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Italians in the History of Mycology: *Proceedings of a symposium held in the Archivo Centrale dello Stato, Rome, 4-5 October 1995,* edited by Silvano Onofri, Antonio Graniti, & Laura Zucconi. Mycotaxon, Ltd. 1999. Softbound, 163 pp., illustrated, 16.5 x 23.5 cm. $35.00 plus postage. (Please ***order direct*** from Accademia Nazionale delle Scienze, detta dei XL, Villa Lontana, Via Cassia Antica 35, 00190 Roma, Italy, e-mail: acc.scienze@flashnet.it, fax: +39 06 3630057). ISBN 0-930845-09-0.

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STUDIES IN NORTH AMERICAN CORTINARII VI. NEW AND INTERESTING TAXA IN SUBGENUS PHLEGMACIUM FROM THE PACIFIC STATES OF NORTH AMERICA

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Abstract: New taxa of *Cortinarius*, subgenus *Phlegmacium*, described here include *C. cacodes*, *C. fraudulosus* var. *patrickensis*, *C. glaucocephalus*, *C. lilacinocolossus*, *C. subpurpureophyllus* var. *sulphureovelatus*, *C. olivaceopetasatus* and *C. atrochalybaeus*. Further information is provided for *C. spectabilis* M. M. Moser, *C. subpurpureophyllus* var. *subpurpureophyllus* Smith, *C. calyptratus* A.H.Smith and *C. ponderosus* A.H.Smith. The latter is placed in the subgenus *Phlegmacium* rather than in *Myxacium*.

Key Words: *Cortinarius*, *Phlegmacium*, North America, Pacific States

Introduction

In this publication we provide descriptions and information on some of the species of *Cortinarius*, subgenus *Phlegmacium*, that are found in forests from Washington state southward through Oregon into northern California. Many of theses species seem to be more common on the western or Pacific side of the Cascades and coastal mountain ranges in south western Oregon and California; however, others extend eastward into the Cascade and Klamath Mountains, for example, the eastern slopes of

Mount Hood, and the interior of northern California. Additional studies of these taxa will be necessary before more precise information on distribution and ecological parameters are known. This paper is a close companion to Moser and Ammirati (1997, 1999) and Moser (1997a, 1997b) with certain species of *Phlegmacium* in these publications overlapping ecologically and biogeographically. Together with previous papers (Moser and Ammirati, 1996; Moser et al., 1995) they form the basis for the identification of species of *Phlegmacium* in the northwestern United States. Finally these papers also help to clarify certain species or species concepts of A. H. Smith (1939, 1944).

Collecting Locations and Habitats

In the Pacific states of North America the vegetation of the Olympic and Cascade Mountains includes *Pseudotsuga menziesii-Tsuga heterophylla* forests from sea level to low elevations, and *Abies amabilis-Tsuga heterophylla* forests in montane regions, the latter often with *Abies procera* Rehder, *A. grandis* (Dougl.) Forbes, *Pseudotsuga menziesii* (Mirbel) Franco, *Pinus monticola* Dougl. and *Thuja plicata* Donn., depending on the site. At higher elevations or in more continental environments, *Pinus contorta* Dougl., *P. monticola, P. ponderosa* Dougl., *Abies lasiocarpa* (Hook.) Nutt., *A. grandis, Larix occidentalis* Nutt., *Tsuga mertensiana* (Bong.) Carr. and *Picea engelmannii* Parry may be found in various combinations along the Cascades of Oregon and Washington. *Picea sitchensis-Tsuga heterophylla* forests occur in a rather narrow band along the Pacific Coast south to northern California. These forests may occur as pure stands of *Picea*, or as mixed stands that include *Thuja plicata, Sequoia sempervirens* (D.Don.) Endl., *Myrica californica* Cham., *Pinus contorta* or *Pseudotsuga menziesii* in addition to *Tsuga heterophylla* (Raf.) Sarg.. In inland coastal areas of northern California forest can be a mixture of conifer (*Pseudotsuga menziesii)* and hardwood (*Castanopsis, Lithocarpus, Quercus, Umbellularia*). Interior mountains often have transitional vegetation at low- to mid-elevations composed of a mixture of woody plants and trees (*Pseudotsuga, Pinus, Abies, Quercus, Castanopsis, Lithocarpus, Arbutus, Arctostaphylos, Libocedrus*, etc.). depending on site and location. For more details on Oregon and Washington vegetation see Franklin and Dyrness, 1973; for California vegetation see Sawyer and Keeler-Wolf, 1995. These basic references were used in the descriptions below.

The Phlegmacia treated here come from a wide variety of forests and habitats, representing montane, lowland and coastal regions that are influenced primarily by weather patterns coming from the Pacific Ocean, with some continential influence in the more interior regions. The forests include old-growth and mature stands but in addition some areas have been previously harvested for timber. Below are brief descriptions of the collecting sites for this study.

Northern California, Outer North Coast: Sonoma County – Salt Point State Park - 20 miles north of Jenner. - Within the Redwood series; similar to Mendocino sites. **Mendocino County ,** Jackson State Forest - 2.5 miles Southeast of Fort Bragg. Casper - Little Lake Road - Collections were made near the intersection of Roads 408 and 409 (Casper - Little Lake Roads). These sites are dominated by *Lithocarpus densiflora* (Hook. & Arn.) Rehd. mixed with *Sequoia sempervirens* (D.Don.)Endl. and some *Tsuga heterophylla* and *Pseudotsuga menziesii*. In some areas *Pinus muricata* D.Don,, *Abies grandis* or *Arbutus menziesii* Pursh. also occur, as well as *Vaccinium* and *Rhododendron* plus other species depending on the site. At least part of this area is designated as the Redwood/Tanoak association. Russian Gulch State Park and Russian Gulch are within this same area. **Humboldt County** – Trinidad, and Patrick's Point and Richardson Grove State Parks - Sites vary from essentially pure stand of *Picea sitchensis* (Bong.) Carr. to mixtures of this species with *Sequoia sempervirens, Tsuga heterophylla* and other tree and woody plant species; with elements of the Redwood and Sitka Series depending on site and location. Richardson Grove State Park is more interior as compared to Trinidad and Patrick's Point, which are coastal. **Del Norte County** – Jedediah Smith Redwood State Park - A part of the Redwood series; *Sequoia sempervirens* and *Tsuga heterophylla* occur with *Lithocarpus densiflora, Pseudotsuga menziesii, Picea sitchensis* and other woody plants and trees depending on the site.

Northern California, Klamath Range. Del Norte County – Inland from Jedediah Smith Redwood State Park the vegetation changes going from the outer North Coast into the Klamath Range geographical region.- South Fork of the Smith River, Buck Creek Camp and Big Flat Station/ China Mine Road - In these areas both litter covered and bare soils occur; some sites, for exemple, Buck Creek Camp, are dominated by *Lithocarpus densiflora* with *Quercus* spp. and *Pseudotsuga menziesii* mixed in among *Vaccinium* and other woody plants on some sites. Near the intersection of road 426 and the road to Buck Creek Camp a pure stand of *Lithocarpus* was visited. At Big Flat Station / China Mine Road area the vegetation can be quite mixed, including *Pinus, Quercus, Lithocarpus densiflora,* *Pseudotsuga menziesii, Vaccinium , Arctostaphylos, Arbutus menziesii* and *Umbellularia californica.*- Danger point: This locality is about one mile southwest of Grassy Flat Campground on the north side of HW 199. The vegetation on this site is a mixture of *Lithocarpus densiflora, Quercus vacciniifolia* and *Q. chrysolepis,* with *Pseudotsuga menziesii, Pinus. Umbellularia californica, Arbutus menziesii* and *Arctostaphylos* on some sites. In some areas there is a dense shrub cover of *Vaccinium* and other shrubs.

California, Cascade and Klamath Ranges. Shasta County – Castle Crags State Park. Castella – The vegetation on this site is a mixture of conifers and broadleaf sclerophyll species representing the Douglas-fir series and Douglas-fir – Ponderosa Pine series. *Quercus kelloggii, Quercus garryana, Pinus ponderosa, P. lambertiana, Calocedrus, Arbutus* and a variety of other tree and woody plant species occur in this area depending on site and location.

California, Sierra Nevada, Yuba County – Bullards Bar Recreation Area - Schoolhouse Campground – This site is a mixture of trees, including *Pinus ponderosa, P. attenuata, P. lambertiana, Lithocarpus densiflora, Arbutus menziesii, Pseudotsuga menziesii* and *Arctostaphylos* spp. as well as other species, such as *Quercus*, depending on the site.

Southern Oregon, Mixed Evergreen Zone, Josephine County – Cave City (Junction) – The type of *Cortinarius ponderosus* was collected in a mixture of *Pinus ponderosa* and *Quercus* spp. Depending on site and location, this region is generally described as a mixture of needle-leaved and sclerophyllous broad-leaved trees, including the above genera in addition to *Pseudotsuga menziesii, Calocedrus, Lithcarpus densiflora, Arctostaphylos, Arbutus menziesii* and other species.

Oregon, Coast Ranges Province, Benton County - Woods Creek, Mary's Peak - The collecting area was thinned *Tsuga heterophylla* and *Pseudotsuga menziesii*; part of the *Tsuga heterophylla* zone. This is an extensive zone of vegetations throughout Oregon and Washington, and in the Coast Range is inland from the *Picea sitchensis* Zone. *Thuja plicata* may occur on moister sites while *Abies grandis, Picea sitchensis* and species of *Pinus* also may be present.

Oregon, Coastal Forest Zone, Lincoln County - Fogarty State Park - This site is on the immediate coast where a mixture of *Pinus, Picea sitchensis, Pseudotsuga menziesii, Tsuga heterophylla* and *Thuja plicata* occur. It is part of the *Picea sitchensis* Zone and in moister habitats it has *Alnus, Salix, Vaccinium* and other woody plants and trees.

Oregon, *Abies grandis* Zone. Wasco County - Bear Springs and Clear Creek Crossings - These sites represent interior mixed conifer forests primarily composed of *Abies grandis, Pseudotsuga menziesii, Picea engelmannii* and *Larix occidentalis,* with *Tsuga mertensiana, Thuja plicata, Alnus* and other trees and woody species on some sites. Elements of the *Abies lasiocarpa* and *Pinus ponderosa* Zones can be found in this region as well.

Washington, Mount Rainier National Park - Ipsut Creek - The collecting area is mainly of *Tsuga heterophylla, Pseudotsuga menziesii* and *Abies amabilis*, elements of both the *Tsuga heterophylla* and *Abies amabilis* Zones. *Thuja plicata, Alnus rubra* Bong. and *Salix* occur on some sites.

Materials and Methods

For general methods of study and techniques see Moser 1993, Moser et al. 1995 and Moser and Ammirati 1996 and 1997. Description of microscopic characters were from sections mounted in 3% KOH. Spore measurements were made from deposits whenever possible (n=31-35). Abbreviations used to describe the basidiospore measures include: S = standard deviation, Q = quotient of spore length to spore width, V = approximate volume. To describe the density of the lamellae the following measurements are given: L = total number of lamellae reaching the stipe; l = number of lamellulae between two lamellae. Comparison of lamella width with the thickness of the piuleus context was made at about half the radius of the pileus. Color codes include Munsel Soil Color Charts (1975, example of notation, Mu 2.5YR2/4), Ridgway, Color Standards and Color Nomenclature (1912, example, Carob Brown (R)), A. Cailleux, Code des Couleurs des Sols (1981, example, Caill 55S), and Methuen Handbook of Color (example, 1D8). Macrochemical color reactions were made with 20 % or 30% KOH and/or NH_4OH. UV readings were made at approximately 360 nanometers. Collections of Meinhard Moser are deposited in the Herbarium of the Institut für Botanik der Universität Innsbruck (IB) and those of Joe Ammirati and Michelle T. Seidl at the University of Washington Herbarium (WTU).

Taxonomic Treatment

Section Multiformes Kühner & Romagn. ex Brandrud & Melot

Cortinarius (Phlegmacium) cacodes M.M.Mos. & Ammirati sp. nov.

Fig. 1, 2(1) Basidiospores, SEM, 11A

Pileo 60-125(-170) mm lato, primo hemisphaerico margine involuto, demum convexo usque applanato, glutinoso, coloribus mixtis, plerumque vinaceo tincto, saepe areis brunneis praedito, rarior totius brunneo, saepe disco ferrugineo vel rufo, plerumque partialiter obtecto e velo; lamellis primo pallide bubalinis, incarnato-bubalinis, dein cinereo-ochraceis, aetate ferrugineis, acie serrulato, adnatis usque emarginatis, usque ad 8 mm latis, confertis; stipite 40-85(-90) mm longo, 15-30 mm crasso, bulbo oblique marginato 20-40 mm lato, primo albido, dein pallide bubalino, aetate brunnescente in parte inferiore, juventute margine bulbi lilaceo tincto; velo universali primo lilaceo, mox brunnescente, cortina alba; carne albidula, odore fortiter tuberum Solani tuberosi et raphani, sapore miti. Sporis 8.5-11.2 x 5.3-6.2 µm, in media 10.1 x 5.6 µm, amygdaliformibus usque sublimoniformibus, verrucosis, apice glabro, basidiis 31-34 x 7.5-8 µm, tetrasporigeris, absque cystidiis, fibulis praesentibus.
Habitatio: in silvis coniferis (*Tsuga, Pseudotsuga, Abies*). Holotypus IB 91/618, Russian Gulch State Park, Mendocino, California, leg. M. Moser, 30 Nov. 1991

Pileus 60-125 (-170) mm diam, in young stages hemispheric with margin inrolled, later convex to applanate, glutinous, with rather mixed colors but mostly with some vinaceous tinge, Pale Vinaceous Drab (R), Vinaceous Drab (R), Light Vinaceous Drab (R), Brownish Drab (R), Cinnamon Drab (R), but often with some paler brownish areas or more rarely the whole surface paler brown, near Clay Color (R), even some areas darker brown, Sayal Brown (R) and disc often red-brown (Russet (R)), occasionally also the whole surface red-brown, sometimes rather dark, Caill 45R, 47S, 49S, innately fibrillose, on disc often with some patches or spots of veil remains which can discolor red-brown or paler, the very margin in young specimens grayish-whitish. **Lamellae** at first Pinkish Buff (R), later pale grayish ocher (Caill 69M to 70M, Sayal Brown (R)), with age also rust-brown, Ochraceous Tawny (R) to Tawny (R), edges eroded, adnate to emarginate, up to 8 mm wide (equaling 1/2 to 1 times the thickness of pileus context), close to crowded, L=120-150, l=1-3, 16-18/cm at margin. **Stipe** 40-85 (-90) mm long, 15-30 mm thick, the obliquely marginate bulb 20-40 mm, at first white, then pallid, Light Buff (R), Pinkish Buff (R), Cartridge Buff (R), downwards becoming brownish with

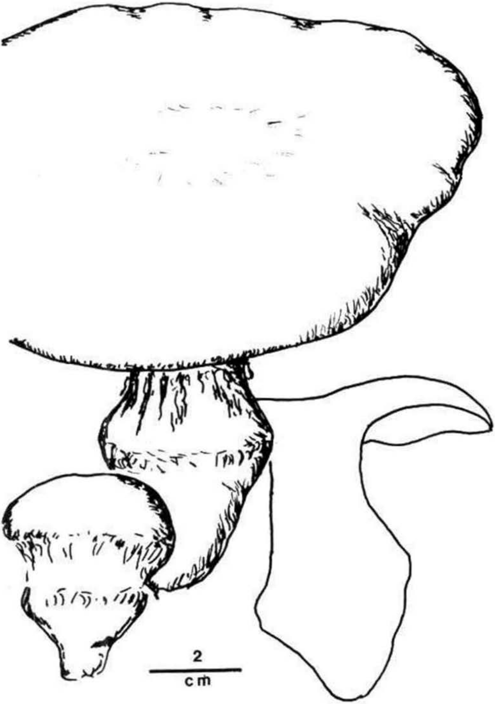

Fig. 1. *Cortinarius cacodes* (91/618) fruit bodies. (nat. size.)

age, bulb margin in young specimens with lilac tinges, later brownish. Universal veil at first lilac, but soon brownish, both on pileus and bulb margin, cortina whitish. **Context** whitish, in stipe sometimes with yellow-brownish discolored areas. **Odor** very strong of raw potatoes and radish (potato cellar). **Taste** mild.

Chemical reactions: KOH gray-brown to yellow-brown on pileus margin, red-brown on disc, in context somewhat yellowish brown (fugacious). Under **UV** bright yellow on lilac areas of pileus and outside of bulb, bluish on lamellae and stipe, pale yellowish on context.

Microscopic characters: Basidiospores 8.5-11.2 x 5.3-6.2 µm, mean 10.15 (S=0.5) x 5.6 (S=0.2) µm, Q=1.6-2, mean 1.8 (S=0.09), V=125-202, mean 167 (S=18.5), almond-shaped to sublimoniform, verrucose, apex smooth. Basidia clavate, 4-spored, 31-34 x 7.5-8 µm, some with yellow content, subhymenial hyphae 3-4.5 µm wide, trama hyphae 5-8 (-9) µm wide, in mediostratum up to 13-14 (-15) µm wide, walls pale yellowish ochraceous in KOH, clamp connections present. Cortina hyphae 2-5.5 µm wide, colorless, clamp connections present. Pileipellis with gelatinous pellicle of 2-4 mm wide, repent hyphae, walls yellowish, slightly curly, clamp connnections present, epicuticular hyphae 4-8 µm wide, walls yellow-brown, without distinct subcutis.

Habitat: Mixed conifer forests, *Tsuga, Pseudotsuga, Abies*.

Collections examined: IB 91/503, Jackson State Forest, Mendocino Co., Little Lake Rd., about 4 miles from Mendocino, leg. M. Moser, 22 Nov. 1991, IB 91/523, same area, 23 Nov. 1991; 91/542, Russian Gulch State Park, Mendocino, 25 Nov. 1991, 91/544, same area and date, 91/618, same area, 30 Nov. 1991 (holotype); 91/565, Richardson Grove State Park, Humboldt Co., 26 Nov. 1991; 95/189 Ipsut Creek, Mt. Rainier Nat. Park, Wash., leg. M. Seidl, 27 Sept 1995; 95/604 and JFA11804, Big Flat Station, South Fork Smith River, Cal., 21 Nov. 1995, 95/680, Caspar - Little Lake Rd., T17N/R17W, quadrant 8, Mendocino Co., leg. M. Moser, 7 Dec. 1995.

Variant: IB 91/718, Bullard's Bar Recreation Area, Schoolhouse Campground, Yuba Co., Calif., mixed forest of *Pinus lambertiana, P. ponderosa, P. attenuta, Lithocarpus, Arbutus, Arctostaphylos,* and *Pseudotsuga*, 9 Dec. 1991. Differs by slightly longer and morer slender basidiospores.

Comments: *Cortinarius cacodes* belongs to section *Multiformes* Kühn. & Romagn. ex Brandr. & Melot. Diagnostic characteristics are the variable colors of the pileus and the strong odor.

Section Cliduchi (Fr.) Sacc.

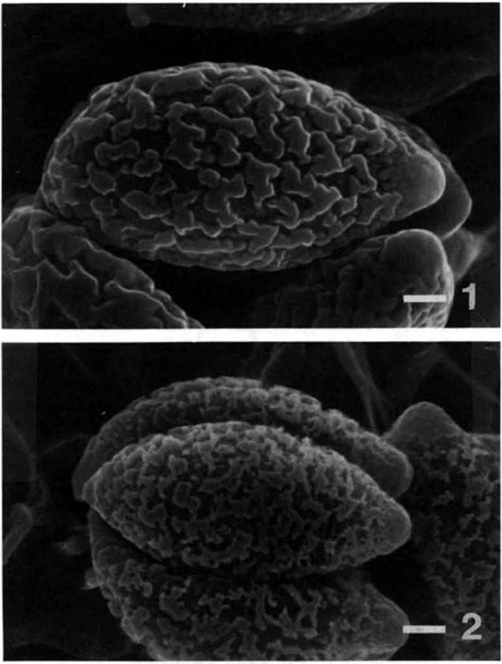

Fig. 2. Basidiospores in SEM of: 1. *Cortinarius cacodes* (91/618).
2. *Cortinarius glaucocephalus* (95/679) (x 9000).

Cortinarius* (*Phlegmacium*) *fraudulosus Britzelm. var. ***patrickensis*** M.M.Moser var. n.

Fig. 3, 11B

Differt a typo pileo magis glutinoso, pallide ochraceo, disco brunneo, saepe punctato vel subtiliter squamuloso, lamellis tenuioribus, subdistantibus, velo brunnescente, odore primo fructuoso, dein leviter terroso ut in *C. variecolore*. Sporis minoribus, 10.8-12.7(-15) x 5.9-7.1 µm, in media 11.7 x 6.5 µm, amygdaliformibus, leviter verrucosis.

Habitatio: in silvis coniferis (*Picea sitkensis*, *Pseudotsuga menziesii*). Holotypus IB 95/617, Patrick's Point State Park prope Trinidad, Humboldt Co., California, leg. M. Moser, 25 Nov. 1995

Pileus 25-90 mm diam, hemispheric, convex to convex-umbonate, then applanate and depressed, glutinous, colors at first pale ochraceous, near Warm Buff (R), the center brownish to brown and often densely punctate or finely squamulose, with age ochraceous and paler brownish colors mixed (finely marbled and sometimes radially streaked), general appearance Caill 65N, sometimes with paler areas near margin, Cream Buff (R), the center somewhat granulose when dry. The margin in young specimens covered and appendiculate by white veil. **Lamellae** at first between Pinkish Buff (R) and Cartridge Buff (R), later paler argillaceous, finally near Honey Yellow (R) to Clay Color (R), broadly emarginate, edges eroded, slightly ventricose, subdistant, L=40-65, l=1-3, 13-14/cm at margin, 5-12 mm wide, 2-5 times thickness of pileus context. **Stipe** 50-120 mm long, 7-15 mm thick, the somewhat clavate base 10-20 mm thick, rather rigid and hard, at first whitish, Cartridge Buff (R) to Cream Buff (R), below the white cortina fibrillose shaggy or floccose from white veil remains, the squamules attain a gray-brown color with age. **Context** whitish at first, with age brownish gray in pileus and stipe cortex, in pith paler, in base whitish. When young rather hard and compact, in pileus rather thin. **Odor** at first somewhat fruity, of green apples then slightly to strongly of green corn.

Chemical reactions. KOH 20% darker brown on pileus surface, on context in young specimens only slightly so, in older stronger gray-brown. Under **UV** lamellae yellow, context blue, pileus and stipe dark.

Microscopic characters: Basidiospores 10.8-12.7 (-15.5) x 5.9-7.1 µm, mean 11.7 (S=0.5) x 6.5 (S=0.3) µm, Q=1.6-2.0 , mean 1.8 (S=0.09), V=197-330 µm^3, mean 253 (S=30) µm^3, almond-shaped, moderately verrucose, apex smooth. Basidia 38-41 x 9-10 µm, clavate, 4-spored, subhymenial hyphae 4-5.5 µm wide, colorless, lamella trama hyphae 5-10 µm wide, colorless, clamp connections present, in mediostratum 10-12 µm wide, without cheilocystidia. Pileipellis with gelatinous layer of more

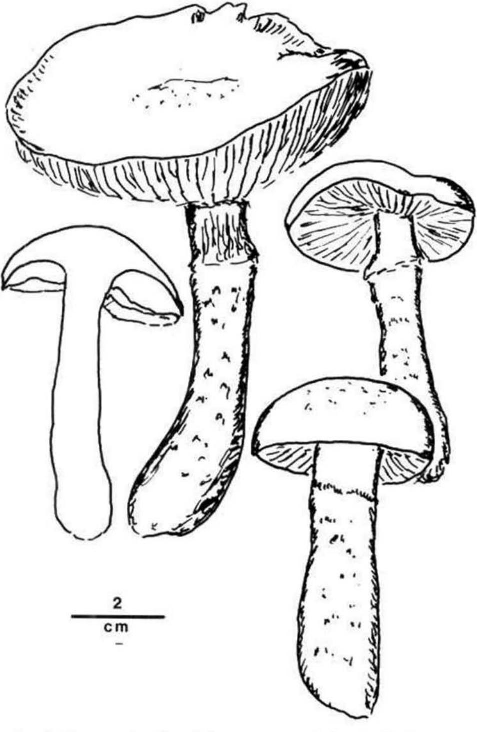

Fig. 3. *Cortinarius fraudulosus* var. *patrickensis* (95/617). Fruit bodies (nat. size)

or less repent hyphae, 4-7 µm wide, with yellowish, partly encrusted walls, clamp connections present, epicuticular hyphae 5-9(-10) µm wide, walls yellow-brown, in subcutis hyphae subcellular, walls yellow-brown. Cortina hyphae 4-4.5 µm wide, colorless, with clamp connections, veil hyphae from stipe 6-7 µm, walls ochraceous, encrusted.

Habitat: under *Picea sitchensis* and *Pseudotsuga menziesii*.

Collections examined: IB 91/580, Patrick's Point State Park near Trinidad, Humboldt County, California, 27 Nov. 1991, leg. M. Moser; IB 95/617 (holotype), same area but another site, 25 Nov. 1995, leg. M. Moser.

Comments: This taxon resembles in many respects *C. fraudulosus* Britzelm., a species we reported from Wyoming (Moser et al. 1995). It differs, however, by a more gelatinous pileus surface, which in *C. fraudulosus* is only slightly viscid or often nearly dry even in wet conditions, brownish colors on the disc, fine squamulosity, brownish discoloring veil, thinner and less distant lamellae, the relatively thin context of pileus, the more rigid stipe and the slightly smaller basidiospores. However, it has many characters in common with *C. fraudulosus*, so we think it best to regard it as a variety of this taxon. The pileus surface resembles that of *C. papulosus* Fr., but the general color, the habit, and the size are the same as in *C. fraudulosus*.

Section Glaucopodes (Konr. & Maubl.) Brandrud & Melot

Cortinarius (Phlegmacium) glaucocephalus M. M. Moser, Ammirati & Halling sp. n.

Fig. 2(2) Basidiospores, SEM, 4, 11C.

Pileo 40-75 mm lato, primo hemisphaerico margine involuto, dein convexo usque applanato, glutinoso, primo obscure atro-veneto, dein glauco-veneto, atrocyaneo, denique glauco disco ferruginascente; lamellis primo obscure caeruleis, dein pallidioribus, griseo tinctis, subfuscis, rotundatis vel emarginatis, acie serrulato, confertis, 4-6 mm latis; stipite 30-60 mm longo, 12-19 mm crasso, bulbo marginato 17-30 mm lato, apice caesio, parte inferiore griseo-veneto, veneto, glauco, margine bulbi viridulo, demum brunneolo, velo viridulo, dein flavo-brunneo usque ferrugineo, cortina fugace; carne pilei albidula, olivaceo tincta, stipitis caeruleo variegata. Odore leniter fungino, sapore miti.

Sporis 8.2-9.4 x 4.1-5 µm, in media 8.8 x 4.7 µm, sublimoniformibus limoniformibusve, verrucosis, vertice glabro, basidiis 27-32 x 7-8 µm, tetrasporigeris, absque cheilocystidiis, fibulis praesentibus.

Habitatio: in silvis mixtis (*Tsuga, Pseudotsuga, Pinus ponderosa, Abies, Acrtostaphylos manzanitae*). Holotypus IB 95/679 Caspar Little Lake Rd.- Quadrant 8 T17N/R17W, Mendocino Co., leg. J. Ammirati & M. Moser, 7 Dec. 1995

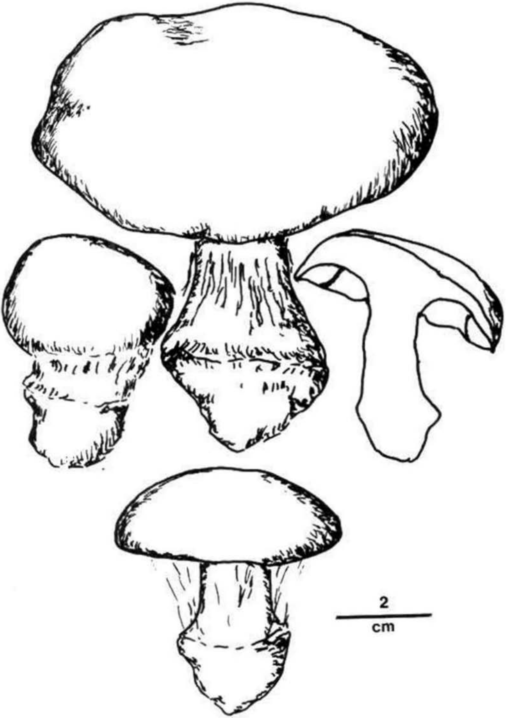

Fig.4. *Cortinarius glaucocephalus* (95/679). Fruit-bodies (nat. size).

Pileus (23-)40-75-(107) mm diam, hemispheric, then convex to applanate, glutinous, with colors dark bluish green often nearly blackish, Dark Grayish Blue-Green (R), Greenish Slate Black (R), later with more blue-green colors, American Green (R), margin in some specimens near Mignonette Green (R), Deep Lichen Green (R), disc with brownish colors, dingy red-brown, Caill 47P, to umber brown, Caill 50S, sometimes larger parts pale blue-green. **Lamellae** at first dark blue, Slate Blue (R), Dark Plumbago Blue (R), Madder Blue (R), Windsor Blue (R), later paler and mixed with gray, Drab (R), rounded adnate to emarginate, edges eroded, close, L=100, l=3, 19-20/cm at margin, 4-6 mm wide (equals 2/3 of pileus context). **Stipe** 30-60 mm long, 12-19 mm thick, the mostly narrow, marginate bulb 17-30 mm, apex grayish blue, Dutch Blue (R) to Deep Dutch Blue (R), downwards increasingly bluish green, glaucous, Glaucous Blue (R), toward the bulb more greenish, Grape Green (R), Mignonette Green (R), but much paler, silky shiny, the bulb margin at first pale greenish, soon becoming yellow- to red-brown. **Veil** at first greenish, soon yellow-brown to red-brown, cortina scanty and fugacious, on expanded basidiomata not recognizable. **Context** in pileus dingy whitish with olivaceous hue, in stipe blue, marbvled, occasionally also with slight pink hue, in bulb dingy whitish with some yellowish or yelowish brown spots and tinges. **Odor** somewhat musty, fungoid, weak, **taste** mild.

Chemical reactions: KOH 20% on pileipellis red-brown, on context dingy brown. Under **UV** pileus dull red, lamellae dark, stipe greenish yellow, context yellow (with few bluish areas).

Microscopic characters: Basidiospores 8.2-9.4 x 4.1-5 µm, mean 8.8 (S=0.3) x 4.7 (S=0.2) µm, Q= 1.7-2.2, mean 1.9, V=81-123 µm^3, mean 101 (S=9) µm^3, sublimoniform to limoniform, verrucose, apex smooth, basidia 27-32 x 7-8 µm, clavate, (2-) 4-spored, without cheilocystidia, edges with basidia and basidioles, subhymenial hyphae 3-4.5 µm wide, trama hyphae 7-12 µm wide, in mediostratum up to 15 µm wide, colorless or walls pale ochraceous in KOH, clamp connections present. Pileipellis with gelatinous layer of 4-5 µm wide, repent hyphae, walls in KOH yellow-brown, granulose encrusted, clamp connections present (slightly banded), epicuticular hyphae 5-12 µm wide, walls yellow-brown in KOH, granulose encrusted, in 12-14 µm wide, more irregular and partly subcellular hyphae.

Habitat: In mixed forests with *Tsuga, Pseudotsuga, Pinus onderosa, Abies*, and *Arctostaphylos manzanita*.

Collections examined: California: IB 91/540, Caspar Little Lake Rd., Mendocino Co., leg R. Halling, 25 Nov. 1991; IB 91/617, same area, leg. R. Halling 30 Nov. 1991; IB 95/679 (holotype) and JFA 11884, same area, T17N/R17W quadrant 8, leg.

J.Ammirati & M. Moser, 7 Dec. 1995; Oregon: IB 95/383 and JFA 11636, Bear Springs, Mt. Hood area, Wasco Co., leg. M. Moser 27 October 1995.

Comments: The species is remarkable for its rapid and strong color change. The two collections from 1991 were rather dark blue to blackish blue. Collection 95/383 from Bear Springs was of older specimens all already with bright blue-green color. Only the rich collections IB 95/679 and JFA 11884 permitted us to recognize that the collection from Oregon (95/383) actually belonges to the same species. The former collection offered all stages of development from one mycelium. The colors seem to be due to an unusual pigment. All color films do not render the blue colors, but the fungus instead appears red-brown. The taxonomic position of *C. glaucocephalus* is unclear. To judge from the colors it may be best placed in section Coerulescentes, but both the shape, size and ornamentation of the basidiospores corresponds more with that found in section Glaucopodes where we place the taxon temporarily.

Section Variecolores (Kühner & Romagn.) Brandrud & Melot

Cortinarius* (*Phlegmacium*) *lilacinocolossus M. M.Moser spec. nov.
.Fig. 5, 6(3) basidiospores, SEM, 11D

Pileo 55-210(-230) mm lato convexo, margine involuto, dein applanato, plerumque depresso, viscido, laete lilaceo, aetate coloribus ferrugineis vel rufo-brunneis immixtis praecipue discum versus sed etiam maculato marginem versus, margine diu lilaceo; lamellis jam juventute argillaceis, fumosis, nullo modo lilaceis, aetate fuscis, adnatis usque emarginatis, 5-10(-15) mm latis, acie serrulato, confertis; stipite 55-95(-130) mm longo, apice 17-53 mm, ad basim 25-62 mm crasso, subclavato usque subfusoideo, albido, parte inferiore obtecto e velo primo albido, brunnescente, saepe fasciculato; carne albida usque pallide bubalina, odore juventute dulcidulo, dein fortiter *Zeae mayidis* ut in *C. variecolore*. KOH (3%) ope reactionem luteam praebente in cuticula carneque, carne KOH 20% reactionem brunneam flavomarginatumque, NH_4OH ope laete luteam praebente. Sporis 9.4-11.5 x 5.5-6 µm, media 10.6 x 5.6 µm, subamygdaliformibus, verrucosis, vertice glabro, basidiis 37-39 x 8-9 µm, tetrasporigeris, absque cheilocystidiis, fibulis praesentibus.
Habitatio: in silvis mixtis (*Pinus lambertiana, P. ponderosa, Lithocarpus. Arbutus. Arctostaphylos, Castanopsis, Pseudotsuga*). Holotypus IB 91/707, Bullard's Bar Recreation area, Schoolhouse campground, Yuba Co., California, leg. M. Moser 9 Dec. 1991.

Pileus 55-210 (-230) mm, convex, margin involute later applanate and finally somewhat depressed, when growing in clusters also somewhat

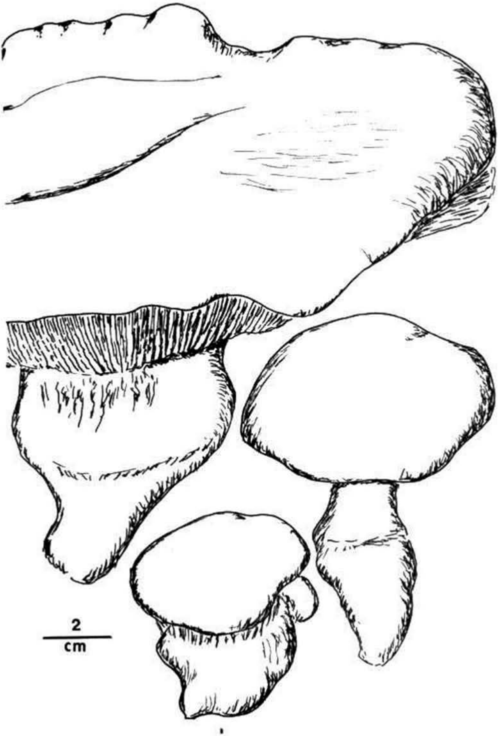

Fig. 5. *Cortinarius lilacinocolossus* (91/707). Fruit-bodies (3/4 nat. size)

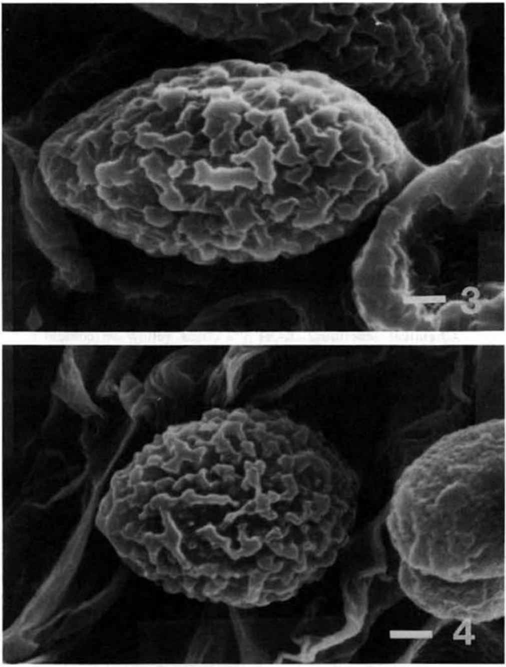

Fig. 6. Basidiospores in SEM of : 3. *Cortinarius lilacinocolossus* (91/707).
4. *Cortinarius atrochalybaeus* (95/656). (x 9000)

deformed, viscid, with bright lilac color, Deep Dull Lavender (R), Deep Vinaceous Lavender (R), then becoming mixed with different shades of reddish brown colors, Cinnamon Brown (R) or paler, Light Vinaceous Fawn (R), starting particularly from disc but also smaller or larger spots towards the margin, but margin remaining mostly lilac, Pale Anilin Lilac (R), Lavender (R), not or only slightly innately fibrillose, sometimes the disc can also fade to about Cream Buff (R). **Lamellae** already in young specimens gray-brown, argillaceous, not lilac, becoming about Wood Brown (R), adnate to emarginate, 5-10 (-15) mm broad, about 1/4 to 1/3 (-2/3) thickness of pileus context, edges eroded, close to crowded, L=100-120 (-160), l=(1-) 3-7, (11-)16-18/cm at margin. **Stipe** 55-95 (-130) mm long, above 17-53 mm thick, the base slightly enlarged or somewhat fusoid (partly due to the fasciculate growth), 25-62 mm thick, white, without any lilac tinges, lower part covered by **veil** remains which are or become pale brownish, in very young buttons white. **Context** in pileus above the lamellae up to 40 mm thick, white to whitish, Cartridge Buff (R) to Cream Buff (R). **Odor** strongly of green corn, earthy, when freshly cut somewhat grass-like, but when quite fresh also a sweetish odor can be present. **Taste** mild.

Chemical reactions. KOH 3% bright yellow on context and on pileipellis of younger specimens, with 20% KOH brown with yellow margin on context, NH_4OH bright yellow on context Under **UV** blue on pileus, stipe and context, lamellae dark.

Microscopic characters: Basidiospores 9.4-11.5 x 5.3-6 µm, mean 10.6 (S=0.5) x 5.6 (S=0.2) µm, Q=1.7-2, mean 1.9, V=138-211 µm^3, mean 174 (S=18) µm^3, narrow-amygdaliform, verrucose, apex smooth, basidia clavate to utriform, 4-spored, 37-39 x 8-9 µm, without cheilocystidia, epicuticular hyphae 4.5-8.5 µm wide, in KOH slightly yellowish, subcutis hardly differentiated, hyphae 5-8 µm wide, pileus trama of hyphae 6-15 µm wide, regular in upper part, irregular in deeper layer. Cortina hyphae 2.5-4 µm wide, clamp connections present.

Habitat: mixed forests with *Pinus lambertiana, P. ponderosa, Lithocarpus, Arbutus, Arctostaphylos, Castanopsis,* and *Pseudotsuga.* Growing in smaller to larger clusters .

Collections examined: IB 91/707, (holotype) Bullard's Bar, Recreation Area, Schoolhouse Campground, Yuba Co., California, leg. M. Moser, 9 Dec. 1991; IB 95/601 and JFA11805, South Fork Smith River, Big Flat Station, near Road toward China Mine, Del Norte Co., California, leg. M. Moser, 21 Nov. 1995.

Comments: This species is remarkable by the size which it can attain, and the fasciculate growth. It is certainly related to *C. variecolor* Fr. but differs by lack of violaceous colors both on lamellae, stipe and context.

Section Caerulescentes Rob. Henry ex Brandrud & Melot

Cortinarius (*Phlegmacium*) *atrochalybaeus* Ammirati & M.M.Moser n.sp.

Fig. 6(4), basidiospores, SEM, 7, 12L.

Pileo 30-70 mm lato, primo hemisphaerico, margine involuto, dein convexo, aetate disco applanato, margine saepe undulato, glutinoso, coloribus atrocaeruleis, margine violaceo, disco fragmentis veli obtecto; lamellis obscure griseo-lazulinis, aetate fuscis, adnatis usque plus minusve emarginatis, 4-6 mm latis, confertis; stipite 30-50 mm longo, 12-20 mm crasso, bulbo marginato 20-25 mm lato, pallide caeruleo, griseo-lazulino, bulbo fimbriato usque subvolvato e velo caeruleo; carne sordide bubalina, in cortice stipitis partialiter caeruleo marmorata; carne KOH ope reactionem brunneam, cuticula atram praebente. Sporis 7.0-8.2 x 4.7-5.4 µm, in medio 7.7 x 5.0 µm, ellipsoideis, verrucosis, basidiis 27-30 x 7-8 µm, clavatis, tetrasporigeris, absque cystidiis, fibulis praesentibus.
Habitatio in silvis frondosis (*Lithocarpus densiflora, Arbutus menziesii, Quercus vacciniifolius, Q. chrysolepis.)*
Holotypus: IB 95/630, isotypus JFA 11829 (WTU), in localita dicta „Danger Point"; Smith River Middle Fork, Del Norte Co., California, leg. J. F. Ammirati, 29. Nov. 1995

Pileus 30-70 mm diam, at first hemispheric, then convex and disc becoming applanate, margin often undulate due to the growth in fascicles, glutinous, with blackish blue color, Dark Slate Violet (R), Deep Slaty Brown (R) to Vinaceous Slate (R), or even darker, Dusky Brown (R), Dark Purplish Black (R), near margin with a narrow zone of bright violet color, Dark Plumbago Gray (R) to Ramier Blue (R), on disc with rather large patches of universal veil. **Lamellae** dark bluish gray at first, Deep Plumbago Blue (R), Dark Plumbago Blue (R), later somewhat paler, Light Plumbago Blue (R), then discoloring and becoming gray-brown, Light Drab (R), with age near Cinnamon Drab (R), rounded adnate or indistinctly emarginate, edges entire to eroded, 4-6 mm wide, equaling thickness of pileus context. **Stipe** 30-50 mm long, 12-20 mm thick, the marginate bulb 20-25 mm, pale bluish, bluish gray, Plumbago Blue (R), Lavender Gray (R), Sky Gray (R), Mineral Gray (R), the bulb fringed by bluish **veil** remains, Pale Grayish Blue-Violet (R) at first, sometimes the veil nearly submembranaceous and forming almost a volva, bulb underneath bluish to white. **Context** not violaceous or only with traces of violet in apical part of stipe, mostly dingy buff, in upper part of stipe slightly marbled with bluish gray. Without distinctive **odor. Taste** mild.

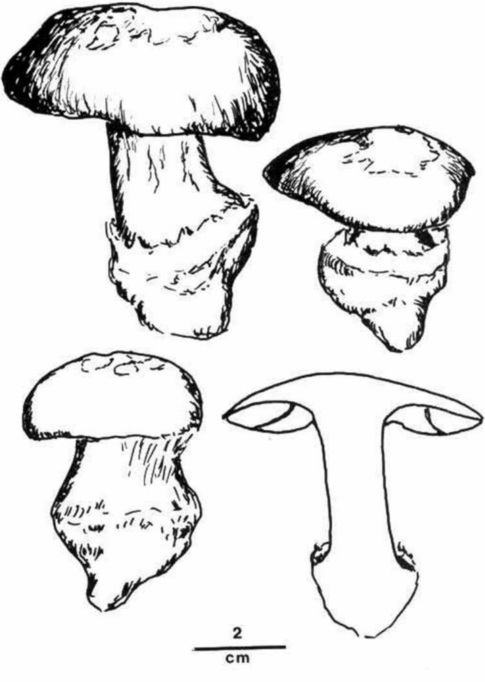

Fig. 7. *Cortinarius atrochalybaeus* (95/656). Fruit-bodies (nat. size)

Chemical reactions: KOH on context brown, on pileipellis black, Lugol negative. Under **UV** pileus dark, gills grayish, stipe yellow with some blue areas, context bluish in upper part, yellow in bulb.

Microscopic characters : Basidiospores 7.0-8.2 x 4.7-5.4 µm, mean 7.7 (S=0.27) x 5.0 (S=0.2) µm, Q=1.4-1.7 , mean 1,5 (S=0.07), V=83-116 μm^3, mean 99 (S=8.5) μm^3, elliptic, verrucose. Basidia 4-spored, clavate, 27-29 (30) x 7-8 µm, young lamella edge with cylindric to clavate sterile cells similar to or smaller in size than basidia (basidioles). Pileipellis with gelatinous surface layer of 2.5-4 µm wide, colorless, repent hyphae with clamp connections. Epicuticular hyphae 5-8 µm wide, walls ochraceous in KOH. Subcutis hyphae broad to subcellular, 12-15 (-20) µm wide, walls ochraceous in KOH, veil from "calyptra" of colorless hyphae, 4-4.5 (5) µm wide with clamp connections, from the bluish "volva" 3-5 µm wide, colorless, with clamp connections.

Habitat: under *Lithocarpus densiflora, Arbutus menziesii* and *Quercus vacciniifolia* and *Q. chrysolepis* on calcareous soil.

Collections examined: IB 95/630 and JFA11829, Danger Point, Smith River Middle Fork, Highway 199, Del Norte Co., California, 29 Nov. 1996, leg. J. F.Ammirati. IB 95/656 and JFA11860, same area but 3 Dec. 1995.

Comments: We considered at first that this fungus might be *C. calyptratus* A. H. Smith (1939). We have another collection from the South Fork of the Smith River which also had a bluish veil. The basidiospores differ significantly from those of *C. atrochalybaeus* but are similar to those of the holotype of *C. calyptratus*, both in size and shape. For comparison we give a description of this collection below under *C. calyptratus*.

Cortinarius* (*Phlegmacium*) *calyptratus A. H. Smith

Contr. Univ. Mich. Herbarium 2:14-15, 1939.
Fig. 8(5) basidiospores, SEM., 12J, 12K

Pileus 45-105 mm diam., convex applanate to depressed and margin finally upturned, glutinous, all specimens with large patches of ochraceous-whitish veil on disc, colors dark grayish violet, (R) Dark Vinaceous Gray (R), Vinaceous Slate (R), or even Violet Gray (R) with brown innate fibrills. **Lamellae** in all our specimens already discolored and brownish, Clay Color (R), Tawny Olive (R), sometimes more Wood Brown (R), only in few specimen with some lilac tint close to the stipe, rounded adnate to emarginate, edges uneven to finely eroded, close, L=80-100, l= 1-3, 15-16/ cm at margin, 8-10 mm wide (equalling thickness of pileus context). **Stipe** 60-80 x 10-20 mm, the marginate bulb 20-35 mm, bulb obliquely

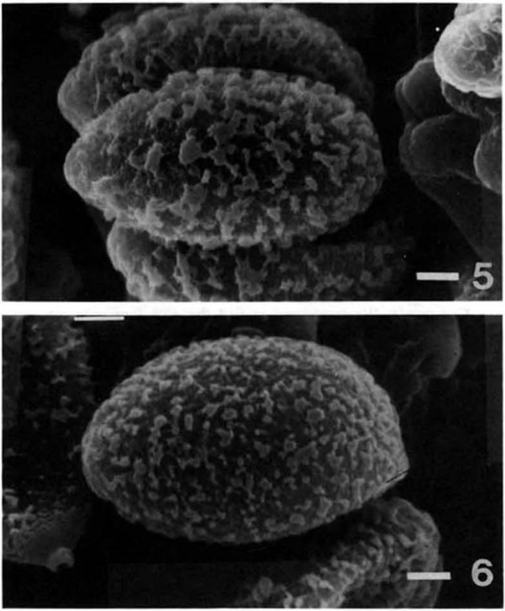

Fig. 8. Basidiospores in SEM of : 5. *Cortinarius calyptratus* (95/589) (x 9000).
6. *Cortinarius ponderosus* (JFA 11755) (x 10000)

marginate to flaring and depressed, apex in most specimens still bluish, lower half in some specimens covered by bluish-violaceous fibrills, the bulb fringed by violaceous bluish **veil**, later becoming ochraceous. **Context** bluish only in apex of stipe, otherwise buff, about Warm Buff (R). Without distinctive **odor, taste** mild.

Chemical reactions: KOH (20%) brown on pileus surface, negative on context. Under **UV** context in stipe and bulb underneath yellow, otherwise dark (negative).

Microscopic characters: Basidiospores 8.2-10 x 4.7-5.4 µm, mean 9.3 (S=0.4) x 5.1 (S=0.2) µm, Q=1.7-2.1, mean 1.8 (S=0.09), V=102-153 µm^3, mean 125 µm^3 (S=13.5), almond-shaped, some even sublimoniform, verrucose, apex smooth, Basidia 4-spored, clavate, 33-35 x 8-9 µm, subhymenial hyphae 2.3-4(-5) µm wide, lamella trama hyphae 5-8 µm wide, in mediostratum 12-14 µm wide, walls ochraceous, with rare clamp connections. Pileipellis with gelatinous pellicle of 3.4 (-4.5) µm wide, more or less repent hyphae with clamp connections, walls colorless to pale ochraceous. Epicuticular hyphae 5.5-8 µm wide, walls ocher-yellowish in KOH, subcutis hyphae 7-10 µm wide, not much differentiated. Hyphae of the calyptrate veil 2.5-4 µm, walls yellowish in KOH, clamp connections present.

Habitat: in a pure forest of *Lithocarpus densiflora* or in mixed stand of *Lithocarpus, Quercus, Pseudotsuga, Umbellularia, Arctostaphylos, Pinus*.

Collection examined: IB 95/589, Smith River South Fork, below intersection of Road 427 and road to Buck Creek Campgound, Del Norte Co., California, 19 Nov. 1995, leg. M. Moser. JFA 11789 Smith River South Fork, Big Flat Station, 19 Nov. 1995, leg. J.F. Ammirati.

Comments: Our specimens show still some lilac tints in the lamellae close to the stipe, the whole stipe is lilac and lower part covered by lilac fibrills. A.H. Smith (1939) reported this species from conifer woods (spruce and redwood) near Crescent City. However, in this area, *Lithocarpus* occurs in all forests but can be easily missed. As we collected the species in pure stands of *Lithocarpus* or mixed stands of conifer and hardwoods we think that it is most likely associated with hardwoods. The basidiospores of the type (Smith 8352) measure 7.7-9.5 x 4.7-5.3 µm, mean 8.6 (S=0.4) x 5.1 (S=0.2), Q=1.5-1.9, mean 1.7 (S=0.1), V= 97-140 µm^3, mean 117 (=10.5) µm^3.

Section Callochroi Brandrud & Melot

***Cortinarius* (*Phlegmacium*) *subpurpureophyllus* A. H. Smith**
Contr. Univ. Mich. Herbarium 2:17-18, 1939.
Fig. 11E,F.

Pileus 35-90 mm diam., at first hemispheric with margin involute, then convex and finally applanate and disc sometimes even slightly depressed, margin sometimes becoming wavy, marginella long remaining inrolled, very glutinous, colors mostly bright red-brown, rufous, Caill 37P, 39P, Kaiser Brown (R) or somewhat darker, margin somewhat paler, in young specimens Caill 45M, in older 45N, with pale ochraceous areas or patches of veil remains laying on the gluten, sometimes such patches up to 1-2 cm inward from margin, disc in older specimens often more dingy, not innately fibrillose. **Lamellae** at first lilac, Light Vinaceous Gray (R), Lavender (R) to Grayish Lavender (R), at maturity near Fawn Color (R), rounded adnate to slightly emarginate, edges slightly uneven to eroded, close to crowded, L= 100-130, l=1-3, 15-17/cm at margin, 4-7 (-8) mm wide, equaling thickness of pileus context. **Stipe** 60-100 mm long, 12-20 mm thick, the oblique and obtusely marginate bulb 25-35 mm, bright lilac at first down to the bulb, Light Vinaceous Gray (R), Grayish Lavender (R), particularly in the lower part of the stipe, in age, however, lilac tinges remaining at the apex, lower parts becoming dingy pallid, somewhat longitudinally striate, the veil remains at the bulb margin violaceous then whitish. **Cortina** grayish. The universal **veil** at first violaceous becoming whitish, on pileus surface becoming ochraceous. **Context** dingy whitish in pileus and bulb, lilac in upper part of stipe, often with brownish spots. **Odor** not distinctive, **taste** mild.

Chemical reactions: KOH (3%) slightly brownish on context, negative on pileipellis or only slightly darker brown, KOH 20% negative on context, dark brown on pileipellis,

Microscopic characters: Basidiospores 10-11.8 x 5.5-6.5 µm, mean 10.9 (S=0.4) x 5.9 (S=0.2) µm, Q=1.7-2.0, mean 1.8 (S=0.07), V=164-255 µm^3, mean 201 (S=20) µm^3, almond-shaped to slightly sublimoniform, verrucose, apex smooth. Basidia 4-spored, clavate, 34-36 x 10-11 µm, pileipellis with about 500 µm thick gelatinous layer of 4-5.5 µm wide hyphae, repent in basal layer, irregular in upper part, often branched, pale- to dark yellowish encrusted, encrustation sometimes in zig-zag bands, clamp connections present. Epicuticular hyphae 5.5-9 µm wide, repent, with brown encrustation, in subcutis up to 15 µm wide, less pigmented, in trama colorless, irregular to pseudoparenchymatous. Cortina hyphae 2.5-5 µm wide, colorless, clamp connections present.

Habitat. Under *Picea sitchensis, Tsuga heterophylla, Pseudotsuga menziesii.*

Collections examined: California: IB 91/568, Patrick's Point State Park near Trinidad, Humboldt Co., 27 Nov. 1991, leg. M. Moser; Smith 8164 (holotype), Crescent City, 28 Oct. 1937, Smith 8405, near Crescent City.

Comments: The collection (91/568) was rather rich and in excellent condition comprising all stages of development. It seems to agree well with the originl description. The type was collected further north near Crescent City under "spruce", meaning under *P. sitchensis*. Smith also described the adhering veil remains on the pileus. We found the basidiospores of the type collection (Smith 8164) to be 10.2-12.3 x 5.8-6.5 µm, mean 11.1 (S=0.5) x 6.1 (S=0.2) µm, Q=1.7-2, mean 1.8, V=186-270 µm^3, mean 215 (S=21) µm^3, the shape corresponds exactly to our collection. In a second collection of Smith (8405), also from Crescent City, we found the basidiospores 10.5-12 x 5.5-6 µm. Smith indicated the great similarity with *C. purpureophyllus* Kauffm. This, however is a hardwood species from Michigan. The basidiospores of the holotype are similar, slightly more sublimoniform and slightly larger: 10.9-13 x 5.9-7.3 µm, mean 11.9 (S=0.5) x 6.5 (S=0.36) µm, Q=1.56-2, mean 1.8, V=202-326 µm^3, mean 265 (S=33) µm^3. *C. parksiana* A. H. Smith, which Smith collected near Trinidad, Humboldt Co., also seems to be similar and has basidiospores of similar size but their shape is elliptic with blunt ends and distinctly different from those of *C. subpurpureophyllus.*

Cortinarius subpurpureophyllus var. sulphureovelatus **M. M.Moser** nov. var.

Fig. 9, 12G

Differt a typo bulbo infra mycelioque sulphureo. Habitatio:in silvis coniferis (*Tsuga heterophylla, Pseudotsuga menziesii*). Holotypus IB 95/515, Fogarty Creek State Park, Lincoln Co., Oregon, leg. M. Moser & J. Ammirati, 10 Nov. 1995.

Pileus 40-110 mm diam, hemispheric, convex, margin involute, later applanate and slightly depressed, glutinous, bright red-brown, but somewhat paler and darker marbled, Caill 37S, 37R, 37P, margin mostly slightly paler, in young specimens Caill 45M, in older 45N, often with patches of veil remnants floating on the gluten near margin, not innately fibrillose or sometimes slightly darker finely spotted, in some young specimens the spots are larger and darker brown. **Lamellae** at first lilac, Lavender (R) to Grayish Lavender (R), but rather quickly losing this color and becoming argillaceous, with age tinged between Cinnamon Buff (R) and Sayal Brown (R), rounded adnate to emarginate, edges rather strongly eroded, serrulate, crowded, L=120-130, l=1-3, 17-19/cm at margin, 5-7 mm wide (equalling the thickness of pileus context). **Stipe** 70-150 mm long, 10-20 mm thick, the oblique, marginate bulb 25-30 mm wide, at first bright lilac first over the whole length, then discoloring and apex becoming grayish to dingy whitish, above the bulb retaining the lilac color longest, then discoloring brownish to rusty brown, the bulb underneath sulphur yellow (Sulphur Yellow (R) to Greenish Yellow (R)) and the mycelium the same color, bulb margin also with lilac and whitish colors. Young specimens are covered by yellow fibrills, the bulb margin shows also whitish to lilac fringed. **Cortina** whitish. **Context** whitish in all parts. Without distinctive odor, taste mild.

Chemical reactions: KOH (20 %) negative on context, dark brown on pileipellis. Under UV pileus dark purple, lamellae yellowish, stipe bluish (apex sometimes yellowish), bulb yellow-orange, context very faintly yellowish with few bluish areas, in general more dingy whitish.

Microscopic characters: Basidiospores 10-12.2 x 5.5-6.5 µm, mean 11.1 (S=0.5) x 6.1 (S=0.2) µm, almond-shaped to sublimoniform, some even lemon-shaped, verrucose, apex smooth. Without cheilocystidia. Basidia 34-37 x 9-10 µm, clavate, 4-spored, subhymenial hyphae 4-6 µm wide, trama hyphae 6-8 (-10) µm wide, in mediostratum 8-12 µm wide, colorless, with clamp connections. Some refringent hyphae in lamella trama. Pileipellis with gelatinous layer of more or less repent to subrepent hyphae, 3-7 µm wide, walls brown encrusted, granulose and often in garlands. Epicutis thick, hyphae 6-8 µm wide, walls brown encrusted with granules and small platelets, subcutis subcellular, walls brown encrusted.

Habitat: under *Tsuga heterophylla* and *Pseudotsuga menziesii*, *Alnus* nearby.

Collection examined: IB 95/515 (holotype) and JFA 11723, Fogarty Creek State Park, Lincoln Co., Oregon, 10 Nov. 1995, leg. M. Moser & J. F. Ammirati.

Comments: This taxon very much resembles *C. subpurpureophyllus* and the microscopic characters are the same, but it differs by the yellow color of the veil and the darker brown encrustation of the hyphae of the pileipellis. As we know several taxa both in America and Europe where the color of the veil varies between white, yellow and bluish, we think it best to regard this taxon as a variety.

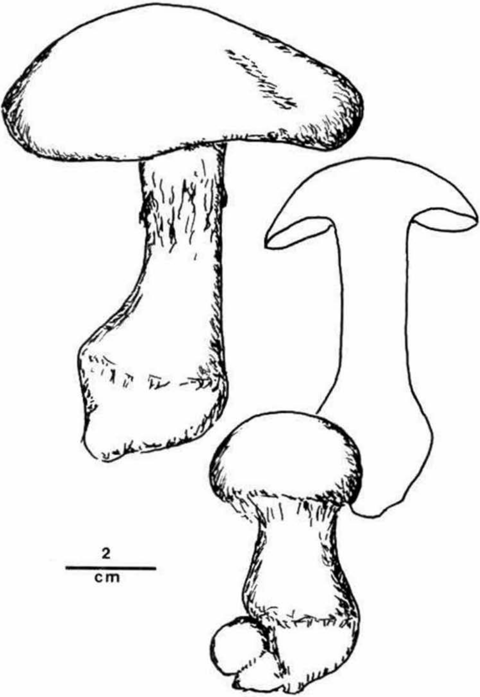

Fig. 9. *Cortinarus subpurpureophyllus* var. *sulphureovelatus* (95(515). Fruit-bodies (nat. size).

Cortinarius* (*Phlegmacium*) *spectabilis M.M.Moser
Sydowia 6:152, 1952.
Fig. 12H

Pileus 3.5-6.5 cm, convex, margin at first involute , with age only the marginella remaining so, glutinous, with pale ochraceous colors, Pinkish Buff (R) to Pale Pinkish Buff (R), disc becoming brownish with age. **Lamellae** pale lilac at first, Pale Bluish Lavender (R), emarginate, edges eroded, close to crowded, L=120, l=1-3, 18-19/cm at margin, 5-9 mm wide, equalling thickness of pileus context. **Stipe** 40-90 x 9-13 mm, with sharply marginate flaring bulb, 20-37 mm wide, pale lilac at first, later only apex retaining lilac color, downwards becoming brownish, margin of bulb slightly lilac from veil remains, later fading to whitish. **Context** lilac in apical cortex layer of stipe, otherwise whitish, in bulb also with brownish yellow areas.

Chemical reactions: KOH 20% immediately ink-red on pileus surface. Under **UV** all parts yellowish with blue areas.

Microscopic characters: Basidiospores 10.8-12.7 x 5.3-6.7 µm, mean 11.7 (S=0.46) x 6.2 (S=0.3) µm, Q= 1.7-2.3, mean 1.9, V= 181-277 µm^3, mean 238 (S=23)µm^3, almond-shaped, tapering at both ends, rugose-verrucose. Basidia 33-35 x 8-9 µm, 4-spored, clavate. Without cheilocystidia. Pileipellis with thick gelatinous layer of rather irregularly arranged, colorless hyphae 2.5-3 µm wide, with clamp connections. Epicuticular hyphae 5.5-6.5 µm wide, walls ochraceous in KOH, easily separating from trama.

Habitat: Under *Pseudotsuga menziesii* and *Larix occidentalis*.

Collection examined : IB 95/433, near Clear Creek Campground, Mt. Hood area, Wasco Co., Oregon, 31 Oct. 1995 leg. M. Moser.

Comments:: The basidiomata of this collection were somewhat smaller than in European collections (pileus 5-10 cm), but agree in colors, veil, chemical reaction and spore shape and size rather well. We considered also a possible identity with *C. metarius* Kauffm., as this species gives the same red reaction with KOH. However, it has more yellow colors and also a yellowish veil. So we excluded this possibility.

Section Fulvi Mos. & Horak

Cortinarius* (*Phlegmacium*) *oliveopetasatus M.M.Moser nov. spec.

Fig. 10, 12 I.

Pileo 60-115 mm lato, convexo margine involuto, interdum leviter crenulato, demum applanato, disco depresso, glutinoso, coloribus obscure olivaceis vel olivaceo-brunneis, disco primo plus minusve ochraceo, aetate rufo, interdum guttato, rarior innato-fibrilloso; lamellis primo argillaceis, dein flavis olivaceo tinctis, aetate ferrugineis, adnatis usque emarginatis, acie subserrulato, confertis, 5-11 mm latis; stipite 55-100 mm longo, 10-25 mm crasso, bulbo oblique marginato, 25-45 mm lato, pallide flavo, dein flavo-brunneo. Margine bulbi flavidulo vel cremeo-bubalino fimbriato; carne albida, bubalina, aetate helvola vel cerina, in cortice stipitis brunnescente, odore debile, leviter graminorum tritorum, sapore miti. Sporis 11.2-13.8-(15.3) x (5.9)-6.5-7.7 µm, medio 12.7 x 7 µm, amygdaliformibus usque sublimoniformibus, verrucosis, vertice glabro, basidiis 35-42 x 8-9 µm, tetrasporigeris, absque cheilocystidiis, fibulis praesentibus.
Habitatio: in silvis coniferis mixtis (*Abies, Picea, Pinus, Tsuga, Pseudotsuga, Larix*).
Holotypus IB 95/360, prope Clear Creek Camp ground, Mt. Hood, Wasco Co., Oregon, leg. M. Moser. 25 Oct. 1995.

Pileus 60-115 mm diam., convex with margin involute, sometimes slightly crenulate, then applanate and center becoming depressed, margin undulate, glutinous, with dark olive-green to olive-brown colors, color difficult to match, close to Caill 75S, near margin Caill 77 R, disc in young specimens more ochraceous, in older ones dark red-brown, sometimes somewhat spotted, more rarely innately fibrillose, sometimes so only on the margin. **Lamellae** in young specimens argillaceous, Caill 70L to 70M, to yellow with olivaceous tinge, color difficult to match, Caill 65N, 80N, with age rusty brown, rounded behind to emarginate, edges eroded, close, l=80-100 (110), l= 1-3, 13-18/ cm at margin, 5-11 mm wide, equals 2/3 to 1 times thickness of pileus context. **Stipe** 55-100 mm long, 10-25 mm thick, the obliquely marginate bulb 25-45 mm thick, pale yellow when fresh, near Maize Yellow (R), Cream Buff (R), later yellow-brown, the bulb fringed by yellowish to cream buff **veil** remains. **Context** whitish, cream colored Cartridge Buff (R), with age the color of oxidized apple slices, in stipe cortex brownish. **Odor** weak, when cut of fresh cut grass. **Taste** mild, slightly of radish.

Chemical reactions: KOH 20% brown on pileus surface and context. **UV** pileus surface green with dark areas, later purple with green areas, lamellae dark, stipe yellow, apex bluish, context yellow with blue areas.

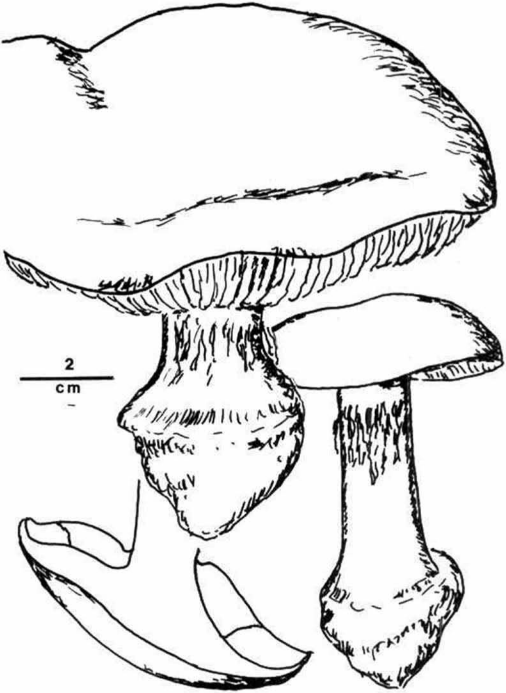

Fig. 10. *Cortinarius oliveopetasatus* (95/387). Fruit-bodies (nat. size).

Microscopic characters: Basidiospores 11.2-13.8(-15.3) x (5.9)-6.5-7.7 µm, mean 12.7 (S=0.6) x 7.0 (S=0.3) µm, Q=1.7-2.0, mean 1.85, V= 245-405 µm^3, mean 328 (S=37) µm^3, almond-shaped to sublimoniform, verrucose, apex smooth. Basidia 35-42 x 8-9 µm, clavate, 4-spored, with clamp connections. Subhymenial hyphae 4-5 µm wide, trama hyphae 6-9 µm wide, in mediostratum 12-16 µm wide. Without cheilocystidia. Pileipellis with thick gelatinous layer of hyphae 4-4.5 (5) µm wide, subrepent to irregularely ascending, colorless or walls brownish encrusted, with clamp connections. Epicuticular hyphae 6-8(-10) µm wide, in KOH with gray-brown walls, sometimes with relatively short segments.

Habitat: In mixed conifer forest (*Abies, Picea, Pinus, Tsuga, Pseudotsuga, Larix*)

Collections examined: IB 95/360 (holotype) near Clear Creek Camp Ground, Mt. Hood area, Wasco Co., Oregon, 25 Oct. 1995, leg. M. Moser, IB 95/397, same area, 28 Oct. 1995, leg. M. Moser, IB 95/390, Bear Springs, Mt. Hood area, Wasco Co., Oregon, 27 Oct. 1995, leg. M. Moser.

Comments: We have several collections of another similar unnamed taxon from the same areas. It differs, however, by more yellowish to olive colors and smaller basidiospores. But it seems closely related.

The taxonomic position of *Cortinarius ponderosus* A.H. Smith.

Contr. Univ. Mich. Herbarium 2:6-8, 1939.
Fig. 8(6) Basidiospores, SEM, 12M.

Alex Smith (1939) described this remarkable species from collections made near Cave (City) Junction in southern Oregon and near Crescent City in northern California, and placed it in subgenus *Myxacium*. In this subgenus, however, it is rather isolated with no closely related species. We have made many records and observations of this species from California and Oregon and studied its range of variability. Smith ascribed the yellowish colors on the stipe to a glutinous veil. In our collections we have not seen a glutinous stipe. Very occasionaly some slime can flow down from the pileus surface and give the appearance of a glutinous stipe. We came to the conclusion, that it is not a *Myxacium* but should be classified as a *Phlegmacium*. As there exists only the original description of the type collection we find it useful to give a description from our recent records.

Pileus in young specimens 70-120 mm diam., in older specimens 200 mm or more in size, at first hemispheric, later convex with strongly involute margin which remains so for a long time, with age applanate, and center becoming slightly depressed, moderately viscid to glutinous, slime yellowish, ground color ochraceous pallid to greenish yellow, Caill 87K to 87L, some spots more greenish, Caill 89L to 89M, but disc dingy red-brown to dark red-brown, Caill 53S, 59P, 57P, sometimes the surface with appressed brown scales and near disc confluent, toward the margin paler yellowish with olivaceous tinge, Caill 87K, 90K, with innate fibrils dissolved in spots and near the margin, where covered by plant debris the margin more or less pure greenish, Caill 87T, texture hard and compact. **Lamellae** at first gray with lilac tinge, Ecru Drab (R) to Light Drab (R), or only gray to argillaceous, Light Olive Gray (R), later changing to gray-brown, Avellaneous (R), with age Wood Brown (R), adnate, rounded behind, edges slightly eroded, narrow, 3-10 mm wide, corresponding to 1/4 to 1/2 thickness of pileus context, close, L=100-130, l= 3, 17-20/cm at margin. **Stipe** 60-150 mm long, 35-80 mm tick, equal or tapering downwards, apex whitish, ivory, occasionally with a greenish tinge, below brown, scaly or with belts and patches, similar to pileus surface, or often larger parts of the stipe totally yellow-brown, sometimes also with greenish-yellowish tints, dry or only after rain with some glutinosity due to slime dropping down from the pileus, rather hard and compact. **Cortina** white, rather strongly developed in younger specimens. **Veil** on pileus glutinous, yellow, but also the brown scales seem to be veil (?) **Context** white, whitish, to ochraceous (Ochraceous Buff (R)) in pileus, pale grayish in upper part of stipe, after exposure to air pale grayish brown, in the base of stipe slightly yellowish to buffy yellowish, in young specimens under the pileipellis occasionally also with a lilac tinge. **Odor** slightly fungoid (of *Fomitopsis marginata*) when freshly cut, or of crushed grass but mixed with some other undefined compound. **Taste** mild, or after prolonged mastication sometimes slightly bitterish.

Chemical reactions: KOH 3% on context negative, on greenish parts of the pileipellis slightly yellow-brown.

Microscopic characters: Basidiospores 7-8.8 x 4.2-5.3 µm, mean 7.9 (S=0.5) x 4.7 (S=0.2) µm, Q=1.5-1.9, mean 1.7 , V=69-120 µm^3, mean 92 (S=13) µm^3, elliptic to almond-shaped, relatively finely verrucose. Without cystidia. Basidia 29-31 x 7-7.5, clavate, 4-spored, subhymenial hyphae 2.5-3 µm wide, colorless, lamella trama hyphae 5-7 µm wide, colorless, in mediostratum up to 10-12 µm wide, clamp connections present. Pileipellis with 250-350 µm thick gelations layer of hyphae 3-4.5 µm wide, walls relatively thick, brownish, sometimes the content also brownish, in other collection colorless, repent near surface, in deeper layers more irregular and less pigmented, with clamp connections. Epicuticular hyphae 4-6(7) µm wide, walls yellow-brown to nearly colorless, without

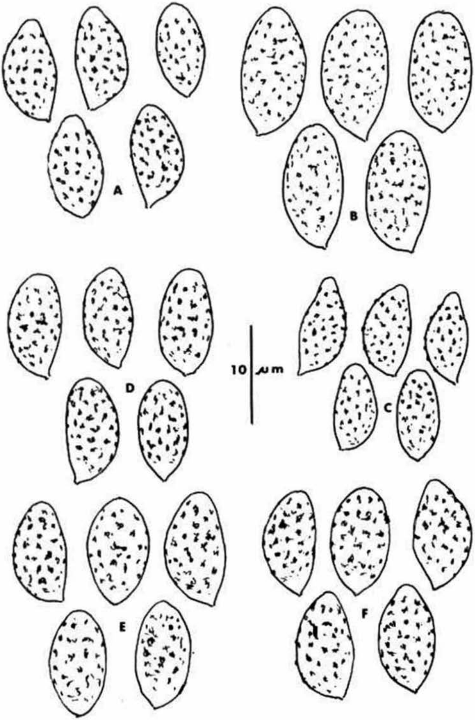

Fig. 11. Spores of : A. *Cortinarius cacodes* (91/618). B. *C. fraudulosus* var. *patrickensis* (95/617), C. *C.glaucocephalus*(95/679). D. *C.lilacinocolossus*(91/707), E.*C. subpurpureophyllus* (Smith 8164,type). F. .*C. subpurpureophyllus* (91/568) (x 2000)

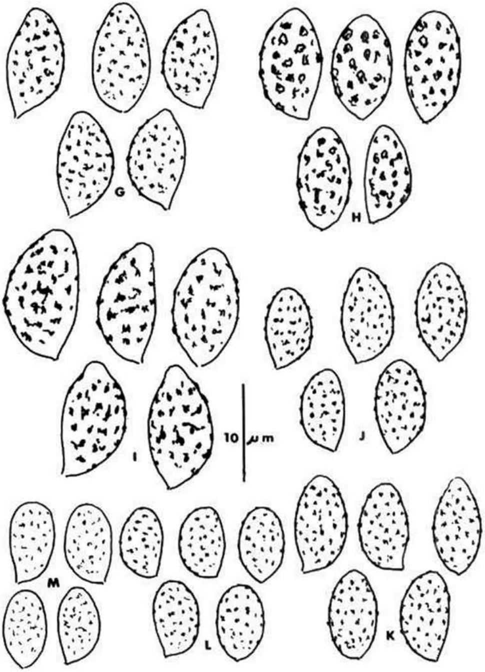

Fig. 12. Spores of: G. *Cortinarius subpurpureophyllus* var. *sulphureovelatus* (95/515). H. *C. spectabilis* (95/433). I. .*C. oliveopetasatus* (95/360). J. *C. calyptratus* (Smith 8352, type). K. *C. calyptratus* (95/360). L. *C. atrochalybaeus* (95/656). M. *C. ponderosus* (95/574) (x 2000)

distinct subcutis. Cortina hyphae 3-4 µm wide, colorless, with clamp connections. If glutinous areas are present on stipe the hyphae have the same dimensions as on pileus surface with brown, somewhat encrusted walls. Stipe cortex hyphae 4.5-6(-7) µm wide, densely packed.

Habitat: under conifers or in mixed conifer- and hardwood forests; particularly with pine species (*Pinus ponderosa*, *P. lambertiana*) or *Pseudotsuga* and *Tsuga*. Also, growing in mixed forests with *Pinus*, *Lithocarpus*, *Pseudotsuga*, *Quercus*, *Arctostaphylos*, *Arbutus*. Often growing in fairy rings and the basidiomata at times almost completely covered by needle litter.

Collections examined: IB91/697, Salt Point State Park, Sonoma Co., California. 7 Dec. 1991, leg. members of San Francisco Mycol. Soc., IB91/698, Bullard's Bar Recreation Area, Schoolhouse Campground, Yuba Co. California, 7 Dec. 1991, leg. D. Desjardin, IB91/709, same area but 9 Dec. 1991, leg. M. Moser, IB95/574, Jedidiah Smith State Park near Crescent City, Del Norte Co., 11 Nov. 1995 leg. M. Moser & J. F. Ammirati, MTS4334, Castle Crags State Park, Castella, Shasta County, Californis. November 28, 1996, leg. J. Ammirati; IB95/543 and JFA11755, Mary's Peak Trail. Benton Co., Oregon, 13 Nov. 1996 leg. J. F. Ammirati. (this is the northernmost locality hitherto known).

Smith collections: Smith 9273 (holotype) and Smith 8191 Cave City, Oregon, 29 Nov. 1937 Smith 9477 Crescent City, California Dec 7 1937.

Comments: Apart from the above listed collections the fungus was frequently observed in 1995 in Northern California but not collected. All collections had dry stipes and also microscopically no gelatinous layer could be demonstrated on stipe surface. So we are convinced that the species should be placed in subgenus *Phlegmacium*. But even here the taxon is rather isolated. *Cortinarius ponderosus* reminds somewhat of the mediterranean *C. herculeus* Malençon (1970). This species, however, has larger basidiospores, a green-corn odor and chemical reactions of the Variecolor-group.

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ON *HYPHODONTIA AUSTRALIS* (CORTICIACEAE, BASIDIOMYCOTA)

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Abstract

Hyphodontia australis is recorded and described from the *Nothofagus* forests of southern Argentina and from New Zealand. The species, previously known from Australia, is an odontioid to hydnoid taxon with orange to chestnut colored hymenial surface that readily turns violet upon the application of a drop of KOH solution. Specimens of *H. australis* from different areas are similar in all features except the spores, that vary from ellipsoid (Australian material including the type), broadly ellipsoid (New Zealand collections), to narrowly ellipsoid or subcylindric (Argentinian specimens). The inclusion of this taxon in *Hyphodontia* is supported by the presence of imperforate parenthesomes, hyphodontioid hyphae, basidia, leptocystidia, and by cultural features.

Key Words: Aphyllophorales, cultural characters, *Hyphodontia*, parenthesomes.

Introduction

During a survey of Corticiaceae *sensu lato* growing on *Nothofagus* spp. (Greslebin and Rajchenberg, 1997a, 1997b, 1998) in the subantarctic, southern forests of Argentina (Cabrera and Willink, 1980), we found the taxon *Hyphodontia australis* (Berk.) Hjortstam. This species was previously known only from Australia and has a particular hymenial surface colouration which, in addition, turns violet with drops of 5% KOH solution. The review of material housed at PDD herbarium also showed that the species is fairly well represented im New Zealand. The purpose of this work is to present full basidiocarp and cultural descriptions of *H. australis*, including the type of parenthesomes.

Materials and methods

Freehand sections of both fresh and dried basidiomata were examined microscopically, mounted in 5% KOH and 1% aqueous phloxine, Melzer's reagent (reaction amyloid, dextrinoid or IKI-; Hawksworth *et al.*, 1995), lactophenol 0.1% cotton blue and 1% aqueous cresyl-blue. Color descriptions were taken from Munsell (1990) and herbarium designations from Holmgren *et al.* (1990). Cultures were obtained from context tissue of fresh basidiomata or isolated from the associated wood-rot, and are kept at the culture collection of the Centro Forestal CIEFAP. Cultural features were studied and described according to Nobles (1965). The species code describing the cultures follows the system of Nobles (1965) with the several modifications summarized by Nakasone (1990). Line drawings of microscopic features were made using a drawing tube on the microscope. Unless other wise indicated all specimens are kept at the Herbarium of the Centro Forestal CIEFAP.

For electron microscope studies a small inoculum of culture CIEFAP N° 226 was grown in liquid media; the growing hyphae were fixed in 2.5% glutaraldehyde buffered with sodium cacodylate and postfixed in 1% osmium tetroxide, stained in 0.5% uranylacetate, dehydrated and embedded in Spurr's low viscosity resin. Serial sections were made and stained with uranylacetate and lead citrate. Photographs were taken on a Jeol CX-II electron microscope.

Results

Hyphodontia australis (Berk.) Hjortstam, Mycotaxon 54: 187, 1995.
FIGS. 1-13
≡ *Grandinia australis* Berk., in Hooker's Bot. Antarct. Voy. Fl. Tasm. 2: 257, 1859.

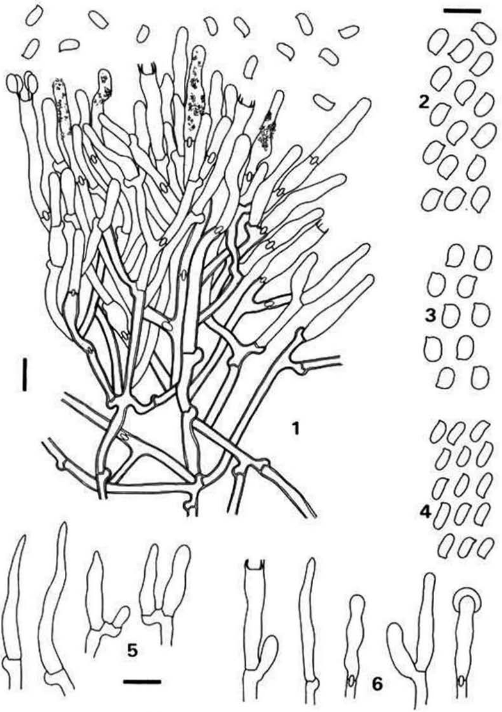
Basidiocarp resupinate, broadly effused, densely felty, 120 to 1000 µm thick. Hymenophore odontioid or hydnoid, sometimes cracking in small patches upon drying, teeth cylindrical, 350-750 µm long. Hymenial surface orange chestnut, red chestnut to light brick red (10R 6/6, 2.5YR 6/6), turning violet in KOH solution, the original color being recovered upon the application of an acid solution. Margin brownish yellow (10YR 6/6), thinning out. Subiculum concolorous with the margin.

Hyphal system monomitic. Generative hyphae clamped, 3-5 µm in diam. Subhymenial hyphae with slightly thickened walls (up to 0.5 µm thick), occasionally thin-walled. Subicular hyphae with walls up to 1 µm thick. All hyphae are covered with fine, dark melleous to chestnut granular material, which colours the hymenium and subiculum and dissolves to turn violet in KOH solution.

Basidia narrowly clavate, subcylindric or slightly sinuous, with 4 sterigmata and a basal clamp.

Leptocystidia poorly differentiated, claviform, slightly moniliform, slightly subulate or capitate, when capitate sometimes with an apical yellowish resinous cap, rarely protruding beyond the hymenium. The basidia, basidioles, leptocystidia and subhymenial hyphae are heavily encrusted with small, hyaline crystals that persist in KOH solution.

Basidiospores narrowly ellipsoid or subcylindric, 5-7 x 2.3-3 µm (Argentinian



Figs. 1-6. *Hyphodontia australis*. 1. Section through the hymenium. 2. Spores of Australian specimen K 56442 (Type). 3. Spores of New Zealand specimen PDD 23692. 4. Spores of Argentinian specimens AG 730 and MR 11041. 5. Leptocystidia of Australian specimen K 56446 and 56443. 6. Leptocystidia of Argentinian specimens AG 730 and 1634. Bar=10 µm.

specimens), ellipsoid, (5.5-)6-6.5(-7) x (3.5-)4-4.5 µm (Australian specimens) or broadly ellipsoid 5-6.5(-7.5) x 4-4.5 µm (New Zealand specimens); hyaline, thin-walled, IKI-, with one or several guttulae in the cytoplasm.

Ultrastructure: Dolipore septa with imperforated parenthesomes (Fig.7).

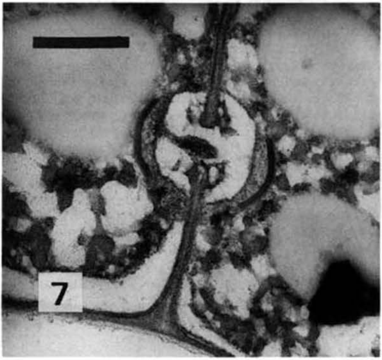


Fig. 7. *Hyphodontia australis*. Dolipore with imperforated parenthesomes. Bar=0.5 µm

Specimens examined. AUSTRALIA, TASMANIA, *ex herb. Berk. 1879* (Type of *Grandinia australis*, K 56442). Ibid., 1928, *leg. J.B. Cleland*, (K 56443). NEW SOUTH WALES, National Park, Sydney, *coll. W.N. Cheesman 1914* (K 56444). VICTORIA, Tarra Valley Park, on rotten trunk *Eucalyptus regnans* F. Muell., 22 Mar. 1956, *coll. K. Healy* (K 56446). NEW ZEALAND, COROMANDEL, Thames, Waiomo Valley, on *Coriaria arborea* Lindsay, 21 Mar. 1954, *leg. J.M. Dingley, det. G.H. Cunningham* (PDD 23692). GISBORNE Lake Waikaremoana, on *Nothofagus solandri* (Hook.) Oerst., Mar. 1949, *leg. P.M. Ambler, det. G.H. Cunningham* (PDD 23700). ARGENTINA, TIERRA DEL FUEGO, Ushuaia, Tolhuin, 3 km E from Hostería Kaikén, 4 Nov. 1996, *leg. A. Greslebin 730*. Ushuaia, Paso Garibaldi, on fallen branches of *Nothofagus pumilio*, 27 Mar. 1998, *leg. ipse 1547*. Ibid., 27 Mar. 1998, *leg. ipse 1548*. RÍO NEGRO, Nahuel Huapi National Park, Puerto Blest, track to Los Cántaros, on fallen branch of *Nothofagus dombeyi* (Mirb.) Oerst., 9 Oct. 1995, *leg. M. Rajchenberg 11041*. CHUBUT, Los Alerces National Park, south arm of Lago Menéndez, on fallen branch of *N. dombeyi* in mixed forest with *Fitzroya cuppresoides* (Mol.) Johnston, 8 May 1998, *leg. R.M. Borges and A. Greslebin 1634*.

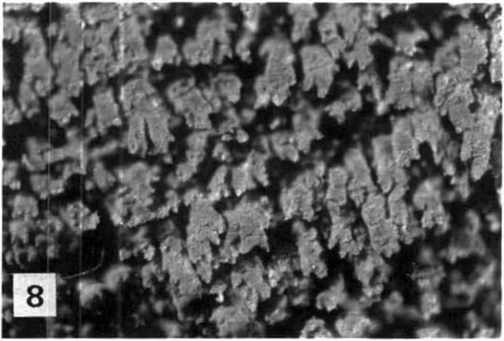


Fig. 8. *Hyphodontia australis*. Basidiocarp, collection MR 11041. 40 x.

Culture description.

Cultures studied. N° 231, from associated decayed wood of basidiocarp AG 1548; N° 226, from associated decayed wood of basidiocarp AG 730.

Macroscopic characters. Growth very slow, 6-6.6 cm by 6 wk. Margin regular, hyaline, submerged in the agar. Colony mostly sub-merged, with only few, cobwebby hyphae present on the agar. Aerial mat only around the inoculum, appressed, subfelty, inconspicuous, white, to 1.5 cm in radius, with irregular and cobwebby margin. Reverse unchanged. Odor sweet.

Oxidase reactions.

GAA: +++, tr; TAA: +++, tr

Microscopic characters. Marginal hyphae clamped, 2-3 µm diam, thin-walled and branched. In older parts, these hyphae are wider, to 4 µm in diam, with many guttulae; developing digitiform branches

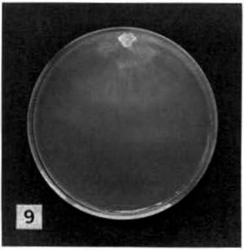
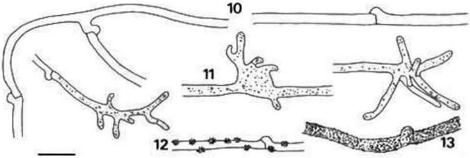


Fig. 9. Macroscopic aspect of culture at 6 wk, strain 231. Bar=2 cm.

either directly off regular hyphae or from intercalary hyphal swellings. Polyhedric, asteriform, hyaline crystals develop in the agar and on the hyphae. In older parts of the aerial mat some hyphae have a characteristic, chestnut colored encrustations that dissolves in KOH solution.

Species code. 2.3.7.32.36.(37).38.47.50.54.



Figs. 10-13. *Hyphodontia australis*. Microscopic cultural features. 10. Marginal hyphae. 11. Guttulate hyphae with digitiform branches. 12. Hyphae with hyaline polyhedric crystals. 13. Hyphae with chestnut colored granular material. Strain Nº 231. Bar=10 µm.

Discussion

Hyphodontia australis is a remarkable species within the genus because of its unusual hymenial color; all the other known species being white, cream, yellowish or ochraceous. It is also distinct by the presence of granular material on the hyphae that is responsible for the violet color change of the hymenial surface upon the application of 5% KOH solution. This reaction appears to be an acid-base reaction, as the application of an acid solution recovers the original hymenial color. This color change is recorded also in other corticioid species as *Phlebia chrysocreas* (Berk. & Curt.) Burds., *Odontia wrightii* (Berk. & Curt.) Burt, *Mycoacia uda* (Fr.) Donk, *Phanerochaete filamentosa* (Berk. & Curt.) Burdsall, *Phanerochaete radicata* (P. Henn.) Nakasone, Bergman & Burdsall and *Ceraceomyces americanus* Nakasone, Bergman & Burdsall (Cunningham, 1963; Lombard *et al.*, 1975; Nakasone *et al.*, 1994). In all cases it is related to the presence of dark melleous and chestnut colored substances encrusting the hyphal system. Thus, this reaction does not seem to show any phylogenetic relationsip. Most other features in *H. australis* agree with the generic concept of *Hyphodontia*, as proposed by Hjortstam (1995). In order to corroborate its inclusion in *Hyphodontia* the type of parenthesome was also studied. Langer (1994) showed that all the parenthesomes studied in species of the genus are of the imperforated type. This was corroborated on other species of the genus by Wu & Huang (1997) and is also the case in *H. australis*; thus, its inclusion in the genus is further supported by this ultrastructural feature. Hjortstam (1995) described relatively large, 40-60 µm long, subulate cystidia, but we were unable to find them in most of the specimens he examined, except K 56446 from Victoria (Australia) with leptocystidia 40-50 µm long. Cultures of *H. australis* did not develop either malocysts or drepanocysts, as is characteristic in some species of the genus (Hassan Kasim & David, 1983;

Nakasone, 1990). We observed that basidiospore shape and size were different in specimens from different areas, which may indicate a speciation process. Because we were unable to perform experimental studies to test this point and because all the other features were similar, we consider it appropiate to maintain all the specimens as a single taxon, with an austral distribution.

Acknowledgments

The Curators of PDD and K herbaria kindly provided specimens under their keeping. The critical review of the manuscript by E. Langer (Tübingen, Germany) is warmly acknowledged. The Agencia Nacional de Promoción Científica y Técnica, Argentina supported this research through PMT-PICT 0252 together with grant PIP 4062/96 from Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina. AG is fellow and MR researcher of CONICET.

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NOTES ON FIVE COMMON BUT LITTLE KNOWN HIGHER BASIDIOMYCETES FROM TROPICAL YUNNAN, CHINA[1]

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Abstract

Five common but little known species in the Chinese mycoflora are reported here. *Microporellus violaceocinerascens*, *M. burkillii*, *Clitopilus crispus*, and *Lactocollybia epia* are reported for the first time for China, while *Heimiomyces tenuipes* is new to Yunnan, southwest China. Mushrooms of the genus *Lactocollybia* were not reported from China before. Interesting and important characters of these species are described and illustrated. Known distribution range for each species is given. It is suggested that *Lactocollybia cycadicola* is very closely related to *L. epia*, if they are not conspecific.

Key words *Microporellus violaceocinerascens*, *M. burkillii*, *Clitopilus crispus*, *Heimiomyces tenuipes*, *Lactocollybia epia*, tropical fungi, Basidiomycetes, China.

During study of macromycetes in tropical Yunnan, southwest China, we have collected specimens of five species, which are new to or little known for China. Important morphological and anatomical characters of the taxa are described and illustrated.

1. ***Microporellus violaceocinerascens*** (Petch) David & Rajch. in Mycotaxon **22:** 303, 1985. *Polyporus violaceocinerascens* Petch in Ann. Roy. Bot. Gard. Peradeniya **6:** 41, 1916.

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[1] The project supported by a grant of the Foundation for Applied Basic Researches of Yunnan Province (no. 98C026Q) and in part by a grant for Systematic and Evolutionary Biology, Chinese Academy of Sciences.

Cystostiptoporus violaceocinerascens (Petch) Ryvarden in Ryvarden & Johansen, A Preliminary Polypore Flora of East Africa, p. 301, 1980.

C. indica Dhanda & Ryvarden in Trans. Brit. Mycol. Soc. **65:** 414, 1975.

Figs. 1-3

Fruitbodies stipitate, solitary to caespitose; pileus 2.5-7 × 4-7 cm, circular, semicircular to flabelliform, sometimes depressed in center, 3-8 mm thick, coriaceous when fresh, hard on drying, dark grey brown, grey brown to yellowish brown, sometimes greyish violaceous, deeper at center, azonate to subzonate to zonate, irregularly wrinkled, pubescent, glabrescent, margin acute and often waved. Stipe 3-8 × 0.3-0.7 cm, lateral or eccentric to central, solid, subcylindrical, grey, dark grey to almost black, sometimes violaceous, pubescent, with a pseudorrhiza. Pores white to greyish white, often with violaceous tint, becoming brown when injured, greyish brown when dried, 2-3 per mm; dissepiments thin and often lacerate; tubes greyish brown, 1-5 mm long. Context cream-colored to greyish white, 1-5 mm thick, not darkening in KOH, azonate.

Hyphal system dimitic; generative hyphae 2-5(-9) μm wide, hyaline, thin-walled, with clamps at septa; skeletal hyphae 3-8 μm wide, subhyaline, thick-walled to almost solid, strongly dextrinoid; basidia 16-24 × 8-10 μm, subclavate to subcylindrical, 4-spored. Cystidia ventricose, subhyaline, thick-walled, 34-70(-120) × 13-25 μm, often incrusted at apex. Spores [130/8/7][*] (6.5-)7.0-8.5(-9.0) × (4.5-)5.0-6.5 μm [Q = (1.19-)1.24-1.55(-1.74), **Q** = 1.40 ± 0.11], often subamygdaliform, but also ovoid to ellipsoid, smooth, hyaline, slightly thick-walled, inamyloid.

Habitat: On the ground in tropical seasonal rainforests.

Specimens examined: Yunnan Prov.: Mengla County, Xishuangbanna Tropical Botanic Garden, alt. 580 m, 4. VIII. 1988, Z. L. Yang 261 (HKAS 21936); 23. VIII. 1990, Z. L. Yang 1149 (HKAS 24871); Mengla County, Menglun Nature Reserve, alt. 590 m, 12. VIII. 1988, Z. L. Yang 423 (HKAS 21937) & 424 (HKAS 21938); alt. 700 m, 20. VIII. 1988, Z. L. Yang 660 (HKAS 21939); alt. 600 m, 11. VIII. 1995, Z. L. Yang 2161 (HKAS 29495) & 2162 (HKAS 29494).

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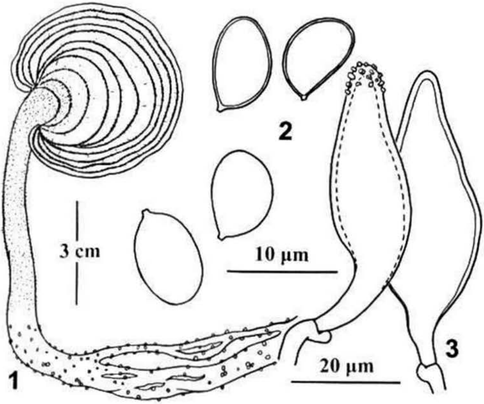
[*] 130 spores from 8 fruitbodies of 7 collections measured in 5% KOH solution, Q is used to mean "length/width ration" of a spore; **Q** means average Q of all specimens ± sample standard deviation.



Figs. 1-3: *Microporellus violaceocinerascens* (HKAS 21936). 1. basidiocarp; 2. spores; 3. pleurocystidia.

Distribution: Known from Sri Lanka, India, Pakistan, and Indonesia (Ryvarden & Dhanda, 1975; Ryvarden & Johansen, 1980; Hattori & Murakami, 1993; Suhirman & Núñez, 1998). It is new to China.

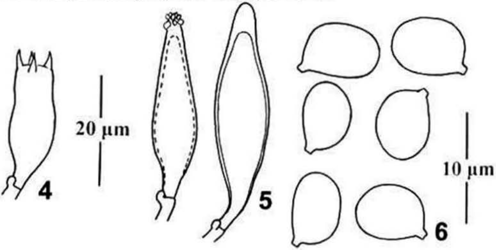
Remarks: This species is characterised by its conspicuous, often incrusted cystidia, strongly dextrinoid skeletal hyphae, and hyaline, slightly thick-walled, often subamygdaliform spores.

2. ***Microporellus burkillii*** (Lloyd) Corner in Beih. zur Nova Hedwigia **86:** 100, 1987.
Polyporus burkillii Lloyd, Mycol. Writ. **6:** 1061, fig. 1995, 1921.

Figs. 4-6

Fruitbodies stipitate, solitary to caespitose; pileus 5-7 × 3-5 cm, reniform to flabelliform, 2-4 mm thick, coriaceous when fresh, hard on drying, grey brown to ochraceous, zonate, irregularly to subradially wrinkled, subglabrous, margin acute and often waved. Stipe 5-6 × 0.5-0.7 cm, subcylindrical, lateral, solid, grey to dark grey, pubescent, swollen as sclerotium at the base. Pores grey, 4-6 per mm; dissepiments not lacerate; tubes greyish white, ca. 1.5 mm long. Context cream-colored to greyish white, 1-2 mm thick, not darkening in KOH, azonate.

Hyphal system dimitic; generative hyphae 2-5 µm wide, hyaline, thin-walled, with clamps at septa; skeletal hyphae 3-8 µm wide, subhyaline, thick-walled to almost solid, strongly dextrinoid; basidia 18-22 × 7.5-9 µm, subclavate to subcylindrical, 4-spored. Cystidia ventricose, subhyaline, thick-walled, 25-40 × 8-13 µm, often incrusted at apex. Spores [40/2/1] (5.0-)5.5-6.5(-7.0) × (4.0-)4.5-5.5(-6.0) µm [Q = (1.06-)1.11-1.40(-1.44), **Q** = 1.22 ± 0.09], broadly ellipsoid to ellipsoid, smooth, hyaline, slightly thick-walled, inamyloid.



Figs. 4-6: *Microporellus burkillii* (HKAS 29413). 4. basidium; 5. pleurocystidia; 6. spores.

Habitat: On the ground in tropical seasonal rainforest.

Specimen examined: Yunnan Prov.: Jinghong County, Damenglong, alt. 700 m, 14. VIII. 1995, M. Zang 12587 (HKAS 29413).

Distribution: Malaya, Singapore, Borneo (Corner, 1987). It is new to China.

Remarks: As compared to *Microporellus violaceocinerascens*, *M. burkillii* is characterised by its smaller pores, and broadly ellipsoid to ellipsoid, smaller spores. According to Corner (1987), *M. burkillii* is very variable. He distinguished a few varieties. Since the variation range of *M. burkillii* is not well known, we prefer not to give an infraspecific epithet for the specimen.

3. *Lactocollybia epia* (Berk. & Br.) Pegler in Kew Bull. Addit. Ser. **12:** 77, 1986.

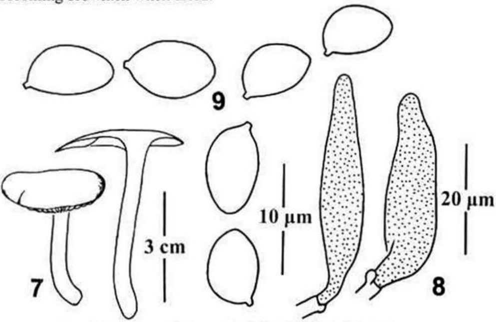
Agaricus epicus Berk. & Br. in Journ. Linn. Soc., Bot. **11:** 517, 1871.

?*Lactocollybia cycadicola* (Joss.) Singer in Schweiz. Zeitschr. f. Pilzk. **17:** 71, 1939.

Collybia cycadicola Joss. in Bull. Soc. Mycol. France **51:** 246, 1935.

Figs. 7-9

Pileus 1-3 cm in diam., convex to applanate, sometimes slightly depressed at the central part, often hygrophanous, smooth, glabrous, white to cream-colored, becoming yellow brown when dried; context thin, whitish; lamellae adnate to decurrent, close, 1-2 mm high, cream-colored, becoming brownish when dried; stipe 1-6 × 0.2-0.5 cm, subcylindrical, central to eccentric, glabrous to fibrillose, white to whitish, becoming brownish when dried.



Figs. 7-9: *Lactocollybia epia* (HKAS 24790). 7. basidiocarps; 8. pleurocystidia; 9. spores.

Spores [70/4/3] (6.0-)6.5-8.5(-9.0) × 4.0-5.5(-6.0) µm [Q = (1.30-)1.33-1.75(-2.0), **Q** = 1.52 ± 0.14], subamygdaliform, smooth, hyaline, thin-walled, inamyloid. Basidia 18-22 × 6.5-7.5 µm, clavate, 4-spored. Pleurocystidia (gloeocystidia) numerous, 30-65 × 8-18 µm, fusiform, sometimes clavate or subcylindrical, thin-walled, usually with yellow to yellow brown contents. Cheilocystidia 20-38 × 5-9 µm, subcylindrical to subfusiform, hyaline, thin-walled. All hyphae with clamp connections.

Habitat: On rotten woods of Angiospermae in tropical and southern subtropical forests.
Specimens examined: Yunnan Prov.: Mengla County, Menglun, alt. 650 m, 9. VIII. 1991, Z. L. Yang 1472 (HKAS 24789); Menghai County, near the county city, alt. 1250 m, 16. VIII. 1991, P. G. Liu 957 (HKAS 24790); Menghai County, Mangao Nature Reserve, alt. 1200 m, 16. VIII. 1991, G. Song 232 (HKAS 24518).
Distribution: pantropical (Pegler, 1986). This genus and the present species is new to China.

Remarks: *Lactocollybia epia* is characterised by the white to cream-colored fruitbodies growing on wood with numerous gloeo-elements and subamygdaliform spores. Corner (1994) provided excellent microscopic illustrations for the species.

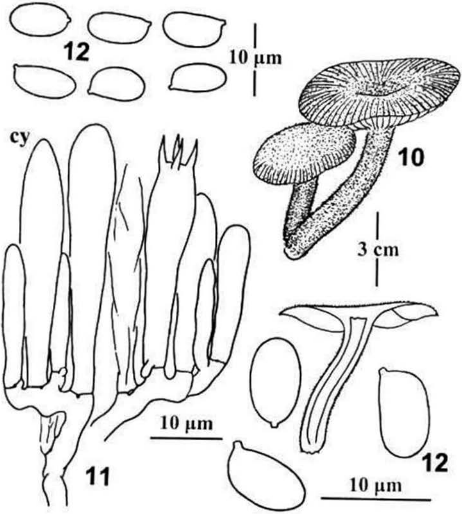
Josserand (1935) described *Collybia cycadicola* [=*Lactocollybia cycadicola* (Joss.) Singer] from France as growing on Asian cycads (*Cycas revoluta* and C. *tonkinensis*). According to his description and illustrations of the species, it is very closely related with the present species if they are not conspecific.

4. *Heimiomyces tenuipes* (Schwein.) Singer in Mycologia **35:** 159, 1943.
Agaricus tenuipes Schwein. in Trans. Amer. Phil. Soc. II, **4:** 147, 1822.
Heimiomyces neovelutipes (Hongo) Horak in Sydowia **32:** 148, 1979.

Figs. 10-14

Pileus 3-6 cm in diam., convex to applanate, often depressed at center, margin slightly incurved, strongly translucent-striate when wet; surface yellow to golden yellow or orange yellow, slightly darker on disc, hygrophanous, wholly villous, glabrescent; Lamellae adnexed to emarginate, yellow, 3-10 mm high, ventricose, often intervenose, distant to subdistant. Stipe 4-7 × 0.5-1 cm, central, subcylindrical, densely covered with yellow, yellow brown to gold yellow velvet, hollow.

Spores [50/2/1] (6.5-)7.0-9.5 (-10.0) × (3.5-)4.0-5.0(-5.5) μm [Q = (1.44-)1.67-2.13 (-2.5), **Q** = 1.90 ± 0.18], ellipsoid to long ellipsoid, smooth, hyaline, thin-walled, amyloid. Basidia 25-50 × 5.5-7.5 μm, clavate, 4-spored. Cheilocystidia 38-50 × 5-10 μm, with irregular, rodlike branches, with brownish, slightly thick wall. Cystidioles 35-45 × 5-7 μm,



Figs. 10-12: *Heimiomyces tenuipes* (HKAS 2322). 10. basidiocarps; 11. hymenium with basidia and a cystidiole (cy); 12. spores.

fusiform with subacute apices. Pileipellis 60-100 µm thick, composed of subradially to somewhat irregularly arranged, barrel-shaped to ellipsoid, brownish, inflated cells (35-90 × 25-55 µm) with gelatinized and refractive cell wall (2-8 µm thick); hairs on pileus (pileocystidia) often grouped into fascicles, vertically to irregularly arranged, brown, slightly thick-walled, 3-5 µm wide. Subcutis composed of subradially arranged, frequently branching, gelatinized, hyaline, filamentous hyphae, 2-5 mm wide. Trama of pileus composed of irregularly arranged ellipsoid to long ellipsoid, sometimes ovoid, hyaline, inflated cells (85-170 × 25-40 µm) with gelatinized and refractive cell wall (5-10 µm thick), mixed with

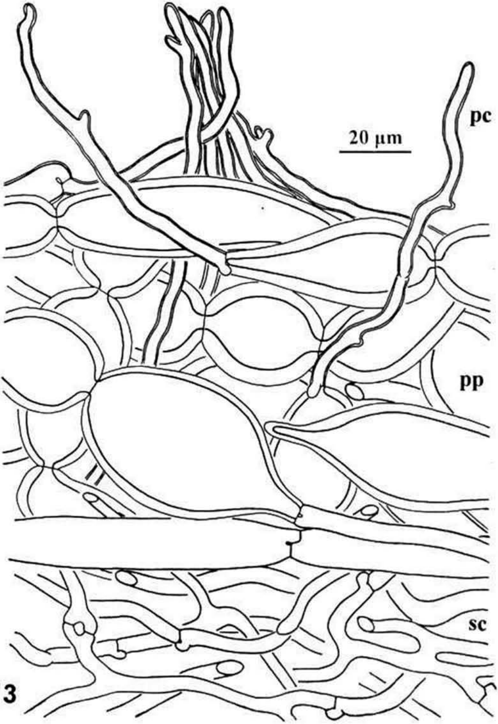


Fig. 13: Pileocystidia (pc), pileipellis (pp) and subcutis (sc) of *Heimiomyces tenuipes* (HKAS 2322).

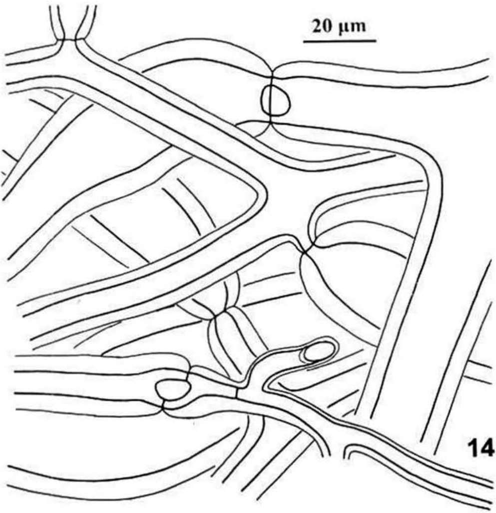


Fig. 14: Trama of pileus of *Heimiomyces tenuipes* (HKAS 2322).

gelatinized, filamentous hyphae, 3-7 µm wide. Hairs on surface of stipe (caulocystidia) 200-700 × 3-8 µm, cylindrical, sometimes branched, with brown thick wall. All hyphae with clamps.

Habitat: On dead logs in tropical forests.
Specimen examined: Yunnan Prov.: Jinghong County, Menghan, 19. X. 1974, M. Zang 2322 (HKAS 2322).
Distribution: widely distributed in tropical regions of the world (Corner, 1996). It occurs also in North America (Miller, 1968; Redhead & Ginns, 1980). It is new to Yunnan. In China it was also reported from Fujian Prov., southeastern China (Huang, 1998).

Remarks: The appearance of the fruitbodies of *Heimiomyces tenuipes* is reminiscent of the temperate species *Flammulina velutipes* (Curt.: Fr.) Karst. from which it may be separated by the non-viscid pileus, amyloid spores, and more importantly by the different anatomical structure of the fruitbody.

Hongo (1976), and Corner (1996) consider *H. neovelutipes* as a synonym of *H. tenuipes*. Horak (1979) regards *H. neovelutipes* as an independent species. For the time being, we follow the suggestion of the former two.

5. ***Clitopilus crispus*** Pat. in Bull. Soc. Myc. France **29:** 214, 1913.

Figs. 15-17

Pileus 2-7 cm in diam., convex to applanate, often slightly depressed at center, white to chalk white, margin incurved, finely subfimbriate, with radially arranged fine ridges extending nearly halfway to the disc; context white; lamellae 2-3 mm high, decurrent, white to cream-colored to pinkish; stipe 2-6 × 0.3-0.8 cm, subcylindrical, central to excentric, white, smooth, sometimes finely fibrillose.

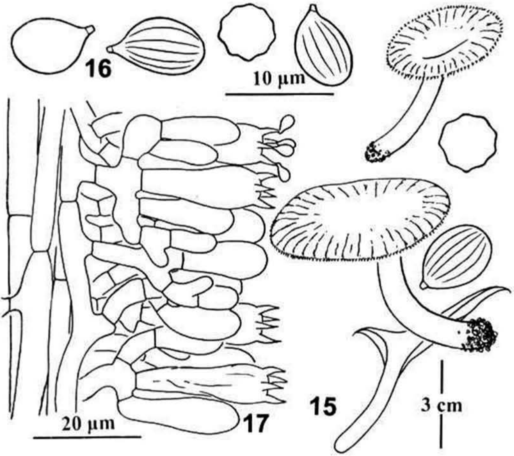
Spores [110/6/5] (5.5-)6.0-7.5(-9.0) × (4.0-)4.5-5.5(-6.0) µm [Q = (1.10-)1.20-1.50(-1.70), **Q** = 1.36 ± 0.11], ovoid to broad ellipsoid to ellipsoid in side view, angular in apical view, with 8-11 low longitudinal ridges, thin-walled, hyaline to subhyaline. Basidia 20-30 × 8-10 µm, subclavate, 4-spored, rarely 1-, 2-, or 3-spored; sterigmata about 3 µm long; basal septa without clamps; subhymenium consisting of short segments, 3-5 µm wide; hymenophoral trama more or less regular, with thin-walled hyphae 3-7 µm wide; pleurocystidia and cheilocystidia absent.

Habitat: on soil, usually on slopes of roadsides.

Specimens examined: Yunnan Prov.: Mengla County, Xishuangbanna Tropical Botanic Garden, alt. 580 m, 4. VIII. 1988, Z. L. Yang 270 (HKAS 21819) & 271 (HKAS 21820); 17. X. 1989, Z. L. Yang 704 (HKAS 22146); 21. X. 1989, Z. L. Yang 768 (HKAS 22147). Jinghong: Damenglong, alt. 650 m, 14. VIII, 1995, Z. L. Yang 2175 (HKAS 29488).

Distribution: Viet Nam. It is new to China.

Remarks: Boedijn (1951) treated *C. crispus* as a synonym of *C. apalus* (Berk. & Br.) Petch without any explanation. Pegler (1977 & 1986) hadn't listed *C. crispus* as a synonym of *C. apalus*. *Clitopilus apalus* seems to possess a smooth pileus (Pegler, 1977 & 1986). For the time



Figs. 15-17: *Clitopilus crispus* (HKAS 29488). 15. basidiocarps; 16. spores; 17. hymenium, subhymenium and hymenophoral trama.

being, the author inclines to treat *C. crispus* separately because the pilei of all specimens cited above have a finely subfimbriate pileal margin with subradially arranged low ridges. In China collections of *Clitopilus crispus* might be wrongly identified as *C. prunulus* (Scop.: Fr.) Kummer (Chang & Mao, 1995; Huang, 1998). Study of a collection of the latter species from Germany (Herbarium F. Oberwinkler 20563) shows that the spores have 5-6(-7) longitudinal ridges and are significantly larger, [20/1/1] 10.0-12.5(-19.0) × (4.5-)5.0-6.5(-7.0) µm, with Q = 1.91-2.5 (-2.83), **Q** = 2.29 ± 0.26.

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TuberKey: A DELTA-BASED TOOL FOR THE DESCRIPTION AND INTERACTIVE IDENTIFICATION OF TRUFFLES

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ABSTRACT

Forty-five descriptors of truffle morphology and habitat/host plant preferences were coded in a format adhering to the DELTA (DEscription Language for TAxonomy) standard. Character states, both qualitative and quantitative, were described for 18 truffle species. Special care was taken in the description of taxa belonging to the so-called 'white' and 'whitish' truffles, which are often difficult to identify simply on the basis of traditional morphological characters, while available literature data corroborated by direct observations of fresh ascocarp samples were utilized for the other truffle species. For a subset of taxa in our study sample, species-specific molecular markers and anatomo-morphological characters of the mycorrhizae were also annotated. DELTA descriptors were used to develop TuberKey, a package of illustrated information and identification programs that allows the use of interactive keys to search and interrogate the entire character database and to recognize truffle species. Interactive identification can be conducted locally on a personal computer, or through the Internet via the World Wide Web. Other facilities provided by TuberKey are the automatic generation of new keys and natural language descriptions, and data transformation for morphology-based cladistic analyses. The DELTA database of truffle characters as well as the identification software can be accessed at the URL: http://www.truffle.org/tuberkey.

Key words: truffles, *Tuber*, DELTA, WebDelta, taxonomy, morphological characters.

Extensive morphological convergence, sharing of similar habitats, and coexistence in the same geographic area may all confound the recognition of truffle species belonging to the genus *Tuber* (Pezizales: Tuberaceae). Various biochemical (Pacioni and Pomponi, 1989; Pacioni et al., 1997) and molecular biological (Bertini et al., 1998; Gandeboeuf et al., 1997; Lanfranco et al., 1998; Rubini et al., 1998) methods for the unambiguous identification of truffles have been reported in recent years. Nevertheless, the correct assessment of market truffle value, the prevention of commercial frauds, and the documentation of *Tuber* biodiversity by field studies, would all benefit from a reliable, morphology-based identification method, also accessible to non-specialists. A significant advance in this direction can be afforded by computer-assisted recognition methods. The implementation of these new recognition tools rests upon the preliminary definition of character descriptors and the codification of the corresponding character states into a computer-manageable format. DELTA (DEscription Language for TAxonomy) is the most widely used format for taxonomic data codification and represents a powerful method to record character descriptions for computer processing (Dallwitz, 1980). It can be adapted to various software applications and has already been applied successfully to a variety of organisms including plants (Aiken et al., 1997), insects (Christiansen et al., 1990) and viruses (Boswell et al., 1986). Importantly, associated with the DELTA format are sets of computer programs that provide facilities for the generation and typesetting of descriptions, and for interactive identification and information retrieval (Dallwitz et al., 1993).

In the area of mycology, DELTA has been applied recently to the codification of the anatomo-morphological characters of the mycorrhizae from different orders of fungi (Rambold and Agerer, 1997). The practical value and resolution capacity of DELTA, however, may both gain from the use of multiple readily accessible characters, such as those of the ascocarps, and from its application to a rather restricted set of commercially valuable fungi, such as ascomycetous truffles. We thus set out to develop TuberKey, a package that includes a DELTA database, illustrated information, and programs for the interactive identification of truffles. The database presently contains 18 species, but it can be easily extended by any external user to include other truffles or to improve the description of those already present.

MORPHOLOGICAL ANALYSIS

Anatomo-morphological data for *Tuber panniferum* Tul. & C. Tul., *T. maculatum* Vittad., *T. magnatum* Pico, *T. borchii* Vittad. and *T. dryophilum* Tul. & C. Tul. were obtained from the examination, for each truffle species, of at least 5 ascocarps collected in different geographic areas (Table 1). Fresh truffles (collected by no more than 2 days) were initially identified and catalogued; the name, altitude, exposure and habitat of the site of collection were annotated, together with the date of collection and the putative type of host plant. Macroscopical characters, such as the size, the presence of an orifice or cavity and the shape of the ascocarp, the color and external surface features of the peridium, the color of the gleba and the form of the vein mesh, were evaluated by visual inspection. Individual ascocarps were then microscopically examined. The type, shape and size of peridium ornamentation and the size of fertile and sterile veins were examined with a Zeiss stereomicroscope SR at a magnification of x 25. Cryostat (Tissue-Tek Miles) and hand-cut sections of individual ascocarps, including the gleba and the peridium, were used for optical microscope analysis (Leitz Laborlux 12). The total thickness of the peridium, as well as the thickness of the inner and the outer layer were measured at a magnification of 100x; for each specimen, four different, randomly chosen areas of the peridium were analyzed. The sizes of external and internal peridial cells were also measured by determining (at a magnification of 400x) the maximum and minimum dimensions of five contiguous cells within a randomly chosen area. Other peridium features that have been examined are the color of the different layers, the presence, length and basal diameter of cystidia, the presence and number of septa. The anatomo-morphological features of cells associated to sterile veins in the gleba were similarly analyzed by optical microscopy at a 650x magnification. For each sample, ten randomly chosen asci were analyzed at a magnification of 400x. The shape, the color, the size (maximum and minimum dimensions excluding ornamentation), and the number of spores were evaluated. As recommended by Gross (1987), only tetraspore asci, where present, were subjected to morphometric analysis. This included the color, the shape, and the dimensions of spores determined at a 630x magnification. Spores devoid of ornamentations as well as ornamented spores were considered; in the latter case, both the type and the size of sporal ornamentations were recorded. For reticulate spores, the size and the number of meshes along the main axis of the spore were determined. The mean value, the standard deviation, the range of variation, and limit values were calculated for each species; the height of spore ornamentations was determined according to the formula of Gross (1987). All the above data were determined for each numerical character, while alternative, qualitatively different states were established for individual descriptive characters. All specimens were then dried up in an air-convection dessicator, catalogued and stored into our herbarium (CMI-UNIBO) as vouchers.

Available literature data were utilized to describe the mycorrhizae of *Tuber maculatum*, *T. magnatum*, *T. borchii*, *T. brumale* Vittad., *T. aestivum* Vittad., *T. dryophilum*, *T. puberulum* Berk & Br., *T. melanosporum* Vittad., *T. uncinatum* Chatin, *T. macrosporum* Vittad. *and T. indicum* Cooke & Masee (Table 1). For 12 taxa previously subjected to molecular analysis, species-specific molecular markers derived from the ITS ribosomal DNA region were also considered (Table 1).

DATA RECORDING

Anatomo-morphological data were digitized using the *ad hoc* developed software package WebDelta. WebDelta is an application written in the Perl language that allows to maintain any DELTA database through the Internet. WebDelta directly reads the information contained in the "character" and "specification" files of the DELTA format and output a Web form consisting of multiple choice queries, numerical and text fields. The validity of numerical fields is verified with Java routines, and, in the case of an error, an alert message is displayed. Upon data submission, queries are translated into the DELTA format and saved as an ASCII file. For each data submission, the username, the taxon and the date are registered into a log file. Prior to any upgrading of the database, a backup copy of the file is automatically created. WebDelta is retrievable at the URL http://www.truffle.org/webdelta.html.

Photographs and drawings were used to document both macroscopical and microscopical characters. All photographic slides were digitized and the images were stored in a BMP format. Image manipulation was limited to cropping, scaling, and sharpening, and was performed with Adobe PhotoShop. The resulting files were stored in a JPEG format and subsequently converted into a GIF format for use in the INTKEY package. Image labeling was done with the DELTA software INTMATE.

CHARACTER DESCRIPTION IN THE DELTA FORMAT

A set of 43 macroscopical and microscopical features of the peridium, spores and gleba, plus two characters regarding the habitat and the putative host plant was initially selected as the basis for an informative description of truffles. This set of character descriptors includes 17 of the 25 characters originally proposed by Trappe as the key for the different genera of hypogeus ascomycetes (Trappe, 1979) and 28 additional characters. Among the latter, 14 describe anatomical features, common to various hypogeus genera, such as the biometric characteristics of the peridium, ascii and spores, while the other 14 characters are peculiar of the genus *Tuber*.

Table 1. Truffle species sampled for character description

Species	Collection locality	Specimen number	GenBank Acc. Number	References
T. magnatum	Pianoro, Bologna Pianoro, Bologna Pianoro, Bologna Budrio, Bologna Sant'Agostino	1160-30 1208-34 1208-35 1219-36 1289-44	TMAJ2509	**1**,*2,3,4,5,6*
T. borchii	Pianoro, Bologna Pianoro. Bologna Marina di Ravenna Marina di Ravenna Monterenzio, Bologna Monterenzio Bologna	1166-9 1178-11 1183-8 1183-15 1185-20 1185-24	AF003920	*7,4*,**8**,*6,9*
T. maculatum	Molinella, Bologna Molinella, Bologna Molinella, Bologna San Lazzaro, Bologna San Lazzaro, Bologna	1095-3 1096-10 1104-14 1146-28 1146-29	AF003919	*10*,**8**
T. puberulum	Pianoro, Bologna Pianoro, Bologna Pianoro, Bologna Pianoro, Bologna Pianoro, Bologna	1107-11 1108-12 1141-15 1260-44 1276-52	AF003918	*11*,**12,8**
T. dryophilum	Pianoro, Bologna Monterenzio, Bologna Pianoro, Bologna Marina di Ravenna San Lazzaro, Bologna	1192-21 1196-22 1199-23 1202-24 1248-26	AF003917	**8**
T. panniferum	Montagnola Senese, Siena Montagnola Senese, Siena Montagnola Senese, Siena Montagnola Senese, Siena Montagnola Senese, Siena	1234-1 1234-2 1234-3 1234-4 1234-5	AF073510	**1**
T. rufum				**12**,*13*,**8**,*14*
T. foetidum	Pianoro, Bologna	1153-7		**12,8**
T. excavatum			AF073509	**12,8**
T. uncinatum	Pavullo, Modena San Lazzaro, Bologna Pianoro, Bologna	1297-1 1291-12 1152-8		**15**,*16*
T. aestivum			U95175	**15,8**,*6,9*
T. indicum	Imported from China Imported from China Imported from China Imported from China	1080-1 1252-1 1343-1 1344	TIU89360 TIU89361 TIU89362	*17*,**18**,*19*,**20**
T. melanosporum			TMU89359	**1**,*3*,**12**,*6,9*
T. brumale			AF001010	**1**,*3*,**12,8**,*6,9*
T. macrosporum				**1**,*3*,**8**,*6*
T. pseudoexcavatum				**21**
T. mesentericum				**1**,*3*,**12,8**,*6,9*
Choiromyces meandriformis			AF003910	**1,8**

These are the morphology of peridium warts and cystidia, ascocarp veins, the height of sporal ornamentations and the number of meshes within the spore reticulum. A set of 14 characters regarding morphological features of the mycorrhizae has also been included. Such characters were selected as those that exhibit the highest variability among truffle species, but are least affected by the particular type of host plant. Molecular characters, in the form of theoretical restriction fragment length polymorphisms (RFLPs) obtained by digestion of the ITS1-5.8S-ITS2 ribosomal DNA region with three different endonucleases (*EcoRI*, *SphI* and *HincII*) were also considered. These highly discriminating markers, which in this group of fungi show very little (if any) intraspecific variation, may be used to distinguish between taxa that are very closely related morphologically (see below), or in cases in which only very small or deteriorated samples are available for identification. The complete list of characters and character state descriptors is reported in Appendix 1.

Beyond their subdivision into ascocarp morphology (43), habitat and host plant (2), molecular (3) and mycorrhizal (14), these characters can also be distinguished operationally according to their readiness of evaluation. In fact, molecular and mycorrhizal characters are in general more difficult to assess than ascocarp characters. Among the latter, one can further distinguish between easily discernible characters (e.g. # 2-6, 9 and 10 in Appendix 1), whose evaluation does not require any specialized instrumentation nor a skilled operator, and other, less accessible characters (e.g. # 11-29 in Appendix 1).

Sixteen truffle species widely diffused in Italy, plus two Asiatic truffles (*Tuber indicum* and *T. pseudoexcavatum* Wang *et al.)* often involved in commercial frauds, have been considered in the present analysis (Table 1). They all belong to the genus *Tuber* with the exception of *Choiromyces meandriformis* Vittad. that, although not assigned to the Tuberaceae by current taxonomic classifications, has been shown to be strictly related to the genus *Tuber* by recent molecular phylogenetic studies (O'Donnell et al., 1997; Percudani et al., 1999). The ascocarps of five "white" or "whitish" truffles (Table 1), which are poorly described in the literature, were directly examined both macroscopically and microscopically, while available morphological data were utilized for the ascocarps of the remaining 13 species.

All characters, both numerical and descriptive, were encoded in the DELTA format. The DELTA syntax has a great versatility for the description of morphological characters, but does not incorporate any facility for the proper handling of molecular data. To overcome this limitation, ribosomal DNA polymorphisms were described with character states corresponding to all possible DNA fragment lengths. Accordingly, the fragments produced by the three restriction enzymes we selected as the most diagnostic, was subdivided into size classes spaced by 50 base pairs that were then encoded as an unordered multistate (Appendix 1, characters #47-49). A 50 base pairs step was chosen because it represents the resolution limit of commonly used agarose gel electrophoresis methods.

Note to Table 1. References in bold-face and in italics pertain, respectively, to ascocarp and to mycorrhiza characters. **1**. Ceruti (1960); *2*. Fontana et al. (1990); *3*. Granetti (1995); *4*. Granetti et al. (1995); *5*. Palenzona and Fontana (1978); *6*. Zambonelli et al. (1993); *7*. Fontana et al. (1992); **8**. Pegler et al. (1993); *9*. Zambonelli et al. (1995); *10*. Fassi and Fontana (1967); *11*. Blaschke (1987); **12**. Gross (1987); *13*. Palenzona et al. (1972); *14*. Pirazzi (1998); **15**. Chevalier and Frochot (1997); *16*. Zambonelli and Govi (1990); *17*. Comandini and Pacioni (1997); **18**. Garcia Montero et al. (1997); *19*. Zambonelli et al. (1997); **20**. Zhang and Minter (1988); **21**. Wang et al. (1988).

Character descriptions were digitized in the DELTA format using the dedicated software WebDelta, which employs the "character" and "specification" files of the DELTA format to automatically build a Web interface capable of creating and upgrading an "item" database. With the aid of a Web browser, any user can fill out individual states of the character description form and introduce comments to all numerical and text fields as well as to any particular state through multiple choice queries. The main advantage of WebDelta is that a single DELTA database, containing character descriptions, can be accessed and modified through the Internet without any prior knowledge of the DELTA syntax.

THE DELTA DATABASE OF TRUFFLE CHARACTERS

The complete set of DELTA-encoded character states for the 18 truffles under examination is shown in Table 2. Although the characters are not fully described for all 18 truffle species, this does not preclude the use of the DELTA database for identification, catalogation and cladistic purposes. It should also be noted that molecular characters states (#47-49) have been described using the logical 'or' (/) instead of the 'and' (&) operator. For example, the pattern produced by digestion of the ITS region of *Tuber borchii* with *HincII* contains three DNA fragments of 56, 105 and 408 base pairs. Such fragments have been encoded as 2/3/6, and it is sufficient to choose any one of these three states to sort out *Tuber borchii* as a candidate species. Although less stringent, the use of the logical 'or' operator decreases the possibility of errors during identification.

The discrimination capacity of the DELTA database varies for different subsets of truffles and depends on the number of available characters as well as on intrinsic morphological similarities among truffle species. To visualize the characters that are capable of species discrimination in a complete set of pairwise comparisons, a matrix of non-overlapping character state differences was generated using the "Difference" command of the INTKEY software (Dallwitz, 1980) (Table 3). As expected, the number of differentiating characters largely varies for different groups of taxa, and it is lowest for highly related groups such as the white and the whitish truffles (Table 3, upper left corner). More specifically, this cross-comparison matrix shows that no character, other than RFLP markers, unambiguously discriminates between *Tuber borchii* and *T. puberulum*. In fact, the only potential distinguishing feature is "spore shape", a partly overlapped character which can vary from ellipsoidal/subglobose in *Tuber borchii* to globose/subglobose in *T. puberulum*. Only one morphological character in our dataset, namely the presence of external cystidia in the peridium, fully distinguishes *Tuber magnatum* and *T. dryophilum*. A similar case is found within the black truffles for *Tuber aestivum* and *T. uncinatum*, where the only differentiating character is the length of spore ornamentations This character, however, is a quantitative one and this makes even more challenging the discrimination between these two morphotypes whose actual species separation is still controversial (Chevalier and Frochot, 1997).

TuberKey IMPLEMENTATION

The DELTA database formed the core of TuberKey, a package of retrievable taxonomic information, bibliographic references, explanatory notes, illustrations and truffle identification tools. Included in TuberKey are 62 photographs and 18 drawings regarding macroscopical and microscopical features of truffles and of their host plants that should help the user during the identification process. TuberKey offers a Web based identification system accessible through the Internet. This implementation utilizes the NAVIKEY software (http://www.herbaria.harvard.edu/computerlab/web_keys/navikey) for interactive queries of the truffle database. Although NAVIKEY does not incorporate all the features of standard taxonomic description languages, it has the great advantage of requiring only commonly used web browsers for interactive identification.

TuberKey also offers a stand-alone version that can be queried on a personal computer by means of INTKEY (Dallwitz et al., 1993), a Windows-based program for the interactive access to DELTA format data. This software has several useful features: displaying of full or diagnostic descriptions of taxa; detection of differences or similarities between any group of taxa in terms of any set of characters; entry and deletion of descriptors in any order during identification; allowance for errors, either made by the user during data entry or present in the recorded dataset; estimates of variability or uncertainty in attributes; direct processing of numerical values, including ranges and non-contiguous sets of values. In addition, INTKEY can rank the various characters according to their reliability and distribution in the group of taxa under examination. Although the program suggests a list of characters ranked according to their resolving power, the user can choose any sequence of descriptors without following a predetermined order. This flexibility may be particularly significant in the case of truffles, where the ascocarp of a certain species may only be available for a restricted growing season, in a particular stage of maturation or conservation status, and/or collected at distant sites, thus needing to be preserved in a dried state.

Another useful feature offered by the DELTA database is the possibility to readily translate character descriptors into other formats, including those for cladistic analysis and natural language description. An example of the natural language description of *T. magnatum*, produced by TuberKey using the CONFOR software (Dallwitz et al., 1993), is reported in Appendix 2.

CONCLUSIONS

The codification into a standard format of 45 ascocarp anatomo-morphological characters, 2 habitat-related descriptors, and corresponding character state descriptions for 18 species of truffles formed the basis for the creation of TuberKey. Critical for the development of TuberKey was the set up of WebDelta for character state codification. This software offers two main advantages that should prompt the future expansion of the truffle database: i) character description is easily accessible to outside users as well as to multiple research groups through a computer connected to the Internet; ii) the input of data in standard format does not require any prior knowledge of the DELTA syntax. A schematic representation of the TuberKey database and of its applications is presented in Figure 1.

TuberKey is a new tool for truffle identification aimed at agricultural researchers, food inspectors, custom officers, mycologists, students, collectors and conservationists. Additional facilities provided by TuberKey are the guided access to species-specific molecular markers and to mycorrhizal morphology data for a subset of taxa, the automatic generation of new keys and natural language descriptions, and data transformation for morphology-based cladistic analyses of truffles.

Table 2. Character states of the 18 truffle species under examination

CHARACTER	*T. magnatum*	*T. borchii*	*T. maculatum*	*T. puberulum*	*T. dryophilum*	*T. panniferum*	*T. rufum*	*T. foetidum*	*T. excavatum*
2	1/2/3	1/2/3	1/2	1/2	1/2	1/2/3	1/2	1/2	1/2
3	1	1	1	1	1	2	1	1	2
4	1-6(-20)	(0.5-)1-5 (-10)	(0.3-)0.5-1.5-2.5(-4)	0.5-1	0.5-4	0.4-5	0.5-2(-4)	0.6-3(-4)	1-3.5(-5)
5	3/4/5/6	3/4/5/6	3/4/5/6	3/4/5/6	3/4/5	5	1/3/5/6	5/6	1/1/3/4/5
6	1	1	1	1	1	1	1	1	1
7	-	-	-	-	-	-	-	-	-
8	1	4	1	4	1	3	2	2	1/2
9	2/3/6/7	6	2/3/6	2/6	2/6	2/6	5/6	5/6	3/6
10	2	1	1	1	2	1	1	1	1
11	(253-) 337-421-505 (-532)	(133-) 263-405-547 (-713)	(293-) 383-536-689 (-851)	150-200	(186-) 216-301-386 (-452)	(228-) 313-439-565 (-695)	250-400	250-400 (-500)	200-350
12	(27-) 45-78-111 (-146)	(115-) 115-206-300 (-399)	(53-) 54-87-120 (-133)	?	(65-) 68-112-156 (-199)	(76-) 113-182-251 (-283)	80-90	?	30-40
13	1/2	1/2	1/2	1/2	2	2	2	2/3	1/2
14	2	1/2	2/3	1/2	1/2	1/2	1	1/2	2
15	(3-)9-12-15 (-16)	(6-)9-15-21 (-29)	(5-)11-16-21(-30)	10-15	(6-)9-15-21 (-21)	(6-)8-11-14 (-17)	12-15	(11-)18-26 (-32)	8-15
16	(3-)6-9-12 (-13)	(3-)7-10-13 (-16)	(3-)4-9-14 (-26)	?	(6-)7-11-15 (-16)	(3-)5-7-9 (-13)	12-15	(11-)18-26 (-32)	8-15
17	(186-) 251-336-421 (-479)	(66-) 82-232-382 (-465)	(319-) 322-480-638 (-784)	?	(47-) 92-162-232 (-292)	(22-) 104-187-270 (-370)	150-300	?	160-320
18	1	1	1	1	1	?	?	1	1
19	3	3	3	?	?	2	3	2/3	3
20	(3-)3-6-9 (-10)	(3-)7-11-15 (-16)	(3-)4-10-16 (-26)	?	(3-)3-6-9 (-10)	(3-)11-15-19 (-25)	4-5	?	?
21	(3-)3-5-7(-7)	(3-)5-6-7(-7)	(3-)3-5-7 (-10)	?	(3-)3-5-7(-7)	(7-)8-12-16 (-20)	4-5	?	?
22	2	1	2	1	1	1	2	2	2
23	-	(39-)41-55-69(-80)	-	60-110	(22-)22-31-40(-45)	(11-)15-118-221(-931)	-	-	-
24	-	(3-)4-5-6(-6)	-	4.5-9	(4-)4-7-10 (-10)	?	-	-	-
25	-	1	-	1	1	1	-	-	-
26	-	1	-	1-4	1-2	?	-	-	-
27	50-160	?	?	?	?	?	?	?	?
28	2	2	2	2	2	1/2	?	1	?
29	?	?	?	?	?	?	?	?	?
30	2	2	2	2	2	2	½	2	2
31	(53-)61-69-77(-90)	(63-)71-83-95(-106)	(58-)63-75-85(-98)	80-108	(63-)77-90-103(-126)	(53-)61-71-81(-93)	57-83	60-90	95-135(-180)
32	(26-)42-53-64(-68)	(42-)54-66-78(-90)	(37-)45-54-63(-72)	66-95	(42-)55-66-77(-90)	(37-)49-60-71(-80)	44-63	45-60	85-105

Table 2. *continued*

CHARACTER	*T. uncinatum*	*T. aestivum*	*T. indicum*	*T. melanosporum*	*T. brumale*	*T. macrosporum*	*T. pseudoexcavatum*	*T. mesentericum*	*Choiromyces meandriformis*
2	1/3	1/3	1/2	1/3	1/2/3	1/2/3	1	1/3	1/3
3	1/2	1/2	1	1	1	1	2	2	1
4	1-10	1-10	(1-)1-3(-7)	1-7(-10)	0.5-5	1-4(-7)	3.5	1-5(-10)	3-8(-12)
5	13/5	13/5	13/5/6	13/5	13	13/2/5/6	11/5	13/2/5	1/3/4/5
6	2	2	2	2	2	1/2	2	2	1
7	2	2	1	2	1/2	1	1	2	-
8	-	-	-	-	-	2	-	-	1
9	6	3/6	9/10	6/9/10	2/10	2/6	2/6	2/6	1/3/6
10	2	2	2	2	1	2	1	2	2
11	200-400	200-400	550-800	400-700	100-150	200-300	290-500	?	150-200
12	50	50-150	500-600	200-300	70-100	80-100	190-350	?	?
13	2/3	2/3	3	3	3	3/4	3	?	½
14	1	1	2	2	1/2	3	2	?	2
15	10-15	10-15(-20)	10-20	5-15	?	?	10-20	?	15-30
16	10-15	10-15(-20)	10-20	4-10	?	?	10-20	?	10-20
17	150-300	150-300	50-200	200-400	30-50	120-200	100-140	?	?
18	1	1	1/2	1/2	1/2	2	1	?	1
19	3	3	3	2/3	3	3	3	?	3
20	?	?	3-5	4-8	?	?	3-9	?	6-9
21	3	?	3-5	4-8	?	?	?	?	?
22	2	2	2	2	2	2	2	2	2
23	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-
27	?	?	?	?	?	?	?	?	?
28	2	2	2	2	?	?	2	?	?
29	?	?	?	?	?	?	?	?	?
30	2	2	2	2	2	2	2	2	1
31	60-90(-110)	60-90(-110)	50	90-140	70-96	95-140	60-85(-105)	27-53	130-200
32	55-70	55-70	75	80-120	60-75	65-95	45-70	23-37	60-70

Table 2. ***continued***

CHARACTER	*T. magnatum*	*T. borchii*	*T. maculatum*	*T. puberulum*	*T. dryophilum*	*T. panniferum*	*T. rufum*	*T. foetidum*	*T. excavatum*
33	1-4	(1-)1-4(-5)	1-3(-4)	1-4	1-4	(2-)5-6-7(-8)	1-5	1-4(-5)	(1-)3-5(-6)
34	1	1	1	1	1	1	1	1	1
35	?	?	?	?	?	?	?	?	?
36	?	?	?	?	?	?	?	?	?
37	4/5	3/4	3/4	4/5	4	4/5	3/4	3/4	3
38	(20-)22-25-28(-37)	(18-)25-29-33(-37)	(20-)25-30-35(-40)	28-31-34	(24-)28-31-34(-39)	(18-)19-24-29(-31)	22-27	24-26	28-31-35
39	(16-)19-21-23(-25)	(18-)22-26-30(-30)	(14-)20-23-26(-28)	28-31-34	(24-)27-29-31(-32)	(18-)21-24-27(-32)	16-21	20-21	(20-)22-25-28
40	½	2/3	1/2	2/3	1/2	2	2/3	2/3	½
41	2	2	2	2	2	1	1	2	2
42	(2-)3-4-5(-7)	(2-)3-4-5(-7)	-	?	(2-)3-4-5(-7)	(4,2-)5,1-6,5-7,3(-9,5)	2-3(-4)	4-5	?
43	(6-)8-10-12(-16)	(3-)4-6-8(-9)	(3-)3-4-5(-7)	?	(3-)5-7-9(-15)	-	-	(4-)6-15(-20)	3-6
44	(2-)3(-4)	(3-)4-5-6(-10)	(3-)3-4-5(-6)	5-8	(3-)4-5-6(-7)	-	-	4-6(-7)	3-4
45	1	1	1	1	1	1	1	1	1
46	1/2/3/4/5/6/7	1/2/3/4/5/6/7/12/13	6/7/12	12	1/9/12	1	1/9/12	1/9	1/9
47	7	2/4	3	3	2/4	8	?	?	?
48	5/6	5	4/6	4/6	4/5	5/7	?	?	?
49	1/8	2/3/6	7	7	1/7	3/8	?	?	?
51	1/2	1/2	1/2	1/2	1/2	?	1/2	?	?
52	1	1	1	1	1	?	1	?	?
53	1	1	1	1	1	?	1	?	?
54	1/2/6	2/6	2/6	2/6	2/6	?	6	?	?
55	6/10	6/10	6/10	6/10	6/10	?	10	?	?
56	1/2	2	1/2	2	1/2	?	1	?	?
57	1	1	1	1	1	?	-	?	?
58	1	1	1	1	1	?	-	?	?
59	1	1	1	1	1	?	-	?	?
60	1	1	?	1	1	?	-	?	?
61	-	-	?	-	-	?	-	?	?
62	-	-	?	-	-	?	-	?	?
63	-	-	?	-	-	?	-	?	?
64	3	2/3	3	3	3	?	3	?	?

Table 2. *continued*

CHARACTER	*T. uncinatum*	*T. aestivum*	*T. indicum*	*T. melanosporum*	*T. brumale*	*T. macrosporum*	*T. pseudoexcavatum*	*T. mesentericum*	*Choiromyces meandriformis*
33	1-6(-7)	1-6(-7)	(1-)3-5(-6)	1-6	2-5	1-3	1-8	1-3(-4)	8
34	1	1	1	1	1	1	1	1	1
35	?	?	2	?	?	?	?	?	1
36	?	?	1	?	?	?	?	?	?
37	3/4	3/4	3/4	3	3	3	3	3	5
38	25-32	25-36	(25-)31(-38)	29-32-35	26-31	40-75	(23-)24-28 (-35)	31-33-36	16-20
39	17-28	18-28	(21-)25(-29)	20-23-26	18-23	30-50	16-19(-22)	24-26-29	16-20
40	1/2/3	1/2/3	5	4	1/2	4	4	2/3	1/2
41	2	2	1	1	1	2	1/2	2	1
42	4-5(-8)	1-2-3	3-6	2-3	3-4	3-4	5-8	?	3-6
43	?	?	-	-	-	?	?	?	-
44	3-5	3-5	-	-	-	7-9	?	?	-
45	1	1	?	1	1	1	?	1	1
46	1/2/3/4/5/ 9/10/12/13	1/2/3/4/9/ 10/12/13	1	1/2/3/4/ 5/11/12	1/2/5	1/6/7/10	12	1/3	1/5/9
47	?	?	3/4	3/4	4/6	?	?	?	4
48	?	?	5/6	5/6	8	?	?	?	5/7
49	?	?	2/3/6/8	2/3/6	2/4/7	?	?	?	1/8
51	1/2	1/2	1/2	1/2	1/2	1/2	?	1/2	?
52	1	1	1	1	1	1	?	1	?
53	1	1	1	1	1	1	?	1	?
54	2/6	2/6	2/6	2/6/10	2/6	2/6	?	2/6	?
55	6/10	6/10	6/10/11	6/10	6/10	6/10	?	6/10	?
56	1/2	1/2	1/2	1/2	1/2	1/2	?	1/2	?
57	2	2	1	1	1	1	?	2	?
58	3	3	2	2/3	2	2/3	?	3	?
59	2	2	1	1	1	2	?	1	?
60	1	1	2	1/2	1	2	?	1/2	?
61	-	-	2	2	-	2	?	1	?
62	-	-	1/2	1/2	-	2	?	2	?
63	-	-	1/2/3	1/2	-	2/3	?	1	?
64	1	1	1/3	2/3	3	3	?	1	?

Note. Character states have been codified with the DELTA syntax (see also Appendix 1). The '/' separator of multistate characters corresponds to an 'or'. Numeric characters are given as follows: numbers in parentheses denote extreme values; numbers not in parentheses represent the range of variation and the mean value. When only one number is given it corresponds to the mean value, while when two numbers are given they correspond to the range of variation and the mean is omitted. The annotations '-' and '?' indicate, respectively, inapplicable characters and characters that have not been described.

Table 3. Character differences among the 18 truffle species under examination

	T. borchii (54)	T. maculatum (48)	T. puberulum (46)	T. dryophilum (53)	T. panniferum (38)	T. rufum (39)	T. foetidum (32)	T. excavatum (32)	T. uncinatum (45)
T. magnatum (51)	8 10 22 47 49	10 47 49	8 10-11 22 39 44 46-47 49	22 47	3 8 10 19 22 41 47	8 10 14 41	8 10 28	3 10 31-32 37	6 14 57-59 64
T. borchii (54)		8 22 47-49	47-49	8 10 49	3 8 19 41 47	8 12 22 41 56	8 22 28	3 8 12 22	6 10 12 22 57-59 64
T. maculatum (48)			8 11 22	10 17 22 47	3 8 19 22 41 46-49	8 14 17 41	8 28 46	3 12 32 46	6 10 12 14 17 57-59 64
T. puberulum (46)				8 10 23 47	3 8 11 41 46-49	8 11 22 32 38-39 41 56	8 11 22 28 32 38-39 46	3 8 22 37 44 46	6 10 22 57-59 64
T. dryophilum (53)					3 8 10 41 47 49	8 10 22 39 41	8 10 22 28 39	3 10 12 22 37	6 12 22 57-59 64
T. panniferum (38)						3 8 19 21-22 42	3 8 22 41	8 12 19 22 31-32 37 41	6 10 12 19 21-22 41
T. rufum (39)							41	3 12 14 31-32 38 41	6 10 12 21 41 64
T. foetidum (32)								3 31-32 38	6 10 28
T. excavatum (32)									6 10 12 14 32
T. uncinatum (45)									
T. aestivum (44)									
T. indicum (52)									
T. melanosporum (51)									
T. brumale (43)									
T. macrosporum (45)									
T. pseudoexcavatum (32)									
T. mesentericum (35)									

Table 3. *continued*

T. aestivum (44)	T. indicum (52)	T. melanosporum (51)	T. brumale (43)	T. macrosporum (45)	T. pseudoexcavatum (32)	T. mesentericum (35)	Choiromyces meandriformis (34)	
6 14 57-59 64	6 9 11-13 31-32 40-41 47 58 60	6 12-13 32 37 40-41 47 49 58	5-6 10-11 13 17 37 41 47-49 58	8 13-14 18 31 37-40 44 58-60	3 6 10 12-13 17 37 40 46	3 6 37 57-58 64	11 30-31 33 41 47	T. magnatum (51)
6 10 22 57-58 64	6 9-10 12-13 22 31 40-41 58 60	6 10 13 22 40-41 58	5-6 9 12-13 17 22 41 48 58	8 10 12-14 18 22 38 40 58-60	3 6 13 22 40	3 6 10 22 31-32 57-58 64	8 10 22 30-31 33 37 41 49	T. borchii (54)
6 10 14 17 57-59 64	6 9-10 12-13 17 31-32 40-41 46 49 58	6 10 12-13 32 40-41 49 58	5-6 11 13 17 41 46-48 58	8 10 13 17-18 39-40 44 58-59	3 6 12-13 17 40	3 6 10 31 46 57-58 64	10-11 30-31 33 37 41 46-49	T. maculatum (48)
6 10 22 57-59 64	6 9-11 13 22 31 40-41 46 49 58 60	6 10-11 13 22 37 39-41 49 58	5-6 13 22 37 39 41 46-48 58	8 10 13-14 18 22 37-38 40 46 58-60	3-4 6 11 13 22 37 39-40	3 6 10 22 31-32 37 46 57-58 64	4 8 10 22 30-31 33 38-39 41 46-49	T. puberulum (46)
6 22 57-59 64	6 9 11-13 22 31 40-41 49 58 60	6 12-13 22 37 40-41 49 58	5-6 10-11 13 22 37 39 41 48 58	8 13-14 18 22 37-38 40 58-60	3 6 10 13 22 37 39-40	3 6 22 31-32 37 57-58 64	22 30-31 33 37-39 41	T. dryophilum (53)
6 10 19 22 41-42	3 6 9-10 12-13 19 21-22 31 40 47	3 6 10 13 22 37 40 42 47	3 5-6 11 13 19 22 37 42 47-49	3 8 10 13-14 19 22 31 37-38 40-42	6 13 19 22 37 40 46	6 10 22 37 41	3 8 10-11 19 22 30-31 47	T. panniferum (38)
6 10 41 64	6 9-14 31-32 40	6 10 12-14 16 31-32 38 40	6 9 11 13 17	10 13-14 31-32 38-41	3 6 12-14 17 40 42	3 6 10 31-32 38-39 41 64	8 10-11 14 20 31 33 37-38	T. rufum (39)
6 10 28 42	6 9-11 28 31-32 40-41	6 10 16 28 32 38 40-42	5-6 9 11 41	10 14 18 31-32 38-40	3 6 28 40 46	3 6 10 31-32 38-39	8 10-11 30-31 33 37-38 41	T. foetidum (32)
6 10 12 14 32	3 6 9-13 31-32 40-41	3 6 10-13 40-41	3 5-6 9 11-13 17 32 41	3 10 12-14 18 38-40 44	6 12-13 17 32 40 46	6 10 31-32	3 10 30 32-33 37-38 41	T. excavatum (32)
42	7 9 11-12 14 31-32 40-41 57-60	12 14 21 32 40-42 57 59 64	9-12 17 41 57-59 64	7 12 14 18 38-40 44 57 60 64	7 10 12 14 17 40	31-32 59	6 14 30-31 33 37-38 41	T. uncinatum (45)
	7 9 11-12 14 31-32 40-41 57-60	12 14 32 40-41 57 59 64	9-11 17 41 57-59 64	7 14 18 38-40 44 57 60 64	7 10 12 14 17 40 42	31-32 59	6 14 30-31 33 37-38 41	T. aestivum (44)
		7 12 31-32 40	10-12 31 40 48 60	9 11-12 14 31 38-41 59	3 9-12 31-32 40 46	3 7 9 32 40-41 57-58 61	6 9 11 13 20 30-33 35 37-40	T. indicum (52)
			10-12 17 32 40 48	7 11-12 14 38-39 41 59	3 7 10 17 32 42	3 31-32 40-41 57 61 64	6 11 13 30 32-33 37-38 40 49	T. melanosporum (51)
				10-11 14 17 38-41 59-60	3 5 11-12 17 40 42 46	3 10 31-32 39 41 57-58 64	5-6 9-10 13 30-31 33 37-38 48-49	T. brumale (43)
					3 10 12 14 18 38-39 42 46	3 7 31-32 38-40 57 59 61 63-64	8 13-14 18 30 33 37-41	T. macrosporum (45)
						7 10 31-32 39-40 46	3 6 10-11 13 30-31 37-38 40 46	T. pseudoexcavatum (32)
							3 6 30-33 37-39 41	T. mesentericum (35)

Note. The "differences" array was obtained with the INTKEY software using the command: DIFFERENCES (x, y) ALL, where x and y is any combination of two different truffle species. Numbers in parentheses below the species name indicate the number of characters that have been described for that particular taxon. Molecular characters have only been considered for those species having more than 500 base pairs of sequenced ITS region. Enclosed by a double boundary in the upper left corner are all the so-called white whitish truffles.

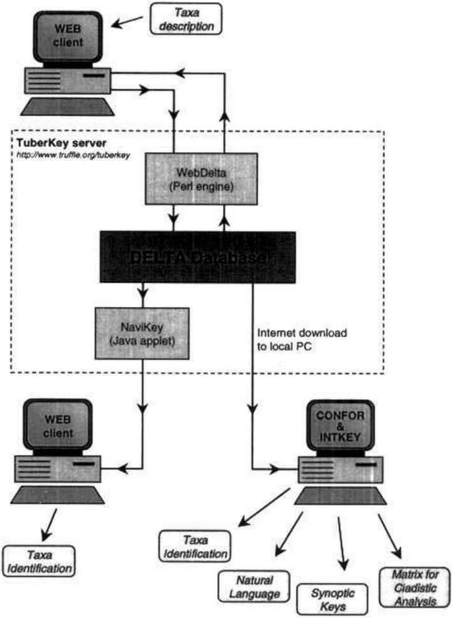

Figure 1. Schematic representation of the TuberKey Web site (dashed box), illustrating the creation and the possible uses of the DELTA database of truffle characters.

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APPENDIX 1. THE CHARACTER LIST

1. <Nomenclature, comments, associations, bibliography>/

Ascocarp morphology

2. Ascocarp <shape>/
    1. subglobose/
    2. globose/
    3. lobed/
3. Ascocarp orifice or cavity <presence>/
    1. absent/
    2. present/
4. Ascocarp <dimension>/
    cm in diameter/
5. Ascocarp <surface color>/
    1. white/
    2. gray/
    3. yellow/
    4. ochre/
    5. brown/
    6. red/
    7. violet/
    8. purple/
    9. green/
    10. blue/
    11. orange/
    12. pink/
    13. black/
6. Ascocarp <surface configuration>/
    1. smooth <even>/
    2. with warts/
7. Ascocarp warts <with lens, type>/
    1. flat/
    2. angulated/
8. Ascocarp peridium <surface fine texture>/
    1. glabrous/
    2. scabrous <showing flat warts only with lens>/
    3. pubescent/
    4. finely pubescent <only with lens>/
9. Ascocarp color of spore-bearing tissue <at maturity>/
    1. white/
    2. grey/
    3. yellow/
    4. pink/
    5. red/
    6. brown/
    7. olive/
    8. violet/
    9. purple/
    10. black/
10. Ascocarp veins <gleba>/
    1. large and rare/
    2. narrow and numerous/
11. Peridium <thickness>/
    micron/
12. Peridium outermost layers <thickness>/
    micron/
13. Peridium <outermost layers color>/
    1. hyaline/
    2. yellow-brown/
    3. red-brown/
    4. brown/
14. Peridium anatomical structure <outermost layers>/
    1. pseudoparenchymatic with angular cells/
    2. pseudoparenchimatic with roundish cells/
    3. plectenchymatic/
15. Peridium cell tangential dimension <outermost layers>/
    micron/
16. Peridium cell radial dimension <outermost layers>/
    micron/
17. Peridium innermost layers <thickness>/
    micron/
18. Peridium color <innermost layers>/
    1. hyaline/
    2. yellow-brown/
    3. red-brown/
    4. brown/
19. Peridium anatomical structure <innermost layers>/
    1. psedoparenchimatic with angular cells/
    2. pseudoparenchimatic with roundish cells/
    3. plectenchymatic/
20. Peridium cell tangential dimension <innermost layers>/
    micron/
21. Peridium cell radial dimension <innermost layers>/
    micron/

22. Peridium external cystidia <presence>/
    1. present/
    2. absent/
23. Cystidia length/
    micron/
24. Cystidia basal diameter/
    micron/
25. Cystidia septa <presence>/
    1. present/
    2. absent/
26. Cystidia <septa number>/
27. Sterile veins <thickness>/
    micron/
28. Sterile veins <anatomical features>/
    1. pseudoparenchimatic/
    2. plectenchimatic/
29. Fertile veins <thickness>/
    micron/

Asci and spores morphology

30. Asci <shape>/
    1. sacata/
    2. globose/
    3. cylindrical/
31. Asci major axis <dimension>/
    micron/
32. Asci minor axis <dimension>/
    micron/
33. Asci number of spores per ascus <at maturity>/
34. Asci <spore arrangement>/
    1. irregularly clustered/
    2. regularly clustered/
35. Asci iodine reaction <in Melzer's reagent>/
    1. yellow/
    2. orange/
    3. blue only near ascus apex/
    4. diffusely green or blue over most of ascus/
36. Asci color in KOH/
    1. hyaline/
    2. brown/
37. Spores <shape>/
    1. fusoid/
    2. cylindric/
    3. ellipsoid/
    4. subglobose/
    5. globose/
38. Spores major axis <lenght excluding ornamentation in 4-spore asci>/
    micrometer lenght/
39. Spores minor axis <lenght excluding ornamentation in 4-spore asci>/
    micrometer lenght/
40. Spores color <at maturity>/
    1. yellow/
    2. pale brown/
    3. medium brown/
    4. dark brown/
    5. nearly opaque/
41. Spores <ornamentation at maturity>/
    1. spines/
    2. reticulation/
42. Spores ornamentation length/
    micron/
43. Spores mesh width <ornamentation>/
    micron/
44. Spores number of meshes along the major axis <ornamentation>/

Distribution

45. Habitat/
    1. temperate/
    2. boreal/
    3. tropical/
    4. subalpine/
    5. subartic/
    6. desert/
46. Putative plant host/
    1. Quercus/
    2. Corylus/
    3. Ostrya/
    4. Carpinus/
    5. Tilia/
    6. Populus/
    7. Salix/
    8. Alnus/
    9. Fagus/
    10. Castanea/
    11. Cistus/
    12. Pinus/
    13. Cedrus/
    14. Abies/

DNA polymorphism

47. ITS restriction pattern with EcoRI/
    1. 50-100 bp/
    2. 200-250 bp/
    3. 250-300 bp/
    4. 300-350 bp/
    5. 400-450 bp/

    6. 550-600 bp/
    7. 600-650 bp/
    8. 650-700 bp/

48. ITS restriction pattern with SphI/
    1. less than 50 bp/
    2. 50-100 bp/
    3. 100-150 bp/
    4. 200-250 bp/
    5. 250-300 bp/
    6. 300-350 bp/
    7. 350-400 bp/
    8. 900-950 bp/
49. ITS restriction pattern with HincII/
    1. less than 50 bp/
    2. 50-100 bp/
    3. 100-150 bp/
    4. 300-350 bp/
    5. 350-400 bp/
    6. 400-450 bp/
    7. 500-550 bp/
    8. 550-600 bp/
50. DNA sequence ID of the ITS1-5.8S-ITS2 regions/

Mycorrhizae morphology

51. Mycorrhizae emanting hyphae/
    1. absent/
    2. rare/
    3. abundant covering the roots/
52. Mycorrhizae anatomy of emanating hyphae: clamps <presence>/
    1. absent/
    2. present/
53. Mycorrhizae color of emanating hyphae/
    1. hyaline/
    2. braun/
    3. black/
54. Mycorrhizae color of very tip/
    1. white/
    2. whitish/
    3. yellow/
    4. orange/
    5. reddish/
    6. ochre, yellowish brown/
    7. greyish/
    8. violet/
    9. greenish/
    10. brown/
    11. black/
55. Mycorrhizae color of older parts/
    1. white/
    2. whitish/
    3. yellow/
    4. orange/
    5. reddish/
    6. ochre, yellowish brown/
    7. greyish/
    8. violet/
    9. greenish/
    10. brown/
    11. black/
56. Mycorrhizae cystidia <presence>/
    1. absent/
    2. present/
57. Mycorrhizae <cystidia shape>/
    1. needle like/
    2. wolly/
58. Mycorrhizae color <cystidia>/
    1. hyaline/
    2. pale yellow/
    3. ochre/
    4. brown/
59. Mycorrhizae intercalate swelling <cystidia, presence>/
    1. absent/
    2. present/
60. Mycorrhizae ramification <cystidia, presence>/
    1. absent/
    2. present/
61. Mycorrhizae <cystidia ramification frequence>/
    1. rare <less tha in 10% of cystidia>/
    2. abundant <more tha in 10% of cystidia>/
62. Mycorrhizae <cystidia ramification type>/
    1. monopodial/
    2. dichotomous/
63. Mycorrhizae <cystidia ramification position>/
    1. proximal/
    2. medial/
    3. distal/
64. Mycorrhizae anatomy of the mantle <in the plan view>/
    1. pseudoparenchymatus with angular cells/
    2. pseudoparenchymatus with rounds cells/
    3. pseudoparenchymatus with epidermoid hyphal cells "like a puzzle"/
    4. plectenchimatous/

APPENDIX 2. A NATURAL-LANGUAGE DESCRIPTION

The description was automatically generated from the DELTA database using the CONFOR program. Natural-language descriptions of all the examined taxa are available at the URL: http://www.truffle.org/tuberkey/natlang-english/index.htm.

Tuber magnatum

Tuber magnatum Pico In Melethemata inauguralia de fungorum generatione et propagatione: 80(1788) specimens examined: CMI-UNIBO 1160-30 CMI-UNIBO 1208-34 CMI-UNIBO 1208-35 CMI-UNIBO 1219-36 CMI-UNIBO 1289-44.

Ascocarp morphology. Ascocarp subglobose or globose or lobed, orifice or cavity absent, 1-6(-20) cm in diameter, yellow or ochre or brown or red, smooth, peridium glabrous, color of spore-bearing tissue grey or yellow or brown (hazel) or olive, veins narrow and numerous. Peridium (253-)337-421-505(-532) micron, outermost layers (27-)45-78-111(-146) micron, hyaline or yellow-brown (yellowish), anatomical structure pseudoparenchimatic with roundish cells, cell tangential dimension (3-)9-12-15(-16) micron, cell radial dimension (3-)6-9-12(-13) micron, innermost layers (186-)251-336-421(-479) micron, color hyaline, anatomical structure plectenchymatic, cell tangential dimension 3-6-9(-10) micron, cell radial dimension 3-5-7 micron, external cystidia absent. Sterile veins 50-160 micron, plectenchimatic.

Asci and spores morphology. Asci globose, major axis (53-)61-69-77(-90) micron, minor axis (26-)42-53-64(-68) micron, number of spores per ascus 1-4, irregularly clustered.
Spores subglobose or globose, major axis (20-)22-25-28(-37) micrometer lenght, minor axis (16-)19-21-23(-25) micrometer lenght, color yellow or pale brown, reticulation; ornamentation length (2-)3-4-5(-7) micron; mesh width (6-)8-10-12(-16) micron; number of meshes along the major axis (2-)3(-4).

Distribution. Habitat temperate; Putative plant host Quercus, or Corylus, or Ostrya, or Carpinus, or Tilia, or Populus, or Salix.

DNA polymorphism. ITS restriction pattern with *EcoRI* 600-650 bp; *SphI* 250-300 bp, or 300-350 bp; *HincII* less than 50 bp, or 550-600 bp; DNA sequence ID of the ITS1-5.8S-ITS2 regions TMAJ2509.

Mycorrhizae morphology. Mycorrhizae emanting hyphae absent, or rare; anatomy of emanating hyphae: clamps absent; color of emanating hyphae hyaline; color of very tip white, or whitish, or ochre, yellowish brown; color of older parts ochre, yellowish brown, or brown; cystidia absent, or present; needle like; color hyaline; intercalate swelling absent; ramification absent; anatomy of the mantle pseudoparenchymatus with epidermoid hyphal cells "like a puzzle".

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SOUTH AFRICAN FUNGI 11. SUILLUS SALMONICOLOR - A BOLETE NEW TO SOUTH AFRICA

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Suillus salmonicolor (Frost) Halling is recorded for the first time from South Africa, based on a collection made in Mpumalanga. The material, which is fully described, is compared and contrasted with *S. luteus* (Fr.) Roussel.

Key words: *Suillus salmonicolor*, *S. cothurnatus*, *S. pinorigidus*, *S. subluteus*, *S. luteus*, South Africa.

Introduction

In 1998 a gathering of a slimy bolete with a prominent glutinous ring was collected by Dr J. Duminy, and subsequently identified as *Suillus salmonicolor* (Frost) Halling, a species native to North America and not previously known from South Africa. It represents one of the few collections of this species outside of the North American continent.

S. salmonicolor shows certain similarities with *S. luteus* (Fr.) Roussel, which also occurs in South Africa, if rarely, and the two taxa could be confused at a casual glance. Indeed, it will be necessary in future to exercise care when naming these sticky annulate *Suillus* species associated with pines, even though both are fortunately edible. A description follows:

Suillus salmonicolor (Frost) Halling, Mycologia **75**, 85, 1983.
Boletus salmonicolor Frost, Bull. Buffalo Soc. Nat. Sci. **2**, 100, 1874.
Boletus subluteus Peck, Bull. N.Y. State Museum 1(2), 62, 1887.
Suillus subluteus (Peck) Snell, in Slipp & Snell Lloydia, **7**, 34, 1944.
Suillus cothurnatus Sing., Farlowia **2**, 261, 1945.
Suillus pinorigidus Snell & Dick, Mycologia, **48**, 304, 1956.

Pileus 5-8 cm diam., campanulate, becoming convex, surface viscid, initially yellowish cream, densely marked with innate, radiating, rivulose dark-brown lines; youngest specimens with a general purplish tint, but purple tints not visible in older fruit-bodies. **Pores** dark yellow-brown, sometimes with olive tint. **Tubes** to 11 mm long, concolorous with the pores. **Stipe** 60-90 mm long, tapering strongly to a pointed base, 10-12 mm broad at the apex, to 4 mm broad at the base, pallid, blue-grey with blackish dots above the ring; yellow-brown below the ring, and also ornamented with black dots, and at the extreme base with yellow mycelium. Annulus well developed at about the mid portion of the stipe, shining translucent, olive-green, glutinous, rupturing at the stipe, before rupturing at the pileal margin, and rolling up to form a thick, white rim (well shown in Smith (1985) and by Lincoff (1981); later rupturing also at pileal margin, and collapsing on to the stipe, as a broad, adpressed band (not forming a spreading membranous ring). **Flesh** pale olivaceous yellow in pileus, ochre-brown in stipe, and bright ochre-yellow at extreme base of stipe. In older specimens flesh in pileus up to 15mm thick, dirty-cream. No bluing in the cut flesh or on handling. **Cuticle of pileus** of repent, gelatinized, indistinct, hyaline hyphae, permeated by abundant, refractive, oleiferous elements, which are branched, vermiform and with yellowish content, 4.0-6.6 μm d. Hyphae of pileal context lacking clamp-connections and to 20μm d. **Tube trama** regular, of thin-walled, hyaline hyphae, lacking clamp-connections, 3.0-5.0 (6.6) μm d., oleiferous hyphae few. **Hyphae of stipitipellis** of thin-walled, hyaline, parallel hyphae, 3.0-6.6 μm d. and very few oleiferous hyphae. **Glandular dots** on stipe above the annulus, comprising elongated clavate, or subcapitate, rarely subcylindric or fusoid elements, with thin or distinct walls, and appearing hyaline to subhyaline; these elements 50-66 μm long, and 7.5-13.0 μm wide at the apex. **Basida** 16-18 x 6.0-7.0μm, thin-walled, hyaline, 4 spored. **Spores** 7.0-8.2 x 2.75-3.0 μm, brown, boletoid in shape.

In pine forest, Mpumalanga, between Sabie and White River, at the Witklip Dam. Dr Johan Duminy, February 1998. **PRUM** 4730

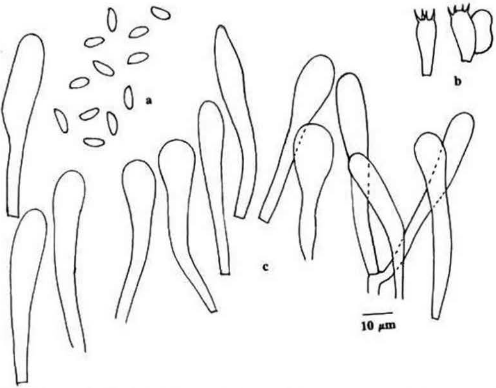
Distribution in South Africa:

Known only from the above collection.

General Distribution:

Suillus salmonicolor is widespread in North America and according to Both (1993) [writing of *Boletus subluteus*] it is found from Quebec and Nova Scotia south to North Carolina, west to Michigan. It is also recorded from Mexico: Garcia & Castillo (1981) as *S. subluteus*; Cappello, S & Cifuetes, J (1982) as *S. cothurnatus* var. *hiemalis*; Laferriere & Gilbertson (1992) as *S. pinorigidus*.

In the Old World *S. salmonicolor* is known to occur in Eastern Asia: Former Soviet Union: Kamchatka (Kalamees & Vaasma, 1981 as *S. subluteus*); Lake Baikal (Nezdojminogo 1973, as *S. subluteus*); Barguzin Mountain Range (Nezdojminogo, 1971, as *S. subluteus*). Eastern Himalayas and Tibet (Wang & Zang, 1983; Zang, 1986, as *S. subluteus*). Taiwan: (Chen, 1987 as *S. subluteus*). Philippine Islands (Watling 1995 as *S. cothurnatus*). Europe : Finland (Engel, 1996 as *S. cothurnatus* var. *hiemalis*).



Figs. 1. a-c. *Suillus salmonicolor*. a. Spores. b. Basidia. c. Elements comprising glandular dots on stipe.

Discussion:

Until Halling (1983) demonstrated that the oldest available epithet for this bolete was *B. salmonicolor* Frost, it had, hitherto, been widely discussed in the literature under the rather appropriate name *S. subluteus* (Peck) Snell. However, Halling (l.c.) lectotypified *B. salmonicolor* by a Frost specimen (No. 3213) in the Pringle Herbarium, University of Vermont, Burlingham, U.S.A., and provided a full account of the microscopic characters of this material. As a result he proposed the transfer of Frost's species to *Suillus* as *S. salmonicolor* (Frost) Halling - a species which he succinctly characterized as viscid with salmon ochraceous colours.

In South Africa *S. salmonicolor* could only be confused with *S. luteus* (L.: Fr.) S.F. Gray. However, the fruit-bodies of these two taxa have a quite different aspect. Fruit-bodies of *S. luteus* are robust to stocky, with a rather stout cylindrical, to slightly clavate stipe, up to 3cm d., while the fruit-bodies of *S. salmonicolor* are less robust, with a proportionately much taller and narrower stipe. The stipe of *S. luteus* is cylindric to clavate and rather stout, while that of *S. salmonicolor* is proportionally tall and narrow, and frequently tapered to a pointed base. Further, the surface of the stipe in *S. luteus* has glandular dots for the most part conspicuously developed above the annulus, while in *S. salmonicolor* the glandular dots are conspicuous throughout the length of the stipe.

The colour of the pileus also differs considerably. In *S. luteus* the pileus is usually dark chestnut-brown or sepia, with a virgate appearance, and sometimes develops a violaceous tint. The pileus of *S. salmonicolor* is altogether paler, more yellowish and varies from salmon ochraceous (Halling 1983) at least when young, to yellowish or yellowish brown, and in age to dingy yellow-brown, with a tendency to develop olive tints, and to become virgate.

The annulus of the two species is also distinctive. In *S. luteus* it ruptures from the margin of the pileus and forms a striking horizontal, membranous ring. By contrast in *S. salmonicolor* the annulus often ruptures from the stipe before tearing away from the pileal margin, with the result that the free edge of the annulus rolls up and forms a thick white rim adjacent to the stipe (well shown in Smith 1963, No 50; Smith & Smith 1985, No 64.) while still attached to the margin of the pileus; the annulus then appearing funnel-shaped. Finally, when rupture occurs at both stipe and pileal margin, the annulus collapses on to the stipe as a broad band. This type of rupturing of the annulus is never observed in *S. luteus*.

There is also a difference in colour of the flesh between *S. luteus* and *S. salmonicolor*. In the former it is virtually white throughout, while in *S. salmonicolor* it is pale yellow to pale orange-yellow, changing in the stem base to yellow-brown or bright ochre-yellow.

Confusion with *Suillus granulatus* (L.: Fr.)O. Kuntze and *S. bovinus* (L.: Fr.)O. Kuntze and *S. bellinii* (Inz.) Watling - the only other members of the genus *Suillus* Micheli ex S.F. Gray occurring in South Africa - should not pose a problem, since these taxa lack an annulus.

S. salmonicolor occurs in association with various species of *Pinus*, with which it no doubt forms a mycorrhizal relationship; 2 -, 3 -, and 5- needled pines have all been cited as associates of this bolete. In North America *S. salmonicolor* has been found growing with *Pinus australis, P. banksiana, P. palustris, P. resinosa, P rigida, P. strobus* and *P. taeda* but this list does not pretend to be exhaustive. In Kamchatka it has been found in association with *P. pumila*, while in the Philippine Islands it occurs with *P. kesiya*.

While there are extensive plantations of various pines in South Africa, there are no native species, and it therefore seems reasonable to assume that *S. salmonicolor* is an exotic species which has been introduced, possibly fairly recently, into South Africa.

Illustrations:

Illustrations of *S. salmonicolor* include the following: Grund, D.W. & Harrison, A.K. (1976) Pl 61 *as G. subluteus*: Lincoff, G.H. (1981) No. 37 as *S. subluteus*; Smith, A.H. (1963) No 50 as S. subluteus; Smith, A.H. & Thiers, H. (1964) Pl. 28 as *S. subluteus*; Smith, A.H. & Thiers, H. (1971) Pl 21 as *S. subluteus*; Snell, W.H. & Dick, E.A. (1970) Pl. 18 as *S. subluteus*; Pl. 19 as *S. pinorigidus*.

Acknowledgements

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MYCOLOGICAL LITERATURE RELEVANT TO NEW CALEDONIA

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ABSTRACT: An annotated list of publications relating to fungi of New Caledonia is presented. Over two hundreds titles were retrieved, starting from the year 1845. Interestingly more publications were issued from the start of the new European settlement in 1853 up to the first World War, than for the period between the two World Wars. For the latter only four titles could be located.

Before the first World War, Patouillard from the Paris Museum contributed much to our knowledge of the higher fungi of this island. After 1945, a series of papers of phytopathological interest were successively published by resident specialists such as Dadant, Bugnicourt, Huguenin and finally Köhler and Pellegrin. For the same period, pure taxonomic studies were undertaken by visiting mycologists such as Heim, Horak and Mouchacca.

In comparison to information accumulated on the higher plants of New Caledonia, present knowledge of its fungi is definitely limited.

KEY WORDS: fungi, New Caledonia, documentation, taxonomy, phytopathology

INTRODUCTION

Recent interest in fungi of New Caledonia has resulted in the publication of a series of papers on the island's mycobiota. Information on ascomycetes based on material collected in New Caledonia was summarized by Mouchacca (1998). An updated annotated check-list of holobasidiomycetes reported from New Caledonia was published by Horak & Mouchacca (1998); the list integrates observations reported since the start of the botanical exploration by d'Entrecasteaux in 1793. Mouchacca & Horak (1999) prepared a similar list for rusts and smuts based on specimens kept in the small New Caledonian herbarium. A similar document on reported deuteromycetes is under preparation by Mouchacca & McKenzie. Finally, Elix & McCarthy (1998) produced a document on the distribution of lichens in 33 island groups and isolated islands (including New Caledonia and its dependancies) of the South Pacific region.

A general account on the island's mycological history awaits preparation. Some aspects of this history were provided, however, in the papers focusing on particular taxonomic fungal groups. The present contribution is a continuation of previous work undertaken to critically assess information on the biodiversity of the fungi in New Caledonia. It brings together all available titles published since the establishment of European settlement in the area in 1853. Contents of the papers either concern only New Caledonia and its dependancies, or include information relevant to this island.

TITLES RETRIEVED

All publications retrieved are fully referenced with author's name (s), title, date and place of publication and page numbers. Many are also accompanied by a short descriptive annotation. For papers introducing fungi then considered as being new to science, binomials of the relevant taxa are specified.

Journal titles are abbreviated according to B-P-H/S (Botanico-Periodicum-Huntianum/Supplementum Hunt Institute for Botanical Documentation, Pittsburgh, 1991). Citation of fungal author's names follows Brummit & Powell (1992). In the text, only one abbreviation is introduced; New Caledonia: NC.

AMIR H. & PINEAU R., 1998. Effects of metals on the germination and growth of fungal isolates from New Caledonian ultramafic soils. Soil Biol. Biochem. **30**: 2043-2054.
According to the authors, a higher degree of tolerance to some heavy metal cations characteristic of New Caledonian ultramafic soils could explain the absence of few fungal genera in cultivated soils of this island.

ANONYMOUS, 1952. Current Research in the South Pacific in the field of economic development. South Pacific Commission, Nouméa, Technical Paper No. 29, 82 p.
Provides information on several items of phytopathological interest for the islands of NC and New Hebrides (now Vanuatu). For NC, diseases considered are dry rot of coffee, black rot of cabbage, and collar rot and rapid decay of oranges.

ANONYMOUS, 1954. Phytopathologie - Courrier des Chercheurs de l'Office de la Recherche Scientifique d'Outre-Mer. ORSTOM, Paris **8**: 159-186.
Includes a report by F. Bugnicourt on a new disease of taro plants imported from New Hebrides and grown on the east coast of NC. The causal agent proved to be *Pythium irregulare*. Another report by R. Dadant focuses on infection of *Coffea arabica* by rust, *Hemileia vastatrix* and thread-blight of coconut palms by *Corticium penicillatum*.

ANONYMOUS, 1954. Congrès de la protection des végétaux et de leurs produits sous les climats chauds. (Congress on the protection of plants and their products in hot climates), Marseille, Institut Français d'Outre-Mer (21-25 septembre 1954), 543 p.
F. Bugnicourt (pp. 235-239) presented his list of parasitic fungi of cultivated plants in NC.

BATISTA A.C., BEZZERA J.L, BARROS T.T. & LEAL F.B., 1970. Sôbre un novo gênero de *Microthyriaceae* da Nova Caledônia. Publ. Univ. Recife Inst. Micol. **637**: 1-11.
Protologue of *Vizellopsis grevilleae* gen. nov., sp. nov.

BEZZERA J.L., BARROS T.T. & LEAL F.B., 1970. *Hugueninia*, un nôvo gênero da familia *Microthyriaceae*. Publ. Univ. Recife Inst. Micol. **643**: 1-11.

Diagnosis of *Hugueninia freycinetiae* gen. nov. & sp. nov., dedicated to the phytopathologist B. Huguenin who communicated the described material from NC.

BLANDEAU J., 1911. *Hemileia*. Revue Agricole de la Chambre d'Agriculture de la Nouvelle-Calédonie, octobre 1911, pp. 17-19.

Reports on the first record of this coffee rust in NC.

BOCCAS B., 1983. Etude des *Fusarium* parasites du maïs et des mycotoxines fusariennes en Nouvelle-Calédonie. Compte rendu de première année de recherche CORDET (projet C 78), 6 p.

A preliminary note on the prevalence of *Fusarium moniliforme* on maize grains used for feeding horses.

BOCCAS B., KÖHLER F. & PELLEGRIN F., 1983. *Hemileia vastatrix* and New Caledonia. IVth International Congress of Plant Pathology, Melbourne, September 1983, poster abstract.

Reports on the spread of the disease in relation to the ongoing interest in coffee production in NC.

BOCCAS B., KÖHLER F. & PELLEGRIN F., 1985. Les races physiologiques d'*Hemileia vastatrix* en Nouvelle-Calédonie et à Vanuatu. Café, Cacao, Thé **29**: 177-182.

Urediniospore samples were inoculated onto clones of *Coffea arabica* and three virulence factors were identified in NC but only one in Vanuatu.

BOCCAS B., PELLEGRIN F., KÖHLER F., HAMEURT J., KONGOULEUX J., LAURENT D., DOMENECH J. & STACHURSKI F., 1985. La fusariose du maïs et les mycotoxines fusariennes en Nouvelle-Calédonie. Rapport pour la CORDET sur les recherches effectuées en 1982, 1983, 1984 (projet C 78), 31 p. (technical report).

BOCCAS B., PELLEGRIN F., KÖHLER F. & KONGOULEUX J., 1986. La fusariose du maïs en Nouvelle-Calédonie. Convention ORSTOM-CEE, Rapport du Service de Phytopathologie, Document Centre ORSTOM Nouméa (technical report), 19 p.

A preliminary note on the prevalence of *Fusarium moniliforme* on maize grains used for feeding horses.

BOCCAS B., PELLEGRIN F., KÖHLER F., SEIVERT B. & PILACKI A., 1984. La rouille orangée du caféier Arabica en Nouvelle-Calédonie. 2. Essais de contrôle chimique. Café, Cacao, Thé **28**: 203-208.

Conveys data from field chemical control measures for reducing rust infection.

BOCCAS B., SEIVERT B., PELLEGRIN F. & KÖHLER F., 1981. La rouille orangée du caféier en Nouvelle-Calédonie. Service de Phytopathologie, Document Centre ORSTOM Nouméa (technical report), 32 p.

BOCCAS B., SEIVERT B., PELLEGRIN F. & KÖHLER F., 1981. La rouille orangée du caféier Arabica en Nouvelle-Calédonie. Rapport sur les recherches épidémiologiques et génétiques en 1980. Rapport du Service de Phytopathologie et Direction des Services Ruraux, Document Centre ORSTOM Nouméa (technical report), 70 p.

Hemileia vastatrix on *Coffea arabica*.

BOIDIN J., LANQUETIN P. & MacKEE H.S., 1986. *Vararia rosulenta* (Basidiomycète, Lachnocladiaceae), nouvelle espèce néo-calédonienne. Windahlia **16**: 81-84.

BOOTH C. & SHAW D.E., 1967. *Anthostomella fusispora* sp. nov. and *A. cylindrospora* sp. nov. on *Cocos nucifera*. Papua and New Guinea Agricultural Journal **19**: 94-98.

Reports on the presence in NC of the new ascomycete *Anthostomella cylindrospora* described from material collected in New Guinea.

BOUCARON C., KÖHLER F., MICOLAU E., MORCHOINE C., NANDRIS D. & PELLEGRIN F., 1992. Amélioration phytosanitaire de la culture du maïs en Nouvelle-Calédonie. Rapport CORDET (technical report), 28 p.

Discusses trials to select new varieties of corn resistant to *Fusarium moniliforme* and three rust diseases prevalent in the island.

BRAUN U., MOUCHACCA J. & McKENZIE E.H.C., 1999. Cercosporoid hyphomycetes from New Caledonia and some other South Pacific islands. New Zealand J. Bot. **37**: 297-327.

A taxonomic revision of collected members of this group in the area.

BRESINSKY A. & BINDER M., 1998. *Leratiomyces* nom. nov. für eine bislang nicht gültig beschriebene Gattung der Strophariaceae (Agaricales) aus Neukaledonien. Z. Mykol. **64** : 79-82.

The new name *Leratiomyces* Bresinsky & Binder is proposed for the invalid *Le Ratia* Pat. 1907. New combinations are established for the four known taxa of the genus.

BUGNICOURT F., 1949. Les espèces du genre *Curvularia* isolées des semences de riz. VIIth Pacific International Scientific Congress in Auckland (2-8 February 1949) and Christchurch (16-22 February 1949), New Zealand, Lecture abstract.

Distribution of several *Curvularia* species in rice grains grown in the South Pacific region and Vietnam. F. Bugnicourt spent several years in Vietnam before arriving in NC (see Mouchacca, 1997).

BUGNICOURT F., 1950. Les espèces du genre *Curvularia* isolées des semences de riz. Rev. Gén. Bot. **57**: 65-77.

Provides frequencies of occurrences of five *Curvularia* species on rice grains grown in Vietnam and in the South Pacific. Only *Curvularia lunata* was detected on samples from NC with *C. oryzae* and *C. uncinula* proposed as new species.

BUGNICOURT F., 1950. Sur une méthode de contamination artificielle. Son application pour la recherche d'arbres résistants à certaines maladies cryptogamiques. Rev. Gén. Bot. **57**: 157-167.

A method is described for testing the resistance of trees to fungal diseases. It was first applied in Vietnam then in NC for testing Robusta coffee trees against a species of *Thielaviopsis* recently observed to cause a typical hadromycosis.

BUGNICOURT F., 1951. Mycoflore des semences du riz. In 'Conférence Phytosanitaire du Pacifique Sud, Suva, Fidji (2-11 avril 1951)'. Rapport de la Conférence sur la Quarantaine Végétale et Animale, Suva, Fidji, avril 1951. Commission du Pacifique Sud, Nouméa, Rapport Technique No. 9, 5 p.

Considers fungi observed on rice grains grown in several islands in the area.

BUGNICOURT F., 1952. Note sur la mycoflore des semences de riz dans les territoires du Pacifique Sud. Rev. Mycol. (Supplément Colonial) **17**: 26-29.

Reports on the occurrence of 20 different species of fungi on rice seeds from the Fiji Islands, NC, Dutch New Guinea, Tahiti, Hawaiian Islands and Australia.

BUGNICOURT F., 1952. Note on the mycoflora of rice seed in the territories of the South Pacific Commission. South Pacific Commission, Nouméa, Technical Paper No. 21, 5 p.

An English translation of the previous publication.

BUGNICOURT F., 1952. Une espèce fusarienne nouvelle, parasite du riz. Rev. Gén. Bot. **59**: 13-18.

Rice grains grown by the dry culture technique in NC were affected by *Fusarium annulatum* sp. nov.

BUGNICOURT F., 1952. Contribution à l'étude systématique de deux micromycètes parasites du riz. Rev. Gén. Bot. **59**: 413-420.
Details the distribution of *Trichoconis padwickii* and *Helicoceras oryzii* on rice in Vietnam and the South Pacific.

BUGNICOURT F., 1954. Champignons parasites des plantes cultivées en Nouvelle-Calédonie. In 'Congrés de la protection des végétaux et de leurs produits sous les climats chauds (21-24 septembre 1954)'. Institut Français d'Outre-Mer, Marseille, pp. 235-239.
The author introduced his first list of parasitic fungi of cultivated plants in NC.

BUGNICOURT F., 1955. Deux espèces nouvelles d'*Helminthosporium* isolées de semences du riz. Rev. Gén. Bot. **62**: 238-243.
Two new species of *Helminthosporium* occurring in rice grain in the South Pacific region are described but without a Latin diagnosis: *H. hawaiiense* and *H. australiense*; both were later recorded in NC.

BUGNICOURT F., 1956. Champignons parasites de plantes cultivées en Nouvelle-Calédonie. Institut Français d'Océanie, ORSTOM, Nouméa, 23 p.
An elaborate list of diseases of economic importance prepared on the fungal and on a host base.

BUGNICOURT F., 1958. Sur une maladie du maïs. Revue Agricole de la Nouvelle-Calédonie, **9** (Nos. 10-12, octobre-novembre), pp. 1-5.
Maize grains grown in NC were found to be infected by *Fusarium moniliforme* and *F. graminearum*.

BUGNICOURT F., 1958. Contribution à l'étude de *Cladosporium colocasiae* Sawada. Rev. Mycol. **23**: 233-236.
In NC the fungus is frequently present in plantings of *Colocasia antiquorum* where it produces a foliar disease.

BUGNICOURT F., COHIC F. & DADANT R., 1951. Catalogue des parasites animaux et végétaux des plantes cultivées de Nouvelle-Calédonie. Institut Français d'Océanie, ORSTOM, Nouméa, 120 p.
A serious attempt to produce a catalogue listing the principal plant and animal parasites of cultivated plants in NC with information on incidence and economic importance.

BUGNICOURT F. & MARTY J., 1961. Champignons parasites des plantes cultivées en Nouvelle-Calédonie. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa, Imprimerie Nouvelle D. Tardieu, 20 p.
This list includes a host index (102 species) and a list of 183 pathogenic fungi.

COMBES R., 1952. Exposé des activités de l'Office de la Recherche Scientifique d'Outre-Mer pour les années 1946-1949-1950. ORSTOM, Paris, 71 p.
For NC this report discusses the recent achievements of the plant pathological laboratory at the Institut Français d'Océanie in Nouméa: presents a preliminary list of crop diseases, outlines methods of growing better crops and controlling diseases. The activities of the new local consultative epidemic committee are also reviewed.

COOKE M.C., 1887. Australasian Fungi. Grevillea **16**: 30-33.
Protologue of *Agaricus (Lepiota) echinodermatus*.

CRIÉ L., 1874. Sur une altération pathologique des feuilles de l'*Ionidium austro-caledonicum* Vieill. J. Pharm. Chim., sér. **IV**, **19**: 113-114.

Reports the presence of *Septoria chatiniana* sp. nov. on plant material collected by Vieillard and maintained in the Paris Museum. Dedicated to M. Chatin, then director of the 'Ecole Supérieure de Pharmacie de Paris'.

CRIÉ L., 1874. Coup d'oeil sur la végétation fongine de la Nouvelle-Calédonie. Bull. Soc. Linn. Normandie **8**: 442-451.

A review of the then available information on NC fungi extended with the author's observations from his examination of original plant material. Includes the protologue of *Rhytisma austro-caledonicum*.

CRIÉ L., 1878. Recherches sur les Dépazées. Ann. Sci. Nat., sér. **VI**, Botanique 7: 5-60.

In this thesis memoir the author reviews current knowledge on known species of *Depazea*; proposal of *D. australis* sp. nov. observed on plant material from NC.

CRIÉ L., 1879. Sur les Pyrénomycètes inférieurs de la Nouvelle-Calédonie. Compt. Rend. Hebd. Séances Acad. Sci., Paris, sér. **I**, **89**: 994-995.

A report on several fungi observed on plant material from NC in the Paris Museum. Refers to his earlier proposal of *Depazea australis* and briefly introduces the new taxa *Phoma eugeniarum* (on leaves of *Eugenia* sp.), *Pestalozzia austro-caledonicum* and *Phyllosticta apiculatum* (on leaves of *Caesalpinea* sp.).

As indicated by Mouchacca (1998), Crié made no attempt to segregate material of the fungi he proposed as new from the plant specimens scanned at the Paris Museum. So annotations by Crié on relevant plant sheets should be studied for type material retreival.

DADANT R., 1950. La défense des couches à semis des cultures maraîchères contre la 'fonte de semis' en Nouvelle-Calédonie. Revue Agricole de la Nouvelle-Calédonie, N. S., **1** (Nos. 3-4, mars-avril), pp. 4-5.

A note for market growers of damping-off diseases of seedlings.

DADANT R., 1950. Premiers principes de lutte contre les maladies des pommes de terre. Revue Agricole de la Nouvelle-Calédonie, N. S., **1** (Nos. 5-6, mai-juin), pp. 7-8.

A popular note on control measures for fungal and other diseases of potatoes.

DADANT R., 1950. Au sujet de la maladie du Black-rot des choux. Revue Agricole de la Nouvelle-Calédonie, N. S., **1** (Nos. 9-10, septembre-octobre), pp. 13-14.

A popular note on this cabbage black-rot disease.

DADANT R., 1950. Sur une nouvelle maladie du *Coffea robusta* en Nouvelle-Calédonie. Rev. Gén. Bot. **57**: 168-167.

Robusta coffee in NC is affected by a fungus disease leading to death of the tree. The fungus belongs to the genus *Thielaviopsis* and following the author 'if it should prove to be a new species, the name *T. neocaledoniae* could be selected'. The hyphomycete was later renamed *Chalara neocaledoniae* (see Kiffer & Delon, 1983).

DADANT R., 1952. Sur deux maladies des caféiers. Revue Agricole de la Nouvelle-Calédonie, **3** (Nos. 1-2, janvier-février), pp. 4-5.

Conveys information on two fungal diseases of local coffee trees induced by *Ustulina zonata* and a dematiaceous hyphomycete for which the invalidly published binomial *Thielaviopsis neocaledoniae* was proposed.

DADANT R., 1952. Un moyen pratique de lutte contre l'*Oidium* des melons. Revue Agricole de la Nouvelle-Calédonie **3** (Nos. 3-4, mars-avril), pp. 4-5.

Control measures against *Oidium erysiphoides* infecting melons. This *Oidium* is now regarded as a *nom. amb.* (Braun, 1995). *Erysiphe polygoni* and *Sphaerotheca* *fuliginea* are actually commonly encountered on melons in NC (see Kohler & Pellegrin, 1992).

DADANT R., 1953. Contribution à l'étude de *Oospora citri-aurantii* Ferraris, parasite des agrumes en Nouvelle-Calédonie. Rev. Pathol. Vég. Entomol. Agric. France **32**: 87-92.

Reports on the severe economic losses due to the rotting of citrus fruits by this fungus following skin puntures caused by insects. According to Braun (1995), the cited binomial does not represent a powdery mildew. It is not reported by Kohler & Pellegrin (1992).

DADANT R., 1953. *Corticium penicillatum* Petch, Thread blight du cocotier. Rev. Mycol., Supplément Colonial **18**: 1-4.

A descriptive sheet of the parasite and problems induced in the South Pacific region.

DADANT R., 1954. Le caféier en Nouvelle-Calédonie, ses maladies. Agron. Trop. (Nogent-sur-Marne) **9**: 49-58.

Reviews coffee diseases (mainly Arabica and Robusta) of fungal origin or resulting from physiological disorders.

DADANT R., 1955. Une maladie du Taro en Nouvelle-Calédonie. Atti del VI Congresso Internazionale di Microbiologia, Roma, 6-12 September 1953, vol. 5, Session No. 14, pp. 250-257.

Discusses the history, epidemiology and control measures of a new disease of taro imported with plants from New Hebrides. The causal agent is described as *Pythium irregulare* var. *neocaledonica*, var. nov. but without a Latin diagnosis. The status of the variety was not re-assessed in the relevant monograph by Plaats-Niterink (1981).

DESJARDIN D.E. & HORAK E., 1997. *Marasmius* and *Gloiocephala* in the South Pacific Region: Papua New Guinea, New Caledonia, and New Zealand taxa. Bibl. Mycol. **168**: 1-83.

For NC protologues of *Marasmius aurantiobasalis* var. *hispidipes* and *M. ochroleucus* and new records of *M. pellucidus*, *M. amabilis* and *M. elatus*.

DOMENECH J., 1982. Etude d'un foyer de leucoencéphalomacie du cheval en Nouvelle-Calédonie. Rapport IEMVT (technical report), 6 p.

First mention of an equine leucoencephalomalacy due to a mycotoxicosis.

DOMENECH J., BOCCAS B., PELLEGRIN F., LAURENT D., KÖHLER F., MAGNOL J. & LAMBERT C., 1984. Etude de la fusariose du maïs à *Fusarium moniliforme* en Nouvelle-Calédonie et de la pathologie equine associée à la leucoencephalomalacie toxique. Rev. Elev. Méd. vét. Pays trop. **37**: 253-259.

Reports on cases of this mycotoxicosis and sources of maize infection in NC.

DOMENECH J., BOCCAS B., PELLEGRIN F., LAURENT D., KÖHLER F., MAGNOL J. & LAMBERT C., 1985. Equine leukoencephalomalacia in New Caledonia. Austral. Veterin. J. **62**: 422-423.

A short account of the distribution of this mycotoxicosis in NC.

DOMENECH J., BREGEAT D. & BOCCAS B., 1982. Les mycotoxicoses en pathologie animale : intérêt de leur étude en Nouvelle-Calédonie. Revue d'Elevage et de Médecine Vétérinaire de Nouvelle-Calédonie **1**: 11-18.

A review for local farmers on the various aspects of animal mycotoxicoses.

DUMBLETON L .J., 1954. A list of plant diseases recorded in South Pacific Territories. South Pacific Commission, Nouméa, New Caledonia, Technical Paper No. 78, 78 p. (a French translation is available).

This useful list of parasites (including viruses) and hosts includes the territories in which they have been recorded. The bibliography contains several titles for NC.

DUSSERT P., 1911. Semences de caféiers réfractaires à *Hemileia*. Revue Agricole de la Chambre d'Agriculture de la Nouvelle-Calédonie, novembre 1911, pp. 17-20.

ELIX J.A. & McCARTHY P.M., 1998. Catalogue of the Lichens of the Smaller Pacific Islands. Bibl. Lichen. **70**: 1-361.
Check-list of lichens are presented for each island group and isolated islands including NC and its dependancies.

FIRMAN I.D., 1975. Annotated bibliography of sources of information on plant disease distribution in the area of the South Pacific Commission. South Pacific Commission, Nouméa, New Caledonia, Technical Paper No. 172, 23 p.
This host list is based on Dumbleton's list; it attempts to include and reconcile information from other disease reports. The bibliogrpahy contains references for NC.

FIRMAN I. D., 1978. Plant pathology in the region served by the South Pacific Commision. Rev. Pl. Pathol. **57**: 85-90.
After an introduction this review considers plant pathology at the regional and national levels, early records of fungi and diseases, lists of diseases, work on the main crop plants and quarantine regulations.

FIRMAN I. D., 1978. Bibliography of plant pathology and mycology in the area of the South Pacific Commission 1820-1976. South Pacific Commission, Technical Paper No. 176, 78 p.
An extended annotated list of titles dealing with plant pathology in the area.

FRAYSSE A., 1911. L'*Hemileia vastatrix* à Ponérihouen. Revue Agricole de la Chambre d'Agriculture de la Nouvelle-Calédonie, juin 1911, pp. 3-12.
Reports the development of coffee rust in this part of NC. The author was then Secretary of the Agricultural Chamber in NC. A specimen of rusted coffee from Ponérihouen dated 1909 is present in the 'Herb. Station Centrale de Pathologie Végétale de Versailles' now lodged in PC.

GUZMAN G. & HORAK E., 1978. New species of *Psilocybe* from Papua New Guinea, New Caledonia and New Zealand. Sydowia **31**: 44-54.
Protologue of *Psilocybe neocaledonica*. The record of this fungus in NC was not reported by Horak & Mouchacca (1998).

HANSFORD C. G., 1958. A new species of *Amazonia*. Kew Bull. **1957**: 410.
Amazonia novae-caledoniae sp. nov., on plant material at the Royal Botanic Gardens.

HARIOT P. & PATOUILLARD N., 1903. Quelques Champignons de la Nouvelle-Calédonie, de la collection du Muséum. J. Bot. (Morot) **17**: 6-15.
The paper deals with 84 taxa identified from specimens collected by Bernier, former Curator of the Musée de Nouméa. 13 proved to be new species: *Daldinia cognata*, *Geoglossum* (*Eugeoglossum*) *noumeanum*, *Hypoxylon neocaledonicum*, *Kretzschmaria scruposa*, *Xylaria corrugata*; *Ganoderma insulare*, *Lentinus araucariae*, *Leucoporus asperulus*, *Marasmius amabilis*, *Polysaccum pusillum*, *Stereum neocaledonicum*, *Trametes aratoides* and *Xanthochrous bernieri*.

HEIM R., 1936. Aperçu sur les Champignons toxiques et comestibles des Colonies Françaises. In 'Pathologie Exotique Vétérinaire et Comparée III.' G. Curasson éd., pp. 1-31 (Vigot Fres. : Paris Imp. G. Thane, Liège).
Includes information on most of the basidiomycetes earlier recorded in these colonies.

HEIM R., 1951. Notes sur la flore mycologique des terres du Pacifique Sud. IV. Le genre néo-calédonien *Le Ratia* Pat. Rev. Mycol. **16**: 154-158.

A modern description of *Leratia similis* based on fresh specimens collected by Dadant and handed to the author while revisiting the island after the 1949 Pacific Science Congress in Christchurch, New Zealand.

HEIM R., 1951. Les champignons luminescents de l'Océanie. Compt. Rend. Hebd. Séances Acad. Sci., Paris **233**: 8-11.

Reports on the collection during his 1949 visit to NC of bioluminescent specimens of *Mycena rorida* var. *lamprospora*, *M. illuminans*, *Poromycena decipiens*, *P. manipularis* and a *Pleurotus* sp. The records of these taxa in NC were not reported by Horak & Mouchacca (1998).

HEIM R., 1965. Les Meioorganés, phylum reliant les Bolets aux Polypores. Compt. Rend. Hebd. Séances Acad. Sci., Paris **261**: 1717-1720.

Introduces the new genus *Meiorganum* based on material collected in NC; the proposed type species *M. neocaledonicum* is not described in this paper.

HEIM R., 1965. Les Meioorganés, phylum reliant les Bolets aux Polypores. Rev. Mycol. **30**: 307-329.

The description of the type species *Meiorganum neocaledonicum* sp. nov. is not accompanied by a Latin diagnosis.

HEIM R., 1966. Quelques Ascomycètes remarquables V. Morilles tropicales (Pacifique Sud). Bull. Trimestriel Soc. Mycol. France **82**: 442-449.

The new *Morchella anteridiformis* is introduced without a Latin diagnosis.

HEIM R., 1966. *Breves diagnoses latinae novitatum genericorum* (2ème série). Rev. Mycol. **31**: 150-159.

Latin diagnoses of *Morchella anteridiformis* and *Meiorganum neocaledonicum*.

HEIM R. 1967. Notes sur la flore mycologique des terres du Pacifique Sud. V. Une Russule à spores échinulées. Rev. Mycol. **32**: 3-11.

Introduces *Russula echinospora* sp. nov. but without a Latin diagnosis.

HEIM R., 1967. Les enigmes des *Le Ratia*. Rev. Mycol. **32**: 11-15.

Debates the phylogeny of the genus based on observations of fresh material of accepted species.

HEIM R., 1967. *Breves diagnoses latinae novitatum genericorum specificarumque nuper descriptorum*. Rev. Mycol. **32**: 203-210.

Includes a Latin diagnosis of *Russula echinospora*.

HEIM R., 1968. Notes sur la flore mycologique des terres du Pacifique Sud. VIII. Nouvelles recherches sur les *Le Ratia* Pat. Rev. Mycol. **33**: 137-154.

Reports observations derived from the first living cultures prepared for two members of the genus. Also includes a description of *Leratia atrovirens* sp. nov. but proposed without a Latin diagnosis.

HEIM R., 1968. *Breves diagnoses latinae novitatum genericorum specificarumque nuper descriptorum*. 4ème série. Rev. Mycol. **33**: 211-217.

Inludes a Latin diagnosis of *Leratia atrovirens*.

HEIM R. & PERREAU J., 1963. Le genre *Boletellus* à Madagascar et en Nouvelle-Calédonie. Rev. Mycol. **28**: 191-199.

Reports on a collection of *Boletellus ananas* made by R. Heim in NC in 1949.

HENNINGS P., 1903. *Squamotubera* P. Henn. gen. nov. *Xylariacearum*. Hedwigia **42**: 308-309.

Squamotubera leratii gen. nov. & sp. nov. is based on material sent by A.J. Le Rat.

HORAK E., 1973. *Entoloma* (Agaricales) in Indomalaya and Australasia. Beih. Nova Hedwigia **43**: 1-352.
Protologue of *Entoloma aromaticum*.

HORAK E., 1977. *Crepidotus episphaeria* and related species from the southern hemisphere. Ber. Schweiz. Bot. Ges. **87**: 227-235.
Descriptions of two new *Crepidotus* species from NC: *C. aureus* and *C. hirsutellus*.

HORAK E., 1978. *Mycena rorida* (Fr.) Quél. and related species from the southern hemisphere. Ber. Schweiz. Bot. Ges. **88**: 20-29.
Proposal of *Mycena irritans* sp. nov.

HORAK E., 1979. Paxilloid Agaricales in Australasia. Sydowia **32**: 154-166.
Protologue of *Paxillus chalybaeus*.

HORAK E., 1980. *Entoloma* (Agaricales) in Indomalaya and Australasia. Beih. Nova Hedwigia **65**: 1-352.
For NC the following new taxa are proposed: *Claudopus miraculosus*, *Entoloma canobrunnescens*, *E. extraordinarium*, *E. floccosodentatum*, *E. glaucopus*, *E. neocaledonicum*, *E. proprium*, *E. rotundisporum* and *E. translucidum*.

HORAK E., 1980. New and remarkable Hymenomycetes from tropical forests in Indonesia (Java) and Australasia. Sydowia **33**: 39-63.
The following new taxa from NC are introduced: *Boletus perroseus*, *B. phytolaccae*, *Cuphocybe ferruginea* and *Lepiota atrata*.

HORAK E., 1981. Notes on taxonomy and biogeography of *Rozites* Karsten. Sydowia **34**: 94-108.
Introduces *Rozites neocaledonica* sp. nov.

HORAK E., 1983. Mycogeography in the South Pacific Region: Agaricales and Boletales. In 'Pacific Mycogeography: a preliminary approach'. Eds. K.A. Pirozynski & J. Walker. Austral. J. Bot., Suppl. Ser. No. 10, pp. 1-41.
Reviews known distribution of basidiomycetous taxa in the area.

HORAK E. & MOUCHACCA J., 1998. Annotated check-list of New Caledonian Basidiomycota. I. Holobasidiomycetes. Mycotaxon **68**: 75-129.
Contains basic descriptive and taxonomic information on over three hundred taxa collected in NC and its dependancies (with fewer from French Polynesia or Samoa); almost one third were collected for the first time in this island. A state of the art document on these fungi for the area.

HORAK E. & WOOD A. E., 1990. Fr. (Agaricales) in Australasia. I. Subgen. *Myxacium* and subgen. *Paramyxacium*. Sydowia **42**: 88-168.
Proposal of the following new taxa collected in NC: *Cortinarius (Myxacium) necessarius*, *C. neocaledonicus* and *C. verecundus*.

HUGUENIN B., 1964. Micromycètes du Pacifique Sud (1^{re} Contribution). Parasites foliicoles des *Pandanus*. Bull. Trimestriel Soc. Mycol. France **80**: 172-185.
Protologues of new taxa inducing foliar diseases of *Pandanus tectorius* in the South Pacific area: *Microcyclus pandani*, *Oxydothis pandani*, *Parastigmatea pandani* and *Diplococcium pandani*.

HUGUENIN B., 1964. Micromycètes du Pacifique Sud ($2^{ème}$ Contribution). Une affection tumorale du Niaouli. Rev. Mycol. **29**: 259-266.
Description and symptoms induced by the new ascomycete *Pleomassaria melaleucae* and its anamorph developing on swellings of *Melaleuca leucodendron* in NC.

HUGUENIN B., 1965. Micromycètes du Pacifique Sud. III. Dématiées de Nouvelle-Calédonie. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 11 p.

HUGUENIN B., 1965. Une méthode de lutte contre le pourridié des Caféiers en Nouvelle-Calédonie. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 11 p.

HUGUENIN B., 1965. La pourriture radiculaire des *Xanthosoma sagittifolium* (L.) Schott. causée par *Pythium irregulare* Buisman var. *neocaledenica* Dadant, Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 70 p.

HUGUENIN B., 1965. Rapport de participation aux travaux de la 5$^{\text{ème}}$ réunion du Comité Phytosanitaire de la F.A.O. pour la région du S.E. Asiatique et du Pacifique, Canberra, Australie, 26 novembre - 2 décembre 1964. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 17 p.

HUGUENIN B., 1965. Micromycètes du Pacifique Sud (3$^{\text{ème}}$ Contribution). (1). Dématiées de Nouvelle-Calédonie. Bull. Trimestriel Soc. Mycol. France **81**: 686-698.

Protologues of new dematiaceous fungi in relation to some plant diseases: *Cercospora alphitoniae*, *Stenella tristaniae*, *Stenellopsis fagraeae* gen. nov. & sp. nov., *Stemphylium xanthosomae* and *Bipolaris xanthosomae*.

HUGUENIN B., 1965. Micromycètes du Pacifique Sud (4$^{\text{ème}}$ Contribution). (1) Deux Ascomycètes de Nouvelle-Calédonie. Bull. Trimestriel Soc. Mycol. France **81**: 699-703.

Protologues of two ascomycetes isolated from plant material: *Herpotrichia erythrinae* and *Thielavia neocaledoniensis*; the latter will later on be the type species of the new genus *Isia* D.Hawksw. & Manoharachary.

HUGUENIN B., 1965. Micromycètes du Pacifique Sud. V. Urédinales de Nouvelle-Calédonie. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 15 p.

HUGUENIN B., 1965. Micromycètes de Nouvelle-Calédonie. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 20 p.

HUGUENIN B., 1966. Micromycètes de Nouvelle-Calédonie. Cahiers ORSTOM, Série Biologie **1**: 61-91.

The list provides records of 425 species isolated in culture. Fungi reported belong to 215 genera developing on 182 host-plants or on other substrates. They are either new for NC or previously quoted in former lists of parasitic fungi of cultivated plants or in the relevant preliminary technical reports on the same subject.

HUGUENIN B., 1966. Micromycètes du Pacifique Sud (5$^{\text{ème}}$ Contribution). Uredinales de Nouvelle-Calédonie (I). Bull. Trimestriel Soc. Mycol. France **82**: 248-273.

A total of 46 rust species are considered. *Dicheirina vienottii* and *Ravenalia neocaledoniensis* are new species. Modern descriptions of 8 other rusts are also included.

HUGUENIN B., 1967. Microfungi of New Caledonia. F. A. O. Plant Protection Commission, Technical Document No. 57, 8 p.

An enlarged copy of a similar paper published a year before.

HUGUENIN B., (1967) 1968. Micromycètes du Pacifique Sud (6$^{\text{ème}}$ Contribution). Uredinales de Nouvelle-Calédonie (2). Bull. Trimestriel Soc. Mycol. France **83**: 941-951.

Reports on 8 Uredinales recorded for the first time in NC. Three new *Puccinia* are established: *P. lifuensis*, *P. montisfontium* and *P. thiensis*.

HUGUENIN B., 1967. Note bibliographique sur les nodules mycorrhiziens des *Podocarpacées*. Laboratoire de Phytopathologie, Centre ORSTOM, Nouméa (technical report), 12 p.

HUGUENIN B., 1968. Les nodules mycorrhiziens du *Casuarina deplancheana* de Nouvelle-Calédonie. Laboratoire de Phytopathologie, Centre ORSTOM, Nouméa (technical report), 33 p.

HUGUENIN B., 1968. Les complexes mycorrhiziens endotrophes du *Casuarina deplancheana*. Premiers résultats des études phénologiques faites au cours des années 1967-68. Laboratoire de Phytopathologie, Centre ORSTOM, Nouméa (technical report), 14 p.

HUGUENIN B., 1969. Micromycètes du Pacifique Sud. (7ème Contribution). Meliolinées de Nouvelle-Calédonie. Rev. Mycol. **34**: 23-61.
The first contribution on NC Meliolinae. 25 new species or varieties are described with records of 17 other species known from Australian, Indo-malaysian and Pacific mycofloras. New taxa are: *Amazonia geniostomatis*, *A. pancheriae*, *Asteridiella melaleucae*, *A. schmidii*, *Meliola albizziae-granulosae*, *M. alstoniae-comptonii*, *M. alyxiicola*, *M. calpidiae*, *M. choryzandrae*, *M. codiae*, *M. comptonellae*, *M. couthoviae*, *M. dognyensis*, *M. dysoxyli-nitidi*, *M. dysoxyli-nitidi* var. *minor*, *M. grevillae-gilivrayi*, *M. kisubiensis* var. *acronychiae*, *M. montisfontium*, *M. mouensis*, *M. nothofagi*, *M. osmanthi-cymosi*, *M. oxerae*, *M. stenocarpi*, *M. tieghemopanacis* and *M. venezuelana* var. *neocaledonica*.

HUGUENIN B., 1969. Micromycètes du Pacifique Sud (8ème Contribution). Ascomycètes de Nouvelle-Calédonie (II). Cah. Pacifique **13**: 295-308.
Mainly fungi from NC: *Microcyclus niaouli* sp. nov., records of two species of *Corynelia* and descriptions of five new species of *Caliciopsis*: *C. myrticola*, *C. podocarpi*, *C. rapanae*, *C. veillonii* and *C. xanthostomatis*.

HUGUENIN B., 1969. Les nodules mycorhiziens du *Casuarina deplancheana* de Nouvelle-Calédonie. Thèse de 3ème cycle, Biologie Végétale, Faculté des Sciences, Université de Rouen, 62 p.

HUGUENIN B. & KÖHLER F., 1969. Quelques Myxomycètes de Nouvelle-Calédonie. Bull. Trimestriel Soc. Mycol. France 85: 381-383.
24 species listed, most being reported for the first time from NC.

HUGHES S.J., 1993. *Meliolina* and its excluded species. Mycol. Pap. **166**: 1-255.
Protologue of *Meliolina novae-caledoniae* based on an incorrectly identified specimen of *Meliola cladotricha* from NC, and a record of *Meliolina degeneri*.

IRAT. Rapport Annuel, 1983. Institut des Recherches Agronomiques Tropicales et des Cultures Vivrières, Nogent-sur-Marne, France, 295 p.
Accounts are given on work done among others on fungus diseases of *Xanthosoma sagittifolium* in NC.

JOHNSON T.W. Jr, 1950. A study of one isolate of *Brevilegnia* from New Caledonia. Mycologia **42**: 242-252.
Protologue of *Brevilegnia longicaulis* from soil samples sent by Prof. J.T. Buchholz.

KIFFER E. & DELON R., 1983. *Chalara elegans* (: *Thielaviopsis basicola*) and allied species. II. Validation of two taxa. Mycotaxon **18**: 165-174.
Chalara neocaledoniae is proposed for the invalidly published *Thielaviopsis neocaledoniae*, agent of a coffee disease in NC; similar symptoms were also observed there on *Psidium guayava*.

KÖHLER F., 1984. Encyclopédie de la Nouvelle-Calédonie. Tome 3. Faune et Flore Terrestres. Les Champignons, pp. 130-140. Neto Diffusion, Nouméa.

KÖHLER F., 1985. Agents pathogènes et maladies physiologiques des plantes cultivées en Nouvelle-Calédonie et aux Iles Wallis et Futuna. Laboratoire de Phytopathologie, Centre ORSTOM, Nouméa (technical report), 46 p.

A list of pathogens inducing diseases of garden, nursery and fruit plants, cereals and fodder plants, ornamentals and trees.

KÖHLER F., 1987. Agents pathogènes et maladies physiologiques des plantes cultivées en Nouvelle-Calédonie et aux Iles Wallis et Futuna. Catalogues Sciences de la Vie, Phytopathologie No. 1, Institut Français de Recherche Scientifique pour le Développement en Coopération ORSTOM, Centre de Nouméa, Nouvelle-Calédonie, 48 p.

An update of the previous lists of fungi parasitic on cultivated plants on these islands. Almost 300 taxa developing on 130 hosts are indexed.

KÖHLER F. & PELLEGRIN F., 1992. Pathologie des végétaux cultivés. Nouvelle-Calédonie, Polynésie Française et Wallis et Futuna. Editions de l'ORSTOM, Collections Didactiques, Paris, 171 p.

A popular, richly illustrated book with coloured photographs of many diseases of cultivated plants to be found in the Pacific French territories.

KÖHLER F., PELLEGRIN F., JACKSON G. & McKENZIE E., 1997. Diseases of Cultivated Plants in Pacific Island Countries. South Pacific Commission, Nouméa, New Caledonia, 186 p.

A comprehensive expanded English version of the former French edition published by the first two authors.

KÖHLER F., PELLEGRIN F. & LAURENT D., 1988. La toxicogenèse chez *Fusarium moniliforme* : nouvelles observations. Microbiol. Alim. Nut. **6**: 165-169.

Recent development of this *Fusarium* mycotoxicosis in NC.

LAMOUROUX N., PELLEGRIN F., NANDRIS D. & KÖHLER F., 1995. The *Coffea arabica* fungal pathosystem in New Caledonia: Interactions at two different spacial scales. J. Phytopath. **143**: 403-403.

Biometrical studies of the development of rust disease in coffee plantations.

LAURENT D., GOASDOUE N., KÖHLER F., PELLEGRIN F. & PLATZER N., 1990. Caracterisation of cyclonerodiol from corn infested by *Fusarium moniliforme* Sheld.: one and two dimensional 1H and 13C N.M.R. study. Magnetic Resonance Chemistry **28**: 662.

LAURENT D., LANSON M., GOASDOUE N., KÖHLER F., PELLEGRIN F. & PLATZER N., 1990. Etude au R.M.N. 1H et 13C de la macrofusine, toxine isolée de maïs infesté par *Fusarium moniliforme* Sheld. Analusis **18**: 172-179.

LAURENT D., PELLEGRIN F., KÖHLER F., FOUQUET L., LAMBERT C. & BOCCAS B., 1988. *Fusarium moniliforme* du maïs en Nouvelle-Calédonie : Toxicologie animale. Microbiol. Alim. Nut. **6**: 159-164.

Evaluation of toxinogenic levels of strains of this *Fusarium* species isolated from locally infected fodder corn.

LAURENT D., PELLEGRIN F., KÖHLER F., COSTA R., THEVENON J. & HUERRE M., 1989. La fumonisine B1 dans la pathogènie de la leucoencéphalomalacie equine. Microbiol. Alim. Nut. **7**: 285-291.

Caracterisation of a new toxin (fumonisine B1) isolated from *Fusarium moniliforme*.

LAURENT D., PELLEGRIN F., KÖHLER F., COSTA R., THEVENON J., DEMERSEMAN P., GUILLAUMEL J. & PLATZER N., 1992. Is Fumonisin B1 responsible for equine leucoencephalomalacia ? Xth World Congress on Animal,

Plant and Microbial Toxins, Singapore, ABSTRACT, November 3-8, 1991. Toxicon **30**: 530.

LAURENT D., PELLEGRIN F., KÖHLER F., LAMBERT C., HAMEURT J., BOCCAS B. & DOMENECH J., 1887. Toxicité aigüe sur canetons Pékin de souches de *Fusarium moniliforme* isolées de maïs en Nouvelle-Calédonie. Microbiol. Alim. Nut. **5**: 11-15.
Toxicological studies of *F. moniliforme* strains isolated from locally infected corn.

LAURENT D., PLATZER N., KÖHLER F., SAUVIAT P. & PELLEGRIN F., 1989. Macrofusine et micromoniline : deux nouvelles mycotoxines isolées de maïs infesté par *Fusarium moniliforme* Sheld. Microbiol. Alim. Nut. **7**: 9-16.
Reports the isolation of two novel molecules from cultures of *Fusarium moniliforme* isolated from mouldy fodder corn in NC.

LEVEILLE J. H., 1845. Champignons exotiques. Ann. Sci. Nat. (Paris), sér. **III**, Botanique, **3**: 58-60.
Protologue of *Depazea celastrina*.

MAAS GEESTERANUS R.A. & HORAK E., 1995. *Mycena* and related genera from Papua New Guinea and New Caledonia. Bibl. Mycol. **159**: 143-229.
Introduces the following new taxa from NC: *Filoboletus conus*, *F. pustulosus*, *Mycena odora* and *M. rubidolimbata*.

MARTY J., 1958. Maladies cryptogamiques observées à l'Ecole d'Agriculture de Port-Laguerre. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 12 p.

MARTY J., 1958 Rapport d'une mission phytopathologique à Lifou (Iles Loyauté), 2-9 décembre 1956. Laboratoire de Phytopathologie, Institut Français d'Océanie, ORSTOM, Nouméa (technical report), 20 p.
List of the pathogens of cultivated plants in Lifou island, NC.

McKENZIE E.H.C., 1991. Dematiaceous Hyphomycetes on *Freycinetia* (*Pandanaceae*) 1. *Stachybotrys*. Mycotaxon **41**: 179-188.
Protologue of *Stachybotrys breviusculus* and record of *S. parvispora*, both from NC.

McKENZIE E.H.C., 1991. Dematiaceous Hyphomycetes on *Freycinetia* (*Pandanaceae*) 2. *Zebrospora* gen. nov. Mycotaxon **41**: 189-193.
Record of the type species *Zebrospora bicolor* in NC.

McKENZIE E.H.C., 1992. Dematiaceous Hyphomycetes on *Freycinetia* (*Pandanaceae*) 3. *Chalarodes* gen. nov. Mycotaxon **42**: 89-93.
Protologue of the type species *Chalarodes obconica*.

McKENZIE E.H.C., 1993. New species of *Cryptophiale* from New Zealand and New Caledonia. Mycotaxon **46**: 307-312.
Records of *Cryptophiale orthospora* (proposed as new species) and of *C. manifesta* in NC.

McKENZIE E.H.C., 1995. Dematiaceous Hyphomycetes on *Pandanaceae*. 5. *Sporidesmium sensu lato*. Mycotaxon **56**: 9-29.
Records of *Ellisembia vaginata* (new taxon) and of *Sporidesmium freycinetiae* in NC.

McKENZIE E.H.C. & HYDE K.D., 1997. Microfungi on *Pandanaceae*. In 'Biodiversity of Tropical Microfungi' (Hyde D.K., ed.). Hong Kong University Press, pp. 157-177.
Provides all records on hosts of this plant family in NC.

McKENZIE E.H.C. & KUTHUBUTHEEN A.J., 1993. Dematiaceous hyphomycetes on *Freycinetia* (*Pandanaceae*) 4. *Cryptophiale*. Mycotaxon **47**: 87-92.

Protologue of *Cryptophiale novae-caledoniae*.

MOUCHACCA J., 1990. Champignons de Nouvelle-Calédonie I. Quelques dématiées intéressantes de litière forestière. Persoonia **14**: 151-160.

Includes descriptions of six rare dematiaceous taxa being also new records for NC.

MOUCHACCA J., 1990. Champignons de Nouvelle-Calédonie II. Quelques dématiées intéressantes de litière forestière. Nova Hedwigia **51**: 459-468.

Descriptions of six other uncommon dematiaceous taxa previously unrecorded for NC.

MOUCHACCA J., 1997. Francis BUGNICOURT (1907-1991). Crypt. Mycol. **18**: 173-181.

An account of the life history of the French phytopathologist in Vietnam and New Caledonia and of his scientific achievements: lists of publications and of new taxa proposed.

MOUCHACCA J., 1998. Ascomycetes described from New Caledonia, South Pacific Region. Mycotaxon **67**: 99-121.

Includes basic taxonomic information (descriptive and taxonomic) of over 100 species having protologues based on material collected in NC (with fewer from French Polynesia). A comprehensive document on the topic.

MOUCHACCA J. & HORAK E., 1998. Annotated check-list of New Caledonian Basidiomycota. II. Rusts and Smuts. Mycotaxon **69**: 13-20.

Provides basic information of 70 members of both groups having specimens in the Neocaledonian Herbarium in Paris.

MOUCHACCA J. & McKENZIE E.H.C., 1994. Deuteromycetes of New Caledonia. Vth International Mycological Congress, ABSTRACTS, August 14-21, 1994, Vancouver, University of British Columbia, poster abstract, p. 149.

Preliminary information on the project 'Annotated check-list of NC deuteromycetes'.

MOUCHACCA J. & ZUCCONI L., 1994. Fungi of New Caledonia III. Some interesting dematiaceous hyphomycetes from leaf litter. Crypt. Mycol. **15**: 27-38.

Descriptions and distribution of six little documented dematiaceous fungi also being new additions; *Diplocladiella scalaroides* is redescribed from original material.

MÜLLER J., 1884. Lichenes Otaitensis a cl. G. Brunaud lecti et ab. E. Roumeguère communicati. Rev. Myc. (Toulouse) **6**: 90-95.

Provides a list of ten new records for NC. The only new taxon then proposed is *Cora nitida* from Tahiti.

MÜLLER J., 1887. Enumération de quelques lichens de Nouméa. Receuillis par M. Théophile Savés, communiqués par le Chevalier Roumeguère. Rev. Myc. (Toulouse) **9**: 77-82.

Provides a list of 73 lichens including ten new taxa. The names of ten basidiomycetes are also indicated.

NANDRIS D., PELLEGRIN F. & KÖHLER F., 1997. Influence of environment on host-pathogen relationships: coffee pathosystem modeling. P. A. T. P. (Pacific Association of Tropical Phytopathology) Newsletter **15**: 5-7.

NICHOLAS C., 1921. L'essence du niaouli menacée dans sa production en Nouvelle-Calédonie. Bull. Soc. Pathol. Exot. **14**: 396-397.

A saprophytic fungus reported which follows insect damage in *Melaleuca leucodendron*.

NYLANDER W., 1859. *Prodromus expositionis Lichenum Novae Caledoniae*. Ann. Sci. Nat. (Paris), sér. **IV**, Botanique, **12**: 280-284.

A list of lichens collected by Vieillard and Pancher, with several being new taxa.

NYLANDER W., 1861. *Expositio Lichenum Novae Caledoniae*. Ann. Sci. Nat. (Paris), sér. **IV**, Botanique, **15**: 37-54.

Additions to the lichen flora of NC; these bring to 105 the number of recorded taxa.

NYLANDER W., 1867. *Novae explorationes Lichenum Neo-Caledoniae*. Flora **50**: 193-197. Further additions to the lichen flora of NC.

NYLANDER W., 1868. *Synopsis Lichenum Novae Caledoniae*. Bull. Soc. Linn., Normandie, sér. **II**, **2**: 39-140. Seors express. Caen (Blanc. Hardel) 1868.

An updated document on the lichen flora of NC.

O'CONNOR B.A., 1969. Exotic plant pests and diseases. South Pacific Commission, Nouméa, New Caledonia, [Illustrated (some coloured), 244 refs].

A fully illustrated, loose leaf handbook of diseases to be eradicated from, or prevented from spreading, within the area of the South Pacific Commission. The individual diseases (symptoms, spread, damage and control) are described under each crop.

PATOUILLARD N, 1887. Contributions à l'étude des Champignons extraeuropéens. Bull. Trimestriel Soc. Mycol. France **3**: 119-131.

A list of 20 novel taxa including *Hypomyces caledonicus* from NC.

PATOUILLARD N., 1887. Champignons de la Nouvelle-Calédonie (1). Bull. Trimestriel Soc. Mycol. France **3**: 168-178.

A list of 65 taxa identified from material collected by Vieillard, Pancher and Balansa, maintained at the Paris Museum. New taxa reported are: *Bagnisiella palmarum*, *Gibbera pezizoidea*, *Nummularia macrospora* and *Poronia ustorum*; *Hymenochaete perpusilla*, *Lenzites marginata*, *Polyporus mycenoides*, *P. pancheri* and *Polystictus flabelliformis* var. *crenatolobatus*; *Aecidium balansiae* and *Sorosporium caledonicum*.

PATOUILLARD N., 1898. Champignons nouveaux ou peu connus. Bull. Trimestriel Soc. Mycol. France **14**: 149-156.

A list of ten new taxa including *Polyporus spermatolepidis* from NC.

PATOUILLARD N., 1901. Quelques Champignons des colonies françaises. Agric. Prat. Pays Chauds **1** (2): 262-265.

A list of over 30 taxa from NC. New species proposed: *Hexagonia casuarinae*, *Lentinus eradicatus*, *L. radicosus* and *Xanthochrous niaouli*.

PATOUILLARD N., 1902. Descriptions de quelques champignons extraeuropéens. Bull. Trimestriel Soc. Mycol. France **18**: 299-330.

Protologues of 12 taxa with *Hexagonia amplexens* and *Xylaria hemiglossa* collected from NC.

PATOUILLARD N., 1902. Quelques Champignons des Colonies Françaises. Agric. Prat. Pays Chauds **1** (6): 766-767.

The paper contains a list of 12 taxa from the former French Congo and a second list of 20 taxa from NC, including the new *Hexagonia tenuis* forma *nana*.

PATOUILLARD N., 1905. Champignons de la Nouvelle-Calédonie receuillis par M. Le Rat. Agric. Prat. Pays Chauds **5** (2): 522-526.

A list of 30 taxa including the new *Hypoxylon haematostroma* var. *lerati*, *Androsaceus umbrinus*, *Daedalea hydnopora*, *Ungulina lerati* and *U. polychroa*.

PATOUILLARD N., 1906. Un *Mitremyces* de la Nouvelle-Calédonie. In Lloyd, Mycol. Not. **22**: 273-274.

Protologue of *Mitremyces leratii*.

PATOUILLARD N., 1907. *Le Ratia*, nouveau genre de la série des Cauloglossum. Bull. Trimestriel Soc. Mycol. France **23**: 50-52.

Leratia similis gen. nov. & sp. nov. Dedicated to the collector A.J. Le Rat.

PATOUILLARD N., 1908. Champignons nouveaux ou peu connus (3). Bull. Trimestriel Soc. Mycol. France **24**: 1-12.

Treats 21 species from various geographic origins. New taxa from NC are: *Hydnum crocidens* var. *subexcentricum*, *Merulius chlorinus* and *Mycena chlorocephala*.

PATOUILLARD N., 1908. Champignons de la Nouvelle-Calédonie (suite). (2). Bull. Trimestriel Soc. Mycol. France **24**: 165-168.

Three new taxa are proposed: *Crinipellis elatus*, *Spongipellis stramineus* and *Stereum campaniforme*.

PATOUILLARD N., 1909. Champignons de la Nouvelle-Calédonie (suite). (3). IV. Le genre *Trichoglossum* Boud. V. *Le Ratia smaragdina*. Bull. Trimestriel Soc. Mycol. France **25**: 129-134.

Protologues of *Trichoglossum gracile* and *Leratia smaragdina*.

PATOUILLARD N., 1910. Champignons de la Nouvelle-Calédonie (suite). (4). VI. Le genre *Gallacea* Lloyd. Bull. Trimestriel Soc. Mycol. France **27**: 34-38.

Gallacea avellanea sp. nov. The relevant publication year was erroneously given as 1911 by Horak & Mouchacca (1998).

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PATOUILLARD N., 1915. Champignons de la Nouvelle-Calédonie (suite). (6). Bull. Trimestriel Soc. Mycol. France **31**: 31-35. VIII. *Cyphella crateriformis* sp. nov. IX. *Pleurotus stella* sp. nov. X. *Hysterangium neocaledonicum* sp. nov. XI. *Sarcosoma leratii* sp. nov. XII. *Nummularia fuscodisca* sp. nov.

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PEYROT G., 1910. Note sur les maladies du caféier à Vaté. Revue Agricole de la Chambre d'Agriculture de la Nouvelle-Calédonie, décembre 1910, pp. 25-29.

Report on the development of coffee diseases in this part of NC.

RISBEC J., 1930. Le café en Nouvelle-Calédonie. Agron. Colon. **19**: 97-104.

First part of a review on the history, development and diseases of economic importance on coffee trees in NC. The author was then in the position of 'Head of the Permanent Commission of Biological Studies' in NC.

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Reports on observations made in NC coffee plantations during the 1932 year.

RISBEC J., 1936. Les parasites du caféier en Nouvelle-Calédonie. Agron. Colon. **25**: 105-123.

Details about the pathology of the most serious pathogens of Robusta coffee trees: *Heimileia vastatrix* and *Stilbum nanum*.

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A trial to define the relation between rust attack and cultural methods.

SINGER R., 1942. A monographic study of the genera *Crinipellis* and *Chaetocalathus*. Lilloa Rev. Bot. Tucumano **8**: 441-534.
An exhaustive critical survey of the genus *Crinipellis* regarded by plant pathologists as the most important agaric infectious genus. Protologues of several new taxa include *Crinipellis carecomoeis* var. *subelata* and *C. mirabilis* from NC.

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A list of lichen taxa including some new species.

SMITH G., 1965. Three new species of *Penicillium*, *P. asperisporium* nom. nov. and *P. lapidosum* Raper & Fennell emend. Trans. Brit. Mycol. Soc. **48**: 273-277.
The description of the new *Penicillium novae-caledoniae* is based on a soil-borne strain provided by B. Huguenin; later reduced to synonymy under *P. canescens*.

SPOONER B.N., 1985. A new *Didymophaeria* (Pleosporales) from ascocarps of *Corynelia uberata*. Trans. Brit. Mycol. Soc. **85**: 545-547.
Protologue of *Didymosphaeria corynelia*.

UDAGAWA S.-I., UCHIYAMA S. & KAMIYA S., 1994. Two new pyrenomycetous Ascomycetes from New Caledonia. Mycoscience **35**: 319-325.
Protologues of *Anthostomella pacifica* and *Chaetomium nova-caledonicum*.

UDAGAWA S.-I., UCHIYAMA S. & KAMIYA S., 1994. A second species of *Ascotricha* with non-ostiolate ascomata. Mycotaxon **52**: 215-220.
Description of the new *Ascotricha novae-caledoniae*.

VIEILLARD E., 1862. Plantes utiles de la Nouvelle-Calédonie. Ann. Sci. Nat., Paris, sér. **IV**, Botanique, **16**: 228-276.
Indicates the names of two edible fungi (a *Hydnum* close to *H. caput-medusae* Fr. and *Agaricus edulis* Bull. ?) consumed at that time by the natives and European peoples.

VOUAUX Léon (l'abbé), 1910. Description de quelques espèces de Champignons. Bull. Trimestriel Soc. Mycol. France **26**: 153-157.
Protologues of 8 ascomycetes; *Diatrypella fourcroyae*, *Nummularia oospora*, *Phragmonaevia lignicola*, *Gloniella insularis* and *Gloniopsis xylogramma* are from NC.

WAKEFIELD E. M., 1920. Fungi of New Caledonia and the Loyalty Islands. In 'F. Sarasin & J. Roux. Recherche Scientifique Nouvelle Calédonie et aux Iles Loyalty'. B: Botanique, Berlin, vol. **1** (2): 89-108.
A list of almost 100 taxa of ascomycetes and basidiomycetes with an additionnal set of ten lichens. The former comprises the ten new species earlier reported by Wakefield *et al.* (1916).

WAKEFIELD E. M., 1922. Fungi (on New Caledonia). In 'Pendle A.B., Baker E.G. & Muare S.G.M. A systematic account of the plants collected in New Caledonia and Isle of Pines by Professor R.H. Compton'. Manuscript Admitted in 1914; Part 3: Cryptogams (Hepaticae-Fungi). J. Linn. Soc., Bot. **46**: 8-93.
Provides a list of 33 taxa with nine being new records for NC while two others represent new taxa: *Encoelia neocaledonica* and *Clavaria flabellata*.

WAKEFIELD E.M., MASSEE G. & COTTON A.D., 1916. Neucaledonische Pilze. Vierteljahrsschrift der Naturfrschenden Gesellschaft in Zürich **61**: 628-631 (manuscript submitted in April 1914).
A list of ten new species based on material collected by F. Sarasin and J. Roux in NC and the Loyalty Islands: *Nectria nigro-ostiolata*, *Xylaria hirtella*, *Amanita pumila*, *Clavaria sarasini*, *Dacryomitra tenuis*, *Lachnocladium neglectum*, *Leratia coccinea*, *Marasmius sulcatus* and *Stereum* (*Lloydiella*) *umbrinoalutaceum*.

ZANG M.U., 1995. A new species of the genus *Gastroboletus* from New Caledonia. Mycotaxon **54**: 408-412.
Protologue of *Gastroboletus doii*.

DISCUSSION

The first report on fungi of New Caledonia is by Léveillé (1845). He described *Depazea celastrina* based on a specimen collected by L.A. Deschamps and J. La Billardière during the first French expedition to the island led by d'Entrecasteaux in 1793. The establishment of a European settlement in 1853 triggered a serious interest in the mycobiota of this tropical territory. This is evidenced by the number of documents that were published on this group of microorganisms. This interest persisted until the advent of the first World War. A major characteristic of the early papers is their authorship by overseas mycologists in European centres.

Significant contributions of the early pioneer years are those of Nylander (1859-1868) and Müller (1884-1887) on lichens of New Caledonia. Basidiomycetes, and to a less extent Ascomycetes (and deuteromycetes), were reported in a notable series of papers appearing over a period of thirty years. These major documents are principally due to Patouillard (1887-1915). By comparison, papers by resident contributors are few and of little substance. They merely report information linked to edible mushrooms (Vieillard, 1862) or relate to the outbreak of *Hemileia vastatrix* (coffee rust) in parts of New Caledonia (Blandeau, 1911; Fraysse, 1911; Peyrot, 1910).

Studies achieved before World War I were based on material present in the Paris Museum and collected earlier by E. Vieillard and E. Déplanche, or later on by I. Pancher and B. Balansa. Besides these specimens, additional material was regularly sent by resident collectors such as J. Bérnier and A.J. Le Rat, directly or indirectly to N. Patouillard.

The period between the two World Wars was very unproductive with regard to fungal studies and only four titles appeared during these years. They were authored by non-mycologists such as Nicholas (1921) and Risbec (1930-1936). Indeed, the advent of steamships drastically reduced the frequency of ships anchoring in Nouméa for renewal of supply and this severly affected the overall island activity. Besides, damage in Europe during the war years, relegated to a low priority any interest in far away French territories.

The advent of World War II highlighted the strategic importance of the island in the South Pacific region. This was evidenced by the rapid establishment of a very important allied base in the southern part of New Caledonia. This presence indirectly revived interest in activities involving fungi. Thus in 1949, the new 'Institut Français d'Océanie (IFO)' was created at Nouméa (now Centre IRD-ORSTOM de Nouméa). Establishment of the Institute led to a surge of local scientific studies conducted by resident plant pathologists.

Notable interest in plant pathogenic fungi of New Caledonia started with the arrival of R. Dadant in 1947 (-1953). He was immediately followed by F. Bugnicourt in 1949 (-1961) and later by J. Marty (1956-1961). This expert team endeavoured to prepare a list of plant diseases of economic importance and to recommend appropriate control measures (see Combes, 1952). The result was a series of publications (including several internal technical reports) extending throughout the period from 1949 to 1961.

In 1962, B. Huguenin replaced the former phytopathologists. He rapidly undertook intensive collecting in the area. Titles of Huguenin's series 'Micromycètes du Pacifique Sud' appeared from 1962 to 1969, along with several internal technical reports. Following Huguenin's relocation in Africa, interest in local plant pathology problems stopped for a period of ten years. It resumed with the arrival of F. Köhler and F. Pellegrin and a few other specialists of ORSTOM. From 1981 onwards, papers appeared relating to coffee rust (*Hemileia vastatrix*) and a mycotoxicosis of horses induced by *Fusarium moniliforme* developing on maize grains. This research period has just ended (1999) with the return to France of the resident phytopathologists.

The study of saprobic fungi was the main interest of mycologists visiting the island or receiving material from local correspondents. Among notable post World War II visitors were R. Heim and E. Horak, both of whom were interested in basidiomycete taxa. Heim collected in New Caledonia on two occasions in addition to receiving specimens. In a series of papers from 1951 to 1968, he provided descriptions and protologues of several interesting higher fungi. Horak visited the island several times starting from 1967. Observations resulting from his collections were reported in a series of papers beginning in 1977. This flow of publications is still ongoing.

In line with this activity, Mouchacca (1998) surveyed records of new ascomycetes described from New Caledonia. He also provided some information on hyphomycetes inhabiting forest litter and initiated a survey of this taxonomic group. Some records of hyphomycetes have been also provided by McKenzie since 1991.

Besides these publications a few casual taxonomic papers have been authored by other mycologists, mostly after 1950. Also the concomitant creation with the IFO Centre of the South Pacific Commission in Nouméa enhanced research in various fields of local interest within the widespread islands of the Pacific. This resulted in the production of large documents reporting titles on plant pathology and mycology in the area including New Caledonia (Firman, 1975-1978).

Mycological knowledge of New Caledonia is very poor when compared with the well studied, rich vegetation of this tropical land. The 'Flore de Nouvelle Calédonie' issued by the Laboratoire de Phanérogamie, Muséum National d'Histoire Naturelle, Paris, comprises 22 volumes, appearing since 1961. These documents confirm this tropical island has an extremely diverse and interesting flora with many endemic plants. This high degree of endemism would suggest that interesting plant-fungus associations await to be discovered besides the saprobic tropical fungi.

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NOTES ON KOREAN CERCOSPORAE AND ALLIED GENERA (III)

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The present paper continues the investigations on Korean Cercosporae. Shin and Braun (1993, 1996) listed 77 species of this group of fungi including six new species, one new variety, four new combinations, one new name, and 50 new records for Korea. Thirty species are listed in the present paper, including three new species and two new combinations. The new species *Cercosporella cimicifugae*, *Pseudocercospora cercidis-chinensis*, and *P. lythri* are described and illustrated. Furthermore, *Cercospora pallida* and *C. liriopes* are transferred to *Pseudocercospora* and *Stenellopsis*, respectively. Most species are new to the fungus flora of Korea.

All samples were collected by H.D. Shin in Korea between 1991-1998, and the examinations of the material were carried out in collaboration between the two authors. Most of the common species are not fully described, as they have been dealt with in other important reference books on Cercosporae. All specimens, including type collections, are deposited in the herbarium (SMK) of the Department of Agricultural Biology, Korea University, Seoul, Korea. Duplicates are housed at HAL.

(1) *Cercospora citrullina* Cooke, Grevillea 12: 31 (1883)

On *Cucurbita moschata* Duchesne, Seoul, Korea, 3 X 1997, Shin; on *Luffa cylindrica* (L.) Roem., Suwon, Korea, 23 X 1997, Shin. This fungus is known on *C. moschata* (Park, 1967), but *L. cylindrica* is a new host species for Korea.

(2) *Cercospora coreopsidis* Ray, Mycologia 33: 174 (1941)
On *Coreopsis lanceolata* L., Chunchon, Korea, 19 VIII 1998, Shin. This is the first record of this species from Korea.

(3) *Cercospora flagellaris* Ellis & G. Martin, Amer. Nat. 16: 1003 (1882)
On *Phytolacca esculenta* Van Houtte, Chunchon, Korea, 6 X 1996, Shin. Known from Korea (Kim and Shin, 1999b).

(4) *Cercospora gomphrenae* Ray, Mycologia 36: 172 (1944)
On *Gomphrena globosa* L., Yangku, Korea, 4 X 1998, Shin. This is the first record of this species from Korea.

(5) *Cercospora hydrangeae* Ellis & Everh., J. Mycol. 8: 71 (1902)
On *Hydrangea macrophylla* (Thunb.) Serige (= *H. paniculata* Sieb.), Suwon, Korea, 2 X 1998, Shin; on *H. serrata* var. *acuminata* (Sieb. & Zucc.) Wils., Chunchon, Korea, 9 X 1998, Shin. This is the first record of this species from Korea.

(6) *Cercospora kikuchii* T. Matsumoto & Tomoy., Ann. Phytopath. Soc. Japan 1(6): 1 (1925)
On *Glycine max* (L.) Merr., Chunchon, Korea, 1 X 1998, Shin. Known from Korea (Nakata and Takimoto, 1928; Kim and Shin, 1999a).

(7) *Cercospora mirabilis* Tharp, Mycologia 9: 111 (1917)
On *Mirabilis jalapa* L., Suwon, Korea, 17 X 1997, Shin. This is the first record of this species from Korea.

(8) *Cercospora physalidis* Ellis, Amer. Nat. 16: 810 (1882)
On *Physalis alkekengi* var. *franchetii* (Masters) Hort., Chunchon, Korea, 19 VIII 1998, Shin. This is the first record of this species from Korea.

(9) *Cercospora plantaginis* Sacc., Michelia 1: 267 (1879)
On *Plantago lanceolata* L., Suwon, Korea, 30 X 1996, Shin. This is the first record of this species from Korea.

(10) *Cercospora ricinella* Sacc. & Berl., Atti R. Ist. Ven. Sci. Lett. Arti. VI. 3: 721 (1885)
On *Ricinus communis* L., Chunchon, Korea, 9 X 1998, Shin. Known from Korea (Nakata and Takimoto, 1928).

(11) *Cercospora tabacina* Ellis & Everh., J. Mycol. 4: 6 (1888)
On *Rudbeckia bicolor* Nutt., Suwon, Korea, 17 X 1997, Shin. This is the first record of this species from Korea.

(12) *Cercospora volkameriae* Speg., Rev. Mus. de la Plata 15: 47 (1908)
On *Cleodendron trichotomum* Thunb., Seoul, Korea, 16 IX 1997, Shin. This is the first record of this species from Korea.

(13) ***Cercosporella cimicifugae*** sp. nov. Fig. 1.

Maculae amphigenae, disseminatae vel confluentes, angulares vel irregulares, per venas limitatae, plerumque 3-10 mm latae, vel confluentes et usque 20 mm latae, in epiphyllo in centro griseo-brunneae, in hypophyllo griseo-brunneae vel atrobrunneae. Caespituli hypophylli. Mycelium immersum; hyphae septatae, ramosae, fere incolorae. Stromata nulla vel parva, ex cellulis paucis, inflatis, olivaceis composita. Conidiophora fasciculata (3-10), per stoma emergentia, recta vel subrecta, non geniculata, non ramosa, hyalina vel subhyalina, 0-1(-2)-septata, apicem versus attenuata, 20-50 × 4-6.5 µm. Cicatrices conidiales conspicuae, terminales et laterales, 2-3 µm diam., convexae vel subtruncatae, incrassatae, non vel leniter fuscatae. Conidia solitaria, filiformia vel obclavato-cylindrica, recta vel leniter curvata, hyalina vel subhyalina, guttulata, 1-14-septata, ad septa constricta, 40-180 × 5.5-9.5 µm, apice obtusa vel subobtusa, basi obconico-truncata vel obtusa; hila incrassata, non vel leniter fuscata, 2-3 µm lata.

Leaf spots amphigenous, scattered to confluent, angular to irregular, vein-limited, 3-10 mm diam., or up to 20 mm or more when confluent, centre greyish brown with dark brown margins on the upper surface, greyish brown to deep brown without definite margins on the lower surface. Caespituli hypophyllous. Mycelium internal, hyphae septate, branched, almost colourless. Stromata lacking to small, rudimentary to poorly developed, composed of a few swollen, brown hyphal cells. Conidiophores 3-10 in loose fascicles from stomatal openings, straight to substraight, not geniculate, not branched, hyaline to subhyaline throughout, 0-1(-2)-septate, irregular in width, gently tapered at the upper portion, 20-50 × 4-6.5 µm; conidial scars conspicuous, terminal and lateral, 2-3 µm diam., somewhat protuberant, convex to subtruncate, thickened, not or only slightly darkened, but refractive. Conidia solitary, filiform to obclavate-cylindric, straight to mildly curved, hyaline to subhyaline due to oil drops, guttulate, 1-14-septate, constricted at the septa, variable in length, 40-180 × 5.5-9.5 µm, obtuse to subobtuse at the apex, short obconically truncate to obtuse at the base; hilum thickened, not or only slightly darkened, refractive, slightly protuberant, 2-3 µm wide.

Holotypus: On leaves of *Cimicifuga heracleifolia* Kom. (Ranunculaceae), Kangnung, Korea, 24 IX 1998, Shin (SMK 15224).
Isotypus: HAL.
Note: Two species of cercosporoid fungi have been recorded on *Cimicifuga* spp. *Phaeoramularia actaeae* (Ellis & Holw.) U. Braun (1993) is clearly

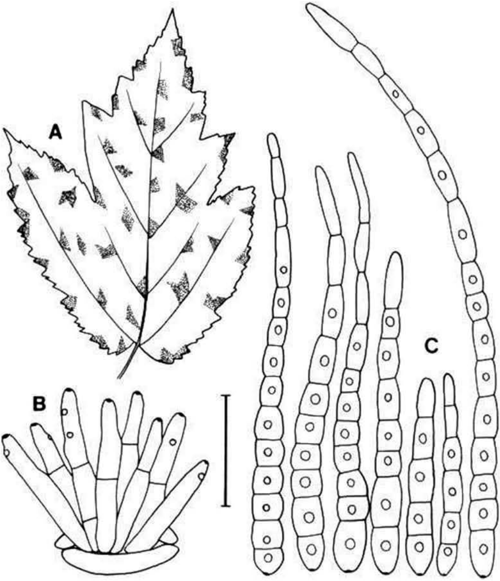

Fig. 1. *Cercosporella cimicifugae* sp. nov.: **A.** Leaf spots on *Cimicifuga heracleifolia*; **B.** Conidiophores; **C.** Conidia. Bar = 30 µm. H.D. Shin del.

different from the present fungus by having pigmented conidiophores and catenate conidia. *Cercospora cimicifugae* Pai & P.K. Chi (1965) is a true member of the genus *Cercospora* s. str., morphologically hardly distinct from *C. apii* s. lat. The present fungus is well-characterized by clourless conidiophores and its guttulate, constricted, large conidia. There is no comparable

Cercosporella species. Therefore, this fungus must be considered as a new, undescribed species.

(14) *Mycovellosiella ariae* (Fuckel) U. Braun, Hedwigia 50: 518 (1990)
On *Sorbus commixta* Hedl., Seoul, Korea, 17 VIII 1998, Shin. This is the first record of this species from Korea.

(15) *Pseudocercospora abelmoschi* (Ellis & Everh.) Deighton, Mycol. Pap. 140: 138 (1976)
On *Hibiscus syriacus* L., Hongchon, Korea, 21 VIII 1998, Shin. This is the first record of this species from Korea.

(16) ***Pseudocercospora cercidis-chinensis*** sp. nov. Fig. 2.

Syn.: *Cercospora cercidis* Nishikado, Nogaku-Kenkyu 36: 411-415 (1944), nom. illeg.; non *C. cercidis* Ray, 1941.
Misapplied names: *Cercospora chionea* sensu Katsuki (1965: 39), Chupp (1954: 293) p. p.; *Pseudocercospora chionea* (Ellis & Everh.) X.J. Liu & Y.L. Guo, Mycosystema 2: 231 (1989)

Maculae amphigenae, disseminatae vel confluentes, subcirculares vel irregulares, 2-10 mm diam., in epiphyllo griseo-brunneae vel atrobrunneae, in hypophyllo griseo-brunneae vel rubro-brunneae. Casepituli amphigeni. Mycelium primarium immersum; hyphae septatae, ramosae, fere hyalinae. Mycelium secundarium externum; hyphae sepatae, ramosae, olivaceo-brunneae. Stromata magna, bene evoluta, globosa, erumpentes, olivaceo-brunnea vel brunnea, 20-50 µm diam. Conidiophora usque 20 in fasciculo denso, leniter divergentia, substomatalia, recta vel subrecta, non geniculata, non ramosa, pallide olivaceo-brunnea, 0-1-septata, 10-40 × 3-5.5 µm. Cicatrices conidiales inconspicuae. Conidia solitaria, filiformia vel obclavato-cylindrica, recta vel leniter curvata, pallidissime olivacea vel subhyalina, guttulata, 3-7-septata, ad septa non constricta, 40-85 × 2.5-4 µm, apice obtusa vel subobtusa, basi obconica vel truncata; hila inconspicua.

Leaf spots amphigenous, scattered to confluent, subcircular to irregular, 2-10 mm diam., greyish brown to dark brown with blackish brown margins on the upper surface, greyish brown to dull reddish brown without definite margins on the lower surface. Caespituli amphigenous. Primary mycelium internal, hyphae septate, branched, almost colourless. Secondary mycelium external, hyphae septate, branched, olivaceous brown. Stromata large, well-developed, globular, erumpent, olivaceous brown to brown, 20-50 µm diam. Conidiophores up to 20 in very dense fascicles, emerging through stomatal openings, slightly divergent, straight to substraight, not geniculate, not branched, pale olivaceous brown, 0-1-septate, irregular in width, 10-40 × 3-

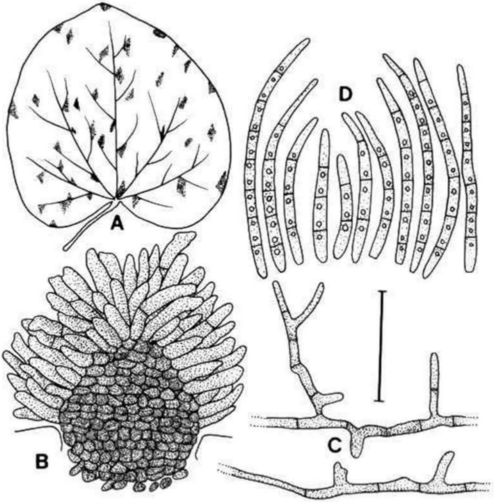

Fig. 2. *Pseudocercospora cercidis-chinensis* sp. nov.: **A.** Leaf spots on *Cercis chinensis*; **B.** Conidiophores; **C.** Conidia. Bar = 30 µm. H.D. Shin del.

5.5 µm; conidial scars inconspicuous. Conidia solitary, filiform to obclavate-cylindric, straight to mildly curved, very pale olivaceous to subhyaline, guttulate, 3-7-septate, not constricted at the septa, 40-85 × 2.5-4 µm, obtuse to subobtuse at the apex, obconic to truncate at the base; hilum unthickened, not darkened.

Holotypus: On leaves of *Cercis chinensis* Bunge (Leguminosae), Kyongju, Korea, 26 VIII 1998, Shin. (SMK 14924).
Isotypus: HAL.

Note: Chupp (1954) placed collections of cercosporoid hyphomycetes on *Cercis chinensis* from Asia in *Cercospora chionea* Ellis & Everh. Katsuki (1965) and Guo and Hsieh (1995) followed Chupp's treatment. Guo and Liu (1989) reallocated *C. chionea* to *Pseudocercospora*. The cercosporoid fungus on *C. chinensis*, which is widespread in China and Japan, is, indeed, a member of *Pseudocercospora*, but not conspecific with *C. chionea*. Braun (1993b) re-examined type material and various other North American collections on *Cercis canadensis*. Based on the conspicuous conidial scars observed on the fungus occurring on these specimens, a new combination in *Passalora* as *P. chionea* was introduced. Since there is no valid name for the *Pseudocercospora* species occurring on *C. chinensis*, it is necessary to introduce a new name.

(17) *Pseudocercospora clematidis* Goh & W.H. Hsieh, Trans. Mycol. Soc. R.O.C. 4: 6 (1989)

On *Clematis apiifolia* A.P. DC., Kangnung, Korea, 24 IX 1998, Shin. This is the first record of this species from Korea.

(18) *Pseudocercospora contraria* (Syd. & P. Syd) Deighton, Mycol. Papers 140: 30 (1976)

On *Dioscorea quinqueloba* Thunb., Kimhae, Korea, 6 X 1998, Shin. This is the first record of this species from Korea.

(19) *Pseudocercospora cotoneasteri* (Katsuki & Kobayashi) Deighton, Trans. Brit. Mycol. Soc. 88: 389 (1987)

On *Cotoneaster integerrima* Medicus, Jinju, Korea, 18 IX 1998, Shin. This is the first record of this species from Korea.

(20) *Pseudocercospora cruenta* (Sacc.) Deighton, Mycol. Pap. 140: 142 (1976)

On *Vigna sinensis* King, Seoul, Korea, 13 IX 1998, Shin. Known from Korea (Park, 1967).

(21) *Pseudocercospora lythracearum* (Heald & F.A. Wolf) X.J. Liu & Y.L. Guo, Acta Mycol. Sin. 11: 294 (1992)

On *Lagerstroemia indica* L., Jinju, Korea, 18 IX 1998, Shin. This is the first record of this species from Korea.

(22) ***Pseudocercospora lythri*** sp. nov. Fig. 3.

Maculae amphigenae, disseminatae vel confluentes, plerumque per venas limitatae, 2-5 mm diam., interdum usque 10 mm latae, brunneae vel rubrobrunneae, margine indistincto. Caespituli amphigeni. Mycelium primarium immersum; hyphae septatae, ramosae. Mycelium secundarium externum, amphigenum; hyphae exigue ramosae, subhyalinae vel pallide olivaceae, leves, septatae, 1.5-4 µm latae. Stromata minuta vel magna, bene evoluta, subglobosa, 15-45 µm diam., brunnea vel atrobrunnea, ex cellulis olivaceis, inflatis composita. Conidiophora fasciculata (3-30), subrecta vel geniculato-sinuosa, non ramosa, olivaceo-brunnea, basim versus pallidiora, 0-3-septata, (10-)20-90 × 2.5-4(-5.5) µm; cicatrices conidiales inconspicuae; cellulae conidiogenae integratae, terminales, 10-30 µm longae; conidiophora secundaria solitaria, lateralia, erecta. Conidia solitaria, obclavato-subcylindrica, subrecta vel leniter curvata, pallide olivaceo-brunnea vel subhyalina, 1-13-septata, ad septa leniter constricta, 20-110 × 3-5 µm, apice obtusa vel subobtusa, basi obconico-truncata vel subtruncata; hila non incrassata, non fuscata, 1-2 µm lata.

Leaf spots amphigenous, scattered to confluent, angular to irregular, usually vein-limited, 2-5 mm diam., sometimes up to 10 mm or more, brown to reddish brown without definite margins. Caespituli amphigenous. Primary mycelium internal, hyphae septate, branched. Secondary mycelium external, amphigenous; hyphae creeping, sparingly branched, subhyaline to pale olivaceous, smooth, septate, 1.5-4 µm wide. Stromata small to large, well-developed, subglobular, 15-45 µm diam., brown to deep brown, composed of olivaceous, swollen hyphal cells. Conidiophores 3-30 in loose to dense fascicles, substraight to geniculate-sinuous, not branched, olivaceous brown at the base and paler upwards, 0-3-septate, (10-)20-90 × 2.5-4(-5.5) µm; conidial scars inconspicuous; conidiogenous cells integrated, terminal, 10-30 µm long; secondary conidiophores solitary, arising from creeping hyphae, lateral, erect. Conidia solitary, obclavate-subcylindric, substraight to mildly curved, pale olivaceous brown to subhyaline, 1-13-septate, slightly constricted at the septa, variable in length, 20-110 × 3-5 µm, obtuse to subobtuse at the apex, obconically truncate to subtruncate at the base; hilum unthickened, not darkened, 1-2 µm wide.

Holotypus: On leaves of *Lythrum anceps* (Köhne) Makino (Lythraceae), Chunchon, Korea, 21 IX 1991, Shin (SMK 11109).

Isotypus: HAL.

Additional specimens preserved: SMK 11882 (19 VIII 1992, Suwon), 12975 (12 IX1994, Suwon), 15283 (1 X 1998, Suwon).

Note: *Stenella lythri* (Westend.) Mulder is the only cercosporoid species recorded on *Lythrum* spp. Several other species recorded on Lythraceae are listed in Chupp's (1954) monograph, but the present fungus is not closely related to them. It is, however, allied to *Pseudocercospora lagerstroemiigena* Goh & W.H. Hsieh (Hsieh and Goh, 1990), but differs in having wider conidia.

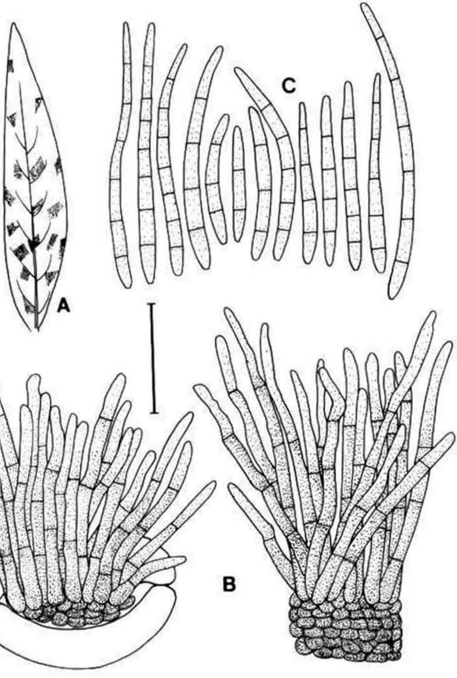

Fig. 3. *Pseudocercospora lythri* sp. nov.: **A.** Leaf spots on *Lythrum anceps*; **B.** Conidiophores; **C.** Conidia. Bar = 30 µm. H.D. Shin del.

(23) ***Pseudocercospora pallida*** (Ellis & Everh.) comb. nov. Fig. 4.

Bas.: *Cercospora pallida* Ellis & Everh., J. Mycol. 3: 21 (1887), non *C. pallida* (Berk. & M.A. Curtis) Cooke, 1888.
≡ *Cercospora langloisii* Sacc., Syll. Fung. 10: 647 (1892)
= *C. duplicata* Ellis & Everh., J. Mycol. 5: 70 (1889)
= *C. capreolata* Ellis & Everh., J. Mycol. 8: 70 (1902)

Leaf spots amphigenous, scattered to confluent, distinct, circular to angular, 1-6 mm diam., occasionally confluent and larger, at first greyish brown to brown with indistinct margins, later centre appearing greyish white with indistinct border lines. Caespituli epiphyllous. Mycelium internal, hyphae septate, branched, hyaline. Stromata small to medium, globular to subglobular, 16-35 μm diam., brown to dark brown, composed of several brown hyphal cells. Conidiophores usually reduced to conidiogenous cells, 10-35(-50) in very dense fascicles, erumpent through the cuticle, straight to substraight, not geniculate, not branched, olivaceous brown to pale brown, aseptate, 12-26 × 2.5-4 μm; conidial scars inconspicuous. Conidia solitary, filiform-cylindric, narrowly obclavate-subcylindric in shorter ones, straight to mildly curved, subhyaline to very pale olivaceous, guttulate, 2-11-septate, not constricted at the septa, variable in length, 20-105 × 2-4 μm, subacute to subobtuse at the apex, obconically truncate at the base; hilum unthickened, not darkened, 1 μm wide.

On leaves of *Campsis grandiflora* K. Schum. (Bignoniaceae), SMK 15005 (4 IX 1998, Seoul), 15122 (18 IX 1998, Jinju), 15295 (1 X 1998, Suwon), 15411 (8 X 1998, Suwon), and 15633 (3 XI 1998, Seoul).

Note: The present material agrees perfectly with Chupp's (1954) description of this species. He mentioned that the conidial scars are inconspicuous, which could be confirmed in the course of the present study. Hence, *C. pallida* has to be allocated to *Pseudocercospora*. Chupp (l.c.) used the name *C. duplicata* for this species, but *C. pallida* Ellis & Everh. is the correct name. The combination *C. pallida* (Berk. & M.A. Curtis) Cooke was introduced in 1888, so that this name has to be considered as an illegitimate homonym.

(24) *Pseudocercospora rubi* (Sacc.) Deighton, Mycol. Papers 140:152 (1976)
On *Rubus coreanus* Miq., Jinju, Korea, 19 IX 1998, Shin.

Note: Shin and Braun (1996) treated a Korean collection on *Rubus oldhamii* as var. *subhyalina* because of its subhyaline conidiophores and conidia. The present material is rather close to var. *rubi*: Fructifications usually epiphyllous; conidiophores longer (13-50 μm) and pale olivaceous brown; conidia obconically truncate at the base and obtuse to subacute at the apex. Therefore, this collection is somewhat intermediate between the two varieties. *R. coreanus* was recorded as a host plant for this species from Korea (Kim and Shin, 1999a).

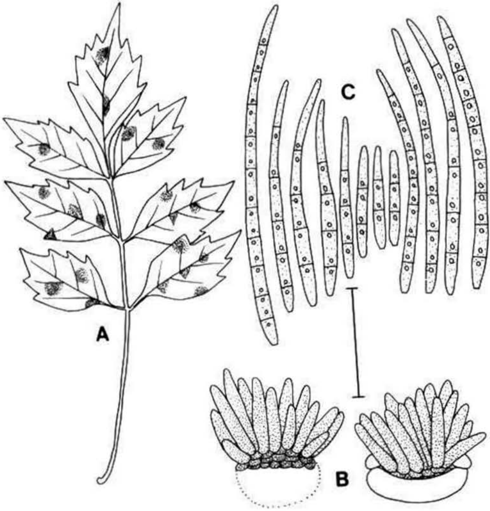

Fig. 4. *Pseudocercospora pallida* comb. nov.: **A.** Leaf spots on *Campsis grandiflora*; **B.** Conidiophores; **C.** Conidia. Bar = 30 ㎛. H.D. Shin del.

(25) *Pseudocercospora salicina* (Ellis & Everh.) Deighton, Mycol. Papers 140: 96 (1976)

On *Salix* sp., Kangnung, Korea, 9 X 1996, Shin. Known from Korea (Kim and Shin, 1999b).

(26) *Pseudocercospora varia* (Peck) J.K. Bai & M.Y. Cheng, Acta Mycol. Sin. 11: 123 (1992)

On *Viburnum sargentii* Köhne, Pyongchang, Korea, 25 VIII 1998, Shin. This is the first record of this species from Korea.

(27) *Pseudocercospora zelkowae* (Hori) X.J. Liu & Y.L. Guo, Acta Mycol. Sin. 12: 33 (1993)

On *Zelkowa serrata* Makino, Seoul, Korea, 4 IX 1998, Shin. (Anonymous, 1940; Kim and Shin, 1999a).

(28) *Ramularia grevilleana* (Tul. & C. Tul) Jørst. var. *grevilleana*, Meld. Stat. Plantenpatol. Inst. 1: 17 (1945) emend. U. Braun

On *Fragaria ananassa* (L.) Duchesne, Yangku, Korea, 7 VI 1998, Shin. Known from Korea (Park, 1967).

(29) *Ramularia wisconsina* H.C. Greene, Amer. Midland Nat. 44: 641 (1950)

On *Erechtites hieracifolia* (L.) Raf., Seoul, Korea, 30 VII 1998, Shin. This is the first record of this species from Korea.

(30) ***Stenellopsis liriopes*** (F.L. Tai) comb. nov. Fig. 5.

Bas.: *Cercospora liriopes* F.L. Tai, Sci. Repts. Natl. Tsing Hua Univ. B. 2: 431, 1937.

Leaf spots amphigenous, scattered, circular, 1-5 mm diam., centre appearing tan to dingy grey with reddish brown raised margins, sometimes with blackish dots in the centre of the upper surface when viewed by means of a hand lens. Caespituli amphigenous, punctiform, blackish. Mycelium internal, hyphae septate, branched, hyaline, 2-4 µm wide. Stromata large, well-developed, globular, 25-70 µm diam., dark brown to blackish brown, composed of several swollen hyphal cells. Conidiophores (5-)10-40 in loose to dense fascicles, arising from stomata and erumpent through the cuticle, substraight to curved, sometime sinuous, not geniculate, not branched, olivaceous brown throughout, 0-2-septate, smooth or almost so, variable in length, 5-40 × 2-4 µm; conidiogenous cells integrated, terminal or conidiophores reduced to conidiogenous cells; conidial scars visible, truncate, 1-2 µm diam., unthickened to slightly thickened, somewhat darkened, refractive. Conidia solitary, subcylindric-obclavate, mildly curved to straight, subhyaline, verruculose, not constricted at the septa, (0-)2-6-septate, (10-)20-100 × 2.5-3.5 µm, obtuse at the apex, obconically truncate to subtruncate at the base; hilum unthickened, not darkened, 1-2 µm wide.

On leaves of *Liriope platyphylla* Wang & Tang (Liliaceae s. lat. [Convallariaceae]). SMK 14852 (21 VIII 1998, Chunchon), 15279 (1 X 1998, Seoul).

Note: The morphological features of this collection agree well with those given in the description of *Cercospora liriopes* F.L. Tai, but the latter species is not congeneric with *Cercospora* s. str. The conidia are conspicuously verruculose and the conidial scars are truncate, unthickened to slightly

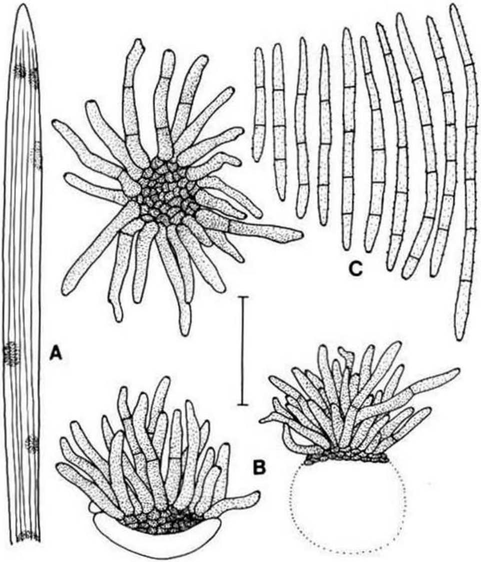

Fig. 5. *Stenellopsis liriopes* comb. nov.: **A.** Leaf spots on *Liriope platyphylla*; **B.** Conidiophores; **C.** Conidia. Bar = 30 µm. H.D. Shin del.

thickened, somewhat darkened, refractive. This species is *Stenella*-like, but without secondary mycelium. These features agree well with *Stenellopsis*, so that this species is transferred to the latter genus.

ACKNOWLEDGEMENTS

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STUDIES IN NEOTROPICAL POLYPORES 5
NEW AND NOTEWORTHY SPECIES FROM PUERTO RICO AND VIRGIN ISLANDS

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ABSTRACT

17 polypores new to Puerto Rico are reported. *Diplomitoporus incisus* Ryvarden, *Tyromyces limitatus* Ryvarden and *Tyromyces nodulosus* Ryvarden are described as new. The combination *Diplomitoporus hondurensis* (Murrill) Ryvarden is proposed. The second known collection of *Hymenochaete raunkiaeri* Bres. is reported from the type locality on St. John, US Virgin Islands.

Key words: Polyporaceae, Puerto Rico, Virgin Islands.

Introduction

The fungi of Puerto Rico and the Virgin Islands are better known than for almost any neotropical area thanks to Stevenson's comprehensive checklist (Stevenson 1975). Nevertheless, the recent intensive collecting under the Basidiomycetes of the Greater Antilles project has revealed many species hitherto not known from the island. These are reported below and specimens of all species are deposited in the herbarium UPRRP, CFMR besides duplicates in O, except for *H. raunkiaeri* from St. Johns which is deposited at NY.

CORTICIACEAE

Climacodon pulcherrimus (Berk. & W. A. Curtis) Nikolajeva
Luiza Pinones, at base of Cocalaba, 19. Nov. 1996, leg. E. Horak.
This is a beautiful white, pileate, strongly hydnoid species of uncertain taxonomic affinity, and its place in Corticiaceae is preliminary. In the field it is easily taken as a hydnoid representative of Hericiaceae. However, all species in this family have amyloid basidiospores. The species was originally described from North Carolina, United States, and is widespread in the subtropical and warm temperate zone.

GANODERMATACEAE

Amauroderma schomburgkii (Mont. & Berk.) Torrend
Luquillo Mts. Rio Grande, Palo Huaco, trail to El Cacique, 21. July 1999, S. A. Cantrell 9928, PR 5517.
This is a widespread and rather common species in South America, but known north to Cuba (Furtado 1981).

Ganoderma perzonatum Murrill
Cayey municipality, Carite Commonwealth Forest, 23. June 1996, Ryvarden 39013.
The species was originally described from Cuba and has not been reported since. This is not surprising since the taxonomy of the laccate species of *Ganoderma* has been in a chaotic state due to a proliferation of names (about 260 currently - see Moncalvo & Ryvarden 1998) and a complete lack of manuals with trustworthy characters.
Macroscopically this species is similar to *G. resinaceum* Boudier, a common species in the neotropics, but is separated by smaller basidiospores and finely encrusted apical cells in the cuticle.

HYMENOCHAETACEAE

Hymenochaete raunkiaeri Bres.
Virgin Island, St. John, Cinnamon Bay, 25. May 1994, D.J. Lodge St. J. no 129, NY.
The species was described from St. John in 1920 (Leger 1998), but has apparently not been reported since. It is recognized by a pale reddish brown, strongly resupinate and adnate basidiocarp and oblong, small and ellipsoid basidiospores.

Inonotus splitbergeri (Mont.) Ryvarden
Luquillo Mts., El Verde, 27. August 1993, Boyd & Lodge PR 1235.1. Same locality, trail to Rio Sonadora, 24. Aug. 1993, M. Boyd & S. A. Cantrell CFMR-PR 1235.
This is a neotropical species which, to my knowledge, has not been reported from the Greater Antilles before, and the island of Puerto Rico seems to be its northernmost locality. The species is fairly common in the Amazonian basin and was described originally from Surinam.

POLYPORACEAE

Antrodiella liebmannii (Fr.) Ryvarden
Rio Grande, Big Tree Trail, 18. June 1996, Ryvarden 38930. Luquillo

Mts., Bisley Watershed, 6. June 1997, Ryvarden 40284, Guajataca, road near Magote Cerro Alto, Isabella, 27. June 1996, Ryvarden 39133.
A widespread pantropical species.

Antrodiella hydrophila (Berk.) Ryvarden
Luquillo Mts., El Verde Res. Area, above Control Center, 27. Aug. 1993, D. J. Lodge & M. Boyd, PR 1248; Toro Negro Comm. Forest, Cordillera Central, 24. June 1996, Ryvarden 39038; Guajataca, road near Magote Cerro Alto, Isabella 27. June 1996, Ryvarden 39102; Sabana Field Research Station, 22. November 1997, N. W. Legon PR 220.
A neotropical and fairly common species in the Caribbean, originally described from Cuba.

Antrodiella reflexa Lindblad & Ryvarden
Luquillo Mts., Bisley Watershed, 6. June 1997, Ryvarden 40320.
The species was recently described from Costa Rica (Lindblad & Ryvarden 1999) and is recognized by its pileate basidiocarps and tiny basidiospores, far smaller than for any other pileate *Antrodiella* species known from the neotropics.

Ceriporiopsis balanae Niemelä
Maricao Commonwealth Forest, 25. June 1996, Ryvarden 39076, Luquillo Mts., El Verde Station, 19. June 1996, Ryvarden 38966 and Luquillo, Bisley Watershed, 6. June 1997, Ryvarden 40288.
The species was originally described from Northern Canada (Niemelä 1985) and its was surprising to find it in a tropical environment like that of Puerto Rico. However, the collections have been compared with authentic material and their identities have also been confirmed by T. Niemelä. It is obvious that the species is hidden in some herbaria on the American mainland, either under "*Poria*" or is misfiled under different names. The white resupinate polypores are often notoriously difficult to determine.

Diplomitoporus hondurensis (Murrill) Ryvarden comb. nov.
Basionym: *Poria hondurensis* Murrill, Mycologia 12:303, 1920.
Luquillo Mts., Caribbean National Forest, Angelito trail, 8. June 1998, Ryvarden 40817.
Basidiocarps resupinate, up to 2 mm thick, adnate, brittle when dry, margin narrow, white to cream, pore surface white, pores angular, in

parts irregular and slightly incised, 2-4 per mm, in parts with hyphal pegs, some as hydnoid protuberances, others as an initial development of partition walls, tube layer concolorous with pores, up to 2 mm thick, subiculum very thin and white.

Hyphal system dimitic, generative hyphae hyaline, with clamps, 2-3 µm wide, skeletal hyphae predominant, solid to thick-walled, hyaline, negative in Melzer's reagent, 2-3 µm in diam. often mixed with coarse crystalline matter.

Cystidia and other sterile hymenial elements absent.

Dendrohyphidia present, both along the dissepiments where they are abundant and prominent, and among the basidia where they are smaller and with less apical protuberances.

Basidia 10-15 x 5-6 µm with basal clamps and 4 sterigmata, also observed with 2 sterigmata in the type.

Basidiospores oblong ellipsoid to cylindrical, thin-walled, negative in Melzer's reagent, 5-8 x 3-3.5 µm.

Type of rot. White rot.

Substrate. On dead hardwoods.

Distribution. Puerto Rico and Honduras (type locality), but certainly has a wider distribution in the Caribbean.

Remarks. The species is microscopically separated by the dendrohyphidia and larger basidiospores from the following species, *D. incisa*, which is macroscopically rather similar except that its pores are more irregularly incised.

The genus *Grammothele* is characterized by dendrohyphidia in both the hymenium and along the dissepiments. However, the genus is typified by *G. lineata* Berk. & Curtis, a rather distinct species having a deeply split hymenophore which is semiporoid to semihydnoid and dotted with numerous, strongly dextrinoid hyphal pegs that are initially hyaline, later becoming almost blackish, and then the basidiocarp looking almost like an old polypore attacked by a small pyrenomycete. Thus, it felt more natural to place *Poria hondurensis* in *Diplomitoporus* where the skeletal hyphae are non-dextrinoid and evenly distributed in the basidiocarp in all known species.

For the time being it is difficult to decide whether the dendrohyphidia should be given more taxonomic weight than other characters, but as the they are known from numerous corticoid and poroid genera, it seems reasonable to look upon them as secondary characters.

Diplomitoporus incisus Ryvarden nova sp.

Fructificatio resupinata, pori albidis, angulatis 1-3 per mm, tubi et contextibus albidis, systema hyphale dimiticum, hyphae generatoriae hyalinae, fibulatae, hyphae skeletales hyalinae, basidiosporae ellipsoideae, 5.5-6.5 (7) x 2.5-3 µm.

Holotype: Puerto Rico, Caribbean National Forest, El Verde Field Station, 19. June 1996, on dead hardwood tree, Ryvarden 38952 CFMR-PR-5471 and isotypes in UPRRP and O.

Etymology: incisus = deeply cut, referring to the incised pores.

Basidiocarps resupinate, up to 3 mm thick, adnate, brittle to tough when dry, margin narrow, white to cream, pore surface white to cream, pores irregular, sinuous, split and incised, 1-3 per mm, in some parts slightly more regular and 3-4 per mm, tube layer concolorous with pores, up to 4 mm thick, subiculum thin and white.

Hyphal system dimitic, generative hyphae hyaline, with clamps, 2-3 µm wide, skeletal hyphae predominant, solid to thick-walled, hyaline, negative in Melzer's reagent, 3-6 µm in diam.

Cystidia and other sterile hymenial elements absent.

Basidia 12-18 x 5-6 µm with basal clamps and 4 sterigmata.

Basidiospores oblong ellipsoid, hyaline, smooth, negative in Melzer's reagent, 5.5-6.5 (-7) x 2.5-3 µm.

Type of rot. White rot.

Substrate. On dead hardwoods.

Distribution. Besides the type locality also known from French Guiana (see below).

Remarks. The species is recognized by its white basidiocarp, the irregular split pores and the oblong basidiospores. *Diplomitoporus overholtsii* (Pil.) Gilb. & Ryvarden which is also known from Central America, has wider basidiospores, viz. 5.5-7 x 3.5-5 µm and more regular round pores. *Diplomitoporus dilutabilis* Loguercio-Leite & Wright recently described from Brazil (Loguercio-Leite & J.Wright 1998) has a trimitic hyphal system and allantoid basidiospores, thus different from the new species described here. *Diplomitoporus costaricensis* Lindblad & Ryvarden has much smaller pores, viz. 6-7 per mm and shorter basidiospores, viz. 4-4.5 x 2-2.5 µm. See comments under *D. honduerensis* above for differences with that species.

Besides these species, no other species of the genus have been reported from the neotropics although a small number of tentatively new species in the genus are under consideration.

Additional specimens examined. Puerto Rico The type locality, 27. August 1993, D. J. Lodge & M. Boyd, PR 1254, same locality 22 March 1994, H. H. Burdsall & D. J. Lodge, CFMR-PR 1467 (with culture), Chicken Farm, Sabana, 4. December 1997, N. W Legon PR 339, **French Guiana**: Upper Marouini River, 5 km WSW of Monpe Soula, August 1987, G. Samuels et al. 6170 (O, NY).

Hapalopilus albocitrinus (Petch) Ryvarden
Toro Negro Commonwealth Forest, 24. June 1996, Ryvarden 39044.
The deep yellow surface becoming reddish when dry makes this a distinct species. It is pantropical and was originally described from Sri Lanka, but again described by Murrill as *Poria rhoadsii* from Cuba.

Junghuhnia carneola (Bres.) Ryvarden
Luquillo Mts., Bisley Watershed, 8. June 1997, Ryvarden 40317, CFMR-PR 5457 with culture.
A widespread pantropical species. In fresh condition rather easy to recognize due to the pale citric yellow pore surface becoming reddish to pale brown when bruised or dried.

Junghuhnia minuta Lindblad & Ryvarden
Luquillo Mts., Bisley Watershed, H.H. Burdsall Jr. HHB-15018 PR 1513, 24. March 1994, same locality, 6. June 1997, Ryvarden 40279.
The species was recently described from Costa Rica (Lindblad & Ryvarden 1999) and is characterized by minute basidiospores and large encrusted cystidia.

Junghuhnia subundata (Murrill) Ryvarden
Sabana field station, 18. November 1997, N.W. Legon PR no 159.
A rare Caribbean species, originally described from Cuba.

Oxyporus populinus (Schum.:Fr.) Donk
Cayey municipality, Carite Commonwealth Forest, 23. June 1996, Ryvarden 39015; Luquillo Mts., Bisley Watershed, 6. June 1997, Ryvarden 40293.
This is an almost cosmopolitan species though in Africa and South America it is only collected in the mountains.

Trichaptum byssogenus (Jungh.) Ryvarden
El Verde Res. Area, 1993, M. Boyd PR 5509 CFMR and O.
This is a conspicuous species with a strigose pileus and angular large pores with a distinct violet to pink tinge when fresh. It is pantropical and was originally described from Java, Indonesia.

Trichaptum durum (Jungh.) Corner
Luquillo Mts., Bisley Watershed, H.H. Burdsall Jr, HHB-15010, O, CFMR, PR 1505 with culture, 24. March 1994, on dead *Casearia arborea*.

Tyromyces limitatus Ryvarden nova sp. Fig. 1A-D
Fructificatio pileata, pori brunneus, angulatis 7-9 per mm, contextibus duplex, ochraceous, systema hyphale monomiticum, hyphae generatoriae hyalinae, fibulatae, basidiosporae ellipsoideae, 3-3.2 x 2-2.4 µm.
Holotype: Puerto Rico, Rio Grande Mun., Luquillo Mounts. La Coca trail, 25. May 1997, S. A. Cantrell & D. Llorens, S. A. Cantrell 9746, PR-4578 in CFMR, isotypes in UPRRP and O.
Basidiocarp annual, pileate, spathulate to flabelliform, semicircular and up to 5 cm in diameter, and 4 mm thick at the base, soft when fresh, hard and brittle when dry and slightly curled due to some shrinking by drying, margin thin and entire, then partly split by drying, upper surface ochraceous to pale brown, dull, finely scrupose (lens) and faintly concentrically zoned, pore surface ochraceous when fresh, drying deeper brown, pores angular to round, thin-walled, invisible to the naked eye, 7-9 per mm, tubes concolorous with the pore surface up 2 mm deep and with a dense zone next to the context, context duplex, up to 3 mm thick, lower part up to 2 mm thick, cream to pale ochraceous, separated with a dense dark brown resinous line from the denser pilear cover, which is 0.5 mm thick at the base.
Hyphal system monomitic; generative hyphae with clamps, thin- to very thick-walled, 3-10 µm wide measured in 3% KOH with large conspicuous clamps
Cystidioles present in the hymenium, sharply pointed, smooth, thin-walled and hyaline, up to 15 µm long and 5 µm wide in the middle.
Basidia clavate, with 4 sterigmata, 12-15 x 4-5 µm with a basal clamp.
Basidiospores ellipsoid, hyaline, IKI-, 3-3.2 x 2-2.4 um.
Substrata. Dead hardwood log.
Distribution. Known only from the type locality.
Remarks. This is a remarkable species with its distinct duplex context, a character not previously reported from *Tyromyces*. The upper pilear cover is probably soft and pliable when fresh drying hard and finely scrupose with distinct tufts of agglutinated hyphae. The very wide and thick-walled generative hyphae in the context are also striking.

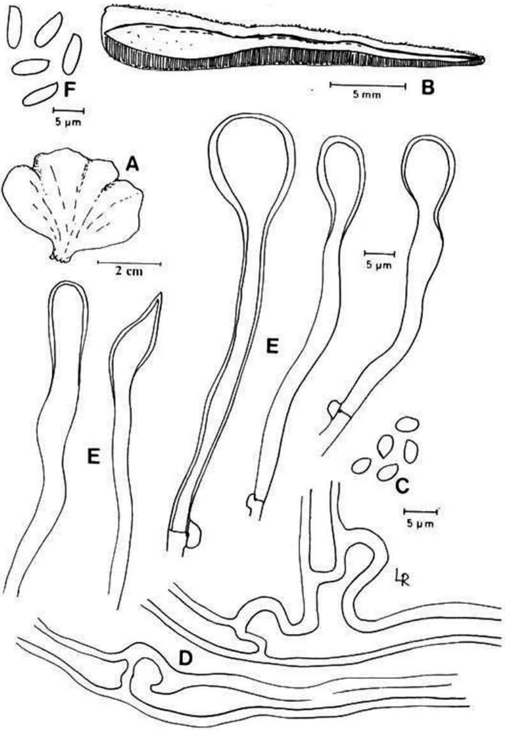

Fig. 1 *Tyromyces limitatus* A) basidiocarp seen from above, B) section through basidiocarp, C) basidiospores, D) generative hyphae from the context, *T. nodulosus* E) cystidia, F) basidiospores. From the holotypes.

Tyromyces nodulosus Ryvarden, nova sp. Fig 1 E-F.
Fructificatio pileata, pori albidis, angulatis 3-4 per mm, tubi et contextibus albidis, systema hyphale dimiticum, hyphae generatoriae hyalinae, fibulatae, hyphae skeletales hyalinae, cystidia hyalinae, laeves, tubuliforma, basidiosporae cylindricae, 5-6 (7) x 1.5-2 µm
Holotype: Puerto Rico, Mayaguez municipality, University of Puerto Rico, between road and Finanzas Bldg., 4 Sept. 1998, on bark of living tree causing a white rot, A. M. Nieves-Rivera, PR 5292,(CFMR, isotypes in UPRRP and O).

Basidiocarp annual, pileate, nodulose with several sloping pilei in long vertical rows, individual pilei projecting up to 1 cm from the substrate and 1.5 cm thick at the base, fragile when dry, upper surface whitish, pressed velutinate, azonate, margin rounded, pore surface white when fresh, drying cream, pores angular to round, 3-4 per mm, tubes cream, up to 2 mm deep, drying fragile, context soft and fibrous, cream, 1 cm thick.

Hyphal system dimitic; generative hyphae with clamps, thin-walled, 2-6 µm wide, skeletal hyphae present only in the context, hyaline, straight and thick-walled when observed in 3% KOH, less so in Melzer's reagent in which they are without reaction.

Cystidia present in dissepiments as apically widened hyphal ends, club shaped to distinctly bulbous, apical part up to 15 µm in diameter and with thickened walls, hyaline, up to 120 µm long to the basal clamps from which they arise, negative in Melzer's reagent.

Basidia clavate, 15-22 x 5-6 µm with 4 sterigmata.

Basidiospores cylindric, hyaline, thin-walled, 5-6 (7) x 1.5-2 µm, negative in Melzer's reagent.

Substrata. On the bark of living tree of unknown identity.

Distribution. Known only from the type locality.

Remarks. The species is recognized by its nodulose habitat giving it an appearance of a badly developed specimen of *Trametes* species until a microscopical examination is undertaken and the conspicuous cystidia are observed. The cystidia are larger though somewhat reminiscent of those of many *Hyphodontia* species, but the hyphal system of this corticoid genus is grossly different from that observed in this new species.

Wrightoporia bracei (Murrill) Ryvarden
Guajataca Commonwealth Forest, Verada Nueva trail, 26. June 1996, Ryvarden 39094, CFMR-PR 5516.
The species was described originally from the Bahamas, but has later

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COMPUTER AIDED SYSTEMATIC EVALUATION OF MORPHOLOGICAL CHARACTERS OF THE OPHIOSTOMATOID FUNGI

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ABSTRACT

Ceratocystis sensu lato includes over 100 species that are accommodated in three genera, *Ceratocystis sensu stricto*, *Ceratocystiopsis* and *Ophiostoma*. In the taxonomic history of these fungi, many different characters have been emphasised, including ascospore morphology, presence or absence of ascospore sheaths, anamorphs, conidium ontogeny, and others. These characters have often been applied inconsistently. For example, species with falcate ascospores were assigned to *Ceratocystiopsis*, while other groups of species having different ascospore forms were not given similar status. The advent of computer aided systematics has made it possible to analyse morphological characters objectively and to determine their influence on classification systems. Unfortunately, computer characters do not lend themselves to describe variation in morphological characters. Information is thus lost in the process of translating morphological characters into computer character states. This study describes a process of using binary code to describe morphological characters in terms of multi-state characters. This system allows for the inclusion of natural variation in computer aided parsimony. Furthermore, characters can be weighted equally, selectively or deleted to determine their effect on the taxonomic position of species being considered. Using this approach to code characters, species of *Ceratocystis sensu lato* were analysed using the parsimony analysis package PAUP. Morphologically, *Ceratocystis sensu stricto* forms a distinct monophyletic group to *Ophiostoma* and *Ceratocystiopsis*. Species of *Ceratocystiopsis* cluster with species of *Ophiostoma*. Results indicate that anamorph characters are important in distinguishing different groups in *Ceratocystis sensu lato*.

KEYWORDS: *Ophiostoma*, *Ceratocystis*, *Ceratocystiopsis*, morphology, character coding, phylogeny, computer systematics.

INTRODUCTION

Ceratocystis sensu lato (*s.l.*) (Upadhyay, 1981) includes over 100 species that are presently accommodated in three genera, *Ceratocystis sensu stricto* (*s.s.*) Ellis & Halst., *Ceratocystiopsis* H.P. Upadhyay & W.B. Kendr. and *Ophiostoma* Syd. & P. Syd. (de Hoog and Scheffer, 1984; Wingfield *et al.*, 1993). Species in *Ceratocystis* have *Chalara* Corda anamorphs. *Ceratocystiopsis* spp. have several anamorph states including *Sporothrix* Hektoen & C.F. Perkins, *Hyalorhinocladiella* H.P. Upadhyay & W.B. Kendr. and *Chalara* (Upadhyay & Kendrick, 1975). Anamorphs of species of *Ophiostoma* are found in the genera, *Sporothrix*, *Hyalorhinocladiella*, *Leptographium* Lagerb. & Melin and *Graphium* Corda (Mouton *et al.*, 1994).

The Ophiostomatoid fungi produce morphologically similar ascomata but have many different ascospore forms (Olchowecki and Reid, 1974). Griffin (1968) thus subdivided *Ceratocystis s.l.*, based on ascospore form and the presence or absence of sheaths around these spores. Upadhyay and Kendrick (1975) argued that species of *Ceratocystis s.l.* with sheathed, elongate to falcate ascospores were distinct and established the genus *Ceratocystiopsis* for these taxa. Ultrastructural studies have shown that sheaths represent secondary layers (Van Wyk *et al.*, 1993) which are the remains of the perithecial cavity during ascospore development (Van Wyk *et al.*, 1991). Therefore, the taxonomic distinction of genera in *Ceratocystis s.l.* based on sheathed and unsheathed ascospore morphology in *Ceratocystis s.l.* is of dubious value.

Upadhyay (1981) distributed species remaining in *Ceratocystis* into four sections based on ascospore morphology. Section **Ceratocystis** (Type *C. fimbriata* Ellis & Halst.) included species with hat, half-moon or cucullate-shaped sheaths; section **Ophiostoma** (Type *O. piliferum* (Fr.) Syd. & P. Syd.) to accommodate species without sheaths; section **Ips** (Type *C. ips* (Rumbold) Nannf.) was established to accommodate species with pillow-shaped sheaths; section **Endoconidiophora** (Type *C. coerulescens*, (Münch) B.K. Bakshi) accommodating species with elongate or inequilateral sheaths. The sections **Endoconidiophora** and **Ceratocystis** comprised the **Fimbriata** group, previously established by Olchowecki and Reid (1974). After having previously established *Ceratocystiopsis*, based on ascospore form, it is surprising that Upadhyay (1981) established these sections rather than assigning them generic status.

Despite the presence of different anamorphs in *Ceratocystis s.l.*, their application in the taxonomy of these fungi has been controversial. Upadhyay and Kendrick (1975) and Upadhyay (1981) recognised several anamorph genera in *Ceratocystis s.l.* These included, *Chalara* (Nag Raj and Kendrick, 1993); *Leptographium*-like (*Verticicladiella* Hughes, *Phialocephala* W.B. Kendr.) (Wingfield, 1985; Wingfield, 1993); *Graphium*-like (*Phialographium* H.P. Upadhyay & W.B. Kendr., *Graphilbum* H.P. Upadhyay & W.B. Kendr., *Hyalopesotum* H.P. Upadhyay & W.B. Kendr., *Pachnodium* H.P. Upadhyay & W.B. Kendr., *Pesotum* Crane & Schokn., *Graphiocladiella* H.P. Upadhyay) (Seifert and Okada, 1993); *Sporothrix*-like (*Hyalodendron* Diddens); and *Hyalorhinocladiella* H.P. Upadhyay & W.B. Kendr.) (de Hoog, 1993). *Graphium* is considered the synnematous analogue of *Leptographium* (Upadhyay, 1981; Wingfield, 1993), while *Sporothrix* and *Hylorhinocladiella* are similar to each other differing only in the presence or absence of conidiogenous denticles (de Hoog, 1993). Conidia develop in the *Chalara* anamorphs of *Ceratocystis* and *Ceratocystiopsis* enteroblastically by ring-wall building, while conidia in the anamorph genera of *Ophiostoma* are produced holoblastically by apical-wall building (with the exception of *Cp. falcata*) (Minter *et al.*, 1982; 1983). Based on conidium ontogeny, *Cp. falcata* should reside in *Ceratocystis*. This species is taxonomically placed in *Ceratocystiopsis* due to its falcate sheathed ascospores. Recent studies using molecular data have shown that *Cp. falcata* is not phylogenetically related to species of *Ceratocystiopsis* (Hausner *et al.*, 1993).

Weijman and de Hoog (1975) argued for the separation of *Ceratocystis* and *Ophiostoma* due to the respective absence or presence of rhamnose and cellulose in their cell walls. Species of *Ceratocystis* lack rhamnose and cellulose in their cell walls. Furthermore, species of *Ceratocystis s.s.* are sensitive to low concentrations of the antibiotic cycloheximide. This is in contrast to the tolerance exhibited by species of *Ophiostoma* (Harrington, 1981; de Hoog and Scheffer, 1984).

Using molecular techniques such as ribosomal DNA sequencing, it has been possible to determine that *Ceratocystis* and *Ophiostoma* are phylogenetically distinct (Spatafora and Blackwell, 1993). Based on partial sequences of the small subunit ribosomal RNA gene it appears that *Ceratocystis* is phylogenetically best accommodated in the Microascales and *Ophiostoma* in Diaporthiales (Berbee and Taylor, 1992a, 1992b; Spatafora and Blackwell, 1993). Hausner *et al.* (1993) found that species of *Ophiostoma* and *Ceratocystiopsis* (with the exception of *Cp. proteae* M.J. Wingf. & P.S. van Wyk = *Gondwanamyces proteae* Marais & M.J. Wingf. and *Cp. falcata* (E.F. Wright & Cain) H.P. Upadhyay appear to form a monophyletic group, although a great degree of genetic diversity was found within this genus.

Three genera are currently accepted in the broader group of Ophiostomatoid fungi. These include: (1) *Ceratocystis*, with type species *C. fimbriata*; (2) *Ceratocystiopsis*, with type species *Cp. minuta* (Siem.) H.P. Upadhyay & W.B. Kendr.; and (3) *Ophiostoma*, and type species *O. piliferum*. There is a logical separation of species of *Ceratocystis* from species of *Ceratocystiopsis* and *Ophiostoma* based on conidium ontogeny. However, the distinction between *Ceratocystiopsis* and *Ophiostoma* is less clear, with species in these genera sharing various characteristics.

One of the problems in morphological systematics relates to how homology is recognised (Lutzoni and Vilgalys, 1995). The problem arises due to the difficulty of character interpretation (Tehler, 1990). The only way to test observed character homology is to expose all possible homology statements simultaneously to parsimony analysis (Tehler, 1990). With the advent of computer systematics, it has become possible to analyse large numbers of characters simultaneously. This has overcome the first step in treating morphological characters objectively.

One of the greatest challenges in morphological systematics relates to the interpretation of characters. A morphological character must be described in terms of quantitative grades (for example, ascospore size ranges) or qualitative characters (for example, light brown, brown to black or black pigmented ascospores) (Tehler, 1990). A further problem is encountered in unintentionally weighting characters selectively in data sets. Using different numbers of character states for different morphological characters introduces biased weighting. Examples of this can be found in every recent study analysing morphological characters (Lutzoni and Vilgalys, 1995; McLaughlin *et al.*, 1995; Petrini, 1993; Tehler, 1990). For example, Tehler (1990) assigned seven characters and 17 character states to ascospore morphology while five characters and 10 character states were used for pycnidia and conidia. Due to the difference in the number of character states used to describe these characters, ascospore morphology will have greater weight in computer analysis. This may contribute to the incongruency encountered between morphological and molecular data sets.

"The objective for any systematist must be to present a phylogeny and classification with a minimum of "*ad hoc*" hypotheses. This is not accomplished by the partitioning of data." (Tehler, 1995). This sentiment reflects the ultimate aim of systematics, to simultaneously assess all data and derive holistic phylogenies. The term 'holistic phylogenies' is used to imply phylogenies that take all available characters (morphological and molecular) into consideration. However, this is not currently possible. Morphological data cannot currently be coded in such a way as to objectively reflect true morphology. What in reality is being compared is the taxonomist's perception of various characters. Using consensus trees for both morphological and molecular data is, we believe, the only way to realise a holistic approach to systematics (Lutzoni and Vilgalys, 1995; McLaughlin *et al.*, 1995; Nishida *et al.*, 1995; Tehler, 1995). This will only be truly possible when morphology and molecular characters can be treated at the same level without *a priori* weighting.

In this study, we make use of computer aided systematics to evaluate the various morphological characters used in the taxonomy of the Ophiostomatoid fungi. The aim of this study was to test the hypothetical taxonomy (of these fungi) proposed by Upadhyay (1981) and Seifert *et al.* (1993). Morphological characters were coded objectively and analysed using parsimony methods.

MATERIALS AND METHODS

SOURCE OF MORPHOLOGICAL DATA

The data used in this study were compiled from the literature and are based on published descriptions, measurements, photographs and sketches of taxa (Table 1). The greatest proportion of data were extracted from the monograph of Upadhyay (1981). In some cases descriptions were taken from original papers such as those for; *O. novo-ulmi* (Brasier, 1991); *C. virescens* (Davidson, 1944); *C. laricicola* (Redfern *et al.*, 1987); *O. cucullatum* and *O. flexuosum* (Solheim, 1986). Species with incomplete descriptions were excluded. These included *C. autographa* B.K. Bakshi, *C. denticulata* R.W. Davidson, *C. hyalothecium* R.W. Davidson, *C. pseudominor* Olchow. and J. Reid, *Cp. conicollis* (Olchow. and J. Reid) H.P. Upadhyay, *Cp. ochracea* (H.D. Griffin) H.P. Upadhyay, *Cp. retussi* (R.W. Davidson and T.E. Hinds) H.P. Upadhyay, *O. adjuncti* (R.W. Davidson) T.C. Harr., *O. coronata* Olchow. and J. Reid, *O. perparvispora* Hunt, *O. distortum* (R.W. Davidson) de Hoog and R.J. Scheff., *O. europhiodes* (E.F. Wright and Cain) H. Solheim, *O. grande* Samuels and Müller, *O. grandiocarpum* (Kowalski and Butin) Rulamort, *O. novae-zelandiae* (Hutchison and J. Reid) Rulamort, *O. penicillatum* (Grosm.) Siem., *O. polonicum* Siem., *O. polyporicola* Constant. and Ryman, *O. proliferum* (Kowalski and Butin) Rulamort, *O. serpens* (Goid.) Arx, *O. subannulatum* Livingston and R.W. Davidson, *O. valdivanum* (Butin) Rulamort, and *O. wagneri* (Goheen and Cobb) T.C. Harr. *Microascus longirostris* Zukal was included as outgroup to determine the homoplasy of morphological characters (Morton and Smith, 1963).

Table 1. List of taxa[a] used in analyses

1	*C. adiposa* (Butler) C. Moreau
2	*C. angusticollis* E.F. Wright & H.D. Griffin
3	*C. deltoideospora* Olchow. & J. Reid
4	*C. californica* DeVay, R.W. Davidson & Moller
5	*C. coerulescens* (Münch) B.K. Bakshi
6	*C. fagacearum* (Bretz) Hunt
7	*C. fimbriata* Ellis & Halst.
8	*C. laricicola* Redfern & Minter
9	*C. magnifica* H.D. Griffin
10	*C. moniliformis* (Hedgc.) C. Moreau
11	*C. paradoxa* (Dade) C. Moreau
12	*C. populicola* Olchow. & J. Reid
13	*C. radicicola* (Bliss) C. Moreau
14	*C. stenospora* H.D. Griffin
15	*C. tenella* R.W. Davidson
16	*C. tubicollis* Olchow. & J. Reid
17	*C. virescens* (R.W. Davidson) C. Moreau
18	*Cp. alba* (DeVay, R.W. Davidson & Moller) H.P. Upadhyay
19	*Cp. collifera* Marm. & Butin
20	*Cp. concentrica* (Olchow. & J. Reid) H.P. Upadhyay
21	*Cp. crenulata* (Olchow. & J. Reid) H.P. Upadhyay
22	*Cp. falcata* (E.F. Wright & Cain) H.P. Upadhyay
23	*Cp. fasciata* (Olchow. & J. Reid) H.P. Upadhyay
24	*Cp. longispora* (Olchow. & J. Reid) H.P. Upadhyay
25	*Cp. minima* (Olchow. & J. Reid) H.P. Upadhyay
26	*Cp. minuta* (Siem.) H.P. Upadhyay & W.B. Kendr.
27	*Cp. minuta-bicolor* (R.W. Davidson) H.P. Upadhyay & W.B. Kendr.
28	*Cp. pallidobrunnea* (Olchow. & J. Reid) H.P. Upadhyay
29	*Cp. ranaculosus* T.J. Perry & Bridges
30	*Cp. spinulosa* (H.D. Griffin) H.P. Upadhyay
31	*O. abietinum* Marm. & Butin
32	*O. abiocarpum* (R.W. Davidson) T.C. Harr.
33	*O. aequivaginata* Olchow. & J. Reid
34	*O. ainoae* H. Solheim
35	*O. allantospora* H.D. Griffin
36	*O. araucariae* (Butin) de Hoog & R.J. Scheff.
37	*C. arborea* Olchow. & J. Reid
38	*O. aureum* (Rob.-Jeffr. & R.W. Davidson) T.C. Harr.
39	*O. bacillosporum* (Butin & Zimm.) de Hoog & R.J. Scheff.
40	*O. bicolor* R.W. Davidson & Wells
41	*O. brevicolla* (R.W. Davidson) de Hoog & R.J. Scheff.
42	*O. brunneo-ciliatum* Mathiesen-Käärik
43	*C. brunneocrinata* E.F. Wright & Cain
44	*O. cainii* (Olchow. & J. Reid) T.C. Harr.
45	*O. canum* (Münch) Syd. & P. Syd.
46	*O. clavigerum* (Rob.-Jeffr. & R.W. Davidson) T.C. Harr.

47	*O. columnaris* Olchow. & J. Reid
48	*O. conicolum* Marm. & Butin
49	*O. crassivaginatum* (H.D. Griffin) T.C. Harr.
50	*O. cucullatum* H. Solheim
51	*O. davidsonii* (Olchow. & J. Reid) H. Solheim
52	*O. dryocoetidis* (W.B. Kendr. & Molnar) de Hoog & R.J. Scheff.
53	*O. epigloeum* (Guerrero) de Hoog & R.J. Scheff.
54	*O. flexosum* H. Solheim
55	*O. francke-grosmanniae* (R.W. Davidson) de Hoog & R.J. Scheff.
56	*O. grandifoliae* (R.W. Davidson) T.C. Harr.
57	*O. huntii* (Rob.-Jeffr.) de Hoog & R.J. Scheff.
58	*O. introcitrina* Olchow. & J. Reid
59	*O. ips* (Rumbold) Nannf.
60	*O. leptographioides* (R.W. Davidson) Arx
61	*O. leucocarpa* R.W. Davidson
62	*O. megalobrunneum* (R.W. Davidson & Toole) de Hoog & R.J. Scheff.
63	*O. minus* (Hedgc.) Syd. & P. Syd.
64	*O. multiannulatum* (Hedgc. & R.W. Davidson) Fr.
65	*O. narcissi* Limber
66	*O. nigrocarpum* (R.W. Davidson) de Hoog
67	*O. nigrum* (R.W. Davidson) de Hoog & R.J. Scheff.
68	*O. nothofagi* (Butin) Rulamort
69	*O. novo-ulmi* Brasier
70	*O. obscura* (R.W. Davidson) Arx
71	*O. olivaceapinii* R.W. Davidson
72	*O. olivaceum* Mathiesen
73	*O. piceae* (Münch) Syd. & P. Syd.
74	*O. piceaperdum* (Rumbold) Arx
75	*O. piliferum* (Fr.) Syd. & P. Syd.
76	*O. pluriannulatum* (Hedgc.) Syd. & P. Syd.
77	*O. populinum* (T.E. Hinds & R.W. Davidson) de Hoog & R.J. Scheff.
78	*O. robustum* (Rob.-Jeffr. & R.W. Davidson) T.C. Harr.
79	*O. rostrocoronatum* (R.W. Davidson & Eslyn) de Hoog & R.J. Scheff.
80	*O. rostrocylindricum* (R.W. Davidson) Arx
81	*O. sagmatospora* (E.F. Wright & Cain) H. Solheim
82	*O. seticolle* (R.W. Davidson) de Hoog & R.J. Scheff.
83	*O. sparsum* (R.W. Davidson) de Hoog & R.J. Scheff.
84	*O. stenoceras* (Robak) Melin & Nannf.
85	*O. tetropii* Mathiesen
86	*O. torticiliata* Olchow. & J. Reid
87	*O. tremulo-aureum* (R.W. Davidson & T.E. Hinds) de Hoog & R.J. Scheff.
88	*O. triangulosporum* Butin
89	*O. trinacriforme* (Parker) T.C. Harr.
90	*O. ulmi* (Buisman) Nannf.

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[a] *C.* refers to *Ceratocystis*, *Cp.* to *Ceratocystiopsis* and *O.* to *Ophiostoma*.

CHARACTER CODING

A total of eight morphological characters, four for the anamorph and four for the teleomorph, were used to describe taxa (Table 2a, 2b). Anamorph characters included type of conidiophore (mononematous and/or synnematous), conidiogenesis, type of anamorph (*Chalara*, *Graphium*, *Hyalorhinocladiella*, *Leptographium* and *Sporothrix*) and conidial morphology. Teleomorph characters included ascoma base, ascoma neck, ostiolar hyphae and ascospore morphology. Characters such as shape of peridial cells, ascomatal ornamentation, length of ostiolar hyphae and conidiophore dimension, were excluded because they were often not mentioned in descriptions.

Morphological characters were described in terms of multi-state characters (Table 2a, 2b). Qualitative characters were described using numerical ranges published by Grylls and Seifert (1993) in a synoptic key to the Ophiostomatoid fungi. Binary states (0 and 1) were used to indicate the presence or absence of character states for the various characters (Table 3).

Where more than one anamorph was present in a taxon, the characters of the synanamorph were also included in the analysis. In the event that only one anamorph was present for a taxon, the anamorph was used as synanamorph for comparative purposes. In taxa where the anamorph is unknown (*C. magnifica* and *C. stenospora*), anamorph characters were treated as missing data.

PARSIMONY AND DISTANCE ANALYSIS

A data set (Table 3) established for each taxon using a wide range of character states (Table 2a, 2b), was analysed using parsimony methods. The most parsimonious tree was derived using heuristic search techniques of PAUP 3.1.1 (Phylogenetic Analysis Using Parsimony) (Swofford, 1993). Unweighted character states were analysed using PAUP and the most parsimonious tree produced. Characters were equally weighted using fractional weighting of character states (Table 4). This was achieved by weighting individual character states. The fractional weight of character states was determined by dividing the greatest number of character states used for each character by the number of character states pertaining to that particular character. Using this approach, a monophyletic outgroup was determined and used to root trees in subsequent analyses.

To simplify later analyses, a subset of 55 taxa was chosen based on the groupings of the tree resulting from equally weighted characters (Fig. 1). Bootstraping (1000 replicates) was done to calculate the confidence intervals of the different branching points on the tree. To determine the contribution of different characters (Table 2a, 2b) to tree topology, perithecial base (1-3, 4-10), perithecial neck (11, 12-21, 22-26), ostiolar hyphae (27, 28-30), ascospore morphology (31-37, 38-43, 44-47), conidiophore (48-49), conidiogenesis (50-51), anamorph type (52-57) and conidial morphology (58, 59-64, 65-69, 70-73, 74-79, 80-84, 85-88), were weighted consecutively, twice as heavily as any other character. Characters were also deleted from analyses consecutively to determine the effect of the absence of characters. *Microascus longirostris* was included in the analysis to determine the effect of homoplasy of morphological characters used to determine tree topologies.

Table 2a. Teleomorph character states used in the morphology data set.

Characterstate		1	2	3	4	5	6	7	8	9	10
1. Perithecial base											
1-3	Base pigmentation	dark brown to black	light brown or olivaceous	white or hyaline	-	-	-	-	-	-	-
4-10	Diameter (μm)	<50	50-100	100-150	150-200	200-300	300-500	>500	-	-	-
2. Perithecial neck											
11	Neck	present / absent									
12-21	Length (μm)	<50	50-100	100-200	200-300	300-500	500-750	750-1000	1000-1500	1500-5000	>5000
22-26	Width at apex	<10	10-20	20-30	30-45	>45	-	-	-	-	-
3. Ostiolar hyphae											
27	Ostiolar hyphae	present / absent	-	-	-	-	-	-	-	-	-
28-30	Type	divergent	parallel	convergent	-	-	-	-	-	-	-
4. Ascospore											
31-37	Shape	oblong to ellipsoidal	curved, allantoid, orange section	fussiform x falcate	appearing sheathed	secondary wall hat shaped	secondary wall pillow shaped	secondary wall same shape as ascospore	-	-	-
38-43	Length (μm)	<3	3-5	5-7	7-10	10-20	>20	-	-	-	-
44-47	Width (μm)	<2	2-3	3-4	>4	-	-	-	-	-	-

Table 2b. Anamorph character states used in the morphology data set.

Characterstate		1	2	3	4	5	6
5. Conidiophore							
48-49	Type	mononematous	synnematous	-	-	-	-
6. Conidiogenesis							
50-51	Type	holoblastic	enteroblastic	-	-	-	-
7. Anamorph							
52-57	Type	*Chalara*	*Graphium*	*Hyalorhinocladiella*	*Leptographium*	*Sporothrix*	other
8. Conidia / Anamorph							
58	Septation	present / absent	-	-	-	-	-
59-64	Shape	globose	ellipsoidal to ovate	oblong to ellipsoidal	clavate	Y or T shaped	fussiform
65-69	Length (µm)	<5	5-7	7-10	10-20	>20	-
70-73	Width (µm)	<2	2-3	3-4	>4	-	-
Conidia / Synanamorph							
74-79	Shape	globose	ellipsoidal to ovate	oblong to ellipsoidal	clavate	Y or T shaped	fussiform
80-84	Length (µm)	<5	5-7	7-10	10-20	>20	-
85-88	Width (µm)	<2	2-3	3-4	>4	-	-

Table 3. Coded data matrix for taxa (Table 1)[a] coded according to character states in Table 2.

	Character							
	1	2	3	4	5	6	7	8
1	1000000111	1000000011001100	1100	01001001001100001110	01	01	100000	111000001100011111000001100011
2	1000110000	1000011000001000	1100	10001001110000110001	10	01	010000	001100111101110001100111101110
3	1001100000	1001110000010000	1000	01000000100000100010	10	01	000010	011101110001000011101110001000
4	1000110000	1001110000001100	1100	10001010011000110010	10	01	001000	011000100001100011000100001100
5	1000110000	1000001110001000	1100	01000000110000100010	10	01	000010	011001111101110011001111101110
6	1000011000	1000001100001000	1100	01001001000100010010	01	01	100000	011000011110001011000011110001
7	1000110000	1011000000011000	1110	10001010010000100010	10	01	000010	011110110000011011110110000011
8	1000000110	1000110000000001	1110	11001001001110011010	01	01	100000	011000111100110011000111100110
9	1000011100	1111111100001000	1110	01001100011100010010	01	01	100000	001000001110111001000001110111
10	1000000100	1000001100000110	1100	11001001010000110010	01	01	100000	001000001110001001000001110001
11	1000000111	1000000110001100	0000	01001001100000100010	??	01	???1??	011100001000010011100001000010
12	1000111100	1000001100001000	1100	01001100011000010010	01	01	100000	011000011100111011000011100111
13	1100001100	1000001110000110	1110	01001001001100011110	01	01	100000	011000001100111011000001100111
14	1000110000	1011000000010000	1110	01001001010000110010	10	01	000010	001100100001000001100100001000
15	0101111100	1111111100000110	1100	10001001001110011010	01	01	100000	001000011110111001000011110111
16	1001100000	1011000000001000	0000	01001001011100100000	??	01	000000	??????????????????????????????
17	1000110000	1001110000011000	1100	01000000010000100010	10	01	000010	011100111001100011100111001100
18	1000110000	1010000000001000	0000	10001011010000100010	10	01	001000	011100110001000011100110001000
19	1000001100	1111111100001???	1100	01001001001100100010	??	01	??????	011000011110100011000011110100
20	0010110000	1011100000011000	1011	01101001001100100010	10	01	001000	011101011000110011101011000110
21	1000100000	1100000000010000	1001	00101001000010100010	10	01	000010	110000110001000110000110001000
22	1000100000	1010000000011000	0001	00101001000110100010	10	01	000010	000110100001000000110100001000
23	1001100000	1001000000011000	1110	00101001001100100010	10	01	001000	011100110001100011100110001100
24	1000100000	1100000000010000	0000	00101001000001100010	01	01	100000	001100111001000001100111001000
25	1001100000	1010000000010000	1011	00101001000110100010	10	01	001000	011100100001000011100100001000
26	1001110000	1110000000011000	1001	00101001000110100010	10	01	000010	001110011101110001110011101110
27	1001110000	1100000000001100	1001	00101001000010100010	10	01	001000	011100110001000011100110001000
28	1000100000	1111000000001100	1011	01101001001110100010	10	01	001000	011000110001000011000110001000
29	0101100000	1011100000011000	1001	00101001000011100010	10	01	001000	011000110001000011000110001000
30	1000100000	1100000000011000	1001	01001100000010100010	10	01	000010	001000110001000001000110001000

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31 1001110000-11100000000?????-0000-10101000000110110010-10-01-000010-001100011001000001100011001000
32 1001100000-1100000000010000-1001-00101001000110100010-10-01-000010-110010110001100110010110001100
33 1000011100-1000011000011000-1100-01000000010000010010-10-01-000010-001100110001000001100110001000
34 1000001100-11111111100?????-0000-01000000010000100010-10-01-000100-011000011101100011000011101100
35 1001110000-1001111000011000-1110-01101001110000100010-10-01-001000-111100110001100111100110001100
36 1000110000-1000011000001100-1100-10001001010000100001-10-01-010000-011100111001110011100111001110
37 1000111100-1000001110001100-1010-01000000110000110010-10-01-001000-011100111001110011100111001110
38 1000111000-1000110000001000-0000-01000000010000100011-10-01-011000-011100100001000011100110001000
39 1000000110-0000000000000000-0000-01001100011000011010-10-01-000100-010100011101110010100011101110
40 1000110000-1000110000001100-1100-10000000001110100010-10-01-001000-011100110001100011100110001100
41 0110001110-1000001110000111-0000-10001010011000011010-10-01-001000-011100111001111011100111001111
42 1000011000-1000110000001100-1011-01001001001100011010-10-01-000100-001100111001100001100111001100
43 1000000110-1000001110001100-1100-10001010010000110001-10-01-010000-011000110001000011000110001000
44 1000011110-1000111100000110-0000-01001100011000111001-10-01-010000-001100111001100001100111001100
45 1001111000-1111111100011000-0000-01000000011000110010-10-01-?????1-110000111101111110000111101111
46 1000000111-0000000000000000-0000-01001100011000011110-10-11-010000-001100000110001001100000110001
47 1000111100-1000011000001000-0000-10001010111000110001-10-01-010000-001100110001100001100110001100
48 0100001100-1000001000001100-1101-01000000011000100010-10-01-000010-011100110000011011100110000011
49 1001110000-1110000000001000-1110-00101001000110100010-10-01-000100-001100111101000001100111101000
50 1100110000-1000111000001000-1100-01001100001000011001-10-01-010000-011000111001110011000111001110
51 1000100000-1001110000001100-1010-01001001011000011001-10-01-010000-011000111001100011000111001100
52 1000001100-1001111000000011-1000-01001001001000111010-10-01-000100-011100001100111011100001100111
53 1000011000-1001111000001000-0000-01000000110000100010-10-01-000010-011100110001100011100110001100
54 1000011000-1000001100001000-1100-10001010010000100010-10-01-000010-011110110001110011110110001110
55• 1000011000-1001110000000100-1010-01001001011000010010-10-01-000100-111000100001100111000100001100
56 1000011000-1000011100001100-1100-01001001010000100010-10-01-000100-011100100001000011100100001000
57 1000000110-1111111000001110-0000-01001100010000110010-10-01-000100-011000111001111011000111001111
58 1000011100-1000011000001100-0000-01000000110000100001-10-01-010000-001100100001000001100100001000
59 1000011110-1000111110001100-0000-10001010011000110011-10-01-011000-011100111001100111000110000011
60 1000011000-1001000000001100-1110-01001010001100011010-10-01-000100-011000111001100011000111001100
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61	0010011000-1000001100000001-1100-01000000110000100010-10-01-000010-001101110001100001101110001100
62	1000000010-10000001100?????-1110-01000000110000100010-10-01-000010-011100111001100011100111001100
63	1000110000-1011000000011000-0100-01000000111000100010-10-01-001000-011100110001110011100110001110
64	1000011100-1111111111111000-1100-11000000110000100010-10-01-000010-011001111101110011001111101110
65	1000011000-1001110000001000-0000-10000000110000100010-10-01-000010-011100111001110011100111001110
66	1001110000-1001000000001000-1100-01000000010000100010-10-01-000010-011100110001100011100110001100
67	1000110000-1001110000001100-1110-10001010010000110010-10-01-001000-011100111001100011100111001100
68	1000000011-1111111111100001-0000-01000000010000010010-10-01-000010-010000100001000010000100001000
69	1000110000-1000111000011000-1100-01000000011000100011-10-01-010010-011100111100100011000110001100
70	1000110000-1000110000001100-1000-11001010011000010001-10-01-010000-011000111000011011000111000011
71	1000001000-1000111000001000-1111-01001100011000110001-10-01-010000-011000111001100011000111001100
72	1000100000-1001110000001100-1010-01001100011000011001-10-01-010000-011000111001110011000111001110
73	1000111000-1000001110011100-0100-01000000110000100011-10-01-010010-011000011101110011000110001100
74	1000001000-1110000000001110-0000-01001100011100011010-10-01-000100-011000111000110011000111000110
75	1000111100-1000011111111000-1110-01000000010000100010-10-01-000010-011001111001100011001111001100
76	1000111100-1000001111011000-1100-01000000010000100010-10-01-000010-011001111101100011001111101100
77	1000001100-1000001110001110-1100-01000000010000110010-10-01-000010-011001011101110011001011101110
78	1000001110-0000000000000000-0000-01001100011000011010-10-01-000100-010000111000111010000111000111
79	1000011000-1001111000001100-1100-01000000011000110010-10-01-000010-011100111001100011100111001100
80	1000011100-1000011000000110-0000-01001001110000100010-10-01-000100-011100110001100011100110001100
81	1000110000-1011110000001100-1010-01001100011100011101-10-01-010000-011100111000011011100111000011
82	1000010000-1001000000000001-1011-10001010011000010010-10-01-001000-011100110001100011100110001100
83	1000011000-1111100000001100-0000-10001010011000110001-10-01-010000-011000100001000011000100001000
84	1000111000-1000011110001000-1100-01000000110000100010-10-01-000010-011100110001100011100110001100
85	1000001110-1000001110001100-1100-01000000110000100010-10-01-000010-011000110001000011000110001000
86	1000011000-1000011110001100-1100-01001001110000100001-10-01-010000-011100100001000011100100001000
87	1000110000-1000011000001100-1010-01000000011000110010-10-01-001000-011100011001100011100011001100
88	1000001100-1000000110001100-1100-01001101010000010010-10-01-001000-011000111001111011000111001111
89	1000000100-0000000000000000-0000-01001100011000011010-10-01-000100-011000111001111011000111001111
90	1000011000-1001110000001000-1100-01000000011000100011-10-01-010010-011100111101100011000110001100

[a] Taxa numbers correspond to those listed in Table 1.

Table 4. Fractional weighting of character states to equally weight characters.

Morphological character	Number of character states	Equal weighting of characters[a]
Teleomorph		
1. Perithecial	10	310
2. Perithecial	16	193
3. Ostiolar	4	775
4. Ascospore	20	182
Anamorph		
5. Conidiophore	2	1550
6. Conidiogenesis	2	1550
7. Anamorph	6	516
8. Conidia	31	100

[a] Equal weight of characters = $(x \div y) \times 100$, where,

x - largest number of character states per character (31),

y - number of character states of this character.

RESULTS

Using the heuristic search option on the unweighted data set resulted in 20 equally most parsimonious trees. All 20 tree topologies were incongruent with the accepted classification of the Ophiostomatoid fungi (Seifert *et al.*, 1993; Upadhyay, 1981). Species of *Ceratocystis* were thus interspersed with species of *Ophiostoma* and *Ceratocystiopsis* without any obvious pattern consistent with our knowledge of this group.

In the analysis of equally weighted characters using fractional weighting, three trees rooted to midpoint were produced (Fig. 1). The tree topologies were similar, differing only within clusters. The tree topology was such that the species were divided into two groups i.e. species of *Ceratocystis* and species of *Ophiostoma* and *Ceratocystiopsis*. Notable exceptions were species presently residing in *Ceratocystis* (*C. angusticollis*, *C. californica*, *C. deltoideospora*, *C. populicola*, *C. tenella* and *C. tubicollis*) that grouped with species of *Ophiostoma*. *Ceratocystiopsis falcata*, grouped with species of *Ceratocystis*. The *Ceratocystis* group formed a distinct monophyly and was used as outgroup in further analyses. Species of *Ophiostoma* and *Ceratocystiopsis* were found in separate clusters. Species with *Graphium* anamorphs grouped together, including certain species with *Graphium* as well as *Sporothrix* synanamorphs, (*O. araucariae*, *O. ulmi*, *O. novo-ulmi* and *O. piceae*). Species with *Sporothrix* or *Hyalorhinocladiella* anamorphs occurred in two clusters. The first group included only species with *Sporothrix* anamorphs while the second group incorporated species with *Hyalorhinocladiella* anamorphs and some species with *Sporothrix* anamorphs. Species with *Leptographium* anamorphs also resided in a separate cluster. The tree homoplasy index of morphological characters was 0.848 and the consistency index was 0.152.

Based on the dendrogram produced by equally weighting characters (Fig. 1), a subset of 55 taxa, representing the different groups, were selected for further analysis. A single most parsimonious tree was produced using the heuristic search option (Fig. 2). The tree was rooted using species of *Ceratocystis*, including *Cp. falcata*, as outgroup. The *Ceratocystis* group was separate from species of *Ophiostoma* and *Ceratocystiopsis*, with a 98% confidence interval (Fig. 2). The *Graphium* and *Sporothrix* groups both had bootstrap values of 100%. The bootstrap value for the *Leptographium* group was 87% while the *Hyalorhinocladiella* group had a bootstrap value of 95%. The homoplasy index for the tree was 0.775 and the consistency index 0.225. When *M. longirostris* was included in the analysis, it was found to group within the *Leptographium* cluster (Fig. 3).

Weighting various characters did not always produce tree topologies that were congruent with the equal weighting of characters. Weighting perithecial base resulted in nine trees. The grouping topology was similar to that in Figure 2, with differences in the internal rearrangements of the *Graphium* and *Ceratocystis* groups. Weighting of the perithecial neck character produced two trees, with loss of resolution in the *Leptographium* and *Hyalorhinocladiella* groups. Weighting of ostiolar hyphae resulted in nine trees. The *Ceratocystis*, *Graphium* and *Leptographium* groups, with the exception of *O. leptographioides*, maintained resolution. Taxa in the *Sporothrix* and *Hyalorhinocladiella* groups were intermixed with *O. leptographioides*.

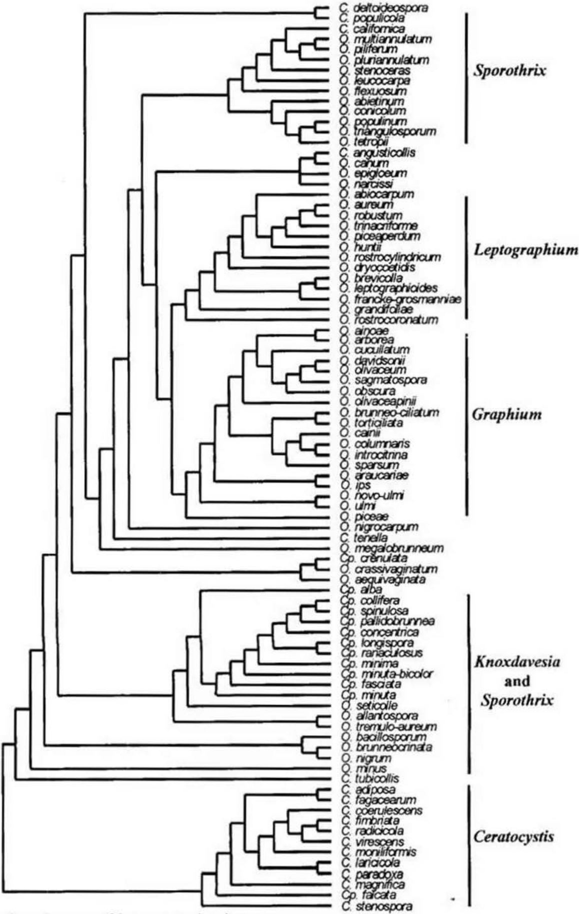

Fig. 1. Consensus of three most parsimonious trees.

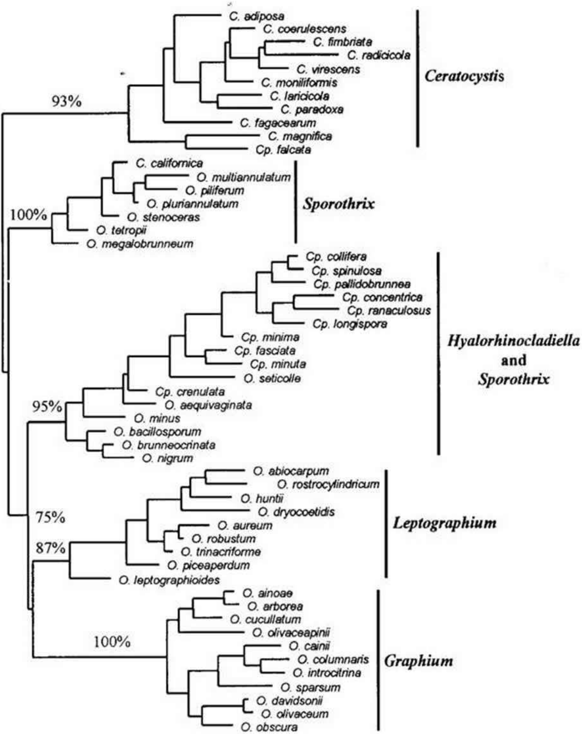

Fig. 2. Most parsimonious tree of selected taxa.

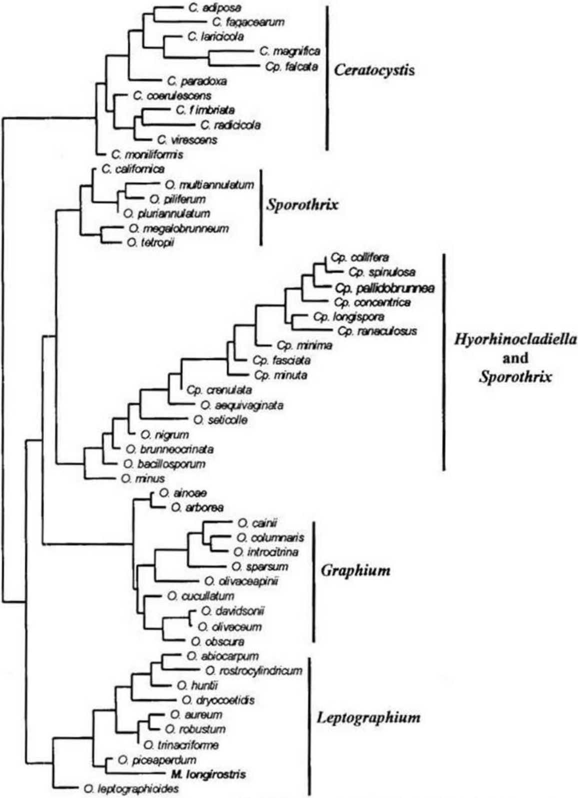

Fig. 3. Most parsimonious tree with *M. longirostris* included in the taxa selection.

Weighting ascospore morphology resulted in two trees with a loss of resolution in the *Hyalorhinocladiella* group.

Weighting anamorph characters had less of an effect on tree topology than it did with teleomorph characters. Weighting conidiophore and anamorph type, resulted in one tree with similar topology to that where characters were equally weighted. Weighting the type of conidiogenesis character produced three trees. The different groups were maintained with internal rearrangements occurring in the *Graphium* group in all the trees. Weighting of conidial morphology produced four trees of which the *Hyalorhinocladiella* group was unresolved and internal rearrangements occurred in the *Graphium* and *Sporothrix* groups.

Deleting characters from analyses had a greater effect on tree topology than did weighting. Deleting perithecial base resulted in 10 trees, all having the same group topology as that in Figure 2, but with internal rearrangements. Excluding perithecial neck resulted in 15 trees. *Ceratocystis magnifica* grouped within the *Leptographium* group and rearrangements occurred in the *Hyalorhinocladiella* and *Leptographium* groups. Deletion of ostiolar hyphae resulted in two trees. Here, species in the *Leptographium* group and *C. virescens* were unresolved. Deleting ascospore morphology resulted in nine trees, in which the *Graphium* and *Sporothrix* groups were maintained. The *Leptographium* group included *C. magnifica* while *Hyalorhinocladiella* was split into two separate clusters.

Deletion of anamorph characters had a similar effect on tree topology as did the deletion of teleomorph characters. Excluding type of conidiophore resulted in three trees. Here, *Ceratocystis* and *Sporothrix* groups were maintained while taxa in the *Graphium*, *Hyalorhinocladiella* and *Leptographium* groups were intermixed. Deleting type of conidiogenesis from the analysis produced five trees in which the *Graphium* and *Sporothrix* groups were maintained. The *Leptographium* group included *C. magnifica* while the *Hyalorhinocladiella* group included *Cp. falcata*. Removing anamorph type resulted in 12 trees in which the groups *Ceratocystis*, *Sporothrix* and *Graphium* were maintained. The *Hyalorhinocladiella* group included *O. leptographioides* with the grouping of other taxa in the *Leptographium* group, unresolved. Deleting conidial morphology from the analysis resulted in 89 trees. All the groups, *Ceratocystis*, *Graphium*, *Sporothrix*, *Leptographium* and *Hyalorhinocladiella* were maintained with rearrangements of taxa occurring within groups.

DISCUSSION

In this study of published morphological characters, the grouping of species in *Ceratocystis s.l.* based on anamorph type suggests that this character is important in the delineation of phylogenetic groups. The exception is that species with *Hyalorhinocladiella* anamorphs form a group that includes species with *Sporothrix* anamorphs. Benade *et al.* (1996) found that the *Hyalorhinocladiella* anamorph is similar to *Sporothrix* and that there is apparently a continuum of developmental stages between these two genera. The clustering of species with similar anamorph type may ultimately form a sound basis of different genera within *Ophiostoma sensu lato*.

Weighting individual character states can be used to cancel the effect of assigning different numbers of character states to different characters. Analysis of equally weighted morphological characters of the Ophiostomatoid fungi produced tree topologies reasonably congruent with those from studies using molecular data (Berbee and Taylor, 1992a; 1992b; Hausner *et al.*, 1993; Spatafora and Blackwell, 1993). Results from parsimony analysis, of equally weighted morphological characters, support the view that *Ceratocystis s.s.* is a distinct genus from *Ophiostoma*. Furthermore, in analyses testing the homology of all morphological characters simultaneously, there does not appear to be any justification for separating species of *Ceratocystiopsis* from *Ophiostoma*. This finding based on morphological data is congruent with molecular data that suggests that *Ceratocystiopsis* and *Ophiostoma* form a monophyletic group (Hausner *et al.*, 1993).

Using parsimony analysis of equally weighted characters with unrooted trees (rooted to midpoint), species of *Ceratocystis* (with the exception of *C. angusticollis*, *C. californica*, *C. deltoideospora*, *C. populicola*, *C. tenella*, *C. tubicollis* and the inclusion of *Cp. falcata*) were identified as a monophyletic group. We can support the exclusion of *C. angusticollis*, *C. californica*, *C. deltoideospora*, *C. populicola*, *C. tenella*, *C. tubicollis* from *Ceratocystis* based on the fact that these species have anamorphs reminiscent of those in *Ophiostoma* and these species should be transferred to the latter genus (Seifert *et al.*, 1993).

The inclusion of *Cp. falcata* in *Ceratocystis* is justifiable as this fungus is more reminiscent of species in *Ceratocystis*. *Ceratocystiopsis falcata* has a *Chalara* anamorph, which is characteristic of species of *Ceratocystis s.s.* However, sequence, RFLP and hybridisation data (Hausner *et al.*, 1993; Viljoen *et al.*, 1999) suggest that *Cp. falcata* is phylogenetically distant from species of *Ceratocystis*. Ascospore morphology on its own is, therefore, not a good characteristic on which to base genera, as has previously been shown by Hausner *et al.* (1993). It would appear that the characters used in the taxonomy of the Ophiostomatoid fungi are highly convergent. This is supported by high homoplasy values for the trees resulting from PAUP analyses.

Consecutive weighting of morphological characters was useful in determining the effect of those characters on tree topology. Thus, weighting different morphological characters changed tree topology to a greater or lesser extent. Weighting perithecial base, conidiophore, conidiogenesis and anamorph type, did not affect tree topology. However, weighting perithecial neck, ostiolar hyphae, ascospore and conidial morphology resulted in a loss of resolution in one or more groups of taxa. Furthermore, no single morphological character, when weighted, resulted in the simultaneous loss of resolution in all groups of taxa. Therefore, the effect of perithecial neck, ostiolar hyphae, ascospore and conidial morphology on the taxonomy of these fungi is collective. This suggests that groups of characters, rather than single characters, should be used simultaneously in the taxonomy of these fungi. This is unfortunately not possible without the aid of computer based systematics. Results underline the importance of character description in computer systematics.

Removing morphological characters from analyses, placed the weighting of characters in perspective. Perithecial base was the only character that did not change tree topology. Perithecial neck, ostiolar hyphae, ascospore morphology, conidiophore, conidiogenesis, anamorph type and conidial morphology contributed to a wide range of changes in tree topology. No single deleted character resulted in loss of resolution of all the different groups. For example, deleting anamorph type did not change the distinction between *Ceratocystis*, *Graphium* and *Sporothrix* groups. The *Leptographium* group was unresolved with *O. leptographioides* included in the *Hyalorhinocladiella* group. Therefore, the distinction between the groups of taxa, is not solely based on a single morphological characteristic. Furthermore, the low consistency index values and high homoplasy values confirm that the morphological characters, used in the taxonomy of the Ophiostomatoid fungi, are highly convergent. However, the high bootstrap values for the different nodes of the tree is an indication that the grouping of taxa within the trees is valid and is not a result of any single character.

Species of *Microascus* are morphologically similar to the Ophiostomatoid fungi. However, analysis of sequence data (Berbee and Taylor, 1992a; 1992b; Spatafora and Blackwell, 1993) has shown that *Microascus* is phylogenetically distinct from *Ophiostoma*. The inclusion of *M. longirostris* in the *Leptographium* group (Fig. 4) is, therefore, an indication that many of the morphological characters used in the taxonomy of these fungi are highly convergent. This is supported by the high homoplasy value (0.775) for the tree topology.

Computer analysis of morphological characters is error prone, because of the plastic nature of these characters and the way in which they are expressed in a data base. This bias is introduced by reducing a character to an exclusive state, regardless of the variation within that character. Under these conditions, the taxonomist must make the decision that one character state, above all others, best describes a taxon character. Using a binary system to indicate the presence or absence of multi-state characters does not restrict morphological characters from being expressed as selective character states in a data matrix. The advantage of this approach is that the data matrix will reflect shared character states and shared characters. Furthermore, using a combination of multi-state character states in conjunction with a binary system, allows the expression of natural variation within a coded data matrix. The binary coding thus makes it possible to assign each character equal weight or to weight certain characters preferentially. This is useful in determining the effect that different characters have on tree topologies, and can be used to identify divergent or convergent morphological characters.

This study provides an objective taxonomic hypothesis for the Ophiostomatoid fungi based on equally weighted morphological characters. In sumary, the genus *Ceratocyctis s.s.* is distictint from *Ophiostoma* while species of *Ceratocystiopsis* and *Ophiostoma* form a monophyletic group. Despite the high degree of homoplasy of characters, results strongly suggest that anamorph type may be an important character on which further subdivisions, in *Ceratocystiopsis* and *Ophiostoma*, may be based.

We have attempted to address the problems pertaining to character description and different numbers of character states, by using an inclusive approach and equal weighting of morphological characters. The effect is evident when comparing the result of unweighted versus equally weighted characters. Only the analyses of equally weighted characters produced tree topologies congruent to hypothetical classifications. Furthermore, it appears that collections of morphological characters, rather than single characters, are important in the taxonomy of the Ophiostomatoid fungi. The taxonomic hypothesis arising from this morphology study should now be tested using less subjective data sets, such as those derived using molecular techniques.

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CORTICIOID SPECIES
(BASIDIOMYCOTINA, APHYLLOPHORALES)
FROM COLOMBIA II

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ABSTRACT

26 species are reported as new for Colombia of which *Aleurocystis habgallae*, *Amaurodon viridis*, *Amylocorticium africanum*, *Brevicellicium allantosporum*, *Hyphodontia alutacea*, *H. orasinusensis* and *Leifia flabelliradiata* are new to South America. *Hypochniciellum luteolum* Hjortstam & Ryvarden and *Radulodon venustum* Hjortstam & Ryvarden are described as new. Keys are provided for tropical species of *Amylocorticium*, South American species of *Brevicellicium* and all species in *Candelabrochaete* and *Hypochniciellum*.

INTRODUCTION

The first report on Colombian corticioid fungi (Hjortstam and Ryvarden 1997) provided details of the expedition on which the specimens were collected, where they are deposited, etc. To avoid excessive citations of locality names, the following list indicates where the cited collections were made. Collections numbered 15814 – 15912: Magdalena province, Toyrona national park, at sea level, 14 June 1978; 15913 – 16050: Magdalena province, San Lorenzo, Station Reservo, Sierro Nevada, 1900 m, 16. June 1978.
Species marked with an asterisk are new to Colombia.

LIST OF SPECIES

***Aleurocystis habgallae** (Berk. & Broome) G. Cunn.
Specimen: 15987. A pantropical species originally described from Sri Lanka. The closely related species *A. magnispora* (Burt) P.A. Lemke was reported from Colombia by Ryvarden (1998).

Aleurodiscus mirabilis (Berk. & M. A. Curtis) Höhn.
Specimen: 15999. Originally described from Cuba, this species has a pantropical distribution. For a description see Núñez and Ryvarden (1997).

Amaurodon viridis (Alb. & Schwein.:Fr.) J. Schröt.
Specimens: 16013, 16029. Not previously reported from South America. The species is better known as *Tomentella chlorina* (Massee) G. Cunn. The temperate distribution was shown by Kõljalg (1996). It is further known from Australia (Tasmania), the type locality for *Thelephora viridis* Berk. and *Hypochnus chlorinus* Massee. Malençon (1952) also reported it from Tunisia as *Caldesiella viridis* (Alb. & Schwein.) Pat.
We have also found the species in Venezuela (Estado Bolivar, Las Nieves, Ryvarden 37750, O), where it was rather common and occurred with *Tomentellago aeruginascens* Hjortstam & Ryvarden (second known collection) and *Amaurodon hydnoides* Kõljalg & Ryvarden (type locality).

Amylocorticium africanum Hjortstam
Specimen: 15916. Previously known only from Africa and recorded several times in Malawi, Kenya, and Tanzania. Boidin and Lanquetin (1995) reported it from Ethiopia. There are no other species in the genus as yet recorded in South America. *Amylocorticium africanum* should be easy to recognize by its cream-coloured hymenophore with a distinct and byssoid subiculum and by its suballantoid spores with a pale blue amyloid reaction.

Key to tropical species of *Amylocorticium*

1. Cystidia absent **2**
1. Cystidia present **3**
2. Hymenophore whitish, spores almost allantoid, usually 6-7 x (1.75-) 2-2.5 µm. Morocco and New Zealand .... ***cebennense***
2. Hymenophore pale yellowish or brownish, spores ellipsoid, 4.5-5.5 µm long, becoming dextrinoid. India .... ***indicum***
3. Cystidia as vesicular protuberances on the hyphae, spores suballantoid 5.5-6.5(-7) x 1.5-2 µm. Africa, South America .... ***africanum***
3. With other kind of cystidia, sometimes septate, projecting above the basidia **4**
4. Spores ellipsoid, 4.5-5.5 µm long. Morocco .... ***subincarnatum***
4. Spores narrowly ellipsoid to almost cylindrical, 7.5-8 µm long. Morocco .... ***subsulphureum***

Asterostroma andinum Pat.
Specimens: 15887, 16024. Presumably pantropical. For a key to and descriptions of *Asterostroma* species, see Boidin, Lanquetin and Gilles (1997).

Botryobasidium digitatum (D. P. Rogers) G. Langer
Specimen: 15969. This seems to be the first record since it was described from Panama.
BASIDIOME thin, arachnoid to hypochnoid, greyish white, cystidia projecting slightly and easily observed under a dissecting microscope. HYPHAL SYSTEM monomitic; subicular hyphae with thickened wall or thick-walled, hyaline to very pale yellowish, 7-12 µm wide, other hyphae thin-walled, narrower, hyaline, all hyphae without clamp connections. CYSTIDIA rather sparse, projecting as much as 30-50 µm above the basidia, thin-walled and about 8-10 µm wide. BASIDIA stout, with an indistinct suburniform appearance, 20-25 x 9-12 µm, with four sterigmata and lacking a basal clamp connection. SPORES hyaline, almost broadly navicular, apically obtuse, smooth and thin-walled, 10-12(-13) x 4.5-5 µm, inamyloid, indextrinoid and acyanophilous. There are often immaturely discharged spores which are somewhat smaller.
The four-sterigmate basidia with navicular spores and presence of cystidial elements should be sufficient for recognition. As far as we know, the species is previously known only from the type locality in Panama. The species occupies an uncertain taxonomic position and we are of the opinion that its current placement in *Botryobasidium* is somewhat dubious. It reminds one of *Athelicium stridi* forma *efibulatum* K.H. Larss. & Hjortstam in its basidial morphology and shape of spores, though the latter are considerably smaller in *B. digitatum*. For the time being we maintain the species in *Botryobasidium*.

Botryobasidium subcoronatum (Höhn. & Litsch.) Donk
Specimen: 15928, 15972. This species has a world-wide distribution.

Brevicellicium allantosporum Hjortstam & Ryvarden
Specimens: 15872, 15873. Originally described from Africa, *B. allantosporum* is the most deviating species in the genus due to its small, allantoid spores and strongly encrusted aculeal hyphae. However, it has isodiametric hyphae next to the basidia, typical of *Brevicellicium*.

Key to species of *Brevicellicium* in South America

1. Hymenophore soft or fragile, granular to odontioid, at least the aculeal hyphae strongly encrusted, spores reniform to allantoid, 4 x 1.5-1.8 µm. Brazil, Colombia .... ***allantosporum***
1. Spores differently shaped, mainly subglobose, hymenophore smooth or granular to odontioid, no evident granulation of aculeal hyphae **2**
2. Hymenophore smooth, spores somewhat lacrimoid 4.5-5(-6) x 3.5-4 µm. Colombia .... ***exile***
2. Hymenophore granular or odontioid **3**

3. Basidiome rather hard, hymenophore granular, verrucae more or less globose, spores asymmetric, about 5 µm across. Argentina, Brazil and Venezuela .... ***olivascens***
3. Basidiome rather tough, hymenophore with very dense granules or slightly odontioid, spores subglobose, somewhat angular, 3.5-4 µm diam. Brazil, Colombia .... ***molle***

******Candelabrochaete simulans*** Hjortstam
Specimen: 15978. The genus *Candelabrochaete* is mainly tropical and subtropical and the species are not well known. Specimens are few or known only from the type-collections, but seem, like some species in *Phanerochaete*, to be closely related to each other. *Candelabrochaete. simulans*, described from Thailand, has ellipsoid spores, shorter than those of *C. magnihypha* (Burt) Burds., and also has somewhat narrower cystidia. The latter is evidently a rare species (see Burdsall 1984).

Key to species of *Candelabrochaete*

1. Basidiomes fragile when dried, hymenophore grandinioid to somewhat odontioid with blunt aculei, cystidia septate, thick-walled at least in the upper part and 6-10 µm wide, with thick-walled conidia, spores subglobose 5-5.5 x 4-4.5 µm. South America (Argentina, Brazil) .... ***dispar***
1. Not with this combination of characters, spores ellipsoid or allantoid ... **2**
2. Basidiomes rather thick, spores allantoid 4.5-5(-6.5) x 1.5-2 µm. Mainly in northern hemisphere and South America (Brazil) .... ***septocystidia***
2. Basidiomes thin or moderately thick, spores ellipsoid, narrowly ellipsoid or cylindrical, if allantoid then broader than 2 µm **3**
3. Basidiomes thin and almost pellicular, closely adnate, not separable from he substratum, cystidia thin-walled, non-septate, hyaline and subulate, smooth, spores about 6.5-7 x 2.8-3.5 µm, on bamboo and deciduous wood. South America (Brazil). .... ***adnata***
3. Basidiomes different, cystidia septate **4**
4. Basidiomes rather thick, hymenophore grandinioid to odontioid, cystidia thin-walled, spores ellipsoid 5.5-6 x 3-3.25 µm. Northern hemisphere, eastern Africa and South America (Brazil) .... ***verruculosa***
4. Hymenophore smooth or almost so, but often strongly pilose with protruding cystidia, at least near the base pigmented yellowish brown, moderately thick to thick-walled, spores allantoid to cylindric **5**
5. Spores suballantoid to allantoid (6-)7-8(-9.5) x 3-3.5(-4)µm, cystidia moderately thick-walled. USA (Florida, Louisiana) .... ***langloisii***
5. Spores ellipsoid to ± cylindric, moderately thick to thick-walled **6**
6. Basidiomes robust, cystidia thick-walled, obtuse or sometimes subcapitate, spores almost cylindric 4.25-6(-6.5) x 2.25-3 µm. Africa (Gabon), South America (Brazil) .... ***africana***

6. Basidiomes thin, more or less pellicular, cystidia moderately thick to thick-walled, spores ellipsoid **7**
7. Spores short-ellipsoid 4.5-5.5 x 3-3.25 µm, cystidia 6-8(-10) µm wide. South America (Colombia), Asia (Thailand). .... ***simulans***
7. Spores 6-10 µm long **8**
8. Spores ellipsoid 6-7(-8) x 3-4 µm; cystidia 9-15 µm wide. USA (Florida). .... ***magnihypha***
8. Spores ellipsoid to cylindrical 6.5-10 x 3-4.5 µm, cystidia 6-10 µm wide. New Zealand. .... ***eruciformis***

***_Cericium luteoincrustatum_** Hjortstam & Ryvarden
Specimen: 15876. The species was described from Argentina (Hjortstam and Ryvarden 1986) and reported by Wu (1990) from Taiwan in the genus *Amethicium* Hjortstam. See further Hjortstam (1995).

***_Cotylidia aurantiaca_** (Pers.) A.L. Welden
Specimens: 15819, 15835. According to Reid (1965) a very common species in tropical America.

***_Dendrothele nivosa_** (Berk. & M. A. Curtis ex Höhn. & Litsch.) P. A. Lemke
Specimen: 15947. A pustulate species with finely rugose spores, about 20-22 x 15-17 µm. Probably rare in North America, West Indies and Asia, (see further Lemke 1964). Cunningham (1963) reported it from Australia.

***_Dextrinocystis capitata_** (D.P. Rogers & Boquiren) Gilb. & M. Blackw.
Specimen: 15889. This species seems to prefer palm-trees and bamboo. The genus comes close to *Tubulicrinis*, but is easily separated by having dextrinoid cystidia.

***_Gloeodontia discolor_** (Berk. & M.A.Curtis) Boidin
Specimen: 15837. Probably pantropical.

Gloeodontia pyramidata (Berk. & M.A.Curtis) Hjortstam
Specimen: 15993. Reported earlier by Hjortstam and Ryvarden (1997) from Colombia. According to the original description *Gloeodontia americana* Rajchenb. is evidently very similar. The main differences between the species seem to be the less abundant skeletal hyphae and slightly smaller spores in *G. pyramidata*. The former is known only from the type and the name was introduced to replace *Irpex regularissimus* Rick, an invalid name. For further details see Rajchenberg (1987).

Hyphoderma gemmeum (D.P. Rogers) Donk .... **Fig. 1 a-d**
Specimens: 15881, 15960. This species was originally described from Co-

lombia (Magdalena) and is similar to *H. argillaceum* (Bres.) Donk, but separated by slender cystidia and somewhat smaller spores.

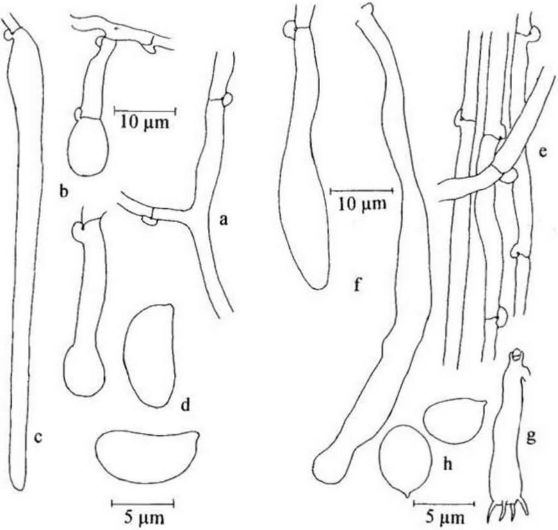

Fig. 1. ***Hyphoderma gemmeum***. Holotype, (Peniophora gemmea) G.W. Martin 3698 (IA). a) hypha b) capitate cystidia c) tubular cystidium d) spores. ***Radulodon venustus***. Holotype, Hjm 16838 e) hyphae f) cystidia g) basidium h) spores.

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Hyphoderma cfr ***obtusiforme*** J. Erikss. & Å. Strid

Specimens: 15986, 15996. The main difference from the European collections is the spores, which are slightly larger than normal for *Hyphoderma obtusiforme*. The Colombian specimens are also strongly reminiscent of *Hyphoderma gigasporum* Boidin & Gilles, described from Reunion (Boidin and Gilles, 1991). In the original description of the latter, the hymenophore was said to be finely odontioid, whereas in the Colombian specimens it is smooth.

Hyphoderma variolosum Boidin et al.
Specimen: 15688. This specimen was erroneously reported as *Hyphoderma heterocystidium* (Burt) Donk by Hjortstam and Ryvarden (1997). *H. variolosum* was originally described from Africa (Central African Republic). For a detailed description, illustration and discussion see Boidin, Lanquetin and Gilles (1991).

***Hyphodontia alutacea** (Fr.) J. Erikss.
Specimen: 15981. *Hyphodontia alutacea* has not previously been collected from subtropical or tropical areas and was an unexpected species in this collection, since it is typical of coniferous wood in the temperate zone. However, morphologically the Colombian specimen is identical with those from Northern Europe.

Hyphodontia niemelaei Sheng H. Wu
Specimens: 15918, 15996/B. The species is very similar to *H. apacheriensis* (Gilb. & Canf.) Hjortstam & Ryvarden and seems only to be separated by somewhat narrower spores. Hyphodontia niemelaei was originally described from Taiwan (Wu 1990) and reported by Langer (1994) from Colombia and Cameroon. Further investigation seems necessary to confirm the separation of the two species.

***Hyphodontia orasinusensis** Gilb. & M. Blackw.
Specimen: 16048. Previously known only from the type (USA, Louisiana). For a detailed description and illustration, see Gilbertson and Blackwell (1988). One of the most striking characteristics of the species is that the basal hyphae lack clamp connections. *Hyphodontia microspora* J. Erikss. & Hjortstam is similar, but has somewhat narrower spores (1.5-2 μm) and clamp-connections at all septa. *Odontia palmae* Rick ex Rambo was considered to be an illegitimate name (nomenclatural not mentioned in the protologue) by Hjortstam and Ryvarden (1982) and the same as *H. microspora,* but later on taken up as an independent species by Langer (1994). There is, however, a discrepancy between Langer's spores measurements and Hjortstam and Ryvarden's descriptions of the specimen. Langer indicates the width to be 2.5-3 μm, whereas Hjortstam and Ryvarden give 1.5-1.75(-2) μm. In a re-examination of the type we find the spores variable, but approximately the same size as in *H. microspora.* We still believe that *Hyphodontia palmae* Rick ex E. Langer is a synonym of *H. microspora.* Further, Langer cited the type as a Lectotype, but it should be the Holotype. *H. palmae* is known only from the type (portion in O).

Hypochniciellum luteolum Hjortstam & Ryvarden **nov. sp.**
Basidioma resupinatum, laxe adnatum, pelliculare vel membranaceum. Hymenophorum leve, plus minus luteolum. Subiculo distincto, albido, margine

indefinito, rhizomorphis inconspicuis vel nullis. Systema hyphale monomiticum; hyphis subicularibus tenuitunicatis, modice ramosis, leviter incrustatis, 2-3 µm latis, hyphis ceteris semilibus sed 3-4 µm latis. Hyphae omnes fibulatae. Basidia subcylindracea (10-)12-15(-20) x 3.5-4 µm, 4 sterigmatibus, sporis levibus, crassitunicatis, late ellipsoideis, 2.75-3 x 2-2.25 µm, pallide amyloideis.

Holotypus: Colombia, Magdalena, Sierra Nevada de Santa Marta, Reserva Forestal San Lorenzo, 17-19 June 1978, Leif Ryvarden No. 15952 (O). Isotypi: (GB and Hjm private herb.).

BASIDIOME resupinate, loosely adnate, thin. HYMENOPHORE smooth, pellicular to membranous, pale yellow with the margin indefinite and without conspicuous hyphal strands, subiculum distinct, greyish white to white. HYPHAL SYSTEM monomitic; subicular hyphae thin-walled, moderately branched, hyaline, 2-3 µm wide, some encrusted with rather small crystals. Other hyphae similar or slightly broader and up to 4 µm wide. All hyphae with clamp connections. CYSTIDIA absent. BASIDIA subcylindric, (10-)12-15(-20) x 3.5-4 µm, with four sterigmata and a basal clamp connection. SPORES smooth, becoming thick-walled, short ellipsoid, slightly variable in size, normally 2.75 -3 x 2-2.25 µm, with a distinct or weakly amyloid reaction, acyanophilous or with a weak reaction in Cotton blue.

This species behaves a resemblance to the generic type of *Hypochniciellum* in its pellicular and smooth fruitbody, hyphae with clamp connections, and lack of cystidial elements. The basidia are fairly small and the spores are at least slightly thick-walled. The main difference is the weakly amyloid spores. The genus *Amyloathelia* should also be considered, but *Amyloathelia* species have larger spores, generally 6-11 µm long, which are besides, distinctly amyloid. Small and smooth spores can also be seen in *Trechispora*, though never with an amyloid reaction, and the hyphal septa are typically ampullate. For the time being we prefer *Hypochniciellum* as the most appropriate genus for the new species.

Key to *Hypochniciellum*

1. Cystidia present , but generally few, spores 5.5-7 x 2.5-3.5 µm. Europe, North America, Canary Islands, mostly on coniferous wood .... **molle**
1. Cystidia absent **2**
2. Spores inamyloid, 4-5 x 2.5-3 µm. Europe, North America, Kenya, India .... **ovoideum**
2. Spores weakly amyloid **3**
3. Spores 6-8 µm long **4**
3. Spores shorter, 4.5(-5) µm long **5**

4. Spores 6-8 x 4-5 µm (Rajchenb. and Wright, 1987) Argentina. **iaganicum**
4. Spores 5-7 x 3-4 µm, Europe and possibly Argentina . **cremeoisabellinum**
5. Spores 3.5-4.5 x 2.5 µm, on coniferous wood. Europe (Sweden), North America, Canary Islands .... **subillaqueatum**
5. Spores 2.75-3 x 2-2.25 µm .... **luteolum**

Leifia flabelliradiata (J. Erikss. & Hjortstam) Ginns
Specimen: 16003. Previously not recorded from South America. The species was originally described as *Phanerochaete flabelliradiata* J. Erikss. & Hjortstam (1981). Later Burdsall (1985) transferred it to *Tubulicrinis*, mainly due to the morphology of the cystidia. Hjortstam (1986) made it the type species of the monotypic *Granulocystis*, being unaware that the name was preoccupied. Finally Ginns (1998) proposed *Leifa*.
The distribution is not well known, but it has been collected several times in Northern Europe and Ginns and Lefebvre (1993) listed it from a few states in Canada and USA. From subtropical and tropical areas it was reported from Taiwan (Wu 1997) and Thailand (Hjortstam and Larsson 1995).
The significant microscopical details are hyphae without clamp connections, thick-walled cystidia swelling at least in KOH, and ellipsoid to suballantoid spores.

Lindtneria cfr. ***chordulata*** (D.P. Rogers) Hjortstam
Specimen: 15870. The specimen is slightly deviating in lacking clamp connections and in having inconspicuously ornamented spores. The specimen seems to be identical with Ryvarden 15756, reported by Hjortstam and Ryvarden (1997) under this name. It should also be noted that these clamp-less specimens are quite similar to *Cristinia brevicellularis* Hjortstam (Hjortstam and Grosse-Brauckmann 1993), but the smooth and slightly larger spores of the latter are sufficient for a definite separation.

Phanerochaete australis Jülich
Specimen: 15816. This seems to be a rather common species in South America. It is very similar to *P. flavocarnea* (Petch) Hjortstam (from Sri Lanka), but may be separated by a paler hymenophore and slightly smaller spores.

Phanerochaete filamentosa (Berk. & M. A. Curtis) Burds.
Specimen: 15946. This species is quite similar to and probably confused with both *P. radicata* and *P. borneensis*. See further Nakasone, Bergman, and Burdsall (1994).

Phanerochaete subquercina (Henn.) Hjortstam
Specimen: 16031. A rather poor specimen and the determination is somewhat uncertain. Previously it was reported from South America by Hjortstam and

Larsson (1995). The species is described several times in the literature, as *Odonticium australe* D. A. Reid (Galapagos Islands), *Phanerochaete radulans* Hallenb. (Iran), *Odontia subirpicoidea* Rick (Brazil), and *Radulum subquercinum* Henn. (Java). Though it lacks clamp connections at all septa, its position in *Phanerochaete* is uncertain and is more probably related to species of *Mycoacia*.

****Phlebia livida*** (Pers.:Fr.) Bres.
Specimen: 15976. Seems to be a cosmopolitan species.

****Phlebia tremellosa*** (Schrad.: Fr.) Nakasone & Burds.
Specimen: 16040. A tiny specimen, but the determination is certain. This is a cosmopolitan species although rare in tropical areas.

Phlebiella cfr. ***vaga*** (Fr.) P. Karst.
Specimen: 16033.

****Phlebiopsis ravenelii*** (Cooke) Hjortstam
Specimens: 15818, 15900 (on palm tree). Both this species and *P. flavidoalba* have been described from USA, (South Carolina and Georgia respectively) and are presumably pantropical. The latter is similar to *P. ravenelii*, but has larger spores, often up to 6-7 x 4.5-5 µm, whereas in *P. ravenelii* they are 4.5-6 x 2.5-3 µm.

Radulodon venustus Hjortstam & Ryvarden **nov. sp.** .... **Fig. 1 e-h**
Basidioma resupinatum, arcte adnatum, distincte aculeatum; aculei circiter 2 mm longi, conici, simplicis vel aggregati. Color initio albidum tum plus minus stramineum. Systema hyphale monomiticum; hyphae tenuitunicatae vel crassiusculae, 2.5-3.5(-4) µm latae, fibulatae. Cystidia tubulosa, tenuitunicata, constricta vel sinuosa, 50-80(-150) x 6-8 µm. Basidia subclavata, leviter constricta, generaliter 20 x 5 µm, 4 sterigmatibus. Sporae subglobosae, tenuitunicatae, leves, 4.5-5 x 3.5 µm, neque amyloideae neque dextrinoideae.

Holotypus: Brazil, Sao Paulo, Cananeia, Ilha do Cardoso, on bark of palm, 2-5 Feb. 1987, Hjortstam 16838 (K).
Paratypi: ditto, on wood of deciduous trees, L. Ryvarden 24717 (GB, K). Colombia L. Ryvarden 15910/B (GB).
Etymology: venustus = graceful

BASIDIOME resupinate, closely adnate. HYMENOPHORE distinctly hydnoid with about 2 mm long, conical aculei, usually solitary but sometimes aggregated, smooth or more commonly with small outgrowths along the side. HYPHAL SYSTEM monomitic; hyphae thin-walled or with slight wall thickening, 2.5-3.5(-4) µm wide, closely intermingled in the subiculum and the centre part of the aculei, all hyphae with clamp connections. CYSTIDIA rather frequent, 50-80(-150) x 6-8 µm, mostly of subhymenial origin, with a rather dense protoplasm (KOH and Melzer's reagent), tubular, thin-walled, constricted and sinuous. BASIDIA subclavate, 18-20(-25) x 4-5 µm, with four sterigmata and a basal clamp connection. SPORES subglobose, smooth, thin-walled, 4.5-5 x 3.5 µm, with homogeneous contents, inamyloid, indextrinoid.

This species is strongly reminiscent of other species in *Radulodon*, except that the spores are thin-walled. Otherwise, and especially in its hyphal texture, hydnoid basidiome and subglobose spores, the species conforms to the concept of the genus.

Resinicium friabile Hjortstam & Melo
Specimen: 15982. The species is very similar to *R. bicolor* (Alb. & Schwein.: Fr.) Parmasto, but has differently shaped spores. See Hjortstam and Melo (1997).

Stereopsis radicans (Berk.) D. A. Reid
Specimens: 15862, 15885. According to Reid (1965) a pantropical species.

Trechispora clanculare (Park.-Rhodes) K. H. Larss.
Specimen: 15903. Confirmed by K H Larsson. In South America previously known only from Brazil, see Hjortstam and Larsson (1995).

Vararia sphaericospora Gilb.
Specimens: 15980, 15994. In South America previously known from Argentina (Iguazu) and Brazil (São Paulo), see Hjortstam and Larsson (1995).

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ONLINE RESOURCES FOR FUNGAL TAXONOMY & NOMENCLATURE:
Collections Online

Kathie T. Hodge
WWW Virtual Library: Mycology
http://mycology.cornell.edu/

> ...a vast backlog of environmental data is lying unused
> in institutions all around the world.
> D.G. Green, 1994
> http://www.csu.edu.au/.WWW/people/dgg/taxon.htm

One impetus for developing databases for herbaria and culture collections has been to facilitate collection management; Lane suggests a broader goal: to provide the widest possible audience with access to biological information. Herbaria and culture collections are potentially vast sources of data for ecologists, policy-makers, natural products chemists, geneticists, biogeographers, systematists, and conservationists. After all, it is through use that collections increase in value.
Lane: Roles of Natural History Collections
http://www.mobot.org/MOBOT/research/Rolenathistcol.html

TOOLS FOR DATABASING

The major obstacle to collection computerization is the cost in time and money for data entry. But assuming computerization is inevitable and you might as well get started, your first task is to decide on a software platform on which your data can grow. Until recently, most institutions developed their own software, resulting in a handful of applications that are powerful but proprietary, and not easily transferable to other collections.

MODELS

It's tempting to begin computerizing a collection using one's favorite spreadsheet or database software. Some have thought very deeply about collection issues, however, and conceived information models that not only facilitate data management but will in future facilitate data exchange. The International Working Group on Taxonomic Databases (TDWG) presents a synthesis of models and associated standards:
TDWG http://www.tdwg.org/
Every institution will customize to some extent, but there are now enough high-quality collection management systems that building your own may be unwarranted. Significant benefits of going with a precompiled package include support,

compatibility with mainstream data models, and quick start-up. Costs may include cessation of upgrades, limited possibilities of customization, and problems stemming from the peculiarities of your data. Below is a selection of available systems developed with biological collections in mind.

BIOTA	http://viceroy.eeb.uconn.edu/biota
BRAHMS	http://www.brahms.co.uk/
HSQL	http://www.nacse.org/databases/
SPECIFY	http://www.usobi.org/specify/Docs.html
TRACY	http://www.csdl.tamu.edu/FLORA/input/inputsys.html

RESOURCES

Next, the endless tedium of data entry! Maybe you can use a scanner; maybe you need a team of skilled keyboardists. Many data to be entered are universal, for example, authorities, localities, taxon names, and addresses. And some of this information is available on the internet, saving you the trouble of typing them in yourself. Authors who have described taxa covered by the botanical code can be sought in the online databases at Kew. Index Herbariorum online provides addresses for herbaria world wide. The Plant Names project promises to provide distributed databases of bibliographical data for seed plant species (maybe fungi too, someday?), and Index Nominum Genericorum (Plantarum) online provides generic names. There are few large online databases of fungal species names as yet; Species 2000 is one project with that goal.

Authors of Plant Names (Kew)	http://www.rbgkew.org.uk/web.dbs/webdbsintro.html
Index Herbariorum	http://www.nybg.org/bsci/ih/ih.html
Plant Names Project	http://pnp.huh.harvard.edu/
Index Nominum Genericorum (Plantarum)	http://www.nmnh.si.edu/ing/
Species 2000	http://www.sp2000.org/

THE HUMAN SIDE

We've not even touched on the practical aspects of data quality control, validation, alpha taxonomy, classification systems, determination histories, handwriting interpretation, vague locality data, specimen quality, back-up systems… There's a lot of work to be done.Many culture collections have developed computerized databases; fewer herbaria have. Mycological collections are listed at the WWW VL: Mycology; there are too many to list here.

WWW VL: Mycology, Collections	http://mycology.cornell.edu/fcollect.html

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ANNOUNCEMENT

NEW BOOK REVIEW EDITOR

We are pleased to announce that Professor David L. Hawksworth, MycoNova, 114 Finchley Lane, Hendon, London, NW4 1DG, United Kingdom (formerly Director of the International Mycological Institute), has accepted appointment to the post of Book Review Editor of MYCOTAXON effective with volume 74. Authors and publishers should submit their publications to be reviewed in MYCOTAXON directly to him. Dr. Hawksworth can be reached also by E-mail at <myconova@btinternet.com> and by Phone/FAX at (+44-8) 203-4282.

Dr. Eric H. C. McKenzie, Landcare Research, Auckland, New Zealand served as our Book Review Editor from 1997 to1999 (volumes 63-73). We would like to express our gratitude for improving the Book Review section, writing reviews, and participating in informing the mycological community on new literature.

Pavel Lizoň
Editor-in-Chief

Publication Date for Volume Seventy-Three

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