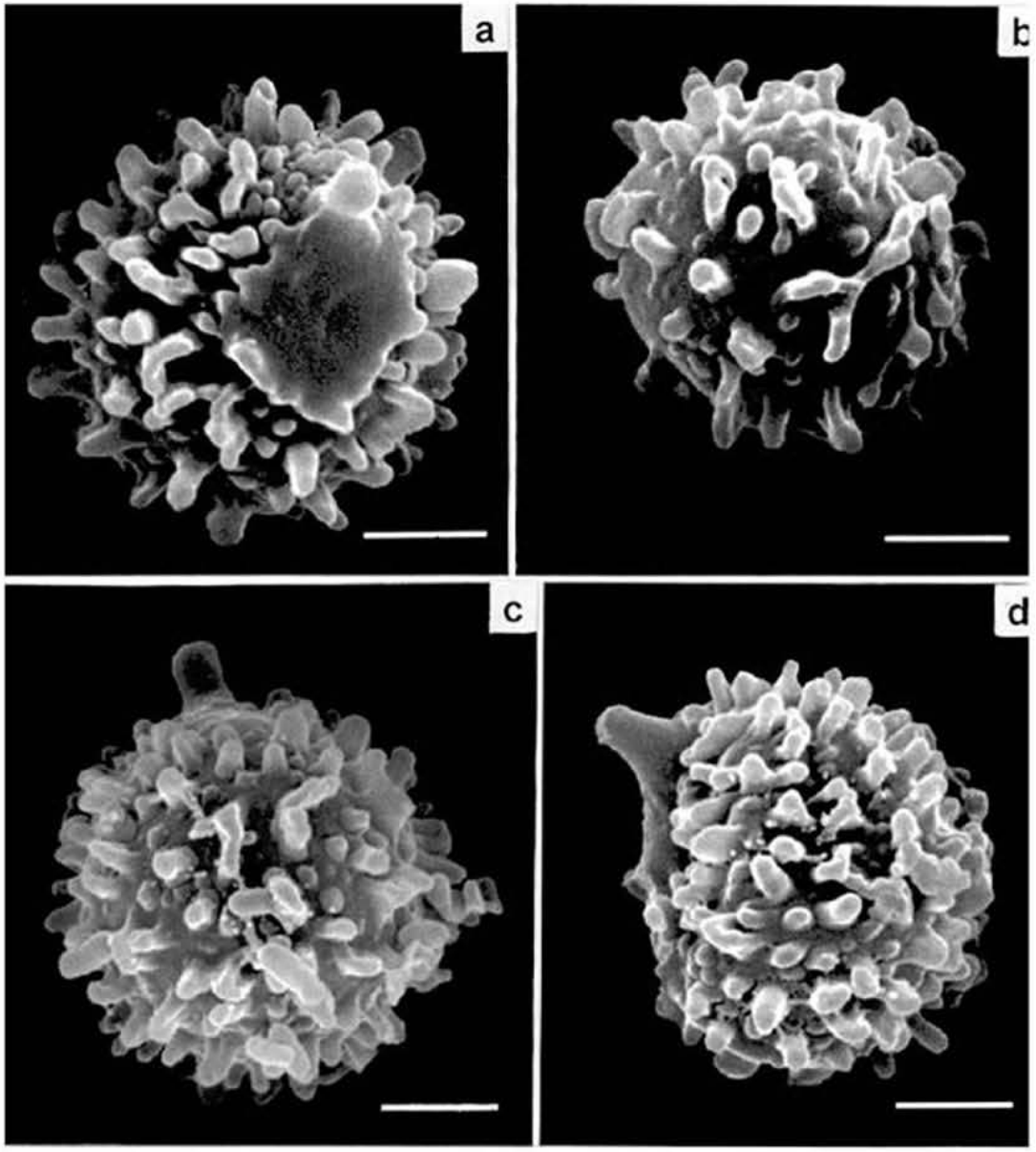

Fig. 2. Scanning Electron Micrographs of basidiospores of *Lactarius capitatus* (from holotype). a–b. X 8500. c–d. X 8000. Bars = 2 μm.

Lactarius nonpiscis Verbeken shares with the present taxon capitate, septate and thick walled elements of the suprapellis, stipitipellis and hymenial marginal cells, as well as verrucose basidiospores (Verbeken et al. 2000). However, *L. nonpiscis* differs by having smaller basidiomata [pileus 13–26 mm diam, stipe 20-40 x 3-7 (-10) mm], strongly wrinkled pileipellis with small veins, more ellipsoid basidiospores (Q = 1.31-1.36) and higher basidiospore ornamentation (up to 1.5 μm) (Verbeken et al. 2000).

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MYCOTAXON

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Four new records in the genus *Albatrellus* (*Aphyllophorales, Albatrellaceae*) from China

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Abstract—*Albatrellus citrinus*, *A. flettii*, *A. skamanius* and *A. tianschanicus* are newly reported from China. Line drawings depict the microscopic characters of the four species.

Key words—diagnostic characters, distribution

Introduction

Thirteen species of the genus *Albatrellus* have been recorded from China (Bi, Zheng & Li 1994, Mao 1998, Zhang 1999, Zhao & Zhang 1991, Zhao 1998, Zheng 1992). In recent years, during the course of our studies on the genus *Albatrellus* from southwestern China, ninety-eight specimens were examined. Twelve species were identified. Among them, *Albatrellus citrinus* Ryman, *A. flettii* Morse ex Pouz., *A. skamanius* (Murr.) Pouz. and *A. tianschanicus* (Bondartsev) Pouz. are new to China. Differences between similar species are provided and discussed.

Materials and Methods

The descriptions appear in alphabetical order by species name. Features of fresh basidiomes were taken from field notes with the specimens.

Microscopic examination of basidiomes and measurements of microscopic structures were made from freehand sections mounted in 5% KOH, 1% congo red and Melzer's reagent.

All specimens examined are preserved in the Cryptogamic Herbarium, Kunming Institute of Botany, Academia Sinica (HKAS).

**Corresponding author*

Descriptions of the Species

Albatrellus citrinus **Ryman**, Mycol. Res. **107** (10): 1243-1246, 2003

Fig. 1: a-d

SPECIMEN EXAMINED — CHINA, TIBET: Ri Dong, under *Picea*, alt. 3200 m. 13. Sept. 1982, Zang 984 (HKAS 10748).

REMARKS: The characters of the specimen cited above agree closely with the original description. This is especially true of the macroscopic characters and habitat. According to the macroscopic characters, the specimen has small scales in the center of the pileal surface, not so smooth as described in the original description. Other characters are identical with the holotype. The basidiomes of the holotype grew solitary or more often clustered in large rings, amongst mosses in herb-rich spruce forest on calcareous soil (Ryman et al. 2003). The Chinese specimen was also collected under *Picea*.

The microscopic characters of this species were not given in detail in the original description, simply stated as "hyphal system monomitic, without clamp connections," and gave the size of the basidiospores. More detailed microscopic characters drawn from the specimen cited above are provided to give more information about this species.

Hyphal system monomitic. Generative hyphae without clamp connections. Contextual hyphae hyaline, mostly 7.0-15.0 μm in diameter, some inflated up to 30 μm, branching, thick-walled, the walls up to 1.5 μm thick (Fig.1-d). Tramal hyphae are more uniform, 3.0-6.0 μm in diameter, thin-walled (Fig.1-c). Pileipellis hyphae repent or some erupt, cylindrical.

Cystidia none. Basidia clavate, 24.0-30.0 × 8.5-10.0 μm, 4-sterigmate, each 2.0-3.0 μm long, simple-septate at the base. Basidiospores distinctly amyloid, broadly ellipsoid, measured 4.5-5.5 × 3.0-4.5 μm (Fig.1-a), which are slightly larger than that of the holotype (4-4.5 × 3-4 μm). This slight difference does not warrant a specific or varietal distinction.

There are two species similar to *A. citrunus*. One is *A. subrubescens*, due to the coloration of the basidiomes, generative hyphae lack clamp connections and amy- loid basidiospores of similar size. However, it can be distinguished from *A. citrinus* in the normally larger basidiomes, the pileus turning orange, not yellow on handling, and growing with *Pinus* on poor sandy soil. Another is *A. ovinus*, morphologically similar to the species in that it also grows in connection with *Picea* and has basidiomes turning yellow with age or when handled. But *A. ovinus* has much larger basidiomes, the yellow colors of the pileus usually have a green tint, the fresh basidiomes never turning orange when dried, and the basidiospores are inamyloid. *A. citrinus* and *A. ovinus* seem to be more closely related than to *A. subrubescens* according to the result of molecular data (Ryman et al. 2003).

This species has previously only been reported from Sweden (Ryman et al. 2003) and is new to China.

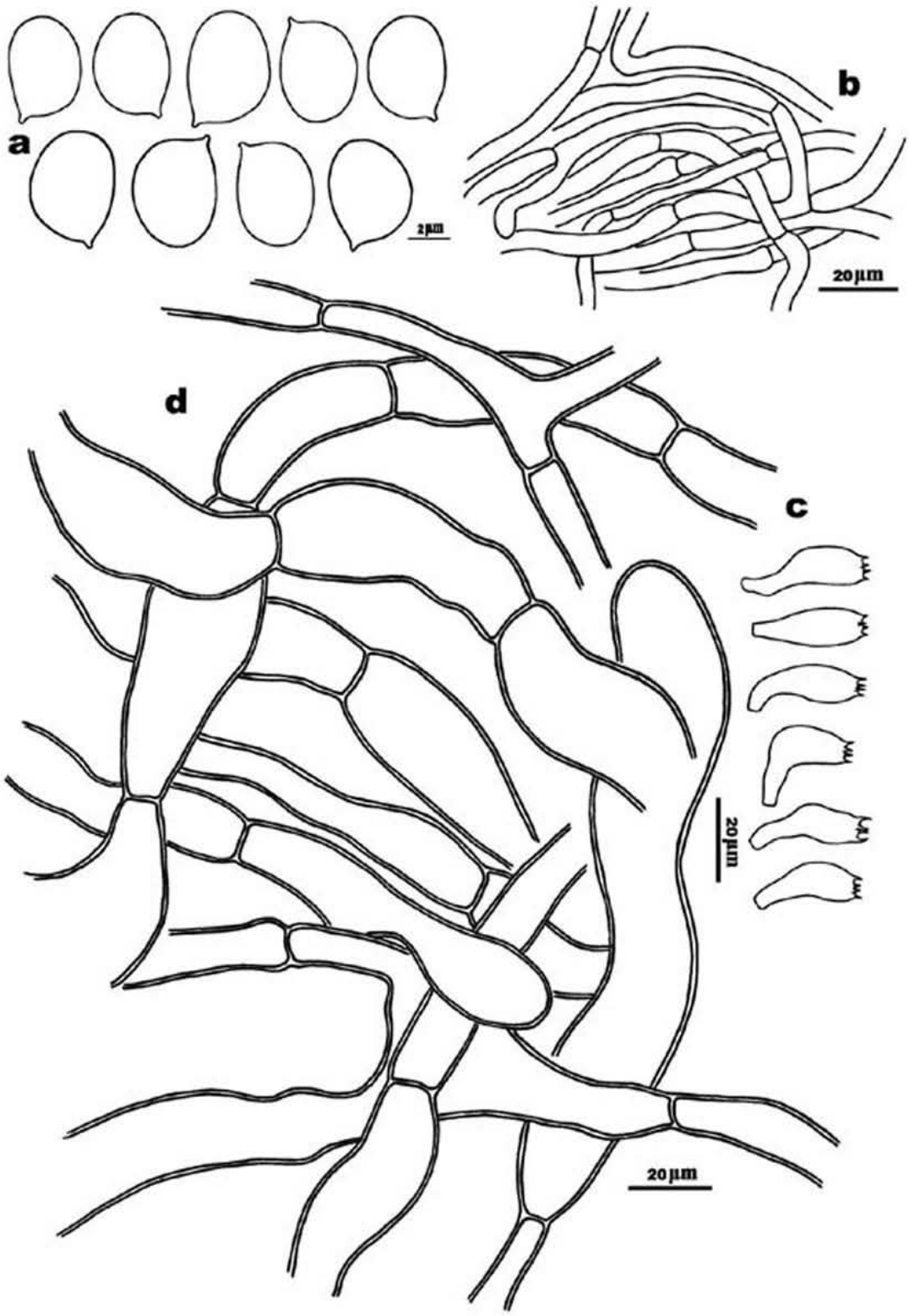

Fig.1 *Albatrellus citrinus* Ryman (HKAS 10748)
a. basidiospores b. tramal hyphae c. basidia d. contextual hyphae

***Albatrellus flettii* Morse ex Pouz.**, Česká Mykol. **26**: 198, 1972
Polyporus flettii Morse, Mycologia **33**: 507, 1941 (invalid name, no Latin diagnosis)

Fig. 2: a-d

SPECIMEN EXAMINED — CHINA, YUNNAN PROV.: Nanhua Co. town wild mushroom market. 26. Aug. 2002. Zheng Huan-Di 128 (HKAS 21574).

REMARKS: The Chinese specimen matches closely the original description and other accounts of *A. flettii* (Morse 1941, Pouzar 1972, Gilbertson & Ryvarden 1986, Ginns 1997). However, the pileus of the specimen is only 9 cm in diameter, which is smaller than that of the North American specimens (up to 20 cm). In addition, some characters of the species drawn from the Chinese specimen were not mentioned in the previous articles (Morse 1941, Pouzar 1972, Gilbertson & Ryvarden 1986, Ginns 1997). They are described as following.

The blue tints of the pileus surface becoming deeper when touched or scraped, with some light brick red splotches after kept in herbarium for some time. The pore surface is cream colored, slowly becoming blue when bruised and brownish on drying.

The species is microscopically similar to *A. confluens* (Alb. & Schw. : Fr.) Kotl. & Pouz. in hyphal characters and basidiospore morphology. They are different in the color of the pileal surface. *A. flettii* is blue-green, whereas *A. confluens* is totally orangish buff to pinkish buff. The coloration variation of different basidiomes of *A. flettii* in all sizes and ages had been described in detail (Ginns 1997). It is impossible to distinguish both species on basis of their microscopic characters without knowing their colors in fresh condition. There was a peculiar character occurring in both species, which called acanthopendia, are cylindrical appendages on the mycelial hyphae covering the stipe base. They are ornamented with hollow, conical spines, being very similar to the acanthophyses of some resupinate and similar fungi (Pouzar 1972). This structure was not mentioned in other articles and was not observed in the Chinese specimen. The rare morphological differences between basidiomes of *A. flettii* and *A. confluens* indicate that they are sister species and may be subspecies (Ginns 1997).

Another *Albatrellus* species with bluish pileal surface is *A. caeruleoporus* (Pk.) Pouz. However, its pileus and pores are entirely blue-gray and the generative hyphae are simply septate, whereas *A. flettii* has blue-green pileal surface but whitish pores and the generative hyphae have clamp connections.

This species had been collected under mixed forest (Morse 1941) and typically with *Tsuga*, other conifer genera and hardwood genera also present in the vicinity of it (Kropp & Trappe 1982, Ginns 1997, Gawin 1998). The specimen cited above was encountered in the market of Yunnan, so the habitat data is unknown. The species is widely distributed in USA (Gilbertson & Ryvarden 1986, Ginns 1997) and is new to China.

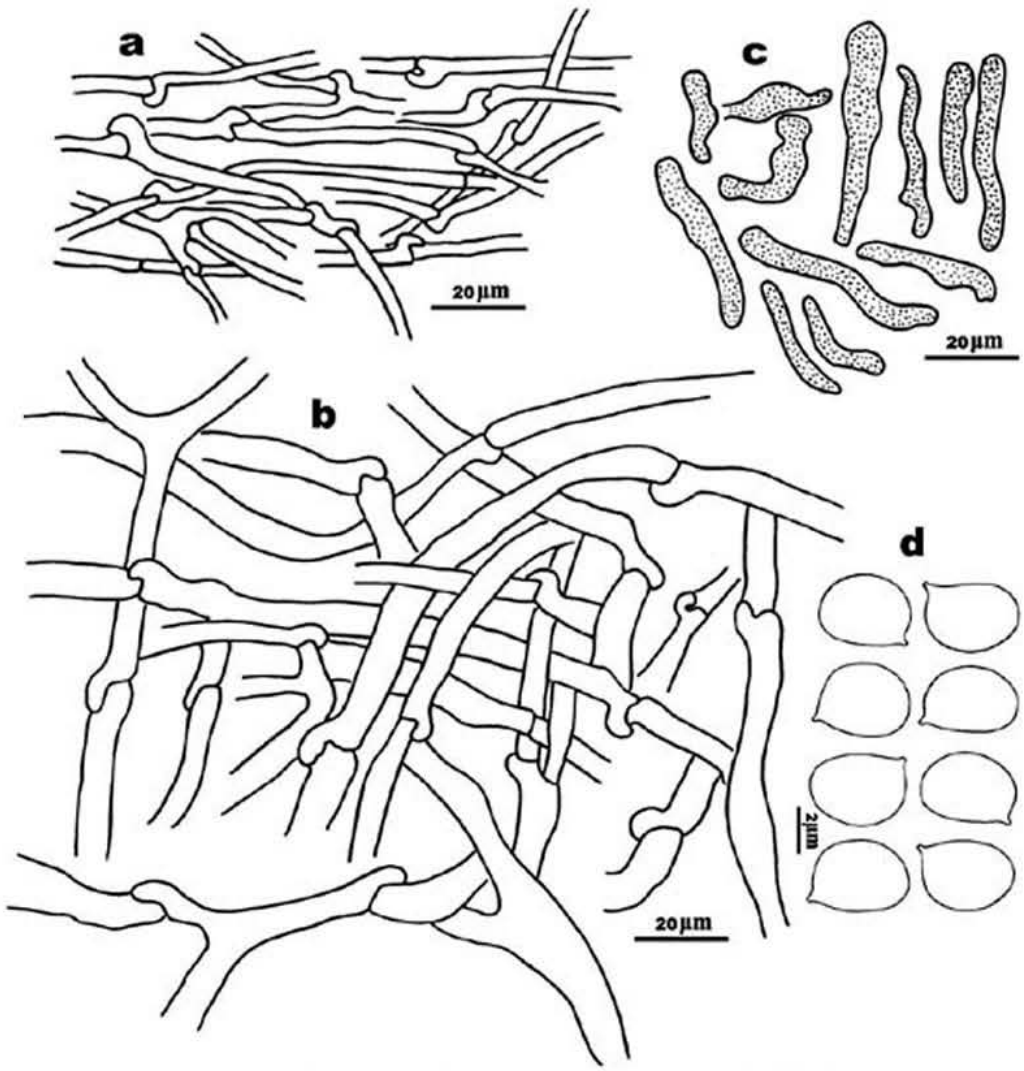

Fig.2 *Albatrellus flettii* Morse ex Pouz. (HKAS 21574)
a. tramal hyphae b. contextual hyphae c. gloeoplerous hyphae d. basidiospores

***Albatrellus skamanius* (Murr.) Pouz.**, Česká Mykol. **26**: 199, 1972
***Polyporus skamanius* Murr.**, Mycologia **38**: 348, 1946

Fig.3: a-d

SPECIMEN EXAMINED — CHINA, YUNNAN PROV.: Nanhua Co. town wild mushroom market. 9. Sept. 2000. Wang Xiang-Hua1156 (HKAS 37109).

REMARKS: The specimen cited above has glabrous to aerolate, blackish pileus, whitish pores and context, generative hyphae with clamp connections and large basidiospores. These are the diagnostic characters of *A. skamanius*. However, there are a few differences between specimens from China and North America. The tubes of the Chinese specimen are discoloring cream or light brownish when bruised, not bruising gray, and the context is not discoloring when cracked or injured as indicated in the description of North American specimens (Ginns 1997). In addition, it was reported that the gloeoplerous hyphae are frequent in context and trama (Gilbertson & Ryvarden 1986, Ginns 1997), but they were rarely seen in our specimen. Probably they are variable because of

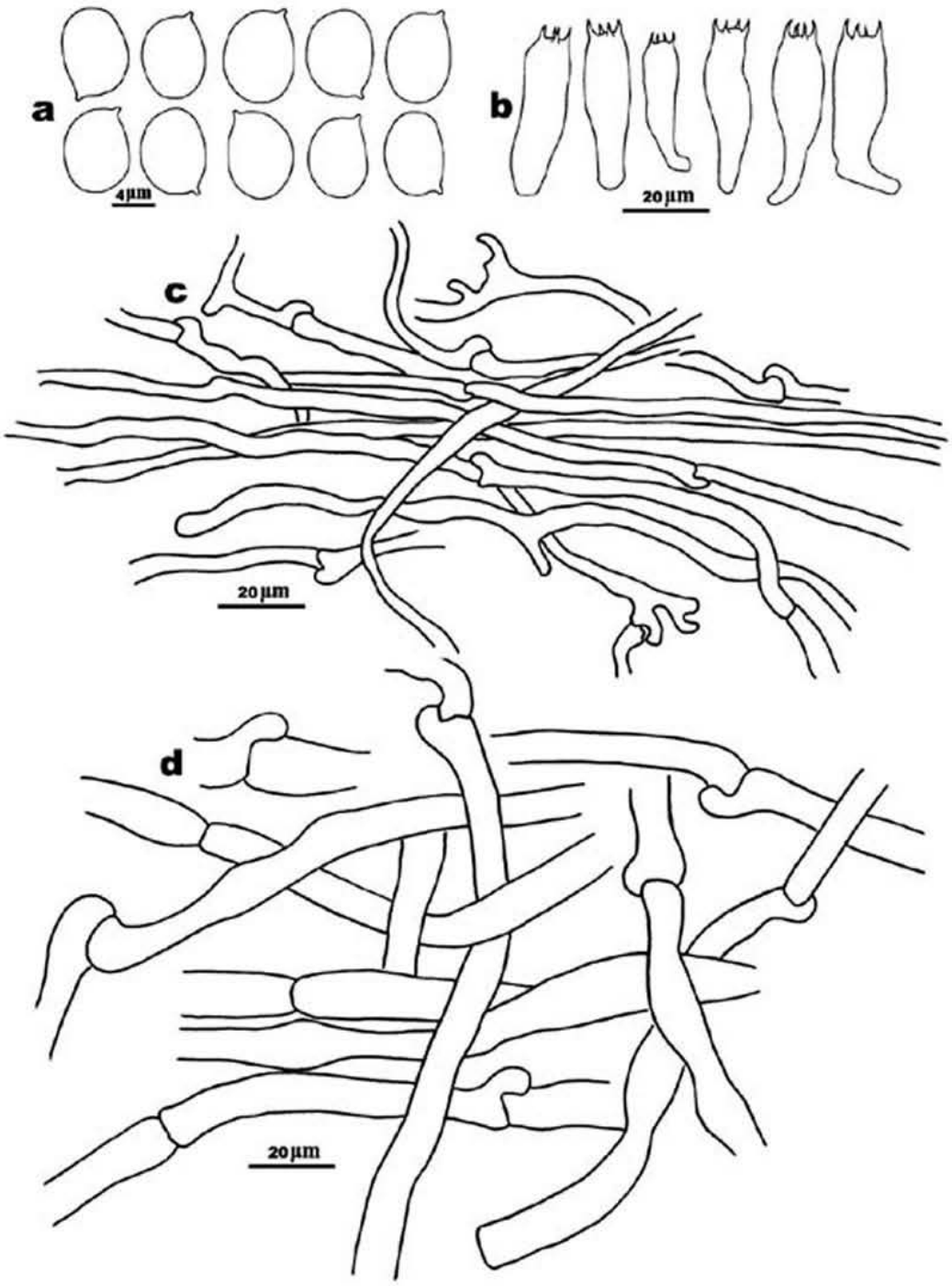

Fig.3 *Albatrellus skamanius* (Murr.) Pouz. (HKAS 37109)
a. basidiospores b. basidia c. tramal hyphae d. contextual hyphae

different environments and development stage of basidiomes.

The two other *Albatrellus* species with large pores, clamp connections, and relatively larger basidiospores are *A. ellisii* (Berk.) Pouz. and *A. pes-caprae* (Pers. : Fr.) Pouz.. *A. ellisii* is distinguished by its olivaceous yellow, yellowish to yellowish tan pileus, becoming grass greenish on handling, and covered by a layer of thick and coarsely

scales composed of erect hyphae. *A. pes-caprae* is distinguished by its brownish to reddish brown color of the pileus and the fibrillose scales covering the pileus surface. In addition, the basidiospores of *A. skamanius* are slightly smaller than those of *A. ellisii and A. pes-caprae* (Gilbertson & Ryvarden 1986, Ginns 1997).

This species is collected under conifers, maybe fir or *Tsuga* (Murrill 1946, Gilbertson & Ryvarden 1986, Ginns 1997). It occurs in northwestern USA (Gilbertson & Ryvarden 1986, Ginns 1997, Pouz. 1972) and is new to China.

***Albatrellus tianschanicus* (Bondartsev) Pouzar**, Folia Geobot. Phytotax. Bohem. **1**: 358, 1966

***Scutiger tianschanicus* Bondartsev**, Bot. Mater. Otdel. Spor. Rastenij. **13**: 220-221, 1930

Fig.4: a-d

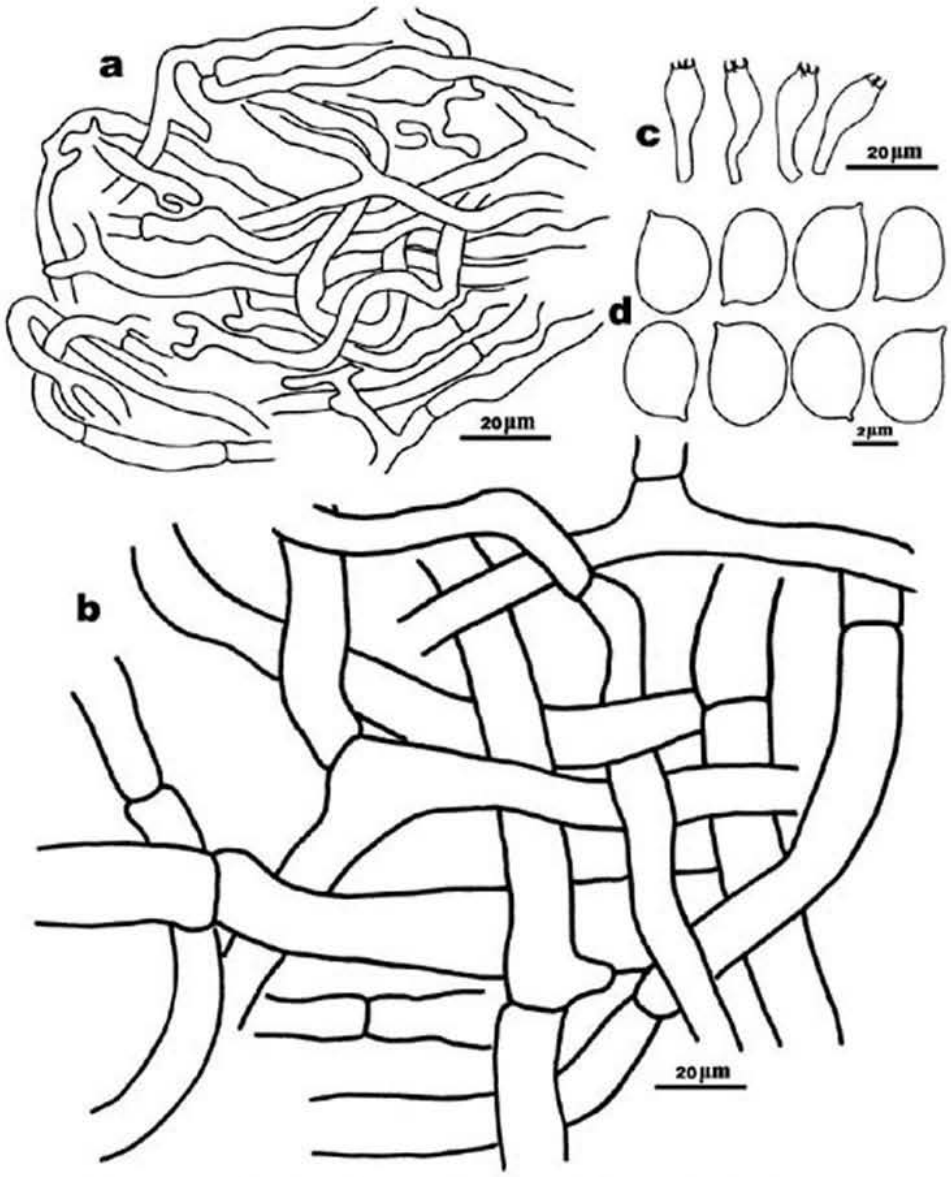

Fig.4 *Albatrellus tianschanicus* (Bondartsev) Pouzar (HKAS 23855)
a. tramal hyphae b. contextual hyphae c. basidia d. basidiospores

SPECIMEN EXAMINED — CHINA, SICHUAN PROV.: Hongyuan. 23. Aug. 1991. Yuan Ming-Sheng1695 (HKAS 23855).

REMARKS: The squamulose pileal surface, the apricot coloration, the light orange stipe with a black base, and generative hyphae lacking clamp connections are conspicuous characters which can be used to distinguish *A. tianschanicus* from other *Albatrellus* species. The specimen cited above is in close agreement with the diagnostic characters mentioned above. It is reported that basidiomes are centrally stipitate (Núñez & Ryvarden 2001, Ryvarden & Gilbertson 1993), however, the stipe of the Chinese specimen is slightly eccentric. The basidiospores of Chinese specimen measured 3.5-5.0 × 2.5-4.0 μm, which has a wider range than that of Russian collections (measured 4.5-5.5 × 3-4 μm, Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001).

The species is close to *A. cantharellus* (Lloyd) Pouz. because both lack clamp connections and have amyloid basidiospores. It differs in its smaller basidiospores (measured 5-7 × 4.5-5.5 μm in *A. cantharellus*) and light orange stipe with a black base which is white in *A. cantharellus* (Núñez & Ryvarden 2001).

This species is reported on the ground under *Picea* (Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001). It occurs in central Russia (Ryvarden & Gilbertson 1993, Núñez & Ryvarden 2001) and is new to China.

Acknowledgements

The authors would like to thank Prof. Leif Ryvarden, Division of Botany and Plant Physiology, Department of Biology, University of Oslo, Norway and Dr. James H. Ginns, ECORC, Agriculture and Agri-Food Canada for their critical reviews, and for their invaluable comments and suggestions on this manuscript. The study was supported in part by grant from the National Science Foundation of China (No.30070004) and the Knowledge Innovation Program of the Chinese Academy of Sciences (project grant no. KSCXZ-1-09-06 & KSCXZ-SW-101C).

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地花菌属的四个中国新记录种

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摘要：本文报道了地花菌属的四个中国新记录种。柠檬黄地花菌(*Albatrellus citrinus* Ryman)菌盖表面黄白色，子实层白色，干后子实体变为橙色，生殖菌丝没有锁状联合，担孢子4.5-5.5 × 3.0-4.5 μm，淀粉质，生于云杉(*Picea*)林下。蓝黄地花菌(*A. flettii* Morse ex Pouz.)菌盖表面幼时蓝色，蓝色会随着生长慢慢消褪，子实层白色，生殖菌丝具锁状联合，担孢子较小，4.5-5.5 × 3.0-4.5 μm。黑色地花菌[*A. skamanius* (Murr.) Pouz.]菌盖表面为黑色，龟裂成许多小块状的鳞片，子实层白色，生殖菌丝具锁状联合，孢子大，7.0-9.0 × 5.5-6.5 μm。天山地花菌[*A. tianschanicus* (Bondartsev) Pouz.]子实体杏黄色或淡橙色，菌盖表面具小鳞片，菌柄上部杏黄色，基部渐细且为黑色，生殖菌丝没有锁状联合，担孢子3.5-5.0 × 2.5-4.0 μm，淀粉质。

关键词：地花菌属，新记录种，中国

MYCOTAXON

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A new North American species in the lichen genus *Physcia* (Ascomycota) with a unique thallus morphology

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Abstract—A new species belonging to the lichen genus *Physcia* and with an unusual subcrustose growth form is described and illustrated. *Physcia dakotensis*, with a primary distribution in the northern Great Plains, has previously been mistaken for the eastern North American species, *P. subtilis*.

Key words—*Physciaceae*, lichenized fungus, taxonomy

Soon after arriving in North Dakota in 1975, I began regional lichen collecting activities, and soon encountered a tiny, unidentifiable and apparently undescribed, saxicolous lichen species that seemed to belong to the genus *Physcia*. Depending on the color of the rock substrate and the accompanying lichens, this small species can sometimes be almost invisible in the field (sans lens), and a number of my early collections were made as incidental admixtures in collections of other, more conspicuous lichens. Since then, I have encountered a number of larger collections with well developed thalli, some of them among my own collections and some received from other collectors. This species is now known to be at least locally common on rock (especially hard, acidic rock such as granite or quartzite) from the Dakotas to Kansas and Iowa, and I have now seen enough material to formally describe this new taxon. Although the distribution is broader than I originally believed, I have chosen to retain the name I originally used for it:

Physcia dakotensis sp. nov. (Fig. 1 & 2)

Thallus arcte adnatus, subcrustaceus, superne griseus vel griseo-albidus, diameter usque 2 cm, subtus pallidus, rhizinae sparsissimus vel plus minusve absens. Lobi 0.2-0.6 mm lati, lineari-elongati, plus minusve contigua, superficies superior sorediati-isidiati.

Thallus foliose to subcrustose, gray to gray-white, often noticeably darkened on the very lobe-tips; commonly orbicular, most often 1-2 cm in diameter, occasionally larger or appearing larger by coalescent thalli. Lobes flat at the ends, often becoming weakly convex inward, narrow, (0.1) 0.2-0.6 mm in width, more or less linear-elongate and broadening slightly at the tips, often confluent or occasionally somewhat imbricate

toward the ends, closely appressed and adnate except right at the tips. Upper surface developing irregular small soralia on internal lobe ends or edges, at first scattered but sometimes becoming abundant, the soredia coarsely granular or becoming more or less upright and strongly isidioid. Medulla white. Lower surface more or less white where visible on the lobe ends, but elsewhere closely appressed to the substrate; rhizines sparse and very poorly developed or essentially absent, usually occurring only as occasional small and irregular pegs. Upper cortex paraplect-enchymatous, the medulla mostly hyphal, lower cortex poorly defined from the medulla or missing, except on the lobe ends where it seems to be little more than compacted hyphae intergrading with the medulla. Apothecia relatively frequent in well developed thalli and sometimes common, up to 0.9 mm in diameter, sessile, more or less flat to weakly concave, the disk black, the exciple entire or occasionally becoming granular isidioid on larger ones; hymenium 80-100 μm thick, ascospores (10) 11-14 (16) x (5.5) 6.5-10 μm, indistinctly *Physcia*-type, the lumina not strongly angular except at an early stage. Pycnidia frequent, often large and conspicuous, partly exposed on the thallus surface; conidia (3.5) 4-5.5 (6.5) x <1-1 μ, more or less rod-shaped, occasionally with a slight bend.

Chemistry: cortex K+ yellow, medulla K- (the medulla is very thin and must be tested very carefully to avoid confusion with the K+ test in the cortex); producing atranorin (identified by TLC).

Type: United States of America. South Dakota. Marshall Co.: along Hwy 25 about 0.4 km S of junction with Hwy 10, just S of Lake City, 45° 42.9' N, 97° 24.58' W, *Esslinger 16030-2* (Holotype, DUKE; Isotypes, US, S, Herb. Essl.).

Selected specimens examined: United States of America. **North Dakota**. Barnes Co.: about 29 km S of Valley City, at Clausen Springs Recreation Area, *Esslinger 5006, 5027* (Herb. Essl.), 19 km W of Valley City, 6.5 km and 2.4 km E of Sanborn, *Trana 2084, 2131, 2138* (MIN), just outside of Valley City, *Trana 1716* (MIN); Morton Co.: ca. 6.4 km S of Mandan at Fort Abraham Lincoln, open prairie, *Esslinger 8410* (Herb. Essl.); Stutsman Co.: Central Grasslands Experiment Station, ca. 13 km NW of Streeter, *Esslinger 8381, 8362* (Herb. Essl.); Kidder Co.: Central Grasslands Experiment Station, *Esslinger s.n.* (Herb. Essl.). **South Dakota.** Brookings Co.: ca. 16 km NW of Brookings at West Oakwood Game Production Area, 44° 27' N, 97° 02' W, *Esslinger 16419, 16420, 16422, 16426* (Herb. Essl.); Deuel Co.: The Nature Conservancy's Altamont Prairie, 44° 53.35' N, 96° 32.06' W, *Wilson4199* (OMA, Herb. Essl.), The Nature Conservancy's Jacobsen Fen Preserve, *Wilson 4198* (OMA, Herb. Essl.); Grant Co.: Blue Cloud Abbey, 45O 15.18"N, *Wilson 4005* (MIN, KANU, OMA, Herb. Essl.); Lincoln Co.: The Nature Conservancy's Wilson Savannah Preserve, 43°09.23' N, 96° 28.29' W, *Wilson 4201* (OMA, Herb. Essl.), Windrows Polo Field, 43° 29.41' N, 96° 35.93' W, *Wilson 4200* (OMA, Herb. Essl.); Minnehaha Co.: Palisades State Park, 43° 41.11' N, 96° 31.51' W, *Wilson 3943, 4179* (Herb. Essl.), 1.6 km S & 1.6 km W of Branden, Big Sioux Recreation Area, 43° 34.85'N, 96° 35.87' W, *Wilson 3576* (OMA. Herb. Essl.); Moody Co.: The Nature Conservancy's Sioux Prairie, 44° 01.75' N, 96° 47.29' W, *Wilson 4191* (Herb. Essl.); Turner Co.: 21 km W and 1.6 km S of Hurley, 43° 15.74' N, 97° 20.33' W, *Wilson 3833* (OMA, Herb. Essl.). **Minnesota**: Brown Co.: Mound Creek County Park, 44° 06.91'N, 95°05.26' W, *Wilson* 4222 (OMA, Herb.

Essl.); Clay Co.: 5.6 km S of Felton, *Thomson 20455* (MIN); Cottonwood Co.: The Nature Conservancy's Red Rocks Preserve, 44° 05.43' N, 95° 01.15' W, *Wilson 4217* (OMA, Herb. Essl.); Lincoln Co. : The Nature Conservancy's Hole in the Mountain Preserve, 44° 14.28' N, 96° 18.13' W, *Wilson, 4194* (OMA, Herb. Essl.); Lyon Co.:

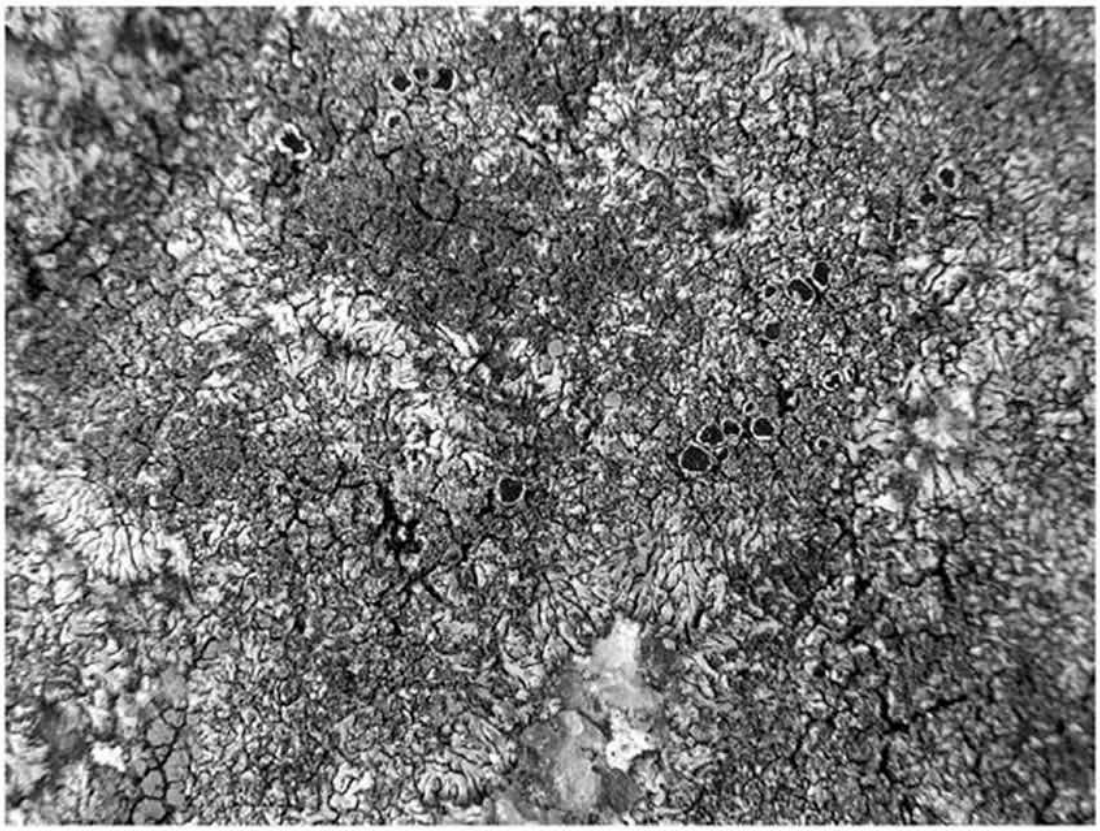

Fig. 1. Part of the holotype of *Physcia dakotensis* (x3).

Camden State Park, 44° 21.99' N, 95° 56.86' W, *Wilson 4196* (OMA, Herb. Essl.); Pipestone Co.: Pipestone National Monument, 44° 00.62' N, 96° 19.22' W, *Wilson 4193* (OMA, Herb. Essl.); Rock Co.: Blue Mounds State Park, 43° 43.21' N, 96° 11.50' W, *Wilson 4159*, (OMA, Herb. Essl.); Swift Co.: ca. 19.3 km W of Murdock on Rte 33, *Wheeler 16971* (MIN). **Iowa**. Bremer Co.: *Fink*, 1894, 1895 (MIN); Dickinson Co.: The Nature Conservancy's Freda Haffner Kettlehole Preserve, 43° 20.74'N, 95° 13.24'W, *Wilson 4206* (Herb. Essl.), *4207* (OMA, Herb. Essl.); Emmet Co.: Anderson Prairie State Preserve, 43° 26.27' N, 94° 52.25' W, *Wilson 4210* (OMA, Herb. Essl.); Fayette Co.: *Fink*, 1894 (MIN); Lyon Co.: ca. 4.8 km N & 13.7 km W of Larchwood, Gitchie Manitou State Preserve, 43° 30.03' N, 96° 35.50' W, *Wilson 3537* (OMA, Herb. Essl.); Sioux Co.: Oak Grove Park, 1.6 km E & 5.6 km N of Hawarden, 43° 03.3' N, 96° 28.46' W, *Wilson 4204* (OMA, Herb. Essl.). **Kansas**. Chase Co.: 0.8 km S, 4.8 km W of Jct of 240th Rd & Hwy 177 at Cottonwood Falls, 38° 21.95' N, 96° 35.8' W, *Morse 10183* (KANU); Chautauqua Co.: 0.4 km E, 0.4 km S of Chautauqua, 37° 01.38'N, 96°

10.38'W, *Advaita 1999* (Herb. Essl., KANU; with admixture of *P. halei*); Cherokee Co.: 4.8 km E, 0.4 km N of Jct of US Hwy 69 & KS Hwy 96 at Crestline, 37° 10.88' N, 94° 38.98' W, *Morse 10183* (Herb. Essl., with admixture of *P. subtilis*); Douglas Co.: 7.2 km S, 3.6 km W of Stull, 38° 54.04 N, 95° 29.6'W, *Morse 10553* (Herb. Essl., KANU) Labette Co.: 1.6 km N, 7.2 km E of Cherryville, 37° 16.52'N, 95° 28.4'W, *Advaita* 2791 (KANU); Montgomery Co.: 4 km N of Havana, 37° 07.99' N, 95° 56.24' W, *Advaita 2387* (Herb. Essl., KANU); Shawnee Co.: 0.8 km SE of Willard, Herbert Reinhard Green Wildlife Area, 39° 05.03' N, 95° 56.27' W, *Advaita 1371* (Herb. Essl.).

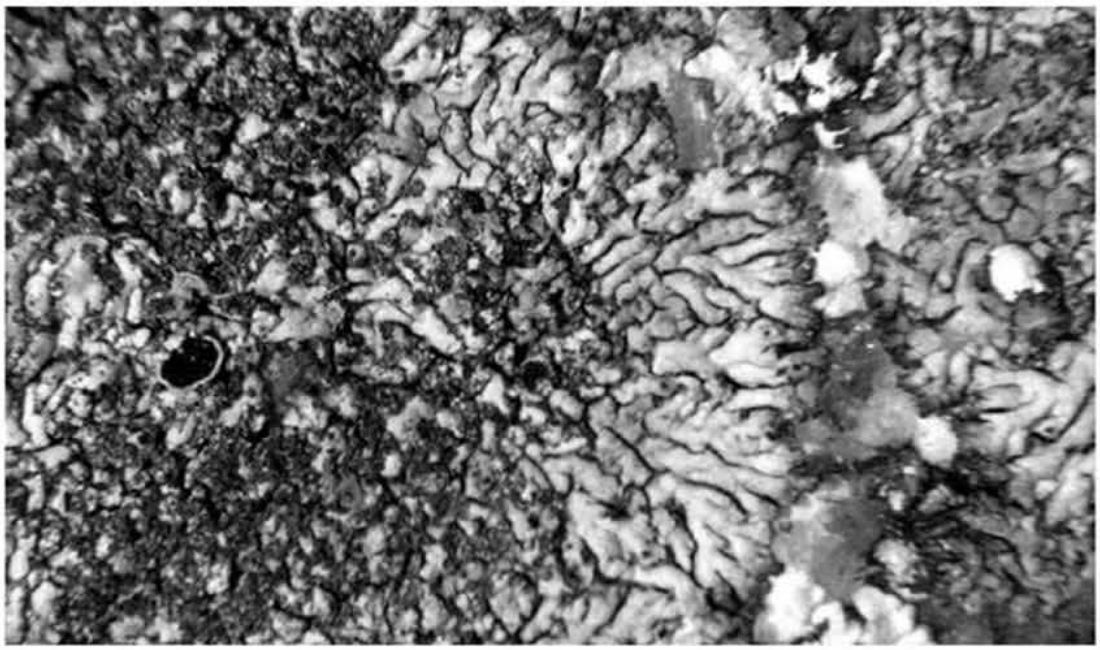

Fig. 2. Closeup of part of the holotype of *Physcia dakotensis* (x7.5)

Although small and easily overlooked, this new species is distinctive and easy to distinguish from other members of the genus. In the past, it is most likely to have been misidentified as *P. subtilis* Degel., a slightly similar, small and saxicolous species (Fig. 3). However, the latter species is sorediate-blastidiate and has a very distinctive lower cortex with well developed and conspicuous rhizines, although these range from sparse to moderately numerous. The thallus habit of *P. subtilis* varies, from distinctly raised off of the substrate to fairly closely appressed, but is never tightly adnate and subcrustose as are most specimens of *P. dakotensis*. In *P. subtilis*, entire thalli or at least large parts of individual lobes are easily removable from the substrate essentially intact, whereas in *P. dakotensis*, thallus removal is impossible and usually only the very end of the lobes are separable from the substrate, and then only while viewing under a dissecting microscope. Among all the specimens examined for this study, only one had been removed from the rock substrate, and it was so fragmented as to be almost unidentifiable. This subcrustose habit appears to be unique among known species of *Physcia*, although two specimens seen from Kansas, which apparently represent a fertile, non-sorediate taxon, are equally if not more closely attached. These possibly represent a new taxon and are still being studied.

The taxonomy of *P. subtilis* and related taxa requires further study. Although *P. subtilis* has been described as having a paraplectenchymatous medulla composed of more or less isodiametric cells, the material seen by me from the Midwest, as well as much of the material from the eastern U.S., has a dense, compactly hyphal to almost prosoplectenchymatous medulla. This material may actually represent a distinct taxon but, regardless, is easily distinguished from *P. dakotensis*.

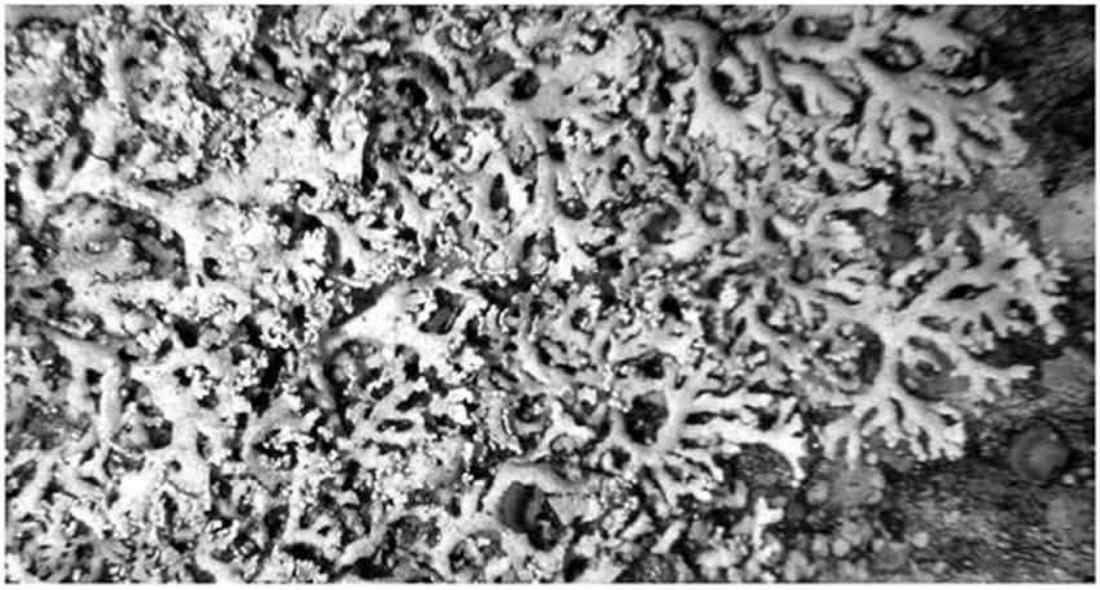

Fig. 3. Closeup of *Physcia subtilis*, Esslinger 3253 (Herb. Essl., x7.5)

Some specimens of *P. dakotensis*, especially the most closely appressed and tightly adnate specimens, on which rhizines can be seen with difficulty if at all, can be reminiscent of certain placodioid species of *Rinodina*. A specimen was sent to John Sheard, who kindly confirmed that he had seen nothing like it described in *Rinodina*.

Apparently, this is the first species to be described in the genus *Physcia* (sensu stricto) that lacks well developed rhizines and has an essentially subcrustose habit. Older treatments of *Physcia*, as well as the most recent North American treatment (Thomson 1963), included subcrustose elements such as today's *Hyperphyscia* within the genus, but these taxa have long been removed from the genus. No species with a subcrustose habit are described in modern works on the genus (e.g. Moberg 1990, 1997, 2002, Nowak 1993). In *P. dakotensis*, only the ends of the lobes are more or less separable from the substrate intact, and even there only a poorly defined lower cortex is visible.

Physcia dakotensis occurs primarily on exposed rock in prairies, pastures, and other very open areas. In the eastern Dakotas, one very common habitat is the piles of field stones occurring in many farm fields, which are mostly composed of granite or similar acidic rock. One specimen from central North Dakota (*Trana 2084*, MIN) was growing on a well-weathered fence post. The distribution as known today, coincides approximately with the northern region of the Great Plains.

Acknowledgements

I wish to thank John Sheard for examining a specimen of this taxon and confirming that it had not previously been described as a *Rinodina*. My gratitude is also extended to Caleb Morse (KANU) and Cliff Wetmore (MIN) for arranging specimen loans, and especially to Nancy Wilson for the gifting of many specimens.

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MYCOTAXON

Volume 90(2), pp. 307–309 *October-December 2004*

Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Ceriporia, Ceriporiopsis* and *Perenniporia*

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Abstract—Distribution and host plants in North Carolina are given for 6 species of *Ceriporia*, 2 of *Ceriporiopsis* and 10 of *Perenniporia*. A county distribution map is provided for each of the taxa with seven reported for the first time in North Carolina. Numerous new fungus-host plant associations are reported. Species checklists and figures can be accessed at: http://www.cals.ncsu.edu/plantpath/Personnel/Faculty/Grand/mycotaxon_2.pdf

Key words—fungus distribution, polypores

Introduction

The importance of biodiversity and biogeography of fungi was addressed by Grand & Vernia (2004). Previous studies of poroid wood decay fungi in North Carolina provided information on the occurrence and host plants (Vernia & Grand 2000, Grand & Vernia 2002, 2003, Jung 1987). Grand and Vernia (2004) recently reported on the occurrence and host plants of species of *Phellinus* and *Schizopora*. This report is the second in a continuation of a long-term study of poroid wood decay fungi in North Carolina and deals with species of *Ceriporia, Ceriporiopsis* and *Perenniporia*.

Materials and methods

Details of study sites, collection and identification procedures were presented in Grand & Vernia (2004).

Species of fungi on plant hosts were intensively collected from 1997-2003 by the authors. Data from other studies (Grand et al. 1975, Jung 1987), collections in the Mycological Herbarium (NCU), North Carolina State University, records of the Plant Disease and Insect Clinic, Plant Pathology Department, NCSU were used in developing the distribution maps. Likewise, data from the BPI website (Farr et al. n.d.) provided some county data.

Collections were made of all uncommon species of *Ceriporia, Ceriporiopsis* and *Perenniporia*, unusual forms of these species and species on new or unusual hosts. Specimens were identified using existing taxonomic treatments (Breitenbach &

Kraenzlin 1986, Gilbertson & Ryvarden 1986, 1987, Jung 1987, Lowe 1966, Lowe & Gilbertson 1961, Overholts 1953). Nomenclature and authorities are from Gilbertson & Ryvarden (1986, 1987) and Kirk & Ansell (1992) for fungi and Kartesz & Kartesz (1980) for host plants.

The majority of collection sites were in state parks, game lands and natural areas, Nantahala, Pisgah, Croatan and Uwharrie National Forests, the Blue Ridge Parkway and the Great Smoky Mountains National Park. A county distribution map is provided for each species (Figs. 1-18).

Results and discussion

Ceriporia reticulata (Pers.: Fr.) Domanski, *C. viridans* (Berk. & Broome) Donk, *Ceriporiopsis gilvescens* (Bres.) Domanski, *Perenniporia ellipsospora* Ryvarden & Gilb., *P. phloiophila* Gilb. & M. Blackwell, *P. robiniophila* (Murrill) Ryvarden and *P. tephrophora* (Mont.) Ryvarden are reported for the first time in North Carolina.

Only *Ceriporia alachuana* (Murrill) Hallenb. (Fig. 1), *Perenniporia medullapanis* (Jacq.: Fr.) Donk (Fig. 12), *P. subacida* (Peck) Donk (Fig. 16) and *P. tenuis* (Fig. 17) were collected frequently enough to establish a distributional pattern in North Carolina.

The ranges of *C. reticulata* and *C. viridans* are extended considerably south and east, respectively, of those previously reported for these species (Gilbertson & Ryvarden 1986). The range of *Ceriporiopsis gilvescens* is extended considerably south of previous reports (Gilbertson & Ryvarden 1986). *Perenniporia tephrophora* was previously reported only from Louisiana.

Fifty-five new hosts are reported for the 18 species of *Ceriporia*, *Ceriporiopsis*, and *Perenniporia*. See list of species for specific fungus-host combinations.

Acknowledgements

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MYCOTAXON

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The genus *Lentinus* in Kerala State, India

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Abstract—Nine species of *Lentinus* from Kerala State, India are documented. A new species, *L. dicholamellatus*, is described. *Lentinus polychrous*, *L. strigosus*, *L. hookerianus*, and *L. similis* are new records for Kerala.

Keywords—*Polyporaceae*, *Polyporales*, Basidiomycota

Introduction

Although species of *Lentinus* Fr. (*Polyporaceae*, *Polyporales*, Basidiomycota) are dominant elements of agaricoid mycota of the tropics, very little information is available on the species occurring in Kerala State, India. Manjula (1983), in her revised list of agarics known from India, listed seventeen species of *Lentinus*. From Kerala State, only four species of *Lentinus* have been recorded so far. These include *L. caespiticola* Pat. & Har. (Manimohan & Leelavathy 1995), *L. giganteus* Berk. (Joseph *et al.* 1995), *L. sajor-caju* (Fr.) Fr. (Sathe & Daniel 1980), and *L. squarrosulus* Mont. (Sharma et al. 1985). During our studies on agarics of Kerala, we encountered nine species of *Lentinus*, including a new species, which are documented here.

Materials and Methods

Microscopic observations were made on material mounted in 3% aqueous KOH. Colour codes refer to Kornerup & Wanscher (1978). All collections examined, except those of *L. caespiticola*, are deposited in the National Herbarium of the Netherlands, Leiden (L). *Lentinus caespiticola* collections are at Kew Herbarium (K).

Key to the species

1. Context with skeleto-ligative hyphae; hyphal pegs present 2
1. Context without skeleto-ligative hyphae; hyphal pegs absent 5

2. Lamellae repeatedly furcate; lamellulae very rare or absent; spores 6-10 x 3-5 μm ..... *L. dicholamellatus*

2. Lamellae not repeatedly furcate; lamellulae present 3

3. Pileal surface lacking erect squamules, golden beige; spores 5-7 x 2-2.5 μm ..... *L. sajor-caju*

3. Pileal surface squamose-squarrose 4

4. Pileus cinnamon yellow with concentric zones of fulvous or darker recurved squamules; spores 7-9 x 2-3 μm ..... *L. polychrous*

4. Pileus whitish to cream-coloured, with concentric zones of whitish or brownish squamules; spores 5-7 x 1.7 μm ..... *L. squarrosulus*

5. Hymenophoral cystidia present as either gloeocystidia or metuloids 6

5. Gloeocystidia or metuloids are absent; sometimes skeletocystidia may be present- 7

6. Basidiomata small; graminicolous; hymenium with gloeocystidia; spores 5-7.5 x 4- 5.5 μm ..... *L. caespiticola*

6. Basidiomata medium-sized to large; not graminicolous; gloeocystidia absent but metuloids present; spores 4-6.5 x 2-3.5 μm ..... *L. strigosus*

7. Pileal surface glabrescent or with appressed-fibrillose squamules; spores 5-7 x 4-4.5 μm, ovo-elliptical ..... *L. giganteus*

7. Pileal and stipe surface velutinate to hispid-strigose; spores different 8

8. Pileus 2-4.5 cm diam.; surface densely villose to hispid-strigose; no striations or zonations; lamellae crowded; stipe 1-2 cm x 4-6 mm, not arising from a sclerotium or pseudosclerotium; spores 5-6.5 x 3-4 um, ovo-ellipsoid in shape ..... *L. hookerianus*

8. Pileus 5-10 cm diam.; surface finely velutinate with closely plicate-striate; lamellae subdistant to close; stipe 4-9 cm x 3-8 mm, arising from a pseudosclerotium; spores 5-7 x 2.5-3 μm, oblong-cylindrical in shape ..... *L. similis*

Description of new species

Lentinus dicholamellatus Manim. *sp. nov.* **FIGURES 1-2**

Pileus 1-16 cm latus, primo convexo-umbilicatus, postea infundibuliformis, primo pallide luteus, postea atrobrunneus, subtiliter fibrilloso-striatus, squamulis appressis minutis praeditus. Lamellae decurrentes, luteoalbidae, confertae, angustae, repetite furcatae. Lamellulae nullae vel inusitatae. Stipes 1.5-10 cm x 3-20 mm, centralis, cylindricus, solidus, primo luteoalbidus, postea brunneus, tomentosus, saepe squamulosus. Sporae 6-10 x 3-5 μm, oblongo-ellipsoideae vel subcylindricae. Basidia 15-29 x 4.5-9 μm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 8-47 x 3-7 μm, sinuoso-cylindrica, raro nodulosa, crassitunicata, atro brunnea. Pleurocystidia nulla. Paxillae hypharum praesentiae. Trama hymenophoralis ex hyphis radiatis instructa. Systema hypharum dimitica; hyphae generatoriae 2-6 μm latae, tenuitunicatae, hyalinae; hyphae skeleto-ligativae 2-6 μm latae, crassitunicatae, hyalinae, ramosae. Epicutis pilei disrupta, ex hyphis 2-7 μm latis luteobrunneis fibulatis crassitunicatis composita. Ad lignum putrescens.

Basidiomata medium-sized to large and robust, growing scattered or in small or large clusters on decaying wood. **Pileus** 1-16 cm in diam., initially convex with a depressed centre, becoming deeply infundibuliform; surface initially pale yellow (4A2/4A3),

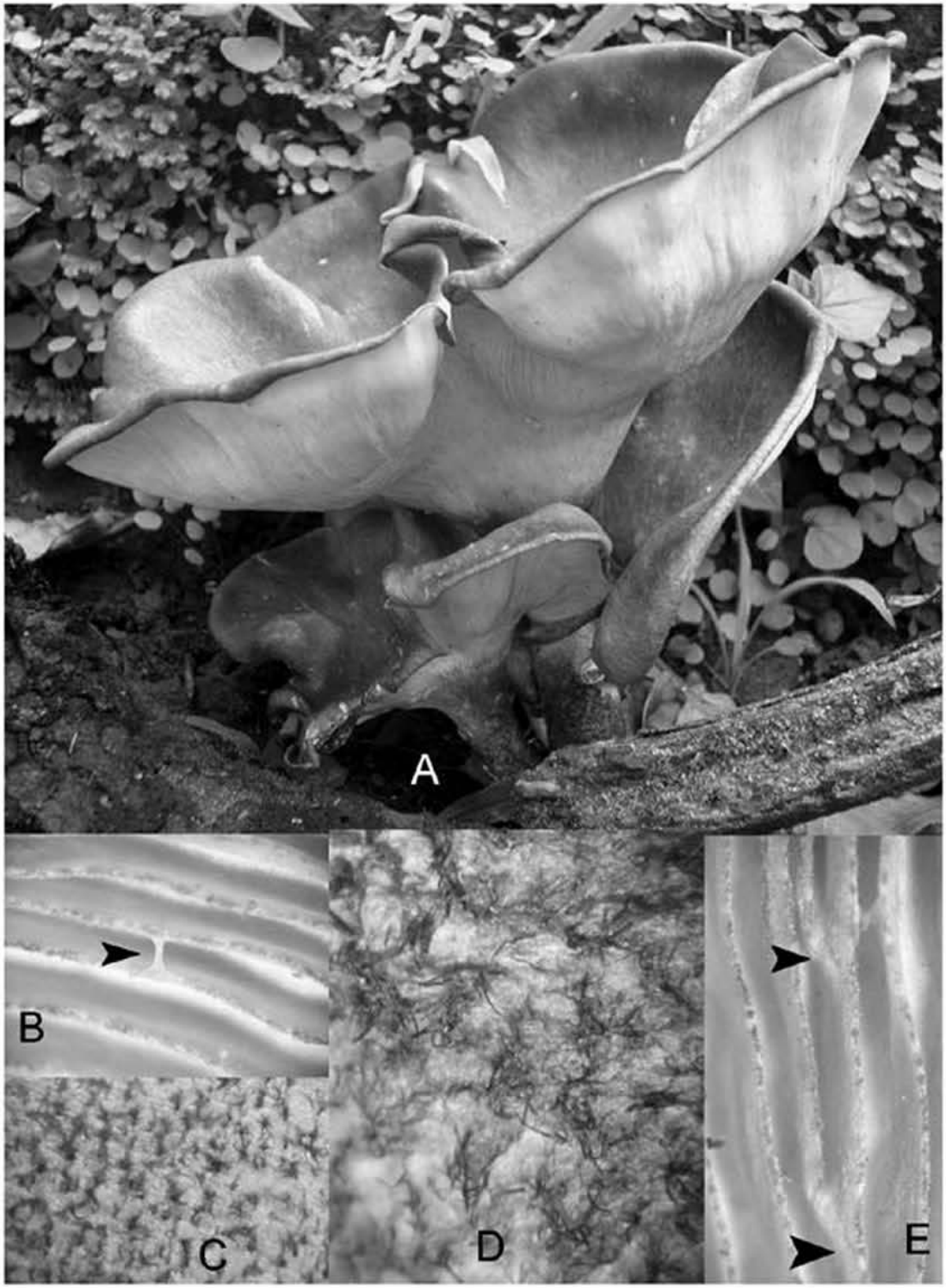

Fig. 1. *Lentinus dicholamellatus*: A, basidiomata, x 0.7; B, bridge-like structures connecting adjacent lamellae (arrow), x 8; C, squamules of pileal surface, x 3; D, squamules of stipe surface, x 4; E, repeatedly furcate lamellae (arrows), x 8.

changing through greyish orange (5B4), brownish orange (5C4) or greyish brown (5E4/5E5) and finally becoming dark brown (6F6), finely radially fibrillose-striate to the naked eye, under a lens densely dotted with very fine appressed or erect squamules; margin incurved and remaining so, entire becoming undulate or lobate. **Context** pale yellow (3A3/4A2), 1 mm or less wide. **Lamellae** deeply decurrent, crowded, yellowish white (4A2), less than 1.5 mm wide; lamellulae very few or even absent but lamellae often repeatedly furcate at several levels; edge finely fimbriate and spotted greyish brown under a lens. **Stipe** 1.5-10 cm x 3-20 mm, central or eccentric, almost equal or slightly tapering towards base, terete, solid; surface initially yellowish white (4A2), becoming greyish brown (6E4) or brown (8F4), tomentose, sometimes dotted with erect pointed squamules; base not attached to a pseudo- or true sclerotium. **Odour** not distinctive.

Spores 6-10 x 3-5 (7.68±1.08 x 4.35±0.45) μm, Q = 1.25-2.33, Qm = 1.79, mostly oblong-ellipsoid to subcylindric, some widely ellipsoid, ellipsoid or cylindric, hyaline, thin-walled, smooth, inamyloid. **Basidia** 15-29 x 4.5-9 μm, clavate to cylindrico-clavate, 4-spored; sterigmata up to 3 μm long. Lamella-edge sterile. **Cheilocystidia** 8-47 x 3-7 μm, sinuous-cylindric, rarely nodulose, thick-walled, with a dark brown wall pigment, often with basal clamp connections. **Pleurocystidia** absent. **Hyphal pegs** scattered on the hymenium, 62.5-185 x 37.5-87.5 μm, projecting up to 150 μm beyond the hymenial surface, conic to somewhat cylindric, composed of thin-walled hyphae. Structures identical to hyphal pegs in all aspects but interconnecting adjacent lamellae frequently seen towards the lamella-edges. **Lamellar trama** irregular, of radiate construction; dimitic, composed predominantly of skeleto-ligative hyphae, 2-6 μm wide, with a thick wall up to 1.5 μm wide, hyaline, with gradually tapering branches; generative hyphae 2-6 μm wide, thin- to slightly thick-walled, septate, branched, with prominent clamp-connections. **Pileal trama** inter-woven, dimitic; hyphae similar to those of lamellar trama. **Pileipellis** a cutis of thick-walled generative hyphae frequently disrupted by bundles of loosely aggregated erect hyphae or ascending or erect bundles of cystidioid end-cells similar to cheilocystidia; hyphae 2-7 μm wide, thick-walled, with a pale yellowish to dark yellowish brown wall and sometimes with dark brown encrustations, with clamp-connections. **Stipitipellis** a trichodermium composed of 1.5-7 μm wide, thin- to slightly thick-walled, pale yellowish to yellow brown generative hyphae with frequent clamp connections: squamules of the stipe surface composed of ascending or erect, 300-650 μm long bundles of 1.5-3.5 μm wide, slightly thick-walled, dark brown hyphae.

COLLECTIONS EXAMINED — INDIA, KERALA STATE, Malappuram District, CALICUT UNIVERSITY CAMPUS: 2 August 2003, *P. Manimohan, M796*; 2 August 2003, *N. Divya, D8*; 6 August 2003, *P. Manimohan, M797*; 7 August 2003, *P. Manimohan, M798* **(holotype)**; 7 August 2003, *P. Manimohan, M799* (all at L).

Repeatedly furcate lamellae, near absence of lamellulae, presence of both skeleto-ligative hyphae and hyphal pegs, and the uninflating generative hyphae together place this species in section *Dicholamellatae* Pegler of the subgenus *Lentinus*. It does not agree with any of the three species admitted by Pegler (1983) in that section. The Southeast Asian species *L. badius* (Berk.) Berk., and the Australasian species *L. araucariae* Har. & Pat. show the following differences: distinctive subpyramidal pseudoparenchymatous velar squamules on the pileal surface, smaller spores, absence

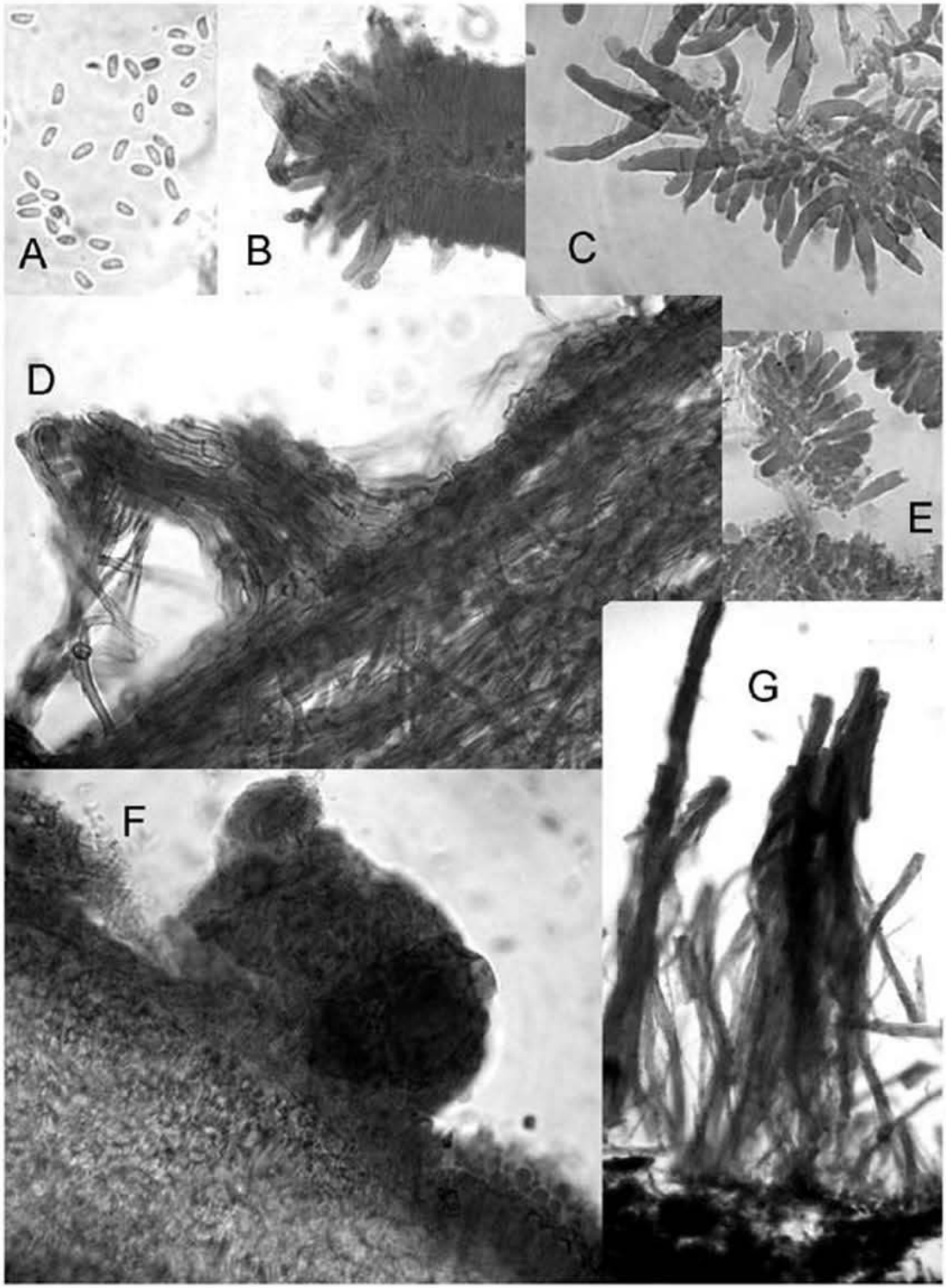

Fig. 2. *Lentinus dicholamellatus:* A, spores, x 300; B, lamella-edge, x 400; C, cheilocystidia, x 500; D, pileipellis, x 400; E, basidia, x 450; F, hyphal peg, x 500; G, stipitipellis, x 100.

of both cheilocystidia and emerging hyphae on the lamella-edge, extremely abundant hyphal pegs, wider (up to 12.5 μm) skeleto-ligative hyphae with a much thicker (up to 4 μm) wall, and a gelatinized hypodermium. The African species *L. brunneofloccosus* Pegler is characterized by a complete absence of hyphal pegs in the hymenium, and large, thick, detersile squamules on the pileal surface. Apart from these differences, *L. dicholamellatus* shows one unique feature: the adjacent lamellae are often interconnected by bridge-like structures (Fig. 1B), which are strikingly similar to hyphal pegs in morphology and composition. These structures are usually seen towards the lamella-edge. This seems to be a consistent feature of this species as we observed them in all the specimens of *L. dicholamellatus* examined by us although their frequency ranged from very frequent to very sparse.

Comments on other species

***Lentinus sajor-caju* (Fr.) Fr.,** Epicrisis: 393. 1838.

Although this species is widely referred to as *Pleurotus sajor-caju* (Fr.) Singer, it is a true *Lentinus* species owing to the presence of skeleto-ligative hyphae. The Kerala collections agree remarkably closely with those described by Pegler (1983) and do not show any kind of disagreement in any feature. The spores measured 5-7 x 2-2.5 μm.

Collections examined — **INDIA, Kerala State, Thiruvananthapuram District**, Palode, TBGRI campus: 4 May 1996, *K. B. Vrinda, TBGT3010*; 26 June 1996, *K. B. Vrinda, TBGT5841* (all at L).

***Lentinus polychrous* Lév.,** Ann. Sci. Nat., Bot. ser. 3, 2: 175. 1844.

Lentinus polychrous is a species confined to South and Southeast Asia. Although Pegler (1983) described this species as dimitic, Corner (1981) described it to be almost trimitic. Our observation of the Kerala collection revealed distinct generative, skeletal, and skeleto-ligative hyphae and thus it confirms Corner's observation. According to Pegler (1983), it is rare to encounter a fertile hymenophore in this species. Supporting this observation, basidia were not observed in one of the two collections made in Kerala. Spores of our collections measured 6-9(10) x 2.5-3(4) μm.

Collections examined — **INDIA, Kerala State, Ernakulam District**, Iringole Sacred Grove: 20 August 1994, *K. B. Vrinda, TBGT1440*; **Thiruvananthapuram District**, Palode, TBGRI Campus: 29 March 1995, *K. B. Vrinda, TBGT2004* (all at L).

***Lentinus squarrosulus* Mont.,** Ann. Sci. Nat. Bot. Ser.2., 18: 21. 1842.

Lentinus squarrosulus is a paleotropical species showing wide distribution. According to Pegler (1983), the fungus reported as *L. crinitus* by Natarajan & Raman (1981) from southern India represents *L. squarrosulus*. Spores of the Kerala collections measured 5-7.5 x 1.75-3 μm.

Collections examined — **INDIA, Kerala State, Ernakulam District**, Iringole Sacred Grove: 15 October 1994, *K. B. Vrinda, TBGT1773*; **Thiruvananthapuram District**, Palode, TBGRI campus: 25 November 1993, *K. B. Vrinda, TBGT437*; **Palakkad District**, Dhoni: 23 February 1996, *K. B. Vrinda, TBGT3734*; **Malappuram District**, Calicut University Campus: 26 July, 2003, *N. Divya, D5*; 21 October, 2003, *P. Manimohan, M800*; 18 November 2003, *Arun Kumar, AK14* (all at L).

***Lentinus caespiticola* Pat. & Har.,** J. Bot., Paris 14: 240. 1900.

Lentinus caespiticola is unique among species of *Lentinus* in that it is graminicolous. Manimohan & Leelavathy (1995) observed that the collections made from Kerala State never showed the caespitose habit, one of the characteristic features of this species, and hence they erected a new variety, *L. caespiticola* var. *asiaticus* Manim. & Leelav., based on the Kerala collections. Spores of the Kerala collections measured 5-7.5 x 4-5.5 μm. A full description of the Kerala collections is given in Manimohan & Leelavathy (1995) and we fully agree with their observations and conclusions.

Collections examined — **INDIA**, **Kerala State**, **Malappuram District**, Calicut University Campus: 23 October 1990, *P. Manimohan, K(M)25899*; 24 October 1990, *P. Manimohan, K(M)25900*; 29 September 1992, *P. Manimohan, K(M)25901*; 30 September 1992, *P. Manimohan, K(M)25902*; 26 October 1993, *P. Manimohan, K(M)25898* (all at K).

***Lentinus strigosus* (Schwein.) Fr.,** Syst. Orb. Veg.:77. 1825.

Lentinus strigosus has a geographical distribution ranging from the tropics to subtemperate regions. The distinguishing features of the species are the short, eccentric, hispid stipe, the pale-coloured pileus lacking striations and zonations, the small ellipsoid spores and the large metuloidal cystidia. The Kerala collections nicely fit into the description of the species given by Pegler (1983). Spores of our collections measured 4-6.5 x 2-3.5 μm.

Collections examined — **INDIA**, **Kerala State**, **Wayanad District**, Mundakkai: 12 September 1985, *P. Manimohan, M341*; **Kannur District**, Pulikurumba: 23 September 1997, *P. Manimohan, M730* (all at L).

***Lentinus giganteus* Berk.,** Hooker Lond. Journ. Bot. 6: 493. 1847.

Our collections agree with L. *giganteus* in almost all features except that they lack caulocystidia, which were observed by Pegler (1983). Spores of the present collections measured 5-7 x 4-4.5 μm.

Collections examined — **INDIA**, **Kerala State**, **Malappuram District**, Calicut University Campus: 20 September 2001, *P. Manimohan, M764*; 1 June 2001, *P. Manimohan, M760*; **Thiruvananthapuram District**, Palode, TBGRI campus: 6 November 1993, *K. B. Vrinda, TBGT256*; 27 October 1994, *K. B. Vrinda, TBGT1843*; 3 November 1994, *K. B. Vrinda TBGT1885*; 11 May 2001, *C. K. Pradeep, TBGT5303*; **Thiruvananthapuram District**, Kallar: 18 April 1996, *C. K. Pradeep, TBGT2916* (all at L).

***Lentinus hookerianus* Berk.,** Hooker Journ. Bot. & Kew Misc. 3:44. 1851.

Lentinus hookerianus had so far been known only from West Bengal (Pegler, 1983). The Kerala collection agrees with Pegler's (1983) description of the species in most macroscopic and microscopic characters. However, a few minor differences could be observed. According to Pegler (1983), the fasciculate hairs on the pileal surface are 1-2 mm long whereas the hairs were consistently less than 1 mm in the present collection. Another deviation is the presence of thin-walled cystidia similar to cheilocystidia on the sides of the lamellae. Spores of the Kerala collections measured 5-6.5 x 3-4 μm.

Collection examined — **INDIA**, **Kerala State**, **Malappuram District**, Calicut University Campus: 6 July 1999, *P. Manimohan, M606* (at L).

***Lentinus similis* Berk. & Broome,** Journ. Linn. Soc., Bot. 14: 43. 1873.

Lentinus similis is strikingly similar to *L. ciliatus* Lév. in several macroscopic and microscopic features. The former, however, can be differentiated in the field itself because of its radially plicate-sulcate pileus. The Kerala collections, the spores of which measured 5-7 x 2.5-3 μm, fully agree with the description of *L. similis* given by Pegler (1983).

Collections examined — INDIA, KERALA STATE, Wayanad District, MUNDAKKAI: 12 September 1985, *P. Manimohan, M340*; **Kannur District**, PULIKURUMBA: 5 August 1997, *P. Manimohan, M717*; **Thiruvananthapuram District**, PALODE, TBGRI CAMPUS: 19 October 1993, *C. K. Pradeep, TBGT35* (all at L).

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Changes and additions to the Checklist of North American Lichens. - II

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Abstract—*Graphis rigidula* and *Vezdaea retigera* are reported for the first time from North America. *Placidium tuckermanii* has been found to be a junior synonym of *Endocarpon arboreum*. Thus, the new combination *Placidium arboreum* is proposed. *Lecanora deplanans* is placed in synonymy with *Ionaspis lacustris*. The following names are lectotypified: *Endocarpon arboreum*, *Endocarpon tuckermanii*, *Lecanora deplanans*.

1. *Graphis rigidula* Müll. Arg.

Graphis rigidula is reported for the first time from North America on the basis of several collections from North Carolina cited below. The species was found growing on the bark of slightly shaded trees and occurred with *Byssoloma* sp., *Gyrostomum scyphuliferum* (Acharius) Nylander, *Phaeographis dendritica* (Acharius) Müll. Arg., *P. lobata* (Eschweiler) Müll. Arg., *Sarcographa tricosa* (Acharius) Müll. Arg., and a sterile sorediate species of *Thelotremataceae*. *Graphis rigidula* is easily distinguished from other North American species of *Graphis* by the combination of a striate, fully carbonized lateral exciple (lacking below), lack of lichen substances, and colorless (10)-13-14 celled ascospores, that are 8-per ascus and (40)-50-65 x (8)-9-11 μm.

Specimens Examined. – USA. NORTH CAROLINA. BRUNSWICK COUNTY: Dense maritime forest with large *Quercus virginiana*, mostly in various stages of destruction for residential development, Bald Head Island. *Lendemer 1320 & Yahr* (DUKE!, NY!, hb Lendemer!), *Lendemer 1628 & Yahr* (DUKE!, NY!, SBBG!, hb. Lendemer!), *Yahr 4832 & Lendemer* (DUKE!), *Yahr 4866 & Lendemer* (DUKE!).

2. *Ionaspis lacustris* (Withering) Lutzoni

Lichen lacustris Withering, Arr. Brit. pl. ed. 3, 4: 21. 1796. TYPE: Griffith (BM, not seen).

Ionaspis lacustris (Withering) Lutzoni, Sys. Bot., 20: 253. 1995. (full synonymy not provided here)

Syn. nov. *Lecanora deplanans* Nylander, *in* Millspaugh & Nuttall, Bot. Gaz., 22(4): 334. 1896. TYPE: On sandstone, [Short Creek], West Virginia, USA. *W.W Calkins s.n.* (H-NYL #24809!, lectotype **[selected here]**; NY!, PH!, probable isolectotypes).

The type material of *Lecanora deplanans* was identified as *Lecanora lacustris* (= *Ionaspis lacustris*) by Weber (1958, annotation) however the synonymy does not appear to have been formally published and the name *L. deplanans* remains on the North American checklist (Esslinger 1997). It should be noted that though the protologue cites L.W. Nuttall as the collector of the type, the specimen in H-NYL selected here as the lectotype was labeled by Nylander as having been collected by W.W. Calkins. The probable duplicate in PH lists L.W. Nuttall as the collector. This type of confusion is often encountered when attempting to typify taxa based on material sent to experts by W.W. Calkins. Refer to Brodo et al. (2001) for a description of *I. lacustris*.

3. *Placidium arboreum* (Schweinitz *ex* Michener) Lendemer *comb. nov.*

Endocarpon arboreum Schweinitz MSS, *in* herb. Schweinitz (PH)

Endocarpon arboreum Schweinitz *ex* Fries *nomen nudum*, Lich. Eur. Ref. p.407. 1831.

Endocarpon arboreum Schweinitz *ex* Michener *in* Darlington, Flora Cestrica, ed. 3, p.451. 1853. TYPE: On bark, sine loc., USA. *Schweinitz* s.n. (PH #991055c!, lectotype **[selected here]**).

Dermatocarpon arboreum (Schweinitz *ex* Fries) Fink, Lichens Minn. p. 244. 1910.

Syn. nov. *Endocarpon tuckermanii* Ravenel MSS, *in* herb. Tuckerman (FH-TUCK)

Endocarpon tuckermanii Montagne, Sylloge Gener. Spec. Cryptog. p. 359. 1856. TYPE: On *Carya sp.*, among mosses, Santee Canal, South Carolina, USA, *H.W. Ravenel* #138 = Reliquiae Tuckermanianae, no. 42 (FH-TUCK!, lectotype **[selected here]**; FH!, UC!, US!, isolectotypes).

Endopyrenium tuckermanii (Montagne) Müll. Arg., Bot. Jahrb., 6: 377. 1885.

Dermatocarpon tuckermanii (Montagne) Zahlbuckner, Cat. Lich. Univ. 1: 238. 1921.

Catapyrenium tuckermanii (Montagne) Thomson, Bryologst, 90: 36. 1987.

Placidium tuckermanii (Montagne) Breuss, Ann. Natur. Mus. Wien 98B: 39. 1996.

The name *Endocarpon arboreum* was originally proposed by Schweinitz in manuscript form. Elias Fries (1831) first published the name noting it to be "a poorly developed *Sticta*". Clearly Fries did not accept *E. arboreum* and thus this publication of the name by Fries must be considered a *nomen nudum*. Later authors, e.g. Thomson (1987), and Breuss (1996) have used the epithet "*tuckermanii*" for this lichen, however, Michener had published a valid description of *Endocarpon arboreum* in Darlington's

Flora Cestrica three years prior to the publication of the name *Endocarpon tuckermanii* by Montagne (1856). See Thomson (1987) or Brodo et al. (2001) for a description of this species under the names *Catapyrenium tuckermanii* and *Placidium tuckermanii* respectively.

4. *Vezdaea retigera* Poelt & Döbbeler

The genus *Vezdaea* includes a number of inconspicuous taxa that are often confined to disturbance based habitats. The most common species, *V. leprosa* (P. James) Vězda, was only recently reported from North America (Buck et al., 1999) and two additional species have been reported since (Brodo 2001, Westberg 2004). The report of another species is thus not unexpected. The collection of *V. retigera* reported here was found overgrowing organic matter and bryophytes along a roadside and was associated with an undetermined sterile sorediate crust, *Porpidia crustulata* (Acharius) Hertel & Knoph, *Trapelia placodioides* Coppins & P. James, and *Xanthoparmelia* spp. For a description of *V. retigera* refer to Poelt & Döbbeler (1975).

Specimens Examined. – USA. PENNSYLVANIA. SULLIVAN COUNTY: Mixed northern hardwood forest with gradation from primarily *Acer, Fraxinus,* and *Betula* to hemlock (*Tsuga*), with shaded boulders, on a north facing slope, area around amphitheater, east of Mineral Spring Road along Loyalsock Creek, Worlds End State Park. *Lendemer 2284 & Macklin* (NY!, hb. Lendemer!).

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A taxonomic study of the family *Podoscyphaceae* (Basidiomycetes), new species and new records in Cameroon

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Abstract — Two species of *Cymatoderma*, ten species of *Podoscypha* and three species of *Stereopsis* are recorded from the Mbalmayo forest reserve, Cameroon. *C. elegans, P. nitidula, P. petalodes* subsp. *rosulata, P. simulans, S. hiscens* f. *rosea* and *S. radicans* are new to Cameroon. *P. disseminata* sp. nov. is described and illustrated. A key to species of *Podoscyphaceae* in Cameroon is provided.

Key words — *Podoscypha disseminata*, stipitate steroid fungi, survey

Introduction

The family *Podocyphaceae* Reid (1965) was proposed to accommodate stipitate steroid fungi belonging to the genera *Podoscypha* Pat., *Cymatoderma* Jungh., *Stereopsis* D. A. Reid, *Cotylidia* P. Karst., *Inflatostereum* D. A. Reid and *Aquascypha* D. A. Reid, with *Podoscypha* as the type genus. The remaining taxa were grouped in the family *Lachnocladiaceae* D. A. Reid with *Lachnocladium* Lév. emend. Corner as the type genus. The former family encompasses taxa characterized by spathulate to infundibuliform basidiomata, upper surface glabrous to hirsute, hyphal system mono-, di- to trimitic, cystidia and gloeocystidia often present and always with smooth spores. While in the latter, basidiomata are resupinate, clavarioid to spathulate, hyphal system dimitic with dichophitic binding hyphae and basidiospores smooth, verrucose or echinulate. This paper deals with the diversity of the family *Podoscyphaceae*, with special emphasis on the genera *Cymatoderma*, *Podoscypha* and *Stereopsis* occurring in Cameroon.

In contrast to the African fungal flora as a whole, which is still understudied, African species of *Podoscyphaceae* are relatively well known (Boidin, 1966). The family is widely distributed in tropical and subtropical regions with some endemic taxa. In the most important work on stipitate steroid fungi to date, Reid (1965) reported four genera of *Podoscyphaceae* from Africa, including about seventeen species, in which nine species of *Podoscypha*, one species of *Cotylidia*, four species of *Cymatoderma* and three species of *Stereopsis*. He reported twenty-six species of *Podoscypha*, nine species of *Cymatoderma* and ten species of *Stereopsis* for the world mycobiota. In the following years, many new taxa have been described and other varieties accepted on

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specific level (Berthelet & Boidin, 1996; Boidin & Lanquetin, 1973; Ryvarden, 1997; Wu, 2003).

Earlier contributions to the *Podoscyphaceae* in Central Africa are the works of Boidin (1961 & 1966) with special emphasis on Congo and Central African Republic with extension to surrounding countries as Cameroon, a new species *P. nuda* Boidin was described. None of the various studies on the Basidiomycetes in Cameroon (Berthet & Boidin, 1966; Hjortstam & *al.*, 1993; Calonge & Daniëls, 1998; Núñez & Daniëls, 1999; Roberts 1999, 2000 and 2001) has been exclusively focused on the *Podoscyphaceae*. Nevertheless, based on the scanty and fragmentary data available, up to fourteen species of *Podoscyphaceae* are reported from Cameroon (Boidin, 1961, 1966; Boidin & Lanquetin, 1973; Hjortstam & *al.*, 1993). In the framework of the survey on the Southern Cameroon mycoflora, twenty-five collections resulting from three years (2001-2003) monitoring in the Mbalmayo forest reserve lead the report of fifteen taxa of *Podoscyphaceae*, all previously not reported for this area, with six taxa representing new records for Cameroon. Furthermore, after thorough microscopic study and literature survey, some specimens appear to represent undescribed species that is herein proposed as new. Hitherto reported species of *Podoscyphaceae* from Cameroon are keyed.

Material and Methods

The specimens were collected in the Mbalmayo Forest Reserve (MFR) located about 47 km southern of Yaoundé, an area of 9700 ha lying between 500-650 m asl. (11° 54′ E, 3° 58′ N). Morphological description was based on fresh material. Microscopic structures were mainly observed on dried material. Free-hand thin sections were mounted in 5% KOH unless otherwise noted. Optical microscopy studies were carried out at 400 and 1000 X using an Olympus BX51TF microscope. Size ranges of basidiospores were based on ocular micrometer measurements. E value is the length divided by the width of the basidiospore and Q value is the mean of E of N = 30 basidiospores. Light photography was done with a Nikon COOLPIX 4500 Digital, and processed in Photoshop (Adobe Photoshop 4.0). Line drawings were made using a grid as drawing aid representing a magnitude of × 2000. Colour terms in parentheses are those of Kornerup & Wanscher (1978). The species mentioned are arranged alphabetically. The new records for Cameroon are marked with an asterisk (*). The herbaria are cited according to Holmgren et al. (1990). The following notes are based on our collections and other African specimens preserved in the National Botanic Garden of Belgium (BR). Specimens are deposited at the herbarium of Cryptogamy Laboratory, Faculty of Science, University of Yaounde I, Cameroon (HUYI).

Taxonomy

New species

Podoscypha disseminata Douanla-Meli **sp. nov.** **PLATE 1; FIGURE 1**

Basidiomata usque 1-2 cm alta, 05-1.5 cm lata, flabelliformia vel perfecte infundibuliformia; Pileus pureo-brunneus. Superficies superior glabra, non zonatus. Superficies inferior pruinosa. Hypharum systema dimiticum. Chlamydosporae 6-12 × 5-9 µm, copiosa, hyalinae.

muris crassis, globosae, subglobosae vel ovatae. Pileocystidia usque ad 70 µm longa et 13-20 µm lata, cylindrica vel subcylindrica, muris crassis, copiosa septis instructa. Caulocystidia (45-)50–100 × 16-21.5 µm, pilocystidiis similia, muris crassis. Cystidia nulla. Gloeocystidia (30-)40-110 × (4-)6-10 µm, copiosa fusiformia, elongata, subcylindrica sed basi inflata, muris tenuibus instructa. Basidia usque (16-)22-39 × 3.5-5 µm, cylindrica vel subclavata, unispora vel bispora. Basidiosporae (4-)4.5-6(-7) × (2.5-)3-4(-4.5) µm, ellipsoidae vel ovatae.

Ad Mbalmayo silva nova Oyack II-Cameroon, m 500-650 a.s.l., 11° 54′ E, 3° 58′ N, on emortuus lignum, leg. C. Douanla-Meli, 09.X.2002. Holotype: herb. HUYI DMC 232, Isotype in O.

Etymology— The epithet *disseminata* refers to the smaller habit clustered on dead wood.

Basidiomata erect, stipitate, funnel-shaped, infundibuliform with a swallow cup, at times enrolled and appear cylindrical to setiform, or flabellate narrowing behind into a very short stipe, clustered or growing in colonies of discrete basidiomata, not concrescent, 1-2 cm from the base of the stalk to the margin, and up to 0.5-1.5 cm wide; **Pileus** leathery, glabrous, shining, almost translucent, brownish yellow (5C8), brown (6D6) to brown orange (6C8) on fresh, fading upon drying to red brown (10C8), azonate, margin entire and may become deeply indented; hymenial surface smooth, concoloured with the upper surface on fresh, becoming greyish white (-B1), pruinose; **Stipe** up to 0.4-1.2 cm long and 1-1.5 mm in width, rudimentary to distinct, round to flattened, concoloured, turning grey brownish (6E2-6E4), glabrous towards the hymenophore and covered below with a tuff of whitish stiff hairs, equal to slightly tapering towards the base, and attached to the substrate by a yellowish pale (2A3), distinct basal mycelial disc; **Context** thin, less than 1mm thick, brown beige (6E3).

Hyphal system dimitic, consisting of generative and skeletal hyphae. The generative hyphae 2-5 µm in diameter, strongly branched, bearing prominent clamp connections at the septa, hyaline, thin-walled. Skeletal hyphae 2-6 µm in diameter, not branched, hyaline, with refractive, thickened walls; **Chlamydospores** very abundant throughout the pileus, the hymenial layers and the stipe, arising as terminal swellings on very short side branches of the generative hyphae, hyaline, the inner part occupied by a large vacuole or numerous small globules, with a strongly thickened, smooth walls, which appear to be double, variable in size and shape, 6-12 × 5-9 µm, globose, subglobose, ovate to pyriform; **Gloeocystidia** present, with variable size ranging from (30-)40-110 × (4-)6-10 µm, thin-walled, fusoid with swollen base to subcylindrical, at times contorted or strangulated, gradually tapering towards the obtuse apices, arising at any level of the hymenium, immerge in the thickening hymenium, few traverse the entire width, but occasionally exceeding the level of the basidia, then up to 20 µm; **Cystidia** absent; **Pileocystidia** up to 70 µm in length and 13-20 µm wide, subcylindrical to cylindrical, with broadly rounded apices, hyaline, thick-walled, almost with frequent transverse septa, much scanty at the surface of the cap, having a deep seated origin, continuing as thick-walled skeletal hyphae; **Caulocystidia** variable in size, (45-)50-100 × 16-21.5 µm, abundant, similar in shape to the pileocystidia, but usually rather larger and longer, hyaline, thickened walls of up to 4 µm, with numerous transverse septa, cylindrical and slightly tapering at the base, pedunculate, continuing as a skeletal hyphae; **Basidia** (16-)22-39 × 3.5-5 µm, cylindrical to subclavate, with 1-2 long sterigmata, of up to 10 µm long, almost filled with both small and large oil droplets, thin-walled, matured basidia projecting beyond the palisade of up to 7 µm, also numerous basidioles present;

Basidiospores white in mass, (4-)4.5-6(-7) × (2.5-)3-4(-4.5) µm, E = 1.3-1.8; Q = 1.4, broadly ellipsoid to ovate, hyaline in KOH, thin-walled, smooth, with a single large oil drop.

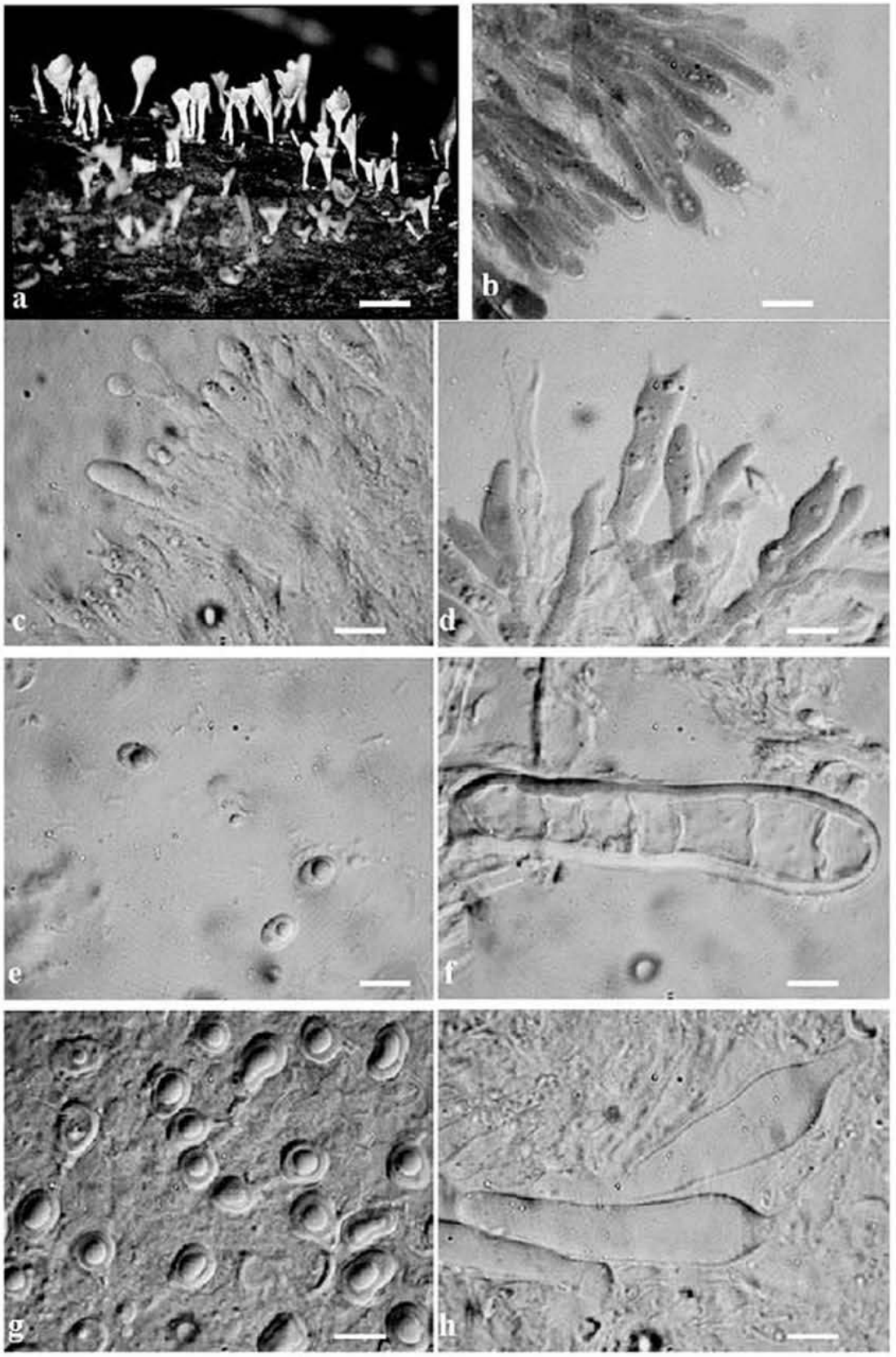
Ecology and distribution. Clustered to growing in dense colonies on dead wood of undetermined tree in the semi-deciduous forest with *Sterculiaceae* and *Ulmaceae*. Hitherto only known from the Mbalmayo forest reserve, Cameroon.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Oyack II, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., 9.X.2002, C. Douanla-Meli, DMC 232, **HOLOTYPE**-HUYI, ISOTYPE-O.

COMMENTS — *P. disseminata* is characterised and distinguished in having smaller basidiomata, infundibuliform, flabellate to setiform, truly stipitate, pileus surface smooth, basidia 1 to 2-spored, hyphal system dimitic, pileocystidia and caulocystidia present, chlamydospores abundant in all tissues. These features support its position in *Podoscypha*. *P. disseminata* is closest to *P. brasiliensis* D.A. Reid that occurs in Brazil. The basidiomata of both taxa are smaller, lignicolous, growing gregarious and truly infundibuliform to flabellate. According to Reid (1965), *P. brasiliensis* lacks chlamydospores, pileocystidia and caulocystidia; the almost 4-spored basidia also distinguish *P. brasiliensis* from *P. disseminata*. The new taxon is also reminiscent of another Brazilian species, *P. bubalina* D.A. Reid which has smaller basidiomata, 1-2 × 0.3-1.2 cm, truly infundibuliform. However the Brazilian species has smaller basidiospores 3.75-4.75 × (2.2-)2.5-3.2 µm, and lacks chlamydospores and pileocystidia. *P. parvula* Reid is also closely related to *P. disseminata* but may be separated from this taxon by its larger basidiomata golden-orange or orange-brown coloured, lacking chlamydospores and with smaller, (3-)3.2-4(-4.75) × 2-2.5(-3) µm, subglobose to broadly ellipsoid basidiospores.

P. disseminata belongs to the group of *Podoscypha* species with chlamydospores present in the basidiomata tissues, as *P. bolleana* and *P. venustula* (Speg.) D. A. Reid (Reid, 1965). *P. venustula* has a basidiomata up to 6 cm high and 4 cm wide, smaller basidiospores (3.2-)3.5-4.75 × 2.2-3.5(-3.75) µm, and is known only from South America and probably in New Zealand. *P. disseminata* is related to the African *P. bolleana* common in Cameroon. The latter has normally 2-5 cm high basidiomata and may reach 7 cm, can occur in large clusters with many basidiomata fused along their margins. The pileus is glabrous, often ornamented with densely crowded, short, radiating wrinkles which give the surface a lineate-striate effect (Reid 1965). Basidiospores varies from 4.8-5.5(-6) × (3.2-)3.8-4.5 µm (Boidin, 1961), (3.75-)4-5(-6) × (2.2-)2.75-3.2(-4) µm (Reid, 1965). In *P. disseminata*, basidiospores are slightly larger than those of *P. bolleana*, while the pileocystidia and caulocystidia have frequent transverse septa. Furthermore, *P. bolleana* differs from *P. disseminata* in possessing 4-spored basidia. *P. disseminata* differs especially in having 1 to 2-spored basidia, with longer sterigmata; these features in combination with the smaller basidiomata make it a unique species in the genus *Podoscypha*.

Plate 1. — ***Podoscypha disseminata*** (Holotype DMC 232-HUYI). a. Basidiomata clustered on dead wood. b-h. Microfeatures under light microscope. b-d. Basidia 1-2-spored. e. Basidiospores. f. Caulocystidia. g. Chlamydospores. h. Gloeocystidia. Scale bar represents 1 cm for a, and 10 µm for b-h.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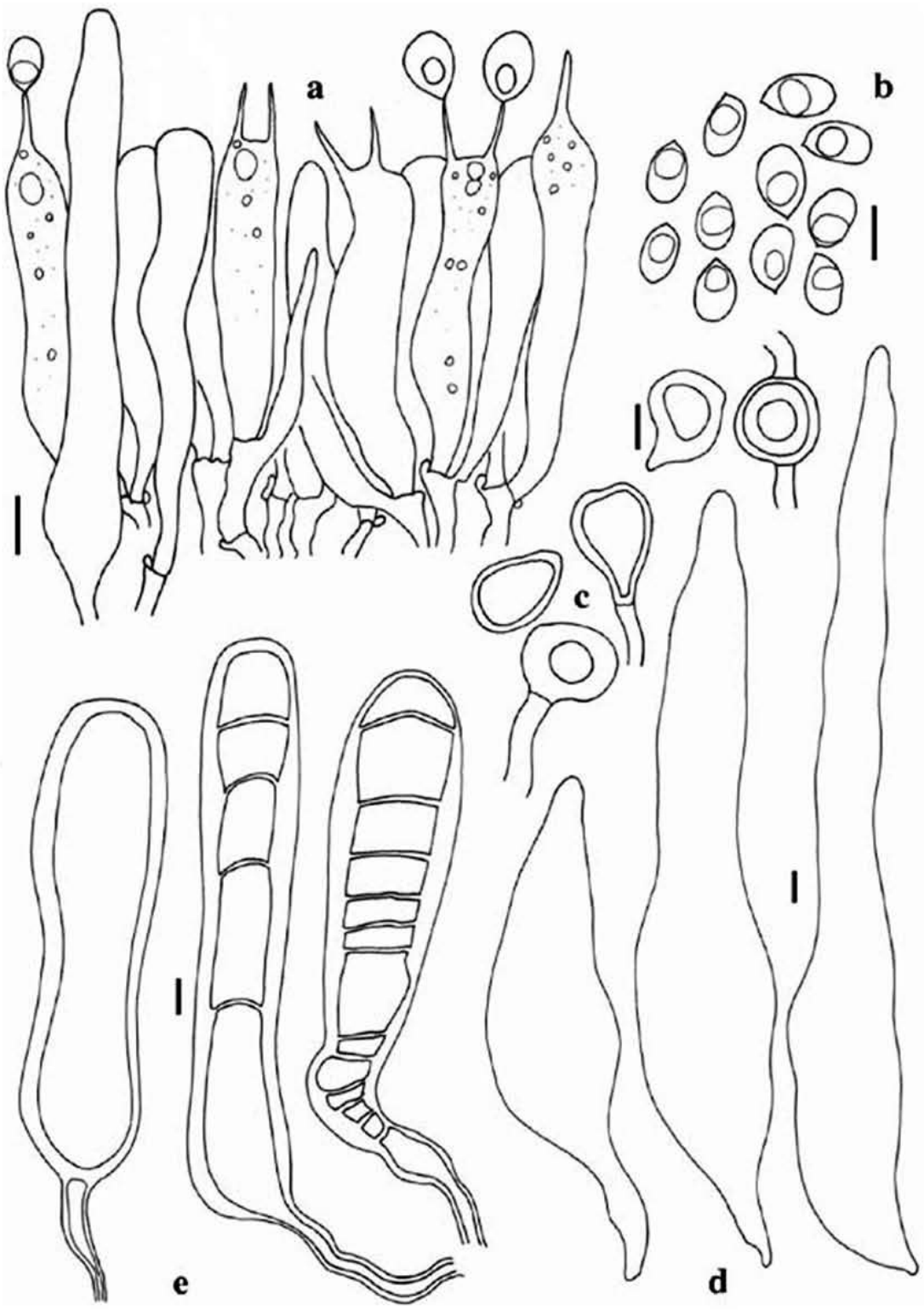

Fig. 1 — *Podoscypha disseminata* (Holotype DMC 232-HUYI). Line drawings. a. Section in the hymenium showing 1-2-spored basidia and intermingled gloeocystidia. b. Basidiospores. c. Chlamydospores. d. Gloeocystidia. e. Pileo- and caulocystidia. Scale bar represents 5 μm.

Taxa recorded

Cymatoderma dendriticum (Pers.) D.A. Reid in Kew Bull. 13: 523, 1958 (1959).
= *Cladoceris dendritica* (Pers) Berk. in Hook. London Journ. Bot., I, p. 152 (1842)

A pantropical species, very common in Cameroon, was first reported from Cameroon by Hennings (1895), later from Douala by Berthet & Boidin (1966), from Korup National Park (Hjortstam & al., 1999; Roberts, 2000).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Oyack II, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on dead wood of *Pinus khasia* (Coniferous), 25.IX.2002, C. Douanla-Meli, DMC 209 (HUYI).
ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV. MBANDA, **Eala**, N 00°03' E 18°19′, IV.1923, Goossens-Fontana (BR-Myc 034162, 18).

Cymatoderma elegans Jungh. in Tijdschr. Nat. Gesch. 7: 290, 1840.
= *Cymatoderma elegans* var. *spongiosum* (Fr.) Boidin in Bull. Jard. Bot. Brux. **30**: 296, 1960.

A very common species in tropical Africa and Asia.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Bilik, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on dead wood, 15.V.2001, C. Douanla-Meli, DMC 110 (HUYI).
ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, **Ipamu**, S 04°07′ E 14°37′, unknown date, Vanderyst H. (BR-Myc 033916, 63).

Podoscypha bolleana (Mont.) Boidin in Bull. Jard. Bot. Brux. 30: 323, 1960.
= *Stereum bolleanum* Mont. in Syll. Crypt.: 177 (1856).

A very common species in Cameroon, it was reported from Bipindi, Southern Cameroon, Douala (Boidin, 1961, 1966; Reid, 1965, Berthelet & Boidin, 1966), Korup National Park (Hjortstam & al., 1999; Roberts 2000). A conspicuous species in the Mbalmayo forest reserve on fallen logs and branches.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MFR-Ekombitie, 11° 54′ E, 3° 58′ N), 500-650 m asl., on dead wood, 15 V 2001, C. Douanla-Meli, DMC 222 (HUYI); MBR-Oyack II, on dead wood, 20.IX.2002, C. Douanla-Meli, DMC 229 (HUYI); 21.IX.2002, C. Douanla-Meli, DMC 228 (HUYI); 21.IX.2002, C. Douanla-Meli, DMC 230 (HUYI); on dead wood of *Diospyros crassiflora* (*Ebenaceae*), 09.X.2002, C. Douanla-Meli, DMC 231 (HUYI).
ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV. KIVU, **Kinawa**, N 00°40′ E 29°50′, 13.IX.1953, De Witte G. F. 9598 bis (BR-Myc 034267, 26).

Podoscypha involuta (Klotzsch apud Fr.) Imazeki in Bull. Govt Forest Exp. Stn. Meguro 57: 98, 1952.
= *Stereum involutum* Kl. in Apud. Fr., Epicr. 546. 1836

A species abundant in tropics. Previously recorded from Cameroon by Hennings (1895), Boidin (1960), known in Tiko, Bembia, Limbe, Buea (Reid, 1965), in Korup National Park (Hjortstam & al., 1999; Roberts 2000).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on dead wood, 15.V.2001, C. Douanla-Meli, DMC 214 (HUYI); MBR-Oyack II, 20.IX.2002,

C. Douanla-Meli DMC 215 (HUYI); 24.IX.2002, C. Douanla-Meli, DMC 216 (HUYI); on dead wood of *Khaya ivorensis*, C. Douanla-Meli, DMC 220 (HUYI), DMC 217 (HUYI); on dead wood of *Triplochiton scleroxylon*, 24.IX.2002, C. Douanla-Meli, DMC 218 (HUYI); 03.X.2002, C. Douanla-Meli, DMC 219 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, Eala, N 00°03′ E 18°19′, IV.1923, Goossens-Fontana (BR-Myc 034320, 79).

**Podoscypha nitidula* (Berk.) Pat. in Duss, Énumération Méthodique des champignons recueillies à la Guadeloupe et à la Martinique (Lons-le-Saunier): 21, 1903.

A species originally described from Brazil, common in South America (Reid, 1965), previously recorded from Cameroon by Berthelet & Boidin (1966) in Douala.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Oyack II, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on the ground, 25.IX.2002, C. Douanla-Meli, DMC 224 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — BURUNDI, PROV. BURUNDI, Siguvyaye ten W van de weg Mutambara-Burundi, S 03°58′ E 29°37′, 02.II.1979, Rameloo J. 6478 (BR-Myc 034362, 24).

Podoscypha parvula (Lloyd) D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

Apparently not common as *P. bolleana* but equally widespread. Known from Cameroon in Mt. Cameroon area (Reid, 1965), recorded in Douala by Boidin & Lanquetin (1973), in Korup National Park by Roberts (2000).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on dead wood, 29.VIII.2003, C. Douanla-Meli, DMC 226 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, Kabamba, S 06°46′ E 23°23′, Lac Tanganyka, 1967, Van Meel L. 66 (BR-Myc. 034370, 32).

**Podoscypha petalodes* subsp. *rosulata* D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

Rather widespread in tropics and subtropics.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., growing on the ground and buried dead wood, 29.VIII.2003, C. Douanla-Meli, DMC 225 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, PROV. KIVU, **Panzi**, S 02°33′ E 28°52′, I.1955, on dead wood, Goossens-Fontana 5432 (BR-Myc. 034388, 50).

**Podoscypha simulans* (D. A. Reid) Sheng H. Wu in Mycotaxon 88: 373-376, 2003
= *Podoscypha fulvo-nitens* var. *simulans* (Berk.) D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

A pantropical species.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on dead wood, 17.V.2001, C. Douanla-Meli, DMC 223 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO,

PROV KIPUSHI, Loc.: **Tumbwe** — S 11°26′ E 27°20′, Van Meel L. 549, 06.I.1947 (BR-Myc. 034299, 58).

Podoscypha thozetii (Berk.) Boidin in Rev. Mycol., Paris 24: 208, 1959.

A common species in tropical Africa, widespread in the Mbalmayo forest reserve.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBF-Oyack II, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on the ground, 20.X.2002, C. Douanla-Meli, DMC 227 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — BURUNDI, Kanyinga, site Lac Rwihinda, between grass, 09.XII.1967, Petit E. 1980 (BR-Myc 034390, 52).

Podoscypha vespillonea (Berk.) Boidin & Lanq. in Persoonia, vol. 7, 2: 141-150, 1973.

A common species in central Africa, widespread in Cameroon, Douala, Edéa, Japoma and the littoral area (Boidin & Lanquetin, 1973), common as *P. involuta* in the Mbalmayo forest reserve.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, Mbalmayo forest reserve, Oyack II, 47 km South east of Yaounde (11° 54′ E, 3° 58′ N), 500-650 m asl., on dead wood, 20.X.2002, leg. C. Douanla-Meli, DMC 220-HUYI.

Podoscypha warneckeana (Henn.) Ryvarden in Mycotaxon 64: 401-403, 1997.
= *Podoscypha nitidula* var. *warneckeana* (Henn.) D. A. Reid in Beih. Nov. Hedwigia **18**: 298, 1965.

A common species in tropical Africa and Asia constantly associated with grass (*Gramineae*). Previously recorded in Douala and surrounding area by Berthet & Boidin (1966).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Oyack II, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on the ground colonized by the Gramineae (*Pennisetum purpureum* Schumach.) along roadside, 25.X.2002, C. Douanla-Meli, DMC 223 (HUYI).

ADDITIONAL SPECIEMEN EXAMINED — DEMOCRATIC REPUBLIC OF CONGO, Angidia, N 03°32′ E 25°47′, V.1931, Lebrun J. 2943 (BR-Myc. 034366, 28).

Stereopsis hiscens (Berk. & Ravenel.) D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

A common species in tropics and subtropics. It was previously reported from Cameroon by Reid (1965), also known from Douala (Berthelet & Boidin, 1966).

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on the ground, 16.X.2002, C. Douanla-Meli, DMC 234 (HUYI).

**Stereopsis hiscens* f. *rosea* D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.
A form previously known only from Malaya (Reid, 1965). A single collection on dead wood.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on the ground, 09.X.2002, C. Douanla-Meli, DMC 236 (HUYI).

**Stereopsis radicans* D. A. Reid in Beih. Nov. Hedwigia 18: 298, 1965.

A common species throughout the tropics and subtropics. Boidin (1966) doubtfully included Cameroon in the distribution area of this species in Central Africa; still no further data for confirmation as Reid (1965) did not examine or mention collections from Cameroon. This specimen is herein presented as new to Cameroon.

SPECIMEN EXAMINED — CAMEROON. CENTRE PROVINCE, Dept. Nyong & So'o, MBR-Oyack II, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, 500-650 m asl., on the ground arising from buried dead wood, 14.VIII.2003, C. Douanla-Meli, DMC 233 (HUYI).

Key to *Podoscyphaceae* genera in Cameroon

1. Hyphal system monomitic, hyphae densely compact, thin to thick-walled, with or without clamps, basidiospores subglobose, cystidia absent.....***Stereopsis***
1. Hyphal system dimitic or trimitic with generative hyphae and thick-walled skeletal hyphae, gloeocystidia present and abundant.....2
   2. Basidiomata much broad, hymenium warty or ridged, stipe stout, hirsute or tomentose, sterile surface tomentose..... ***Cymatoderma***
   2. Basidiomata usually smaller, often thin and translucent with smooth hymenial surface, sterile surface almost glabrous..... ***Podoscypha***

Key to species of *Cymatoderma* in Cameroon

1. Thick-walled cystidia present, hymenium white ornamented, ridged, warty to verrucose, tomentum more or less abundant, sterile surface more colored .....***C. elegans***
1. Thick-walled cystidia absent.....2
   2. Basidiomata stipitate, arising from a large sclerotium, hymenium coarsely veined.....***C. africanum***
   2. Basidiomata dimidiate, sessile to shortly stipitate, hymenium paler than the upper surface.....3
      3. Pileus surface tomentose, beige to fawn coloured, hymenium surface with densely crowded, rather sharp, radiating branched ribs, basidiospores 3-5 × 2.8-4.8 μm; chlamydospores absent.....***C. dendriticum***
      3. Basidiomata tomentose, dimidiate, spores 5-6 × 3.8-4.5 μm, chlamydospores present in the context..... ***C. pallens***

Key to species of *Podoscypha* in Cameroon

1. Thick-walled cystidia present in the hymenium.....2
   2. Pileus glabrous, often zonate, distinctly stipitate, hymenial surface covered with a whitish or greyish pruina..... ***P. mellisii***
   2. Pileus tomentose.....3
      3. Basidiomata mostly attached by a broad, flattened stipe-like base, spathulate, flabellate or reniform, seldom infundibuliform, upper surface light-brown, dark-brown, orange-brown, either uniformly coloured or with narrow zones of various shades..... ***P. involuta***

3. Basidiomata sessile to distinctly stipitate, flabellate, with fused margins to infundibuliform, upper surface ornamented with concentric zones alternately brown to dark-brown..... ***P. vespillonea***

1. Thick-walled cystidia absent in the hymenium..... 4
   4. Basidiomata growing on dead wood..... 5
      5. Chlamydospores present..... 6
         6. Basidiomata usually forming clusters of variously fused pilei or occur as discrete basidiomata, basidia 4-spored..... ***P. bolleana***
         6. Basidiomata smaller 1-2 cm high and 0.5-1.5 cm wide, clusters of discrete basidiomata, infundibuliform, truly stipitate, basidia almost 1-2 spored.....***P. disseminata*** nov. sp.
      5. Chlamydospores absent.....7
         7. Basidiomata bearing a dense tangled mat of fibrillose processes which may arise almost anywhere over the surface of the pileus ..... ***P. ursina***
         7. Surface of the pileus glabrous, lacking all trace of hairs, or antler-like processes visible to the naked eye.....8
            8. Basidiomata, flabellate to spathulate, golden-orange or brown-orange on dry, polymorphic, attached by a conspicuous disc of mycelium, basidiospores (3-)3.2-4(-4.75) × 2-2.5(-3) µm, ... ***P. parvula***
            8. Basidiomata usually infundibuliform, attached by a conspicuous basal disc of mycelium, caulocystidia absent, basidiospores (3-)3.75-4.5-6 × 2-3 µm ..... ***P. simulans***
   4. Basidiomata terrestrial or growing on buried dead wood.....9
      9. Basidiospores large 6-10 × 4-6 µm, basidiomata truly infundibuliform, pale-buff with conspicuous rusty-brown zones when dried ..... ***P. thozetii***
      9. Basidiospores not as above, basidiomata forming dense rosettes or discrete, at times crowded together and fused..... 10
         10. Basidiomata normally forming dense rosettes but occasionally occurring as discrete, of virtually any shape, basidiospores 3,5-6 × 2.5-4 µm..... ***P. petalodes*** subsp. ***rosulata***
         10. Basidiomata usually infundibuliform, rarely flabellate..... 11
            11. Pileus surface glabrous stipe often bearing a few scattered caulocystidia, basidiospores 3.5-6(6.5) × 3-4(-5) µm ..... ***P. nitidula***
            11. Basidiomata always associated with roots or dead culms of grasses (Gramineae), basidiospores 4-6(6.2) × 3-4(-5) µm, subglobose to broadly elliptical..... ***P. warneckeana***

Key to species of *Stereopsis* in Cameroon

1. Clamps connections present.....2
   2. Gloeocystidia present, basidiomata solitary to gregarious, pileus white at first then pale cream, basidiospores subglobose, basidia 2-spored, pantropical..... .....***S. radicans***

2. Gloeocystidia absent.....3
    3. Basidiomata discrete or forming a large complicated rosette or cauliflower-like fructifications, pileus whitish to grayish white, smooth or minutely appressed silky-fibrillose, basidiospores subglobulose with prominent, oblique apiculus, 6-8.5(-8.5) × 6-7.5 μm.....***S. hiscens***
    3. Basidiomata rosette-like, pileus pinkish to brownish, pale brown when dry, radiately fibrillose, basidiospores 6.5-8.5 × 5.5-8 μm, globose, subglobose, to broadly elliptical, almost largely apiculate.....
    .....***S. hiscens*** var. ***rosea***
1. Clamps connections absent, basidiomata white to pale ochraceous on fresh, and drying pinkish buff to buff, hymenial surface cream to pale, drying ochraceous-buff, basidiospores (4.5-)5-7.5 × (3.75-)4-6 μm.....***S. cartilaginea***

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The authors are thankful to the curator of herbarium BR for loaning other African specimens of *Podoscypha* and *Cymatoderma*. Furthermore, Mr. Robert Zambo is thanked for facilitating fieldwork. We are obliged to Prof. Ryvarden and Dr. Hjortstam for critically reviewing and improving the earlier manuscript. This research was financially supported by the grant A/01/20502 from the German Academic Exchange Service (DAAD) to the senior author.

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MYCOTAXON

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Two new species of *Imshaugia* (Ascomycota: *Parmeliaceae*) from South America

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Abstract—*Imshaugia pyxiniformis and I. sipmanii* are described as new to science. Both species are characterized by small subglobose to ellipsoidal ascospores, *Psora*-type conidiophores, short, ampulliform or bifusiform conidia and the presence of cortical lichexanthone and medullary protocetraric acid. In addition, the new combinations *Imshaugia subarida, I. venezolana* and *Parmeliopsis macrospora* are made.

Key words— lichens, taxonomy

Introduction

The small genus *Imshaugia* S.L.F. Meyer was segregated from *Parmeliopsis* (Nyl.) Nyl. in the 1980s (Meyer 1982, 1985). These two genera are distinguished from most other parmelioid genera by the *Psora*-type conidiophores (Type II, Vobis 1980). Meyer segregated *Imshaugia* on the basis of its emergent and partly marginal pycnidia (immersed and laminal in *Parmeliopsis*), its short, ellipsoidal to subglobose ascospores (long and kidney-shaped in *Parmeliopsis*) and its short, ampulliform or bifusiform conidia (long and curved in *Parmeliopsis*). *Imshaugia* is also distinguished from that genus by the fungal cell walls containing *Cetraria*-type lichenan rather than isolichenan. During an investigation of various parmelioid lichens from South America two new species of *Imshaugia* were discovered and form the subject of this paper.

Materials and Methods

The morphology of the lichen specimens were examined using a Zeiss Stemi 2000C stereo microscope, and a Zeiss Axiolab compound microscope. Chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson et al. 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Taxonomic Descriptions

Imshaugia pyxiniformis Elix, *sp. nov.* FIGURE 1A

Thallus ut in Imshaugia placorhodia sed lobis sublineariter vel sublineariter-elongatis, apotheciis angustioribus et lichexanthonum, acidum 4-O-demethylmicrophyllinicum et acidum protocetraricum continente differt.

Etymology: a consequence of the superficial resemblance of this species to various *Pyxine* species.

Type: **BRAZIL.** Pará: Serra do Cachimbo, 888 km N of Cuiabá on Cuiabá-Santarém highway (BR-163), c. 8°45'S, 54°57'W, 350-500 m, on bark in dry vegetation on top of N-S ridge in tall canopy forest on W side of steep slope, *L. Brako & M. J. Dibben 6700*, 4 May 1983; holo: NY.

KEY CHARACTERS — **Thallus** corticolous, foliose, adnate, 3-4 cm wide. **Lobes** contiguous to sparingly imbricate, separate at apices, sublinear to sublinear-elongate, dichotomously to subdichotomously branched, 0.8-1.5 mm wide, eciliate, apices incised. **Upper surface** yellow-gray, flat to weakly convex, emaculate, shiny at apices but dull within, smooth; isidia and soredia absent. **Medulla** white. **Lower surface** ivory to pale brown, ± rugulose; rhizines dense, simple, pale brown to brown, to 1 mm long. **Apothecia** sessile, 0.5-1.2 mm wide; disc flat to weakly concave, dark brown, thalline exciple smooth. **Ascospores** colourless, 8 per ascus, subglobose to broadly ellipsoidal, 7-8 x 5-7 μm. **Pycnidia** common, laminal and marginal, emergent. **Conidia** terminal on conidiophores, ampulliform to weakly bifusiform, 5-7 x 1 μm. **Chemistry** — Cortex K-, UV+ intense yellow; medulla K+ pale yellow-brown, C+ red, KC+ red, P+ orange-red; containing lichexanthone (minor), protocetraric acid (minor), 4-*O*-demethylmicrophyllinic acid (major).

Distribution — At present this species is only known from the type collection.

COMMENTS — This new species is characterized by the narrow, sublinear to sublinear-elongate, eciliate lobes, the lack of vegetative propagules, the pale lower cortex, very dense, simple rhizines and the presence of lichexanthone in the upper cortex (UV+ intense yellow) and 4-*O*-demethylmicrophyllinic and protocetraric acids in the medulla. Superficially *I. pyxiniformis* closely resembles some species of *Pyxine* (e.g. *P. petricola* Nyl. ex Cromb.) with narrow, contiguous lobes, UV+ yellow upper surface and small, sessile apothecia. However, *I. pyxiniformis* can be readily distinguished by the dark brown discs (black in *Pyxine*), the simple, colourless ascospores (brown and 1-septate in *Pyxine*) and the pale lower surface (black in *Pyxine*). Like *I. pyxiniformis*, *P. placorodia* (Ach.) S.L.F. Meyer lacks vegetative propagules but can readily be distinguished by the much wider apothecia (1.5-12 mm wide) with dentate margins, the subirregular lobes and the presence of cortical atranorin and chloroatranorin (UV-) and medullary thamnolic acid.

Imshaugia sipmanii Elix, *sp. nov.* FIGURE 1B

Thallus ut in Imshaugia pyxiniformis sed saxicola, apotheciis substipitatus et acidum 4-O-demethylmicrophyllinicum noncontinente differt.

Etymology: in honour of the collector, renowned Dutch lichenologist Dr Harrie Sipman.

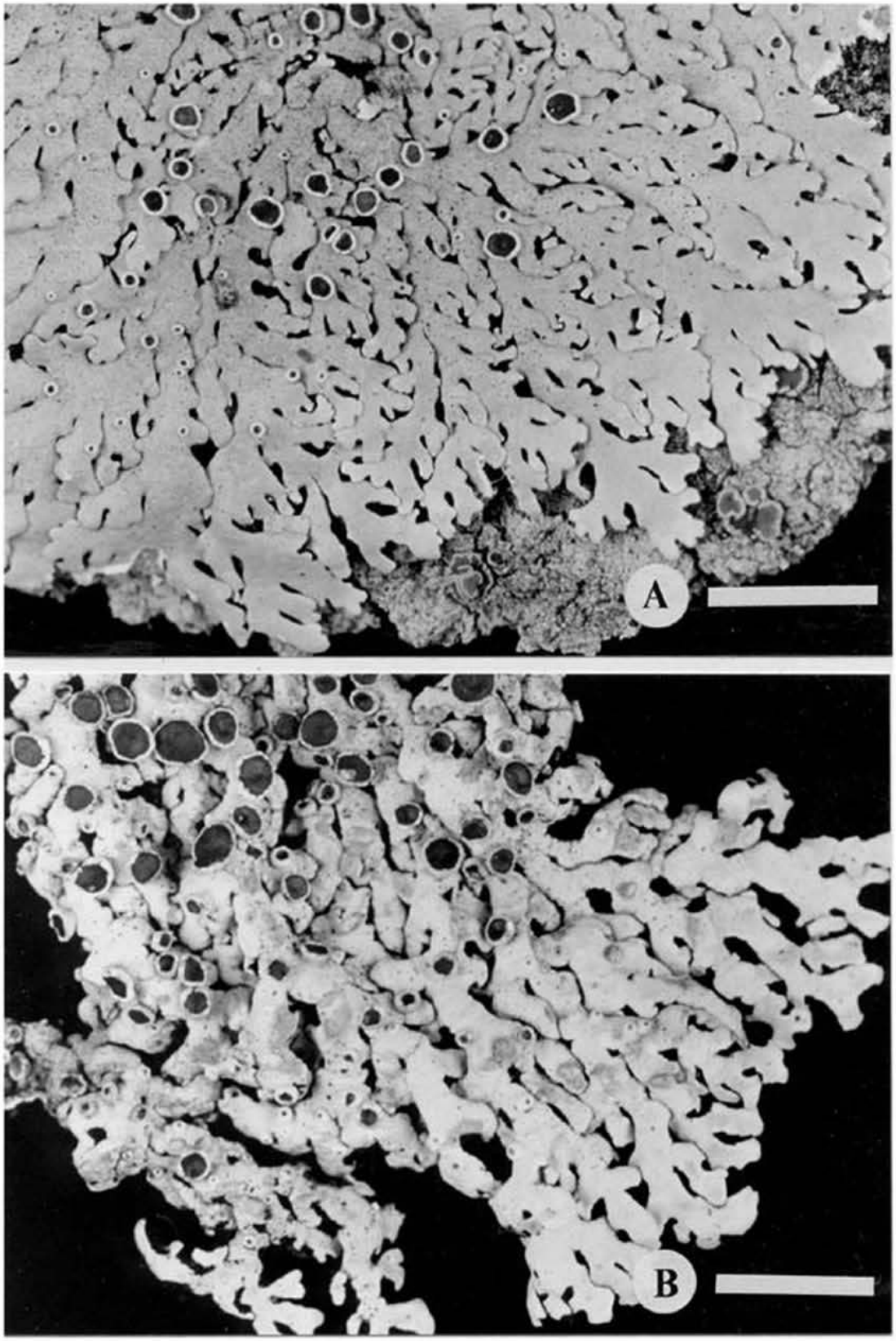

Fig. 1. A: *Imshaugia pyxiniformis* (holotype in NY); B, *Imshaugia sipmanii* (holotype in B). Scale bar = 5.0 mm.

Type: **VENEZUELA.** Estado Bolivar: Cerro Guaiquinima, near NE edge of upper plateau (near camp 2), c. 5°54'N, 63°27'W, 1200 m, on rock in rocky sandstone area with scattered scrub, *H. Sipman 26705*, 7 February 1990; holo: B.

KEY CHARACTERS — **Thallus** saxicolous, foliose, loosely adnate, 3-5 cm wide. **Lobes** contiguous to sparingly imbricate, separate at apices, sublinear to sublinear-elongate, dichotomously branched, 0.8-1.2 mm wide, eciliate, apices incised. **Upper surface** whitish-gray, flat to convex, emaculate, shiny at apices but dull within, smooth to rugulose; isidia and soredia absent. **Medulla** white. **Lower surface** ivory to pale brown, blackening at tips, ± rugulose; rhizines dense, simple, pale brown to brown, to 1 mm long. **Apothecia** substipitate, 0.8-1.5 mm wide; disc flat to weakly concave, dark brown to black, thalline exciple smooth, eventually roughened and pynidiate. **Ascospores** colourless, 8 per ascus, subglobose to broadly ellipsoidal, 7-8 x 6-7 μm. **Pycnidia** common, laminal and marginal, emergent. **Conidia** terminal on conidiophores, bifusiform, 6-8 x 1 μm. **Chemistry** — Cortex K-, UV+ yellow; medulla K+ pale yellow-brown, C-, KC-, P+ orange-red; containing lichexanthone (major), protocetraric acid (major), virensic acid (trace).

Distribution — At present this species is only known from the type collection.

COMMENTS — *Imshaugia sipmanii* closely resembles *I. pyxiniformis*, described above, but differs from that species in being saxicolous rather than corticolous, in having a much more loosely adnate thallus, substipitate apothecia, distinctly bifusiform conidia and in lacking 4-*O*-demethylmicrophyllinic acid in the medulla. These are the only species of *Imshaugia* known to contain lichexanthone rather than atranorin and chloroatranorin in the upper cortex. However, other parmelioid genera (e.g. *Hypotrachyna*) have representative species showing analogous variations in cortical chemistry.

New Combinations

Imshaugia subarida (Elix) Elix, comb. nov.

BASIONYM — *Canoparmelia subarida* Elix, *Mycotaxon* **47**: 103 (1993).

SPECIMENS EXAMINED — AUSTRALIA. South Australia: North-Western Region, 20 km W of Vokes Corner, 28°34'S, 130°29'E, on bark of *Acacia aneura*, *N. N. Donner 7376*, 23 August 1980 (AD). **Western Australia**: Nookaminne Picnic Area, 4 km W of Quairading, 32°01'19"S, 117°22'19"E, 250 m, on dead twigs of *Casuarina*, *J. A. Elix 31794, 31796, 31798*, 22 April 2004 (CANB).

Imshaugia venezolana (Hale) Elix, comb. nov.

BASIONYM — *Pseudoparmelia venezolana* Hale, *Smithsonian Contr. Bot.* **31**: 55 (1993).

SPECIMEN EXAMINED — VENEZUELA. Estado Táchira: Pico Banderas, Páramo de Tamá, 3000-3300 m, exposed rocky paramo, *M. E. Hale 45499a & M. Lopez Figueiras*, 27 March 1975 (CANB, US).

COMMENTS — An examination of representative specimens of the two species above has established that both exhibit emergent pycnidia with *Psora*-type conidiophores and short, ampulliform or weakly bifusiform conidia typical of *Imshaugia*.

Parmeliopsis macrospora (Elix & J.Johnst.) Elix, comb. nov.

BASIONYM — *Canoparmelia macrospora* Elix & J.Johnst., *Mycotaxon* **31**: 491 (1988).

SPECIMENS EXAMINED — **AUSTRALIA. Western Australia:** On trail to The Loop, Kalbarri National Park, 27°33'S, 114°27'E, on dead stump, *H. W. Bennett s.n.*, 26 August 1996 (PERTH); 6 km NE of Mt Harry, Ninghan Station, 29°18'S, 117°33'E, on *Acacia* bark in open scrub, *R. J. Cranfield 8627I*, 26 November 1992 (PERTH); Charles Gardner Flora Reserve, central track, 20 km SW of Tammin along old York Road, 31°47'24"S, 117°28'07"E, 305 m, on base of *Eucalyptus*, *J. A. Elix 31842, 31847*, 22 April 2004 (CANB); site 7, Wanjarri Nature Reserve, 27°27'S, 120°40'E, on bark, *C. S. Fang & R. J. Cranfield 220/94*, 31 August 1994 (PERTH); 4 km E of Bullabulling, 31°01'S, 120°53'E, on base of *Acacia* in open scrubland, *J. A. Elix 21728 & M. V. Sargent*, 20 August 1987 (CANB).

COMMENTS — Examination of additional specimens of this species has established that it has apothecia with large, reniform ascospores (16-20 x 5-6 µm) and immersed pycnidia containing *Psora*-type conidiophores and long, curved (sickle-shaped) conidia (9-11 x 1 µm) typical of *Parmeliopsis*.

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MYCOTAXON

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Conidiobolus antarcticus, a new species from continental Antarctica

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Abstract–*Conidiobolus antarcticus* sp. nov. (*Entomophthorales*: *Ancylistaceae*), was isolated from the antarctic mosses *Scistidium antarctici* and *Hennediella heimii*. It is the first record of an *Entomophthorales* species in continental Antarctica. This new fungus is distinguished from other species of the same genus in the size and shape of the primary conidia and zygospores, and in the disjunctive mycelial hyphae.

Keywords–antarctic fungi, taxonomy

Introduction

An unusual zygomycete assigned to the genus *Conidiobolus* Bref. emend. Humber (1989) has been isolated from the mosses *Scistidium antarctici* and *Hennediella heimii* in Antarctica (Tosi et al., 2002). Although this fungus is represented by a single isolate, the new taxon is sufficiently distinctive to warrant a description of a new species of the genus *Conidiobolus* which is described in this paper.

Materials and Methods

A mixed sample of the mosses *Scistidium antarctici* and *Hennediella heimii* was collected aseptically by R. Bargagli at Kohler Head (75°48'S-162°51'E) in Victoria Land, on the west coast of the Ross Sea, during the austral summer, 2 February 1999.

The sample was placed in a sterile polythene bag, stored at -20°C and processed within two months in the Mycology Laboratory at the University of Pavia. The fungus was isolated by aliquots of 0.25 g of moss broken into small pieces and placed onto the surface of agar Petri dishes containing as cultural media potato dextrose agar (PDA; DIFCO, Detroit, Michigan) and malt extract agar (MEA; DIFCO) with streptomycin

(20 ppm) and penicillin (30 ppm). Triplicate plates were incubated in the dark at 15°C and 24°C and examined daily for two weeks. Isolation and morphological studies of the fungus, modes of reproduction, assimilation of carbon and nitrogen compounds were carried out by means of techniques outlined by King (1976 a, b). Temperature-growth relationships were established at –1, 5, 10, 15, 20, 24, 30 and 45 °C.

The diameter of primary conidia was measured on water agar. Strain cultures in 60-mm Petri-dish bottom containing PDA was placed in the top of inverted plates, each containing two slide mounts with a thin film of PDA on it in order to study development of the colony. Development of the colony from primary discharged conidia was controlled each hour for the first day and then each 24 hrs for 14 days. Specimens for scanning electron microscopy (SEM) were prepared as follows: the fungus growing on PDA was fixed for 4 h in 2.5% glutaraldehyde solution in 0.1 M cacodylate buffer (pH 7.2), post-fixed for 2 h with 1% $0s0_4$, in the same buffer, dehydrated in increasing concentrations of ethanol solutions. The material was processed by the critical point drying method in a Emitech K-850 apparatus. The dried specimens were placed on a mounting base, coated with gold, and examined with a Philips XL 20 scanning electron microscope.

Taxonomic Description

Conidiobolus antarcticus Tosi, Caretta & Humber, sp. nov. (Figs 1-3)

Coloniae in agaro cum saccharo et tubero solani levedinis ad temperatura 20°C crescunt post 5 dies ad 42 mm diam, planae, albae. Mycelium translucens, incospicuum; hyphae septatae, 8-(10)-12 µm latae, cellulis contiguis 3-4plo ramulosis divaricate, actinodendri vel columnae vertebralis simulans. Conidiophora brevia, phototropica. Conidia primaria unitunicata, pyriformia globosa, 25-31(27.7±3)x20-25(22.8±2) µm longa, papilla prominent (5 µm), in cellulis conidiogenis apicale singulariter formantia et violenter absilientia. Conidia secondaria conidiorum primariorum conidis simulans sed parviora. Conidia primaria secondaria tubulos germinalia singulariter aliquotiesve formantia. Sporae perdurantes zygosporae vel azygosporae, globosae, 25-40 (30.2±4) µm diam, parietibus laevibus bistratibus, 2.5-5 µm crassis. Cystidia et rhizoida absentia.

Species ex muscus Scistidium antarctici et Hennediella heimii in Antarctica ad Kohler Head (Victoria Land) sejuncta.

Etymology: the specific epithet refers to the locality from which the specimen was collected.

Colonies grown on PDA for 5 days at 20°C have a diameter of ca 42 mm. Mycelium colourless, inconspicuous. Hyphae septate, 8-(10)-12 µm wide. The mycelium constiuted by short segments (hyphal bodies) that develops from a single conidium. The hyphal segments contiguous, but disjointed putting forth (3-4) short diverticulate branches with an appearance like *Actinodendron* or a vertebrate skeleton's spinal column. Conidiophores short, mostly simply, positively phototropic. Conidiogenous cells undifferentiated in diameter and appearance from vegetative hyphae, with a basal septum, producing a single conidium. Primary conidia unitunicate, pyriform to globose, 25-31(27.7±3)x20-25(22.8±2) µm, with broadly rounded apex and prominent papilla (5 µm), containing numerous globules. Primary conidia forcibly discharged toward light source, germinating on PDA. Secondary conidia formed from primary conidia,

slightly smaller (20%). Primary and secondary conidia producing multiple germ tubes and containing large globules. Resting spores present and numerous. Resting spores *sensu* Benny, Humber and Morton (2001) represented by zygospores and azygospores.

Zygospores smooth, globose 25-40 (30.2 ±4) μm, thick-double walled (2.5-5 μm), containing one or more globules, formed between conjugating cells (gametangia) of different or the same hyphae or hyphal bodies. Azygospores, zygospore-like of the same size, with two thick wall layers (2.5-5 μm), formed without prior gametangial conjugations of the hyphae or hyphal bodies. Cystidia and rhizoids absent. Utilizes $(NH_4)_2SO_4$, glucose and trehalose. Cardinal temperatures for growth: minimum –1°C, optimum 20°C, maximum 26°C.

Holotype: CMM 1018S, slide ex CMM 1018, isolated from mosses *Scistidium antarctici* and *Hennediella heimii*, collected in Antarctica at Kohler Head (Victoria Land), deposited in the Collection of Medical Mycology of the University of Pavia. A living *ex-type* culture ARSEF 6913 (ex CMM 1018) is deposited in the USDA-ARS Collection of Entomopathogenic Fungal Cultures (Ithaca, NY).

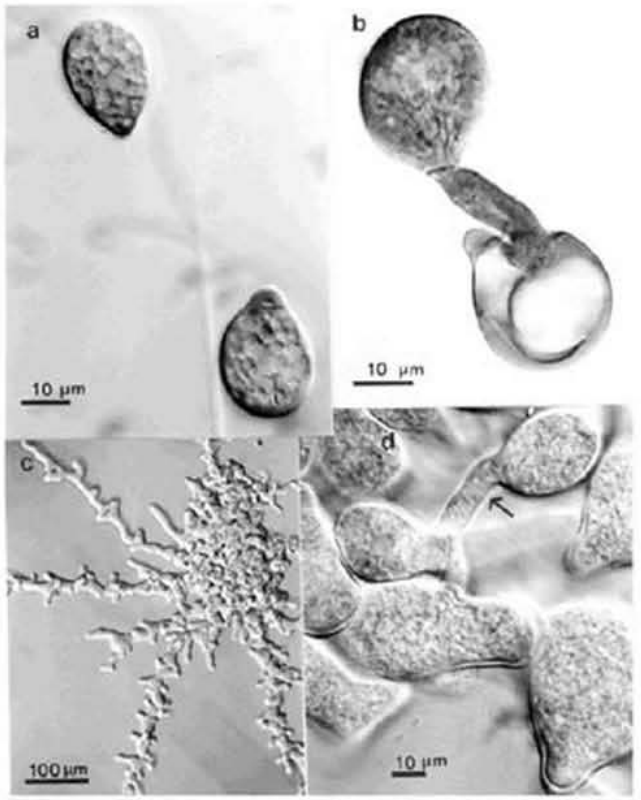

Figure 1 (top). a) Primary conidia, 1000x; b) Production of secondary conidium, 1000x; c) mycelium, 200x; d) production of conidium, the arrow indicates the basal septum, 1000x.

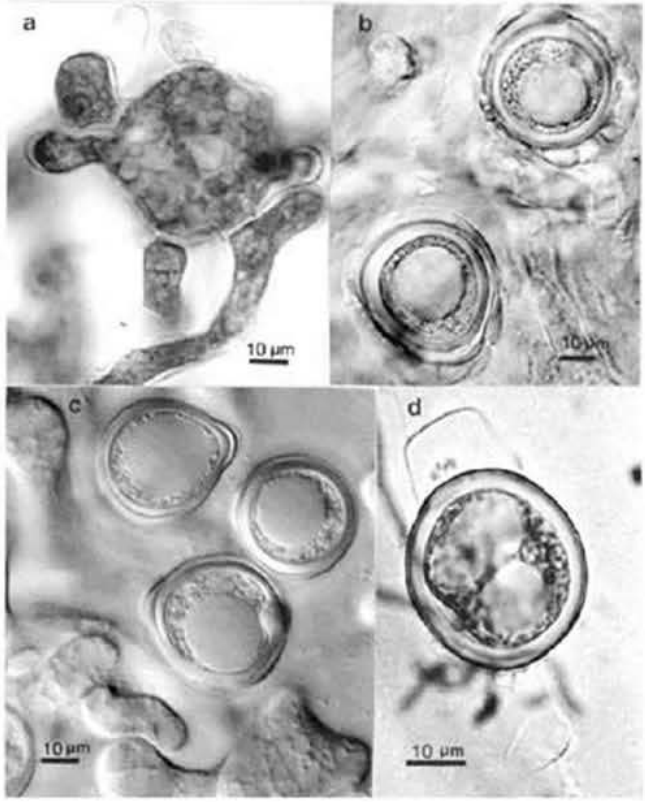

Figure 2 (bottom). a) conidium producing multipolar germ tubes, 1000x; b and c) azygospores, 1000x; d) zygospore formed between the two conjugating gametangia, 1000x.

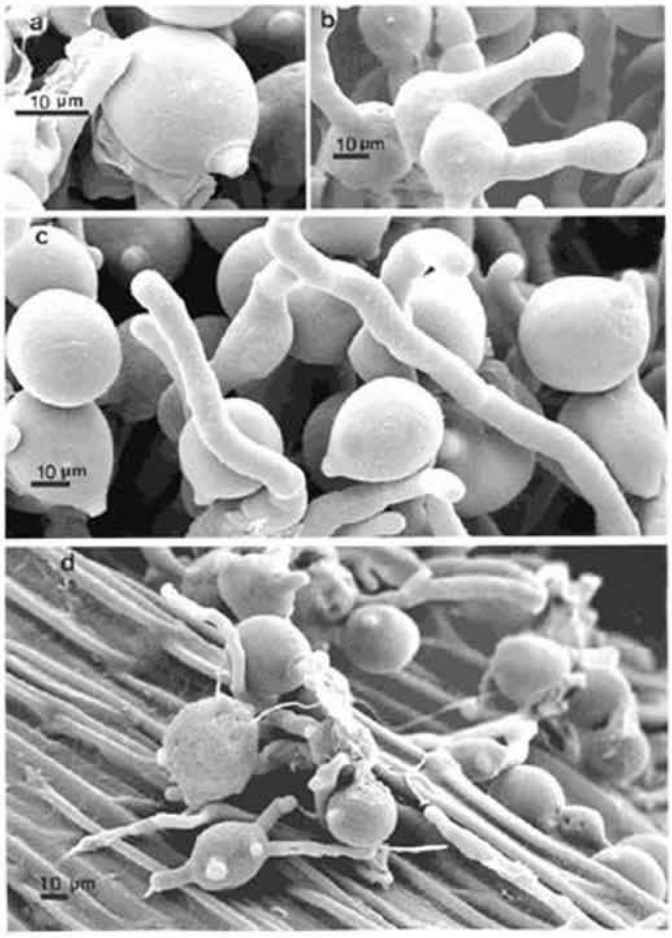

Figure 3. SEM micrographs of: a) primary conidium, 2400x; b) secondary conidia production, 800x; c) conidia and mycelial fragments, 800x; d) mycelium and conidia of the fungus growing on the moss, 540x.

To some extent, the morphological features of *Conidiobolus antarcticus* resemble those of *C. megalotocus* Drechsler, *C. thromboides* Drechsler, *C. bangalorensis* Sriniv. & Thirum. and *C. lamprauges* Drechsler. *C. antarcticus* differs from *C. megalotocus* mainly in the size and shape of the primary conidia but also in the disjunctive branching pattern of the mycelial hyphae, conidiophores *Actinodendron*-like and microconidia lacking in *C. antarcticus*. The vegetative appearance of the fungus is different from *C. thromboides*. The branching pattern is different, and the shape of the conidia is not like that in *C. thromboides*, in which the papilla is prominent and the overall shape of the conidium pyriform; the papilla of our fungus is smaller and emerges more abruptly from the overall outline of the conidium. The papilla of *C. antarcticus* also shows some greater tendency to be apiculate whereas the conidial papilla in *C. thromboides* is not apiculate. Some similarities with *C. antarcticus* are shown by *C. lamprauges* and *C. bangalorensis*. These two entomophthoraceous fungi have been listed by Srinivasan and Thirumalachar (1967) in the zygosporic species of *Conidiobolus*. The size and shape of the zygospores were the important characters for the differentiation of these species. In *C. antarcticus* the zygospores are formed through union of gametangia and the resting spores (variously called chlamydospores or azygospores) are globose measuring 25 to 30 µm. The zygospores of *C. bangalorensis* are globose and 12-18 µm diam, and those of *C. lamprauges* are also usually 12 to 18 µm in diam.

Conidiobolus antarcticus is the first species of *Entomophthorales* recorded from continental Antarctica. Bridge and Worland (2004) recently collected an unidentified species of *Neozygites* from mites, *Alaskozetes antarcticus (Acarina: Oribatidae)*, on Nelson Island off the northwestern tip of the Antarctic Peninsula. The particular climate and the geographically isolated habitat in which the Antarctic strain of *Conidiobolus* lives make this fungus different from all known similar species. This is supported by the fact that there is a high degree of endemism among *Conidiobolus* in the few parts of

the world that have been studied at all intensely for the flora of this entomophthoralean genus, particularly by Drechsler (1953) in U.S.A. and Srinivasan & Thirumalachar in India (1961, 1962a, 1962b, 1965, 1968).

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A new species, *Massarina magniarundinacea*

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Abstract—*Massarina magniarundinacea*, a new pleosporalean fungus, is described and illustrated. It is found on a submerged herbaceous stem from a river in Hokkaido, northern Japan. The shape of ascospores is very similar to that of *M. arundinacea*, but the dimensions are much larger, 67–82 × 6.5–9 μm (vs. 23–40 × 3.5–6 μm in *M. arundinacea*). In artificial media, *M. magniarundinacea* produces a teleomorphic state.

Key words—Ascomycetes, freshwater, *Lophiostoma*, *Pleosporales*, taxonomy

Introduction

During an investigation of freshwater ascomycetes in northern Japan, an interesting pleosporalean fungus was encountered. It was collected from an unknown herbaceous stem submerged in a river, along with another ascomycete, *Massarina arundinacea* (Sowerby: Fr.) Leuchtm. The cylindrical ascospores in the collected fungus resembled those of *M. arundinacea*, but the dimensions of ascospores were almost twice as large as those of the latter. Therefore, we describe the fungus as a new species, *M. magniarundinacea*. Methods of microscopic observation, single ascospore isolation, and cultivation followed Tanaka and Harada (2003a).

Taxonomic Description

Massarina magniarundinacea Kaz. Tanaka & Y. Harada, sp. nov.

FIGURES 1–14, 15A

Ascomata 150–280 μm alta, 310–410 μm diametro, dispersa, erumpentia, subglobosa, basi plana, in latere hyphis sparsis brunneis vestita. Rostrum centrale, breve, aliquantum papillatum, ex cellulis brunneis globosis 2–4 μm diametro compositum. Paries ascomatis in latere 12.5–20 μm crassus, ex cellulis 4–5-stratis polygonis 3–18 × 2–4.5 μm compositus, ad basim 5–7.5 μm crassus et parum evolvens. Pseudoparaphyses copiosae, cellulosae, 1.5–3.5

μm crassus, ramificantes, per spatial 5–17 μm longa septatae. Asci (119–) 125–182.5 (–200) × 25–35 (–47.5) μm, fissitunicati, anguste ovati, apice rotundati, stipitati, octospori. Ascosporae tri- vel tetraseriatae, 67–82 × 6.5–9 μm, cylindricae vel anguste fusiformes, fere curvatae, 1–2-septatae, valde constrictae ad septum primum submedianum (0.52–0.57), infirme constrictae ad medium hemisphaerii superioris, cum septo alio in hemisphaerio inferiore formantes, hyalinae vel pallide olivaceae, laeves, guttulatae, tunica gelatinosa circumdantes.

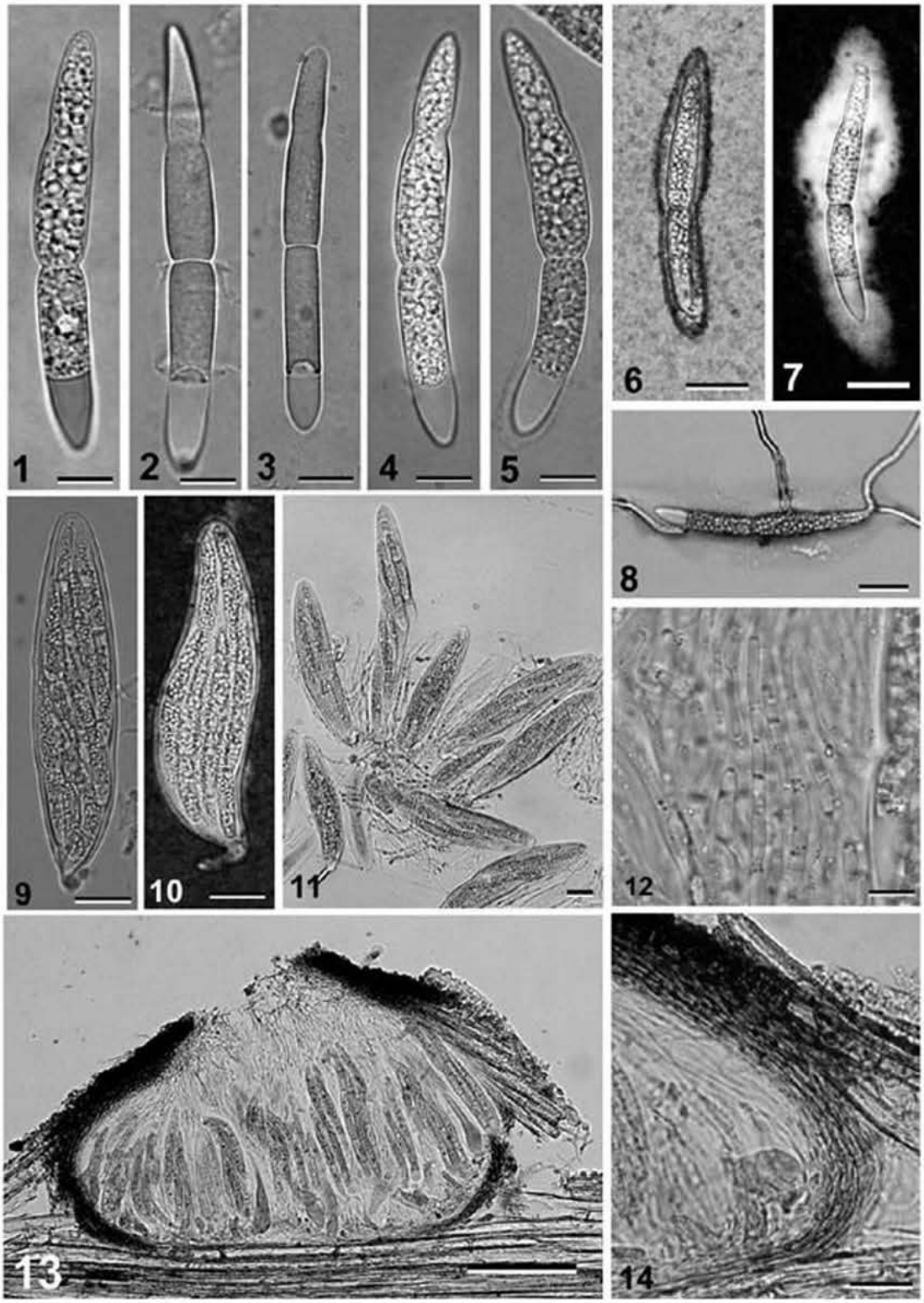
Etymology: from the Latin *magni-* meaning large, and the epithet of a similar species, *arundinacea*.

Ascomata 150–280 μm high, 310–410 μm diameter, scattered, erumpent, subglobose, flattened at the base, with sparse brown hyphae at sides. Beak central, short, slightly papillate, composed of dark brown globose cells of 2–4 μm diameter. Ascomal wall at sides 12.5–20 μm thick and composed of 4–5 layers of polygonal cells of 3–18 × 2–4.5 μm, at the base 5–7.5 μm thick and poorly developed. Pseudoparaphyses numerous, cellular, 1.5–3.5 μm thick, branched, with septa at 5- to 17- μm intervals. Asci (119–) 125–182.5 (–200) × 25–35 (–47.5) μm (mean = 151.5 × 30.2 μm, n = 37), fissitunicate, narrowly ovoid, rounded at the apex, short-stalked, with 8 tri- to tetraseriate ascospores. Ascospores 67–82 × 6.5–9 μm (mean = 74.0 × 7.7, n = 50), L/W 8.4–11.0 (mean = 9.6, n = 50), cylindrical to narrowly fusiform, mostly curved, with 1–2 septa, strongly constricted at the primary submedian septum (0.52–0.57; mean = 0.54, n = 50), weakly constricted at the middle of upper hemisphere, with an additional septum in the lower hemisphere, hyaline to pale olivaceous, smooth, with numerous small guttules in fresh condition, surrounded by a sheath. Sheath narrow at first, 3 μm thick at sides, 7 μm thick at the base, later enlarged in water, 11 μm at sides, 15 μm at the base.

CULTURAL CHARACTERISTICS — Colonies on potato dextrose agar (PDA; Difco, Detroit, MI, USA) 33 mm in diameter after incubation for 4 weeks at 20 °C in the dark, at first white, later Olive-Brown (4D3; Kornerup and Wanscher 1978) to Bluish-Grey (22D2), with irregular margin; reverse Dark-Green (28F3); no pigment produced. On rice straw agar (Tanaka and Harada 2003a), ascomata formed on the surface of rice straws within 2 months. Ascospores similar to those found in nature, (64.5–) 69–82.5 (–85) × (7–) 8–10 μm (mean = 75.3 × 9.3 μm, n = 65), L/W 7.2–9.7 (mean = 8.2, n = 65), and with a submedian primary septum (0.53–0.59; mean = 0.56, n = 65).

MATERIALS EXAMINED — **JAPAN:** Ariake small river, Ariake, Akkeshi, Hokkaido (144°52.0'E, 43°01.2'N), on submerged dead stems of an unknown herbaceous plant, June 3, 2003, K. Tanaka and S. Hatakeyama 1174 (maintained at Herbarium of Hirosaki University, Fungi: HHUF 28293 holotype; single ascospore culture MAFF 239294). Dried culture specimens grown on culms of *Oryza sativa* L., from culture MAFF 239294 (HHUF 28294, HHUF 28335, IMI 391849). Slides made from holotype (HHUF 28295, IMI 391850), Slide made from culture MAFF 239294 (HHUF 28296).

COMMENTS — *Massarina magniarundinacea* has cylindrical ascospores which are constricted at the primary septum and middle portion of upper hemisphere, and are surrounded by a mucilaginous sheath elongated below. These ascospore features are somewhat similar to those of *M. arundinacea* [= *Lophiostoma arundinacea* (Sowerby: Fr.) Aptroot & K.D. Hyde; Hyde et al., 2002]. However, the



Figs. 1–14. Micrographs of *Massarina magniarundinacea*. **1–5.** Ascospores; **6, 7.** Ascospores with a sheath (in India ink); **8.** Germinating ascospore; **9–11.** Asci; **12.** Cellular pseudoparaphyses; **13.** Ascomata in longitudinal section; **14.** Ascomal wall in longitudinal section. (1–3, 7, 8, 11, 13, 14 from holotype; 4–6, 9, 10, 12 from culture MAFF 239294). Scale bars: 1–5, 12 = 10 μm; 6–11, 14 = 20 μm; 13 = 100 μm.

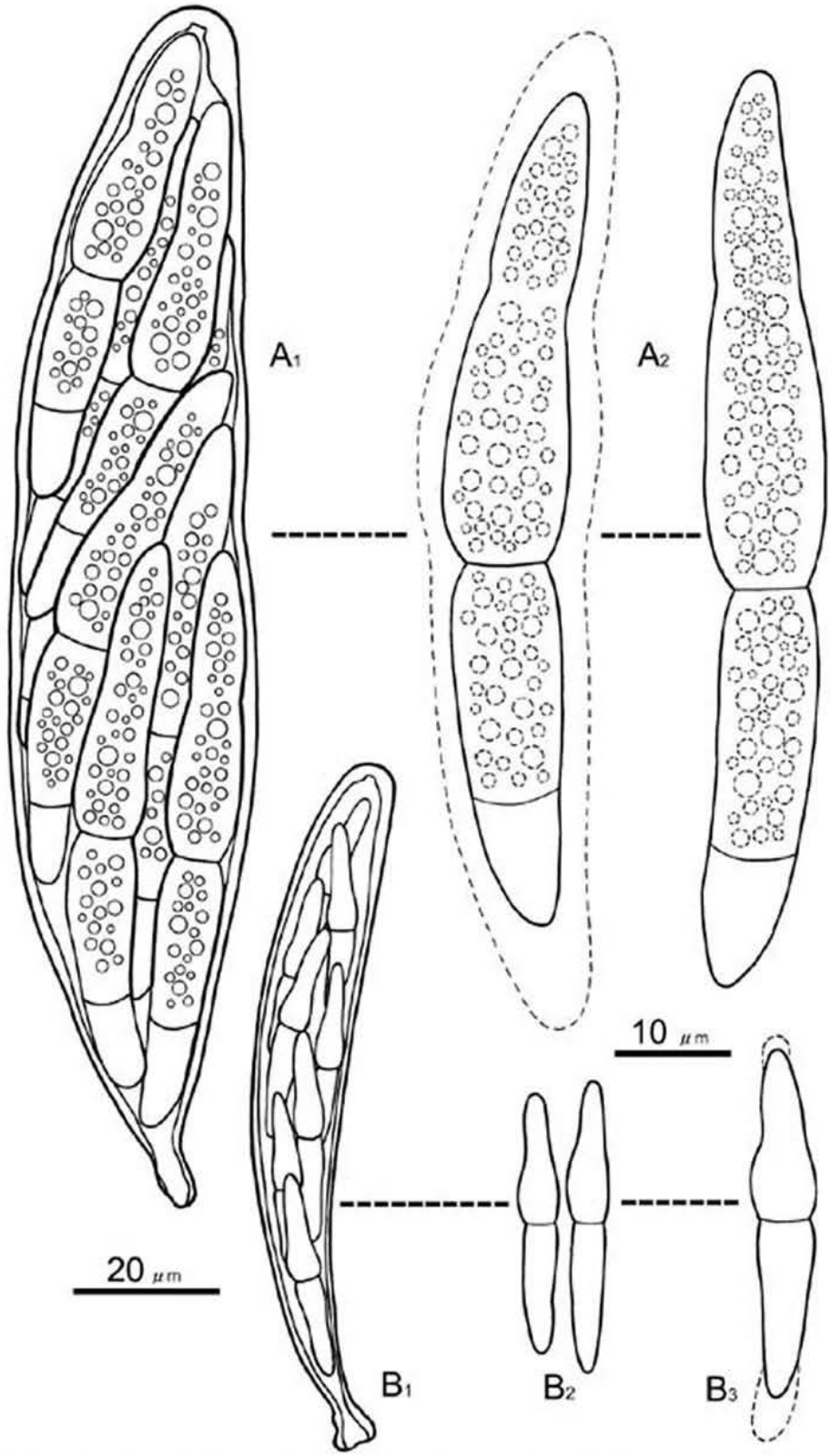


Fig. 15. Line drawings of *Massarina magniarundinacea* (**A**) and *M. arundinacea* (**B**). A_1. Ascus; A_2. Ascospores; B_1. Ascus; B_2, B_3 Ascospores. (A_1, A_2 from MAFF 239294; B_1, B_2 from HHUF 27542; B_3 from YAM 22555).

ascospore dimensions of *M. magniarundinacea* are considerably larger (67–82 × 6.5–9 μm vs. 23–40 × 3.5–6 μm in *M. arundinacea*, Tanaka and Harada 2003b). There are also important differences in the septal position of ascospores. The primary septum is clearly submedian (0.54) in *M. magniarundinacea*, but median (0.50) in the latter. The additional septum is always formed at lower hemisphere in *M. magniarundinacea*, but at upper hemisphere in the latter (Shoemaker and Babcock 1989). The morphological differences of ascus and ascospore between both species are illustrated in figure 15.

In addition, the colony characteristics on artifical medium differ in both species. The colony growth rates of *M. magniarundinacea* are very slow (33 mm on PDA / 4 weeks, at 20 °C in the dark) as compared to those of *M. arundinacea* (75 mm, same condition; Tanaka and Harada 2003b).

This species was found on a submerged herbaceous stem which was mainly colonized by *M. arundinacea*. The latter species, a common fungus on culms of *Phragmites australis* (Cav.) Trin. ex Steud., is known as a freshwater ascomycete (Shearer 1993). *Massarina magniarundinacea* also may have a freshwater habitat, but additional collections are needed to confirm this.

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Taxonomic notes on *Pannaria pallida* from southern South America and New Zealand

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Abstract – The genus *Psoroma sensu lat.* in southern South America is poorly known. Although there have been some new species reported, bibliographic revisions and species checklists published, no systematic revision has been undertaken. We now report our initial results of morphological, anatomical and chemical studies on two such species (*Ps. pallidum*, *Ps. pulchrum*). We have shown these two species to be synonymous. Furthermore, following the circumscription of *Pannaria* proposed by P.M. Jørgensen, we adopt here the name *Pannaria pallida*, previously proposed by Hue, as the valid combination.

Key words – lichens, *Pannariaceae*, Southern Hemisphere, emended description

Introduction

The genus *Psoroma* Michaux (1803) includes a heterogeneous group of lichens from the family *Pannariaceae* (lichenized Ascomycota). Despite of the fact that the first species of *Psoroma* were described from the Northern Hemisphere (including *Ps. hypnorum* (Valh.) Gray, the type species of the genus), it is now considered to be predominantly a Southern Hemisphere genus, with circumantarctic distribution (Galloway 1985, Jørgensen & Galloway 1992). Indeed, *Psoroma* is a widespread element in the subantarctic rainforests as well as in the Antarctic regions, where it grows on soil and over mosses (Henssen & Renner 1981, Galloway 1985). Until recently the genus included approximately 50 species, mainly from South America, New Zealand and Australia. More recently, the circumscription of the genus has undergone considerable changes (Jørgensen 1994, 2000, 2001, Elvebakk & Galloway 2003),

which resulted in a number of foliose species being transferred to the genus *Pannaria* (type: *Pannaria rubiginosa* (Ach.) Bory). Characteristic features including the ascus tip, the related secondary chemistry as well as the morphology and the anatomy of the thallus suggested a close relationship between the foliose species of *Psoroma* and those of *Pannaria s. st.*, although they contain different types of photobionts (e.g. green algae including *Myrmecia* and cyanobacteria such as *Nostoc* respectively) (Jørgensen 1994, 2001).

However, no world monograph or comprehensive revision of *Psoroma* is available. Treatments of the genus in the Flora of New Zealand (Galloway 1985) and the Flora of Australia (Jørgensen & Galloway 1992) represent the most significant contributions to the knowledge of the genus; a revision of *Psoroma* in South America would be highly significant. Several new species have been described from South America over the past 50 years (Lamb 1953, 1955, James & Henssen 1975, Henssen & Renner 1981, Henssen et al. 1983, Henssen 1983, Scutari & Calvelo 1995, Jørgensen & Wedin 1999). Although bibliographic revisions and checklists for different South American countries have been published (Lamb 1958, Calvelo 1992, Galloway & Quilhot 1998, Calvelo & Liberatore 2001), no comparative study involving extensive fieldwork has been undertaken.

Psoroma pallidum was described by Nylander (1859), based on a South American collection (holotype: country not specified (probably Chile), Strait of Magallanes, D. Le Guillou and Lechler *supra linga putrescentia corticesque*, in Mus. Paris, ex herb. W. Nylander, nr. 30827, H). Unfortunately the type is very small and provides little information.

Malme (1925) described *Psoroma pulchrum* based on a collection from Tierra del Fuego (holotype: Fuegia (Argentina), Ushuaia, *habitat in truncis Fagi antarcticae* (*Nothofagus antarctica*), Dusén 257, L 5121, S). Although Malme studied specimens of *Ps. pallidum* collected by Dusén in Chile, he explicitly stated that he considered *Ps. pulchrum* and *Ps. pallidum* two separate species. They were segregated mainly by the structure of the upper cortex (stratified or non-stratified) and by additional anatomical features. Subsequently, Lamb (1953) reported on the poorly known species, *Ps. calophyllum* Müll. Arg., as well as notes regarding *Ps. pulchrum* and *Ps. pallidum*.

The present paper is the first contribution towards a revision of the genus *Psoroma* in South America, with special reference to the species occurring in Argentina. We have studied the morphology, anatomy and chemistry of *Ps. pulchrum* and *Ps. pallidum* and considered them to be synonymous. Furthermore we accept that *Ps. pallidum* belongs to *Pannaria*, as previously proposed by Hue (1902).

Material and Methods

Lichen collections – Collections from various herbaria were studied (BA, BACF, BCRU, BM, H, LIL, MSC, S), including specimens from South America, New Zealand and Australia. Recent collections from northwestern Patagonia, Nahuel Huapi National Park and surrounding areas were also investigated; the latter are preserved in private herbaria (Calvelo and Passo). Abbreviations for herbaria follow Index Herbariorum (Holmgrem & Holmgrem 2001).

Morphological and anatomical studies – Morphological observations were made under a dissecting microscope. Anatomical features of the thallus and the apothecia were examined by sections, using a compound light microscope. All anatomical sections and size measurements were determined on water-mounted slides. For descriptions of anatomical structures of the thallus and the fruiting bodies, sections were stained with lactophenol cotton blue. For a detailed study of the asci, the preparations were pre-treated with a KOH solution (10%) and then with Meltzer´s reagent, in order to reveal the ascus tip structure.

Chemistry – Natural compounds were characterized by high performance liquid chromatography (HPLC) with retention index values (RI) calculated from benzoic acid and solorinic acid controls (Elix 1996; Elix & Wardlaw 2000; Feige et al. 1993). A Merck Hitachi Spectra System and a Beckman 5μ C18 column, and spectrometric detectors were used. Two solvent systems A and B were used: 1% aqueous ortho-phosphoric acid and methanol in the ratio 7:3 (A) and methanol (B). The HPLC was coupled to photodiode array detectors for ultraviolet spectroscopic comparisons. By this means the ultraviolet spectra observed for the various components eluting in the HPLC chromatogram were recorded and computer-matched against a library of ultraviolet spectra recorded for authentic metabolites under identical conditions. For a complete chemical profile TLC analyses were performed following standardized protocols (White & James 1985, Huneck & Yoshimura 1996).

Results

Table 1 provides a comparative summary of the main characters reported by Malme (1925) for *Ps. pulchrum* and *Ps. pallidum*.

Based on our examination of the type specimens of both species as well as several more recent collections, we reviewed the characters discussed by Malme (1925) and subsequently by Lamb (1953), regarding these two species.

Morphology – Figures 1a and 1b illustrate the type specimens of *Ps. pallidum* and *Ps. pulchrum*.

As mentioned previously the type specimen of *Ps. pallidum* is quite small. It is clearly foliose, but it is not possible to infer the lobe shape from it. No prothallus is visible. The upper surface is uneven, matt, and yellowish, while the lower surface is white at the margins but brownish in the centre. The rhizines are simple to squarrose, pale to buff. The apothecia are round, 2–3 mm in diameter, plane to slightly concave or irregular due to mutual pressure and pruinose when young. The cephalodia located on the lower surface are globose, 0.5–2 mm and concolorous with the thallus.

Psoroma pulchrum has a foliose thallus, ca. 10 cm in diameter. The lobes are laciniate, 2 to 4 mm wide and discrete at the margins, imbricate and overlapping in the centre. The upper surface is uneven, small papillose, matt, yellowish to yellow-brown. The lower surface is pale-buff at the margins but brown in the centre of the lobes. It is rhizinate, with white to brownish rhizines.

Table 1—Morphological and anatomical characters of *Psoroma pulchum* and *Psoroma pallidum*, extracted from Malme (1925).

Character	*Ps. pulchrum*	*Ps. pallidum*
Lobules	Laciniate, sublinear, 2-3 mm wide, margins notched	Laciniate
Color	Glaucous, creamy to yellow-brown	Creamy to yellow-brown
Upper surface	Uneven, verrucose, matt	--
Apothecia	Rounded, or deformed by mutual pressure. Disc plane 2-3 mm, pruinose.	Rounded, 2-2.5 mm
Thecium	200-250 μm	140-160 μm
I-Reaction	+ vinose rubescens	Positive
Paraphyses	Branched at apices	Simple
Spores	Globose to subglobose, 12-15 μm, epispore verrucose.	Ovoid, 12-17 to 9-12 μm. epispore $\pm$smooth
Cortical structure	80 μm, stratified. Irregular, fused thick walled hyphae, and vertical pachydermatic cells.	70 μm manifestly parenchymatose

Apothecia are numerous, rounded to irregular due to mutual pressure. Disc 2–3 mm in diameter, orange to dark brown, plane to irregular, with an occasional central depression, pruinose when young. Cephalodia located on the lower face, globose to cerebroid.

The comparison of numerous collections of *Ps. pallidum* from Chile, Argentina and New Zealand, led us to detect some intraspecific variability regarding the thallus morphology. While some specimens exhibit a discrete and laciniate thallus, with sublinear and dichotomously branched lobes (Fig. 1c), other collections exhibit a disordered, imbricate growth form which is not clearly laciniate (Fig. 1d). The examination of numerous specimens *in situ* indicated that these characteristics are probably determined by ecological factors. From our field observations, *Ps. pallidum* specimens growing in the coldest subantarctic habitats, where they spread over mosses or on bark mixed with mosses or other lichens, often have irregularly arranged lobes (Fig. 1d). In such specimens the lobes are shorter and discrete only at the margin. The apothecia are crowded and usually have a central depression on the disc. In contrast, specimens from humid *Nothofagus* forests usually grow directly on bark and are not associated with other lichens. Such specimens have a discrete and clearly laciniate thallus, with less apothecia and plane discs (fig. 1c). Older, larger specimens tend to became more or less imbricate. The upper surface is less uneven, especially in collections from shaded habitats.

Both species have similar, globose cephalodia located in the lower surface.

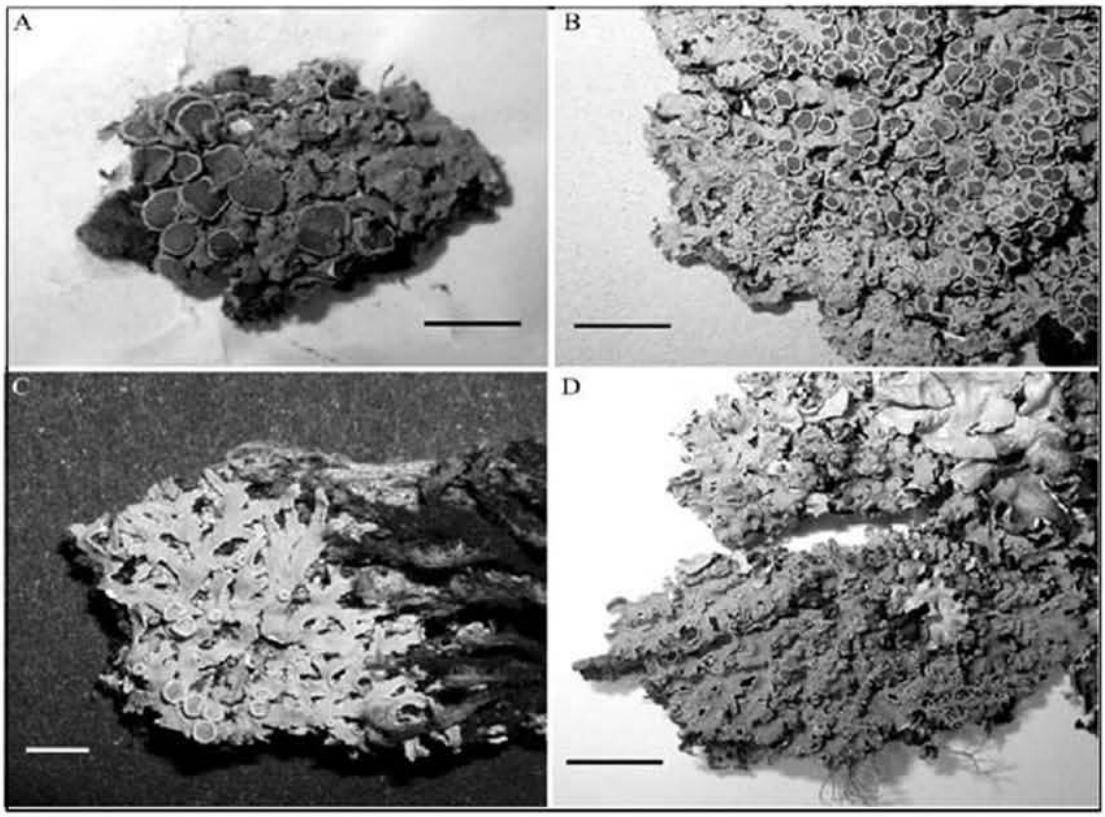
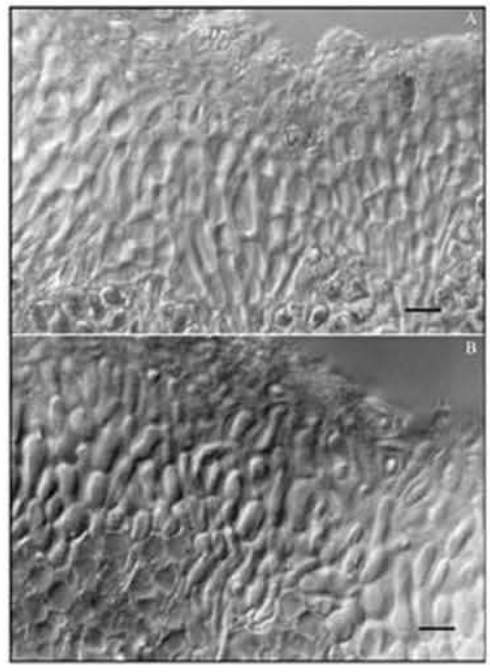


Figure 1 (above) – General view of mature thalli of : **A**. holotype of *Psoroma pallidum*; **B**, holotype of *Psoroma pulchrum*; **C** *Psoroma pallidum* Calvelo 831, from north western Patagonia; **D**, *Psoroma pallidum* L 47185 (S), from Magallanes, southern Chile. Bars: A= 0,5 cm; B= 1,5 cm; C= 0,5 cm; D= 1 cm.

Figure 2 (below right) – Thallus sections of the type specimens of *Ps. pallidum* (A) and *Ps. pulchrum* (B), showing the stratified structure of the cortex. Bar = 10 μm



Anatomical characters – Figure 2 shows the stratified structure of the cortical layer of *Ps. pulchrum* and *Ps. pallidum*. For both species, the external layer is formed from pale yellow hyphae, with thick, highly gelatinized walls, that are packed together and intertwined in various directions. This layer was defined by Lamb (1953) as "decomposed". The lactophenol stain causes the pale yellow coloration to became more evident, ultimately turning pale violet so that crystal incrustations can be clearly distinguished.

Immediately below this layer, a pseudoparenchymatous layer is present, formed from ±isodiametric, periclinal arranged cells. The type collection of *Ps.*

pallidum is so small that very few sections could be prepared. For this reason it was impossible to study the variability of the anatomical features within the thallus. However, variations in cortical height were studied in the type collection of *Ps. pulchrum*. In certain sections, the decomposed layer was significantly greater than in other sections and so was more conspicuous than that observed on the type material of *Ps. pallidum*. Consequently, this character proved to be ambiguous, with many intermediate forms observed for both "species".

The algal layer is compact, with algae partially immersed within the cortex and 60–80 μm high; no differences were observed between the two species. The medulla is thick (100–150 μm), compact, with hyphae disposed subparallel to the cortex and with brown crystals deposited on the cell walls beneath the algal layer. No lower cortex was observed.

The height of the hymenium is quite variable in different specimens, and could not be studied in the apothecia of the type of *Ps. pallidum*. The iodine reactions of the hymenia did not revealed any differences between the two species. Both specimens exhibit a positive blue-reddish (blue, after washing with water) reaction. The ascus tips have no special apical structures, and only the surrounding of the ascus became stained. The ascospores of both "species" were identical, being globose to subglobose, 11–17 μm, with a thick, verrucose epispore.

Chemistry – Specimens of both species from different localities in South America and New Zealand were analysed. All showed the same chemical profile. The major medullary substance is the depsidone pannarin (Fig. 3a), with minor amounts of norpannarin (Fig. 3b), pannarin methyl acetal and two unknown pigments.

Some collections of *Ps. contortum* Müll. Arg. and *Ps. xanthomelanum* Nyl. form New Zealand and Australia, were also analysed for comparison purpose. *Ps. contortum* contained pannarin and contortin as the major substances, but also contains porphyrilic acid, while *Ps. xanthomelanum* contains contortin and zeorin as the major substances with small amounts of pannarin and its derivates.

Discussion

Lamb (1953) initially described the typical "decomposed" cortical layer for *Ps. calophyllum*, but also stated that it was similar to the cortical structure found in the type of *Ps. pulchrum*. However, we have now observed this structure in the type of both *Ps. pulchrum* and *Ps. pallidum*, even though it is slightly more obvious in the former. Our investigations indicated that this character is subject to variability induced by ecological factors, and many intermediate forms were observed. It is not possible to segregate the two species using such an ambiguous character.

Furthermore, it was apparent that the stratified cortex and especially the decomposed layer are responsible for the uneven appearance of the upper surface for both species. As previously mentioned, this character was also found to be ambiguous and variable. A similar relationship between the structure of the cortex and the appearance of the upper surface was also observed in other foliose species of *Psoroma*.

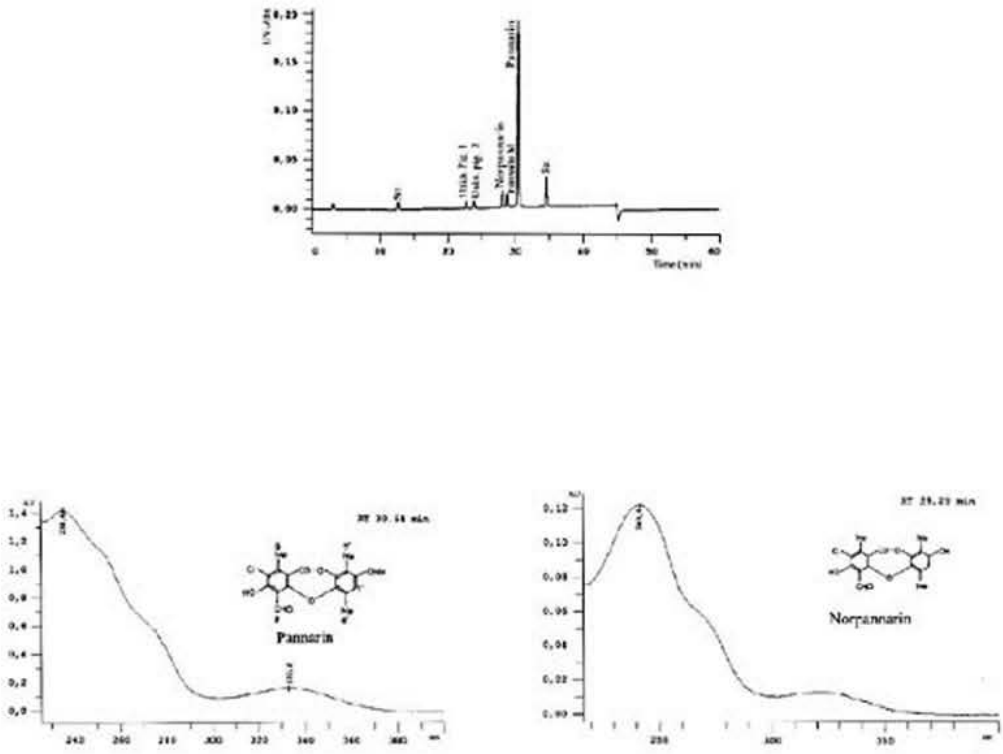


Figure 3 – Typical HPLC chromatogram, UV spectra and chemical structures of the depsidones, pannarin and norpannarin, extracted from the thallus of *Ps. pallidum* (str= standard substances).

Indeed, both *Pannaria sphinctrina* (Mont.) Hue and *P. rubiginosa* (Ach.) Bory have a smooth and shiny upper surface, and a cortex with an even epicortical layer formed from dead, gelatinized cells. By contrast, the New Zealand endemic *Ps. arenosum* Nyl., has a loosely arranged layer of hyphae, giving rise to the tomentose upper surface typical for this species (Passo, unpublished data).

Malme (1925) also used the shape of the ascospores and the anatomy of the apothecia to segregate the two species. However, as described above, we did not observe differences in:

- the height of the hymenia, as mentioned previously by Lamb (1953)
- the iodine reaction of the hymenia
- the ascus tips, since no apical structure was observed (only the surrounding of the ascus was stained).
- the ascospores, which are globose to subglobose, 11–17 μm, with a thick, verrucose epispore in both cases.

Indeed, Lamb (1953, 1958) recognized that the anatomical characters used by Malme (1925) were not sufficiently significant to segregate the two species, and that it would probably be better to separate *Ps. pulchrum* by the narrowly laciniate lobes, the absence of cephalodia, the globose ascospores with the typical verrucose epispore and the positive iodine reaction of the hymenia.

However, in our opinion these characters are also deficient, since the shape and size of the lobes depend on ecological factors. Similar ecological dependence was observed by James (1975) for the related species with laciniate lobes, *Pannaria durietzii* (P.W. James) Elvebakk & Galloway.

The absence of cephalodia is not a characteristic of *Ps. pulchrum* as the type specimen has well developed, globose to cerebrioid cephalodia on the lower surface.

Conclusion

As a result of the present investigation, we consider that the relevant morphological, anatomical and chemical characters, do not provide sufficient criteria to segregate *Ps. pulchrum* and *Ps. pallidum*. Consequently, we believe that *Ps. pulchrum* and *Ps. pallidum* are synonymous.

Furthermore, the various characters studied confirm that this species belongs to the genus *Pannaria* (Jørgensen 2001) as proposed by Hue (1902). An emended description of the species, outlining its intraspecific variability is given.

Pannaria pallida (Nyl.) Hue, *Bull. Soc. Bot. France*, 48: 56 (1902)
ammed. Passo, Calvelo & Stocker
= *Psoroma pallidum* Nyl., *Annal Scienc. Nat. Bot.* Ser. 4., 12: 294 (1859)

Holotype: Chile?, Magallanic Strait, D. Le Guillou-Lechler "*supra linga putrescentia corticesque*" (H-NYL 30827!)

Syn. Nov. Psoroma pulchrum Malme in *Ark. Bot. 20A* (3): 12 (1925)

Holotype: Fuegia (Argentina), Ushuaia, "*in truncis Fagi antarcticae*", 8-I-1896, Dúsen 257 ex herb. Gust. O. Malme, L 5121 (S!).

Thallus foliose, lobate, closely attached centrally, free at margins, without a prothallus, 6–10 cm wide. Lobes laciniate, radiating, discrete to ±imbricate, especially in the centre of large specimens; subdichomously to irregularly branched, 2–5 mm wide, 6–25 mm long. Lobe tips usually crisped and inrolled. Margins irregular, notched, thickened, sometimes with small secondary lobes in older parts. *Upper surface* distinctly to irregular-roughened, uneven, papillate, pruinose or minutely white-tomentose in younger parts, bright green when wet, pale greenish-grey when dry, yellowish-green-glaucous to yellow-brown in herbarium. *Lower surface* white at margins, cottony, tomentose, pale brown to buff centrally, distinctly rhizinate, especially in the centre. Rhizines short, to 2 mm, simple to squarrose, white at the margins, brown to buff, sometimes partially blue-black centrally, with cyanobacteria captured between the rhizines. *Cephalodia* present on lower surface, or rarely projecting from the margins or among rhizines and tomentum, simple, globose to cerebriform when large, buff or brown. *Apothecia* numerous, clustered, central, rarely marginal, disc red-brown, 0.5–4 mm, wide, densely bluish-white pruinose at first, smooth, rounded and plane to ±gyrose by mutual pressure, in some cases with central depressions, glabrous at maturity, margins concolorous with thallus, crenulate-sulcate, ±obscuring the disc at first.

Anatomy. Upper cortex 50–95 μm thick, stratified. Upper layer of thick walled hyphae,

3–5 μm thick, irregularly arranged, ±free to fused together by gelatinous material, 20 to 25 μm high. Lower layer pseudoparenchymatous, 50 to 70 μm high, with rounded isodiametric cells, periclinally arranged. Algal layer compact, sometimes with algae immersed in the cortex, 60–80 μm high. Medulla thick, 100–150 μm wide, compact, formed by hyphae, ±parallel to the upper surface, with brown crystals in the upper part. Lower cortex absent.

Apothecia: hymenium 140–200 μm high, paraphyses simple to branched at the tips, septate. Ascus clavate, ascospores 8, uniseriate, globose to subglobose, 11–18 μm, epispore thick, 2 μm, verrucose. Hymenium I+, surroundings of the ascus stain blue.

Chemistry: Medulla P+ orange. Pannarin (major), norpannarin (minor) and pannarin methyl acetal (minor/trace) and 2 unidentified pigments.

Selected specimens studied:

Psoroma pallidum: **ARGENTINA**, **Prov. de Río Negro**, Depto. Bariloche, Cerro Tronador, Ventisquero Negro, sobre tronco de *Nothofagus pumilio*, 11-XII-2001, Passo 04; Passo 05. Llao Llao, sobre tronco de *Nothofagos dombeyi*, XI-1992, Calvelo 831. Puerto Blest, I-1996, Calvelo 2069. Lago Guillelmo, 13-III-1989, Calvelo 2071. Arroyo Casa de Piedra, sobre *N. dombeyi*, 12-V-1991, Calvelo 2068.

Prov. de Tierra del Fuego, Isla de los Estados, Bahia Capitan Canepa, 3-XI-1971, H. Imshaug (52970), MSC 16213. Canal de Beagle, Lapataia, on the ground on a deforested hillside. 21-II-1940, Rolf Santesson, L 47183 (S). Isla Grande, *Nothofagus* forest near Hostería Alakush on Lago Roca, 25-XI-1971, Imshaug and Ohlsson, L 47184 (S). Lago Frio, on dying *Nothofagus*, on west of lake, alt. Ca. 100 ft., 24-I-1959, P.W. James (1246), BM 762051.

CHILE: **XII Región**, Península Brunswick, El Parrillar, sobre *Nothofagus*, 21-XII-1967, H. Imshaug (59300), MSC 93496. Isla Juan Fernández, Los Inocentes, 4-XII-1965, H. Imshaug (37470), MSC 80490. Magallanes, Rio Rubens, near Hotel Río Rubens (about 50 km SE of Natales), on *Nothofagus*, 12-I-1941, Rolf Santesson (5639), L 47188 (S). Tierra del Fuego, Canal Whiteside, Puerto Yartou, in fallen trunks in *Nothofagus betuloides-Drimys* forest, 29-I-1941, Rolf Santesson (5811), L 47186 (S), Rolf Santesson (6846), L 47185 (S). **X Región**, Peulla, Lago Margarita, sobre *N. dombeyi*, 10-II-1989, Calvelo 2105. Parque Nacional Vicente Perez Rosales, Petrohue, Río Petrohue near falls, alt. 500 m, on rocks and in *Nothofagus* forest, 10-X-1986, B.J. Coppins, D.J. Galloway, G. Guzman and P.W. James (4567), BM 762050, (4681), BM 762048, (4710) BM 762042. **IX Region**, Parque Nacional Conguillio, Parque de los Paraguas, Laguna Captren, alt. ca. 1000 m, *N. dombeyi* and *N. pumulio* forest, 20-XI-1986, B.J. Coppins, D.J. Galloway, G. Guzman and P.W. James (5319), BM 762049.

NEW ZEALAND: **South Island**, Canterbury, Puketariki Ecological Region, Craigeburn Range, Broken River, alt. 1040 m, on mountain beech, D.B. Rogan 125, 14-I-1998, MSC 672933 (ex AK 235435). Evoca Str. Lake Ohau, XI-1958, J. Murray, BM 762047. Craigieburn Forest Park, track from information centre to Lyndon Saddle, mountain beech forest (*Nothofagus solandri var. cliffortioides*), 8-IX-1981, F.J. Walker, BM 762045. Otago, Sugarloaf, IV-1958, Cess., BM 762041.

Psoroma contortum: **ARGENTINA**, **South-West Patagonia**, Cerro Mayo, on boles of *N. dombeyi*, near the Cerro Mayo glacier in small wood, contorted, pseodogyrose apothecia and pale lobes, 11-II-1959, P.W. James (2038), BM 762060.

CHILE: **Tierra del Fuego**, Canal Whiteside, Puerto Yartou, in *Maytenus magellanica*, 2-II-1940, Rolf Santesson (6751), BM 762059. Patagonia, Fjordo Andrew, on *Nothofagus betuloides* bark, 3-XII-1985, A. Newton, BM 762058.

AUSTRALIA: North Queensland, Atherton Tableland, Mount Lewis, above Julatten, in upland rain forest, 3000 ft, on trees, 18-4-1968, W.A. Weber BM 762043.

Psoroma xanthomelanum: **NEW ZEALAND, Auckland Islands,** Musgrave Harbour, on *Metrosideros*, 28-XII-1972, H. Imshaug (57063), MSC 144333. Smith Harbour, on *Metrosideros*, 01-I-1973, H. Imshaug (57240), MSC 144337. **Campbell Island**, Perseverance Harbour, on *Myrsine*, 16-I-1970, H. Imshaug (5434), MSC 104887, H. Imshaug (46066), MSC. 104882. Moubray Hill, 12-I-1970, H. Imshaug (46886), MSC 110666.

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The genus *Xanthoparmelia*, nom. cons. prop. (lichenized Ascomycota) in Slovakia

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Abstract—Seven species of *Xanthoparmelia* have been recorded for Slovakia, of which *X. angustiphylla* and *X. tinctina* are new for the country. The occurrence of *X. mougeotii*, previously reported as being extinct, was confirmed. The redetermination of all the specimens cited as *X. verrucigera* established that this species does not occur in the country. The species are segregated on the basis of morphological and chemical characters and notes on their taxonomy distribution and nomenclature are presented and a key to the species provided.

Key words—*Parmeliaceae*, chromatography

Introduction

Hale (1990) was the first to clearly delimit the genus *Xanthoparmelia*. He accepted 406 species worldwide but this has since increased to over 600 taxa (Giordani & al. 2002, Elix 2003). There are only 19 species of the genus reported for Europe in four chemotypes (viz. fumarprotocetraric acid, norstictic acid, salazinic acid and stictic acid) out of 40 known chemotypes (Giordani & al. 2002) and 7 species in Slovakia. Because *Chondropsis* Nyl. represents an older name for taxa sharing the same monophyletic clade as *Xanthoparmelia*, Hawksworth and Crespo (2002) have proposed the later name for conservation.

Xanthoparmelia has not previously been recognized as a distinct genus in Slovakia but was included in *Parmelia* sens. lat. in the last edition of the checklist (Pišút & al. 1998). There have been some previous studies on the taxonomy of the Slovak members of *Xanthoparmelia*. J. Suza studied the taxonomy of *X. mougeotii* (1934, 1950), *X. felkaensis* and *X. verrucigera* (Suza 1930, 1951; Paclová & Lisická 1998) but most papers reported floristic and biogeographical information on common species such as *X. conspersa* and *X. somloensis* (e. g. Suza 1945; Pišút & Lányi 1972; Pišút & Liška 1985). *X. protomatrae*, which is not a rare species, has been reported only once (Pišút 1983). Pustulková (1976) studied numerous voucher specimens (BRA, BRNM, BRNU, OP, PRC, PRM, SLO) for her thesis on the distribution of the genus *Parmelia* in

Slovakia but reported only three species, *X. conspersa*, *X. mougeotii* and *X. somloensis* (as *P. taractica*).

The checklist of lichens for the Western Carpathians (Bielczyk & al. 2004) gives incorrect information on the distribution of *X. sublaevis* and *X. tinctina*. In Europe the distribution of *X. sublaevis* is limited to the Iberian Peninsula and Italy (Hale, 1990; Giordani et al., 2002). Suza recorded this species as *P. molliuscula* var. *hypoclysta* and *P. conspersa* var. *hypoclysta* (Suza 1930, 1931a, 1931b, 1946; Suza et al. 1931). A number of these specimens have now been redetermined as *X. somloensis*. Thus the occurence of *X. sublaevis* in Slovakia, as well as in Czech Republic and Austria, is improbable despite various literature reports.

Materials and Methods

The present study is based on the critical examination of almost 700 *Xanthoparmelia* specimens from Slovakia (291 specimens) and other countries and of available type or original material held in institutional and private collections (BP, BRA, BRNM, G, GZU, LTM, NIM, PRC, PRM, ROM, SAV, TNP, W, ZAM, herb. County Museum Příbram, herb. A. Lackovičová, herb. E. Lisická, herb. P. Mráz, herb. V. Orthová, herb. I. Pišút, herb. A. Vězda).

The delimitation of taxa has been based on the morphological characters of the thalli, lobes, isidia, soredia, the colour of the lower surface, as well as on macrochemical tests on the medulla. These tests were supported by detection of specific compounds using thin layer chromatography, TLC (Culberson & Johnson, 1982 and White & James, 1985) and high performance liquid chromatography, HPLC (Feige & al., 1993). Synonymies have been validated by examining type specimens (where available).

The list of specimens studied records the exact citation of the collection site (numerical code in brackets refers to the UTM mapping scheme) for all type specimens as well as rare and interesting specimens from Slovakia. Herbarium/collection acronyms follow Index herbariorum (Holmgren & al., 1990). The detailed distribution of the species in Slovakia is presented on grid maps.

Taxonomy

Xanthoparmelia angustiphylla (Gyeln.) Hale, Mycotaxon 33: 401, 1988.
≡ *Parmelia conspersa* var. *angustiphylla* Gyeln., Feddes Repert. 29: 153, 1931.
= *Parmelia subconspersa* f. *marusica* Gyeln., Ann. Mycol. 36: 290, 1938.

Thallus ± pulvinate, loosely adnate to adnate to the substratum. *Lobes* 0.8-2 mm wide, subirregular to sublinear, dichotomously branched, contiguous to imbricate and sometimes densely laciniate with age. *Upper surface* dull yellowish green, emaculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* black, moderately rhizinate. *Pycnidia* and *apothecia* common, *conidia* bifusiform.

CHEMISTRY Cortex K-; medulla K+ yellow to orange, C-, KC-, P+ yellow to orange. TLC: Usnic acid, stictic a., norstictic a. HPLC: Usnic acid (minor), stictic a. (major),

constictic a. (minor), norstictic a. (minor) cryptostictic a. (minor), peristictic a. (trace), connorstictic a. (trace).

DISTRIBUTION AND HABITAT

The species has been reported from North America (Canada, USA) and Europe (Sweden, Belgium, Germany, Hungary, the former Czechoslovakia) (Hale, 1990) and Italy (Giordani & al. 2002). Despite this statement by Hale, no specimens identified as *X. angustiphylla* or *Parmelia subconspersa* f. *marusica* from Slovakia and/or Czech Republic were found among the herbarium collections. Neither Slovak (Pišút & al., 1998) nor Czech checklists (Vězda & Liška, 1999) list this species. Nevertheless, this species does occur in Slovakia on rock surface at elevation 250-1890 m but is an infrequently collected taxon. In Slovakia it has probably been overlooked and not segregated from the chemically similar *X. conspersa* and the morphologically similar *X. somloensis*.

NOTES

X. angustiphylla is similar in its morphology and chemistry (stictic acid chemosyndrome in the medulla) to *X. conspersa* but is nonisidiate. Skult (1992) noted that "*X. angustiphylla* cannot in my opinion be accorded recognition as a separate species. It seems to be an extreme morphotype within *X. conspersa*, an exponent of the great morphological variation of that species", but it is accorded species status in the present work.

Hale (1990) designated lectotypes for both *Parmelia conspersa* var. *angustiphylla* and *P. subconspersa* f. *marusica* even though they were based on single elements and thus represent holotype specimens (ICBN, Art. 9.1 and 9.8).

SPECIMENS EXAMINED

TYPES. Hungary. "Com. Nógrad Hungariae, pr. p. Diósjenő, in decl. m. Csóványos, ad rup. siliceum. in silva. alt. ca 600 m s. m., 1926.IV.24, leg. Dr. V. Gyelnik" (BP 21641T538, holotype of *Parmelia conspersa* var. *angustiphylla* Gyeln.). Romania. "Transsilvania. Marusicum. circa pagum Nagytalmács, ad terram, 1935.VII.13-14, leg. Dr. V. Gyelnik, det. 1936.VI. V. Gyelnik TYPUS" (BP 21624T719, holotype of *P. subconspersa* f. *marusica* Gyeln.).

SLOVAKIA. KREMNICKÉ VRCHY [7479a]: "Stará Kremnička [village], Potôčik, (zást. ČSAD), okraj lesa, vých. svah, na liparitovom kameni [rock], ca. 250 m, 28.11.1963, J. K. Lányi" (as *P. stenophylla*, BRA). MALÁ FATRA [6879a]: "Žilina, near village Strečno, right side river Váh, on the siliceous rocks behinde ruin Starý hrad (564.6 m) towards to Strečniansky priesmyk (slip), S-SW slopes, ca. 450-400 m, 19.8.2002, V. Orthová & A. Guttová" (SAV). MALÉ KARPATY [7669b, 7570c]: "hradisko Zámčisko [hill] pri Harmónii [part of town Modra], žula [granite], mach, 460 m, 23.V.1971, A. Follrichová" (as *P. stenophylla*, BRA), fr.!; "Častá village, valley Častianska dolina, debris (broken rocks) on south slope above game park, siliceous rock, ca 400 m, 29.10.2003, A. Guttová, A. Lackovičová & V. Orthová" (BRA). NÍZKE TATRY [7180d]: "Ad saxa schistosa cuprum continentia (strues fodinae lapidorum) supra pag. Špania dolina, ca. 750 m, 1.7.1993, E. Lisická" (BRA). POHRONSKÝ INOVEC [7577d]: "Nová Baňa [village]: Háj - kaplnka "Ave Mária", les, západný svah, na liparitovom kameni [rock], ca. 280 m, 28.XI.1963, J. K. Lányi" (as *P. stenophylla*, BRA). STOLICKÉ VRCHY [7287d]: "Čierna Lehota [village], S od obce, dolina Lehotského potoka [valley] – ľavá strana, pod kótou 678,1, exp. JJZ, skalné bralo (vyvreté horniny) [rock], ca 615 m, 6.6.2001, D. Blanár" (BRA). TRIBEČ [7575d]: "in monte Lysec supra pag. Velčice, ad saxa quartzitica 500 m, 5.1977, L. Opold" (as *P. somloensis*, BRA). VYSOKÉ TATRY [6886b]: "Batizovské pleso, 1890 m, granite, IX.1929,

leg. J. Suza" (as *P. conspersa* var. *alpigena*, PRM 637070); "supra lacum Batizovské pleso, in rupibus graniticis mylonitisatis, alt. 1890 m s. m. – VIII.1964, A. Vězda" (herb. Vězda).

In total 11 Slovak specimens, 2 types and 4 other European specimens were studied (BP, BRA, PRM, SAV, herb. Vězda).

Xanthoparmelia conspersa (Ach.) Hale, Phytologia 28:485, 1974.

≡ *Lichen conspersus* Ach., Lich. Suec. Prodr.: 118, 1798; lectotype: Sweden, H; isolectotype BM.[1] [lectotype and isolectotype not seen].
= *Parmelia bakonyensis* Gyeln., Feddes Repert. 29: 154, 1931.
= *Parmelia atlantica* Gyeln., Feddes Repert. 29: 280, 1931, [non *P. atlantica* Ach.].
= *Parmelia conspersa* var. *vadaskertensis* Gyeln., Feddes Repert. 29: 291, 1931.
= *Parmelia bohemica* Gyeln., Feddes Repert. 30: 218, 1932.
= *Parmelia isidiata* f. *phonolitica* Gyeln., Feddes Repert. 30: 210, 1932.
= *Parmelia lojkana* f. *phonoliticola* Gyeln., Servít et Klement, Věstn. Král. České Společn. Nauk, Tř. Mat.-Přír. 2: 29, 1933.
= *Parmelia conspersa* f. *lignicola* Gyeln. et Fóriss, Gyeln. in Ann. Mycol. 36: 274, 1938.
= *Parmelia pseudoservitiana* f. *ornata* Gyeln., Ann. Mycol. 36: 287, 1938.
= *Parmelia isidiata* var. *adventiva* Gyeln., Feddes Repert. 29: 154, 1931.
= *Parmelia conspersa* var. *tatrensis* Suza, Acta Bot. Bohem. 9: 26, 1930.
= *Parmelia tarpatakensis* Gyeln., Magyar Bot. Lapok 29: 32, 1930.
= *Parmelia isidiigera* f. *ligustica* Gyeln., Ann. Mycol. 36: 281, 1938.

Thallus forming rosettes, adnate to loosely adnate to the substratum. *Lobes* 1-3 mm wide, subirregular, contiguous, margin brown rimmed, sometimes densely laciniate with age at the center. *Upper surface* yellowish-green, emaculate, isidiate. *Isidia* cylindrical, simply to coralloid branched with black tips. *Medulla* white. *Lower surface* black, with brown margins, sparsely rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* rather rare, the rim isidiate.

CHEMISTRY Cortex K-; medulla K+ yellow to orange, C-, KC-, P+ yellow to orange. TLC: Usnic acid, norstictic a., stictic a., cryptostictic a., constictic a. HPLC: Usnic acid (minor), stictic a. (major), constictic a. (minor), norstictic a. (minor) cryptostictic a. (minor), peristictic a. (trace), connorstictic a. (trace).

DISTRIBUTION AND HABITAT

The species has been reported from Europe, North and South America and Asia. It occurs from sea level to montane areas (Nimis, 1993) with an altitudinal range 150-1900 m in Slovakia. *X. conspersa* prefers silicate rocks, rarely growing on bark or wood. It appears that *X. conspersa* is retreating from high elevations of Vysoké Tatry Mts. in Slovakia where it was quite common in the past (Suza, 1926, 1927, 1932, 1949, 1951).

NOTES

The species has sometimes been confused with some closely related species. *X. angustiphylla* has similar chemistry (stictic acid) and a similar black lower surface but

[1] according to Hale (1990).

lacks isidia. *X. tinctina* is isidiate like *X conspersa*, but has globose isidia and contains salazinic acid in the medulla (K+ red). *X. verrucigera* is morphologically very similar to *X. conspersa* and must be distinguished by chromatography (stictic, lusitanic and verrucigeric acid but no norstictic acid), but it does not appear to occur in Slovakia.

Hale (1990) listed *Parmelia isidiigera* f. *ligustica* and *P. tarpatakensis* in synonymy with *X. verrucigera*. However, examination of the type specimens established that both represent *X. conspersa*.

The names *Parmelia bakonyensis*, *P. conspersa* var. *vadaskertensis*, *P. bohemica*, *P. isidiata* f. *phonolitica*, *P. lojkana* f. *phonoliticola*, *P. conspersa* f. *lignicola*, *P. isidiata* var. *adventiva* and *P. tarpatakensis* were based on single elements and thus represent holotype specimens (ICBN, Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

Indeed, Gyelnik himself noted that for *Parmelia conspersa* var. *vadaskertensis*, *P. isidiata* f. *phonolitica*, *P. conspersa* f. *lignicola*, *P. isidiata* var. *adventiva* and *P. tarpatakensis* "spec. orig. in herb. mus. Budapest".

SPECIMENS EXAMINED

TYPES. Hungary. "Com Veszprém prope pagum Csehát in monte "Szöllö hegy", ad rupem basalticum (!sic), ca 300 m s. m., 1925.VIII.18., leg. Gyelnik" (BP 22562T512, holotype of *Parmelia bakonyensis* Gyeln.). France. "Luxeuil (Hte Saone) sur un mur. 1.Aout 1906, legit Dr. Bouly de Lesdain" (BP 21226T511, lectotype of *P. atlantica* Gyeln. designated by Hale 1990). Hungary. "Budapesten. Vadaskert, ad rup. arenar., 1931.V.1., legit Gyelnik V." (BP 22654T549, holotype of *P. conspersa* var. *vadaskertensis* Gyeln., mixed with few thalli of *P. saxatilis*). Czech Republic. "Bohem. mer.: Příběnice, 360 m, 1926, Servít" (BP 21265T518, holotype of *P. bohemica* Gyeln.). Czech Republic. "N. W. Böhmen, Phonolith n. Rösselberg, ± 390 m, 1931, leg. Klement" (BP 22565T608, holotype of *P. isidiata* f. *phonolitica* Gyeln.). Czech Republic. "Nordböhmen: Mittelgebirge, Phonolithblockhalden am Selnitzberg, b. Brüx [Most], ± 400 m, 1931, leg. O. Klement" (BP 22581T620, holotype of *P. lojkana* f. *phonoliticola* Gyeln., mixed of few thalli of *P. saxatilis*). Slovakia. "Hungaria: com. Nógrad, Ad sepem lignum abietinum in pomariis Losoncz [Lučenec], ca 190 m, 11.sept 1909, Fóriss as *P. conspersa* f. *isidiata*, no. 105." (BP 21569T541, holotype of *P. conspersa* f. *lignicola* Gyeln. et Fóriss). France. "Gallia: Rochers granitiques Environs de Sangues, Haute Loire, Novembre 96, leg. Fr. Novatien" (BP 23380T658, lectotype of *P. pseudoservitiana* f. *ornata* Gyeln. designated by Hale 1990). Hungary. "Trachytsziklán a "Dobogókö" plateaján Dömös mel., Esztergom m., ca 700 m, 1920.VIII.7., gyüjt Timkó György no. 4369 (as *P. conspersa* f. *isidiata*)" (BP 22582T606, holotype of *P. isidiata* var. *adventiva* Gyeln.). Slovakia. "Tatra Magna: supra saxa granitica ad lacum Batizovské pleso, ca 1890 m, VII.1924, leg. J.Suza (as *P. conspersa* f. *tatrensis*)" (PRM 637082, lectotype of *P. conspersa* var. *tatrensis* Suza designated by Hale 1990). Slovakia. "Flora Hungarica Gránitsziklán a "Tarpatak" völgyében a 2-ik vizesés mellett a Magas-Tátrában, ca 1300 m, Szepes vm. Gyüjt. Timkó György no.3058, 1916.VII.9" [Mts. Vysoké Tatry, valley Malá Studená dolina near 2-waterfall – waterfalls stream Studeného potoka near Rainerova lodge] (BP 24152T735, holotype of *P. tarpatakensis* Gyeln.). Italy. "Flora ligustica B.co delle Foiche, rupe muscosa a Nord (Varazzo), I.II.1923, C. Sbarbaro no. 39." (BP 22563T609, lectotype of *P. isidiigera* f. *ligustica* Gyeln. designated by Hale 1990).

In total 182 Slovak specimens, 12 type, 24 other European specimens and 20 exsiccata were studied (BP, BRA, G, GZU, LTM, NIM, PRC, PRM, SAV, TNP, W, ZAM, herb.

Lackovičová, herb. Mráz, herb. Orthová, herb. Pišút, herb. Vězda).

Xanthoparmelia felkaensis (Gyeln.) Hale, Mycotaxon 33:403, 1988.
≡ *Parmelia conspersa* var. *felkaensis* Gyeln., Magyar Bot. Lapok 29: 32, 1930.
= *Parmelia conspersa* var. *alpigena* Suza, Acta Bot. Bohem. 9: 26, 1930.
≡ *Parmelia conspersa* f. *alpigena* (Suza) Hale, Smithsonian Contrib. Bot. 74: 115, 1990.

Thallus pulvinate, loosely adnate to the substratum. *Lobes* 0.6-1.2 mm wide, short and irregularly branched, appearing almost inflated, densely imbricate, margins crenate and black rimmed, short lobulate with age. *Upper surface* dark yellowish green, faintly white-maculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* brown to black, sparsely rhizinate. *Apothecia* and *pycnidia* lacking.

CHEMISTRY Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ yellow to orange. TLC: Usnic acid, norstictic a., salazinic a., protocetraric a. HPLC: Usnic acid (minor), salazinic a. (major), norstictic a. (trace), consalazinic a. (trace), protocetraric a. (trace).

DISTRIBUTION AND HABITAT

The species was reported by Hale (1990) from the former Czechoslovakia and Hungary. The "Hungarian" location is in fact situated in Slovakia [Magas Tatra, Felkai vizesés]. In the present study Slovak collections were all from the Vysoké Tatry Mts. According to the specimens studied (G, GZU) this species also occurs in Russia and Austria (first noted here!).

X. felkaensis is a saxicolous species preferring elevated sites with high humidity. It was collected around mountain lakes in the past but there are no recent collection from Slovakia.

NOTES

From its morphology and chemistry (salazinic acid), *X. felkaensis* would appear to be closely related to *X. somloensis*. It can be distinguished by its bright yellow-green pulvinate thallus with short inflated, black-margined imbricate lobes, the brown to black lower surface and by its occurrence at higher elevation. *X. somloensis* has broader, elongate lobes with a pale lower surface and occurs at sunny stands at lower elevation.

The name *P. conspersa* var. *felkaensis* was based on single element and thus this specimen represents a holotype (ICBN Art. 9.1, 9.8), rather than a lectotype as designated Hale (1990).

SPECIMENS EXAMINED

Types. Slovakia. "Granitsziklán a "Felkai vizesés" felett a patak medrében a Magas Tátra, ca 1820 m, Szepes vm. 1917.VIII.1., G. Timkó no. 3618." [Velická dolina valley, granitic rocks in stream bed under Velický vodopád waterfall] (BP 21618T539, holotype of *Parmelia conspersa* var. *felkaensis* Gyeln.; isotype BP 22661 here designated). Slovakia "Tatra Magna, ad saxa granitica ad lacum Batizovské pleso, ca 1890 m., VIII.1924, leg. J. Suza" (PRM 637068, lectotype of *P. conspersa* var. *alpigena* Suza designated by Hale 1990).

Slovakia. Vysoké Tatry [6886b; 6886a]: "Batizovské pleso 1890 m, ad saxa granitica, IX.1929, J.Suza" (as *P. conspersa* v. *alpigena*) (PRM 637071); "ad rupes granitica prope

lacum Velické pleso, ca. 1680 m, VII.1921, J.Suza" (as *P. conspersa* f. *alpigena*) (PRM 637069); "ad saxa granitica mylonitisata inter montes Predná Bašta et Satan. ca. 2300 m, 5.10.1979, E. Lisická" (GZU; herb. Lisická).

Russia. "Caucasus centralis: distr. Tyrnyauz, regio montis Elbrus, in declivibus occidentalibus montis Cheget, 2400-2600 m, 26.6.1984. V. Vašák" (G 244494, as *P. taractica* Krempelh.); "ibid., in declivibus boreo-orientalibus montis Cheget, 2500-2800 m, 21.6.1980, V. Vašák" (G 218859, as *P. taractica*); "ibid., loco Staryj Krugozor dicto, 2900-3100 m, 22.6.1980, V. Vašák" (G 230626, as *P. taractica*). Austria. "Steiermark, Turrach, Eisenhnt, Gipfelfelsen 2440 m, 12.aug.1941, Dr. Karl Schittengruber" (GZU 67-92, as *P. conspersa* f. *hypoclysta*).

In total 7 Slovak specimens and 4 other European specimens (BP, G, GZU, PRM, herb. Lisická) were examined.

Xanthoparmelia mougeotii (Schaerer) Hale, Phytologia 28: 488, 1974.

= *Parmelia mougeotii* Schaerer, Enum. crit. lich. eur. p. 46, 1850; neotype: Switzerland, UPS; isoneotypes: BM, FH, WU.[2]

= *Parmelia mougeotii* f. *incurvoides* Servít, Věst. Král. České Společn. Nauk, Tř. Mat.-Přír. 2: 9, 1937.

= *Parmelia mougeotii* Schaer. f. *deminuta* Servít, Věst. Král. České Společn. Nauk, Tř. Mat.-Přír. 2: 9, 1937; lectotype: Czech Republic, PRM [designated by Hale, 1990 – not located in PRM!].

= *Parmelia mougeotii* f. *microphylla* Anders, Strauch- Laubflechten Mitteleur. p. 146, 1928.

Thallus foliose to subcrustose, tightly to very tightly adnate to rocks, rosette-like, usually areolate in the center, (0.5) 2-4 cm wide. *Lobes* sublinear, very narrow, 0.2-0.5 mm wide, subimbricate and crowded, ± flattened, apices rounded, margin brown rimmed. *Upper surface* dark yellowish-green to black, pale yellow-green at the margins, shiny, emaculate, rugose, transversely cracked with age, moderately sorediate. *Soralia* orbicular, capitate, 0.5-1 mm wide, *soredia* farinose. *Medulla* white. *Lower surface* black, sparsely to moderately rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* very rare, adnate.

CHEMISTRY Cortex K-; medulla K+ yellow to orange, C-, KC-, P+ orange. TLC: Usnic acid, norstictic a., stictic a., constictic a.

DISTRIBUTION AND HABITAT

X. mougeotii has a pantemperate distribution in cool humid regions of the world. The species has been reported from Europe, North, Central and South America, South Africa, Hawaii (Giordani & al., 2002), Asia Minor and Japan (Suza, 1950). The Slovak collection site (Malá Fatra Mts., near Strečno) is the easternmost enclave of the central/continental European distribution of the species (Orthová, 2003a). The sites situated further to the east, e.g. Poland (Cieśliński, 2003), Latvia, Estonia and Lithuania (Motiejünaité, 2002) are influenced by a more oceanic climate.

This species grows on exposed acidic rocks, including granites and sandstones, with relatively flat and smooth surfaces, seldom on bark (Hale, 1990). *X. mougeotii* is

[2] according to Hale (1990).

common in places with heather (*Calluna vulgaris*) and more rarely with birch (*Betula verrucosa*). In shaded positions it grows associated with heather (*Calluna vulgaris*) and blueberry (*Vaccinium myrtillus*) (Suza, 1934, 1950) at elevation 380-450 m.

In Slovakia *X. mougeotii* was reported as being extinct (Pišút, 1985; Pišút et al. 1996; Pišút et al. 1998; Pišút et al. 2001) but was recollected in 2002.

NOTES

X. mougeotii may be confused with the morphologically similar green-coloured sorediate species, *Arctoparmelia incurva* (Pers.) Hale and *Parmeliopsis ambigua* (Wulfen) Nyl. Soralia of *X. mougeotii* are situated in the central part of the thallus and are small, hemispherical and never protruding, while the soralia of *A. incurva* are protruding and situated at the end of the lobes. Apart from chromatography, the most effective way to distinguish these species is to use UV light, the medulla of *A. incurva* is luminiscent blue (alectoronic acid) while the medulla of *X. mougeotii* (stictic acid) and *P. ambigua* (divaricatic acid) are UV-.

Macrochemical reactions of the medulla and soralia may also assist in identification. In *P. ambigua* the medulla reacts K-, P- and UV+ vivid white whereas in *X. mougeotii* the medulla and soralia are K+ yellow to orange, KC-, P+ orange, UV- and *A. incurva* reacts is K-, KC+ pink and UV+ glaucous blue.

Probably the only available specimen associated with the name *Parmelia mougeotii* f. *microphylla* Anders is no. 333 of Anders' Lichenes exsiccati (Hale, 1990 noted specimen as "a possible topotype"). It is designated as a lectotype here.

SPECIMENS EXAMINED

TYPES. France. "Ad saxa silacea in summo m. Heledré prope Brujerium Mougeot, Schaerer, Lichenes Helvetici Exsiccati no. 548" (BRA B-302, isoneotype of *Parmelia mougeotii* Schaer. designated by Hale 1990). Czech Republic. "Železné hory: Mrákotínský kopec 500 m, 15.7.1930, leg. J. Nádvorník, det. Servít" (BRA, lectotype [B-303] and isolectotype [B-304] of *P. mougeotii* f. *incurvoides* Servít here designated). Czech Republic. "Železné hory: Mrákotínský kopec 500 m, 15.7.1930, leg. J. Nádvorník, det. Servít" (BRA B-131, syntype of *P. mougeotii* f. *deminuta* Servít designated here). Czech Republic. "Auf morschem Sandstein im Kiefernwald b. Aschendorf n. B. Leipa, ca. 270 m s. m. Lupe! Selten. 11.VIII.1933. leg. J. Anders. Anders, Lichenes exsiccati no. 333" (PRM 835448, lectotype of *P. mougeotii* f. *microphylla* Anders designated here).

SLOVAKIA. MALÁ FATRA [6879a]: "Žilina: ad ripam dextram flum. Váh prope pag. Strečno (apud ruinam arcis Starý hrad) in rupibus graniticis, ca. 380 m, J. Suza, Suza: Lich. sel. exs. no. 234. Fasc. VIII. (1933)" (BRA, PRC, PRM, BRNM); "ibid., near Strečno village, right side river Váh, on the siliceous rocks behinde ruin Starý hrad (564,6 m) towards to Strečniansky priesmyk (slip), S-SW slopes, ca. 450-400 m, 19.8.2002, V. Orthová & A. Guttová" (herb. Orthová).

CZECH REPUBLIC. "Bohemoslovakia – Bohemia orient., Hlinsko: in cacumine collis "Mrákotinský kopec" prope pagum Mrákotín, alt. 570 m s. m – 17.IV.1960. Ad saxa schistosa in Calluneto. A. Vězda, Vězda: Lich. sel. exs. no. 21." (BP 49971T953, "locus classicus" of *P. mougeotii* f. *incurvoides* Servít).

In total 5 Slovak specimens, 4 types, 34 other specimens and 25 exssicata were studied (BP, BRA, BRNM, PRC, PRM, W, herb. Orthová, herb. Pišút).

Xanthoparmelia protomatrae (Gyeln.) Hale, Phytologia 28:488, 1974.

≡ *Parmelia protomatrae* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia mitrovicensis* Gyeln., Feddes Repert. 30: 216, 1932.
= *Parmelia protomatrae* f. *angustifolia* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia protomatrae* f. *crustaeformis* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia protomatrae* var. *tenuior* Gyeln., Feddes Repert. 29: 155, 1931.
= *Parmelia serbica* Gyeln., Feddes Repert. 30: 216, 1932.
= *Parmelia conspersa* f. *matrae* Gyeln., Ann. Mycol. 30: 450, 1932.
= *Parmelia subconspersa* var. *varazzana* Gyeln., Feddes Repert. 36: 164, 1934.
= *Parmelia nigrescens* Gyeln., Ann. Mycol. 36: 284, 1938.

Thallus loosely adnate to the substratum. *Lobes* 1-2 mm wide, sublinear, elongate, dichotomously branched, separate to contiguous, laciniate at the center with age. *Upper surface* yellowish green, shiny, white maculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* pale or dark brown, moderately rhizinate. *Pycnidia* common, *conidia* bifusiform. *Apothecia* common.

CHEMISTRY Cortex K-; medulla K± brownish, C-, KC-, P+ crimson red. TLC: Usnic acid, fumarprotocetraric a., protocetraric a., salazinic a. HPLC: Usnic acid (minor), fumarprotocetraric a. (major), quaesitic a. (minor), protocetraric a. (minor), succinprotocetraric a. (trace), salazinic a. (trace).

DISTRIBUTION AND HABITAT

The species has been reported from Norway, France, Belgium, Italy, Hungary, the former Yugoslavia and USSR, Saudi Arabia, China (Hale, 1990), Czech Republic (Vězda & Liška, 1999) and Slovakia (Pišút et al., 1998) from altitudes of 150 m to 1200 m. It occurs in similar sites and often together with *X. somloensis*.

The taxon is not very rare even though only one collection was reported prior to the 1980s (Pišút, 1983; Pišút & al., 1993). The voucher specimen for that report (Burda Mts., 1956 by I. Pišút) was not located in BRA but only a specimen from the same site, originally identified as *Parmelia stenophylla*. The present study established that *X. protomatrae* occurs in 17 geographical regions of Slovakia.

NOTES

Morphologically very similar to the common *X. somloensis*, *X. protomatrae* contains fumarprotocetraric acid (medulla K± brownish, P+ crimson red) whereas *X. somloensis* contains salazinic acid (medulla K+ red, P+ yellow to orange).

As the names *Parmelia protomatrae*, *Parmelia protomatrae* f. *angustifolia*, *P. protomatrae* f. *crustaeformis*, *P. protomatrae* var. *tenuior*, *P. conspersa* f. *matrae* and *P. nigrescens* were based on single elements they represent holotype specimens (ICBN Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

SPECIMENS EXAMINED

TYPES. Hungary. "Prope Budapest, m. Vadállókövek, 1926.VIII.18., leg. Gyelnik" (BP 21645T656, holotype of *Parmelia protomatrae* Gyeln.). Serbia. "in saxis ad Mitrovica, alt. 500 m. s. m., 18.X.1916, leg. Andrasowsky" (BP 23309T624/b, lectotype of *P. mitrovicensis* Gyeln. designated by Hale 1990). Hungary. "Hungaria, com. Heves, in montibus Mátra, in m. Hegyes hegy, ad rup. vulcanic., ca 600 m, 1925.VI.1., leg. Gyelnik" (BP 21652T655, holotype of *P. protomatrae* f. *angustifolia* Gyeln.). Hungary. "Com. Heves Hungariae, in montibus

Mátra, in cacum. m. Ajnácskő, ad rup. vulcanic., ca 600 m, 1925.VI.2., leg. Gyelnik" (BP 21662T654, holotype of *P. protomatrae* f. *crustaeformis* Gyeln.). Hungary. "Albae Carolinae, Pulverturm, 26. aug., Haynald" (BP 21625T714, holotype of *P. protomatrae* var. *tenuior* Gyeln.). Serbia. "Serbia in saxis trachitico-andesiticis ad montem Zvecan prope Mitrovica, ca 750 m, leg. 15.X.1916, Andrasowsky" (BP 23873T702/a, lectotype of *P. serbica* Gyeln. designated by Hale 1990). Hungary. "Com. Heves, in montibus Mátra, in cacumine montis Saskő, ad rupem andesiticam, ca 750 m, 1930.VII.23., leg. Gyelnik" (BP 21723T542, holotype of *P. conspersa* f. *matrae* Gyeln.). Italy. "Italia *Parmelia conspersa* forma No. 14b. Flora ligustica. Varazza: Mt. Bonomo, 1922.X.2., leg. Sbarbar" (BP 21633T722, lectotype of *P. subconspersa* var. *varazzana* Gyeln. designated by Hale 1990; original material in herb. Bouly de Læsdain destroyed). Hungary. "Hungaria. In montibus Bükk, Szarvaskő, Pyrkersziklák, ad rupem diabasicum, supra muscos, 1934.VII.23., leg. Gyelnik" (BP 22693T629, holotype of *P. nigrescens* Gyeln.).

In total 28 Slovak specimens, 9 types, 74 other European specimens and 16 exsiccata were studied (BP, BRA, BRNM, G, GZU, LTM, PRC, PRM, W, ZAM, herb. County Museum Příbram, herb. Mráz, herb. Orthová, herb. Pišút, herb. Vězda).

Xanthoparmelia somloensis (Gyeln.) Hale, Mycotaxon 28:96, 1987.

≡ *Parmelia somloënsis* Gyeln., Feddes Repert. 29: 156, 1931.
= *Parmelia conspersa* f. *viridulo-umbrina* Gyeln., Magyar Bot. Lapok 29: 31, 1930.
= *Parmelia convoluta* var. *subdensa* Gyeln., Feddes Repert. 29: 285, 1931.
= *Parmelia hypopallida* Gyeln., Feddes Repert. 30: 217, 1932.
= *Parmelia pseudohungarica* var. *komotauensis* Gyeln., Feddes Repert. 30: 217, 1932.
= *Parmelia imitans* var. *imbricatoides* Gyeln., Feddes Repert. 36: 156, 1934.
= *Parmelia laxa* var. *rosettaeformis* Gyeln., Feddes Repert. 36: 158, 1934.
= *Parmelia laxa* f. *borealis* Gyeln., Feddes Repert. 36: 159, 1934.
= *Parmelia subpolyphylloides* Gyeln., Feddes Repert. 36: 165, 1934.
= *Parmelia imitans* f. *arenicola* Gyeln., Ann. Mycol. 36: 278, 1938.

Thallus loosely adnate to the substratum or very rarely free growing. *Lobes* 1-10 mm wide, sublinear, elongate and dichotomously branched, imbricate, margin brown rimmed. *Upper surface* yellowish green, darkening with age, white maculate. *Isidia* and *soredia* lacking. *Medulla* white. *Lower surface* pale brown to dark brown, moderately rhizinate. *Pycnidia* common, *conidia* bifusiform. *Apothecia* common.

CHEMISTRY Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ yellow to orange. TLC: Usnic acid, norstictic a., salazinic a., protocetraric a. HPLC: Usnic acid (minor), salazinic a. (major), norstictic a. (trace), consalazinic a. (trace), protocetraric a. (trace).

DISTRIBUTION AND HABITAT

This species occurs in Europe, central and eastern Asia and eastern North America (Giordani & al., 2002). In Slovakia this species is recorded in 28 geomorphological areas. The species is known to be saxicolous, to spread over gravel soils or rarely/exceptionally on sand dunes (Borská nížina lowland in Slovakia). It usually occurs on sunshine-exposed siliceous rocks at elevation between 140-1950 m.

NOTES

The species is closely related to *X. felkaensis* (morphologically and chemically) and to *X. protomatrae* (morphologically).

The names *Parmelia conspersa* f. *viridulo-umbrina*, *P. convoluta* var. *subdensa*, *P. laxa* var. *rosettaeformis* and *P. imitans* f. *arenicola* were based on single elements they represent holotype specimens (ICBN, Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

In spite of the fact that '*Parmelia conspersa* f. *convoluta* Rabenh.' is a nomen nudum. Hale (1990) designated both lectotype and isolectotype specimens for this species.

SPECIMENS EXAMINED

TYPES. Hungary. "Com. Veszprém prope pagum Doba, in declivibus montis "Somló", ad rupem basalticam, ca 400 m, 1925.VIII.19, leg. Gyelnik" (BP 21738T704, lectotype of *Parmelia somloënsis* Gyeln. designated by Hale 1990). USA. "On rocks, Plitt, Baltimore, 3.IV.1916, Culb., (as *P. conspersa*)" (BP 33914T550, holotype of *P. conspersa* f. *viridulo-umbrina* Gyeln.). Russia. "In rupe ad Adil-Su (Lojka: It. Cauc. n. 404 as *P. conspersa* f. *polita*)" (BP 21754T552, holotype of *P. convoluta* var. *subdensa* Gyeln.). Czech Republic. "Bohem sept.: Komotau, 1930, Klement 14599, det. Gyelnik" (BP 22518T593, lectotype of *P. hypopallida* Gyeln. designated by Hale 1990). Czech Republic. "Bohem. sept.: Komotau, 1930, leg. Klement 14598, det. Gyelnik" (BP 23374T661, lectotype of *P. pseudohungarica* var. *komotauensis* Gyeln. designated by Hale 1990). Mexico. "Mexique: *Parmelia conspersa* var. *hypoclysta* Nyl., Mexico: formade larges plaques sur les Mochers, Rio Frio, 29.Janvier 1927, leg. Frére Amable." (BP 22524T596, lectotype of *P. imitans* var. *imbricatoides* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed). Hungary. "Gyérfüves, mohás homokbuczkán az Örkényi erdő tisztásán ca. 130 m. Örkény mal., Pest m. 1915.V.30. gyüjt Timkó György (as *P. conspersa*) Spec. orig no. 2165/2" (BP 21704T547, holotype of *P. laxa* var. *rosettaeformis* Gyeln.). Sweden. "E.P. Vrang. Lichenes insulae Torsö. *Parmelia molliuscula* Ach., Torsö: Klippingsberg, Juli 1930, 45-65 m (as *P. pulvinaris* f. *borealis*)" (BP 21643T613, lectotype of *P. laxa* f. *borealis* Gyeln. designated by Hale 1990). Japan. "Japonia *P. conspersa* Abbé Faurie lichens du Japon. No. 1373. Insula Riiskéri, leg. Faurie, Julio 1899" (BP 24010T724, lectotype of *P. subpolyphylloides* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed). France. "Gallia: Canet-Plage prope oppidum Perpignan, ad terram arenaceam, 1933.IX., legit Moesz G." (BP 22500T595, holotype of *P. imitans* f. *arenicola* Gyeln.). Germany. "Auf erratischen Blöcken zwischen Grimma und Hohenstädt in Sachsen, legit Ettich. Rabenhorst, Lichenes europaei no. 891." (BP 21741, '*P. conspersa* f. *convoluta* Rabenh.'; nom. nud.).

HUNGARY. "County Veszprém. On the silicaceous (basalt) rocks of the Mt. Somló, 2 km S of Somlószölös and Doba, 300-350 m a.s.l., leg. E.Farkas et L.Lökös, 9.V.1987" (BP 8701/A, as *Xanthoparmelia somloënsis*, herb. Vězda; BRA; "locus classicus" of *Parmelia somloënsis* Gyeln.).

In total 72 Slovak specimens, 12 type and 47 other European specimens and 34 exsiccata were studied (BP, BRA, BRNM, G, GZU, LTM, PRC, PRM, ROM, ZAM, W, herb. County Museum Příbram, herb. Lackovičová, herb. Mráz, herb. Orthová, herb. Pišút, herb. Vězda).

Xanthoparmelia tinctina (Maheu et Gillet) Hale, Phytologia, 28: 489, 1974.

≡ *Parmelia tinctina* Maheu et Gillet in Bull. Soc. Bot. N. France 72: 860, 1925, [holotype: not seen].

= *Parmelia Körösi-Csomae* Gyeln., Feddes Repert. 29: 156, 1931.

= *Parmelia tokajensis* Gyeln., Feddes Repert. 29: 154, 1931.

= *Parmelia rosea* Gyeln., Feddes Repert. 29: 285, 1931.

= *Parmelia rosea* f. *adventiva* Gyeln., Ann. Mycol. 36: 287, 1938.

Thallus rosette-forming, adnate to loosely adnate to the substratum. *Lobes* subirregular, contiguous to imbricate, 1.5-4 mm wide; apices rotund, margin not black rimmed. *Upper surface* yellowish grey, shiny near periphery, dull in the centre (coriaceous), emaculate, continuous, moderately to densely isidiate. *Isidia* globular to irregularly inflated, thick, the tips syncorticate, pale, rarely weakly erumpent, mostly simple, more rarely branched. *Medulla* white. *Lower surface* black, marginal area brown, sparsely rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* rare.

CHEMISTRY Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ yellow to orange. TLC: Usnic acid, salazinic a. and norstictic a. HPLC: Usnic a. (minor), salazinic a. (major), consalazinic a. (trace), norstictic a. (trace), protocetraric a. (trace).

DISTRIBUTION AND HABITAT

This species has been reported from Sweden, France, Spain, Portugal, Italy, Hungary, Romania, Greece, Bulgaria, the former USSR and Yugoslavia, Algeria, Morocoo, Pakistan (Hale 1990), Madeira (Tavares, 1952; Alstrup, 1991), England (Purvis & al., 1992), Czech Republic (Vězda & Liška, 1999) and India (Divakar & Upreti, 2002). The present study extends this species distribution to Slovakia in Podunajská pahorkatina Mts., Tríbeč Mts. and Zemplínske vrchy Mts. This is a new record for the Slovak lichen flora.

The species is only known to be saxicolous and usually occurs on sunny siliceous rocks at elevation between 200-460 m.

NOTES

X. tinctina is characterized by globose, inflated, pale tipped isidia, a black lower surface and the salazinic acid complex in the medulla. It may be confused with *X. conspersa*, which has simple cylindrical or coralloid branched isidia and the stictic acid complex in the medulla.

Gyelnik (1932a: 215) was the first to report *X. tinctina* (as *P. isidiata* var. *isidiosa*) in Slovakia. His report is, however, erroneous as the voucher specimen is actually *X. conspersa* [Hungary. Comit. Ung, Ad lapidem trachyticum prope pagum Jósza [Jovsa], alt. ca. 180 m, 16.VI.1914, leg. Szatala (sub n. *P. conspersa* f. *isidiata*) (BP 44638), 7198c]. The occurence of *X. tinctina* in Slovakia was not confirmed until the specimens collected in 1961 (BRA) were studied by the author in 2002 and published for the first time here.

As the names *Parmelia tokajensis*, *P. rosea* and *P. Körösi-Csomae* were based on single elements they represent holotype specimens (ICBN Art. 9.1, 9.8) rather than lectotype specimens as designated by Hale (1990).

SPECIMENS EXAMINED

Types. Ukraine. "Jalta mit Cilarowski, Lojka It. Cauc. 87. (as *Parmelia conspersa*)" (BP 22611T611, holotype of *P. Körösi-Csomae* Gyeln.). Hungary. "Com. Zemplén, pr. opp. Tokaj, in cacum. M. "Tokaji hegy" ad rup. siliceam, alt. ca 500 m s. m., 1925.VII.27. leg. Dr. V. Gyelnik" (BP 22563T739, holotype of *P. tokajensis* Gyeln.). Ukraine. "In rupe arenaria prope Jalta in peninsula Taurica (Lojka: It. Cauc. N. 88 as *P. conspersa* f. *coralloidea*), Fertilis" (BP 23361T686, holotype of *P. rosea* Gyeln.). France. "Gallia. Parrique Parmelieés No. 39. (as *P. conspersa* v. *stenophylla* f. *isidiosa*) Parois verticales des roches granitiques, St. Bonnet le Château, Loire, avril 1905, G. Parrique" (BP 23562T689, lectotype of *P. rosea* f. *adventiva* Gyeln. designated by Hale 1990; original material in herb. Bouly de Lesdain destroyed).

SLOVAKIA. PODUNAJSKÁ PAHORKATINA [7776b]: "Mochovce [village], kóta Dobrica, kremence [quartzite], ca. 320 m, 23.4.2003, A. Lackovičová" (herb. Lackovičová). TRÍBEČ [7674d]: "Zobor [hill] nad Nitrou [village], Malá skala – skaly [rock], 360 m, 18.aug.1961, L.Opold" (sub n. *P. stenophylla* mixed with. few thalli of *X. somloensis*) (BRA); "ibid., Kremičité skaly [siliceous rocks] pod nov. pyramídou, z juž. str., 460 m, 20.8.1961, L. Opold (as *P. conspersa*)" (BRA); "Nitra village – Zobor, SW slopes of the elevation Malá skalka by the abandoned quarry, quartzite cliffs, on rock, ca. 320 m, 18.4.2002, V. Orthová, A. Guttová & J. Košťál" (herb. Orthová). ZEMPLÍNSKE VRCHY [7596c]: "Viničky [village]. Nad vinohradmi, 17.5.1977, E. Votavová" (BRA).

In total 13 Slovak specimens, 4 types, 30 other European specimens and 1 exsiccatum were studied (BP, BRA, PRM, herb. Lackovičová, herb. Orthová, herb. Vězda).

Xanthoparmelia verrucigera (Nyl.) Hale, Smith. Contr. Bot. 74: 220, 1990.

≡ *Parmelia verrucigera* Nyl., Flora, 56: 196, 1873; lectotype: France, H [designated by Hale, 1990] [not seen].

= *Parmelia pseudoservitiana* Gyeln., Feddes Repert. 36: 163, 1934.

= *Parmelia servitiana* Gyeln., Servít Hedwigia 71: 273, 1931.

= *Parmelia pulvinaris* (Zahlbr.) Gyel. var. *mediterranea* Gyeln., Servít Hedwigia 71: 272, 1931.

= *Parmelia pseudoservitiana* f. *exornata* Gyeln., Ann. Mycol. 36: 287, 1938.

Thallus adnate to the substrate. *Lobes* subirregular, contiguous to imbricate, 1-3 mm wide. *Upper surface* yellowish green, shiny, continuous, emaculate, (coriaceous), isidiate. *Isidia* verrucose to cylindrical, the tips syncorticate, darkening, sparsely branched. *Medulla* white. *Lower surface* black, moderately rhizinate. *Pycnidia* rare, *conidia* bifusiform. *Apothecia* not commonly developed, the rim isidiate.

CHEMISTRY Cortex K-; medulla K+ yellow, C-, KC-, P+ yellow to orange. TLC: Usnic acid, stictic a., constictic a. HPLC: Usnic acid (minor), stictic a. (major), constictic a. (submajor), verrucigeric a. (minor), cryptostictic a. (trace), lusitanic a. (trace), methyl lusitanate (trace).

DISTRIBUTION AND HABITAT

The species was reported by Hale (1990) from southern and central Europe (France, Italy, Portugal, Romania, Spain and Hungary and from eastern and southern Africa (Giordani & al. 2002). The "Hungarian" collection site [Flora Hungarica, Magas-Tátrában, "Tarpatak" völgyében a 2-ik vizesés – Vysoké Tatry Mts., Malá Studená dolina valley near 2-waterfall - waterfalls stream Studeného potoka near Rainerova lodge (BP 24152T735, holotype of *P. tarpatakensis* Gyeln.)] is, in fact, located in Slovakia. A re-examination of that specimen established that it is in fact *X. conspersa*. *X. verrucigena* was reported from Czech Republic (Suza, 1940; Vězda & Liška, 1999) but the voucher specimen was not located and the species was not recollected at the reported collecting site (Orthová, 2003b).

X. verrucigera is a saxicolous lichen occurring on rock surfaces at an in elevation of 10-80 m. No authentic specimens have been reported from Slovakia.

NOTES

X. verrucigera has rarely branched, verrucose isidia with black, syncorticate apices (Suza, 1940; Hale, 1990) and resembles *X. conspersa*. Chromatography provides the only reliable method for distinguishing these taxa: *X. conspersa* contains stictic and norstictic acids and *X. verrucigera* contains stictic, lusitanic and verrucigeric acids but lacks norstictic acid (Elix & Wardlaw, 2000).

The name *Parmelia verrucigena* was validly published in 1873 not in 1872 (Nylander, Flora 55: 426) as stated both by Hale (1990) and Zahlbruckner (1930).

As the names *Parmelia pseudoservitiana*, *P. servitiana*, *P. pulvinaris* var. *mediterranea* and *P. pseudoservitiana* f. *exornata* were based on single elements they represent holotype specimens (ICBN Art. 9.1 and 9.8) rather than lectotype specimens as designated by Hale (1990).

Parmelia tarpatakensis and *P. isidiigera* f. *ligustica* listed by Hale (1990) as synonyms of *X. verrucigera*, are actually conspecific with *X. conspersa* (see *X. conspersa*).

SPECIMENS EXAMINED

TYPES. France. "Saxicola. Amélie-les-Bains (Pyrénées-Orientales). Fr. Marc. (Harm. no. 113 as *Parmelia. lusitana*)" (BP 23377T665, holotype of *P. pseudoservitiana* Gyeln.). Monte Negro. "Dalmatia: Hercegnovi, 80 m, 5.1929, leg. Servít, rev. Gyelnik" (BP 21566T703, holotype of *P. servitiana* Gyeln.). Monte Negro. "Dalmatia: Hercegnovi, 10-50 m. Substrat. silic., 5.1929, leg. Servit" (BP 22664T667, mixed with few thalli of *X. conspersa* holotype of *P. pulvinaris* var. *mediterranea* Gyeln.). Romania. "Transsilvania. Domugledicum. Iuxt stationem balnei Herkulesfürdő. Siliceicola, 1935.VII.24., leg. et det. V. Gyelnik" (BP 21567T663, holotype of *P. pseudoservitiana* f. *exornata* Gyeln.).

In total 4 type specimens and 2 exsiccata (Harm. no. 113. as *P lusitana* Saxicola. Amélie-les-Bains (Pyrénées-Orientales). Fr. Marc. (herb. Vězda; BP 23377T665) were studied.

Key to the Slovak species of *Xanthoparmelia*[3]

1a Thallus sorediate, subcrustose — ***X. mougeotii***

1b Thallus lacking soredia, foliose — **2**

2a Thallus isidiate, lower surface black — **3**

2b Thallus lacking isidia, lower surface brown or black — **5**

3a Medulla K+ yellow to orange (stictic acid present) — **4**

3b Medulla K+ yellow turns red (salazinic acid present); isidia globose, inflated, pale tipped — ***X. tinctina***

4a Isidia cylindrical, simple or coralloid branched; medulla K+ yellow to orange (norstictic acid present) — ***X. conspersa***

[3]based on specimens studied and on data reported by Divakar & Upreti (2002) and Giordani & al. (2002).

4b Isidia verrucose to cylindrical, sparsely branched; medulla K+ persistent yellow (norstictic acid absent, lusitanic and verrucigeric acids present)
X. verrucigera[4]

5a Medulla K+ yellow turning red (salazinic acid present) or K-, lower surface pale brown or mottled **6**

5b Medulla K+ yellow to orange (stictic acid present), lower surface black
X. angustiphylla

6a Thallus pulvinate, lobes short and densely imbricate, lower surface brown to black, medulla K+ yellow turn red, collected only at high elevation (up 1800 m)
X. felkaensis

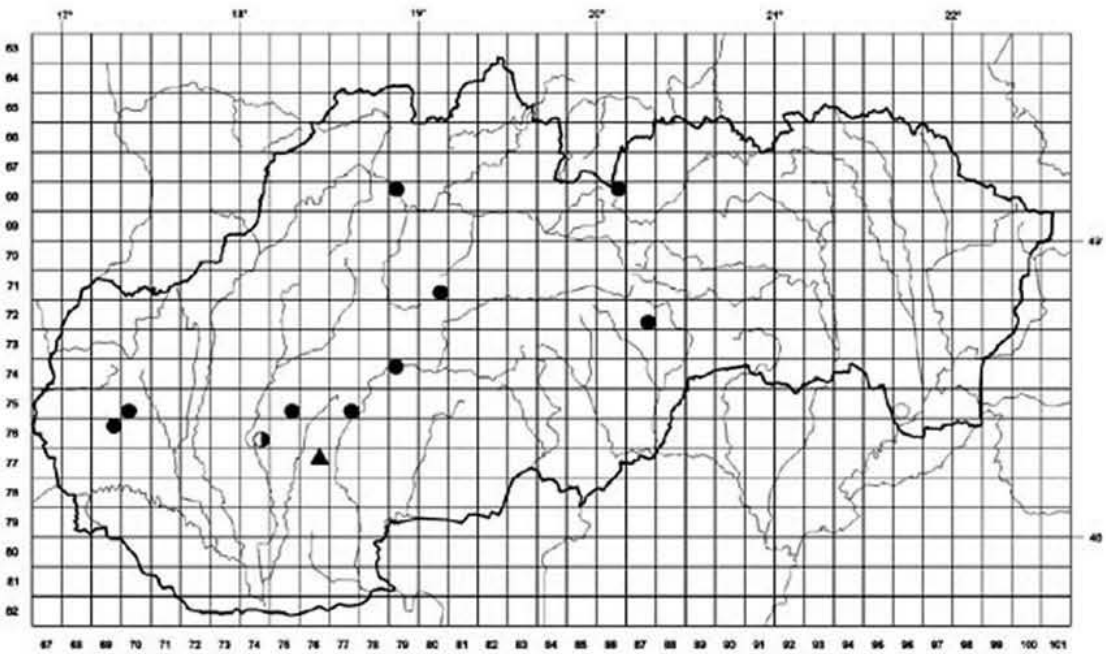
6b Lobes elongate, dichotomously branched, lower surface pale brown **7**

7a Medulla K+ yellow turning red (salazinic acid present) ***X. somloensis***

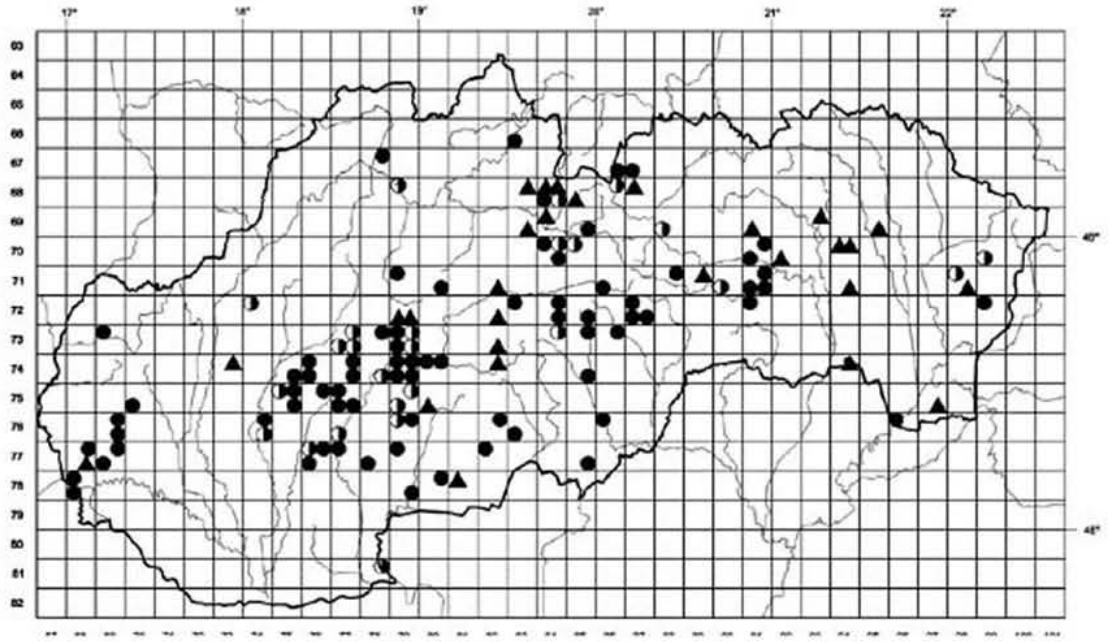
7b Medulla K- or K+ brown, P+ yellow turning crimson red (fumarprotoce-traric acid present) ***X. protomatrae***

[4] erroneously reported from Slovakia.

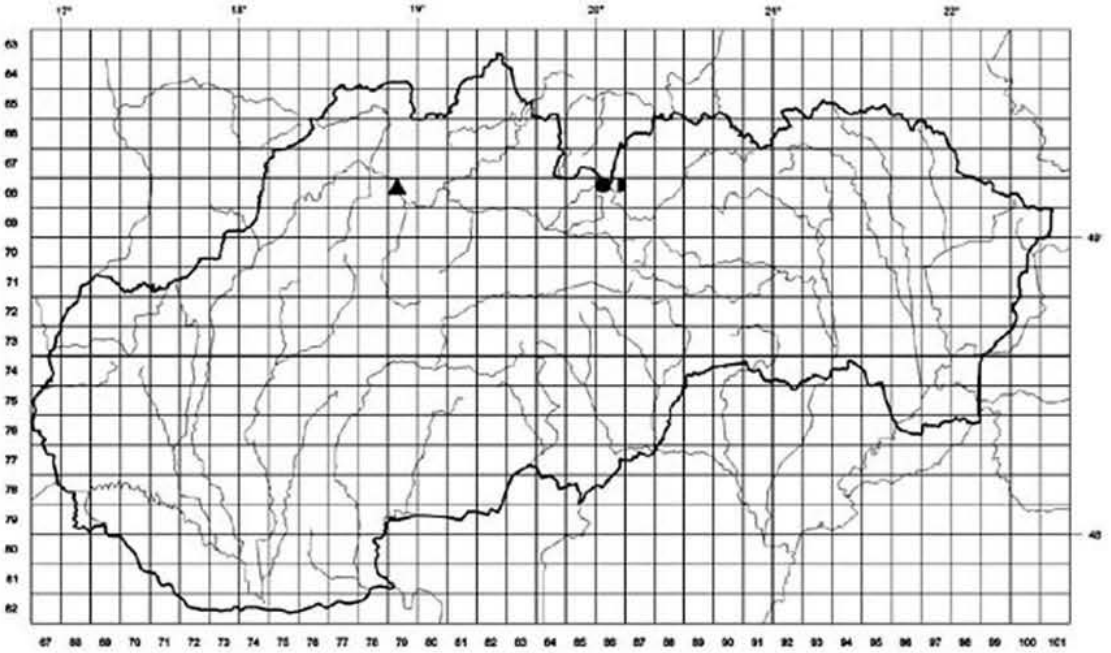
Distribution maps



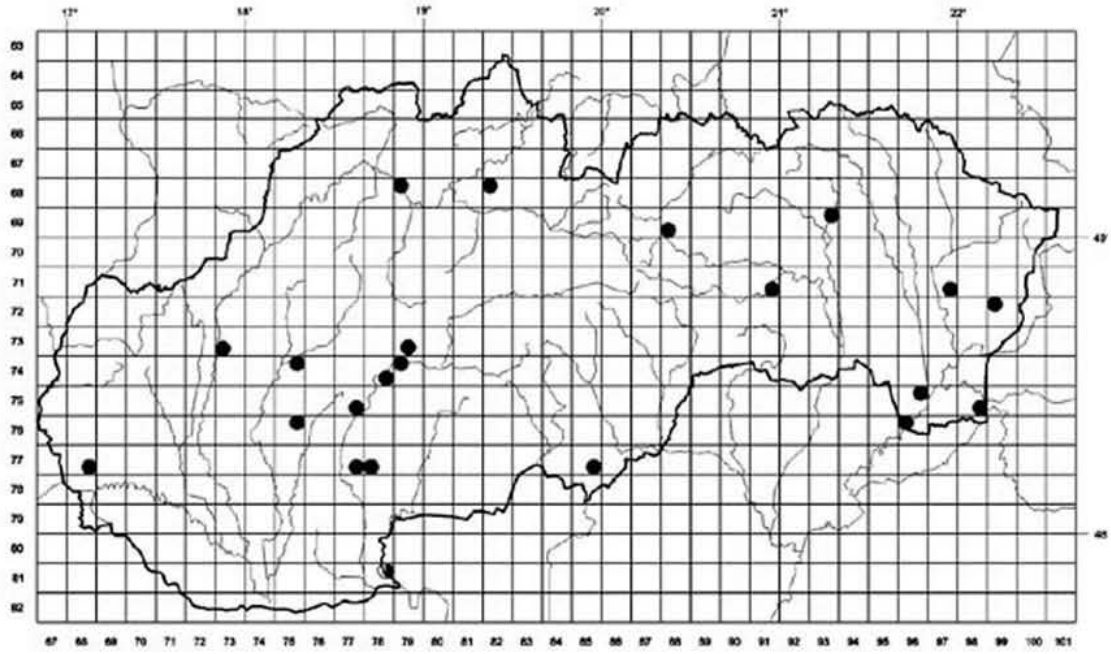
Map 1. Distribution of *Xanthoparmelia angustiphylla* and *X. tinctina*. *Xanthoparmelia angustiphylla* and *X. tinctina* [◑] – specimens examined and published records; *X. angustiphylla* [●] – specimens examined; *X. tinctina* [▲] – specimens examined.



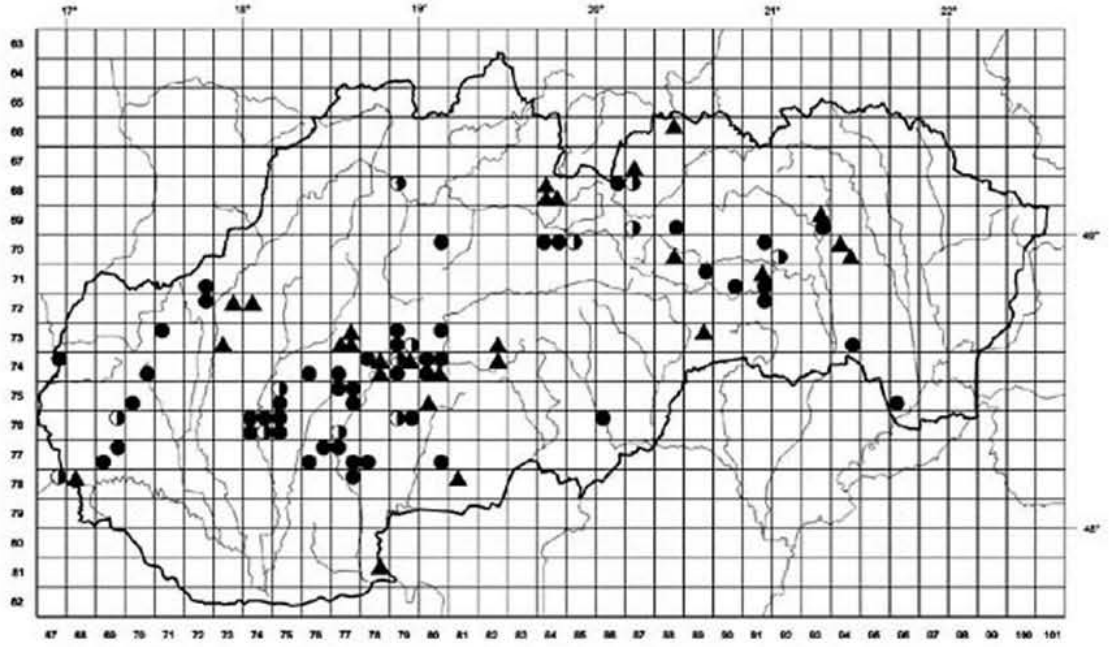
Map 2. Distribution of *Xanthoparmelia conspersa*
[◑] – specimens examined and published records; [●] – specimens examined;
[▲] – published records.



Map 3. Distribution of *Xanthoparmelia felkaensis* and *X. mougeotii*.
Xanthoparmelia felkaensis [◑]– specimens examined and published records;
X. felkaensis [●] –specimens examined;
X. mougeotii [▲] – specimens examined and published records.



Map 4. Distribution of *Xanthoparmelia protomatrae*
[◑] – specimens examined and published records; [●] – specimens examined.



Map 5. Distribution of *Xanthoparmelia somloensis*
[◑] – specimens examined and published records; [●] – specimens examined;
[▲] – published records.

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A new species and two new records of Ustilaginomycetes from China

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Abstract—A new species, *Urocystis puccinelliae* on *Puccinellia tenuiflora*, is described. Two new species for China, *Urocystis alopecuri* on *Alopecurus* sp. and *Anthracoidea sempervirentis* on *Carex scabrirostris*, are reported.

Keywords—smut fungi, taxonomy

Only one known species of *Urocystis* on *Puccinellia distans* (Jacq.) Parl. and *P. hauptiana* V. Kreecz. has been reported from Russia (Azbukina & Karatygin 1995), which is *Urocystis atropidis* (Lavrov) Zundel (1953) with spore balls measuring 21-22(-31) x 17-24 µm, ustilospores measuring 9-14(-19) x 7-9 µm, and 1-2(-4) ustilospores per spore ball. There is a further species of *Urocystis* on *Puccinellia tenuiflora* collected in the Nei Mongol Autonomous Region, in the Northern part of China, which differs from *U. atropidis* by larger spore balls, broader ustilospores, and more ustilospores per spore ball. It is described as:

Urocystis puccinelliae L. Guo & H. C. Zhang, sp. nov. Figs. 1-2

Sori in foliis et vaginis foliis, primo epidermide obtectas, deinde rupturas. Massa sporarum nigrobrunnea, pulverulenta. Glomeruli sporarum subglobosi, ellipsoidei, ovoidei vel irregulares, 17.5-37.5 x 12.5-31 µm, e ustilosporis 1-4(-5) (numeri ustilosporarum 1=27%, 2=45%, 3=20%, 4=6%, 5=2%) constructi, cellulis sterilibus omnino circumdati. Ustilosporae subglobosae, ellipsoideae, ovoideae vel irregulares, 11.5-20 x 9.5-15 µm, rubrobrunneae vel flavidobrunneae; Cellulae steriles ovoideae, subglobosae vel ellipsoideae, 5-11.5 x 5-7.5 µm, flavidobrunneae; pariete 0.5-1(-2) µm crasso, levi, sub SEM verruculoso.

Sori in blades and sheaths of leaves, at first covered by the epidermis, which later ruptures. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or irregular, 17.5-37.5 x 12.5-31 µm, composed of 1-4(-5) ustilospores (1=27%, 2=45%, 3=20%, 4=6%, 5=2%; n=100), completely surrounded by sterile cells. Ustilospores subglobose, ellipsoidal, ovoid, or irregular, 11.5-20 x 9.5-15 µm, reddish-brown or yellowish-brown. Sterile cells ovoid, subglobose, or ellipsoidal, 5-11.5 x 5-7.5 µm, yellowish-brown; wall 0.5-1(-2) µm thick, smooth, as seen by SEM (scanning electron microscopy) verruculose.

On *Puccinellia tenuiflora* (Griseb.) Scribn. et Merr. (*Poaceae*), Nei Mongol: Xilin Gol Meng, Zhagesitai Hu, alt. ca. 1000 m, 15 VII 2003, L. Guo, W. Li & H. C. Zhang 2053, HMAS 89268 (holotypus).

On a species of the genus *Alopecurus*, a species of *Urocystis* was discovered in the Xinjiang Uygur Autonomous Region. It is identified as *U. alopecuri*, which is new to China:

Urocystis alopecuri A.B. Frank, Die Krankheiten der Pflanzen. Pilze, p. 440, 1880. Figs. 3-4

Sori in blades and sheaths of leaves, at first covered by the epidermis, which later ruptures. Spore mass powdery, blackish-brown. Spore balls subglobose or ovoid, 18.5-35(-40) x 15-30.5 μm, composed of 1-3 ustilospores (1=69%, 2=28%, 3=3%; n=100), almost completely surrounded by sterile cells. Ustilospores subglobose, ellipsoidal, ovoid, or subpolyhedral, 14-20 x 12-17 μm, brown; wall 0.8-1 μm thick. Sterile cells subglobose, ovoid, or ellipsoidal, 6.5-13 x 5-10 μm, yellow, wall ca. 0.5-1 μm thick, smooth, as seen by SEM verruculose.

On *Alopecurus* sp. (*Poaceae*), Xinjiang: Hejing, Künes Linchang, alt. ca. 2010 m, 16 VIII 2003, L. Guo & H. C. Zhang 2261, HMAS 89267.

So far 43 species of *Urocystis* have been recorded for China, including *U. puccinelliae* and *U. alopecuri* (in this paper).

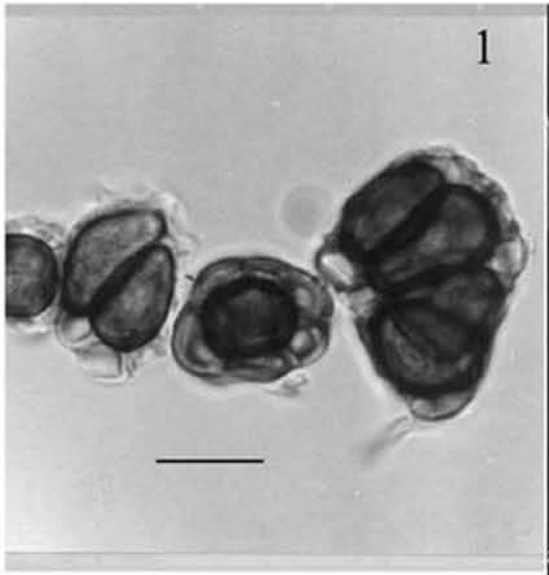
A smut fungus on *Carex scabrirostris* in the section *Frigidae* of the subgenus *Carex* was discovered among unidentified specimens in our herbarium (HMAS). Until now four species of *Anthracoidea* are recognized on species of *Carex* belonging to the section *Frigidae*: 1) *Anthracoidea altera* Nannf. (1979), with ustilospores measuring 16-21 x 15-18 μm, wall ca. 1 μm thick; type on *Carex misandra*, Finland, 2) *Anthracoidea misandrae* Kukkonen (1963), with ustilospores measuring (17-)18-25(-26) x (13-)14-21(-23) μm, wall 0.7-1.5 μm thick, mostly evenly thickened; type on *Carex misandra*, Canada; 3) *Anthracoidea nepalensis* Kakish. & Y. Ono (1988), with ustilospores measuring 14-19 x 11-17 μm, wall 1-1.5 μm thick; type on *Carex nakaona*, Nepal, and 4) *Anthracoidea sempervirentis* Vánky (1979), with ustilospores measuring (16-)19-24(-27) x 14-22 μm, wall 1.5-2.5(-4) μm thick; type on *Carex sempervirens*, Romania.

The fungus on *Carex scabrirostris* in China is identified as *Anthracoidea sempervirentis*, which is new to China (Guo 2000, 2002, 2004; Wang & Piepenbring 2002; Zhang & Guo 2004).

Figs. 1-2. Spore balls of *Urocystis puccinelliae* on *Puccinellia tenuiflora* as seen by LM (light microscopy) and SEM (HMAS 89268, holotypus).

Figs. 3-4. Spore balls of *Urocystis alopecuri* on *Alopecurus* sp. as seen by LM and SEM (HMAS 89267).

Figs. 5-6. Ustilospores of *Anthracoidea sempervirentis* on *Carex scabrirostris* as seen by LM and SEM (HMAS 89270). Bars = 11 μm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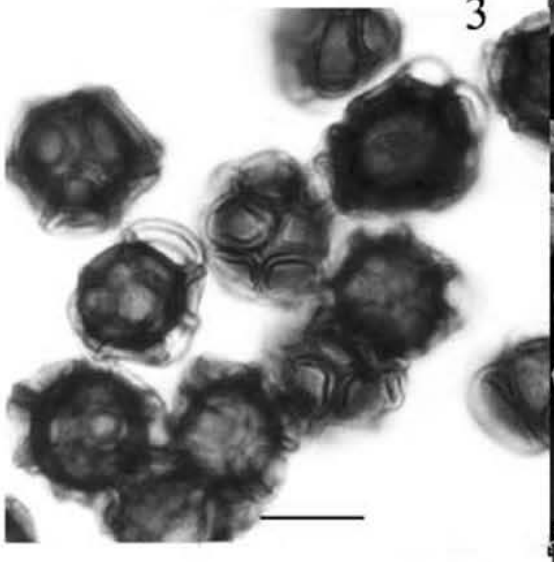
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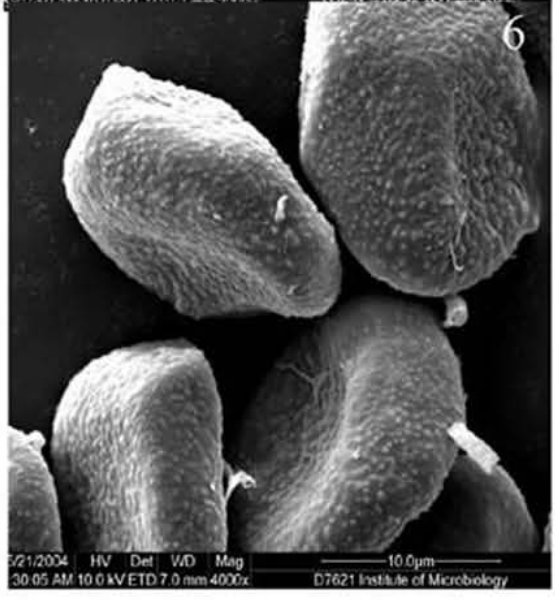
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Anthracoidea sempervirentis Vánky, Bot. Not. 132: 225, 1979. Figs. 5-6

Sori in ovaries, subglobose or ovoid, 1.5-2 mm long, 1-1.8 mm wide, at first covered by a grayish, fungal membrane, later exposed. Spore mass black, semi-agglutinated. Ustilospores in plan view ellipsoidal, subglobose, ovoid, or irregular, 16-25 x 12.5-22 μm, in side view 10-15 μm thick, reddish-brown; wall 1.5-2.5(-3) μm, unevenly thickened, thickest at the angles, no internal swellings, sometimes with 1-2 light reflective areas, surface densely verruculose, the warts often confluent as seen by SEM.

On *Carex scabrirostris* Kükenth. (*Cyperaceae*), Shaanxi: Taibai Shan, Sanyehai, alt. 3450 m, 13 VIII 1963, Q. M. Ma & Y. C. Zong 2954, HMAS 89270.

So far 23 species of *Anthracoideae* have been recorded for China, including *A. sempervirentis* (in this paper).

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Boletus kuthanii, a new name for *Xerocomus flavus* (*Boletales*)

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Abstract—For a transfer of *Xerocomus flavus* into *Boletus*, a new name, *Boletus kuthanii*, non *Boletus flavus* With., is proposed.

Key words—boletes, taxonomy

Xerocomus flavus Singer & Kuthan is a rare species with scattered distribution, restricted to thermophilous broadleaved forests in Czech Republic, Bulgaria and probably in Italy (Singer & Kuthan 1976; Engel et al. 1996; Galli 1998). From Bulgaria it has been reported only once by Kuthan & Kotlaba (1989). The species will be proposed for inclusion in the Red List of Bulgarian fungi (in prep.) as a critically endangered (CR) taxon, according to the Red List Criteria of IUCN (2001).

Specimen examined: Bulgaria, prope Primorsko, humi sub Quercubus, 80 m s.m., 16.VI.1976, leg. et det. J. Kuthan (BRA-273!).

According to Kirk et al. (2001) the species of *Xerocomus* Quél. should be placed into the genus *Boletus* Dill. ex L. For the accommodation of *Xerocomus flavus* Singer & Kuthan, as well as in connection with the view of the investigation of Boletales in Bulgaria, a new combination is needed to be proposed. The name *Boletus flavus* is however preoccupied by *B. flavus* With. (Withering 1792). Consequently a new name must be accepted.

Boletus kuthanii Assyov & Denchev, **nom. nov.**

≡ *Xerocomus flavus* Singer & Kuthan, Česka Mykol. **30**: 153 (1976), non *Boletus flavus* With., Bot. Arr. Brit. Pl. **3**: 415 (1792), q.e. *Suillus grevillei* (Klotzsch : Fr.) Singer, nec *Boletus flavus* Pollini, Fl. Veron. **3**: 607 (1824), q.e. *Inonotus hispidus* (Bull. : Fr.) P. Karst.

Holotype: Southern Moravia, Zdravá Voda, Ždanický les, 4.VIII.1974, leg. K. Kříž & R. Singer (F-C5759, n.v.).

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A new species of *Leucocoprinus* from India

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Abstract—*Leucocoprinus lacrymans sp.nov.* is described, illustrated and discussed based on collections made in Kerala State, India.

Keywords—*Agaricaceae, Agaricales*, Basidiomycota

Introduction

Leucocoprinus Pat. (*Agaricaceae, Agaricales*, Basidiomycota) has been accepted by Singer (1986) and many other authors as a genus distinct from other closely related genera of the tribe *Leucocoprineae* Singer like *Macrolepiota* Singer and *Leucoagaricus* (Locq.) Singer. According to Singer (1986), the genus occupies a position intermediate between *Macrolepiota* and *Leucoagaricus*. The generally small-sized basidiomata and the absence of clamp-connections differentiate *Leucocoprinus* from *Macrolepiota*, while it can be distinguished from *Leucoagaricus* by the fragile coprinoid basidiomata, the plicate-sulcate-striate pileal margin, the relatively large cheilocystidia, and the abundance of pseudoparaphyses (pavement cells) in the hymenium. Reports from around the world reveal its cosmopolitan but predominantly tropical distribution. Singer (1986) recognized 13 species as belonging to the genus while several new species were described later (e.g., Migliozzi *et al.* 1989; Reid 1989, 1990). Manjula (1983) listed 5 species as known from India. During our studies on the lepiotaceous fungi of Kerala State, a new species of *Leucocoprinus* was discovered and is described below.

Materials and Methods

Microscopic observations were made on material mounted in 3% aqueous KOH. Colour codes refer to Kornerup & Wanscher (1978). All collections examined are deposited in the National Herbarium of the Netherlands, Leiden (L).

Description of new species

Leucocoprinus lacrymans T. K. A. Kumar & Manim. *sp.nov.* **FIGURE 1**
Etymology: *lacrymans* (L), weeping

Basidiomata exsudato-punctata, ubi contusus pallide rubro-brunnea. Sporae 5-13 x 4.5-11 µm, late ellipsoideae, ovoideae vel subglobosae, poro germinativo instructae.

Cheilocystidia 10-126 x 4-8 μm, anguste cylindrica vel flexuosa, ad apicem obtusa. Pleurocystidia nulla. Pileipellis e vallo trichodermiali efformata; elementae terminalis 60-125 x 4-8 μm, erectae vel suberectae, cylindricae vel flexuosae, ad apicem obtusae, tenuitunicatae, brunneae. Hyphae omnes defibulatae.

Basidiomata small to somewhat large and robust, all parts turning greenish gray (28D2) on reaction with ammonia fumes and pale reddish brown (8D8) on bruising. **Pileus** 3-8.3 cm diam., at first truncate-cylindrical, then conico-campanulate to convex, finally becoming applanate often with a more or less distinct obtuse umbo; surface white, dotted with minute, appressed, cinnamon (6D6) to rust brown (6E8) squamules that are denser towards the umbo and sparse towards the margin, densely granulose-squamose to somewhat velutinate at the umbo; sulcate-striate towards margin, beaded with golden yellow (5B7) to reddish brown (8D8) watery exudates; margin entire, initially incurved and entire, becoming plane and fissile with age. **Lamellae** free but not attached to a collarium, moderately crowded, ventricose, thin, up to 4mm wide, initially white, turning yellowish white (1A2), finally reddening with age or on drying, with lamellulae of two to three lengths; edge finely fimbriate, tinted grayish on mature specimens. **Stipe** 4-12 x 0.5-0.6 cm, central, terete, almost equal or slightly tapering towards the apex, hollow; surface white to orange white (5A2, 5A3), darkening (6E6, 6E7, 7D5) with age, rather velutinous to villose when young, somewhat appressed-fibrillose when old, beaded with golden yellow (5B7) to reddish brown (8D8) watery exudates; base with white mycelial cords. Annulus superior, white, membranous, evanescent, usually disrupting without trace. **Context** up to 3 mm thick, initially white, turning orange white (5A2) to pale orange (5A3) and finally grayish orange (5B3, 5B4) on prolonged exposure, **Odour** not distinctive. **Spore-print** white.

Spores 5-13 x 4.5-11 (8.63±1.84 x 6.5±1.37) μm, Q = 1.0-1.6, Qm = 1.33, broadly ellipsoid, ovoid or subglobose, with a distinct germ-pore (up to 1.5 μm broad), hyaline, with refractive guttules and a thick complex wall, smooth, dextrinoid, distinctly metachromatic in cresyl blue. **Basidia** 20-28 x 8-12.5 μm, clavate to broadly clavate, with guttulate contents, bearing four sterigmata less than 4 μm long, surrounded by pseudoparaphyses. **Lamella-edge** sterile. **Cheilocystidia** 10-126 x 4-8 μm, narrowly cylindrical to flexuose, with an obtuse apex, often in tufts, thin-walled, hyaline or with pale to dark brown contents. **Pleurocystidia** absent. **Lamellar trama** regular, of thin-walled, hyaline hyphae, 3-7 μm wide, inflated up to 24 μm. **Pileal trama** interwoven: hyphae 3-20 μm wide, thin-walled, hyaline, inamyloid. **Pileipellis** a disrupted cutis with trichodermial patches of ascending or erect elements, 60-125 x 4-8 μm, narrowly cylindrical or somewhat flexuose, with obtuse tips, thin-walled, with brown granular contents; entirely trichodermial at the disc. **Stipitipellis** a disrupted cutis of thin-walled, hyaline to gray-colored hyphae with trichodermial patches of ascending or erect elements; terminal elements up to 100 μm long, 2-5 μm wide, narrowly cylindrical to somewhat flexuose, with obtuse apices. All hyphae lack clamp-connections.

Habitat: On soil and decaying leaf litter around the base of coconut trees, solitary or in clusters.

Known distribution: Known only from the type locality

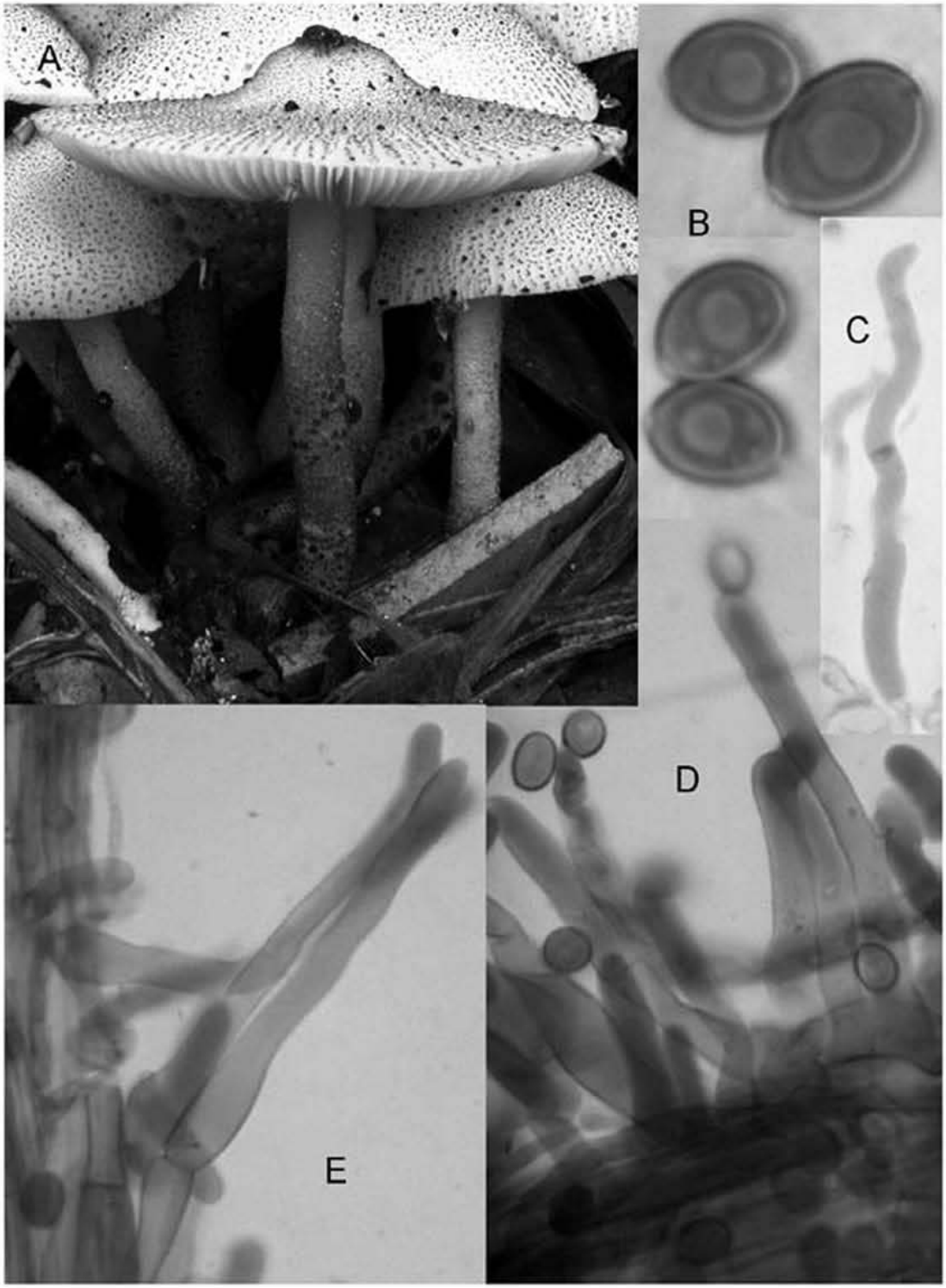

Fig. 1. *Leucocoprinus lacrymans*: A, basidiomata, x 1; B, spores, x 2000; C, cheilocystidium, x 650; D, pileipellis, x 650; E, stipitipellis, x 650

COLLECTIONS EXAMINED — INDIA, KERALA STATE, Calicut District, CALICUT: 28 August 2003, Arun Kumar AK1; 9 April 2004, Arun Kumar AK17 **(holotype)**; 11 April 2004, Arun Kumar AK17a; 27 April 2004, Arun Kumar AK18; 27 April 2004, Arun Kumar AK18a; 28 April 2004, Arun Kumar AK18b; 4 May 2004, Arun Kumar AK18c; 8 May 2004, Arun Kumar AK18d (all at L).

Discussion

Leucocoprinus lacrymans is characterized by small to medium-sized whitish basidiomata dotted with fine brownish squamules and drops of golden yellow to reddish brown exudates, greenish gray coloration of basidiomata on reaction with ammonia fumes, gradual color change to pale reddish brown on bruising, a white context turning orange white to pale orange and finally grayish orange on prolonged exposure, spores showing a wide range of size and shape, conspicuously elongate and flexuous cheilocystidia, and cylindrical pileipellis elements. Larger spore dimensions, exceeding 8(9) x 6 μm, and distinct germ-pore indicate that it belongs to the section *Cepaestipedes* Konrad & Maubl. It is clearly related to the *Leucocoprinus badhamii* complex (Reid, 1990) comprising species which redden on bruising or become green in ammonia fumes. The closest in the complex seems to be *Leucocoprinus meleagris* (Sowerby) Locq., known to be widely distributed in both temperate and tropical regions (Reid, 1990; Pegler, 1977, 1983; Manjula, 1983). These two species have a number of macroscopical and a few microscopical similarities including the size and shape of spores. However, the shape of cheilocystidia, caulocystidia and the elements comprising the scales of the pileus in *Leucocoprinus lacrymans* is always cylindrical while it is never cylindrical but clavate, fusoid or lanceolate often with a distinct apical prolongation in *L. meleagris*. Also, on bruising, the basidiomata of *L. lacrymans* turn pale reddish brown while those of *L. meleagris* turn intensely red. On exposure, the context of *L. lacrymans* changes colour from white through orange white to pale orange while that of *L. meleagris* discolours through lemon yellow to orange red. In addition, the basidiomata of *L. lacrymans* always exude droplets of a golden yellow to reddish brown watery fluid, a feature not known in *L. meleagris* and related species. The Sri Lankan species, *Leucocoprinus holospilotus* (Berk. & Broome) D.A. Reid and *Leucocoprinus biornatus* (Berk. & Broome) Locq., which according to Reid (1990) are microscopically indistinguishable from each other and are closely related to *L. meleagris*, are characterized by unchanging colour of flesh, smaller spore dimensions, clavate or broadly lanceolate cheilocystidia with a mucronate apex and pileal scales comprising of short ovate or broadly lanceolate cystidiiform elements. *Leucocoprinus caldariorum* D. A. Reid, another species similar in appearance and habitat to *L. meleagris*, has a well-developed spreading annulus, broadly amygdaliform spores, ovate, clavate or lanceolate cheilocystidia frequently with apical prolongation and pileal surface with numerous short and squat hairs.

Species belonging to the so-called '*badhamii*-complex' have been shuttling back and forth between *Leucoagaricus* and *Leucocoprinus* (*cfr* Moser 1983 and Reid 1990 with Bon 1993 and Vellinga 2001). We prefer to consider the new species from Kerala as belonging to *Leucocoprinus* because of the abundant development of pseudoparaphyses in the hymenium. Although a recent molecular study (Vellinga, 2004) questions the

validity of it, we believe that this character is very useful to differentiate between *Leucocoprinus* and *Leucoagaricus* as long as we stick to the traditional morphology-based classification.

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A multiple approach to the taxonomy of *Lactarius rubrozonatus* (Basidiomycota, *Russulales*)

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Abstract - The biometric and molecular data supporting the separation of the new taxon *Lactarius rubrozonatus* from *L. sanguifluus* are discussed. The results of a multidisciplinary examination led to separate two close taxa growing sympatrically in symbiotic association with two-needle pines. Even though, morphologically, the only reliable separating characters were pileal zonation and spore size, the autonomy of the new taxon was supported by ITS sequences and the stop of genetic flux in five allozymes. The new taxon, which was previously referred to as *L. vinosus*, was renamed *L. rubrozonatus* because the older epithet was illegitimate.

Key Words - Cryptic speciation, ectomycorrhizal fungi, *Lactarius* section *Dapetes*

Introduction

In the genus *Lactarius* Pers. (*Russulales*, *Basidiomycota*), members of the section *Dapetes* Fr., with mild, red-coloured latex, are ranked among the most prized edible fungi by mushroom hunters. In fact, they are gathered and marketed in many countries, especially in the Mediterranean area, where evidence of this interest dates from Roman frescos and mosaics (Ainsworth 1976).

Lactarius sanguifluus (Paulet : Fr.) Fr., probably the most valued species of this group, grows in symbiosis with some two-needle species of *Pinus*, mainly in South Europe. Its basidiomata exude vinaceous-red latex and show an impressive phenotypical variability, often showing overlapping characters, apparently without further microanatomical differences (Lalli & Pacioni 1982). Unfortunately, this rather complex taxonomic situation is compounded by the nomenclatural problems regarding *Lactarius vinosus* Quél., for which several conflicting descriptions have been published (Blum 1976; Marxmüller & Romagnesi 1991; Courtecuisse & Duhem 1994; Moser & Jülich 1996; Basso 1999), without any reference to types specimens.

Recently (Lalli, Frizzi & Pacioni 2002), a check of populations of *Dapetes* from central Italy, by means of horizontal starch gel electrophoresis of enzymes, has enabled the separation of *Lactarius sanguifluus* into two genetic groups, one of which was provisionally labelled as "*Lactarius vinosus*". Given the strong evidence for the existence of two distinct taxa, there remained to be solved the nomenclatural problems

connected with the epithet *vinosus*. A close scrutiny of these problems revealed that *L. vinosus* was illegitimate (Lalli, Pacioni & Leonardi 2002) and led us to propose a neotypification for *Lactarius sanguifluus* and the new name *L. rubrozonatus* Lalli & Pacioni.

Here, we present further biometric and molecular evidence that support the taxon *Lactarius rubrozonatus*.

Materials and Methods

Specimens

The study was carried out on the dried and frozen specimens already used for the electrophoretic survey on the *Dapetes* (Lalli, Frizzi & Pacioni 2002). Among these, the attention was focused on the 89 specimens referring to different phenotypes of *Lactarius sanguifluus* [typical, grey-violaceous form (= *Lactarius vinosus* ss Blum 1976; Marxmüller & Romagnesi 1991) and an undescribed pinkish form] which exhibited nil genetic distance, and the 47 specimens of both the typical *Lactarius vinosus* ss Courtecuisse & Duhem (1994); Moser & Jülich (1996); Basso (1999), now *L. rubrozonatus*, and a flesh-coloured form with nil genetic distance.

All specimens were collected beneath *Pinus nigra* Arnold or *P. silvestris* L. stands in the Abruzzi, central Italy, and their vauchers are preserved in the Herbarium Mycologicum Aquilanum (AQUI).

Morphology

Microanatomical features were studied with light and scanning electron microscopy. In particular, pseudo-, cheilo- and pleurocystidia, basidia, hymenial trama, pileipellis and stipe cortex were examined using H_2O, KOH 5%, NH_4OH and Melzer, Congo Red, Blue Cotton, Sulphoanylin, Sulphoformol micro-reactions. For each specimen, 10 spores, mounted in KOH, were measured at a magnification of x1000.

Spores from dried herbarium specimens were suspended in distilled water and a drop was put on acetone washed aluminium stubs and then dehydrated in a dessiccator under vacuum with silica gel over night. Samples were coated with a gold layer 200 Å thick in a sputter coater (Agar Auto Sputter Coater) and observed with a Philips XL30CP SEM, at 15 kV.

Table 1. Starch Gel Electrophoresis conditions for detection of allozymes

Abbr.	Enzymes	Buffer *	pH	E. C. N. **	References
MDH	Malate dehydrogenase	1	8.2	1.1.1.37	Shaw and Prasad (1970)
ICD	Isocitrate dehydrogenase	1	8.2	1.1.1.42	Brewer and Sing (1970)
HK	Hexokinase	3	8.0	2.7.1.1	Harris (1966)
AK	Adenylate kinase	2	7.2	2.7.4.3	Brewer and Sing (1970)
PGM	Phosphoglucomutase	2	7.2	2.7.5.1	Brewer and Sing (1970)

* *Buffer systems used: 1) Lithium/borate; 2) Tris/maleate; 3) Tris/versene/borate;*
** *E.C.N.: Nomenclature Committee of the International Union of Biochemistry.*

Starch gel electrophoresis

Homogenates, absorbed in 5 by 5 mm pieces of chromatography paper (Watmann 3MM), were inserted in 10.5% Connaught hydrolyzed horizontal starch gel trays, according to Pacioni & Pomponi (1989).

The electrophoresis (SGE) was conducted at a constant 8 v/cm for 3 h at 4 °C.

According to previous experiences (Pacioni & Pomponi 1989, 1991; Pacioni *et al.* 1993), the specific stainings were done in accordance with Brewer & Sing (1970), Harris (1966), Shaw & Prasad (1970) and the conditions are shown in Table 1, where the list of the enzymatic loci studied with details on the techniques are given.

Six previously identified allozymes: MDH (malate dehydrogenase), ICD (isocitrate dehydrogenase), HK (hexokinase), AK (adenylate kinase), PGM (phosphoglucomutase) and MPI (mannose phosphate isomerase) were comparatively studied.

The mobility of enzymes of the *L. sanguifluus* specimens from S. Lorenzo, Poggio di Roio, L'Aquila, was used as a standard, the mobility of the commonest alleles in this population was taken as 100.

Molecular analyses

Genomic DNA was isolated from small amount of dried and fresh basidiocarps (20-35 mg). The material was ground to a fine powder using a sterilized mortar and liquid nitrogen; than DNA was extracted following the protocol of Bruns *et al.*(1990), checked on a 1% agarose gel and visualized by staining with ethidium bromide. We used the ITS1F and ITS4 oligonucleotide primers (Gardes & Bruns 1993), READYMIX REDTAQ PCR REACTION MIX (SIGMA) for PCR amplification. The cycling parameters were: an initial denaturation at 94°C for 3 min; 35 cycles consisting of 25 s at 95°C, 55 s at 53°C, 2 min at 72°C; and a final extension step for 7 min at 72°C. Negative controls (no DNA template) were included in every experiment. The PCR products were purified using the GenElute™ PCR DNA Purification Kit (SIGMA) and quantified by 2% agarose gel electrophoresis. The DNA templates were directly sequenced using ABI PRISM™BigDye™ Terminator Cycle Sequencing reaction kit (Applied Biosystems), according to manufacturer's protocol, and ABI 377 automated sequencer (Perkin Elmer).

Table 2. Accession numbers of reference sequences.

Species	Country	Vouchers	GenBank acc. no.
Lactarius controversus	Hungary:Nagykoros	Strain 98/33	AJ272246
Lactarius deliciosus	France	Strain D39 clone b	AF249284
Lactarius deterrimus	Germany:Voehrenberg	Ursula Eberhardt ue166	AF140267
Lactarius quieticolor	Germany:Kiebingen	Ursula Eberhardt ue141	AF140269
Lactarius salmonicolor	Germany:Voehrenbach	Ursula Eberhardt ue158	AF140265
Lactarius sanguifluus	France	Strain S22	AF249289
Lactarius sanguifluus	France	Strain S38 clone a	AF249290
Lactarius sanguifluus	France	Strain S38 clone b	AF249291
Lactarius semisanguifluus	Germany:Tuebingen	Ursula Eberhardt ue149	AF140268
Lactarius subsericatus	Germany:Zierenberg	Ursula Eberhardt us95/13a	AF140261
Russula delica	Spain	Strain Rd	AF096987

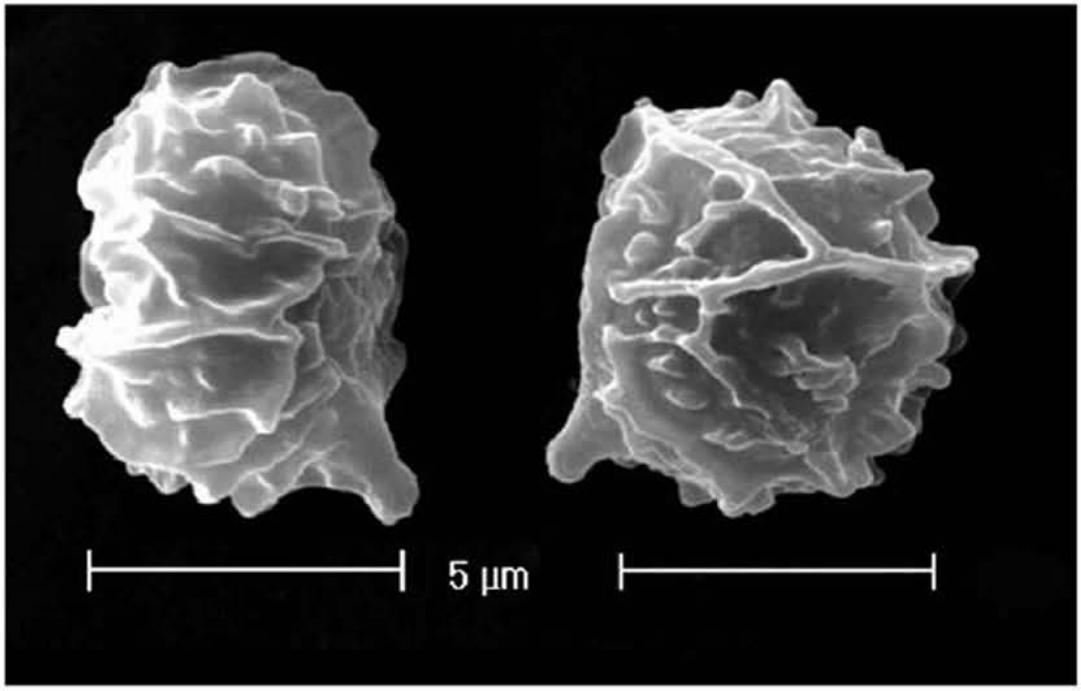

Fig. 1.SEM micrographs of two representative *Lactarius rubrozonatus* (left) and *L. sanguifluus* (right) spores.

Data treatment

Preliminary multiple alignments were generated using Clustal X (Thompson *et al.* 1997) and manually optimized; ambiguous regions were excluded from subsequent analyses. Phylogenetic analyses were conducted using MEGA Software (http://www.megasoftware.net). Eight additional sequences used in this study were retrieved from GenBank; the collections are listed in Table 2 with their GenBank accession number (*Russula delica* Fr. represents an outgroup). Three available sequences of *Lactarius sanguifluus*, also in Table 2, were preliminarily tested with BLAST against our specific sequences.

Maximum parsimony analyses were performed in MEGA selecting the "pairwise delection" mode to consider delections. The initial region (1-50) and the final (782-) were excluded.

The statistical analyses of the morphological character dimensions were performed by the packages S-plus®2000 software (Insightful Corporation – Seattle) and Statistica for Windows® rel. 5.5 (StatSoft.Inc) .

Results

Of all the macro- and microscopic morphological characters taken into consideration, only the cap zonature (continous in *L. rubrozonatus*, absent or spotted in wet *L. sanguifluus*) and spore morphology (Fig. 1) seemed to be distinctive whereas all the others appeared to be useless. Recently, Nuytinck & Verbeken (2003), dealing with the same taxa, have pointed out some morphological diagnostic differences between them. *L. vinosus* (= *L. rubrozonatus*) exhibits only vinaceous red tinges without the orange shades occurring in *L. sanguifluus*, and it has a more marked tapering of stipe,

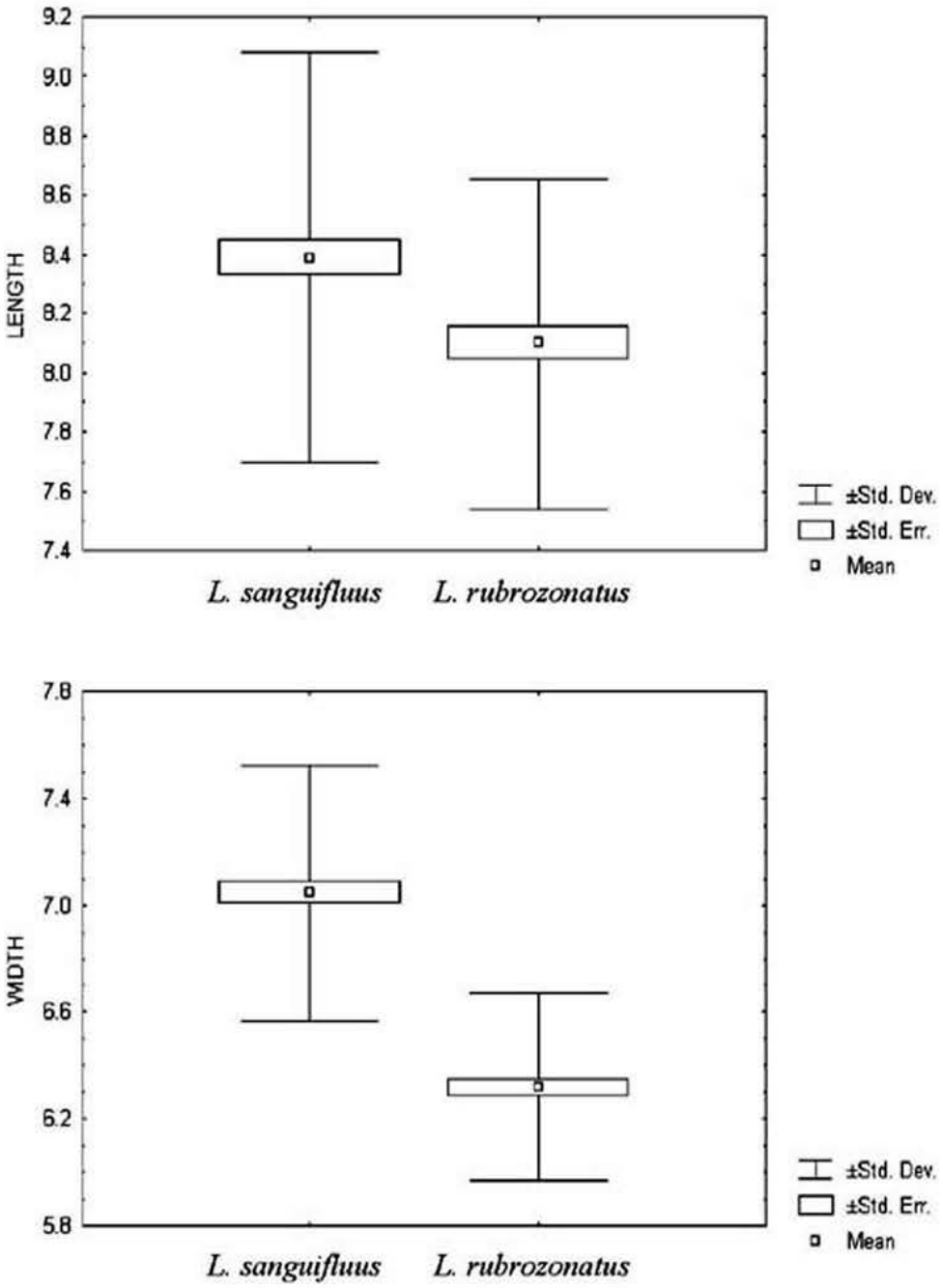

Fig. 2. Box & Whisker Plots comparing mean length (p-value= 0.0019) and width (p-value= 0.00001) of *Lactarius sanguifluus* and *L. rubrozonatus* spores.

a stronger red colour in the cap flesh, and a less complete sporal reticulum. In our opinion, of the above diagnostic features, the validity of which was previously critically examined by us (Lalli & Pacioni 1982; Lalli, Pacioni & Leonardi 2002), only spore ornamentation might be regarded as an additional separating character, but it is of difficult handling, based as it is on small differences in the thickness of the ridges of the reticulum: thinner in *Lactarius rubrozonatus*. The spore size range (length and width) of two taxa could apparently seem overlapping being 6.0-10.8 x 6.0-9.2 µm in *L. sanguifluus* and 6.8-9.6 x 5.2-7.2 µm in *L. rubrozonatus*. However, small but constant differences are found when they are processed separately (Table 3).

Table 3. Confront of *L. rubrozonatus* and *Lactarius sanguifluus* spore sizes. Means with standard deviation.

	length	mean	width	mean	L/W mean
L. rubrozonatus	6.8-9.6 µm	8.10 ± 0.56	5.2-7.2 µm	6.32 ± 0.35	1.28 ± 0.09
L. sanguifluus	6.0-10.8 µm	8.39 ± 0.69	6.0-9.2 µm	7.05 ± 0.95	1.19 ± 0.08

In Fig. 2, two Box & Whisker plots, the spore size observed in the two taxa are shown. The t-test demonstrates that the two distributions are statistically well separated for the length (p-value= 0.0019) and width (p-value= 0.00001) of spores, and indeed the ratio L/W values also appear to be significantly different. The spores of *Lactarius sanguifluus* are slightly wider than those of *L. rubrozonatus*.

Table 4 shows allele frequencies for some of the scored allozymes. These data, which concern seven loci (*Mdh-1, Mdh-2, ICD, HK-1, AK, PGM, MPI*), suggest that these alleles are not shared and consequently any genetic flux between the two taxa is clearly stopped. The two taxa are indeed genetically separated.

The ITS sequences of the two taxa result about 700-718 bp long and are deposited in GenBank under accession number: AY292987 (*L. rubrozonatus*), AY296130 (*L. sanguifluus*).

Comparison of our specimens with the sequences of *Lactarius sanguifluus* available in GenBank (Table 2), resulted in complete agreement, with identity values of 98-99%, so confirming the validity of our taxonomic concept.

The elaboration of the data yielded three equally parsimonious trees. The trees have rather low bootstrap values probably because of the poorly informative sites that can be used.

Although sequences seem to be very similar, there are constant differences, especially in the region positioned after the start of ITS1, which support the separation of the two species from a molecular point of view.

The results of these analyses are presented by a consensus diagram obtained from the three most parsimonious trees (Fig. 3). On the grounds of the bootstrap value the two taxa are very close, nevertheless the value is the same as that found between *Lactarius deliciosus* and *L. quieticolor*.

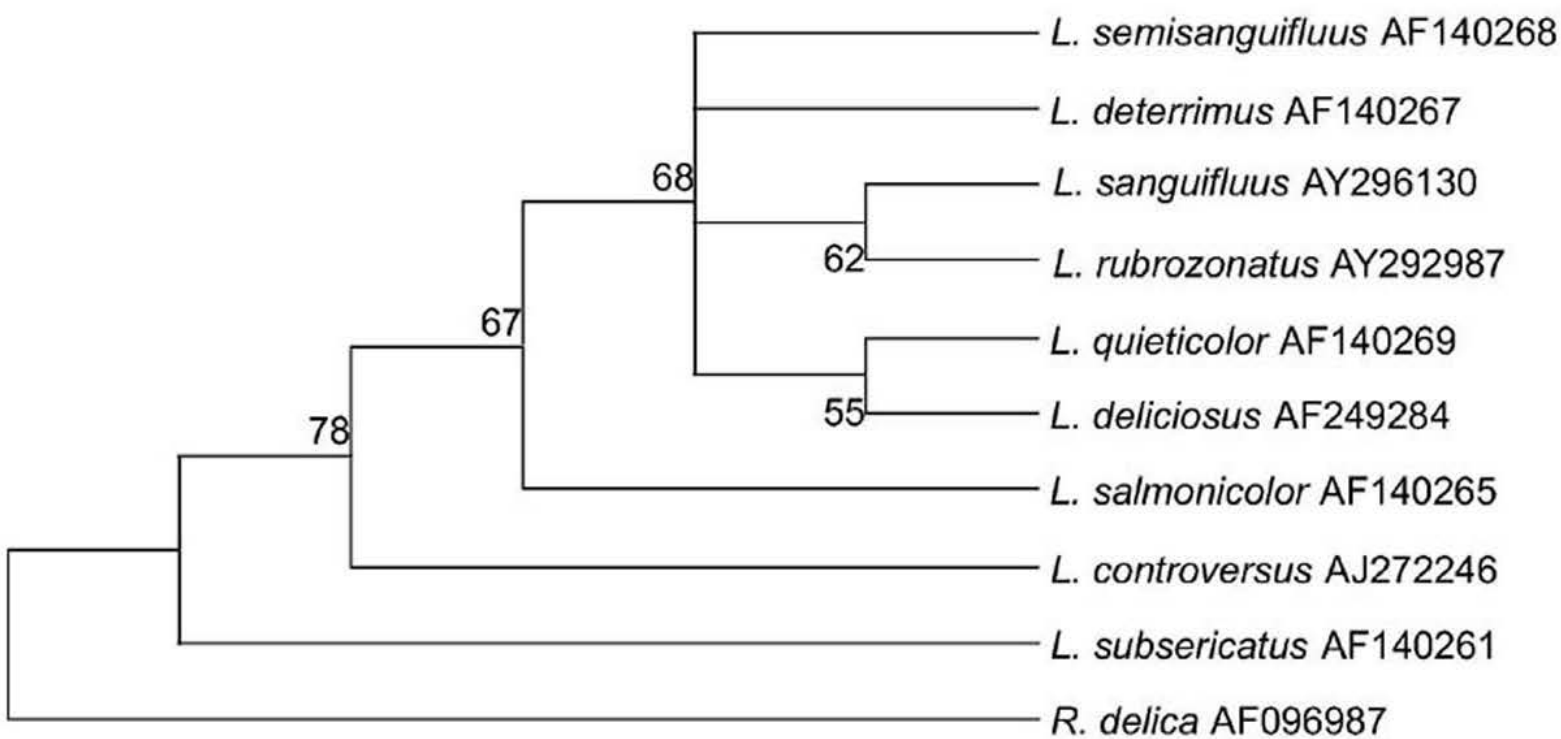

Fig. 3. Consensus tree, based on ITS sequences of 9 taxa of *Lactarius* (7 of the section *Dapetes*). On the tree nodes the boot straps value. *Russula delica* represents an outgroup.

This multiple taxonomic approach has confirmed the existence of two different taxa, distinct from a morphological, genetic and molecular point of view, within the populations symbionts of two-needle pines with vinaceous-red latex, generally ascribed to *Lactarius sanguifluus*.

Table 4. Allele frequencies. Sample sizes (*N*) and allelic mobility relative to the most common alleles are also shown

	L. sanguifluus	*L. rubrozonatus*
Mdh-1	***Malate dehydrogenase***	
(*N*)	*70*	*37*
96/96	--	100
100/100	100	--
Mdh-2		
(*N*)	*69*	*41*
87/92	--	29.3
92/92	--	70.7
100/100	100	--
ICD	***Isocitrate dehydrogenase***	
(*N*)	*84*	*29*
100/100	100	--
103/103	--	100
HK-1	***Hexokinase***	
(*N*)	*89*	*32*
96/96	2.3	--
96/100	25.8	--
100/100	71.9	100
AK	***Adenylate kinase***	
(*N*)	*68*	*44*
94/100	100	27.3
100/100	--	72.7
PGM	***Phosphoglucomutase***	
(*N*)	*89*	*46*
96/100	31.5	100
100/100	68.5	--
MPI	***Mannose phosphate isomerase***	
(*N*)	*83*	*41*
91/97	--	17.1
94/94	47.0	82.3
94/100	38.5	--
100/100	14.5	--

Discussion

The taxa of the section *Dapetes* have generally been separated on the basis of latex, basidioma colours and host trees, because the micromorphological characters are rather poor and of little help for taxonomy. Being species of economical interest both as ectomycorrhizal forestry fungi and food all over the northern hemisphere, additional tools for their identification are necessary.

The two examined taxa, indeed, have a strong morphological similarity, with overlapping characters, and only a small but significant difference in spore size, which is difficult to detect because of an apparent overlapping of their ranges. Quite surprisingly, however, there exists a clear genetic distance due to a reproductive segregation without genetic flux for some genes that undoubtedly discriminates the two taxa, and this separation is reinforced by the dissimilarity at ITS sequence level.

The allozyme data directly show an amphimictic dikaryotic system of reproduction, because of heterozygosity. These two taxa were found to grow sympatrically with *Pinus nigra* and *P. silvestris*. These results could show probably a case of cryptic speciation involving ectomycorrhizal fungi with an amphimictic system of reproduction. Previously the existence of a number of sibling taxa within one same morphotype was shown with the ectomycorrhizal genus *Tuber* Fr. (Pacioni & Pomponi 1991; Pacioni et al. 1993; Urbanelli et al. 1998), however the species of this genus seem to be homokaryotic and, perhaps, automictic, with a permanent binucleate mycelium (Bertault et al. 1998; Frizzi et al. 2001).

On the basis of these results, a re-examination of *L. sanguifluus* collections growing in association with other two-needle pines in southern Europe (including northern Africa and the Middle East) would seem to be in order (Lalli & Pacioni 1982).

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The genus *Tulostoma* in Sonora, Mexico

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Abstract — Seventeen species of *Tulostoma* from 92 collections found in Sonora (Mexico) were studied. Four species: *Tulostoma cyclophorum, T. floridanum, T. involucratum,* and *T. squamosum* are new records for Mexico. Most of the studied material was collected in microphyllous desert scrub and tropical thorn forest during summer and winter. *Tulostoma fimbriatum* was the only species observed in arid, semiarid and temperate areas. *Tulostoma floridanum* and *T. squamosum* showed a restricted distribution in tropical deciduous forest. SEM photographs of spore ornamentation are provided.

Key words — chorology, spore ornamentation, SEM, taxonomy, *Tulostomataceae*

The great biodiversity existing in Sonora has justified the protection of several important reserves in this Mexican state: Upper Gulf of California and Colorado River Delta Biosphere Reserve, including wetlands and estuaries; Pinacate and Grand Desert of Altar Biosphere Reserve, located in a xeric area; Reserve for the Protection of Flora and Fauna Álamos-Cuchujaqui River, with tropical deciduous forest; Ajos-Bavispe National Forest Reserve and Wildlife Refuge, with pine-oak forest.

Sonoran tropical deciduous forest is important as it represents the northern limit of that type of vegetation in the American Continent, being the habitat for certain mushrooms, such as *Rugosospora pseudorubiginosa* (Cifuentes & Guzmán) Guzmán & Band.-Muñoz and *Humphreya coffeata* (Berk.) Steyaert, which are mainly distributed in South America (Esqueda et al. 1999). Little known *Tulostomataceae* have been found in the Sonoran desert, i.e. the genera *Battarreoides* T. Herrera and *Chlamydopus* Speg. (Esqueda et al. 1998b).

Up to the present time only seven species of *Tulostoma* have been cited from Sonora. One of them, *T. portoricense* J.E.Wright, is known only from the holotype from Puerto Rico (Wright 1987) and one collection from Sonora at worldwide level (Esqueda et al. 1998a). *Tulostoma xerophilum* Long is restricted to North America (Wright 1987). *Tulostoma albicans* V.S.White, *T. nanum* (Pat.) J.E.Wright and *T. occidentale* Lloyd (Wright et al. 1972; Guzmán 1975) are critical or ill-defined species, which require further studies to establish their taxonomic position. On the contrary, two other species previously recorded from Sonora, *Tulostoma fimbriatum* Fr., and *T. striatum* G. Cunn. (Wright et al. 1972; Aparicio-Navarro et al. 1994) have been cited in numerous localities around the world.

The diversity of mushrooms from Sonora is clearly pointed out in the present paper. Seventeen species of *Tulostoma* were studied, four of which are new records for the Mexican mycobiota. Material was collected in microphyllous desert scrub, tropical thorn forest, tropical deciduous forest, oak woodland and *Quercus-Juniperus-Pinus* forest.

Material and methods

Studied material was collected in field trips through several localities of Sonora during the last 12 years. The collections have been deposited in the National Herbarium of the Institute of Biology, UNAM (MEXU), the mushroom collection of the "Centro de Estudios Superiores del Estado de Sonora" (CESUES) and the herbarium of the University of Alcalá, Spain (AH). Spore ornamentation of all collections has been studied under SEM according to Moreno et al. (1995).

Taxonomy

Tulostoma albicans V.S. White, *Bull. Torrey Bot. Club* 28: 428. 1901.

(Fig. 1)

Material studied: Agua Prieta municipality, Km 4 Agua Prieta to Nacozari road, E. Herrejon, 13-VIII-1991, CESUES 27. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 11-IX-1996, AH 31747 ex CESUES 2794. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 16.II.1996, CESUES 2369. Ibidem, 17-III-1996, CESUES 2619. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 22-II-1998, CESUES 3698.

REMARKS: *Tulostoma albicans* is recognized by its exoperidium being thinly but clearly membranous, mouth circular and spores smooth to minutely asperulate. Under SEM the ornamentation appears as small and irregular verrucae, some anastomosed.

We agree with the opinion expressed by Wright (1987) regarding the taxonomic problems related to *T. albicans* concept. Definitively, this taxon is ill defined. Specifically, there are two species close to *T. albicans*: *T. moravecii* Pouzar and *T. xerophilum* Long. These are so similar that even the study of their spore ornamentation under SEM fails to

contribute sufficient differences: all of them show spores with similar irregular verrucae. The differentiation between *T. albicans* and *T. xerophilum* is especially problematic since they share a similar distribution area in North America (*T. moravecii* shows an European distribution). Therefore, additional exhaustive studies on North American collections of these species are needed to clarify their taxonomic situation definitively.

Tulostoma albicans has been cited from USA and Mexico (Baja California, Coahuila, Distrito Federal, Durango, Nuevo León, San Luis Potosí, Sonora, Tamaulipas) (Guzmán & Herrera 1969; Wright et al. 1972; Rodríguez-Scherzer & Guzmán-Dávalos 1984; Wright 1987; Guzmán et al. 1992; Moreno et al. 1995). It was observed in summer and winter in microphyllous desert scrub and tropical thorn forest in Sonora. In addition, this species has been collected outside of North America in Argentina, Spain, Sweden and Australia (Wright 1987). Several of these records have been already corrected (Altés 1996; Altés et al. 1996), the rest being somewhat doubtful, in our opinion.

Tulostoma beccarianum Bres. *in* Petri, *Ann. Mycol.* 2: 413-414. 1904.
= *T. simulans* Lloyd, *The Tylostomeae* p.18. 1906.

(Fig. 2)

Material studied: Baviácora municipality, Mazocahui, M. Esqueda & J. Jiménez, 26-III-1993, AH 31748 ex CESUES 1213b. Hermosillo municipality, Ejido Guadalupe Victoria, Calle 26, G. Yanes, 4-VIII-1994, CESUES 1680. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2791. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24-XI-1995, CESUES 2235. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 13-IX-1996, CESUES 3245. Baviácora municipality, Km 72 Mazocahui to Hermosillo road, E. Pérez-Silva, T. Herrera & M. Esqueda, 30-VIII-2001, CESUES 4851. Bacoachi municipality, Km 146 Mazocahui to Cananea road, M. Esqueda & J. Jiménez, 27-III-1993, AH 31759 ex CESUES 1250.

REMARKS: *Tulostoma beccarianum* is recognized by its exoperidium being thinly membranous to indistinct, tubular stoma, and spores having middle-sized verrucae under SEM. This species is frequently misidentified as was underlined by Moreno & Altés (1992) in their study of Spanish collections. This taxon has been cited in several countries, but in Mexico it was only known from Morelos, San Luis Potosí and Distrito Federal (Wright 1987). Thus, this is the first record from Sonora where it was more frequently observed in summer in microphyllous desert scrub and tropical thorn forest.

Tulostoma chudaei Pat., *Bull. Trimestriel Soc. Mycol. France* 23: 84. 1907.

(Fig. 3)

Material studied: Carbó municipality, La Granada ranch, J. Jiménez, 18-I-1994, AH 31749 ex CESUES 1601a. Hermosillo municipality, near to Puerto Libertad town, M. Esqueda, M. Coronado, A. Armenta, A. Núñez & A. Sánchez, 7-XI-1997, CESUES 3757. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A.

Armenta, A. Núñez & R. Santos, 17-III-1996, CESUES 2628. Ibidem, 11-IX-1996, CESUES 2793. Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2826. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 24-XI-1995, CESUES 2232. Ibidem, 29-IV-1996, CESUES 2701. Ibidem, 26-I-1999, CESUES 4787. San Javier municipality, Km 137.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta A. Núñez & R. Santos, 18-II-1996, CESUES 2505.

REMARKS: *Tulostoma chudaei* is recognized by the presence of a typical sand case at the base of the spore sac, stoma circular slightly projecting, exoperidium hyphal, spores verrucose under SEM, and stem being easily separated from the socket. This species has been cited from Africa, America and Australasia (Wright 1987). It was known only from Baja California in Mexico (Guzmán et al. 1992; Moreno et al. 1995). This taxon was present throughout the year in microphyllous desert scrub, tropical thorn forest and tropical deciduous forest.

Tulostoma cretaceum Long, *Mycologia* 36: 321-322. 1944.

(Fig. 4)

Material studied: Baviácora municipality, Km 72 Mazocahui to Hermosillo road, E. Pérez-Silva, T. Herrera & M. Esqueda, 30-VIII-2001, CESUES 4850. Hermosillo municipality, Km 125 Hermosillo to Puerto Libertad road, M. Esqueda, A. Armenta, A. Núñez & A. Sánchez, 29-VIII-1998, AH 31750 ex CESUES 4391. Puerto Peñasco municipality, Pinacate and Grand Desert Biosphere Reserve, Ejido El Norteño, J. Miranda, M. Coronado, A. Sánchez & M. Esqueda, 28-IV-2004, CESUES 5182.

REMARKS: *Tulostoma cretaceum* is recognized by its conspicuous basal mycelial cord, exoperidium hyphal, stoma fibrillose which becomes indefinite, smooth spores under SEM, and capillitium with short branches and sparse septa. It is related to the *T. obesum* group, but is usually more slender than the other species and with a ferruginous gleba (not chocolate brown coloured). There are registered collections from southwestern USA and Argentina (Wright 1987). This taxon is little known in Mexico, being cited only from Baja California (Moreno et al. 1995). In Sonora, it was observed solitary, on sandy soil in microphyllous desert scrub.

Tulostoma cyclophorum Lloyd, *The Tylostomeae* p. 25, 1906.

(Fig. 5)

Material studied: Hermosillo municipality, Centro Ecológico de Sonora, J.M. Villegas, 7-V-1993, AH 31751 ex CESUES 1584.

REMARKS: *Tulostoma cyclophorum* is distinguished by the combination of its remarkable membranous exoperidium, fibrillose stoma, small spores (3.5-4.5 μm diam.), subreticulate under SEM, and the presence of "mycosclereids" covering the

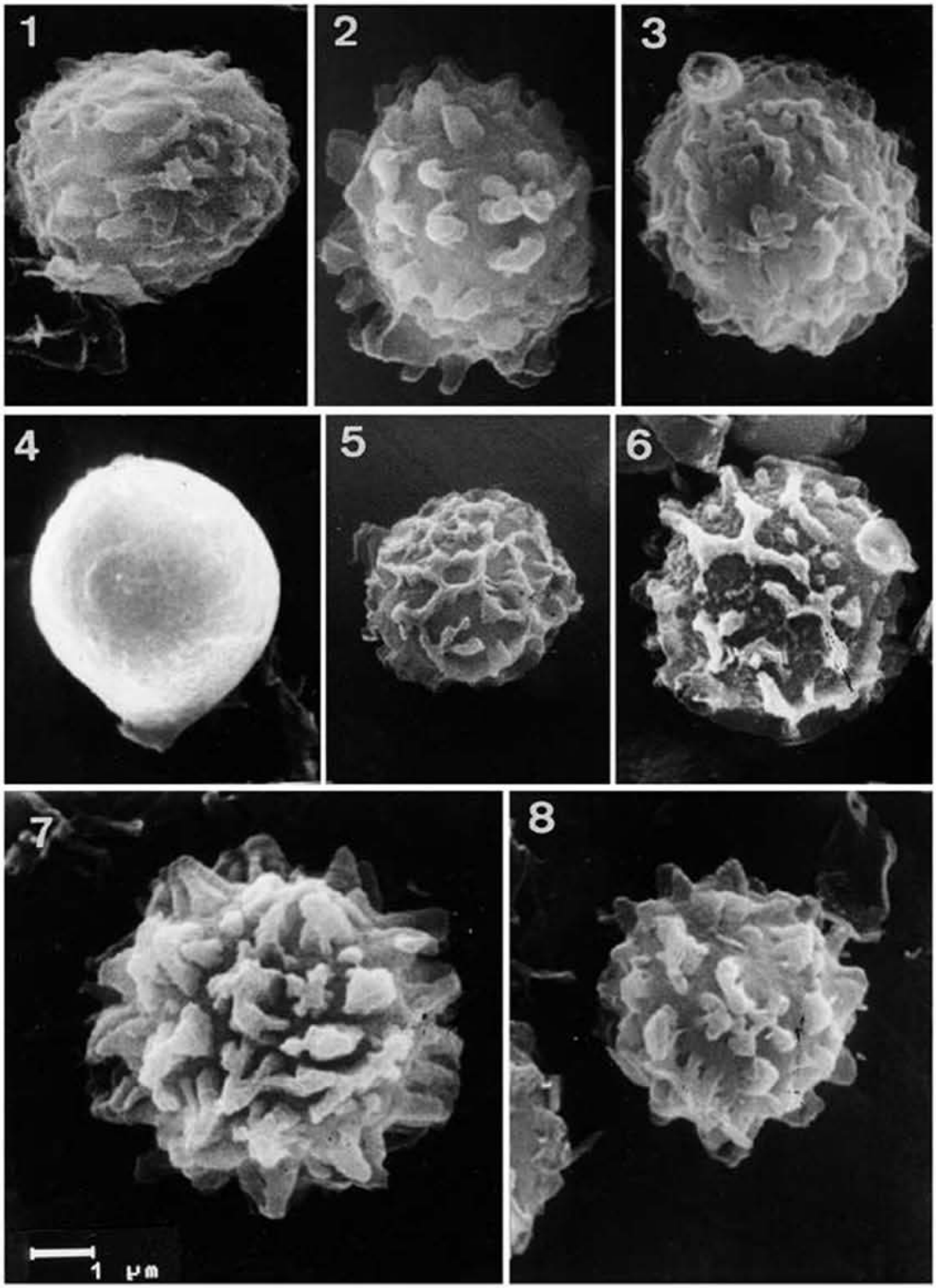

Fig. 1. *Tulostoma albicans* AH 31747. Fig. 2. *T. beccarianum* AH 31748. Fig. 3. *T. chudaei* AH 31749. Fig. 4. *T. cretaceum* AH 31750. Fig. 5. *T. cyclophorum* AH 31751. Fig. 6. *T. fimbriatum* AH 31753. Fig. 7. *T. floridanum* AH 31755. Fig. 8. *T. involucratum* AH 31756.

endoperidium. These structures were not certainly observed in our collections, probably because our specimens are overmature and weathered. However, the remaining features fit very well, and we do not know another described species with spores like these. Although this taxon has been infrequently collected, it is known from several American countries: USA, Brazil, Paraguay, Argentina and Uruguay (Wright 1987), and Europe: Spain (Moreno et al. 1990). This is the first record from Mexico, where it was found on sandy soil in microphyllous desert scrub.

Tulostoma fimbriatum Fr., *Systema Mycologicum* 3: 43. 1829.

(Fig. 6)

Material studied: Álamos municipality, Sierra de Álamos, Las Uvalamas ranch, M. Esqueda, E. Pérez-Silva, I. Buendía & V. Araujo, 12-IX-1994, CESUES 1779 (duplo in AH 31752). Bacoachi municipality, Km 146 Mazocahui to Cananea road, M. Esqueda & J. Jiménez, 27-III-1993, CESUES 1243 (duplo in AH 31753). Ibidem, M. Esqueda, 1-IV-1995, CESUES 1687. La Colorada municipality, Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2821. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2370. Ibidem, 17-III-1996, CESUES 2618. Ibidem, 29-IV-1996, CESUES 2700. Ibidem, 26-VIII-1998, CESUES 4366. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 25-VIII-1998, CESUES 4324. Yécora municipality, Km 258 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 26-XI-1995, CESUES 2312 (duplo in AH 31754). Ibidem, Km 3.2 Yécora to Sahuaripa road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 12-IX-1996, CESUES 3246. Puerto Peñasco municipality, Pinacate and Gran Desert Biosphere Reserve, Ojo de Agua, near to Sonoyta river, A. Sánchez, J. Miranda & I. Encinas, 6-XI-2003, CESUES 5049.

REMARKS: *Tulostoma fimbriatum* is recognized by its fimbriate stoma, hyphal exoperidium and spores with verrucose and subreticulate ornamentation. Within the genus *Tulostoma*, this is one of the most widely distributed species worldwide. In Sonora, it was commonly found in several types of vegetation: Microphyllous desert scrub, tropical thorn forest, tropical deciduous forest, oak woodland and *Quercus-Juniperus-Pinus* forest; solitary or gregarious, throughout the year.

Tulostoma floridanum Lloyd, *The Tylostomeae* p.18, 1906.

(Fig. 7)

Material studied: San Javier Municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, CESUES 3643 (duplo in AH 31755).

REMARKS: *Tulostoma floridanum* has slender basidiocarps, exoperidium hyphal to indistinct, dark reddish brown stem, stoma tubular and spores notably echinulate (LM); under SEM, show large and conical spines which are usually fused at the apex. This species is very similar to *T. squamosum* J.F.Gmel.: Pers. in most of its features, especially by its spore ornamentation under SEM. But *T. squamosum* has a membranous to verrucose exoperidium, leaving circular and whitish plates when it falls off. These plates are formed by hyphae and sphaerocysts (Moreno et al. 1992). The sphaerocysts are absent in the hyphal exoperidium of *T. floridanum*.

Its distribution is known with certainty from USA (Florida) and Cuba and doubtfully from Australia and Arizona (Wright 1987). We found this species near the last locality (Arizona), but on soil rich in organic matter in tropical deciduous forest. This is the first record from Mexico.

Tulostoma involucratum Long, *Mycologia* 36: 330. 1944.

(Fig. 8)

Material studied: La Colorada municipality, Fuente Clara ranch, A. Aparicio, 29-VI-1993, AH 31756 ex CESUES 1684. Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2802. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24-XI-1995, CESUES 2226. Ibidem, 16-II-1996, CESUES 2362. Soyopa municipality, Km 162 Hermosillo to Yécora road, E. Pérez-Silva, T. Herrera, A. Armenta, A. Núñez & R. Santos, 13-IX-1996, CESUES 2917.

REMARKS: *Tulostoma involucratum* is characterized by its membranous exoperidium, large tubular mouth and echinulate spores under LM and large compound verrucae under SEM. In the studied collections the spore ornamentation was less well developed than in the holotype. This species has been cited from USA, Argentina and South Africa (Long 1944; Wright 1987), where it grows on sandy soil in arid regions. This is the first record from Mexico (Sonora), where it was more frequently collected in the summer showing a gregarious habit, on sandy soils, throughout the year except spring, in microphyllous desert scrub and tropical thorn forest.

Tulostoma leiosporum R.E. Fr., *Ark. Bot.* 8: 28. 1909.

(Fig. 11)

= *T. operculatum* Long & S. Ahmad, *Farlowia* 3: 256. 1947.

= *T. puncticulosum* Long & S. Ahmad, *Farlowia* 3: 246. 1947.

= *T. exitum sensu* J.E.Wright, *The genus Tulostoma (Gasteromycetes). A world monograph*. 1987; *sensu* Moreno et al., *Mycologia* 87: 107. 1995; *non* Long & S.Ahmad, *Farlowia* 3: 254. 1947.

Material studied: Carbó municipality, La Granada ranch, J. Jiménez, 18-I-1994, CESUES 1601b. Hermosillo municipality, Centro Ecológico de Sonora, A. Aparicio, 8-VIII-1992, AH 31757 ex CESUES 1685. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2353. Ibidem, 11-IX-1996, CESUES 2811 (duplo in MEXU 24542). Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2816 (duplo in MEXU 24543). Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2371. Ibidem, 9-VI-1996, CESUES 2708. Ibidem, 11-IX-1996, CESUES 2836. Ibidem, 26-I-1999, CESUES 4790. Puerto Peñasco municipality, Pinacate and Grand Desert Biosphere Reserve, Km 75 Sonoyta to San Luis Río Colorado road, J. Miranda, M. Coronado, A. Sánchez & M. Esqueda, 26-IV-2004, CESUES 5145. Ibidem, Cerro Lava, M. Esqueda, M. Coronado, A. Sánchez, J. Miranda & I. Encinas, 26-IV-2004, CESUES 5247. Ibidem, Ejido El Norteño, 28-IV-2004, CESUES 5185. San Javier municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 18-II-1996, CESUES 2504. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A.

Armenta, A. Núñez & R. Santos, 13-IX-1996, CESUES 2910. Ibidem, 22-I-1998, CESUES 3700. Ibidem, 25-VIII-1998, CESUES 4330.

REMARKS: *Tulostoma leiosporum* is characterized by its fibrillose-fimbriate to indefinite stoma, granulose exoperidium, sometimes being slightly membranous, and spores appearing smooth under LM and subsmooth (rugose) under SEM. *Tulostoma leiosporum*, *T. operculatum* and *T. puncticulosum* were synonymized by Moreno et al. (1997). It was previously cited in the Mexican mycobiota under the name *T. exitum* from Baja California (Moreno et al. 1995). This is the first record from Sonora, where it was most commonly collected in summer and winter in microphyllous desert scrub and tropical thorn forest.

Tulostoma macrosporum G.Cunn., *Proc. Linn. Soc. New South Walles* 50: 252. 1925.

(Fig. 9)

Material studied: Hermosillo municipality, Costa de Hermosillo, Calle 36N, G. Yanes, 5-II-1994, CESUES 1599. La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 14-X-1995, CESUES 2169. Ibidem, 29-IV-1996, CESUES 2706. Ibidem, 11-IX-1996, CESUES 2790. Ibidem, 2-VII-1997, CESUES 3307. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2833. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, AH 31758 ex CESUES 3695.

REMARKS: *Tulostoma macrosporum* is recognized by its shortly tubular mouth, thinly membranous exoperidium, and mainly because of its spore size (8-12 μm diam). The most of collections collected in Sonora has a spore ornamentation seemly not very well developed, consisting in irregular membranous crests and some verrucae. Perhaps, this was caused by the maturing conditions.

It is known only in America from USA (California) (doubtful following Wright 1987) and Mexico (Baja California) (Guzmán et al. 1992). This is the first record from Sonora, where it was found on sandy soils in microphyllous desert scrub and tropical thorn forest. According to Altés & Moreno (1999), the other species of *Tulostoma* with large spores (*T. meridionale* J.E.Wright = *T. utahense* J.E.Wright) can be maintained as an autonomous taxon. *Tulostoma meridionale* shows smaller spores (6.5-9 μm diam.) with a more pronounced ornamentation. This species is also included in the Mexican catalogue of *Tulostoma* (Wright 1987; Moreno et al. 1995).

Tulostoma melanocyclum Bres. *in* Petri, *Ann. Mycol.* 2: 415. 1904.

(Fig. 10)

Material studied: Cananea municipality, Sierra de Cananea, M. Esqueda, 1-IV-1995, CESUES 1688. Yécora municipality, Km 4.8 Yécora to Sahuaripa way, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 12-IX-1996, CESUES 3244 (duplo in AH 31760).

REMARKS: *Tulostoma melanocyclum* is mainly recognized by the similar macroscopical features with *T. brumale* Pers.: Pers., but with a hyphal exoperidium

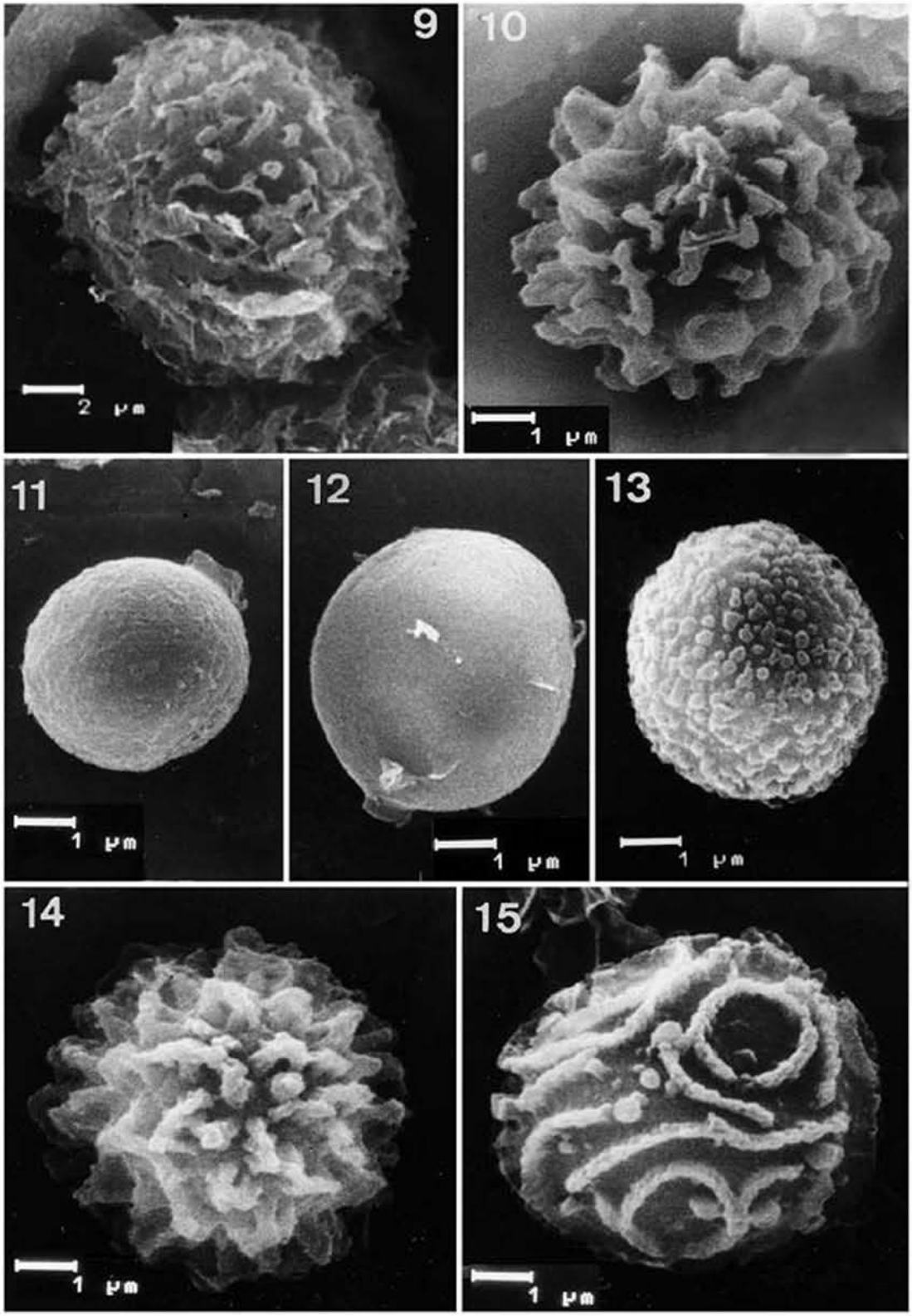

Fig. 9. *Tulostoma macrosporum* AH 31758. Fig. 10. *T. melanocyclum* CESUES 1688. Fig. 11. *T. leiosporum* AH 31757. Fig. 12. *T. obesum* AH 31762. Fig. 13. *T. pulchellum* AH 31763. Fig. 14. *T. squamosum* AH 31765. Fig. 15. *T. striatum* AH 31764.

and different microscopic characteristics: capillitium scarcely swollen at the uncoloured septa, and spores echinulate under LM and with large spines fused at the apex under SEM (similar to the spore ornamentation of *T. squamosum*). This species is little known in the Mexican mycobiota, being previously cited only from San Luis Potosí and Estado de México (Guzmán & Herrera 1969; Wright 1987). This is the first record from Sonora, found mainly in temperate zones.

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

(Fig. 12)

= *T. volvulatum var. obesum* (Cooke & Ellis) J.E.Wright, *The genus Tulostoma (Gasteromycetes). A world monograph*. p.212. 1987.

= *T. kansense* Peck *in* V.S.White, *Bull. Torrey Bot. Club* 28: 430. 1901.

= *T. volvulatum* var. *elatum* Har. & Pat., *Bull. Trimestriel Soc. Mycol. France* 26: 207. 1910.

= *T. volvulatum sensu* Hollós, *Die Gasteromycetes Ungarns*. 1904; *non* I.G.Borshch., *Materialy dla botanicheskoy geografii Aralo-Kaspiyskogo kraya. In Zapisky Imperatorskoy Akademii Nauk*, Suppl. vol. 7, p.189. 1865.

Material studied: Hermosillo municipality, Costa de Hermosillo, La Granada ranch, G. Yanes & J. Jiménez, 3-VIII-1994, CESUES 1612. Ibidem, Ejido 15 de Mayo, A. Sánchez, A. Armenta & M. Coronado, 15-VIII-1998, CESUES 4410. San Luis Río Colorado municipality, San Luis Río Colorado city, E. Santamaría, 19-V-1992, AH 31762 ex CESUES 910.

REMARKS: *Tulostoma obesum* is recognized by its mouth at first being more or less circular, rapidly becoming indefinite, membranous exoperidium, brown gleba, spores appearing smooth both under LM and SEM, and coloured capillitium with few and short branches, without a complete septa (Altés et al. 1999). This species has been cited in Mexico only from Baja California (Ochoa & Moreno 1996).

Tulostoma pulchellum Sacc., *Bull. Soc. Mycol. France* 5: 118. 1889.

(Fig. 13)

Material studied: La Colorada municipality, Km 31 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, AH 31763 ex CESUES 2796. Km 40 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11-IX-1996, CESUES 2828.

REMARKS: *Tulostoma pulchellum* is recognized by its clearly membranous exoperidium, fimbriate and scutellate stoma, spores appearing almost smooth under LM, and with small and densely crowded verrucae under SEM. Its American distribution includes USA, Mexico and Argentina (Ayala et al. 1985; Wright 1987; Guzmán et al. 1992; Moreno et al. 1995). Although Guzmán & Herrera (1969) mentioned that *T. pulchellum* was known from Sonora, they established neither locality nor collection.

Tulostoma squamosum J.F. Gmel.: Pers., *Synopsis Fungorum* p.139. 1801.

(Fig. 15)

= *T. verrucosum* Morgan, *J. Cincinnati Soc. Nat. Hist.* 12: 164. 1890.
= *T. mussooriense* Henn., *Hedwigia* 40: 337. 1901.

Material studied: Álamos municipality, 7.3 km Álamos to Cuchujaqui river, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 13-VI-1998, CESUES 4124 (duplo in AH 31765). San Javier municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, CESUES 3651 (duplo in AH 31766).

REMARKS: *Tulostoma squamosum* is characterized by its thinly membranous exoperidium, sometimes verrucose, stoma tubular, scaly dark brown stem, exoperidium formed by hyphae and groups of sphaerocysts, and echinulate spores, which under SEM is seen to be formed by spines which are usually fused at the apex, sometimes subreticulate (Moreno et al. 1992). Our collections have stems with fewer scales than are typical for this species but the remaining features fit well. Although this taxon has been infrequently collected, it is distributed worldwide. This is the first record from Mexico. In Sonora, it was found on soil rich in organic matter in tropical deciduous forest.

Tulostoma striatum G.Cunn., *Proc. Linn. Soc. New South Wales* 50: 255. 1925.

(Fig. 14)

Material studied: Hermosillo municipality, Centro Ecológico de Sonora, J.M. Villegas, 21-X-1993, CESUES 1586. Ibidem, Las Dunas, near to Puerto Libertad town, A. Sánchez, A. Armenta & M. Esqueda, 23-I-1998, CESUES 3748. La Colorada municipality, Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2361 (duplo in AH 31764).

REMARKS: This species is distinguished by the usually robust spore sac, a rather short stem, a clearly membranous exoperidium, fibrillose-fimbriate stoma, and spores with striate ornamentation and small verrucae among the crests. It is interesting to point out that in the basidiocarps collected in Sonora, the spore ornamentation is striate but unusually verrucose as well. This character is intermediate between typical *T. striatum* and *T. pulchellum var. subfuscum* (V.S.White) J.E.Wright, G.Moreno & Altés.

The presence of *T. striatum* is known in several continents (Wright 1987; Altés & Moreno 1991). In Mexico, this species has been previously cited from Sonora (Wright et al. 1972; Esqueda et al. 1995). The material studied was found in autumn and winter in microphyllous desert scrub and tropical thorn forest.

Tulostoma submembranaceum G.Moreno, Ochoa & J.E.Wright, *Mycologia* 87: 117-119. 1995.

(Fig. 16)

= *T. exitum* Long & S.Ahmad, *Farlowia* 3: 254. 1947. (*nomen rejiciendum*)

Material studied: Hermosillo municipality, Las Palomas ranch, A. Aparicio, 15-II-1992, AH 31767 ex CESUES 1682. San Javier municipality, Km 137 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez, A. Sánchez & R. Santos, 22-I-1998, CESUES 3642.

REMARKS: *Tulostoma submembranaceum* is recognized by its small basidiocarps, fibrillose-fimbriate to indefinite stoma, the very thinly membranous (submembranous) nature of the exoperidium at the base of the spore sac, and minutely verrucose spores. It was described as new species with Mexican material (Baja California) by Moreno et al. (1995). This is the first record from Sonora, where was collected on sandy soil in winter in microphyllous desert scrub and tropical deciduous forest. After *T. submembranaceum* and *T. exitum* had been synonymized, the area of distribution of this species included Argentina and Pakistan (Moreno et al. 1997).

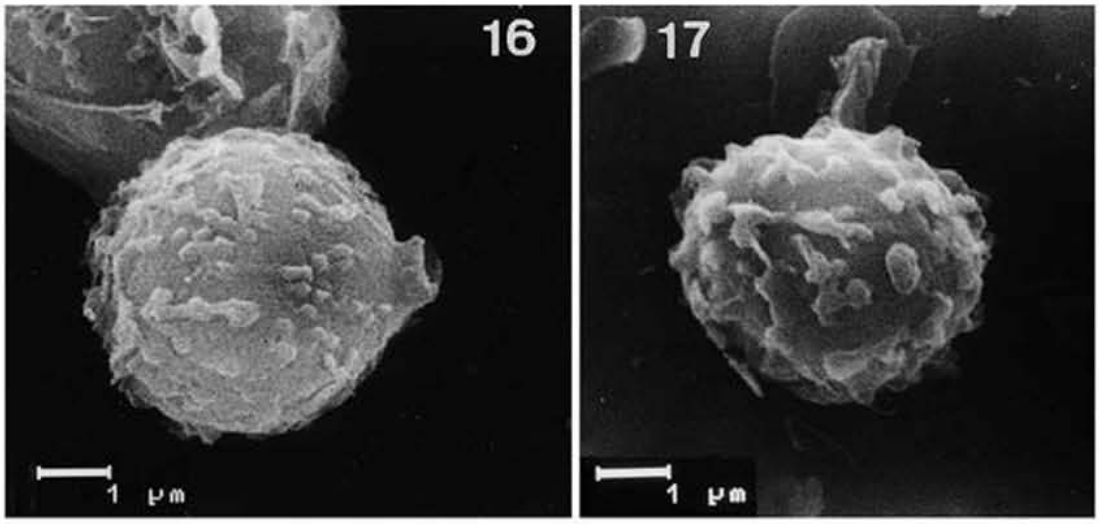

Fig. 16. *Tulostoma submembranaceum* AH 31767. Fig. 17. *T. xerophilum* AH 31768.

Tulostoma xerophilum Long, *Mycologia* 38: 85-87. 1946.

(Fig. 17)

Material studied: Álamos municipality, 7.3 km Álamos to Cuchujaqui river way, A. Sánchez, M. Coronado, A. Armenta, 15-II-1998 CESUES 3903. Baviácora municipality, Mazocahui, M. Esqueda & J. Jiménez, 26-III-1993, CESUES 1213a. La Colorada municipality, Km 31 Hermosillo to Yécora, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 17-III-1996, CESUES 2626. Km 100 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 16-II-1996, CESUES 2369. Ibidem, 17-III-1996, CESUES 2619. Ibidem, 26-VIII-1998, CESUES 4367. Ibidem, 26-I-1999, CESUES 4788. Pitiquito municipality, La Inmaculada ranch, M. Esqueda & M. Amaya, 15-II-1992, CESUES 906 (duplo in AH 31768). San Javier municipality, Km 137.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 26-VIII-1998, CESUES 4287. Km 151 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 22-I-1998, CESUES 3690. Soyopa municipality, Km 162.5 Hermosillo to Yécora road, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 19-IV-1996, CESUES 2644. Ibidem, 22-I-1998, CESUES 3697.

REMARKS: *Tulostoma xerophilum* is characterized by its typically membranous exoperidium, tubular mouth and spores appearing asperulate under LM and with scattered scant verrucae under SEM. It was commented on above, under *T. albicans*, whereby features of *T. xerophilum* are insufficient to establish a clear difference between the two species. For the moment, we are maintaining our collections under the name *T. xerophilum*, because of its slightly slender basidiocarps and spores being somewhat smaller than *T. albicans*. This taxon is known from North America: USA (Arizona, California and Texas), Mexico (Sonora) (Long 1946; Wright 1987), and Spain (Calonge & Martín 1992). This is the second record from Sonora, where it was mainly observed in microphyllous desert scrub during winter with a solitary habit.

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Two new species of *Phanerochaete* from Taiwan

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Abstract—*Phanerochaete brunneocystidiata* and *P. lamprocystidiata*, both of which have lamprocystidia, are reported as new species from tropical and subtropical Taiwan. Descriptions, line drawings, and cultural studies are provided for both species.

Key words—*Aphyllophorales*, Basidiomycota, taxonomy, wood-decaying fungi

Introduction

The genus *Phanerochaete* P. Karst. is a member of the resupinate homo-basidiomycetes, representing the largest genus of the corticioid fungi, with about one hundred species known from around the world (Burdsall 1985, Parmasto 1997, Hjortstam 1997). Taiwan possesses an extremely high number of *Phanerochaete*, with 38 reported from the island (Lin & Chen 1990; Wu 1990, 1995, 1997, 1998, 2000, 2003; Maekawa 1992). This study adds a further two new species of *Phanerochaete* to the Taiwanese total.

Materials and Methods

Free-hand thin sections of basidiocarps were prepared for microscopic studies. For observations and measurements of microscopic characters, 5% KOH was used as a mounting medium to ensure rehydration. Melzer's reagent (IKI) was employed to detect amyloidity and dextrinoidity. Cotton blue (CB) was used as a mounting medium to determine cyanophily. Cultural descriptions and species code diagnoses are from Nobles (1965) with amendments by Boidin and Lanquetin (1983, 1984). Nobles' code as detailed by Nakasone (1990) is adopted in this study. General methods of cultural studies have been previously described by Wu (1996). All studied specimens, as well as fungal cultures, are deposited at the herbarium of the National Museum of Natural Science of ROC (TNM). Isotypes of the two new species are to be distributed to K.

Taxonomy

Phanerochaete brunneocystidiata Sheng H. Wu, sp. nov. (Figs 1-4)

Basidiocarpus effusus, submembranaceo-pelliculus, 80-200 µm crassus; superficies hymenialis plana. Systema hypharum monomiticum; hyphae efibulatae. Lamprocystidia

subulata, brunnea. Basidia clavata, 20-30 x 5.5-6 μm., 4 sterigmatibus. Basidiosporae anguste ellipsoideae, laeves, tenuitunicatae, 5.5-7.5 x 2.7-3.3 μm, IKI-, CB-.

Etymology. From *brunneus* (= brown) + *cystidiata*, referring to the distinct cystidia in this species.

Basidiocarp resupinate, effuse, submembranaceous-pellicular, 80-200 μm thick in section. Hymenial surface pale brownish gray or clay-coloured, smooth, cracked when old; margin thinning, paler, pruinose-filamentose. Hyphal system monomitic; hyphae simple-septate. Subiculum up to ca. 150 μm thick, with fairly loose texture; hyphae variously oriented, colourless, 2.5-4 μm diam., with 0.4-0.8 μm thick walls. Hymenium can be thickening; hyphae colourless, 2-3 μm diam., thin-walled. Lamprocystidia immersed or emergent, arising from subiculum or hymenium, terminal or pleural, subulate, brownish, 25-80 x 5-8 μm (with encrustation), with 0.8-1.8 μm thick walls, those from subiculum usually with elongated, tubular basal parts. Basidia clavate, 20-30 x 5.5-6 μm, 4-sterigmate. Basidiospores narrowly ellipsoid, smooth, thin-walled, 5.5-7.5 x 2.7-3.3 μm, IKI-, CB-.

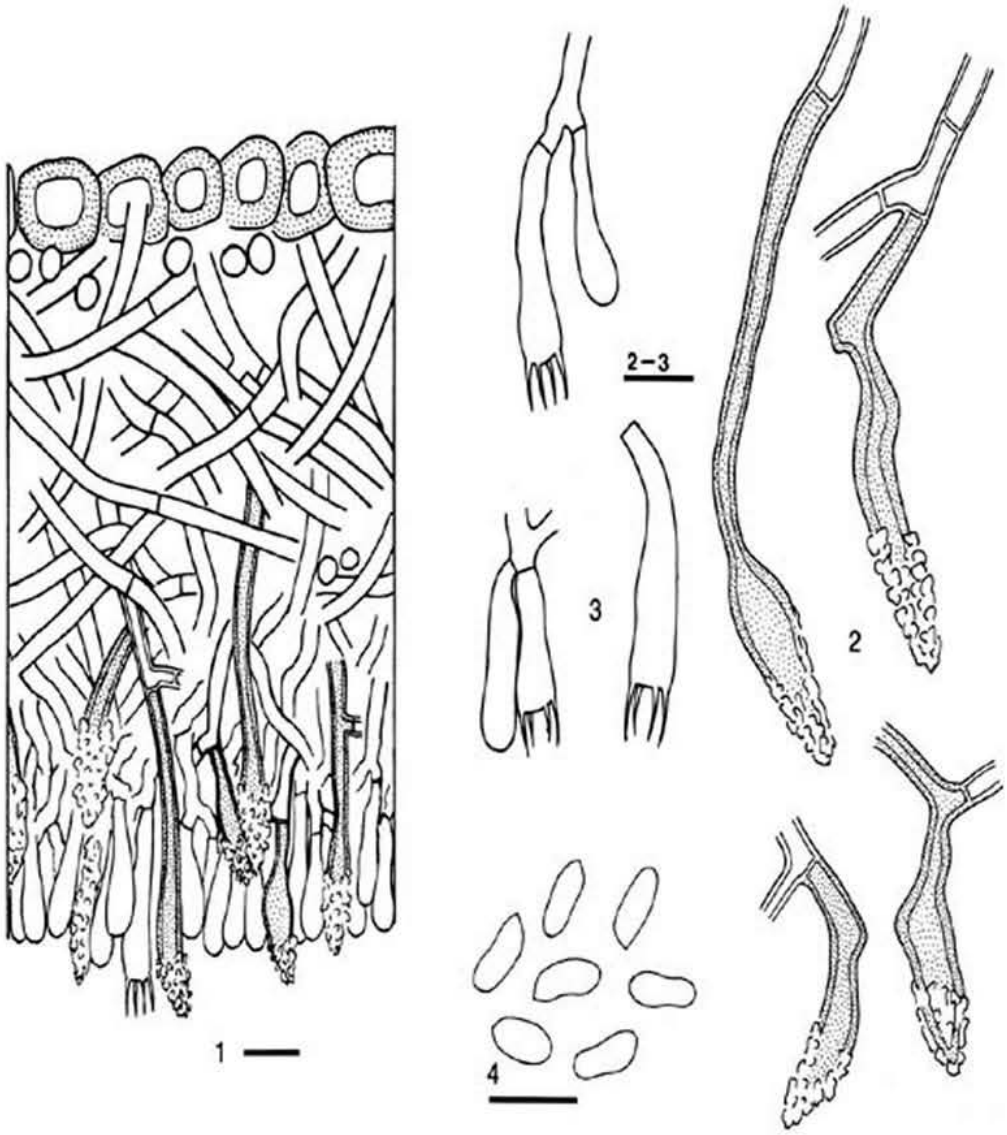
Distribution. **Taiwan.**

Holotype. Taiwan: Taitung: Lanyu, Hungtoushan, alt. 500 m, on branch of *Freycinetia formosana, leg. S.Z. Chen*, 24 Apr 1997, *Chen 666* (TNM F8832; isotype: K).

Additional specimens examined. Taiwan: Taitung: Lanyu, Hungtoushan, alt. 350 m, on branch of *Freycinetia formosana, leg. S.Z. Chen*, 23 Apr 1997, *Chen 646* (TNM F8847). Lanyu, on the way to Tienchih, alt. 100 m, on branch of *Freycinetia formosana, leg. S.H. Wu & J.Y. Tseng*, 1 May 1997, *Wu 9705-37* (TNM F8760); alt. 280 m, on branch of *Fteycinetia formosana, leg. S.H. Wu & J.Y. Tseng, Wu 9805-14* (TNM F10012), alt. 200 m, *Wu 9805-23* (TNM F10021); alt. 200 m, on branch of *Freycinetia formosana, leg. S.Z. Chen*, 24 Oct 1999, *Chen 939* (TNM F10587); alt. 300 m, on branch of *Freycinetia formosana, leg. S.Z. Chen*, 26 Aug 2002, *Chen 1165* (TNM F14782); alt. 350 m, on branch of *Freycinetia formosana, leg. S.Z. Chen*, 26 Aug 2002, *Chen 1143* (TNM F14774), 16 May 2003, *Chen 1274* (TNM F15127). Lanyu, Hsiaotienchih, alt. 150 m, on branch of *Pandanus odoratissimus, leg. S.Z. Chen*, 17 July 2000, *Chen 1078* (TNM F12031),

Cultural description (combined from polysporous mycelia of *Chen 666* and *Chen 1143*). 1 wk growth: Colony radius 52-74 mm. Mat white. Advancing zone uneven. Aerial mycelium pellicular around inoculum, downy elsewhere, plumose in the advancing zone. Advancing hyphae colourless, 2.5-8.5 μm diam., thin-walled, simple-septate. 2 wk growth: Plates covered. Mat white. Aerial mycelium pellicular. 6 wk growth: Plates covered. Mat white, no change in KOH. Aerial mycelium pellicular, occasionally slightly crustose, plumose towards the plate margin. No distinct odor. Not fruiting. Agar bleached. Hyphal system monomitic; aerial hyphae colourless, sparsely or moderately branched, 2-4 μm diam., generally thin-walled, occasionally slightly thick-walled, simple-septate, covered with oily secretion; submerged hyphae colourless, sparsely or moderately branched, 2.5-8 μm diam., mostly thin-walled, rarely slightly thick-walled, simple-septate, rarely with single, double, or multiple clamp connections. Crystals present.

Oxidase reactions. TAA: – or +, tr; – or +, tr. GAA: ++ to ++++, 13-53; ++ to ++++, 20-90+. TyA: –, 55-75; –, 90+.



Figs 1-4. *Phanerochaete brunneocystidiata* (holotype). Fig. 1. Section through basidiocarp. Fig. 2. Lamprocystidia. Fig. 3. Basidia. Fig. 4. Basidiospores. Scale bars = 10 μm.

Species code. (2a). 5. 7. 32. 36. 40. 42. 54.

Remarks. *Phanerochaete brunneocystidiata* resembles *P. crassa* (Lév.) Burds. in having brown lamprocystidia with elongated, tubular basal parts, and having similar-sized basidiospores. *Phanerochaete crassa* grows on hardwood, having resupinate basidiocarps with reflexed margin. *Phanerochaete brunneocystidiata* differs from *P. crassa* by growing on *Pandanaceae* (so far known from *Freycinetia* and *Pandanus*), having absolutely resupinate basidiocarps, and bearing shorter cystidia. This new species is known only from Lanyu (also known as Orchid Island or Botel Tobago), a 46 km^2 tropical island located to the south-east of the main island of Taiwan.

Phanerochaete lamprocystidiata Sheng H. Wu, sp. nov. (Figs 6-10)

Basidiocarpus effusus, ceraceus, 80-280 μm crassus; superficies hymenialis plana. Systema hypharum monomiticum; hyphae efibulatae. Lamprocystidia subulata. Basidia anguste clavata, 30-50 x 5.3-6.3 μm, 4 sterigmatibus. Basidiosporae late ellipsoideae, laeves, tenuitunicatae, (5-) 5.5-7.5 (-8) x 3.8-4.8 μm, IKI-, CB-.

Etymology. Lamprocystidiata, referring to the presence of lamprocystidia in the species.

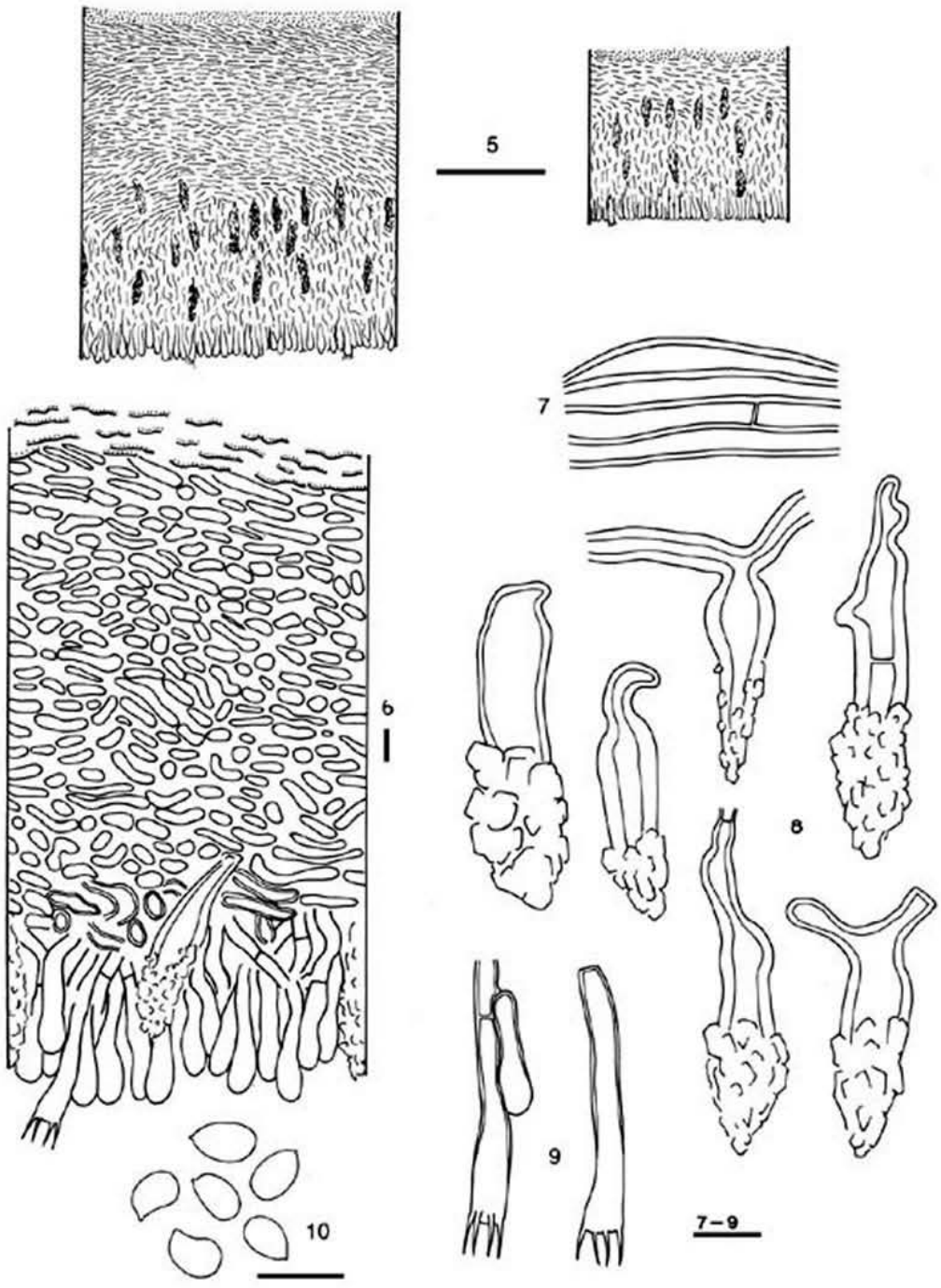
Basidiocarp resupinate, at first forming orbicular patches, then becoming effuse, ceraceous, corneous when dried, 80-280 μm thick in section. Hymenial surface white, grayish white, yellowish white or grayish yellow, smooth, cracked when old; margin fairly determinate, concolorous, usually separable or rolled off from substratum when old. Hyphal system monomitic; hyphae simple-septate. Subiculum with compact texture, composed of a thick and distinct basal layer, up to ca. 150 μm thick; hyphae horizontal, colourless, glued together and almost inseparable, 3-5 μm diam., with 0.5-1μm thick walls. Hymenium occasionally thickening; hyphae colourless, 2-4 μm diam., thin-walled. Lamprocystidia mostly immersed, arising from basal layer close to hymenium, or from hymenial layer, terminal or pleural, subulate, colourless, 30-70 x 10-18 μm (with encrustation), with 1-3 μm thick walls. Basidia narrowly clavate, 30-50 x 5.3-6.3 μm, 4-sterigmate. Basidiospores broadly ellipsoid, smooth, thin-walled, (5-) 5.5-7.5 (-8) x 3.8-4.8 μm, IKI-, CB-.

Distribution. Taiwan.

Holotype. Taiwan. Miaoli: Tahu, Shuiliutung, alt. 250 m, on branch of angiosperm, *leg. S.Z. Chen*, 13 Nov 2000, *Chen 1018* (TNM F12069; isotype: K).

Additional specimens examined. Taiwan. Taipei: Yangminshan, alt. 400 m, on branch of angiosperm, *leg. S.H. Wu*, 24 Jul 1991, *Wu 910724-10* (TNM F252), *910724-14* (TNM F51), *910724-16* (TNM F52), *910724-21* (TNM F253), *910724-24* (TNM F254), *910724-30* (TNM F255) (on branch of *Prunus campanulata*); Kungliao, alt. 200 m, on branch of angiosperm, 25 Jul 1991, *Wu 910725-8* (TNM F258). National Taiwan University, on branch of *Melaleuca leucadendron*, *leg. S.H. Wu*, 17 Oct 1999, *Wu 9910-1* (TNM F10439); on branch of *Koelreuteria henryi*, *leg. S.H. Wu*, 23 Dec 2001, *Wu 0112-41* (TNM F13842). Ilan: Fushan Nature Reserve, alt. 600 m, on branch of angiosperm, *leg. S.H. Wu*, 7 Aug 1991, *Wu 910807-33* (TNM F134). Taichung: Takeng, on branch of angiosperm, *leg. S.Z. Chen*, 7 Nov 1993, *Wu 9311-2* (TNM F1409); Tunghai University, alt. 150 m, on branch of angiosperm, *leg. R.L. Wang & Y.W. Pan*, 21 Aug 1994, *Wu 9408-37* (TNM F2466). Nantou: Lienhuachih, alt. 700 m, on branch of angiosperm, *leg. S.H. Wu*, 25 Oct 1988, *Wu 881025-41* (TNM F14927); *leg. S.Z. Chen*, 19 Oct 1995, *Chen 369* (TNM F4239). Pingtung: Chufengshan, alt. 300 m, on branch of angiosperm, *leg. S.Z. Chen*, 24 May 1998, *Chen 811* (TNM F9889). Hualien: Tailuko, Shenmiku Hiking Trail, on branch of angiosperm, *leg. S.H. Wu et al.*, 10 Sep 2001, *Wu 0109-14* (TNM F13759).

Cultural description (combined from polysporous mycelia of *Chen 1018* and *Wu 881025-41*). 1 wk growth: Colony radius 46-58 mm. Mat white. Advancing zone even. Aerial mycelium downy to cottony. Advancing hyphae colourless, 2.5-6.5 μm diam., thin-walled, simple-septate. 2 wk growth: Plates covered. Mat white. Aerial mycelium pellicular around inoculum, downy to cottony elsewhere. 6 wk growth: Mat white, not change in KOH. Aerial mycelium slightly pellicular. No distinct odor. Not fruiting.



Figs 5-10. *Phanerochaete lamprocystidiata* (Fig. 5: *Wu 9408-37*, Figs. 6-10: holotype). Figs. 5-6. Section through basidiocarp. Fig. 7. Basal hyphae. Fig. 8. Lamprocystidia. Fig. 9. Basidia. Fig. 10. Basidiospores.

Scale bars = 100 μm for Fig. 5; = 10 μm for Figs. 6-10.

Agar bleached. Hyphal system monomitic; hyphae colourless, moderately branched, 2-6.5 μm diam., thin-walled, mostly simple-septate, rarely with single, double, or multiple clamp connections. Crystals present.

Oxidase reactions. TAA: +++, 30-40; +++, 55-70. GAA: ++ or +++, 40-52; ++++. TyA: –, 53-60; –, 90+.

Species code. (2a). 5. 7. 32. 36. 40. 42. 54.

Remarks. *Phanerochaete lamprocystidiata* is characterized by having white to cream basidiocarps, which have a fairly tough consistency. Microscopically, it has a distinct basal layer of compact texture, and bears distinct lamprocystidia. This species is fairly common in subtropical and tropical Taiwan, growing on dead angiosperm wood. Although fairly common in Taiwan, basidiocarps of this species were quite often found without bearing spores. Specimens without spores were not included in this study, and were also not preserved in TNM. *Phanerochaete lamprocystidiata* resembles *P. flavidoalba* (Cooke) S.S. Rattan in the dense texture of its basidiocarps, in having lamprocystidia and in its similar-sized basidiospores. *Phanerochaete lamprocystidiata* generally has whitish hymenial surface, while that of *P. flavidoalba* is yellow-buff. *Phanerochaete lamprocystidiata* has a distinct and thick basal layer, while that of *P. flavidoalba* is thin and sometimes indistinct.

Acknowledgements

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MYCOTAXON

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Phytophthora cyperi on *Digitaria ciliaris* in Hainan Province of China

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Abstract—*Phytophthora cyperi* was discovered in Hainan, China for the first time on *Digitaria ciliaris* (Family *Poaceae*). This is also the first world record of the fungus on a plant species other than *Cyperus*. The controversial nomenclature of the fungal species is discussed.

Key words—*Peronospora cyperi, Kawakamia cyperi, Cyperaceae,* oomycete

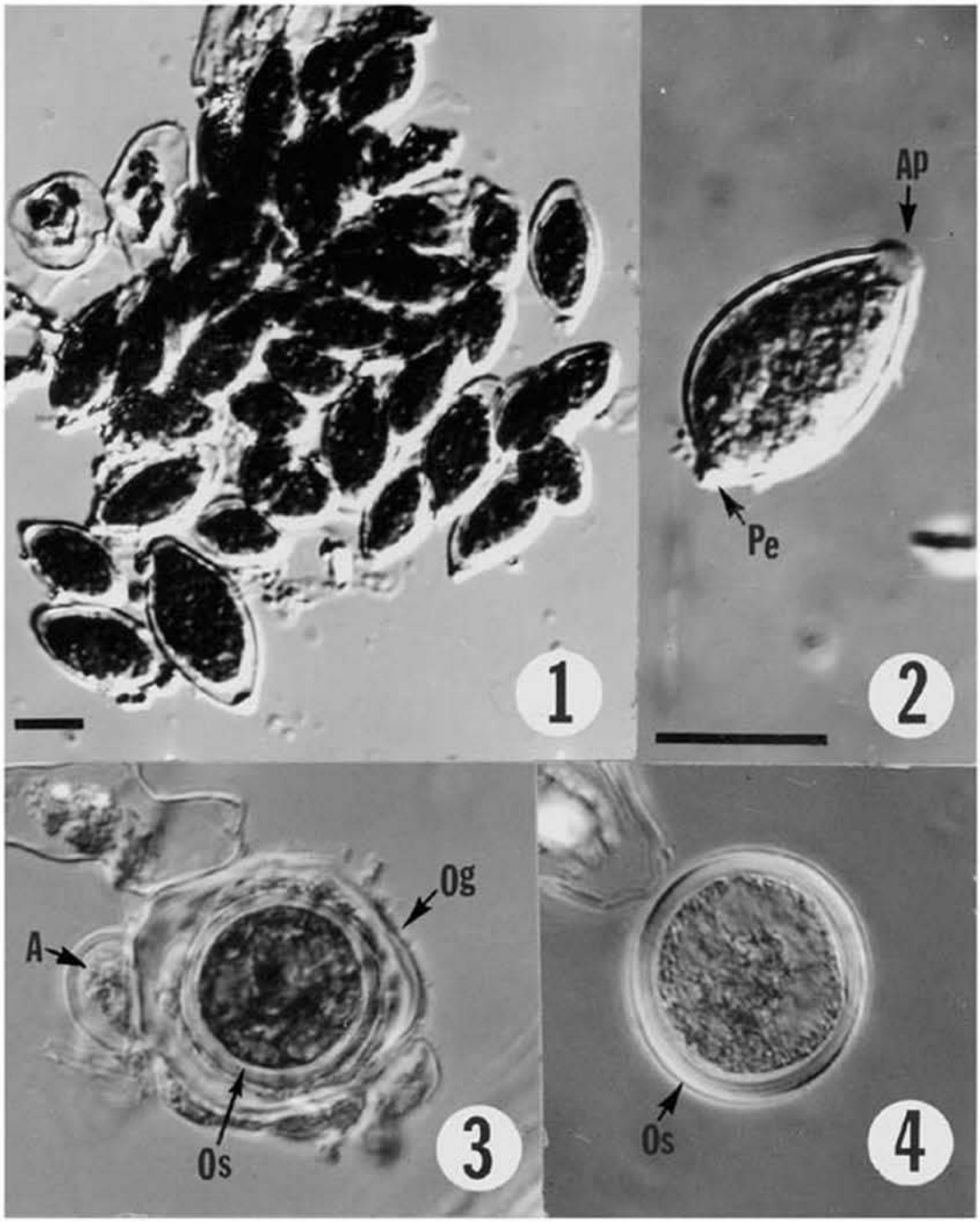
Phytophthora cyperi (Ideta) Ito is a rather uncommon species within the genus *Phytophthora* de Bary. It is parasitic only on species of *Cyperus* (Family *Cyperaceae*), causing brown spots in the stems, leaves and peduncles as well as blight, but its nomenclature is confusing. It was first reported as *Peronospora cyperi* (Ideta 1903, cited in Waterhouse 1956) as the causal agent for red disease or tortoise-shell on shichito mat grass, *C. malaccensis* Lam. in Japan. Miyabe (1903) erected the genus *Kawakamia* and named the fungus on the sedge, *C. tegetiformis* Roxb. as *K. cyperi* (Miyabe & Ideta) Miyabe, synonymous with *Peronospora(?) cyperi* Miyata & Ideta. He considered the genus "nearly allied to *Phytophthora*, from which it differs by the presence of a pedicel-cell and a peculiar tail-like appendage to its conidium, and also by the shape of the conidia and conidiophores." Later, the pathogen was also found on *C. malaccensis* and *C. tegetiformis* in various parts of Taiwan (Kawakamia and Suzuki 1908, Sawada 1915, 1919). In the United States, the fungus was found in Texas and South Carolina in test plots of *C. tegetiformis* imported from Japan (Patterson and Charles 1910) causing downy mildew (anonymous 1960). Wilson (1914) re-examined the diseased specimens from Texas and confirmed its identity. He further noted that "the conidia present a striking likeness in outline to those of *Phytophthora*, but the pedicel is more conspicuous than in any species of this last genus". Based on the drawings of Sawada (1919), Fitzpatrick (1930) concluded "there is no basis for separating it from *Phytophthora*." Ito and Tokunaga (1935) gave it the corrected name: *Phytophthora*

cyperi. Waterhouse (1956) placed *Kawakamia* in synonym with *Phytophthora*, a view shared by most *Phytophthora* researchers (Erwin and Ribeiro 1996). On the other hand, Farr et al. (1989) noted that " the identity of this species is obscure" and recorded the pathogen on *Cyperus* in Texas as *Peronospora cyperi*. However, there is little justification to retain the name *Peronospora*. The conidia of *Peronospora* are non-poroid with uniform wall, germinating only by germ tubes whereas the sporangium of *Phytophthora* has a distinct apex the thickening of which varies with the species (Waterhouse 1973).

Sawada (1927, 1931) also described two similar species on the leaves of *C. rotundati* L. and *C. iriae* L. in Taiwan, respectively as *P. cyperi-rotundati* Sawada and *P. cyperi-iriae* Sawada based primarily on the antheridia, which are predominantly paragynous in the former and paragynous or amphigynous in the latter. Waterhouse (1963) determined that all three species are very similar and she broadened the species concept of *P. cyperi* to include *P. cyperi-rotundati* and *P. cyperi-iriae*. It is characterized by its inability to grow on artificial media, its host specificity on *Cyperus*, the production of caducous, ovoid-ellipsoidal sporangia 52 x 30 μm (L/B ratio 1.7), with flattened apex and shallow apical thickening as well as short occluded pedicel (under 4μm long), spherical smooth oogonia (42 μm diam), oospore almost filling the oogonium (wall 3 μm thick) and predominantly paragynous antheridia (20 x 10 μm). Ho and Chang (1992) re-examined Sawada's original specimens and came to the same conclusion. The "peculiar tail-like appendage of the conidia" as described by Miyabe (1903) was not found. The senior author studied Kawakami's specimen of *K. cyperi* on *C. tegiformis* (BPI 761963) available from the US National Fungus Collection and could not find the "tail-like appendage" but every caducous sporangium bears a short pedicel . It is quite possible that the "peculiar tail-like appendage of the conidia" is the same as the pedicel of the sporangia. In his original description, Miyabe (1903) stated that "cross partition between the conidium and pedicel-cell thickens conspicuously, and remains attached, to a fallen conidium forming a peculiar short tail".

In distribution, *P. cyperi* is limited primarily to Japan, Taiwan and two southern states of America although it was also found in India (Sahaya 1936, Seethalakshmi 1953) causing respectively, leaf blight of *C. tegetiformis* (reported as *K. cyperi*) and *C. rotundus* (reported as *P. cyperi rotundati*). Apparently, there has been no new record of the fungus since the early reports until Tai and Zhang (1990) found it on *C. malaccensis* var. *brevifolius* in Guanxi Province of mainland China.

In June 1998, we found a patch of *Digitaria ciliaris* (Retz) Koeler (Family *Poaceae*) with brown leaf spots and blight of the leaf tips, located in front of the plant pathology laboratory on the campus ground of the Chinese Academy of Tropical Agricultural Sciences. On close examination, we found clusters of deciduous oval semi-papillate sporangia (31x18 μm, L/B ratio 1.8), with apical thickening under 3 μm thick and occluded short pedicel, less than 5 μm long (Figs. 1, 2) produced on sporangiophores through stomata. The hyphae are non-septate, colorless, irregular and knobby growing between host cells. Sex organs (Figs. 3, 4) were found in the intercellular spaces within the leaf tissues. The smooth oogonia (42 μm diam) are brownish, smooth with spherical oospore (31μm diam), oospore wall 2 μm thick and antheridia are paragynous.



Figs. 1-4. *Phytophthora cyperi*. (1) Cluster of sporangia (2) Semi-papillate sporangium with apical thickening (Ap) and short pedicel (Pe) (3) Oogonium (Og) with oospore (Os) and antheridium (A) (4) Oospore (Os) free from oogonium. Scale bar = 10 μm (Fig.1) and 20 μm (Figs. 2-4)

The measurements of the reproductive structures compared well with those reported by Ho *et al* (1995) based on a study of Sawada's original specimens: sporangia 39 x 23 µm (L/B ratio 1.7), oogonia 37 µm diam and oospores 30 µm diam (wall 3 µm thick). Ideta's specimen of *K. cyperis* on *C. tegiformis* (BPI 761963) contains oogonia 36 µm diam and oospores 29 µm diam (wall 2–4 µm thick) whereas Kawakami's specimen

(BPI 76192) contains sporangia measuring 52 x 28 μm (L/B ratio 1.9). Attempts to grow the fungus on artificial agar media failed. Based on these characteristics, the fungus has been identified as *P. cyperi*. It could not be found anywhere else in Hainan other than this discovery. To the best of our knowledge, this is the first report of *P. cyperi* in Hainan, China and also the first record of the fungus on a member of the family *Poaceae* (*Gramineae*) in the world. To date, *P. cyperi* has been known only on species of *Cyperus* although there was a report of foliage blight of bulbous irises, which are mostly hybrids of *Iris xiphium*, and *I. tingitana* (Family *Iridaceae*) in England "associated with an unidentified *Phytophthora* which is possibly related to *P. Cyperi-rotundati* Sawada" (Gibson and Gregory 1940).

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MYCOTAXON

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New records of *Liceales* from China[1]

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Abstract—Six species of *Liceales*—*Licea pusilla, L. variabilis, Tubifera dictyoderma, Cribraria ferruginea, C. filiformis,* and *C. macrospora*—are described and illustrated. They are reported from China for the first time.

Key words—Myxomycetes, SEM, distribution

Introduction

Liceales is suitable for a phylogenetic study of Myxomycetes because of its large variation in morphological characteristics. In *Liceales*, three families, seven genera, and 112 species have been reported worldwide (Kirk et al. 2001).

The first report of Chinese *Liceales* from Taiwan cited 15 species and 4 varieties (Nakazawa 1929), but voucher specimens cannot be found in the herbaria on mainland China.

In the first report from mainland China, Skvortzow (1931) reported 5 species, 3 genera of *Liceales* from Heilongjiang Province including 2 new species, *Licea brassica* Skv. and *L. mandshurica* Skv. The holotypes deposited in the herbarium, Institute of Microbiology, Chinese Academy of Science (HMAS), were checked by Zhou and Li (1978). Martin and Alexopoulos (1969) regarded *L. mandshurica* as a doubtful species because it bears limy plates on the peridium similar to *Lepidoderma*. Zhou and Li (1978) suggested that *L. mandshurica* belongs to the *Physarales* due to its purplish brown spores and limy granules. The type specimen has been damaged and can no longer be identified. Emoto (1931, 1933) reported 3 species in 3 genera of Liceales from Liaoning Province, China. Teng, the Chinese Mycologist who first reported Myxomycetes from China, reported 3 genera, 5 species of *Liceales* from South China (Teng & Teng 1933, 1935, 1937). Later, he reported 10 genera, 16 species and showed the habits and distributions of these species from China (Teng 1963).

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Zhou (1937) reported 5 genera, 5 species of Liceales from North China, including 2 newly recorded genera and 2 newly recorded species. Later, Buchet (1939) reported 2 species of Liceales based on the specimens collected by Licent from Taiyuan, China.

Zhou and Li (1983) decribed a new species, *Cribraria enodis* Zhou & Y. Li. Later, 4 new species, *C. media* H. Li & Y. Li, *Licea reticulospora* H. Li & Y. Li, *Cribraria irregularis* Y. Li and *Cribraria paucidictyon* Y. Li, were described (Li & Li 1994, 1995; Li 2002).

Liu (1981, 1982) reported the Myxomycetes in Jilin Province, including 7 genera, 30 species; Zhou and Li (1983, 1985) reported 4 genera, 6 species in Xinjiang and Tibet; Li (1983) systematically studied *Cribraria* and reported 8 new records; Ing (1987) reported 2 genera, 8 species in Hong Kong; Li (1989) reported 7 genera, 18 species in Shennongjia; and Li and Li (1989) listed 8 genera, 42 species in China.

Later, Li and Chen (1993) and Chen et al. (1994) reported 4 genera, 8 species in Inner Mongolia, and Wang et al. (1994) reported 5 genera, 14 species in Heilongjiang, including one new record. Some species were alternatively obtained through moist chamber culture (Champion and Mitchell 1980; Zhou et al. 1981; Zhao 1983; Chen et al. 1995a). Some reports are from Taiwan (Chiang and Liu 1991; Liu 1980, 1981, 1982, 1983, 1989, 1990; Liu et al. 2002) and Hong Kong (Chung 1997).

To date, 3 families, 8 genera and 50 species in *Liceales* are now reported from China.

In this study, the specimens collected from China and deposited in Mycological Herbarium of Jilin Agricultural University (HMJAU) and the herbarium, Institute of Microbiology, Chinese Academy of Science (HMAS) were checked and re-examined. Six new records, 2 of *Licea*, 1 of *Tubifera* and 3 of *Cribraria*, are added to Chinese flora. The known distributions of these newly record species are provided.

Materials and Methods

The specimens deposited in HMJAU and HMAS were re-examined. Additional specimens, which were obtained from our own field surveys, were also examined. Observations were carried out with a stereomicroscope (40x) and Olympus optical microscope (100x–1000x) after mounting in lactophenol (phenol 20 ml, lactic acid 20 ml, distilled water 20 ml), or in distilled water. The dried specimens of entire sporocarps and broken myxocarps were attached to double-sided adhesive tape on specimen holders of a Scanning Electron Microscope (SEM), and coated with platinum-palladium using a Hitachi E-1030 I sputter. The myxocarps were examined by SEM in the University of Tsukuba, Japan using a Hitachi S-4200 instrument operating at 15 kv.

Taxonomic Descriptions

Licea pusilla Schrad., Nov. Gen. Pl. 19, 1797. FIGURE 1 (1, 2)

Myxocarp sporocarpous; sporocarps scattered or gregarious, sessile, globose, subglobose to pulvinate on a somewhat restricted base, more or less angular, blackish brown to dull black, shining, greatly variable in size, usually 0.5-1.3 mm in diameter; peridium thick, consisting of two closely appressed layers, dehiscent from above reticulate ridges into

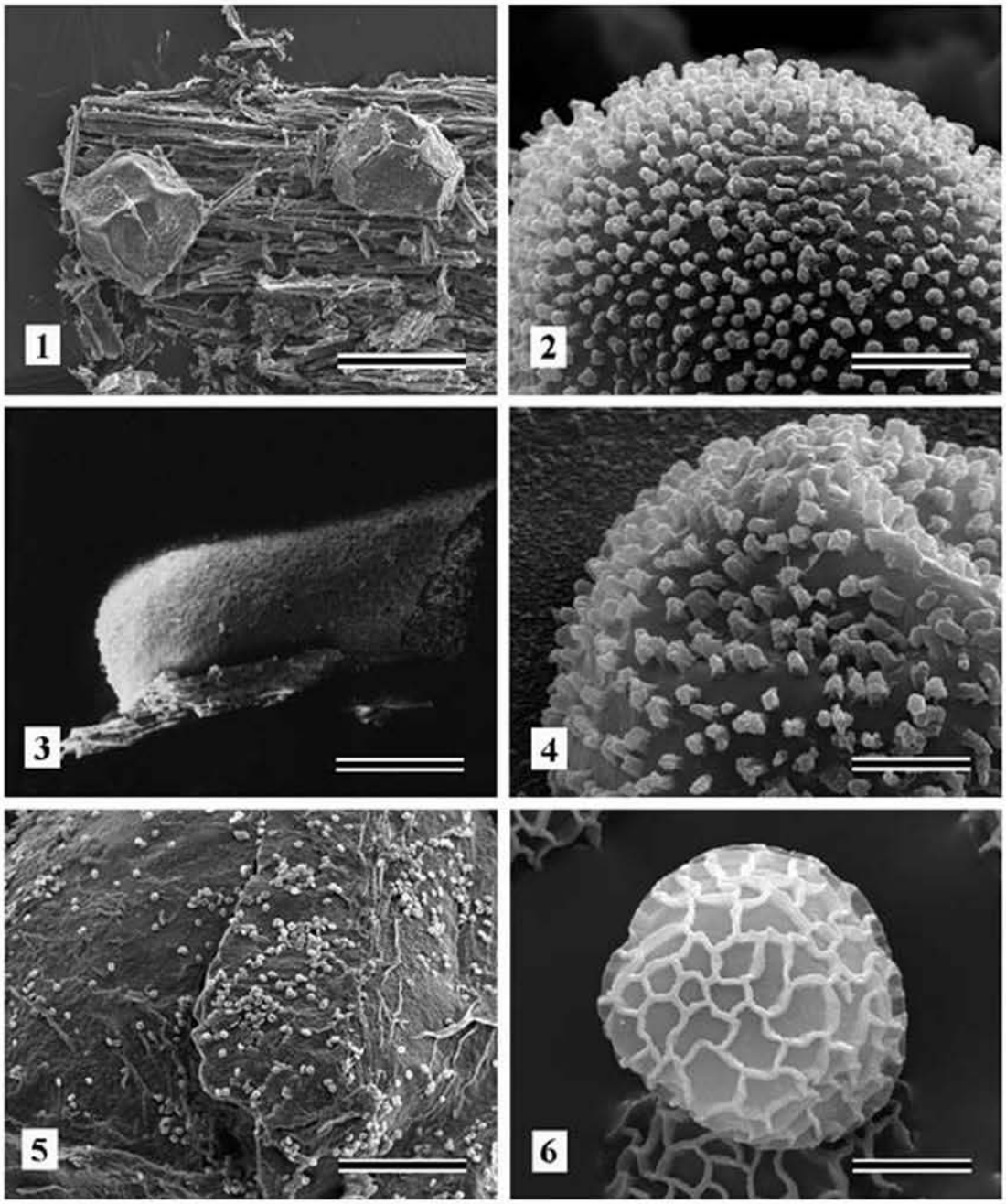

Fig. 1. 1-2. *Licea pusilla* (HMJAU 10061). 1. Two sporocarps (Bar = 200μm). 2. Spore surface (Bar = 2μm). 3-4. *Licea variabilis* (HMAS 1235). 3. Plasmodiocarp (Bar = 0.5 mm). 4. Spore surface (Bar = 2μm). 5-6. *Tubifera dictyoderma* (HMAS 68077). 5. Peridium (Bar = 100μm). 6. Spore (Bar = 2μm).

lobes; spores dark brown in mass, pale olivaceous brown by transmitted light, with wall thinner on one side, globose, densely and minutely warted by SEM, (14.3-) 15.6-16.9(-19.5) μm in diameter.

Ecology and Distribution: On rotten wood and dead bark. Known in Heilongjiang.

SPECIMEN EXAMINED: P. R. CHINA. Heil ongjiang. Aug. 1992.*HMJAU 10061*, Wang.

Remarks: This species is the type of the genus *Licea*, and is regarded as cosmopolitan by some authors (Martin and Alexopoulos 1969; Nannenga-Bremekamp 1991), though it has not previously been reported in China. Because of its relative small size and scattered habit, it is very difficult to find this species in the field. In the species of *Licea* where the peridium has preformed reticulate dehiscence, *L. pusilla* differs from *L. erectoides* Nann.-Bremek. & Y. Yamam. in its sessile sporocarp, from *L. castanea* G. Lister in its larger spores, and from *L. minima* Fr. in its non-cartilaginous peridium and larger spores. This is the first report of this species for Chinese myxomycete biota.

Licea variabilis Schrad., Nov. Gen. Pl. 18, 1797. FIGURE 1 (3, 4)

Myxocarps plasmodiocarpous and/or sporocarpous, scattered or gregarious in small groups; plasmodiocarps elongate to annulate, 1-10 mm long and 0.3-1.0 mm wide, sometimes branching; sporocarps sessile, subglobose to pulvinate, varying in colour from fresh ochraceous to dull dark brown, 0.5-0.8 mm in diameter; peridium consisting of two layers, dehiscing irregularly; outer layer of peridium thick, with dirt particles, gelatinous when fresh; inner layer of peridium membranous, translucent, yellowish; hypothallus usually developed, dull yellow to brown; spores olivaceous to dark reddish brown in mass, pale yellowish brown by transmitted light, globose, minutely and densely spinulose by light microscope (LM), warted by SEM, (10-) 12.5-15 μm in diameter.

Ecology and Distribution: On rotten wood and dead bark. Known in Heilongjiang and Inner Mongolia.

SPECIMENS EXAMINED: P. R. CHINA. Heilongjiang. Aug. 1992. *HMJAU 10093*, Wang. INNER MONGOLIA. Aug. 1991. *HMAS 1235*, Li.

Remarks: As suggested by its specific name, this is a highly variable species. Its characteristics vary in several aspects such as the type, shape and size of myxocarp and the colour and size of its spores. It is one of the largest species in *Licea* where most species form much smaller sporocarps. It is reported to be rather common but, from China, this is the first report.

Tubifera dictyoderma Nann.-Bremek. & Loerak., Proc. K. Ned. Akad. Wet. Ser. C. 88: 121, 1985. FIGURE 1 (5, 6)

Myxocarps pseudoaethalioid, sessile, consisting of densely connected sporocarps, on a slightly protruding hypothallus, slightly depressed, with a smooth surface above, greyish brown to pale chestnut brown, more or less depressed hemispheric, about 5 cm in diameter; sporothecae cylindrical, rounded angular in cross section because of mutual compression, about 3-5 mm tall and 0.5 mm in diameter; peridium sturdy, permanent, with apical walls flattened and reticulate, with vertical walls so close together that they seem merged; pseudocapillitium not present; hypothallus slightly protruding, dull white to whitish yellow; spores cinnamon in mass, pale pink-brown by transmitted light, globose, reticulate, 4.7-5.2 μm in diameter.

Ecology and Distribution: On moss. Known in Jilin.

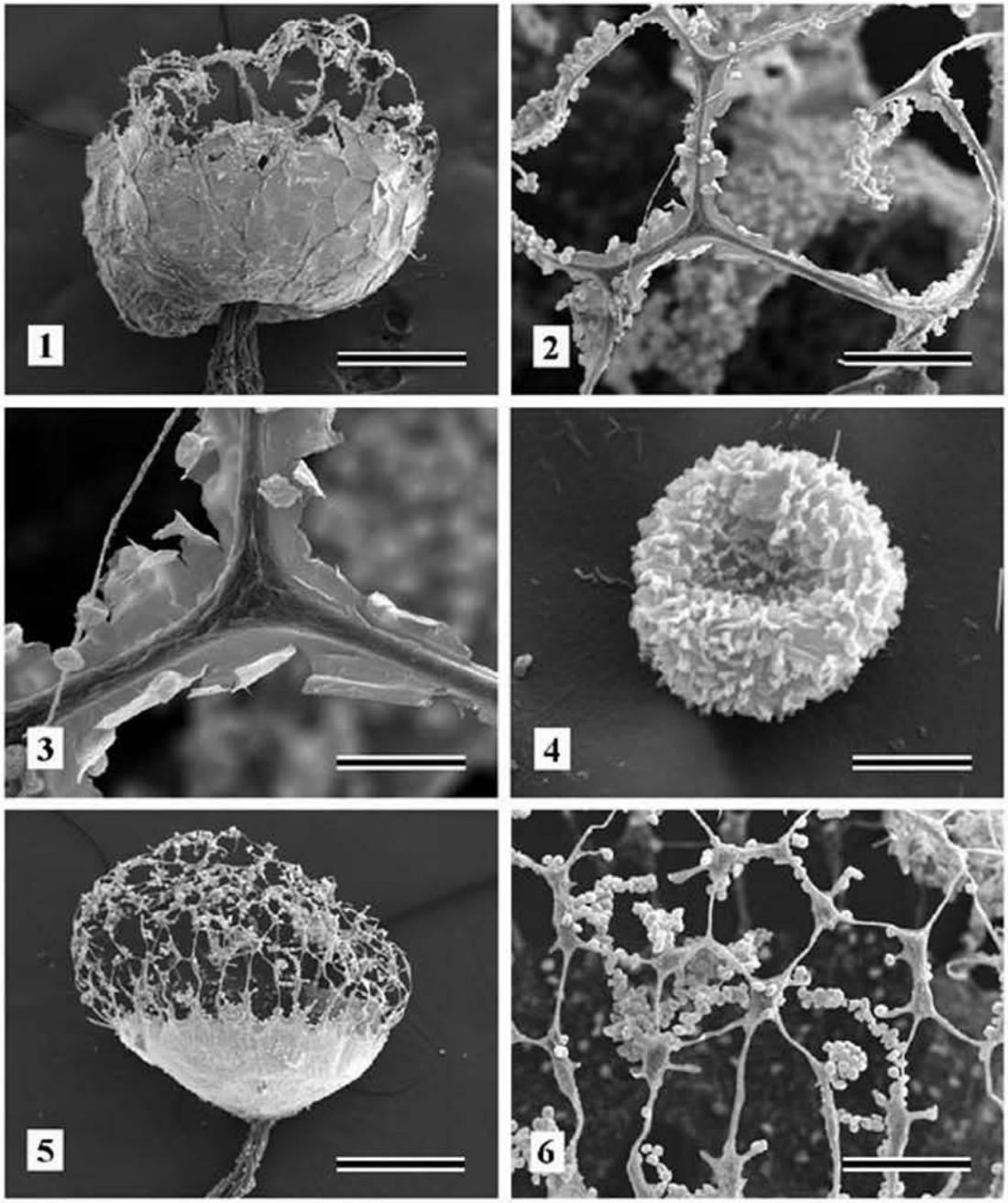

Fig. 2. 1-4. *Cribraria ferruginea* (HMJAU 9589). 1. Peridial net and cup with a stalk (Bar = 300μm). 2. Part of the peridial net (Bar = 60μm). 3. Node with threads (Bar = 20μm). 4. Spore (Bar = 2μm). 5-6. *Cribraria filiformis* (HMAS 91-392). 5. Peridial net and cup with a stalk (Bar = 200μm). 6. Part of the peridial net (Bar = 60μm).

SPECIMENS EXAMINED: P. R. CHINA. Jilin. Sep. 1998. *HMJAU 10064*, Chen. **Jilin.** July 1998. *HMAS 68077*, Wang.

Remarks: It is obviously an intermediate species between *Tubifera* and *Dictydiaethalium*, resembling the latter in its tessellated peridial surface and method of dehiscence of the

pseudoaethalium, but other characteristics clearly group it into the genus *Tubifera*. This specimen differs from the original description (Nannenga-Bremekamp 1985) in not distinctly depressed pseudoaethalia and no capillitia.

Cribraria ferruginea Meylan, Ann. Cons. Jard. Geneve 15-16: 319, 1913.

FIGURE 2 (1-4)

Sporocarps sporocarpous; sporocarps stalked, gregarious or crowded in a group, reddish brown or rusty brown, erect, subglobose or pyriform, 1.0-1.5 mm in diameter, 2.0-3.0 mm tall; net occupying about 2/3 of the sporothecae, loose; net meshes irregular; connecting threads slender; nodes irregular and flattened; cups usually lacking, replaced by sturdy ribs which radiate from the top of stalks; ribs interconnected; dictydine granules 1.5-2.0 μm in diameter; stalk short and robust, longitudinally furrowed, equaling to about half of the diameter, dark red brown or dark fusty brown; hypothallus extending and confluent under the whole group, dark red brown; spores reddish brown in mass, pale rusty red by transmitted light, globose, minutely warted and faintly reticulated by LM, conical-warted by SEM, 6.5-7.8 μm in diameter.

Ecology and Distribution: On dead wood. Known in Jilin and Shaanxi.

SPECIMEN EXAMINED: P. R. CHINA. Jil in. July. 1980. *HMJAU 9589*. Li.

Remarks: The distinct characteristics of this species are the rust brown or red brown sporothecae, short stalks, definite and sturdy ribs and faintly reticulate spores. Nannenga-Bremekamp (1991) showed that there was no reticulum on the spores of the specimens from the Netherlands. The spores of Chinese materials examined have faint reticulation, in agreement with Martin and Alexopoulos (1969).

Cribraria filiformis Nowotny & Neubert, in Neubert, Nowotny & Baumann, Myxom. Deutschl. 1: 77. 1993. FIGURE 2 (5, 6), FIGURE 3 (1, 2)

Sporocarps gregarious, globose, stalked, erect or nodding, ochraceous to dark brown, 0.3-0.7 mm in diameter; net dense, with many free ends; net meshes small; nodes scarcely differentiated, filled with dictydine granules; cup about one-third the height of the sporothecae, metallic, with radially plicate; margin of cup bearing regular teeth; dictydine granules, brownish, 2-3 μm in diameter; stalk dark reddish brown, slender, furrowed, tapered upward, 0.7-1.8 mm long; hypothallus reddish brown or nearly colorless, common to a group; spores ochraceous in mass, pallid by transmitted light, globose, minutely warted, 6.25-7.5 μm in diameter.

Ecology and Distribution: On rotten wood. Know in Inner Mongolia.

SPECIMEN EXAMINED: P. R. CHINA. Inner Mongol ia. Aug. 1991. *IIMAS 91-392*. Li.

Remarks: In the specimen examined, the nodes of peridial net are rarely differentiated and the dense peridial net has many free ends. These characteristics clearly distinguish this species from other *Cribaria species*. In many aspects, such as sporothecae shape, cup size and spore traits, it is easily confused with *C. persoonii* Nann.-Bremek., but the latter has concentrically wrinkled cups and thickened nodes.

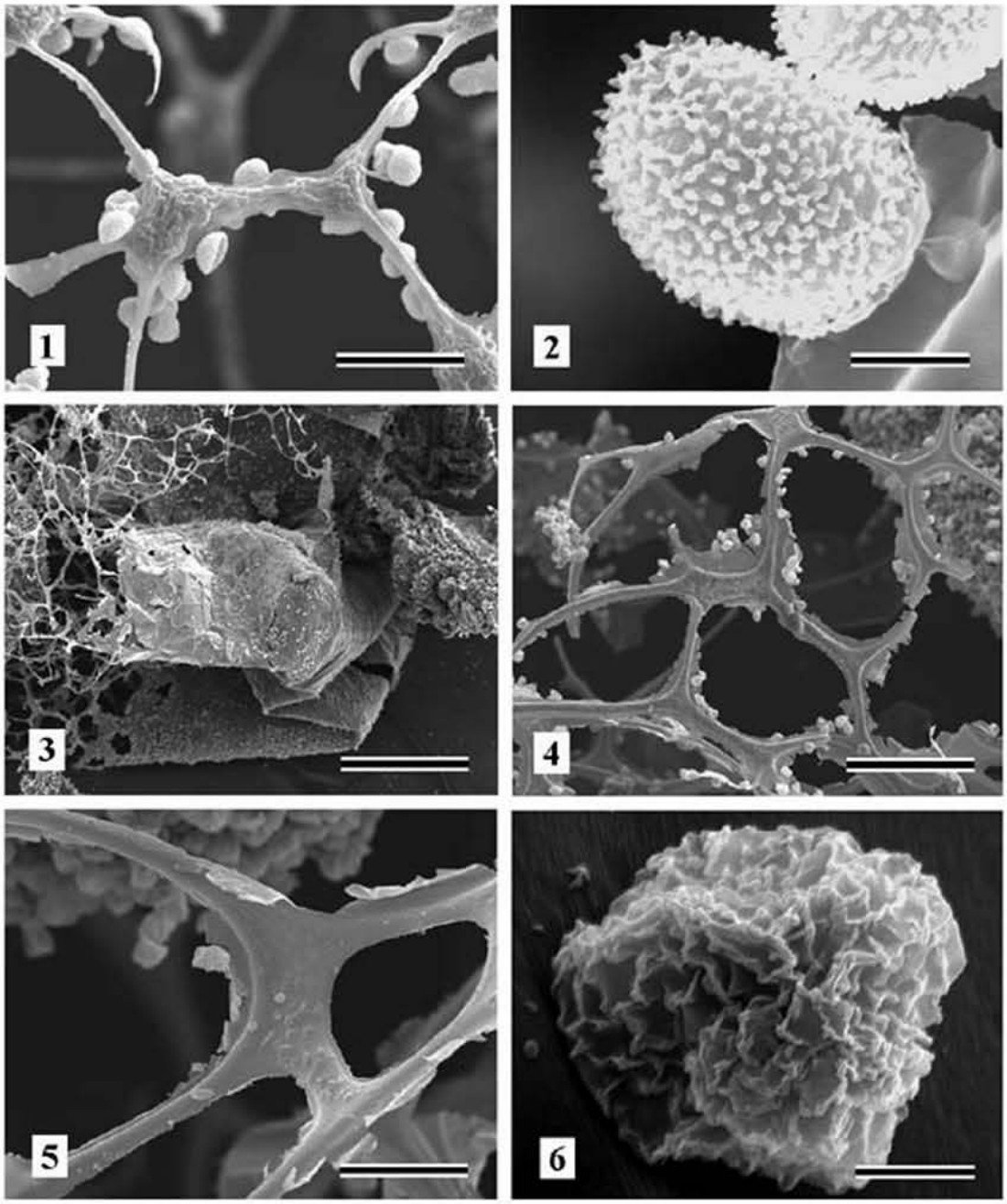

Fig. 3. 1-2. *Cribraria filiformis* (HMAS 91-392). 1. Nodes with threads (Bar = 20μm). 2. Spores (Bar = 2μm). 3-6. *Cribraria macrospora* (HMAS 53731). 3. Peridial net and cup with a stalk (Bar = 300μm). 4. Part of the peridial net (Bar = 60μm). 5. Node with threads (Bar = 20μm). 6. Spores (Bar = 2μm).

Cribraria macrospora Nowotny & Neubert, in Neubert, Nowotny & Baumann, Myxom. Deutschl. 1: 85, 1993. FIGURE 3 (3-6)

Sporocarps gregarious or scattered, stalked, erect, ochraceous, globose or broadly pyriform, 1.2-1.7 mm in diameter, 3.0-3.8 mm tall; net with many short free ends;

nodes flat, slightly expanded, irregular; cup occupying one-fourth of the sporothecae, persistent, with radial ribs and granular lines, with some perforations in the upper part so that it merges gradually with the net; dictydine granules brown, 0.8-1.2 μm in diameter; stalk black, cylindrical, longitudinally furrowed, robust, 1.5-2.3 mm long; hypothallus dark to blackish brown, common to a group; spores ochraceous in mass, brownish by transmitted light, globose, bearing many minute warts by LM, with folds by SEM, 10.0-12.5 μm in diameter.

Ecology and Distribution: On moss. Known in Guangxi and Tibet.

SPECIMENS EXAMINED: **P. R. CHINA. Tibet.** Oct. 1982. *HMAS 53731*,Su. **Guangxi.** July 1997. *HMAS 75371*, Chen.

Remarks: This species is similar to *Cribraria macrocarpa* Schrad. and *C. meylanii* Brandza in size, shape and habit of sporotheca, cup traits, and stalk structure. However, from the former it differs in its ochraceous sporotheca, thicker threads of peridial nets and ochraceous spore mass, and from the latter, in its ochraceous globose sporotheca, smaller cups and ochraceous warted spores. This species has the largest spores in *Cribraria*.

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Glomus aurantium and *G. xanthium*, new species in Glomeromycota

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Abstract–Two new ectocarpic arbuscular mycorrhizal fungal species, *Glomus aurantium* and *G. xanthium* (Glomeromycota), were discovered in the Mediterranean Sea dunes located in Israel, Greece, Italy, and Majorca, Spain. Mature spores of *G. aurantium* are deep orange, globose to subglobose, (70-)98(-120) µm diam, or ovoid, 80-120 x 110-150 µm. Their wall consists of a permanent, flexible to semiflexible, hyaline outermost layer, easily separating from a laminate, deep orange middle layer, and a flexible, hyaline innermost layer. Spores of *G. xanthium* usually are tightly adherent to roots and frequently occur within roots. They are light yellow to ochre, globose to subglobose, (23-)50(-70) µm diam or ovoid, 20-55 x 45-100 µm, and have a spore wall with a rigid, semi-permanent, hyaline to light yellow outermost layer adherent to a rigid, permanent, hyaline middle layer, and a laminate, light yellow to yellow ochre innermost layer. Both *G. aurantium* and *G. xanthium* formed vesicular-arbuscular mycorrhizae in one-species cultures with *Zea mays*. Analysis of ITS and LSU nuclear rDNA in spores placed *G. aurantium* sequences in the *G. versiforme* group, while *G. xanthium* sequences were aligned with those in *Glomus* Group A.

Key words–molecular phylogeny, nuclear ribosomal DNA, vesicular-arbuscular fungi

Introduction

The plant associations hosting exceptionally abundant and diverse populations of arbuscular mycorrhizal fungi (Glomeromycota) are those colonizing maritime sand dunes (Błaszkowski 1993; Koske 1987; Tadych & Błaszkowski 2000). Many of the described species of these fungi have been originally isolated from dunes (Błaszkowski 2003). Examination of pot trap cultures with rhizosphere soils of plants of coastal areas

of the Mediterranean Sea revealed two undescribed species of arbuscular fungi that probably prefer warm sites. They have not been found in ca. 3000 soil samples coming from different dune and non-dune soils of northern Europe (Błaszkowski 2003). These fungi are described here as *Glomus aurantium* and *G. xanthium* spp. nov. based on morphology, ontogenetic patterns of spore differentiation, and molecular properties of spores.

Materials and Methods

Establishment of trap cultures and one-species cultures. Collection of soil samples, establishment of trap and single-species pot cultures, as well as growth conditions generally were as those described previously (Błaszkowski & Tadych 1997). Briefly, rhizosphere soils and roots of sampled plants were collected from a depth of 5-30 cm using a small garden shovel. In the laboratory, about 100-g subsamples were taken from each sample to isolate spores of arbuscular mycorrhizal fungal species sporulating in the field. The remaining part of the sample was either air dried for 2 weeks and subsequently refrigerated at 4°C or directly used to establish trap cultures. Trap cultures were established to obtain a great number of living spores of different developmental stages and to initiate sporulation of species that were present but not sporulating in the field collections. The growing substrate of the trap cultures was the field-collected material mixed with an autoclaved coarse-grained sand coming from maritime dunes adjacent to Świnoujście (pH 6.7; 12 and 26 mg L^{-1} P and K, respectively; Błaszkowski 1995). The mixtures were placed in 9x12.5-cm plastic pots (500 cm^3) and densely seeded with *Plantago lanceolata* L. Plants were grown in a greenhouse at 15-30°C with supplemental 8-16-h lighting provided by one SON-T AGRO sodium lamp (Philips Lighting Poland S. A.) placed 1 m above pots. The maximum light intensity was 180 $\mu E\ m^{-2} s^{-1}$ at pot level. Plants were watered 2-3 times a week. No fertilizer was applied during the growing period. Trap cultures were harvested at approximately 1-month intervals, beginning three months and ending five to seven months after plant emergence. Spores were extracted by wet sieving and decanting (Gerdemann & Nicolson 1963). Presence of mycorrhizae was determined following clearing and staining of roots (Phillips & Hayman 1970) modified as follows: tissue acidification with 20% HCl instead of 1%, and trypan blue concentration 0.1% instead of 0.05% (Koske, pers. comm.).

Single-species pot cultures were established from about 50 to 100 newly formed spores stored before inoculation in water at 4°C for 24 h. After removal of soils debris, spores were collected in a pipette and transferred onto a compact layer of mycorrhizae-free roots of 10-14 day old seedlings of *P. lanceolata* placed at the bottom of a hole *ca.* 1 cm wide and 4 cm deep formed in a wetted growing medium filling 8-cm plastic pots (250 cm^3). The growing medium was an autoclaved sand of maritime dunes adjacent to Świnoujście with chemical properties listed above. Subsequently, the spores were covered with another layer of roots attached to 4-6 additional host plants, and the roots and sandwiched spores were buried in the growing medium. Finally, three to six seeds of *P. lanceolata* were placed on the surface of the growing substrate and covered with a thin layer of autoclaved sand. The cultures were harvested after 4-8 months

and spores were extracted. The effectiveness of this method in establishing one-species cultures usually exceeded 90% (Błaszkowski et al. 2002).

Microscopical survey. Morphological properties of spores and their subcellular structures were determined based on at least 100 spores mounted in polyvinyl alcohol/lactic acid/glycerol (PVLG; Koske & Tessier 1983) and a mixture of PVLG and Melzer's reagent (1:1, v/v). Spores at all stages of development were crushed to varying degrees by applying pressure to the coverslip and then stored at 65°C for 24 h to clear their contents of oil droplets. These were examined under an Olympus BX 50 compound microscope equipped with Nomarski differential interference contrast optics. Microphotographs were recorded on a Sony 3CDD color video camera coupled to the microscope.

Terminology of spore structure is that suggested by Spain et al. (1989), Stürmer & Morton (1997), and Walker (1983). Spore color was examined under a dissecting microscope on fresh specimens immersed in water. Color names are from Kornerup & Wanscher (1983). Nomenclature of fungi and plants is that of Walker & Trappe (1993) and Mirek et al. (1995), respectively. The authors of the fungal names are as those presented at the URL web page http://www.indexfungorum.org/AuthorsOfFungalNames.htm. Specimens were mounted in PVLG on slides and deposited in the Department of Plant Pathology (DPP), University of Agriculture, Szczecin, Poland, and in the herbarium at Oregon State University (OSC) in Corvallis, Oregon, USA.

Color microphotographs of spores and mycorrhizae of *G. aurantium* and *G. xanthium* can be viewed at the URL http://www.agro.ar.szczecin.pl/~jblaszkowski/.

PCR amplification. To amplify DNA from single spores, these were separated in a drop of sterile water. The water was removed before spores were crushed, pipetted with 8 μl of the PCR-Mix and used directly for PCR.

Amplification of the analysed ITS and LSU nrDNA region by PCR was performed on a Hybaid Ltd. OmniGene TR3 CM220 Thermo Cycler (MWG-Biotech, Ebersberg, Germany) in a total volume of 50 μl containing 2 U Taq DNA polymerase (Promega, Heidelberg, Germany), 5 μl of 10x Taq polymerase reaction buffer (Promega), 4 μl 25 mM $MgCl_2$, 10 nmol of each dNTP (MBI-Fermentas, St. Leon-Rot, Germany), 50 pmol of each of the two primers and 1 μl of the DNA extract. The reactions were performed as hot start PCR with 10 min initial denaturation at 94°C before adding the Taq polymerase at 80°C. The PCR program comprised 32 cycles (40 s at 94°C, 30 s at 54°C, 40 s at 72°C). A final elongation of 10 min at 72°C followed the last cycle.

SSU-Glom1 (ATT ACG TCC CTG CCC TTT GTA CA) and LSU-Glom1 (C TT CAA TCG TTT CCC TTT CA) previously described by Renker et al. (2003) were used as primers to amplify the target regions.

Cloning, Sequencing and Sequence Analyses. PCR products were cloned into the pCR4-Topo Vector following the manufacturer's protocol of the TOPO TA Cloning Kit (Invitrogen Life Technologies, Karlsruhe, Germany) and transformed into TOP10 Chemically Competent *Escherichia coli*. Sequencing was done using a LI-COR

DNA Sequencer Long Reader 4200 and the Thermo Sequenase fluorescent labeled primer cycle sequencing kit with 7-deaza-dGTP (Amersham Pharmacia Biotech, Little Chalfont, UK).

DNA sequences of the complete ITS and parts of the ribosomal small and large subunit were submitted to the EMBL database under the accession numbers given in Figs. 17 and 18 for *G. aurantium* and *G. xanthium*. Reference sequences to analyze the systematic position of the new sequences were taken from GenBank. In a first step, only the 5.8S subunit genes embedded between the ITS1 and ITS2 regions were aligned by hand to allow an analysis of the systematic position of *G. aurantium* and *G. xanthium* based on a large sequence data set. In a second step, the full-length ITS sequence of *G. xanthium* was aligned with other *Glomus* Group A *sensu* Schüßler et al. (2001) sequences to take a closer look at its systematic position. Furthermore a small sequence data set of available LSU sequences was aligned to ensure the phylogenetic position of the new species. An alignment of the full-length sequences of *G. aurantium* and *G. xanthium* was not possible due to a lack of comparable sequence data from other AMF species, but also due to the high variation within the ITS1 and ITS2 region when comparing sequences from different groups within the Glomeromycota.

Maximum parsimony analyses were performed with PAUP* 4.0b10 (Swofford 2003) using the heuristic search mode with 10 random-addition sequence replicates, tree bisection-reconnection branch swapping, MULTrees option on and collapse zero-length branches off. All characters were treated as unordered and equally weighted. Strict consensus trees were calculated including all MP trees. The confidence of branching was assessed using 1000 bootstrap resamplings.

The data set used to reconstruct the 5.8S phylogenetic tree (Fig. 17) contained 158 characters of which 83 were constant, 18 parsimony uninformative and 57 parsimony informative. The data set used to reconstruct the LSU tree (Fig. 18) contained 357 characters of which 195 were constant, 55 parsimony uninformative and 107 parsimony informative. The full length ITS tree containing *G. xanthium* (Fig. 35) has 572 characters of which 371 were constant, 74 parsimony uninformative and 127 parsimony informative.

Descriptions of the species

Glomus aurantium J. Błaszk., V. Blanke, C. Renker & F. Buscot, sp. nov.

Figs. 1-16

Sporocarpia ignota. Sporae singulae in solo efformatae; pallide luteae vel aurantiae vel ochraceae; globosae vel subglobosae; (70-)98(-120) µm diam; aliquando ovoideae; 80-120 x 110-150 µm. Tunica sporae e stratis tribus (strati 1-3); strato "1" elastico vel semielastico, glabro, hyalino, (0.7-)1.0(-1.5)µm crasso; strato "2" laminato, glabro, pallide luteo, intense aurantio vel aureo, (2.7-)5.8(-8.8) µm crasso; strato "3" elastico, glabro, hyalino, (0.5-)0.7(-1.0) µm crasso. Hypha subtendens pallide luteo, intense aurantio vel aureo; recta vel recurva; cylindrica, raro coliga; (0.5-)0.7(-1.0) µm lata ad basim sporae; pariete pallide luteo, intense aurantio vel aureo; (0.7-)2.0(-4.7) µm crasso, stratis 1-3 sporae continuo. Porus e septo continuo strati 3 sporae efformata. Mycorrhizas vesicular-arbusculares formans.

HOLOTYPUS. POLAND. Szczecin, infra *P. lanceolata*, 10 Jan. 1998, *Błaszkowski, J., 2444* (DPP).

Sporocarps unknown. *Spores* occur singly in the soil (Fig. 1); origin blastically at the tip of extraradical hyphae of mycorrhizal roots. Spores yellowish white (4A2) when young, deep orange (5A7-8) at maturity, to golden yellow (5B8) when older; globose to subglobose; (70-)98(-120) μm diam; sometimes ovoid; 80-120 x 110-150 μm; with a single subtending hypha (Figs. 1, 11, 12). *Subcellular structure of spores* (Figs. 2-12) consists of one wall including three layers (layers 1-3). Outermost layer 1 permanent, flexible to semiflexible, smooth, hyaline, (0.7-)1.0(-1.5) μm thick (Figs. 2-5, 7-12), sometimes ballooning, and then extending up to 30 μm from layer 1 in spores mounted in PVLG (Fig. 3). This layer frequently accumulates a granular material, up to 1.5-7.0 μm thick, composed of soil debris (Figs. 4, 5, 7, 10). Layer 2 laminate, smooth, yellowish white (4A2) to golden yellow (5B8), (2.7-)5.8(-8.8) μm thick (Figs. 2-12). Layer 3 flexible, smooth, hyaline, (0.5-)0.7(-1.3) μm thick (Figs. 2-12), usually tightly adherent to layer 2 and almost always inseparably attached to the inner surface of subtending hyphal wall layer 3, close at the spore base to form a curved septum in the lumen of the subtending hypha (Fig. 11). None of the spore wall layers reacts in Melzer's reagent. *Subtending hypha* yellowish white (4A2) to golden yellow (5B8), straight or recurvate; cylindrical or slightly flared, rarely constricted; (3.2-)7.1(-11.8) μm wide at the spore base (Figs. 11, 12). *Wall of subtending hypha* yellowish white (4A2) to golden yellow (5B8); (0.7-)2.0(-4.7) μm thick at the spore base; continuous with spore wall layers 1-3 (Fig. 11); layers 1 and 3 extend up to 10.0 and 2.0-3.4 μm, respectively, below the spore base. *Pore* occluded by a septum, (2.0-)2.9(-4.2) μm wide, continuous with spore wall layer 3 (Fig. 11) and occasionally also by a septum formed by a few innermost laminae of spore wall layer 2, positioned 3.0-6.5 μm below the spore base (Fig. 12).

Collections examined. HOLOTYPE. POLAND. Szczecin, from under pot-cultured *P. lanceolata*, 6 Jul. 2003, *Błaszkowski, J., 2444* (DPP); isotypes: *Błaszkowski, J., 2445-2459* (DPP) and two slides at OSC.

Other material examined. ISRAEL. Near Tel-Aviv (32°4'N, 34°46'E), from the root zone of *Cenothera drummondi* Hook, 16 Dec. 1997 and 15 June 2000 and *Ammophila arenaria* (L.) Link, 15 June 2000, *Błaszkowski, J., unnumbered collection* (DPP). SPAIN. Near Cape Salinas (36°19'N, 3°2'E) and Sóller (39°46'N, 2°40'E), Majorca, from around roots of *A. arenaria*, 15 Aug. 2001, *Błaszkowski, J.*, unnumbered collection (DPP). ITALY. Near Calambrone (43°35'N, 10°18'E), from under *A. arenaria*, 11 Oct. 2002, *Błaszkowski, J.*, unnumbered collection (DPP).

Etymology. Aurantium, referring to the orange-golden-colored spores.

Distribution and habitat. Glomus aurantium was discovered in a trap culture with a rhizosphere soil of *C. drummondi* colonizing dunes of the Mediterranean Sea adjacent to Tel-Aviv in December 1997. This fungus also sporulated in 60 other trap cultures with dune rhizosphere soils of *A. arenaria* and *C. drummondi* sampled near Tel-Aviv in 1997 (9 samples) and 2000 (51). Later, spores of *G. aurantium* were isolated from eight trap cultures established from soils collected under *A. arenaria* growing

near Cape Salinas and Sóller, Majorca, Spain, and seven trap cultures containing rhizosphere soil and root mixtures taken from under *A. arenaria* growing in dunes adjacent to Calambrone, Italy.

The arbuscular fungi accompanying *G. aurantium* in the field were *G. constrictum* Trappe and *G. coronatum* Giovann. The fungi co-occurring with *G. aurantium* in trap cultures with Israeli soils were *Acaulospora paulinae* Błaszk., *Archaeospora trappei* (R.N. Ames & Linderman) J.B. Morton & D. Redecker, *G. arenarium* Błaszk. et al., *G. constrictum*, *G. coronatum*, *G. corymbiforme* Błaszk., *G. dominikii* Błaszk., *G. gibbosum* Błaszk., *G. mosseae* (Nicol. & Gerd.) Gerd. & Trappe, *G. xanthium* Błaszk. et al., an undescribed *Glomus* sp., *S. calospora* (Nicol. & Gerd.) C. Walker & F.E. Sanders, and *S. persica* (Koske & C. Walker) C. Walker & F.E. Sanders. Apart from *G. aurantium*, the Majorca's cultures contained *G. constrictum*, *G. coronatum*, *G. dominikii*, *G. macrocarpum* Tul. & C. Tul., two undescribed *Glomus* spp., *S. calospora*, and *S. persica*. The cultures representing Italy still hosted *Ac. scrobiculata* Trappe, *Entrophospora schenckii* Sieverd. & S. Toro, *G. constrictum*, *G. dominikii*, two undescribed *Glomus* spp., *S. fulgida* Koske & C. Walker, and *S. persica*.

Mycorrhizal associations. *Glomus aurantium* was associated in the field with vesicular-arbuscular mycorrhizae of *A. arenaria* in Israel, Majorca, Spain, and Italy, as well as with those of *C. drummondi* growing in Israel.

In one-species cultures with *Z. mays* as the host plant, mycorrhizae of *G. aurantium* consisted of arbuscules, vesicles, as well as intra- and extraradical hyphae (Figs. 13-16). Arbuscules generally were numerous and evenly distributed along root fragments (Fig. 13). Vesicles occurred very abundantly and were globose to subglobose; (18-)32(-45) μm diam; sometimes ellipsoid; 20-40 x 55-110 μm (Fig. 14). Intraradical hyphae were (1.0-)4.8(-7.4) μm wide and grew parallel to the root axis (Fig. 15). They were straight or slightly curved, sometimes formed Y- or H-shaped branches and coils (Fig. 16). The coils were 12.5-50.0 x 22.5-140.0 μm. Extraradical hyphae were (2.5-)4.0(-4.7) μm wide. Their abundance varied, depending on the root fragments examined. In 0.1% trypan blue, arbuscules stained violet white (16A2) to lilac (16B4), vesicles violet white (19A2) to deep blue (19E6), intraradical hyphae violet white (16A2) to

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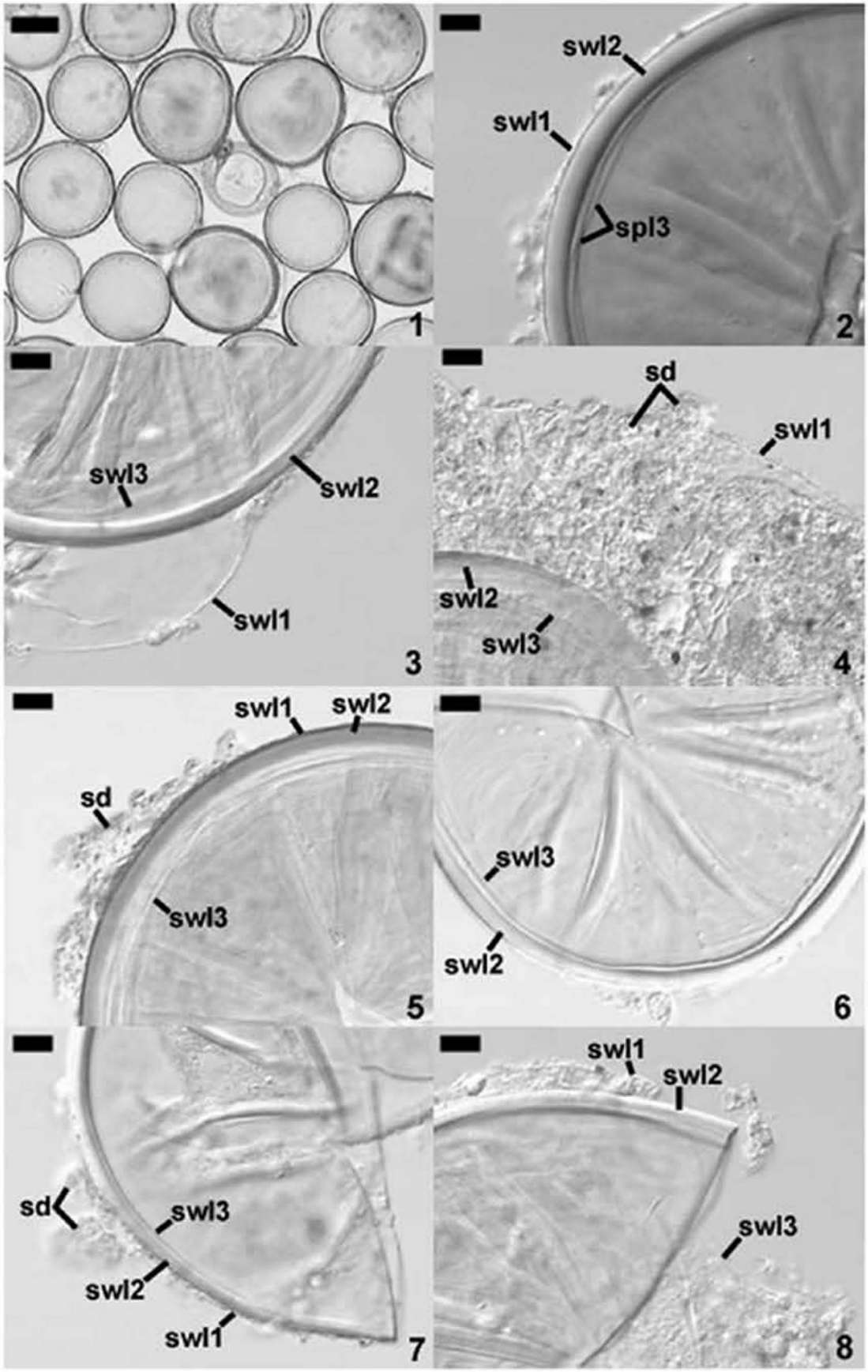
Figs. 1-16. Spores of *Glomus aurantium* and its mycorrhizae in roots of *Zea mays* stained in 0.1% trypan blue. **1.** Mature spores. 2. Adherent spore wall layers 1 (swl1) and 2 (swl2) and spore wall layer 3 (swl3) slightly separated from spore wall layer 2. **3.** Ballooned spore wall layer 1 (swl1) locally separated from spore wall layer 2 (swl2) and spore wall layer 3 (swl3). **4-10.** Spore wall layers (swl) 1-3 and soil debris (sd) accumulated by spore wall layer 1. **11.** Subtending hyphal wall layers 1 (shwl1) and 2 (shwl2) continuous with spore wall layers 1 (swl1) and 2 (swl2); curved septum formed by invaginated spore wall layer 3 (swl3) is visible. **12.** Spore wall layers (swl) 1-3 and subtending hypha with septum (s) continuous with the innermost laminae of spore wall layer 2. **13.** Arbuscules (arb) and arbuscule trunk (tr) developed from intraradical hypha (hyp). **14.** Vesicles (ves). **15.** Straight (shyp), H-(Hb), and Y-(Yb) branched intraradical hyphae. **16.** Coils. Fig. 1., intact spores in water. Fig. 2, spore crushed in PVLG. Figs. 3-12, spores crushed in PVLG+Melzer's reagent. Figs. 13-16, mycorrhizae in PVLG. Figs. 1 and 13-16, bright field microscopy; Figs. 2-12, differential interference contrast. Bars: Fig. 1=50 μm, Figs. 2-16=10 μm.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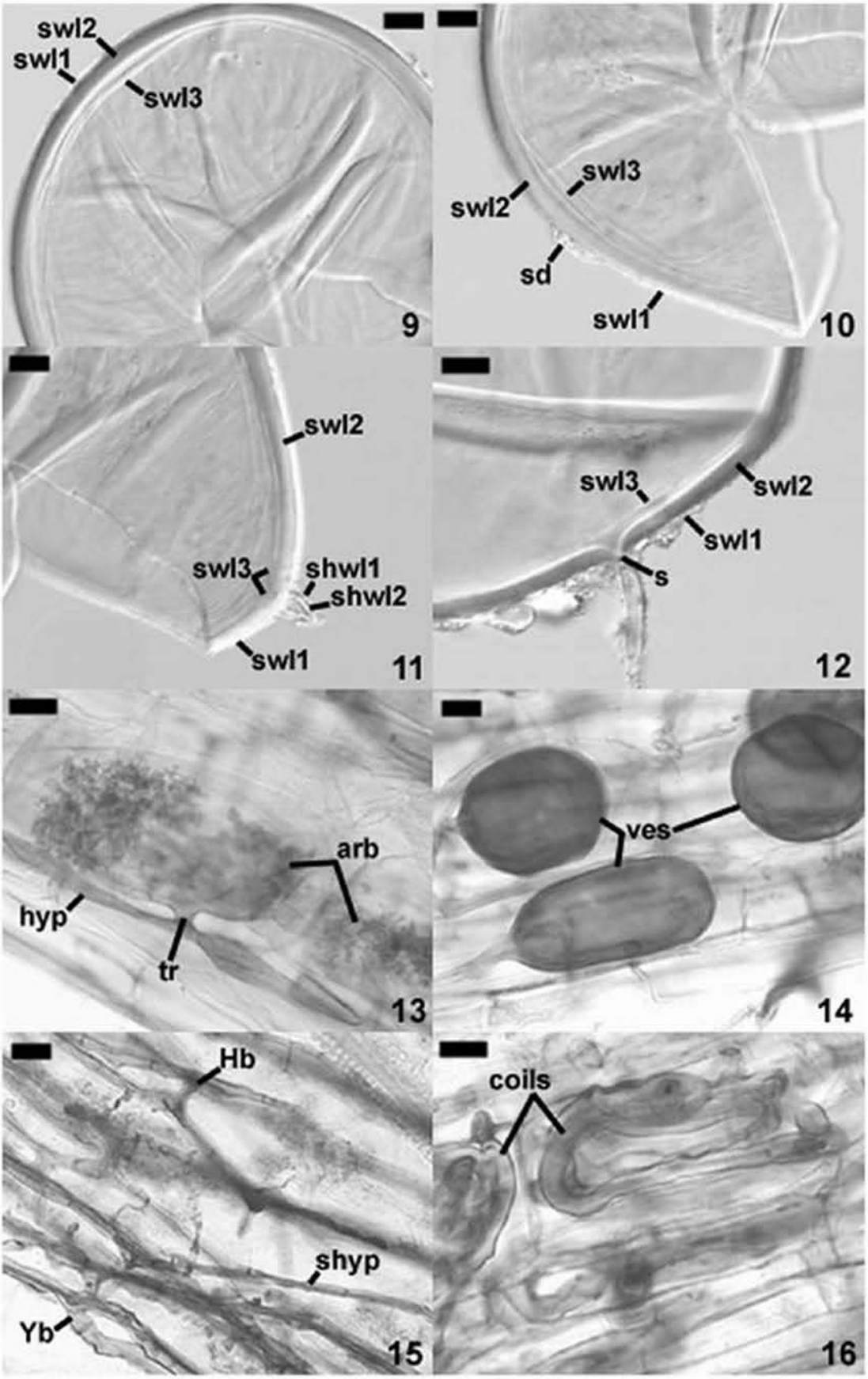
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reddish violet (16C8), coils pale violet (16A3) to reddish violet (16B6), and extraradical hyphae light lilac (16A5) to royal purple (16D8).

Phylogenetic position. The analysis of the 5.8S gene within the ITS region revealed a close relationship between *G. aurantium* and *G. versiforme* (P. Karsten) S.M. Berch (Fig. 17). In the LSU tree, *G. aurantium* is the terminal taxon of a not supported lineage placed sister to the *Glomus* Group A (Fig. 18). Comparing the full length ITS sequences of *G. aurantium* with sequences assigned to *G. versiforme* available in GenBank, the molecular similarity of the two fungi ranged from 89 to 92% (Table 1).

Table 1. Comparison of the *Glomus aurantium* ITS nrDNA sequence with GenBank sequences

Sequences from GenBank	Identity [%]	# bp aligned (with gaps)	# variable positions	# of gaps
Glomus versiforme AF246141	91	548	41	11
Glomus versiforme AF246142	89	550	49	11
Glomus versiforme AF246143	90	550	41	12
Glomus versiforme AJ504642	90	559	34	22
Glomus versiforme AJ504643	92	555	24	21
Glomus versiforme AJ504644	91	547	36	11
Uncultured *Glomus* AY236283	85	561	57	29

Column 2 - the identity of the *Glomus aurantium* ITS sequence (between the priming sites of the ITS1/ITS4 primer) with the sequence mentioned in column 1 (calculated as the value in column 3 minus the values in columns 4 and 5 divided by the value in column 3); column 3 - the number of base pairs of the paired sequence alignments between our sequences and the corresponding sequence of column 1; column 4 - the number of variable positions; column 5 - the number of gaps in these alignments

Discussion. Glomus aurantium most distinguishes its orange-colored spores and their wall structure. In the 3-layered spore wall, the structures most distinctive are the flexible to semi-flexible permanent outermost layer 1, which sometimes balloons in lactic acid-based mountants, and the flexible innermost layer 3. None of the three layers stains in Melzer's reagent.

When viewed under a dissecting microscope, spores of *G. aurantium* most resemble those of *G. pustulatum* Koske et al. and *G. versiforme* because of their orange pigmentation and a similar size range (Błaszkowski 2003; Koske et al. 1986; Morton 2000). Younger, yellow-colored spores of *G. aurantium* are also reminiscent of those of *G. claroideum* N.C. Schenck & S.M. Sm., *G. fasciculatum* (Thaxt.) Gerd. & Trappe emend. C. Walker & Koske, *G. lamellosum* Dalpé et al., and *G. luteum* L.J. Kenn. et al.

Examination of spores crushed in PVLG and PVLG mixed with Melzer's reagent under a compound microscope readily separates *G. aurantium* from the six species listed above. Although both *G. aurantium* and *G. pustulatum* produce spores with a wall consisting of three permanent layers, the outermost layer of the former species is smooth or covered with granular debris and that of *G. pustulatum* is ornamented with blistery, cup- or irregularly-shaped processes (Błaszkowski 2003; Koske et al. 1986).

The character most distinguishing *G. versiforme* from *G. aurantium* is the lack of the innermost flexible spore wall layer of the latter species (Błaszkowski 2003; Morton 2000). Additionally, the outermost spore wall layer in *G. aurantium* is permanent, and that of *G. versiforme* degrades with age.

The spore wall of *G. fasciculatum* and *G. lamellosum* also consists of three layers (Błaszkowski 2003; Błaszkowski et al. 2002; Dalpé et al. 1992; Walker & Koske 1987). Moreover, in *G. fasciculatum*, these layers are persistent and have similar phenotypic properties as those of *G. aurantium*. However, two outer spore wall layers of the former species stain red in Melzer's reagent, whereas all three wall layers of *G. aurantium* spores remain non-reactive in this reagent. Additionally, the outermost spore wall layer of *G. fasciculatum* does not accumulate debris as that of *G. aurantium* and spores of the former fungus frequently occur in aggregates (vs. only single spores in *G. aurantium*).

In contrast to the outermost persistent layer and the innermost in-amyloid layer of spore wall of *G. aurantium*, the outermost wall layer of spores of *G. lamellosum* degrades with age and their innermost layer stains pinkish in Melzer's reagent (Błaszkowski 2003; Błaszkowski et al. 2002; Dalpé et al. 1992; Morton 2000).

Glomus aurantium differs from *G. claroideum* and *G. luteum* in the number of spore wall layers, as well as in their phenotypic and biochemical properties. Spores of *G. claroideum* and *G. luteum* have a penultimate laminate wall layer and an innermost flexible wall layer of spores of *G. aurantium* (Błaszkowski et al. 2003; Kennedy et al. 1999; Schenck & Smith 1982; Stürmer & Morton 1997; Walker & Vestberg 1998). However, the laminate layer in *G. aurantium* is surrounded with only one permanent layer, whereas that of the former two species is covered with two layers, of which each degrades and sloughs with age. Finally, the outermost spore wall layer of *G. claroideum* and *G. luteum* stains pink to purplish red in Melzer's reagent, but remains non-reactive in *Gl. aurantium*.

The accumulation of soil debris on the surface of mature spores of *G. aurantium* is a property that also distinguishes spores of *G. viscosum* Nicol., another species producing spores of a similar structure of their wall and a size range (Morton 2000; Walker et al. 1995). However, spores of *G. viscosum* are much lighter-colored (subhyaline to pale yellow vs. yellowish white to golden yellow in *G. aurantium*) and frequently occur in aggregates (vs. only singly in *G. aurantium*).

The molecular analysis of the 5.8S gene confirmed a close relationship of *G. aurantium* with *G. versiforme* (Fig. 17, Table 1). Based on sequence data from the ribosomal small subunit (SSU), *G. etunicatum* W.N. Becker & Gerd. (isolate W3239/

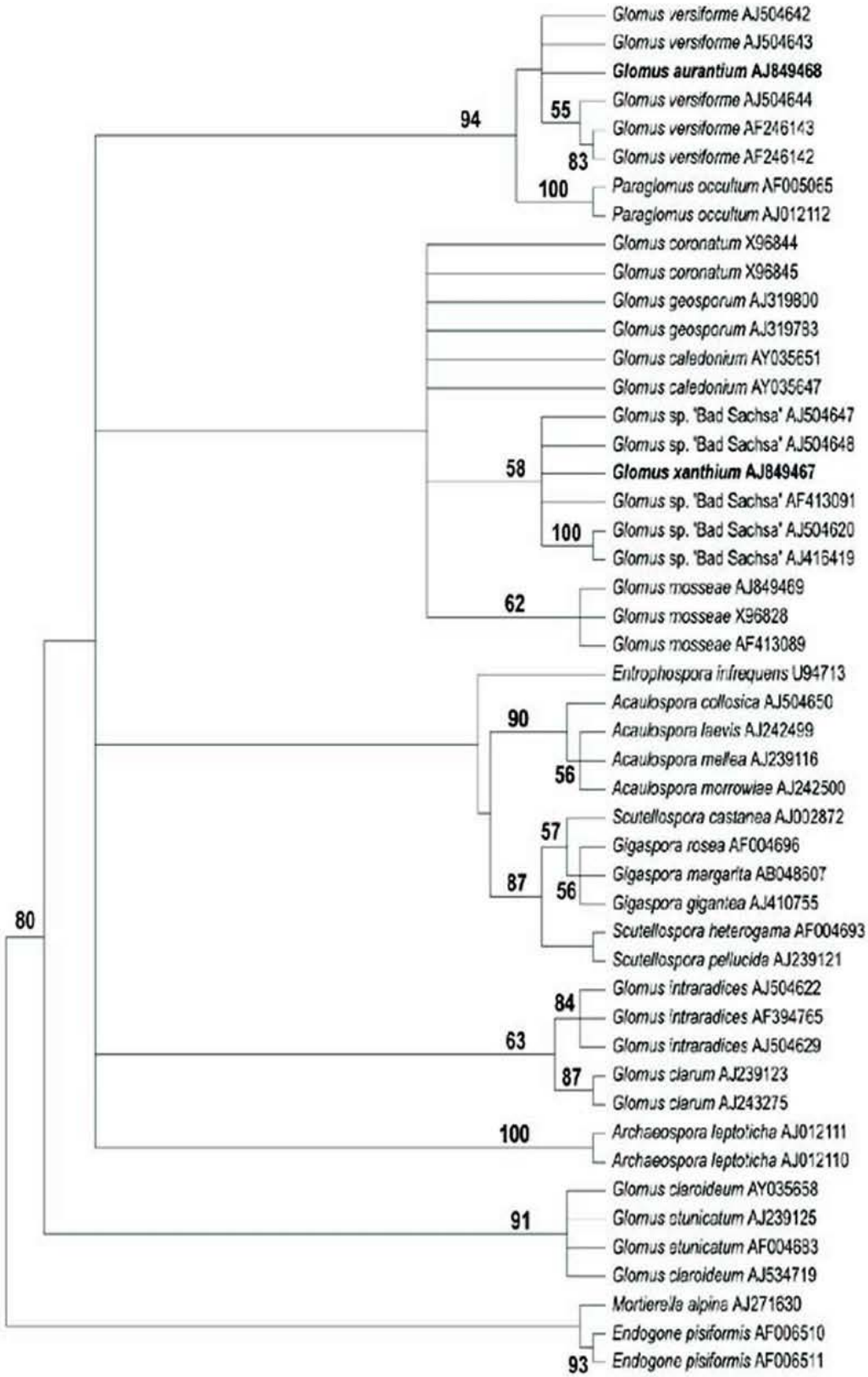

Fig. 17. Strict Consensus Tree of the Glomeromycota based on 49 5.8S sequences of the nrDNA. Phylogenetic positions of the newly described *Glomus aurantium* and *G. xanthium* are given in bold. Numbers above branches give bootstrap support derived from 1000 replicates. Sequences of *Mortierella alpine* and *Endogone pisiformis* were used as outgroups.

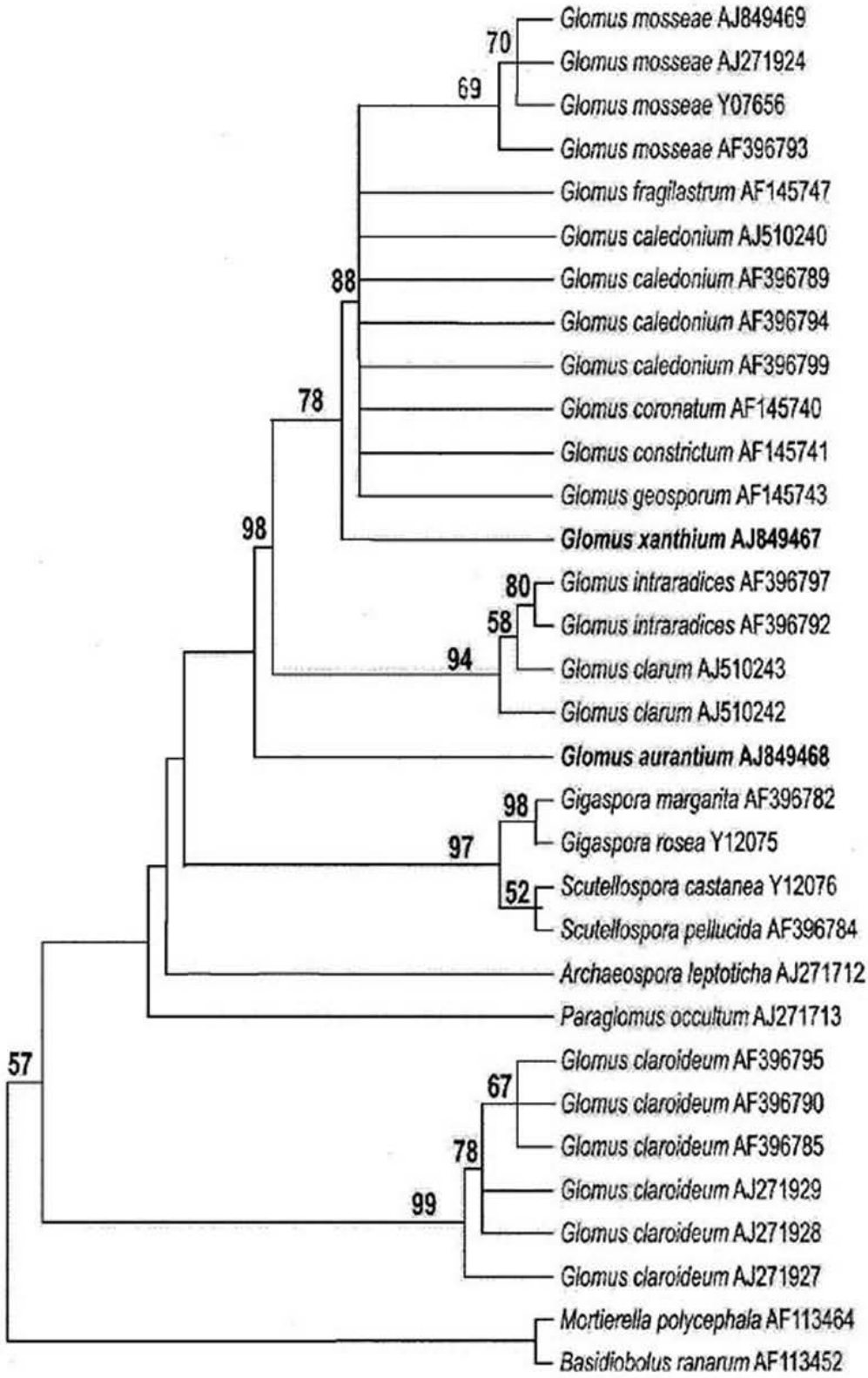

Fig. 18. Strict Consensus Tree of the Glomeromycota based on 34 partial 28S sequences (large subunit) of the nrDNA. Phylogenetic positions of the newly described *Glomus aurantium* and *G. xanthium* are in bold. Numbers above branches give bootstrap support derived from 1000 replicates. *Mortierella polycephala* and *Basidiobolus ranarum* sequences were used as outgroups.

Att382-16) and *G. spurcum* C.M. Pfeiff., C. Walker & Bloss emend. L.J. Kenn. et al. also clustered phylogenetically next to *G. versiforme* (Schüßler et al. 2001). However, Schüßler et al. (2001) showed some SSU sequences of *G. etunicatum* (isolate UT 316) that rather clustered in *Glomus* Group B, which was also the case for ITS sequences of *G. etunicatum* from GenBank used in our study (Fig. 17). Unfortunately, LSU sequence data of *G. versiforme*, *G. etunicatum*, and *G. spurcum* to further assess and confirm the phylogenetic position of *G. aurantium* are missing and therefore *G. aurantium* formed a single lineage in the LSU phylogenetic tree presented here (Fig. 18). Finally, comparing morphological properties of the four fungi listed above, only *G. aurantium* produces spores having an innermost flexible layer in their wall structure (Błaszkowski 2003; Morton 2000).

Glomus xanthium J. Błaszk., V. Blanke, C. Renker & F. Buscot, sp. nov.

Figs. 19-34

Sporocarpia ignota. Sporae singulae in solo efformatae; pallide luteae vel ochraceae; globosae vel subglobosae; (23-)50(-70) µm diam; aliquando ovoideae; 20-55 x 45-100 µm. Tunica sporae e stratis tribus (strati 1-3); strato "1" rigido, glabro, hyalino vel pallide luteo, (1.2-)1.8(-2.7) µm crasso; strato "2" semielastico, hyalino, (0.2-)0.8(-1.2) µm crasso; strato "3" laminato, glabro, pallide luteo vel ochraceo, (0.7-)1.6(-2.2) µm crasso. Hypha pallide lutea vel ochracea; recta vel recurva; cylindrica vel infundibuliforma, raro coliga; (2.7-)5.6(-9.1) µm lata ad basim sporae; pariete pallide luteo vel ochraceo; (0.5-)0.9(-1.5) µm crasso, stratis 1-3 sporae continuo. Porus e septo continuo strati 3 sporae efformata. Arbuscular mycorrhizae formans.

HOLOTYPUS. POLAND. Szczecin, infra *Plantago lanceolata* L., 10 Jan. 1998, *Błaszkowski, J., 2202* (DPP).

Sporocarps unknown. Spores occur singly in the soil (Fig. 19) and usually are closely adherent to roots (Fig. 20), as well as frequently form within roots (Fig. 21); origin blastically at the tip of extraradical hyphae of mycorrhizal roots. *Spores* light yellow (4A4) to yellow ochre (5C7); globose to subglobose; (23-)50(-70) µm diam; sometimes ovoid; 20-55 x 45-100 µm; with a single subtending hypha (Figs. 19-24, 30). *Subcellular structure of spores* (Figs. 22-29) of one wall with three layers (layers 1-3). Outermost layer 1 rigid, smooth, hyaline, ca. 0.5 µm thick, continuous with a one-layered subtending hypha of the most juvenile spores, then darkening to light yellow (4A4) and thickening to (1.2-)1.8(-2.7) µm (Figs. 22-29). Layer 2 rigid, smooth, hyaline, (0.2-)0.8(-1.2) µm thick (Figs. 22-29), closely adherent to layer 1. In mature spores, layer 1 sometimes more or less deteriorates with age (Figs. 28 and 29), whereas layer 2 always remains intact. Layer 3 laminate, smooth, light yellow (4A4) to yellow ochre (5C7), (0.7-)1.6(-2.2) µm thick (Figs. 22-29). In crushed spores, layers 1 and 2 usually are adherent (Figs. 22-26, 28 and 29) or sometimes separate from each other (Fig. 27). However, the two layers easily separate from layer 3 (Figs. 22-29). None of the spore wall layers reacts in Melzer's reagent. The wall of youngest spores consists of layer 1 only. Then, layer 2 origins, and layer 3 begins to form after a full differentiation of layer 2. *Subtending hypha* light yellow (4A3) to yellow ochre (5C7); straight or recurvate; cylindrical or flared (Figs. 24, 30), rarely constricted; (2.7-)5.6(-9.1) µm wide at the spore base. *Wall of subtending hypha* light yellow (4A4) to yellow ochre

(5C7); (0.5-)0.9(-1.5) μm thick at the spore base; continuous with spore wall layers 1—3 (Fig. 30); spore wall layers 1 and 2 extend up to 70 μm below the spore base. *Pore* occluded by a septum, 1.2-2.7 μm wide, continuous with the innermost lamina of spore wall layer 3 (Fig. 30).

Collections examined. HOLOTYPE. POLAND. Szczecin, under pot-cultured *P. lanceolata*, 10 Jan. 1998, *Błaszkowski, J., 2202* (DPP); ISOTYPES: *Błaszkowski, J. 2203-2223* (DPP) and two slides at OSC.

Other material examined. ISRAEL. Near Tel-Aviv (32°4'N, 34°46'E), from the root zone of *C. drummondi*, 16 Dec. 1997 and 15 June 2000, *Błaszkowski, J., unnumbered collection* (DPP). SPAIN. Near Cape Salinas (36°19'N, 3°2'E), Majorca, from around roots of *A. arenaria*, 15 Aug. 2001, *Błaszkowski, J.*, unnumbered collection (DPP). TURKEY. Near Karabucak-Tuzla (36°43'N, 34°59'E), from among roots of *A. arenaria*, 7 June 2001, *Błaszkowski, J.*, unnumbered collection (DPP). ITALY. Near Calambrone (43°35'N, 10°18'E), from under *A. arenaria*, 11 Oct. 2002, *Błaszkowski, J.*, unnumbered collection (DPP).

Etymology. Xanthium, referring to the plant species with which this fungus was originally associated.

Distribution and habitat. Spores of *G. xanthium* were for the first time isolated from a trap culture established with a soil sample collected under *Xanthium* cf. *spinosum* L. colonizing maritime sand dunes adjacent to Veriko in northern Greece (22°35'E, 40°08'N). This fungus was not found in the field-sampled soil. The fungi occurring in the field soil from which *G. xanthium* inoculum originated included two unrecognized *Glomus* spp. and *S. persica*. The arbuscular mycorrhizal fungal species associated with *G. xanthium* in trap cultures were *G. clarum* Nicol. & N.C. Schenck, *G. gibbosum*, and an undescribed *Glomus* sp.

Subsequently, this fungus was revealed in 15 trap cultures with rhizosphere soils of other dune sites of the Mediterranean Sea. They were collected from under *C. drummondi* growing near Tel-Aviv, Israel, in 1997 (one sample) and 2000 (7 samples), from among roots of *A. arenaria* growing near Cape Salinas, Majorca, Spain, in 2001 (2 samples), from under *A. arenaria* growing near Karabucak-Tuzla, Turkey, in 2001 (4 samples), and under *A. arenaria* growing near Calambrone, Italy, in 2002 (one

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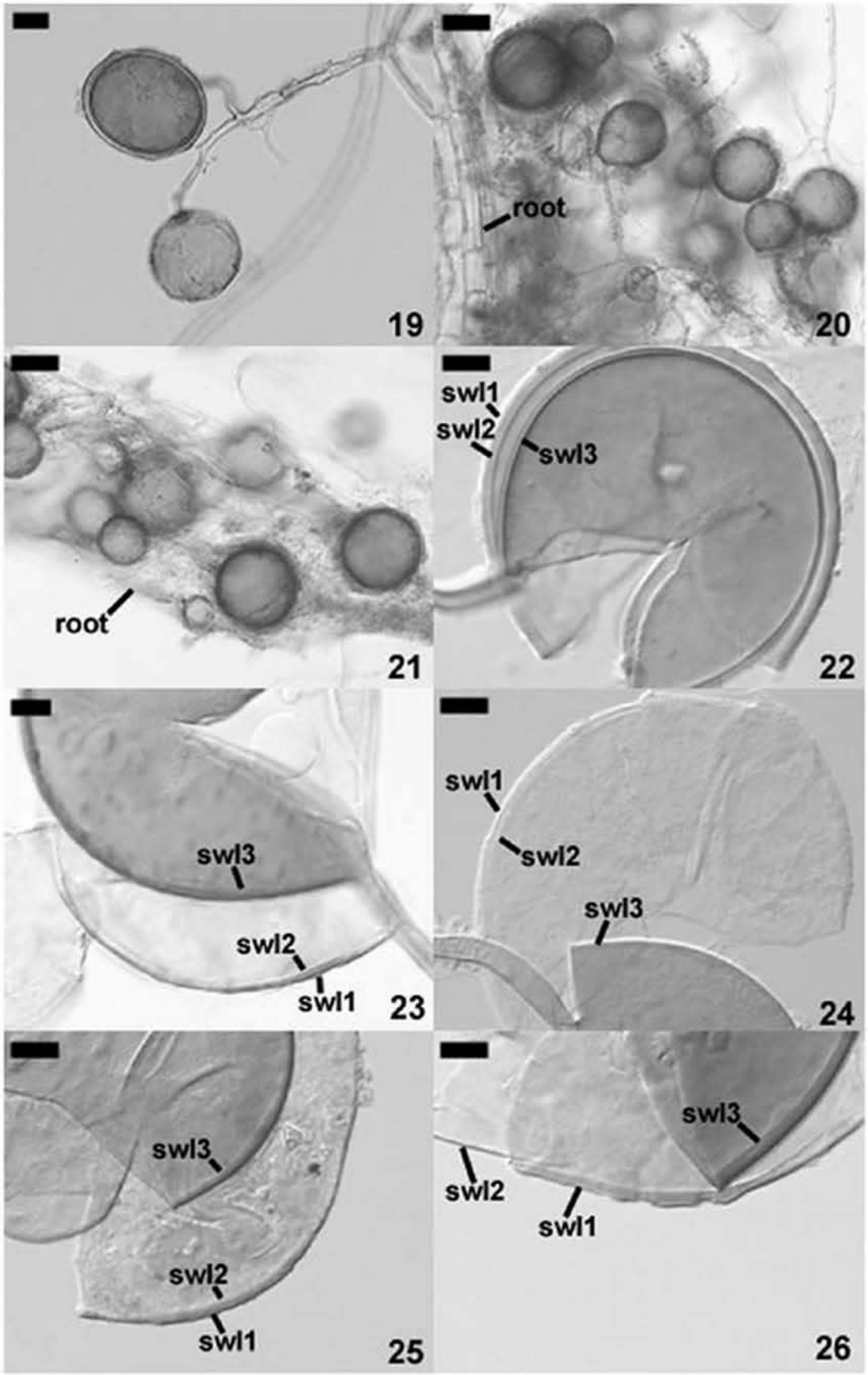
Figs. 19-34. Spores of *Glomus xanthium* and its mycorrhizae in roots of *Zea mays* stained in 0.1% trypan blue. **19.** Extraradical spores with halo formed by spore wall layers 1 and 2. **20.** Spores closely associated with root. 21. Intraradical spores. **22-26.** Adherent spore wall layers 1 (swl1) and 2 (swl2) separated from spore wall layer 3 (swl3). **27.** Spore wall layers (swl) 1-3 separated from each other. **28 and 29.** Highly deteriorated spore wall layer 1 (swl1) adherent to spore wall layer 2 (swl2) separated from spore wall layer 3 (swl3). **30.** Subtending hyphal wall layers (shwl) 1-3; curved septum (s) is visible. **31.** Arbuscules (arb). **32.** Arbuscule (arb), vesicle (ves), and coils of intraradical hyphae. **33.** Vesicles (ves). **34.** Straight (shyp) and coiled (chyp) intraradical hyphae. Figs. 19 and 20, intact spores in water. Fig. 21. Root with spores in PVLG. Figs. 22-24 and 27-30, spores crushed in PVLG. Figs. 25 and 26, spores crushed in PVLG+Melzer's reagent. Figs. 31-34, mycorrhizae in PVLG. Figs. 19-21 and 31-34, bright field microscopy; Figs. 22-30, differential interference contrast. Bars: Fig. 19=20 μm, Figs. 20 and 21=50 μm, Figs. 22-34=10 μm.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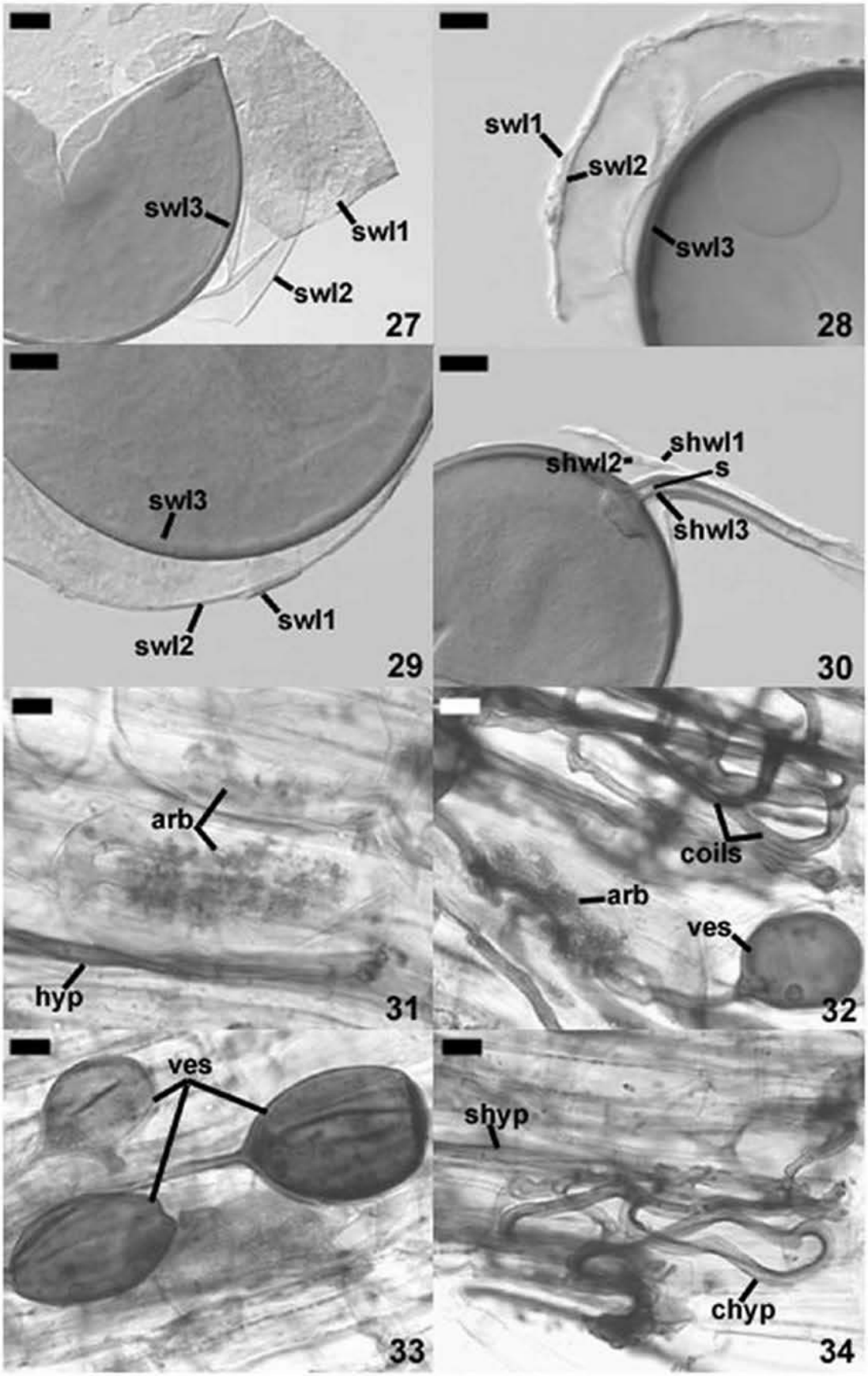
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sample). No study of the composition of arbuscular mycorrhizal fungal species in the field-collected soils was undertaken. The arbuscular mycorrhizal fungi co-occurring with *G. xanthium* in the trap cultures with Israeli soils were *Archaeospora trappei*, *G. constrictum*, *G. dominikii*, *G. claroideum*, *G. coronatum*, and *Scutellospora pellucida* (Nicol. & N.C. Schenck) C. Walker & F.E. Sanders. The Majorca's cultures contained *Ar. trappei*, *G. constrictum*, *G. corymbiforme*, *S. calospora*, those from Turkey *G. constrictum*, *G. coronatum*, *G. fasciculatum*, *G. aurantium*, and *S. calospora*, and those from Italy *Acaulospora bireticulata* F.M. Rothwell & Trappe, *G. aurantium*, *G. microcarpum* Tul. & C. Tul., and *S. persica*.

The chemical properties of the original soils were not determined.

Mycorrhizal associations. *Glomus xanthium* was associated in the field with vesicular-arbuscular mycorrhizae of *X.* cf. *spinosum* in Greece, *C. drummondi* in Israel, and *A. arenaria* in Spain and Turkey. In one-species cultures with *Z. mays* as the host plant, *G. xanthium* formed mycorrhizae with arbuscules, vesicles, as well as intra- and extraradical hyphae (Figs. 31-34). Arbuscules were numerous and generally evenly distributed along the root fragments examined (Fig. 31). Vesicles occurred numerously and were globose to subglobose, (20-)27(-40) μm diam, or ellipsoid, 17.5-40.0 x 22.5-120 μm (Figs. 32 and 33). Intraradical hyphae varied in thickness from (0.9-)5.9(-12.7) μm, grew parallel to the root axis, and sometimes formed Y- or H-shaped branches and coils, 12.5-27.5 x 17.5-55.0 μm (Figs. 31, 32 and 34). Extraradical hyphae were abundant, frequently associated with spores, and measured (3.2-)4.7(-7.4) μm wide. In 0.1% trypan blue, arbuscules stained violet white (16A2) to deep violet (16D8), vesicles violet white (16A2) to deep violet (16E8), intraradical hyphae violet white (16A2) to deep violet (16E8), coils violet white (16A2) to reddish violet (16B6), and extraradical hyphae deep violet (16D8-E8).

Phylogenetic position. Sequence data and phylogenetic analyses placed *Glomus xanthium* in *Glomus* Group A *sensu* Schüßler et al. (2001). Sequences of *G. xanthium* fell into a separate cluster (Fig. 17) or even formed a separate lineage (Fig. 18) within *Glomus* Group A, distinct from all well known species of this group (e.g. *G. mosseae*, *G. coronatum*, *G. caledonium* (Nicol. & Gerd.) Trappe & Gerd., *G. geosporum* (Nicol. & Gerd) C. Walker). However, *G. xanthium* clustered close to a preliminarily named *Glomus* sp. 'Bad Sachsa' (with no further correlation to morphological features) from a gypsum slope of the southern Harz mountains (Germany; Renker et al. 2003, Börstler et al. unpubl. data), displaying identities between 90 and 94% (Fig. 35).

Discussion. Two properties mainly distinguish *G. xanthium* from other *Glomus* species. First, spores of the new fungal species tend to form within or tightly adherent to roots (Figs. 20 and 21). Second, the spores are relatively small, with the outermost layer usually thicker than the innermost layer of the 3-layered spore wall (Figs. 19, 22-24, 27).

The pattern of spore wall differentiation in *G. xanthium* is similar to that of *Glomus* species investigated to date (Błaszkowski 1997; Błaszkowski & Tadych 1997; Morton 1996; Stürmer & Morton 1997), with discrete layers formed successively.

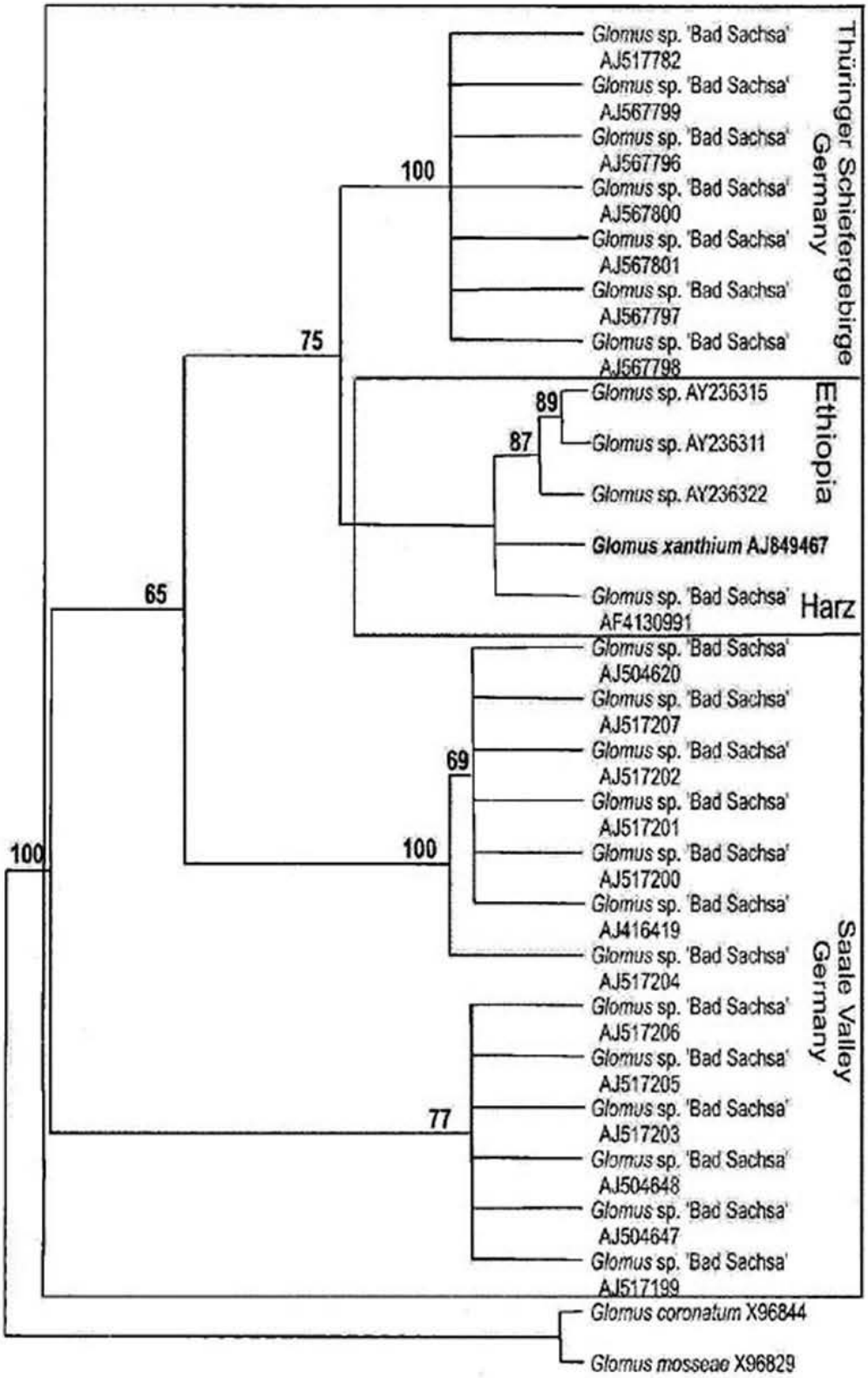

Fig. 35. Strict Consensus Tree of the Glomeromycota belonging to *Glomus* Group A (*sensu* Schüßler et al. 2001) based on 28 ITS sequences of the nrDNA. The phylogenetic position of the newly described *G. xanthium* is given in bold. Numbers above branches give bootstrap support derived from 1000 replicates. Sequences of *Glomus coronatum* and *G. mosseae* were used as outgroups.

When observed under a dissecting microscope, spores of *G. xanthium* most resemble small-spored isolates of *G. aggregatum* N.C. Schenck & Sm. emend. Koske and *G. intraradices* N.C. Schenck & S.M. Sm. These species produce yellow-colored spores that frequently occur in both aggregates tightly associated with roots and inside them (Błaszkowski 2003; Schenck & Smith 1982; Stürmer & Morton 1997).

Using a light microscope, examination of spores crushed in a mixture of PVLG and Melzer's reagent readily separates the three fungi. The spore wall of *G. xanthium* is composed of two, usually adherent rigid, semi-permanent and permanent layers, respectively, readily separating from a laminate innermost layer when crushed (Figs. 22-29). The spore wall of *G. aggregatum* and *G. intraradices* also consists of three layers, of which two outer ones usually detach from the innermost laminate layer in crushed spores (Błaszkowski 2003; Schenck & Smith 1982; Stürmer & Morton 1997). However, the two outer spore wall layers of the latter fungi are short-lived and usually are completely sloughed in mature spores (Błaszkowski 2003; Stürmer & Morton 1997). Additionally, the outermost wall layer of both *G. aggregatum* and *G. intraradices* stains red to purple in Melzer's reagent (Błaszkowski 2003; Stürmer & Morton 1997), whereas that of *G. xanthium* ramains non-reactive in this reagent. Finally, the unique character of *G. aggregatum* is the production of spores inside their parent spores by internal proliferation (Błaszkowski 2003; Koske 1985).

Although morphology placed *G. xanthium* close to *G. intraradices*, molecular data did not confirm this estimation. Unfortunately, there is lack of sequence data for *G. aggregatum*. Based on available molecular data, *G. xanthium* can be considered a member of *Glomus* Group A. While all the well known species of this group are distinct from *G. xanthium*, *Glomus* sp. 'Bad Sachsa'-sequences were found to be the closest relatives in the phylogentic analyses (Figs. 17 and 35). Firstly detected by Landwehr et al. (2002) at a gypsum slope in the southern Harz mountains (Germany), similar sequence types were found in further studies within Germany (Renker et al. 2003, Börstler et al. unpubl. data). Quite recently, Wubet et al. (2003) detected a *Glomus* sp. in Ethiopia colonizing roots of *Prunus africana*. ITS sequences of this fungus fall into the same sequence cluster like *G. xanthium* and the original *Glomus* sp. 'Bad Sachsa' sequence (Fig. 35).

Glomus aurantium and *G. xanthium* are probably adapted to warm soils of southern hemisphere. They have not been found in any of ca. 3000 soil samples collected in different dune and non-dune soils of northern Europe (Błaszkowski 2003). Koske (1987) found temperature to be the main abiotic factor influencing the structure of arbuscular fungi of the barrier dunes extending from New Jersey to Virginia. According to Pirozynski (1968), temperature is the major factor determining the distribution and occurrence of fungi in general.

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MYCOTAXON

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Three new taxa of *Stereocaulon* from China

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Abstract—Three taxa of the lichen genus *Stereocaulon* from China, namely *Stereocaulon intermedium* var. *gracile*, *St. kangdingense* and *St. sorediiphyllum* are described in this paper as new to science. The diagnoses in Latin and descriptions and remarks in English are given. In addition, each taxon is provided with a photograph.

Key words—*Stereocaulon intermedium* var. *gracile*, *St. kangdingense*, *St. sorediiphyllum*

During studies of the lichen genus *Stereocaulon* in China, some interesting specimens drew our attention. After an examination of them in detail three taxa are considered as new to science and described in the present paper.

1. *Stereocaulon intermedium* (Savicz) H. Magn. var. *gracile* M. R. Huang & J. C. Wei, *var. nov.* FIGURE 1

Varietas nostra a var. intermedio *pseudopodetiis decumbentibus et apotheciis nec apicalibus et lateralibus differt.*

TYPE—CHINA. SICHUAN: E. SLOPE OF MT. GONGGA, alt. 2400 m, on sandy soil, 23.VI.1982, *Wang X. Y., Xiao X. & Li B., no. 8841* (HMAS-L, **HOLOTYPE!**).

DESCRIPTION—Primary thallus evanescent in early stage. Secondary thallus with decumbent and caespitose stalks, i.e., pseudopodetia compactly caespitose, tuft-like, decumbent, slightly dorsiventral, cylindrical, slightly twisted, not tapered, gracile, 2.5-5 cm long, 0.5-1 mm thick, moderately branched, irregular, main stems conspicuous, completely decorticated, heavily or sometimes rather thinly tomentose, felted, whitish, not ligneous, without soredia, firmly or sometimes rather loosely attached to substrate; phyllocladia numerous, grain-like to mainly terete-coralloid, 0.1-0.2 mm thick, ash-gray, with paler tips, usually not over 1 mm long, but abundantly branched in an antler-like manner. Cephalodia abundant, sessile, globose to subglobose, 0.1-0.5 (-0.8) mm in diameter, with white pruina in surface or half-immersed in tomentosa, poorly corticate, containing *Nostoc* sp.

Apothecia abundant, terminal and lateral, with pseudolecanorine margin in earlier stage, disappearing later; disc brown, flattened or slightly convex; hymenium hyaline, 40-50 μm thick, both hypothecium and central cone colorless; asci 31-47 μm × 7-10 μm; spores 8 per ascus, colorless, clavate, 3-septate, 27-37 μm × 2-3 μm.

Pycnidia not observed.

CHEMISTRY—K+ yellow, P+ pale yellow; TLC: atranorin, lobaric acid.

OTHER SELECTED SPECIMENS EXAMINED — **CHINA. SICHUAN:** MT. EMEI, alt. 2800 m, on rock, 18.VIII.1963, *Zhao J. D. & Xu L. W., no. 8144*; **Wolong**, alt. 2200 m, on rock, 24.VIII.1982, *Wang X. Y., Xiao X & Li B, no. 9635*. **YUNNAN: Gongshan**, alt. 3300 m, on humus, 26.VII.1982, *Su J. J., no. 2620*; **Weixi**, E. SLOPE OF MT. BILUO, alt. 3300 m, on rock, 13.VII.1981, *Wang X. Y., Xiao X. & Su J. J., no. 4642*. **XIZANG: Nyalam**, alt. 3670 m, on soil, 14.VI.1966, *Wei J. C., Chen J. B. & Zong Y. C., no. 1571*. **INDIA. ANCHAL PRADESH: Chamoli Distr.**, BETWEEN WAAN AND BHUNA, alt. 11500 feet, on soil over rock with mosses and foliose hepatics, *A. Singh, no. 91599-1* (FH!), which was segregated from the holotype specimen of *St. paradoxum* I. M. Lamb.

REMARKS —The variety is distinguished from *St. intermedium* var. *intermedium* (FH-syntype!) mainly by lateral and terminal apothecia and decumbent, gracile and thickly tomentose pseudopodetia. It is widespread in southwestern China.

2. ***Stereocaulon kangdingense*** **M. R. Huang & J. C. Wei,** *sp. nov.* **FIGURE 2**

Species St. esterhuyseniae *similis a qua pseudopodetiis non lignosis tomentulosis et cephalodiis presentibus differt.*

TYPE — CHINA. SICHUAN: Kangding, SHADE, alt. 3300 m, on soil, 18.X.1999, *Chen L. H., no. 990108* (HMAS-L, **HOLOTYPE!**).

DESCRIPTION—Primary thallus evanescent in early stage. Pseudopodetia compactly caespitose, decumbent, obviously dorsiventral, cylindrical, 1-1.5 cm long, 0.5-1 mm thick, expanded into flattened and flabellate ends with digitately divided margins, sparsely dichotomously branched; main stems inconspicuous, completely decorticated on ventral side, covered with thin and smooth tomentosum, well corticate on dorsal side, especially the parts near the tips, not ligneous, without soredia, firmly attached to substrate; phyllocladia scarce, replaced by flabellate pseudopodetial apices or poorly differentiated cortex and adhered to pseudopodetia, crenate-lobulate. Cephalodia abundant, sessile, globose to verrucose, not over 0.5 mm in diameter, bluish, but pruinose in most cases, poorly corticate, containing *Nostoc* sp.

Apothecia and pycnidia not observed.

CHEMISTRY—K+ yellow, P+ red; TLC: atranorin, stictic acid, norstictic acid.

ADDITIONAL SPECIMEN EXAMINED — SICHUAN: NW SLOPE OF MT. GONGGA, alt. 2950 m, on rock, 11.VIII.1982, *Li B., Wang X.Y. & Xiao X., no. 0374*.

REMARKS—It seems to be very close to *St. esterhuyseniae* I. M. Lamb (CANL-holotype!). However, it can be recognized by presence of cephalodia, thin tomentum and non-ligneous pseudopodetia. What is more, the latter species is found only in South Africa so far (Lamb 1953, 1977). The resemblance of these two species suggests that they are a pair of vicarious species.

3. ***Stereocaulon sorediiphyllum*** **M. R. Huang & J. C. Wei,** *sp. nov.* **FIGURE 3**

Species St. coniophylli *similis a qua phyllocladiis granulosis et pseudopodetiorum apicibus non subfoliosis praecipue differt.*

TYPE — CHINA. JILIN: MT. CHANGBAI, alt. 1750 m, on rock, 9.IX.1997, *Guo S. Y., no. 1105* (HMAS-L, **HOLOTYPE!**).

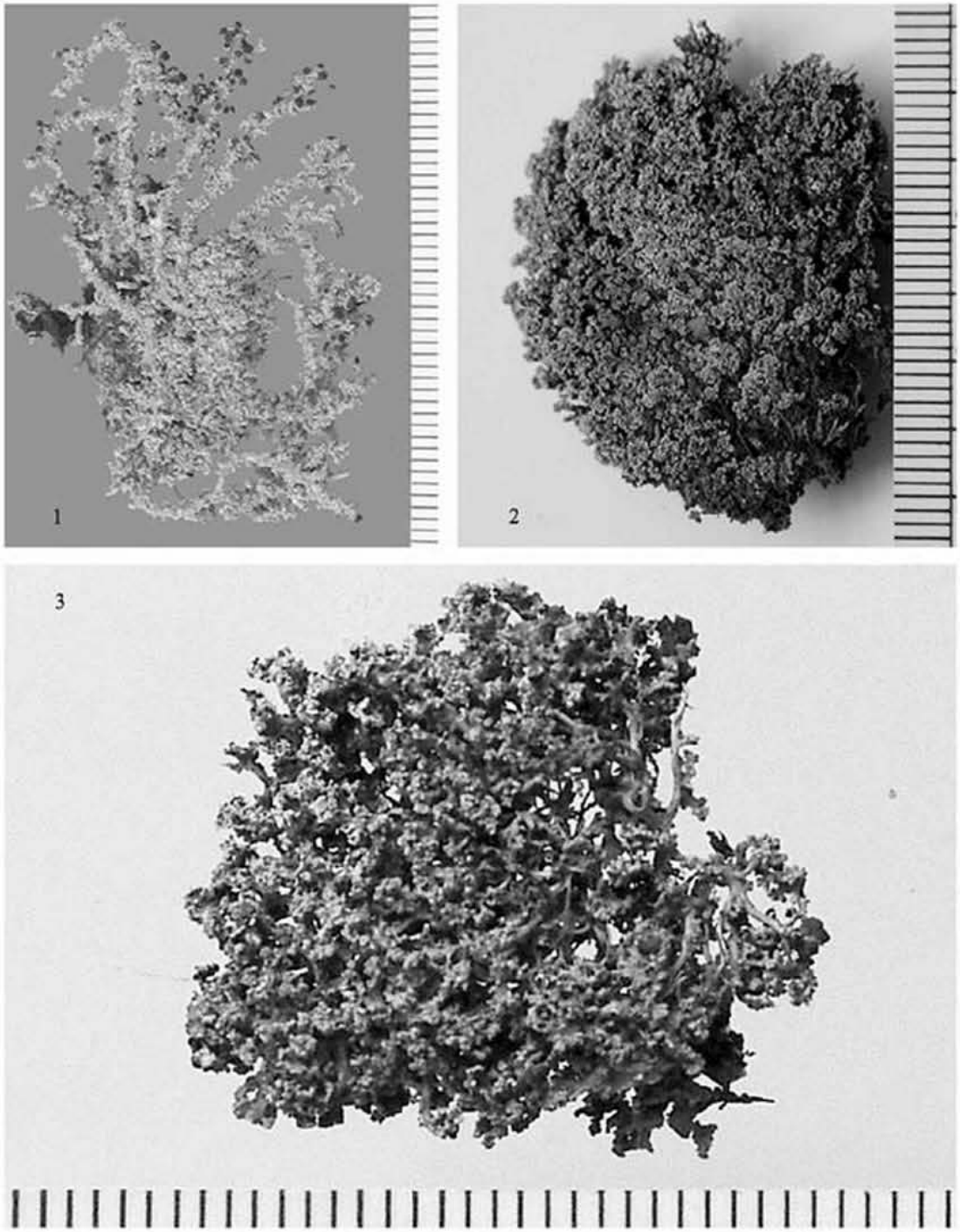

Fig. 1. *Stereocaulon intermedium* var. *gracile* (holotype). Scale=1 mm. Fig. 2. *Stereocaulon kangdingense* (holotype). Scale=1 mm. Fig. 3. *Stereocaulon sorediiphyllum* (holotype). Scale=1 mm.

DESCRIPTION — Primary thallus evanescent in early stage. Pseudopodetia compactly caespitose, erect, not dorsiventral, cylindrical, dwarfish, only 0.5-1.5 cm high, ca. 1 mm in diameter, abundantly branched, mostly corymbose; main stems inconspicuous, completely decorticated, glabrous, not tomentose, yellowish, obviously ligneous, some pseudopodetial ends flattened and subfoliose and brown, corticate on upper surface,

and ecorticate, completely sorediate on lower surface, like but not as much as in *St. coniophyllum* I. M. Lamb, firmly attached to substrate; phyllocladia numerous, grain-like, ca. 0.2 mm in diameter, aggregated at tips of pseudopodetia and their branchlets, but rare or absent in other parts, whitish, thinly pruinose; some phyllocladia are sorediate. Cephalodia rare, sessile, subglobose, 0.5-1.5 mm in diameter, brown, protosacculate, containing *Nostoc* sp.

Apothecia and pycnidia not observed.

CHEMISTRY—K+ yellow, P+ pale yellow. TLC: atranorin, lobaric acid.

ADDITIONAL SPECIMEN EXAMINED — SHAANXI: MT. TAIBAI, on rock, 5.VI.1963, *Wei* J. C. et al., *s.n.*

REMARKS—The new species is closely related to *St. coniophyllum*, from which it is distinguished by bearing numerous grain-like phyllocladia and by the basically nonsubfoliose apices of pseudopodetia.

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MYCOTAXON

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Book reviews and notices

Compiled by

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General

Cultivation and Diseases of *Proteaceae*: *Leucadendron, Leucospermum* and *Protea*. By Pedro W. Crous, Sandra Denman, Joanne E. Taylor, Lizeth Swart & Mary E. Palm. April 2004. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [CBS Biodiversity Series No. 2.] Pp. xii + 228, figs 460, col. plates 32. ISBN 90 70351 50 1. Price: € 60.

This is a most unusual book for one focused on diseases of cultivated plants, in that it combines authoritative information on their cultivation and harvesting for the cut-flower market with detailed taxonomic treatments of the disease-causing organisms. The diseases are divided into the categories: foliar (36); stem, shoot and flower diseases (9); root diseases (7); and those caused by bacteria and phytoplasms (2). In addition there are sections on untreated fungi and poorly understood diseases. In many cases, similar diseases are caused by different fungi on different host genera or species, for example *Batchleromyces*, *Botryosphaeria*, *Colletotrichum*, *Coniothyrium*, *Elsinoë*, *Mycosphaerella*, *Phaeophleospora*, *Pseudocercospora*, and *Trimmatostroma*. In such cases, keys to the species are often included. For each species treated, full nomenclatural information is presented with places of publication and synonyms, but not types (except for newly described species), symptoms are described, there is a detailed description of the fungus on the host and of its cultural characteristics, details on host range and distribution, the disease cycle and epidemiology, control, and other pertinent notes. The fungi are also illustrated by first-rate line drawings and photomicrographs, and in many cases colour photographs of the symptoms. The new genus *Saccharata* is introduced for the species currently known as *Botryosphaeria proteae* (anamorph *Fusicoccum proteae*), the new species *Coniothyrium grandicipis* is described, and one new combination made (*Pseudocladosporium proteae* for *Cladophialophora proteae*). Responsibly, some fungi treated are not referred to species belong to genera which are regarded as currently 'in disarray', for example *Pestalotiopsis* sp. There is an extensive bibliography, and also both general and host indices. The book is sure to become the key reference work commercial growers will want to hand, as well as mycologists

[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.

wishing to identify fungi on plants from this family. Though its level of treatment from the host cultivation, pathological, and fungal taxonomic viewpoints, the book also sets a new 'gold standard' for future texts on the fungi causing diseases of particular crop plants.

Journal of Fungal Research. Editor in Chief Yu Li. 2003 on. Journal of Fungal Research, Jilin Agricultural University, Changchun, Jilin 130118, People's Republic of China. Quarterly. ISSN 1672-3538. Price: US $ 60 p.a.

This new journal is launched in the introduction to the first part by Jiang-chun Wei as 'a window for academic exchange concerning the science, technology and education of pan [*sic*!] fungi'. The first issue (December 2003), which includes an intriguing article by David N. Pegler on 'The fly agaric, soma, Father Christmas and the Vikings', includes 13 research articles, the topics of which range from molecular systematics, to bioactive compounds, diversity, and new records for provinces of China. The second issue (March 2004) has eight papers, including an annotated checklist of *Tricholoma* species in China. Both parts also include 2-4 reviews in Chinese, listed under the heading 'Summary', and covering topics from 'simple and easy DNA preparation' to triterpene constituents of *Ganoderma*. Papers are either in English or Chinese, with abstracts in both languages. The journal has a broader scope than *Mycosystema* (now incorporating *Acta Mycologica Sinica*), and with so much mycological activity going in China today this new journal will provide a much-needed further outlet for that research. It is clearly a title to which all major mycological libraries should subscribe.

Recent Research Developments in Mycology. Managing editor S. G. Pandalai. 2003 on. Transworld Research Network, T.C. 37/661(2), Fort P. O., Trivandrum 695 023, Kerala, India. Pp. 85. ISBN 81 7895 117 7. Price: Not indicated.

There is unquestionably a need for more authoritative review articles in mycology. This aim is implicit in the title of this new series, although no explanation of its objectives appears in the first issue. The first number includes six articles which are diverse in scope. These address hyphal tip growth in *Achlya bisexualis*, blackspot disease of roses, fungal lectins and their roles, commercial applications of *Trichoderma* cellulases, knowledge of Spanish fungi, and white blister rust of pine. While it is evident that the title will be one that should be held by major mycological libraries, just how relevant it will be to systematic mycologists will depend on the topics of articles and the calibre of authors it attracts.

Basidiomycetes

Cytology and Plectology of the *Hymenomycetes*. By Heinz Clémençon (assisted by Valerie Emmett & Ernest E. Emmett). May 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstraße 3A, D-70176 Stuttgart, Germany.] [Bibliotheca Mycologica No. 199.] Pp. viii + 488, tables 12, figs 632. ISBN 3 443 59101 9. Price € 96.

Although not a taxonomic work *per se*, this remarkably detailed treatment of the cellular and subcellular structures and tissues in the *Hymenomycetes* is sure to become

recognized as the key reference work mycologists will wish to have to hand when describing and comparing structural features of macrofungi. Heinz Clémençon published his monumental *Anatomie der Hymenomyceten* in 1997 (Clémençon 1997), but in his Foreword to the new book explains his disappointment at colleagues who requested review copies of that work but never published reviews[2]. He records that another mycologist published 'a rather unpleasant and often unsubstantiated criticism' in *Sydowia*, and that he vowed never to publish a second edition or to translate it into English. Fortunately for mycology, his views were changed by later reviews in other journals (also by mycologists who had not requested free copies), and meeting up with Ernest and Val Emmett in 2000 who agreed to help with the English of a new work; he then 'decided to start writing'. But he also kept his vow; this is not a new edition nor a translation, but a new and substantially shorter book (488 *vs* 996 pages) incorporating data from many new microscopic preparations.

The contents are divided into sections on: Hyphae; the Mycelium; Mitospores; Basidia and basidiospores; Cystidia, pseudocystidia and hyphidia; Pigment topography; Bulbils, sclerotia and pseudosclerotia; Basidiomes; Carpogenesis; and Associations with other organisms. The emphasis is on describing, illustrating, and giving unambiguous names to the structures found. Because of the fine degrees of precision adopted, the numbers of specialized and generally rather unfamiliar terms employed is somewhat daunting. I wonder how many mycologists would know immediately what the following terms referred to: physalohyphae, acrophysalides, hydroplera, malocysts, coriotunica, blastokysts, lipsanoblema, or podostratum? Most of the terms used have been coined before by other mycologists, but have not entered general use. The choice of terms is discussed, and in some cases lists of ones to be avoided or which he has rejected are provided; these categories are especially large in relation to terms used to describe types of cystidia.

The line drawings, electron micrographs and photomicrographs are all superb and clearly have been lovingly executed, although some are reduced to a rather small size.

The chapter on associations with other organisms may at first seem rather out of place, but here the emphasis is on the special structures involved in interactions. Those treated range from bacteria and algae to trees and invertebrates. I found the photographs and drawings of "termitospheres" especially interesting, and I can imagine the updated diagram and key to mycorrhizal types on p. 421 being rapidly incorporated into mycology lectures and used as hand-outs all over the world.

I am sure that the 1997 book did not receive the accolade and circulation it merited primarily because of the length and the language used. The decision to prepare a book of under half the length of the earlier one and also to present it in English will mean that it is perceived and used internationally. The decision to have Valerie and Ernest Emmett assist with the English style was a wise one and their imprint is evident on almost every page. "Val" and "Ern", the first a former schoolteacher and assessor and the latter one of the foremost field mycologists in Europe, have made sure that the

[2] As compiler of the Book Reviews and Notices section for *Mycotaxon*, I have too frequently had the experience of mycologists agreeing to review titles for the journal, but then either never, or belatedly after several reminders, submiting their reviews. Sadly this has meant that a few titles received by *Mycotaxon* have still not been featured in the journal 2-4 years after the books were received from the publishers.

language is lucid and unambiguous almost throughout. Reading between the lines of the Foreword, it is evident that they also repeatedly questioned particular choices and definitions. They have much to be proud of in making the contents as accessible as possible to mycologists in general.

This is sure to become a mycological classic, and deserves to be on the mycological best-seller list. All who work with hymenomycete fungi will need this work to hand, especially as increasing numbers of mycologists take up the recommended terms, and further as many are not defined or nor illustrated in the current edition of *Ainsworth & Bisby's Dictionary of the Fungi* (Kirk *et al.* 2001).

I trust Heinz Clémençon will find at least this review acceptable, and expect the sentiments to be echoed in others yet to appear.

Clémençon, H. (1997) *Anatomie der Hymenomyceten*. Teufen: F. Flück-Wirth.

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.

Fungi of Australia. Volume 2B. Catalogue and Bibliography of Australian Fungi 2. *Basidiomycota* p.p. & *Myxomycota* p.p. By Tom W. May, J. Milne, S. Shingles & R. H. Jones. 2003. Australian Biological Resources Study and CSIRO, CSIRO Publishing, P. O. Box 1139, 150 Oxford Street, Collingwood, Victoria 3066, Australia. Pp. 452, coloured plates 64. ISBN 0 643 06907 0. Price: AS $ 99.

The fine series *Fungi of Australia* is a valuable contribution towards our knowledge of mycology in the region, intending to cover in sixty volumes the great diversity of fungi present in this country. Two volumes have been published to date, both separated into two parts. Volume 1A where John Walker's classification of fungi provides a pragmatic framework at the higher levels (Walker 1996), and which also includes a key to the orders following mainly the concepts outlined in the 7th edition of *Ainsworth & Bisby's Dictionary of the Fungi*, and Volume 1B, both published in 1996 (reviewed in *Mycotaxon* **62**: 492-493, 1997). Volume 2 intends to provide a basic bibliographic tool to facilitate the preparation of taxonomic treatments of Australian fungi, and is designed as well for anyone wishing to use up-to-date names of Australian fungi. Volume 2A covered several orders of agarics, boletes and hypogeous fungi, and was reviewed in *Mycotaxon* **66**: 515-516 (1998). Volume 2B aims to include the remaining genera of six of the orders of larger *Basidiomycota* already dealt with in volume 2A, along with all Australian representatives of a further 19 orders in the *Basidiomycota*, as well as nine orders of the larger *Mycomycota*. In Volume 2B the orders follow the system used in the 8th edition of *Ainsworth & Bisby's Dictionary of the Fungi*, with the exception of *Ceratiomyxales*, which is kept separate from *Protosteliales*. Other parts of the *Fungi of Australia* which will cover the remaining groups of fungi are in preparation. Both parts of Volume 2 provide full bibliographic citations of all names applied to taxa recorded from Australia, list the taxa according to their accepted names, provide a list of synonyms, and compile the relevant literature and pertinent literature records for each accepted name.

Unusually for a checklist, 64 species are illustrated with good quality colour photographs. Any mycologist working in the rich tropical Southern Hemisphere regions wishing to make comparisons between the mycobiotas of different countries or regions will find this book extremely useful and a "must" for reference. The bibliography section

comprises approximately 37 pages of references in 8 pt type, which facilitate access to specialized mycological publications. The conventions used in the citation of literature, abbreviations and contractions are provided as well, the layouit is conveniently explained on the inside fron cover and fly leaf, and the whole is fully indexed.

This book will be useful to both amateurs and professionals who are interested in knowing more about the diverse fungi of this region, as well as those who will work on monographs for later volumes in the series. As there are so few concise guides to the fungi of Australia, this new book is so much more valuable and is sure to be used more extensively than is usual for national catalogues and checklists.

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Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Henrink (*Fungi, Basidiomycota, Hygrocybeae*) in Greenland. By Torbjørn Borgen & Eef Arnolds. 2004. Danish Polar Centre, Strandgade 100H, DK-1401 Coppenhagen, Denmark. [Meddelelser om Grønland, Bioscience No. 54.] Pp. 68, figs 24. ISBN 87 90369 68 8. Price: DKK 200 .

This is a regional monographic treatment of *Hygrocybe s. lat.* and *Camarophyllopsis* in Greenland. A key and descriptions are provided to 26 species and five varieties. Two taxa are described as new: *Hygrocybe rubrolamellata* sp. nov. and *H. conica* var. *aurantiolutea* var. nov. The descriptions are detailed, informative, and well formatted for locating information. The figures are especially noteworthy, and often include superb drawings of the hymenophoral trama or the pileipellis, critical elements in the taxonomy of this group. Plots of spore widths *versus* lengths and variation in size of the pileipellis terminal elements are also provided. The authors propose that the size of the elements in the stipititrama of *Hygrocybe* subsection *Squamulosae* is of taxonomic value, and have presented the data necessary to negate the possibility that this character varies with habitat. The taxonomy is accurate except for what appears to be one misapplied name, *H. cantharellus*. The lamellar trama hyphae of the specimens from Greenland are larger than those from specimens taken near the type locality of *H. cantharellus* in North Carolina, USA (49–194 x 4.5–25.5 *vs* 5.6–44 x 4–16) μm). In addition, the aspect of the basidiomes differs between the European concept used by the authors and the original (the stipe length is generally less than twice the pileus diameter in Europe and Greenland, *vs* 2–4 times longer than the pileus diameter in the Americas). One table showing the distribution of the 30 taxa among the various habitats, and another showing the timing of fruiting for 11 of the more common taxa augment the introductory material and the discussion of ecology. The high quality and detail of the descriptions and supporting line drawings and graphs will make this book appealing to agaricologists working in the North Temperate and boreal zones.

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Ascomycetes

***Laboulbeniales* II. *Acompsomyces* – *Ilyomyces*.** By Sergio Santamaria. November 2003. J. Cramer in Gebrüder Borntraeger Verlagsbuchhandlung, Berlin. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Johannestraße 3A, D-70176 Stuttgart, Germany.] [Flora Mycologica Iberica Vol. 5.] Pp. 344, figs 93. ISBN 3 443 65010 4. Price: € 78.

This contribution, the fifth volume of an ongoing series on Iberian fungi, represents the second volume devoted to members of the *Laboulbeniales*. An earlier issue (Santamaria 1998) dealt only with the large genus *Laboulbenia*. This volume treats 40 additional genera and 106 species, all arranged alphabetically, beginning with *Acompsomyces* and ending with *Ilyomyces*. A third contribution on *Laboulbeniales* is planned to treat the remaining known taxa between *Misgomyces* and *Zodiomyces*.

The current volume more or less mirrors the format of Santamaria (1998) with generic circumscriptions followed by the author's observations, a key to the known Iberian representatives, and detailed descriptions and illustrations of each of these. One improvement over the previous volume is the inclusion of copious illustrations of all species, including, where possible, line drawings of thalli at different stages of development. Many of these drawings are excellent and emphasize key features of note for each taxon.

Descriptions of genera and species are, on the whole, well written yet succinct – although no mention is made of the numbers of thalli studied for each taxon, and therefore, in some cases (e.g. *Acompsomyces brunneolus* and *A. corticariae*) it is difficult to reach conclusions on the utility of particular morphological characters, and indeed on the validity of different taxa. It is also unfortunate that the author did not attempt to re-examine type material in cases of dispute over the status of some "species" (e.g. *Camptomyces europaeus, C. melanopus*).

Despite the above, there is no doubt that this work will be an essential reference for anyone studying *Laboulbeniales*, particularly the European taxa. The quality of the descriptions and illustrations should accommodate those with even a rudimentary knowledge of *Laboulbeniales*. In this regard I am hopeful that a key to the genera will be included in the remaining Part, as this will be critical in attracting new students. The author is to be commended on the level of detail and scholarship contained within this volume.

Santamaria, S. (1998) *Laboulbeniales I. Laboulbenia*. [Flora Mycologica Iberica Vol. 4.] Madrid: Real Jardín Botánico.

ALEX WEIR

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***Hyaloscyphaceae, Sarcoscyphaceae* et *Sarcosomataceae*.** By Wen-Ying Zhuang, Zhi-He Yu & Zheng Wang. 2004. Science Press, 16 Dong-Huang-Cheng-Gen-Bei Street, Beijing 100717, People's Republic of China. [Flora Fungorum Sinicorum Vol. 21.] Pp. 192, figs 66, plates 36. ISBN 7 03 012618 1. Price: US $ 35.

The *Flora Fungorum Sinicorum* is one of five series of monographs produced as a part of the Cryptogamic Flora of China initiative of the Chinese Academy of Sciences.

The project formally started in 1973, and the first fungal volume was published in 1987; this new work represents the 14th to have appeared to date, and the second on discomycete families; Wen-Ying Zhuang prepared one covering the *Geoglossaceae* and *Sclerotiniaceae* in 1998 (vol. 8), and in this new volume she is the author or co-author of all 34 generic accounts included, in total covering 141 species. The largest family covered is the *Hyaloscyphaceae* with 18 genera and 99 species. Keys to the genera in each family and to the species within each genus are provided. The species accounts include full bibliographic citations to both accepted names and synonyms, detailed descriptions, information on hosts and distribution (often by citation of specimens in HMAS), and in many cases clear line drawings of microscopic features. The drawings of excipular tissues are especially carefully made; these structures are not figured in many regional works so this aspect will prove of particular value. The plates comprise half-tone photographs of microsocopic features and scanning electron micrographs of ascospores in selected species, and one in colour showing the macroscopic appearance of four species. Great care clearly went into preparing the original half-tone plates, but the unfortunate quality of the printing limits the amount of information that can be gleaned from them. Habit drawings and photographs are generally absent, which, although not critical, would have been an additional help to those trying to determine species in genera such as *Lachnum*.

No new scientific names appear to be introduced, the authors having previously described new species they have found in primary journals, especially *Mycotaxon*. This is a taxonomic practice commended by many plant systematists as in general journals have wider circulations than books and are therefore more accessible to researchers. Nevertheless, there is clearly yet more work needed on some of the species treated, five having "cf." inserted before the species name. The authors clearly recognize that publication of such synthetic works should not be delayed until all problems are resolved. The aim of treatments like this should be to provide an authoritative synthesis of the current state of knowledge, a foundation on which future researchers can build.

In general the nomenclature appears to have been carefully checked and follows the current *Code*, though I did catch "(Pat. in Duss)" on p. 73 (three times) in author citations where this should have been just "(Pat.)", although the information was correctly presented where the basionym was cited. I also found the placement of indications of sanctioned status before the original place of publication of the name somewhat confusing as the unwary may think that the reference refers to where the name was sanctioned.

Wen-Ying Zhuang is already to me the doyenne of Chinese discomycetes. This new book not only confirms her in that position, but demonstrates that we can expect much more from her now that she has shed some of her formerly demanding administrative tasks in Beijing.

Lichen-forming Fungi

Le genre *Strigula* (Lichens) en Europe et en Macaronésie. By Claude Roux & Emmanuel Sérusiaux (in collaboration with Olivier Bricaud & Brian J. Coppins). July 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung,

D-14129 Berlin, Germany. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstraße 3A, D-70176 Stuttgart, Germany.] [Bibliotheca Lichenologica No. 90.] Pp. 96, figs 39, tables 2. ISBN 3 443 58069 6. Price: € 32.00.

The lichen genus *Strigula* is best known as an abundant and conspicuous element of the foliicolous lichen biota in the (sub)tropics. The species on other substrates and especially those growing (also) outside the tropics are less conspicuous and in general poorly known. A critical study of these species is therefore very welcome, even though most species are only rarely encountered. In practice, they should be looked for in the same microhabitats where *Porina* species are occurring, *viz.* sheltered smooth bark and shaded rock (and of course living leaves, in Europe usually *Buxus*). Species of *Strigula* are undoubtedly sometimes confused with *Porina* species, and the differentiating characters are rather subtle (ascus tip, hamathecium branching) and often difficult to observe. The exception is when macroconidia are being produced, which invariably have typical gelatinous appendages, obvious only when observed with a good microscope. Specimens with only macroconidia have in the past been described sometimes as separate taxa under the illegitimate generic designation *Discosiella*, to which no reference is made in the book.

This revision gives identification keys in English, French and Esperanto to all species in Europe and Macaronesia, and full descriptions of all species in French, with an enumeration of (selected) specimens. Details of all species are illustrated with line drawings. There are separate keys for specimens with (only) macroconidia. Reminiscent species of *Porina* are not included or mentioned in the text.

The book contains much novel information, including six species new to science, one new combination, and three new synonymies. The common corticolous pantropical *S. phaea* is reported from Europe, while the European specimens earlier assigned to the common foliicolous pantropical *S. smaragdula* are shown to belong to a new species. A full description of *S. smaragdula* is given though for comparison. The specimen lists contain many new records for various countries, especially in Western Europe.

The species concept is still a bit unsettling especially in the *S. calcarea*-group. Specimens producing macroconidia only (and no ascomata) are rather frequent, and in fact from two of the species newly described here no ascomata are known at all, whereas from the two other species in the group no macroconidia are known, but only ascomata. This group includes the only terricolous species in the genus, *S. sychnogonoides*, which is still often classified in a separate genus, *Geisleria*, mostly because there is no overwhelming evidence (macroconidia, DNA analyses) that it fits into *Strigula*. It is also still known under the name *Porina glaucocinerea*, to which surprisingly no reference is made in the text. Especially, the broadly fusiform ascospore shape is deviant from the remaining species of *Strigula*, with the exception of the newly described *G. thelopsidoides*, which might in future turn out to be a second species of *Geisleria*.

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Ascomycetes Lichenisati: Species foliosae et fruticulosae. [Lapiškosios ir krūmiškosios kerpės.] By Jurga Motiejūnaitė. 2002. Valstiečių Laikraštis, Botanikas Institutas, Žaliųjų ežerų 49, LT-08406 Vilnius 21, Lithuania. [Mycota Lithuaniae/Lietuvos Grybai Vol. 13(1).] Pp. 312, figs 90, coloured plates 8. ISBN 9986 847 52 4. Price: € 28.

This is the first major work on Lithuanian lichens to have appeared since the checklist of Minkevičius (1963). Following a history of the study of lichens in the country and general accounts of lichens and their biology and ecology, treatments of 189 macrolichen species are presented, of which 16 have not been seen for 50 years or more and 50 are included in the Red Data Book of Lithuania. Keys to genera, and to species within genera are provdied. For each species treated, full bibliographic nomenclatural information is provided, along with descriptions, notes on ecology and distribution, and in many cases distribution maps. The colour plates are of a selection of 30 species. The work is in Lithuanian with a summary in English. I was especially pleased to see this volume included in the *Mycota Lithuaniae* series, as some countries still find it hard to accept that lichen names are those of the fungal component and that their place is thus in fungal rather than botanical series. This will be a major stimulus to the study of lichens in Lithuania, and the author is to be congratulated on producing this detailed synthesis and placing our knowledge of the country's macrolichens on a par with that of many others in Europe.

Minkevičius, A. (1963) Medžiaga lietuvos TSR kerpių florai. *Biologija* (Vilnius) **3**: 79-95.

Contributions to Lichenology: Festschrift in Honour of Hannes Hertel. Edited by Peter Döbbeler & Gerhard Rambold. 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Distributor: E. Schweizerbart'sche Verlagsbuchhandlung, Johannesstrasse 3A, D-70176, Stuttgart, Germany.] [Bibliotheca Lichenologica No. 88.] Pp. vii + 739, figs 181, tables 28. ISBN 3 443 58067 X. Price: € 148.

This Festschrift contains 44 papers by 79 authors from 19 countries. The papers in it were brought together discretely in 2003, and presented as a surprise gift to Hannes Hertel on the occasion of his 65th birthday. A table of contents is available on http://www.schweizerbart.de/pubs/books/bo/bibliothec-05008800-desc.html and maybe one should look at this webpage while browsing through this review in *Mycotaxon*.

Reading through the titles one can see 19 single author contributions, and 13 papers generated by dual author teams, indicating that lichenology is still a subject where substantial contributions can be made by individuals under the restrictions of research on a low budget. For a cross section of lichenology in 2003, this is well worth collecting for the bookshelf even though the price is severe.

There are a number of articles which will be of considerable long term value as references; that of Dagmar Triebel and colleagues on "IndExs–Index of Exsiccatae" is an excellent account of this topic. An herbarium curator's reaction to this paper should be to set up an e-mail co-operative to computerise all *schedae*. Mikhail Andreev's *Miriquidica* account is a must for Northern Hemisphere mountain lichen hunters, and for adventurers in the palaeotropics Harrie Sipman's *Lobaria* paper will be helpful. Floristic works of interest include Edit Farkas on foliicolous lichens from South

Africa, Klaus Kalb on mostly South American lichens, Robert Lücking on foliicolous *Porinaceae*, and Walter Obermayer on Himalayan lichens. All these floristic studies indicate the literature resources one needs to conduct practical lichen identification. One piece of taxonomic humour will be useful for teachers of lichen courses in universities; Ulrich Søchting and co-workers describe a new parasitic species *Caloplaca sauronii* named after the character Sauron in Tolkein's *Lord of the Rings* from a remote part of Antarctica. Thorsten Lumbsch's argument on homoplasy in phylogenetic analyses is essential reading for monographers in training. Overall, this is a finely produced issue that I am sure Hannes Hertel is very pleased with.

The publishers have made available what would normally be written as the proceedings of a conference, or printed as a special issue in a regular journal of an international learned society or instition. With *Bibliotheca Lichenologica* there is always variation in size, frequency of appearance, relevance to one's own interest and price. I imagine that quite a number of members of the lichenological community pick and choose volumes of *Bibliotheca Lichenologica* for their personal libraries, while institutions with lichenologists on their staff have to struggle for budgets to ensure that a full run of *Bibliotheca Lichenologica* is secured. Instead of clamouring again and again for new money issue by issue, or having to decide whether to pick an issue or not, perhaps a personal annual subscription to the series of say € 100 to cover all numbers produced in the year could be considered. Such a setup might also help to subsidise the cost of publishing *Bibliotheca Lichenologica*. This would also ensure that there are at least a few hundred copies even of the most "unpopular" numbers in the series floating about in the libraries of lichenologists. Lichenology is still a small enough subject for students to collect monographs in print to empower themselves to make identifications. With more copies of *Bibliotheca Lichenologica* in circulation in various countries, more will also become available on the second hand market in due course. After all, isolated students need to consult particular volumes to gain access to the writings of inspirational lichenologists!

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A Second Checklist of the Lichens of Italy with a thesaurus of synonyms. By Pier Luigi Nimis & Stefano Martellos. 2003. Museo Regionale di Scienze Nagturali, Saint-Pierre, Valle d'Aosta, Aosta, Italy. [Monografie No. 4; OPTIMA Commission for Lichens Publ. No. 5.] Pp. 192. ISBN not indicated. Price: € 40.

The first critical checklist of Italian lichens since the earliest decades of the twentieth century was prepared by Nimis (1993). This work, presented in English, provides a new checklist in which 2345 infrageneric taxa (i.e. species, subspecies, and varieties), 2244 of which are lichenized and accepted. These figures represent a net increase of 200 species (9.3 %) on the number accepted in 1993. On a regional level, the largest rise has been the number of species known in Umbria, from a modest 47 to 455 species; the richest region is Trento-A.Ad. with 1301 species. The introductory parts also include references to other checklists produced worldwide in recent years and explain both the philosophy adopted and nomenclatural terms, the latter with examples that will be most helpful to the non-taxonomist. The nomenclature follows most recent taxonomic changes, though with the benefit of hindsight it might have been better to adopt fewer

of the parmelioid generic names as more recent molecular data shows that several have to be combined.

The accepted names are listed alphabetically, genus by genus, with author citations but not dates of publication of the accepted names. I suspect that these will be included in the new critical checklist for Italy promised for 2006. However, the main purpose of this publication is to make available the index to synonyms. This includes a staggering 12 600 infrageneric epithets listed alphabetically (with the original generic name in parenthesis) and cross-indexed to the accepted taxa. The total of number of names treated in the book, i.e. accepted epithets and synonyms, is 15 053. Further, the list of synonyms also includes ones used in other parts of southern and eastern Europe and even North Africa. The authors modestly state "this could be of some help in facilitating connections among distributed databases . . . " (p. 5). I am sure it will be, but its importance is more than regional. Indeed, I believe it must be the most extensive list of synonyms used for lichenized fungi to have been published anywhere since the compilation of Zahlbruckner (1921-40).

Only 108 names are listed as "poorly known taxa" or "dubious records"; to have such a modest number of names in these categories represents an enormous achievement in determining the applications of thousands of other names.

This will be of immense value not only in facilitating communication between databases, but to all endeavouring to interpret earlier literature; for example, when compiling local to regional or national checklists, curating herbarium specimens, or trying to interpret earlier ecological and floristic studies. It would be tremendous if this information could be combined with the names already in the *Index Fungorum* database already freely available on the worldwide web (http://www.indexfungorum.org/Names/NAMES.AS) and incorporated into the on-line global lichen checklist started by Tasilo Feuerer (http://www.biologie.uni-hamburg.de/checklists/world_1 /htm); it is already available electronically through ITALIC, the online updated version of Nimis (1993); http://dbiodbs.univ.trieste.it).

The thesaurus dimension makes this book a "must" for all working regularly with names of lichenized fungi, and at such a modest price for both personal and institutional lichenological libraries. Try and secure a copy before the print-run is exhausted!

Nimis, P. L. (1993)*The Lichens of Italy: An annotated catalogue.* [Monografia No. 12.] Turin: Museo Regionale di Scienze Naturali.

Zahlbruckner, A. (1920-40) *Catalogus Lichenum Universalis.* 10 vols. Leipzig: Borntraeger.

Keys to the Lichens of Italy. Vol. 1. Terricolous Species. By Pier Luigi Nimis & Stefano Martellos. 2004. Edizioni Goliardiche, Via SS. Martiri 18, I-34124 Trieste, Italy. [Le Guide di Dryades 1, Serie Licheni I (L-1).] Pp. 341. ISBN 88 88171 73 8. Price: € 45.

Until I saw this work, I would never have guessed that 439 lichen species occurred in terricolous habitats in Italy. But there are problems over the interpretation of this somewhat confusing and often ambiguous term, discussed in detail here. However, in the final analysis the authors adopted a broad and pragmatic view embracing lichens found on the ground regardless of whether they were directly on soils, dead bryophytes, small dead plants, or weathered rocks. The introduction also includes a "largely incomplete"

synopsis of the soil-lichen communities represented which have been given formal names (e.g. *Cladonietum foliaceae* Klem. 1955), guides to users, and explanation of the orders in which characters are used and treated in the keys and descriptions. The characters in the keys are ranked according to the price of equipment needed to study them: progressively passing from bare eyes, through hand lens, chemicals, cheap microscope, UV-lamp, and professional microscope, to chromatography. This move will be applauded by the numerous non-specialists who are sure to use the book and merits emulation.

The keys themselves have been produced using the program FRIDA, which was written by the second author. They are strictly dichotomous and five in number, each dealing with species with a different growth form (i.e. fruticose, foliose, squamulose, crustose, and leprose). Where species key out, a distribution map and full small-type description is provided, along with notes on the ecology, chemicals produced, distribution and sometimes other observations. In order to facilitate the use of the book by non-specialists, a series of more manageable "simplified keys" is provided. Four separate simplified keys consider species on: subalpine-alpine, on acid to subacid substrata; subalpine-alpine, on subneutral to basic (calcareous) substrata; Mediterranean to montane, on acid to subacidic substrata; and Mediterranean to montane, on subneutral to basic (calcareous) substrata. Within each of these categories, subkeys proceed growth-form by growth-form, and there is a glossary dealing even with the most basic terms (e.g. mycelium), again to encourage amateur use. It would have been good to have some lichen illustrations, particularly colour photographs as many of these lichens are brightly coloured and strikingly attractive, but that would inevitably have impacted on the cost.

The habitat focus is an eminently practical one for stand-alone identification aids, but is rarely adopted, although a useful guide to lichens on arid soils in Australia was provided by Eldridge & Tozer (1997), a work I was surprised not to see cited in the otherwise most helpful bibliography. As many of the species have very wide distributions and the text is entirely in English, the book should do much to stimulate surveys and ecological assessments of soil crusts worldwide – hopefully particularly in arid areas where the ecosystem is fragile but so important in stabilizing soil surfaces. All who enjoy lying on their stomachs with a hand lens searching for minute black or even yellowish green ascomata at last have a *vademecum*.

Eldridge, D. & Tozer, M. E. (1997) *A Practical Guide to Soil Lichens and Bryophytes of Australia's Dry Country*. Sydney: Department of Land and Water Conservation.

Eesti Pisisamblikud. Edited by Tiina Randlane & Andres Saag. 2004. Tartu Ülikooli Botaanika ja Ökoloogia Instituudis, Tartu, Estonia. Pp. 584, figs 17, col. figs 84. ISBN 9985 56 916 4. Price: EEK 300.

A comprehensive guide to the macrolichens of Estonia was prepared by Trass & Randlane (1994). That work covered about 300 species, and this new book, also in Estonian, is essentially a companion volume. This was a most ambitious undertaking for two people, and seven additional authors were recruited to prepare the accounts of one or more genera (each of which is attributed to particular authors). It covers not only 647 species of crustose lichens, but further around 100 species of lichenicolous fungi (mainly through contributions by Ave Suija).

Introductory chapters address the nature of lichens, terminology, collection and preservation, lichenicolous fungi (with a Table detailing species occurring on different hosts), chemical reagent tests, TLC characteristics of different lichen extrolites, a systematic arrangement of genera by subclass, order and family, and a glossary illustrated by line drawings. Keys to the lichenicolous genera, sterile crustose lichens, and lichenized genera. The genera are treated alphabetically, with generic descriptions, references to key literature, keys to species, descriptions, separate diagnoses, information on ecology and distribution, and Estonian common names. The colour plates are the only illustrations provided of particular species, but are of a superb quality (and include a few lichenicolous fungi).

This work makes Estonia the only county apart from Sweden (Foucard 2001; see *Mycotaxon* **90**(1): 233-234, 2004) to have keys and descriptions to both its crustose and lichenicolous species between the same covers. An interesting new trend may be emerging, although the Estonian book was surely influenced by the Swedish one (which is cited). However, unlike Foucard's book, all lichenicolous species known in the country are treated, not just those occurring on crustose lichens.

A major achievement for Estonian lichenologists, and a book that all concerned with the distribution of crustose lichens and lichenicolous fungi will need to familiar with.

Foucard, T. (2001) *Svenska Skorplavar och Svampar som växter på dem.* Stockholm: Interpublishing.

Trass, H. & Randlane, T. (1994) *Eesti Suursamblikud.* Tartu: Tartu Ülikooli Botaanika ja Ökoloogia Instituudis.

Väike Sammalde ja Samblike Raamat. By Aino Kalda & Tiina Randlane [with photographs by Taimi Paal & Andres Saag]. 2004. AS Bit, Pikk 68, Tallin 10133, Estonia. Pp. 224. ISBN 9985 2 0926 5. Price: EEK 175.

An introductory guide to the bryophytes and lichens of Estonia. There are 53 lichens treated with superb colour photograph opposite a full page of information about the selected species. While most are macrolichens, it was good to see 17 crustose and squamulose treated. Estonian common names are provided, a box contains diagnostic features, and there is extensive information on ecology and distribution. The author and photographer of the lichen treatments (Tiina Randlane and Andres Saag respectively; *see above*) are leading lichenologists in Estonia, and the work is consequently authoritative. The existence of such a text in the country's language is sure to help encourage the interest of amateurs and students in lichenology and provides a bridge to the more detailed works on the nation's lichens now available (*see above*). However, if lichens had to be twinned with some other organisms, I would have preferred it to be non-lichenized fungi rather than bryophytes; that single act would have given an immediate positive message about their nature.

Checklist of lichens of the Western Carpathians. By Urszula Bielczyk, Anna Lackovičoká, Edit E. Farkas, László Lökös, Jiří Liška, Othmar Breuss & Sergey Y. Kondratyuk. 2004. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Biodiversity of the Carpathians Vol. 1.] Pp. 181, figs 3. ISBN 83 89648 12 1. Price: 30.

The Lichens and allied Fungi of the Polish Carpathians: An annotated checklist. Edited by Urszula Bielczyk. 2003. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Biodiversity of the Polish Carpathians Vol. 1.] Pp. 342, figs 4. ISBN 83 85444 28 9. Price: € 20.

The Carpathian Mountains are an impressive range running in an enormous 1300 km long swathe 100-300 km wide, rising to around 2300 m, and taking in parts of Austria (0.3 % of the range), the Czech Republic (3.2 %), Hungary (4.3 %), Poland (9.3 %), Romania (55 %), Slovakia (17.1 %), and Ukraine (10.3 %). To pull the diverse information and literature on the lichens in the range together has been a major international effort, which in his Foreword to the series Zbigniew Mirek hopes "marks the beginning of a new period in scientific collaboration". Following a short introduction, highlighting the changes in vegetation types with altitude and 107 geomorphological units, the alphabetical listing starts. This covers 1817 species belonging to 288 genera, with synonyms listed below accepted names and also cross-referenced to those from their positions in the alphabetical series. The countries from which each species is recorded are indicated by abbreviated country codes justified to the right-hand side of the pages. There is, however, no information on habitat, frequency, or the dates of records. When I visited the Ukraine sector in 1991, I was struck by both the lichenological richness of some areas, but also the extent to which some of the forests had been disturbed. It would have been of interest to know more of the distribution, frequency, and status of some of the old-forest indicator species in particular.

With some of the leading lichenologists in the pertinent countries involved in the compilation, the taxonomy is in generally up-to-date, with many of the more recent taxonomic changes adopted. However, there are a few nomenclatural quibbles, such as the superfluous citation of authors' names after species epithets in the names of infraspecific taxa other than that including the type, and the retention of "em." in some citations. Lichenicolous fungi are not included in the overall checklist, although some "allied" fungi are. Amongst the latter I was surprised to see the name *Tromera resinae* accepted in that genus and not in *Sarea*, which was adopted for *S. difformis* here.

The treatment on the lichens of the Polish section is much more detailed. Although constituting only 9.3 % of the range, the list accepts a staggering 1327 species, 75 % of all lichens known in the whole of Poland and 73 % of all lichens recorded in the entire Carpathian Mountains. Lichenicolous species are also included, however, which contributes modestly to these high percentages. Surprisingly, two lists are presented rather than an integrated one, dealing with separately with the western (by Urszula Bielczyk) and eastern (by Robert Kościelniak and Józef Kiszka) Polish Carpathians. These are again arranged alphabetically, and literature records are given by a fine system of regions and meso-regions; there are over 300 papers on the lichens of the Polish sector, so this synthesis was clearly much needed. Synomyns are cross-referenced from the index, but also listed under the accepted names in the main listing.

Both volumes are well-produced and entirely in English, and I find it commendable that the first volumes in two different biodiversity series concern lichens, rather than as one might expect, birds, butterflies, fish, or plants – a major achievement for the lichenological community of the region.

The Lichen Genera *Lasallia* and *Umbilicaria* in the Polish Tatra Mts. By Beata Krzewicka. 15 March 2004. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland. [Polish Botanical Studies No. 17.] Pp. 88, figs 67. ISBN 83 89648 11 3. Price: € 15.

This is not just a systematic account to the single species of *Lasallia* and 20 of *Umbilicaria* in the Tatra Mountains, part of the Carpathian range (see above), but also a detailed autecological study. Keys and full descriptions are provided, together with accepted names and synonyms along with their bibliographic citations, information on chemistry and habitats, exsiccates studied, often impressively long lists detailing all collections traced from the area (taking up almost three pages for *U. cylindrica*), and distribution maps (which split pre- and post-1970 records). All but one Polish species (*U. dendrophora*) occurs in the Tatra mountains, and the study includes the first report of *U. aprina* for the Carpathians. Records of *U. arctica* proved to be based on misidentifications, and no recent sites for *L. pustulata, U. microphylla,* nor *U. polyrrhiza* were confirmed. Only four species are categorized as "very common" or "common"; most are rare to very rare, and *P. proboscidea* has declined markedly over the last 50 years. For each species there is a full-page "ecodiagram" containing information on rocks colonized, slope, aspect, insolation, humidity, shelter, altitude, and relation to vegetation belts; essential basic information if conservation programmes using transplanted material are ever contemplated in the future. While there are no illustrations of the species or their habitats, something which I found strange in an otherwise such a comprehensive treatment, scanning electron micrographs are provided of the undersides and thalloconidia of the 11 species in the area that have these structures; thalloconidia also feature strongly in parts of the key. This is a model study in combining sound taxonomy with ecology, chorology, and conservation issues, and further in nomenclatural responsibility in that the name changes in some common species that would arise from the lectotypifications proposed by Jiang-Chun Wei (1993) are not taken up (or even mentioned); formal action by the Committee for Fungi is awaited to irrevocably fix the application of some of the earliest names in this conspicuous lichen genus. If you are planning a detailed national or regional study on a particular lichen genus, this is a model meriting emulation. The author and her supervisor, Maria Olech, are to be congratulated on producing such an impressive regional monograph.

Wei, J.-C. (1993) The lectotypification of some species in the *Umbilicariaceae* described by Linnaeus or Hoffmann. *Mycosystema* **5**(Suppl.): 1-17.

Conidial Fungi

***Phoma* Identification Manual: Differentiation of specific and infra-specific taxa in culture.** By Gerhard H. Boerema, J. de Gruyter, M. E. Noordeloos & Maria E. C. Hamers. April 2004. CABI Publishing, CAB International, Nosworthy Way, Wallingford, Oxford OX10 8DE, UK. Pp. 470, figs 51, col. plate 1. ISBN 0 85199 743 0. Price: £ 75, US $ 140.

This book, which took 12 years to complete, integrates all papers on *Phoma* previously published by Gerhard Boerema and co-workers since the 1960s. The isolates dealt with in this book are mostly of European origin. *Phoma* species occur in all the five

continents, on a variety of substrata, either as pathogens or saprophytes. The genus is fairly large and includes nearly 3000 species names, yet recognizing the genus *Phoma in vitro* or *in vivo* is scarcely a problem for mycologists.

The book is stylishly presented in 17 chapters. The Preface explains that 223 taxa are dealt with in nine sections of *Phoma*, and there is also a list of some *Phoma* species causing diseases in crops. Following the Preface, an Introduction provides an historical account of work on the genus from the 1960s and the preparation of the book from the early 1990s (Gruyter & Noordeloos 1992). Also briefly discussed are earlier interpretations of conidiogenesis in *Phoma* by Boerema (1965) and presentation of a revamped version using some of the terminolgy used by Minter *et al.* (1983) in interpreting conidogenesis. The second chapter deals with nomenclature, and lists the nine recognized sections in *Phoma* with pertinent references. The third chapter entitled Generic Characters has a composite description for the genus encompassing all nine sections, with a brief, revised description of conidiogenesis, once again blending in with the terminology used by Minter *et al.* (1983), and further an account of conidia and secondary septation. The fourth chapter deals with methods and techniques, describing a quaint way of isolating *Phoma* species into culture by using cherry decoction or prune agar when tap water agar with pH adjusted to 5.5 would do just as well. Regarding the key NaOH spot test, the concentration of NaOH used has unfortunately been omitted, so anyone intending to use this character has to refer to Boerema & Höweler (1967) or Dorenbosch (1970), where it is cited as 1M (as'1N').

The fifth chapter deals with circles within a circle, i.e. diagrammatic illustrations of the nine *Phoma* sections according to size and their relationship between sections and other genera, with a key to all sections. It seems that the naming of sections is ambiguous, because the main character of a section is shared by other *Phoma* sections as well. An example is section *Pilosa*, meaning hairy, and intended to accommodate *Phoma* species with hairy pycnidia. In fact several species of *Phoma* placed in other sections, for example, *P. anserina* in section *Phoma* is described "as semi-pilose" (p. 59); all species in *Paraphoma*, and species in section *Plenodomus* (e.g. *P. leonuri*) also have hairy pycnidia. Evidently sect. *Pilosa* seems superfluous if differentiated on this feature. Another example is *Phoma* sect. *Heterospora*, accommodating *Phoma* species with different conidial sizes and shapes, but other sections (e.g. *Macrospora*, *Phyllostictoides*, *Peyronellacea*) also include species with diverse conidia! The key to sections (pp. 20-22) shows that the main characters of a section can be common to species in other sections, resulting in overlaps.

The sixth chapter presents notes on six coelomyceteous genera which the authors suggest as adjacent or convergent, but without any tangible evidence. In the notes under the heading *Pleurophoma*, the type species is given as *P. pleurospora*, but included under that name is *Pleurophoma cava*, which for nearly 24 years (i.e. 1973-96) was known as *Phoma cava* (Boerema & Dorenbosch 1973) but was subsequently renamed *Pleurophoma cava* (Boerema *et al.* 1996) although morphologically and anatomically this fungus is not congeneric with the type species of *Phoma* or *Pleurophoma*. The genus *Ascochyta* is also dealt with, and has notes on its conidiogenesis and septation; the latter topic having previously been discussed in detail (Punithalingam 1979) as interpreted by Luttrell (1963). The seventh chapter mainly explains abbreviations used in the book.

Parts 8 to 16 (pp. 32-410) cover the nine sections of *Phoma* (A to H). Each contains a brief introduction to the sectional characters followed by a key to the taxa, descriptions of taxa in culture, illustrations of conidia, and distributional data. The first deals with section *Phoma*. The key has some flaws, for example on pages 39 and 84 the conidia of *P. herbarum* are given as (3.5-)4 - 5.5(-8) × 1.5 – 2(-3) (rarely reaching 9 μm), but to arrive at this taxon in the key one has to enter at couplets "1" and "2a" with species producing conidia up to 7 μm in length – this will lead to 31 and eventually 36a, *P. herbarum*. In order to arrive at *P. subherbarum*, described with conidia 4-5 (-6.5) × 1.5 – 2 μm, one has to enter the key at 1b and *not* 1a, and then proceed to 2a, then 31 to 31b, then 33 to 33b which leads to 39 and 39a. In the case of *P. herbicola* (p. 85) the conidial measurements are given as 5-7(-8.5)× 2– 3 μm, and one has to enter the key at 2b, "species able to produce conidia longer than 7μm" and this will lead to 46, then on to 46b, 60 b, 61b, 62b and finally 63a . *P. herbicola*. In the description of *P. herbicola* (p. 85), the reaction to NaOH is not given, but the key at 61b requires the result of an NaOH test to proceed further. There is evidence of both lumping and splitting; for example *P. crastophila*, known only from *Setaria verticillata*, is documented and illustrated by photomicrographs from the holotype showing stiff setae around the ostiole and having cylindrical conidia with a guttule at each end (Punithalingam 1981). On that basis, *P. crastophila* belongs in *Paraphoma* and would not be a synonym of *P. herbarum*. Also questionable is the placing of *P. hibernica*, which has conidia 5-8.5(-9.5) × 2-3.5 μm, as a synonym of *P. herbarum*. According to the descriptions, *P. herbarum* (conidia (3.5-)4-5.5(-8) × 1.5-2 (-3) μm) and *P. subherbarum* (conidia 4-5 × 1.5 –2 μm) appear to have almost similar conidial dimensions, but are considered as distinct on the basis of growth rates on OA.

Section *Heterospora* has 17 taxa producing macro- and microconidia of different sizes treated. Although on p. 119 a footnote states that the "breaking or splitting easily at the septa i.e. conidial fragmentation is a phenomenon not observed in conidia of true species of *Ascochyta* or *Stagonospora*", this is incorrect because it has been previously demonstrated that in true *Ascochyta* species the conidia commonly split easily at the septa (Punithalingam 1979: pl. 10, 11, 13). Section *Heterospora* is heterogeneous, a varied assemblage of unrelated taxa including *Ascochyta nigripycnidiicola*, *Phoma oculo-hominis* and *Stagonospora curtisii*. It should be noted that single conidial cultures of *A. nigripycnidiicola* produce thick-walled *Plenodomus*-type pycnidia with distinct annellides, quite unlike the phialides seen in *Phoma* (Punithalingam & Spooner 2002). Apparently, several diverse taxa from a variety of hosts have been conveniently pigeonholed here on the basis of the presence of large and small conidia. Members in this section have limited host (nutritional) preferences which seems to place a constraint on their asexual reproduction mechanism on agar media. Perhaps this might explain why on the host they produce larger, septate conidia and in culture mostly smaller aseptate conidia. Minimal descriptions of the taxa are given and this does not include details of the conidiogenous cells, and even in the synopsis the conidia have only been illustrated by line drawings. It is not known whether one conidiogenous cell produces different types of conidia or just one type of conidium. The key is not easy to use, but inclusion of the identities of the host would make matters less cumbersome. Despite Petrak (1925) having placed *Stagonosporopsis* as a synonym of *Ascochyta*

and that being cited in recent editions of *Ainsworth & Bisby's Dictionary of Fungi*, it is strange that *Stagonosporopsis* continues to be used in this book.

Sect. *Paraphoma* includes 12 taxa with setose pycnidia. Unfortunately, taxa with setose pycnidia also occur in other sections of *Phoma*. There is a key, but it does not seem to have been properly checked. In the key, couplet 6b ("conidia exceeding 5.5 μm") directs one to 8 which in turn keys out to 8a *P. glycinicola* and 8b *P. briardii*. After 8, the key comes to an abrupt dead end. There is no route to reach couplet 9 and so to proceed to copulets 10 and 11. If one enters straight into 9, couplet 9b redirects the user back to itself ("9"). Also, 11a keys out *P. terricola* as having conidia 3–5 × 1.5–2 μm, so this should have been keyed from 6a "Conidia not exceeding 5.5 μm". The inclusion of *Pyrenochaeta oryzae* in *Phoma leveillei* (p. 171) is controversial because *P. oryzae* has stiff setae around the ostiole and shows both short branched conidiophores and simple conidiogenous cells producing narrow conidia 4-6 × 1.5–2 μm (Punithalingam 1980). Also the splitting of taxa, for instance the continued recognition of *P. leveillei* var. *microspora*, seems unnecessary.

Sect. *Peyronellaea* includes 16 taxa which produce characteristic chlamydospores and hyphomycetous (*Epicoccum*) conidia in culture. No teleomorph connection has been established for any member of this section. This is an artificial group comprised mainly of coelomycetes and a hyphomycete. Some taxa (e.g. *P. glomerata, P. pomorum*) have extensive lists of synonyms and misapplied names. The key is usable, but at couplet 4a, it should be noted that *Phoma glomerata* also very occasionally produces 1-septate conidia. The recognition of *P. jolyana* var. *shariensis*, based on the single character of response to temperature seems unreliable.

Sect. *Phyllostictoides* includes 41 taxa, some of which are plant pathogens, a few have *Didymella* teleomorphs, and some pose problems in their taxonomy since our knowledge of them is incomplete. One example is *Phoma exigua* var. *exigua* which is listed with many synonyms (pp. 240–254) one of which is contentious, *Ascochyta phaseolorum*, as a recent morphological and molecular study found by comparison of the ITS sequence from a recently collected *A. phaseolorum* with that of a representative *P. exigua* var. *exigua* that the two are clearly not synonyms (Fatehi *et al.* 2003) and further the *A. phaseolorum* isolate produced a *Didymella* teleomorph. Amongst the other synonyms listed under *P. exigua*, *A. adzamethica* is also included despite the type not being available and its identity established (Alcorn *et al.* 1976, Marasas *et al.* 1974). The teleomorph of *P. arachidicola* is cited (p. 230) as *D. arachidicola*, but on the basis of the ultrastructure of ascus development Wyk et al. (1987) considered that the teleomorph could not be included in *Mycosphaerella*, *Didymella*, or *Didymosphaeria*. Note that in the beginning of the key in couplet 1a, the symbol < (less than) has been incorrectly used (cf. couplet 4a).

Sect. *Sclerophomella* has 12 taxa displaying a range of conidiomatal structures, such as typical *Phoma*-type thick-walled pycnidia, pycnosclerotia, sclerotial bodies, or *Plenodomus*- type conidiomata at some stage of development. The key in this section is incomplete because of the lack of useful cultural data on two species. Some are identifiable from the host material, while others require cultures.

Sect. *Plenodomus* includes 32 taxa, of which only some have typical *Plenodomus*-type conidiomata like those of *Phoma lingam*, a pathogen of cultivated *Brassica* spp. and other plants, which shows a range of stromatic structures on the

different host substrates. Here the identification of taxa is host based, cultural characters are not available for all, and some remain sterile on culturing. The placement of *Phoma cruris-hominis* in synonymy with *P. enteroleuca* seems far-fetched as the former produces cinnabar red colonies with a cinnabar red reverse, comes from human sources and has thin-walled pycnidia and short biguttulate conidia, whereas *P. enteroleuca* comes from *Catalpa bignonioides* and has scleroplectenchymatous pycnidia. There is only a subtle difference given between *P. lingam* and *P. sublingam*; both have similar characters, including the conidial dimensions, and are supposed to be recognized by their teleomorphs! *P. agnita* and *P. astraglina* have distinct multilocular stromatic conidiomata whereas the type species of *Phoma, P. herbarum* has simple thin-walled pycnidia. It seems incongruous that *Plenodomus* should be considered a section of *Phoma*.

Sect. *Macrospora* includes nine taxa from both monocotyledons and dicotyledons. Apparently, the ultrastructure of conidiogenesis was studied in *P. rabiei*, but not in the species chosen as the type for the section which resembles some taxa included in sect. *Heterospora* in its condial characters. Growth rate is given importance in the key to the taxa in this section.

Sect. *Pilosa* has just two taxa, including *P. betae*, a pathogen of *Beta* spp. With respect to pycnidial development in that species, Monte et al. (1989) could not give a precise account on either development or pore formation, but Monte et al (1988) reported that conidiogenesis in *P. betae* differed from that of other *Phoma* spp. in the number of different distinguishable layers in the initial papilla. The three layers described by Boerema & Bollen (1975) in other *Phoma* spp. could not be observed in *P. betae*. *P. betae* can be detected by its ability to produce characteristic holdfast-like structures in shallow water or on agar in a Petri dish; within 48 h at 20 °C holdfasts form where the fungus is in contact with the bottom of the dish (Mangan 1971).

The final chapter deals with 14 miscellaneous taxa, i.e. some unclassified *Phoma*-like taxa and ones with known teleomorphs.

A substantial and well-chosen list of references follows (pp. 426–445), there is a fungus name index (pp. 446–466), and also a combined host-substratum index (pp. 467–470). Inevitably, the book contains few printing errors and incorrect citations, e.g. *Microsphaeropsis olivacea* is cited as "*olivaceous*" (pp. 28, 450), *P. scrophulariicola* is cited as "*scrophulariaecola*" (pp. 252, 463; corrected in *Index of Fungi* **1**: 59, 1942). Similar erroneous citations appear in the text and final index, for instance the epithet of *Phyllosticta strelitziicola* is given as "*strelitziaecola*" (pp. 246, 463), and that of *Phoma oculo-hominis* as "*oculi-hominis*" (p. 440). Also noted is an uncommon abbreviaton "*gr.*" before the epithet "*doliolum*" (pp. 321, 323). The description of *P. lingam* is on p. 359 and not p. 351 as cited in the index (p. 455).

In this work, the morphology of conidiomata, conidia and cultural characters are the main differential characters used for identification. Some taxa have extensive lists of synonyms, but there is little indication as to how such decisions were reached, whether after examination of dried type material or on the basis of recently derived cultures. The NaOH test used does not provide in-depth information that can be harnessed. While this is key publication for all interested in *Phoma*, it must be borne in mind it has its limitation in that *only* isolates in culture can be tracked down using it; for more detailed information it it will be necessary to refer to earlier publications.

Nevertheless, the authors deserve to be congratulated for amalgamating their previous publications into a single book.

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Luttrell, E. S. (1963) Taxonomic criteria in *Helminthosporium*. *Mycologia* **55**: 643–674.

Mangan, A. (1971) A new method for the detection of *Pleospora bjoerlingii* infection of sugar beet seed. *Transactions of the British Mycological Society* **57**: 169–172.

Marasas, W. F. O. Pauer, G. D. & Boerema, G. H. (1974) A serious leaf blotch disease of groundnuts (*Arachis hypogaea* L.) in Southern Africa caused by *Phoma arachidicola* sp. nov. *Phytophylactia* **6**: 195–202.

Minter, D. W., Sutton, B. C. & Brady, B.L. (1983) What are phialides anyway. *Transactions of the British Mycological Society* **81**: 109–120.

Monte E. & Garcia- Acha, I. (1988) Conidiogenesis in *Phoma betae*. *Transactions of the British Mycological Society* **90** : 659–662.

Monte E., Martin, P. M. & Garcia Acha (1989) Pycnidial development in *Phoma betae*. *Mycological Research* **92**: 369–372.

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Punithalingam, E. (1979) Graminicolous *Ascochyta* species. *Mycological Papers* **142**: 1–214.

Punithalingam, E. (1980) *Pyrenochaeta oryzae*. *CMI Descriptions of Pathogenic Fungi and Bacteria* **666**: 1–2.

Punithalingam, E. (1981) New microfungi from cereals and grasses. III. *Nova Hedwigia* **34**: 137–152.

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***Sphaeropsidales*: Genus *Septoria*. [Spuogagrybiečiai (*Sphaeropsidales*): Gentis *Septoria*.]** By Vaclovas Markevičius & Aušra Treigienė. January 2004 ['2003']. Valstiečių Laikraštis, Botanikas Institutas, Žaliųjų ežerų 49, LT-08406 Vilnius 21, Lithuania. [Mycota Lithuaniae/Lietuvos Grybai Vol. 10 (3).] Pp. 200, figs 103, coloured plates 8. ISBN 9986 847 71 0. Price: € 28.

While at first it may seem surprising for a whole book in this series to be devoted to a single genus, this becomes understandable when it is recognized that 205 taxa in *Septoria* are considered to occur on more that 220 host plants in Lithuania. This monograph has entries for 238 taxa, and is based on studies of over 1000 collections as well as all available literature. Most species (33) occur on *Asteraceae*, with lesser numbers on *Poaceae* (19), *Apiaceae* (18), *Fabaceae* and *Rosaceae* (11 each), and *Lamiaceae* (10). The treatments of indvidual taxa include places of publication of the names, literature references (mainly for national records rather than treatments from other regions), descriptions, notes on hosts and distribution in Lithuania and elsewhere, in many cases drawings or photographs of conidia, distribution maps, and in some instances colour photographs of infections. Keys are arranged by host family and genus, an approach that is in need of replacement by one which is organism-based, but which at least provides a pragmatic method of attributing names in the *inter regnum*. In addition to the list of scientific names treated, a comprehensive host index is provided. I made a quick comparison with the monograph of the Indian species (Muthumary, 1999; *Mycotaxon* **85**: 486, 2003), a work not cited here, and found some discrepancies in bibliographic citations of names (e.g. did the name *S. lycopersici* appear in 1881 or 1882?). I was also amused to see *Sphaeria trondicola* Fr. 1823, a sanctioned name, treated as a synonym of *Septoria populi* Desm. 1843 – another case of where the changes in Art. 59 effected at the Sydney Congress in 1981 have still not worked through; the correct name under the current *Code* should be a combination based on Fries' name (which was introduced as a replacement name for *Xyloma concentricum* Pers., *Obs. Mycol.* **2**: 101, 1799), assuming that the pertinent types are conspecific. It is consequently clear that some caution has to be exercised in bibliographical and nomenclatural aspects, and it is unclear which references or types have been personally checked by the authors. Notwithstanding these remarks, there is no doubt that this is a significant contribution to our knowledge of the genus and its species as currently cicumscribed not only nationally but also internationally.

Muthumary, J. (1999) *First Contrbution to a Monograph of Septoria species in India*. Chennai: Centre for Advaced Studies in Botany, University of Madras.

MYCOTAXON

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Instructions to Authors

MYCOTAXON is an international mycological journal devoted to research on the taxonomy and nomenclature of fungi. Publication is open to everyone. Authors are responsible for preparing *camera-ready* computer files or hard copy and obtaining and documenting *peer reviews* of the manuscript made by experts in the field prior to submission. Authors must prepare concise, well-formatted, error-free copy that accurately conveys the author's ideas with an economy of space. The Editor-in-Chief receives publication-ready computer files and/or hard copy of the final manuscript accompanied by a cover letter and complete documentation of the peer reviews.

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THESE INSTRUCTIONS WERE UPDATED **DECEMBER 2004.**

OVERVIEW

I. DETERMINING WHAT IS SUITABLE FOR PUBLICATION IN *MYCOTAXON*

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

Articles may be of any length. A maximum of 64 pages per sole/senior author is permitted free of charge during any one year. ($18US per page will be charged for each page in excess of 64 pages). Similarly, authors are granted one halftone photographic plate for every 10 manuscript pages, so that 11-20 pages qualify for 2 halftone plates, 21-30 pages qualify for 3 halftone plates, and so on. Authors who wish to publish papers with halftones in excess of this allowance will be charged $18US per extra plate. A plate may contain one or more images but is always accompanied by only one legend. Line drawings and tables are not considered half-tone images and are counted as regular pages in assessing page charges.

ABOUT CHECKLISTS: Until 2003, *Mycotaxon* published annotated regional checklists of fungi. These often provided the first comprehensive records of fungi from under-explored areas. Because web-based documents offer a searchable interface and permit rapid integration of new information, the editorial board decided that such checklists are better presented online. Beginning in 2004, *Mycotaxon* will no longer publish regional fungal inventories in their entirety. Instead, the editorial office asks that authors post checklists on the Internet and submit to *Mycotaxon* short (1-4 page) papers summarizing taxa, range and distributions, habitats, and/or references covered and listing URLs to the checklist sites. *Mycotaxon* will post links to the websites summarized in such papers on a special checklists webpage on **<www.mycotaxon.com/weblists.html>**. For an extra fee, *Mycotaxon* will also post downloadable PDF files of checklists formatted by authors who do not maintain their own websites.

Checklist authors are *strongly* encouraged to cite references used to identify the taxa in their research. Checklists and summaries, which will follow the same editorial procedures as regular manuscripts, should be submitted together to the *Mycotaxon* Editor-in-Chief after peer review. After receiving editorial approval, authors wishing to post their checklists on the *Mycotaxon* website should contact the Business manager **<info@mycotaxon.com>** who will supervise placing the PDF files on the webpage and assess a one-time fee of $25. There will be an additional $10 charge for each revision posted on our website with each new version prominently displaying its most recent revision date.

II. PREPARING THE TEXT

Articles may be written in either English or French. Papers should be prepared for publication prior to peer review. Authors submitting copy in English should apply a uniform spelling and grammatical convention (American or British) throughout a manuscript. Precise adherence to all formatting rules (see below) is required.

Authors are **urged** to prepare and submit **computer-generated** manuscripts using word-processing applications (*MSWord®, Corel WordPerfect®*). *Mycotaxon* also encourages use of publishing applications (e.g., *Adobe InDesign®*) where authors can easily combine text with illustrations in one document. Sheridan Press, now responsible for printing *Mycotaxon*, provides a PDF booklet **<http://www.mycotaxon.com/DigiArt_WP.pdf>** that fully explains how to prepare illustrations for use in documents sent for printing. Web-users may submit up to 3 digital TIFF files free of charge to "Digital Expert" **<http://dx.sheridan.com/>** for diagnosis of potential problems prior to submission. Although peer-reviewers must review both text and illustrations, figures should not be integrated into a draft manuscript until after peer-review. Use of standard word-processing applications during this initial phase may be necessary; authors planning to use PDF files, *InDesign®*, or other expensive publishing applications should inquire as to the availability of a computer program to peer-reviewers before preparing reviewer copy. Authors may submit PDF files to the editorial office with all graphics in place to the Editor as a substitute for publication-ready hard copy.

Hard-copy submissions are permitted, but authors should be aware that manuscript processing for hard copy is longer than for computer-formatted copy. *Mycotaxon* no longer reduces over-sized hard-copy manuscripts. Authors now **must** prepare text at the same size as it will appear when published, that is, at 100% or full-scale. Authors are *strongly* urged to format all illustration materials (including graphs, photographs, and line drawings) at 100%.

FINAL COPY MUST CONFORM TO THE FOLLOWING SPECIFICATIONS

A. Page dimensions and margins Margins should be set so as to produce an 11 cm x 17.5 cm print area on the *Mycotaxon*-sized 15.2 x 22.8 cm [6" x 9"] page. Extra space must be allowed at the top of the first (title) page to permit the Editor to insert the *Mycotaxon* header prior to publication. When setting up a page in a word-processing application, computer users should enter a custom size of 15.2 x 22.8 cm and then set the following margins:

Top margin, *Page 1* (Title Page) —> **4 cm**
Top margin, *Pages 2 and following* —> **2.3 cm**
Side margins —> **2.1 cm**
Bottom margin —> **3.0 cm**

B. Text formatting

Fonts (General)—Standard elements of an article are the title, author address information, abstract, keywords, main text, figure legends, acknowledgements, and literature cited. Two primary font families are to be used: the serif Times—Times New Roman (TNR) when Times is not available—and the sans serif Arial—Helvetica (Helv) when Arial in not available.Authors **must** obtain permission to use fonts other than Arial/Helv, Times/TNR, or Courier (limited to use in tables where columnar arrangement is essential, as in presenting sequence data). Symbol characters (α, β, μ) should be inserted using the SYMBOLS menu when preparing text in Times New Roman.

Paragraph settings (General)— Except for occasional line breaks between sections, all text is to be single-spaced. Text formatted with the leading font set one point higher than the text font is permitted; text formatted with 1 1/2 spaces between lines is *not* acceptable. Authors are asked to format paragraphs using the options available in their word-processing applications rather than inserting spacer lines or using 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.

1. 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.

Sentence case means that only the first letter and words that are always capitalized should be in placed in upper case. Latin scientific names for taxa up through and including order should be ***bold italic.*** Titles should be concise, yet informative enough to interest readers. Titles longer than three lines are discouraged. Authors should include names of significant taxa but *not* the names of authorities (author citations). (Titles containing author citations will be **automatically rejected** and returned for reformatting unless the author justifies why an authority is necessary to the title.) List the name of a genus in full only once but otherwise avoid abbreviations. Use arabic numerals, rather than roman. Never end a title with a period, unless the final word is an abbreviation (e.g., "sp. nov."). A sample of a properly formatted title follows:

Studies in *Agaricales* 3: *Phaeocollybia phaeogaleroides* and *P. rifflipes*, new western North American species

2. Author names *Font:* Times, 10-point, Roman (regular), Large & small capital; *Paragraph:* no indent, center aligned.

Author names should be written with the name to be indexed listed *last*. Commas are used to separate names of authors in a series except for before the '&' preceding the last author.

3. 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; City, Code, Country on bottom line.

An E-mail address (in lower case) is **required** for the senior or corresponding author and recommended for junior authors. Second lines that contain insitutional information and/or street addresses must be abbreviated so as to stand on only one line. Do not place commas or periods (except for abbreviations) at the end of address lines.

4. Abstract & Key words—headers *Font:* Arial, 8-point, Bold; *Placement:* on first line preceding text.

The 'Key words' header comprises two words, with only the first letter in upper case.

5. 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.

An abstract is *required* for **all** papers. Compose a paragraph (or sentence or two for 1-4 page papers) summary that is meaningful when read alone apart from the remainder of the paper. Include all new taxa, new combinations, and conclusions. Always prepare one abstract in English. For longer articles, one or two additional abstracts in other languages may be added. Abstracts should be informative but brief, usually *no more* than 15 printed lines long. Omit author citations unless necessary to differentiate homonyms. Abstracts that do not meet these criteria will be returned to the authors for correction.

Authors are *encouraged* to insert a list of *up to 5* key words for use by abstracting services. Terms already used in the title *or* abstract should not be listed. Separate key words or key word phrases by commas, and do not capitalize keywords unless the word or phrase is a proper noun.

6. Primary stand-alone subheadings *Font:* Arial 10-point, Bold/Bold Italic; *Paragraph:* no indent, center aligned.

7. Secondary stand-alone subheadings *Font:* Times 10-point, Bold/Bold Italic; *Paragraph:* no indent, left aligned.

Arial 10-point regular (roman) and Arial 9-point, Bold/Bold Italic are optional.

8. Basic Text *Font:* Times 9-point; *Paragraph:* fully justified (preferred).

For the main text, *briefly* introduce your subject, citing significant background literature. Document your own observations concisely and stress new discoveries. Comply with the current *International Code of Botanical Nomenclature* when describing new taxa or proposing new combinations. To minimize confusion when discussing generic epithets beginning with the same initial letter, we strongly recommend that you abbreviate one using the first **two** letters of the generic name throughout the paper (e.g., *C.* for *Cantharellus* and *Cr.* for *Craterellus).* Names of authorities should appear only once, in a separate table or in the text near where the names are first mentioned or (if new) formally proposed. For authorities of taxa use the abbreviations cited by IPNI in the International Plant Names Index <www.ipni.org/ipni/query_author.html>, the Harvard University Herbaria database <brimsa.huh.harvard.edu/cms-wb/botanist_index.html>, or CABI's *Index Fungorum* <www.indexfungorum.org/Names/Names.asp>. *Authors of Plant Names* by Brummit & Powell (1992) and *Authors of Fungal Names* by Kirk & Amsell (1992) may also be consulted. For acceptable herbarium & collections acronyms, consult *Index Herbariorum* (Holmgren et al. 1990) <www.nybg.org/bsci/ih/searchih.html>. Authors describing new taxa are expected to cite relevant acronyms and registration numbers to facilitate retrieval of the material/data by readers and to deposit (i) type specimens in an official, public herbarium, (ii) ex-type strains in a public culture collection, and/or (iii) sequence data in GenBank. Italics should be reserved for Latin scientific names for taxa up through and including order (required) or for emphasis; common Latin terms (e.g., i.e., inter al., etc.) are be placed in Roman (regular) font.

9. Subordinated text *Font:* Times, 8-point (7-point is preferred in large tables but discouraged in the *Acknowledgements* and *Literature cited* sections).

10. Acknowledgements *Font:* Times, 8-point. *Paragraph:* no indent, left aligned, fully justified.

Peer reviewers, at least, should be cited in this section.

11. Literature cited *Font:* Times, 8- or 9-point; *Paragraph:* Hanging indent, no line spaces between entries.

Include all references cited in the text, ensuring that all references in the "Literature Cited" section are also found in the main text. Standardize abbreviations of journal and other periodical titles. See **BPH** *(Botanico-Periodico-Huntianum,* Lawrence & al. eds., 1968), **BPH/S** *(Botanico-Periodico-Huntianum/Supplementum* Bridson ed., 1991), **TL2** *(Taxonomic Literature*, Stafleu & Cowan, 1976-1988), and the *Supplements to Taxonomic*

Literature (Stafleu & Mennenga, 1992-1995) for recommended abbreviations. Authors are required to **single-space** entries (that is, do *not* separate citations by a blank line) and to follow a consistent citation style throughout. Placing references in *8 pt font* is preferred. Required are (i) using *hanging indents*, (ii) using initials for given names (surnames), (iii) universally placing author last names before initials, (iv) eliminating periods after initials, and (v) using commas *only* to separate listed authors (no "&" or "and").

EXAMPLES

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

Senior AA, Junior BB. 1997. Title with *Latin name* here. Mycotaxon 56: 254-272. (See **sample manuscript** <www.mycotaxon.com/authors/sampleMS.pdf> for further suggestions.)

12. 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).

TEXT CLONE—After receiving editorial approval of a fully formatted document, authors submitting electronic files (preferred) are expected to prepare a text 'clone' from which *all* empty paragraph lines and graphics (including tables, but not figure or table legends) have been removed. This will facilitate export into InDesign® and PDF conversion. Any corrections of text made after editorial approval will be handled using the clone.

III. PREPARING CAMERA-READY ILLUSTRATIONS

A. ILLUSTRATION SIZE & PLACEMENT—All articles published in *Mycotaxon* begin on an **odd**-numbered (right-hand) page, so plan size and placement of illustrations within the text accordingly. When possible, place an illustration on or facing the page of text where the illustration is first mentioned (preferably on a right-hand page). Submit illustrations at the **size** that they will appear in the final publication. (Authors who cannot reduce their illustrations to publication size should contact the Editor-in-Chief for advice or permission to submit oversized copy.) Group figures to facilitate species comparisons and keep page numbers to a minimum. Figure legends belong below the illustration (preferred) or at the bottom of the page *facing* the illustration.

B. LINE DRAWINGS may be submitted as originals, digital images imported from scanned originals, or high quality reduced photocopies of original artwork. Digitally produced drawings incorporating vector information or fonts should be submitted as 600dpi **EPS** files, which describe a single page and can contain any combination of text, graphics, and images.

1. Digital files Authors equipped with computer scanners and applications such as *Adobe Photoshop®*, *InDesign®*, and *PageMaker®* can speedily convert line drawings to 300-600dpi TIFF files for insertion directly into the document. Adjustments to the image — including insertion of scales, numbers, and arrows — are easily handled in such applications. File names for **tables**, now treated as independent graphics, should be be placed below the table legends. Authors who do not submit tables in EPS format must also prepare table clones in *document format* (.doc, .rtf) by removing all borders to expedite export into *InDesign®*. At final submission, authors will submit each separate graphic needed for the final publication. See guidelines for preparation of digital photographs (*C2 below*) for further suggestions. Authors who submit digitally-prepared text with hard copy line drawings should place only photocopies of original drawings onto the final submission manuscript and submit the originals separately (without legends) as described for half-tone photographs (*C1 below*).

2. Hard copy Because line drawings convey only black and white information, they are reproduced by the same process as the main text, enabling drawings and text to be printed together. Authors who submit only hard copy manuscripts should place line drawings onto existing text pages with captions printed directly below or to the side of each drawing. With care, authors generally can reduce oversized drawings using the reduction feature on photocopiers without decreasing image quality and assemble an attractively arranged plate from the cut & paste illustrations and captions.

C. BLACK AND WHITE PHOTOGRAPHS—*Mycotaxon* prints only black & white photographs, but authors may submit color hard copy photos if necessary. Both black & white and color film-based (non-digital) photographs have a "continuous tone" requiring transformation into a separate *halftone image* before they can be printed in a magazine or on a computer printer. A halftone image consists of many variously sized and spaced dots, which are easily seen using a hand lens. Black & white halftones consist only of black dots, but all color halftones contain different sized dots of several colors (usually three plus black) spaced to achieve the desired color balance. Authors using digital or computer-generated images must **not** print such images themselves as "print-ready hard copy" but instead submit high-resolution TIFF grayscale computer files with their hard copy documents.

1. Digital grayscale halftone files Authors who submit **digital photographs** may insert all illustrations and figures into the document utilizing options provided by a publishing application (e.g. *InDesign*®). Photographic software programs such as *Adobe Photoshop*® facilitate preparation of low-resolution **JPG** files (to be used only during the peer and editorial review process) and high-resolution **TIFF** files (the only acceptable format for final submission). Illustration software programs such as *Adobe Illustrator*® should be used to convert vectored line drawings (for phylotrees) to **EPS** files. Configure final TIFF half-tone image files by selecting a *grayscale* setting and typing in dimensions that match the *exact final printed size* when printed at *300-600 dpi* (dots per inch). (TIFF files **must** be formatted in *grayscale* to allow the press to format the photographs properly before printing.) Authors who group photographs into **plates** should ensure that the contrast among individual photographs is not too great before incorporating them into the single TIFF file. *Mycotaxon* will accept photographs or plates that are shorter than the 17.5 xm print height, but plates generally should span the entire printed area width of 11 cm. Label each TIFF graphics file (for both line drawings and halftones) with the *senior* author's name and plate number (e.g., *name_pl#.tif*) **and** enter that information on a separate line above the figure legend in the text clone (e.g., *TIFF plate #*). File names for **tables**, now treated as independent graphics, should be be placed below the table legends. Authors who do not submit tables in EPS format must also prepare table clones in *document format* (.doc, .rtf) by removing all borders to expedite export into *InDesign*®. At final submission, authors will submit each separate graphic needed for the final publication.

2. Hard copy photographs When submitting **hard copy** (or electronic text + illustration hard copy) photographs or plates made by combining photographs, mount each plate onto a separate sheet of heavy white paper or matte board. Be certain to allow sufficient margins around the photograph for editorial markings and printer's directions. Write the first author's name on the reverse of *each* plate. Place no text (except for necessary numbering or lettering, arrows, and other annotations) on halftone plate faces. Print figure legends and other text separately as part of the main text. Sheridan Press will insert these halftone plates into the appropriate publication-ready text files. For plates filling the entire 11 × 17.5 cm print area, place the legend at the bottom of the text page *facing* the plate and separate the caption from the main text by a thin line. Do not border or edge photographs and plates with a line.

IV. OBTAINING PEER REVIEWS AND REVISING REVIEWED MANUSCRIPTS

Mycotaxon is unusual among scientific journals in that it is the responsibility of the authors to obtain peer reviews of their papers before submitting the manuscript. Send a copy of your fully formatted manuscript to **two** scientists in your field of study but *outside your home institution* for critical comment. If you are uncertain whom to approach for review of a manuscript, you are encouraged to send a summary or draft to the Editor-in-Chief, who will then suggest several researchers in the appropriate field.(See *Pre-submission*, below.) It is your responsibility to provide each peer reviewer with the 2001 *Reviewer's Guidelines for Mycotaxon Articles* (*Mycotaxon* 78: 539-540) and the Peer Review checklist, which can be downloaded from the journal's website. It is also your responsibility to provide each reviewer with all graphics files (generally low-resolution

.JPG files, unless more resolution is requested) and text formatted to show placement of graphics files *within* the text.

You are expected respond to suggestions to *both* reviewers by revising and reformatting your manuscript or presenting alternatives before final submission when you will address discrepancies in your cover letter to the Editor-in-Chief. *Double check* that changes have not resulted in any "widows" or "orphans" (single lines at the top or bottom of a page) before pre- and final submission to *Mycotaxon*. Authors may wish to offer junior author status to peer reviewers who make major improvements in the paper. Copies of peer reviewer comments and check lists from both reviewers *must* be included in the final submission. The Editor-in-Chief will acknowledge all peer reviewers in the closing pages of each volume, but authors urged to thank peer reviewers in the acknowledgements section. At least one reviewer must check nomenclature and author citations; this is not the responsibility of the Editor-in-Chief. Peer reviewers may E-mail their comments and checklists directly to the Editor-in-Chief.

V. SUBMISSION PROCESS

A. PEER REVIEW—Submit a fully formatted manuscript to two experts in the field for peer-review. [Two peer reviews are now required for all papers, regardless of length.] Authors should submit tentative titles and abstracts to the Editor-in-Chief *before* preparing the manuscript for peer review, if they are not certain whether their topics fall within the journals taxonomic–nomenclatural focus. The Editor-in-Chief may also aid in the search for suitable experts willing to review manuscripts.

B. PRE-SUBMISSION—After peer review but before final submission, authors with computer-prepared manuscripts are required to pre-submit (preferably as an e-mail attachment) a fully formatted text document with line drawings and half-tones removed but all other formatting in place. Low-resolution JPGs or a PDF displaying the graphics in place may accompany the text document. Authors who submit Adobe *InDesign* files do not need to submit text or graphics separately. Authors with access to the internet who plan to submit hard-copy text manuscripts should E-mail the Editor-in-Chief all title, author, address, abstract, and key word information to expedite processing. Whether computer-genderated or hard-copy, manuscripts that do not conform completely to all text formatting requirements listed above will be returned to the author for revision.

"Mycotaxon presubmission: [corresponding author name + one word manuscript name]" should be included in all presubmission E-mail subject headers, as the Editor-in-Chief will not open E-mails without subject headers.

C. FINAL SUBMISSION—After receiving editorial pre-submission approval, the author should formally submit a revised manuscript and all outstanding supporting documents to the Editor-in-Chief. Final submission may be handled entirely using E-mail when digital files are not too large and author generated PDF files contain all embedded graphics files. Otherwise submission packets should be mailed by governmental or courier postal services (*certified* and/or *signature required*) to one of the addresses on page 506. Individual E-mail attachments should not exceed 4 megabytes without express permission from the Editor-in-Chief.

1. Manuscript:

a. EITHER one PDF file OR one hard copy *with* all graphics in place. The hard copy should be printed only on one side of the paper and with author's name & page numbers on the top right corner of each text page and name & plate number on the back of each illustration.

b. computer-generated publication-ready files as E-mail attachments or on CDs (preferred), zip disks (less preferred), or PC formatted floppies (least desired). Electronic files 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.

2. Supporting documents:

a. a cover letter that list the following *required* information in order:

__1 title

__2 author names*

*for *each* author, also note placement of accents or diacritical marks, and in compound names which is the last name (used for alphabetizing author names in indices)

__3 number of *pages, plates* (not individual figures), and *tables*

__4 type of plates—black&white line-drawing vs. grayscale halftone and how many each submitted as hard copy (halftones must have been prepared from film negatives), 300-600dpi TIF, or 600dpi EPS

__5 the senior and/or corresponding author's mailing address

__6 e-mail addresses and/or fax numbers for *all* authors

__7 names, institutional affiliations, and E-mail addresses of both peer reviewers

__8 a short paragraph explaining why any reviewer recommendations were not followed

__9 a statement indicating a willingness to pay the excess page or plate charges (to be paid after acceptance but prior to publication)

b. comments & checklists from both peer reviewers*
Instructions and checklists can be downloaded from <www.mycotaxon.com/authors/reviewers.html>

c. (only when reurn of artwork is desired) a self-addressed envelope, stamped or, for foreign authors, with sufficient International Reply Coupons to cover postage costs in full

3. Submit materials: Consult the **Author's Checklist** below as a final check of the readiness of the submission before sending to the Editor-in-Chief. Remember to prepare back-up copies, as submissions may be damaged or lost in the mail; keep a dated, print-ready computer file and/or photocopies of all materials you send to the Editor to reduce re-submission time, if necessary.

Any or all items may be sent as E-mail attachments. Those wishing the press to use their own print-quality Adobe PDF files must pre-flight their PDFs with Sheridan Press before final submission and are expected to insert the masthead font and page numbers exactly as requested after final approval and pagination. Authors also are responsible for seeing that peer reviewers E-mail their checklists and comments directly to the Editor-in-Chief. **NOTE:** Authors should always include "Mycotaxon" followed by an author name and an appropriate word in the E-mail subject header to avoid inadvertent deletion of E-mail messages by the Editor. Authors using spam filters should add <editor@mycotaxon.com> and <llnorvell@pnw-ms.com> to their list of permitted incoming addresses.

Authors who mail hard copy submission packets are reminded to **pack your submission securely,** enclose address information within the packet, and to use stiff boards, bubble wrap, and/or plastic cases to protect artwork and CDs.

VI. AVOIDING AUTOMATIC MANUSCRIPT REJECTION

The following criteria may result in **automatic rejection** of submitted manuscripts. Automatically rejected papers may be resubmitted after authors reformat the papers to meet these criteria. Carefully consider the points below to ensure that your paper is not initially rejected on formatting grounds:

A. BEFORE PEER REVIEW AND PRE-SUBMISSION

1. Use single-spacing throughout the paper: Camera-ready documents **must** be single-spaced within paragraphs; paragraphs with internal lines separated by 1 1/2 spaces between lines will be rejected. Text formatted with the **line spacing** set **one** to (rarely) two points higher than the selected text font is acceptable and will provide sufficient separation between text lines of text. Single blank lines may be used to separate paragraphs outside the Acknowledgements and

Literature cited sections but must be eliminated from the text clone at final submission. A full text page typically contains 40–48 9-point font lines, fewer than pages containg sections with subordinated formatted in 7- to 8-point fonts.

2. Select the proper font faces and sizes: Format **titles** in sentence case, 11-point Arial (Helvetica when Arial not available), bold for all words except Latin scientific names (up through order) in bold italic. Primary stand-alone section headers should be centered and in Arial 10-point bold; secondary stand-alone headers should be aligned left and in Times 10–point or Arial 9-point bold. **Main Text** must be in Times 9-point. *Mycotaxon* recommends Times 8–point font for most **subordinated materials** (abstract, Latin diagnoses, specimens examined, figure legends, acknowledgments, and literature cited) and Times/TNR 7-point font for tables. Courier is permitted for displaying DNA sequences when alignment is needed. Use of other fonts and sizes without prior editorial approval is reason for automatic rejection.

3. Select the proper font & paragraph styles: Titles must appear in "sentence case", in which only first word and proper nouns are capitalized. Use **bold** for names of all new taxa and new names of all ranks at the point in the text where they are formally described. Latin names of taxa at ordinal rank and below must be in *italics*, otherwise to be restricted to internal subheadings or emphasized terms. Names of taxa above ordinal rank may be formatted in either italic or normal typeface at the author's discretion. Do not italicize common abbreviations, such as et al., etc., inter al. Occasional use of bold face for subheadings within the text or for names of taxa within keys may be pleasing. You can also occasionally emphasize text using UPPERCASE or LARGE AND SMALL CAPS. (See the **sample manuscript** <www.mycotaxon.com/authors/sampleMS.pdf> for examples of font styles in technical descriptions and specimens examined.)

4. Do not underline: Although underlining is an easy option when using a computer, never underline when preparing publication-ready manuscripts. Underlining is *never* used in printed publications. To achieve emphasis use *italic*, **bold**, or (exceptionally) ***bold italic*** typeface.

5. Deactivate hyperlinks: Text clones containing active hyperlink formatting will be returned for modification. Most recent word-processing applications format email addresses or website URLs automatically in **hyperlink format**, seen as underlined text (often blue). To ensure that such hyperlinks do not appear in the final paper, authors should disable the hyperlink feature option. (MSWord users should follow Format>Styles>Styles-in-Use pathway in their menu bar to delete the Hyperlink and Followed Hyperlink styles settings. Consult your application manual for guidance on other platforms or in other applications.)

6. Headings must not occur alone as the bottom line of a page: Prevent "orphan" headings by arranging them so that there are at least two lines below a heading on the bottom of a page whenever possible. Also do **not** end any heading with a period.

7. Prevent punctuation problems: Commas, periods, and other punctuation should be in the same font style as the words immediately preceding them. Thus commas following italicized words should also be in *italics*, in bold when the preceding words are in **bold**, and in bold italic when the immediately preceding words are in ***bold italic***. The ONLY exception is with paired marks (parentheses, square brackets, quotation marks, single quotation marks, long dashes), where the closing mark takes the same font style as the preceding open mark. With the exception of the sanctioning colon (e.g., Fr. : Fr.), no spaces should come between a punctuation mark and the text preceding it. Likewise, no space should come between an initial paired mark, such as an open parenthesis, and the following text. Only **one** space should separate sentences following a period in computer formatted manuscripts.

8. The micron symbol: μ can be generated in most computer text fonts by using special keystrokes (*e.g.*, "option+m" on a Macintosh or "insert symbol" on a PC). Do *not* import a micron mark from a font different from the one you are using (such as Greek). PC-users who must select μ from "Symbols" should place the symbol in the same-sized font as the surrounding text. Please

send the Editor-in-Chief a list of all symbols that you use in your manuscript, and when at all possible select symbols from the appropriate Arial or Times font selections.

9. Learn the difference between a hyphen, an en-dash and an em-dash: A *hyphen* will break at a line end and is often used whenever the author wants to hyphenate a word manually to ensure well-populated lines in justified text. Authors who have used hyphens in the presubmission process should *remove* all such hyphens during preparation of the final submission text clones, otherwise they may appear in midline after export into *InDesign* by the Editor. An *en* dash (generated on Macintosh computers with "option+dash") is a longer hyphen that does not break at line end; the en dash is frequently used for minus signs in mathematical notation or stands for "to" in time or range as (e.g., 8–10, where the *en* dash prevents the "8-" from occurring on one line and the "10" on the next.) No spaces should come between an *en* dash and the elements it connects. An *em* dash ("shift+option+dash" on Macintosh computers) is the longest and—generally—is reserved for emphasizing observations that would otherwise be enclosed in parentheses. Keystrokes differ on a PC, but the concept is the same.

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