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CONTENTS

[CONTENTS continued overleaf]

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CONTENTS continued

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TABLE OF CONTENTS, VOLUME EIGHTEEN

No. 1 July-September 1983

No. 2 October-December 1983

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EAST AFRICAN RUSTS (UREDINALES), MAINLY FROM UGANDA
1. ON POACEAE

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SUMMARY

Forty seven rust taxa from East Africa, mainly Uganda, are reported. As new are described *Puccinia pseudechinolaenae* on *Pseudechinolaena polystachya*, *Uredo kabaleensis* on *Sporobolus agrostoides*, *Uredo sporoboli-pyramidalidis* on *Sporobolus pyramidalis* and *Uromyces hyparrheniae* on *Hyparrhenia filipendula*, all from Uganda. *Physopella hiratsukae*, *Puccinia andropogonis*, *P. chaseana*, *P. emaculata* and *P. flaccida* are reported as new to Africa. Six rust species are new to Uganda, and two are new to Tanzania.

New host genera and species are recorded. The distribution of the rust species is indicated.

The only comprehensive publication dealing solely with Ugandan rust fungi is the one by Wakefield & Hansford (1949) who recorded 238 rust species on 184 host genera. Previous to this and also later scattered records on Ugandan rust fungi have been published. However, there is still much to be done, with respect to the number of species, host range and distribution.

Most of the material presented below was collected by myself (Gj.) on a botanical excursion to Uganda in September to November 1970. Some of the specimens have been obtained by examining phanerogams preserved in the herbarium of Makerere University in Kampala or from phanerogams collected by K.A. Lye, Agricultural University of Norway, Ås-NLH. A few specimens from adjacent countries, obtained from the herbarium of Makerere or collected by L. Ryvarden and A. Bjørnstad, University of Oslo, are also discussed.

Except for the material collected by Ryvarden and Bjørnstad, the material will be deposited in the herbarium of Makerere University (MHU). Parts of some specimens, in some cases slides only, will be preserved at the herbarium of NPPI. Specimens collected by Ryvarden and Bjørnstad will be kept at the Botanical Museum, Oslo (herb. O).

If not otherwise stated, the localities given are in Uganda. Altitudes are given in metres.

The excursion to Uganda as well as a two months stay in 1981 with Dr. G.B. Cummins, Dept. of Plant Pathology, University of Arizona, Tuczon, Az., U.S.A., was financed by the Norwegian Agency for International Development (NORAD), and for which I am most grateful. I also want to thank the Norwegian botanists mentioned above for giving me the opportunity to examine their collections. My thanks are also due to Mr. A.B. Katende and Mr. P.K. Rwaburindore, Makerere University, Kampala, for their help and company on the excursions, and to Dr. G.B. Cummins for valuable discussions concerning the identifications of the graminicolous rusts presented below. I also want to thank him and Dr. D.M. Henderson, Royal Botanic Garden, Edinburgh, Scotland, for critical reading of the manuscript. Finally I want to thank the Norwegian Plant Protection Institute for giving me leave of abcense in 1970 and 1981.

Phakopsora apoda (Har. & Pat.) Mains. Mycologia 30:45, 1938.
Syn. Puccinia apoda Har. & Pat. Bull.Mus.Hist.nat. Paris 15: 199, 1909.
On Pennisetum polystachion (L.) Schult. (syn. P. setosum (Sw.) A. Rich.)
Bugisu Distr., Central Bugisu Co., 2-3 km N of Busoba, 1200 m, 31.5.1969, K.A. Lye (3141 II), II; Teso Distr., Serere Co., Serere Research Station, 1200 m, Gj. (434), II.

Uredinia with hyaline to golden, incurved, dorsally thickened paraphyses. Urediniospores 23-27(-32) x 17-23 (-25) um, obovoid or ellipsoid, wall about 1.5 um thick, hyaline, echinulate and with scattered, obscure pores.

Wakefield and Hansford (1949) reported this rust species on the same host from Tororo and from Bugwere, Pallisa, and also on Setaria aequalis Stapf from Kampala. However, Cummins (1956) recorded the rust on S. aequalis as Phakopsora setariae Cumm.

Ph. apoda has a wide distribution in Africa, reported from Sudan, Ethiopia, Kenya, Uganda, Tanzania, Mosambique, Malawi, Chad (type locality), Nigeria, Ghana and S. Africa. Outside Africa it is known from Ascension Island, New Zealand and India. This rust species is known only on Pennisetum.

Phakopsora incompleta (Syd.) Cumm. Mycologia 42:786, 1950.
Syn. Puccinia incompleta Syd. in Sydow & Butler, Annls mycol. 10:261, 1912; Uredo polliniae-imberbis Ito, J.Coll.Agr. Tokoku Imp. Univ. 3:246, 1901.
On Hyparrhenia rufa (Nees) Stapf
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, 25.11. 1967, A.B. Fernandes, II, Kabanyolo, 1200 m, Gj. (477), II.
On Themeda triandra Forssk.
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (270), II.

Uredinia with hyaline to yellowish, incurved paraphyses with dorsally and apically thickened wall. Urediniospores 18-32 x 14-20 um, obovoid to nearly globoid, wall 1.5-2 um thick, echinulate and with scattered, obscure pores. Urediniospores measured by me are somewhat longer on *Themeda* (32 um) than those on *Hyparrhenia* (27 um), but they are within the range given by Cummins (1971).

Wakefield & Hansford (1949) reported this rust as *Puccinia incompleta* on *Andropogon dummeri* Stapf (= *A. chinensis* A. Rich.) from Kawanda in W. Mengo.

Hyparrhenia is a new host genus for this rust species, while *Themeda triandra* has been reported as host by Cummins (1957) without giving the locality. The rust has a wide distribution in Asia from India to Japan and the Far East of Siberia, and it is also recorded from New Guinea. Other host genera are *Ischaemum* (type on *I. ciliare* Retz var. *wallichii*, Hack., India), *Dimera*, *Exotheca*, *Microstegium* and *Pollinia*.

Phakopsora loudetiae Cumm. Bull. Torrey Bot. Club 83:223, 1956.

On *Loudetia arundinacea* (A. Roch.) Steud.
Tanzania. Iringa Distr., Ruaha National Park, 4 km SSW of Magangwe Ranger Post, 1360 m, 20.3.1973, A. Bjørnstad (2698), II.
On *Loudetia kagerensis* (K. Schum.) Hutch.
W. Mengo Distr., Busiro Co., Zika Forest, 1160 m, Gj. (76), II.
On *Loudetia phragmitoides* (Peter) Hubb.
Masaka Distr., Buddu Co., Bugabo, near Nabugabo, ca 1100 m, 18.9.1965, S.L. Bandio, II.

Uredinia with pale yellow, dorsally thickened, incurved paraphyses. Urediniospores 20-32 x 14-25 um, wall 1.5-2 um thick, pale cinnamon-brown, densely echinulate with scattered obscure pores.

Ph. loudetiae, reported only from Kenya, Uganda and Nigeria, was described on *L. arundinacea* (A. Rich.) Steud. from Omia Anyema in Uganda. On this host it is also reported from Kenya. On *L. kagerensis* it is reported from Entebbe, and also from Kenya while *L. phragmitoides* is a new host for this rust species.

The rust is new to Tanzania.

Phakopsora setariae Cumm. Bull. Torrey Bot. Club 83: 223, 1956.

On *Setaria homonyma* (Steud.) Chiov. (syn. *S. aequalis* Stapf)
W. Mengo Distr., Busiro Co., Entebbe, 1150 m, Gj. (41), II.
On *Setaria poiretiana* (Schult.) Kunth (syn. *S. caudula* Stapf)
W. Mengo Distr., Busiro Co., Zika Forest, 1160 m, Gj. (77), II + III.
On *Setaria sphacelata* (Schumach.) Moss
Karamoja Distr., Mathenico Co., Mt. Morimoto, SE of Sogolouron, 1500 m, 11.6.1970, K.A. Lye, A.B. Katende & D. Swinscow, II.

Uredinia with hyaline, dorsally and apically thickened paraphyses. Urediniospores 20-34 x (14-)17-20 µm, obovoid or ellipsoid, wall 1-1.5 µm thick, hyaline or slightly yellowish, finely echinulate and with scattered pores. Telia blackish brown, covered by epidermis. Teliospores (18-)22-32 x 9-16 µm, obovoid to ellipsoid, wall 1.5 µm thick, slightly thickened at apex, yellow brown, smooth.

Ph. setariae, described on *S. lancea* Stapf (= *S. homonyma*) from Sudan, has previously been reported as *Ph. apoda* (Har. & Pat.) Maine on *S. aequalis* (= *S. homonyma*) from Kampala by Wakefield & Hansford (1949), but Cummins (1956) placed the same specimen with *Ph. setariae*, while *S. poiretiana* is a new host for this rust. *S. sphacelata* which is a new host in Uganda, has been recorded as host for this rust in Malawi. Outside Africa the rust is reported on *S. palmifolia* (Koen.) Stapf from New Guinea.

Physopella africana (Cumm.) Cumm. & Ramachar. Mycologia 50: 742, 1958.
Syn. *Angiopsora africana* Cumm. Bull. Torrey Bot. Club 83: 221, 1957.
On *Brachiaria brizantha* (A. Rich.) Stapf
W. Mengo Distr., Kyadondo Co., Kampala, Makerere 1200 m, 14.9.1964, Kimura, II, Busiro Co., Entebbe, 1150 m, Gj. (33, 37b, 39), II.
Kenya. Kitale G.R.S. Nursery, 26.1.1955, Alibytekerwa, II.
On *Brachiaria eminii* (Mez) Robyns
Mubende Distr., Singo Co., Mile 70 from Kampala on the Hoima road, Gj. (300), II.
On *Brachiaria jubata* Fig. & De Not. (syn. *S. soluta* Stapf)
Kenya. Green Valley, 1200 m, 2.10.1967, Makundi, II.

Uredinia with peripheral, incurved, nearly hyaline to yellowish paraphyses. Urediniospores 25-34 x 16-20 µm, ellipsoid or obovoid, with nearly hyaline echinulate wall, about 1.5 µm thick, and scattered, obscure pores.

Ph. africana was described on *B. decumbens* Stapf from Kabale in Kigezi. On *B. brizantha* it is reported from Uganda (no locality given) and Kenya, while *B. eminii* and *B. jubata* are new hosts for this rust.

Physopella cameliae (Arth.) Cumm. & Ramachar. Mycologia 50: 742, 1958.
On *Panicum maximum* Jacq.
W. Mengo Distr., Busiro Co., Entebbe, 1150 m, Gj. (24b), II.

Uredinia with small, peripheral, incurved, dorsally and apically thickened, hyaline to yellowish paraphyses. Urediniospores 23-27(-32) x 16-20(-22) µm, ellipsoid or obovoid, wall 1.5-2 µm thick, hyaline, echinulate with scattered, obscure pores.

Ph. cameliae is a new rust species in Uganda, but it has been reported on the same host from Tanzania (Wallace & Wallace 1949, Riley 1960). Its main distribution is on *Pennisetum* spp. and *Setaria* spp. (type on *S. scandens* (Jacq.) Schrad.) in the Americas from Texas (U.S.A.) to Puerto Rico, Trinidad, Brazil and Colombia (type locality).

Physopella hiratsukae (Syd.) Cumm. & Ramachar. Mycologia 50: 742, 1958.
Syn. *Angiopsora hiratsukae* Syd. Annls mycol. 34: 70, 1936.
On *Eragrostis patens* Oliv.
W. Mengo Distr., Buruli Co., Mile 66 on the Kampala-Masindi road, 1200 m, 5.7.1963, Ganzi, II.

Uredinia with hyaline to slightly yellow paraphyses. Urediniospores 19-25 x 14-20 µm, mostly obovoid, with a hyaline, echinulate, less than 1.5 µm thick, echinulate wall and scattered, obscure pores.

This rust is new to Africa, previously reported on *Eragrostis* sp. from Taiwan (type locality) and Japan. *E. patens* is a new host.

Puccinia andropogonicola Hariot & Pat. Bull.Mus.Hist.nat. Paris 1909: 199, 1909.
On *Hyparrhenia filipendula* (Hochst.) Stapf
W. Mengo Distr., Busiro Co., Zika Forest, 1160 m, Gj. (80), II, Entebbe, 1150 m, Gj. (19a), II; Teso Distr., Serere Co., Serere Research Station, 1200 m, Gj. (427), II. Tanzania. Coast Prov., Kwale Distr., Shimba Hills, Pengo Hill, 300 m, 9.1.1970, A. Bjørnstad (241), II.
On *Hyparrhenia newtonii* (Hack.) Stapf
Masaka Distr., Kalungu Co., near Kasasa N of Mukoko, 1180 m, 5.6.1971, K.A. Lye (M 109), II.
On *Hyparrhenia pilgeriana* Hubb.
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (472), II.
On *Hyparrhenia rufa* (Nees) Stapf
West Nile Distr., Vurru Co., 3 km NW of Uleppi, 1100 m, 12.2.1969, K.A. Lye (2186) & R.N. Lester, II.
On *Hypertella dissoluta* (Steud.) W.D. Clayton (syn. *Hyparrhenia dissoluta* (Steud.) Hubb.)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (464), II, Busiro Co., Zika Forest, 1160 m, Gj. (79), II; Masaka Distr., Buddu Co., Mile 70 on the Masaka-Mbarara road, 1400 m, Gj. (297), II.

Uredinia with thin-walled, often somewhat curved, capitate or clavate, hyaline to yellowish paraphyses. Urediniospores 25-32 x 19-28 µm, obovoid, wall brown to dark brown, 2-2.5 µm thick, echinulate and with 3-4 equatorial pores.

On *H. rufa* the urediniospores seem to be somewhat larger, especially wider, than on the other host species, measuring 27-32 x 25-28 µm, against (19-)21-30 x 17-23 µm on the other host species.

In Uganda Wakefield & Hansford (1949) found the rust on *Cymbopogon* sp. and *Hyparrhenia* sp. at Serere in Teso Distr. (see also Cummins 1945). Cummins (1953) reported it on *H. dissoluta* (= *Hypertella dissoluta*) from Kawanda in W. Mengo (listed by Wakefield & Hansford (op.cit.) as *P. kaernbachii* Arth.). The other hosts mentioned are all new to Uganda, but *H. filipendula*, a new host for this rust also in Tanzania, has been reported from Zambia and *H. rufa* from Tanzania and Mauritius. To my knowledge *H.*

newtonii and *H. pilgeriana* are new hosts for this rust. Other hosts are *H. diplandra* (Hack.) Stapf in Kenya, *H. anthistirioides* (A. Rich.) Stapf (syn. *H. pseudocymbaria* (Steud.) Stapf) in Sudan, *Andropogon* spp. in Guinea, Congo and Madagascar and *Cymbopogon* spp. in Ghana, Sudan, Ethiopia and India.

Puccinia andropogonis Schw. Trans. Am. phil. Soc. II. 4: 295, 1832.
On *Cymbopogon densiflorus* (Steud.) Stapf
Kenya. Central Prov., Suam Forest Station, ca 2100 m, 23.-24.1. 1973, L. Ryvarden (9274), II (det. G.B.Cummins).

Uredinia without paraphyses. Urediniospores 23-27 x 18-25 µm, obovoid or ellipsoid to nearly globoid, wall hyaline, 2-2.5 µm thick, echinulate with scattered, obscure pores.

Cymbopogon is a new host genus for this rust, previously known only on *Andropogon* spp. from Canada to Guatemala. The aecial stage (*Aecidium pentastemonis* Schw.) occurs on several host families (Cummins 1971). Ebbels (1972) reported the aecial stage on *Amphicarpa africana* (Hook. f.) Harms from Kigezi, but an examination of the specimen (IMI 155322) showed that the fungus is not an aecium.

Puccinia arthraxonis-ciliaris Cumm. Uredineana 4: 16, 1953.
Syn. *Uredo arthraxonis-ciliaris* P. Henn. Hedwigia 47: 251, 1908.
On *Arthraxon micans* (Nees) Hochst. (syn. *A. quartinianus* (A. Rich.) Nash)
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (276), II; Bugisu Distr., N. Bugisu Co., Bumasifwa School, 1300 m, Gj. (405), II; Manjiya Co., near Bukalasi, 1700 m, 18.11. 1968, K.A. Lye & R.N. Lester (545), II.

Uredinia with clavate, often curved, hyaline to yellowish, thin-walled paraphyses, often slightly thickened at apex. Urediniospores 24-30(-32) x 21-27 µm, broad ellipsoid to subgloboid, often somewhat irregular, wall 1.5 µm thick, pale yellow, echinulate and with (3-)4-5 equatorial pores.

Wakefield & Hansford (1949) reported this species as *U. arthraxonis-ciliaris* on the same host from several localities in the southern part of Uganda, from Mt. Elgon westwards to Kisoro in Kigezi. It is also reported on the same host from Ethiopia and the Philippines. On other *Arthraxon* spp. it is known from New Guinea, Mauritius, India, Nepal, China, Taiwan, Philippines (type locality), Ryukyu Isl., Japan and the Far East of Siberia.

Puccinia brachypodii Otth var. arrhenatheri (Kleb.) Cumm. & H.C. Greene. Mycologia 58: 709, 1966.
Syn. *P. perplexans* Plowr. f. *arrhenatheri* Kleb. Abh. naturw.Ver. Bremen 12: 366, 1892; *P. arrhenatheri* Eriks. Beitr. Biol. Pfl. 8: 14, 1898; *P. deschampsiae* Arth. Bull. Torrey Bot. Club 37:570, 1910.
On *Deschampsia caespitosa* (L.) P. Beauv. var. *latifolia*

(A. Rich.) Hook. f.
Ruwensori, New Bujerk Hut, c. 4000 m, 6.1968, A.C. Hamilton (715), II.

Uredinia with hyaline to pale yellow, capitate paraphyses, often thickened at apex. Urediniospores 23-30 x 20-23 µm, obovoid to ellipsoid, wall 1.5-2 µm thick, pale yellow, echinulate with scattered, obscure pores.

This var. is circumglobal on a long range of host genera with aecia on *Berberis* spp. *Deschampsia* is a new host genus for this var. in Africa, but it is common in Europe esp. on *D. caespitosa*, and it is also reported from Alaska and Colorado in U.S.A. and from Chile, New Guinea and Japan.

Puccinia brachypodii Otth var. poae-nemoralis (Otth) Cumm. & H.C. Greene. Mycologia 58: 705, 1966.
Syn. *P. poae-nemoralis* Otth. Mitth. naturw. Ges. Bern 1870: 113, 1871.
On *Poa annua* L.
Kigezi Distr. Rubanda Co., near Rwaburimbe, 2500 m, 9.12. 1968, K.A. Lye & R.N. Lester, II, and at Mile 26 on road Kabale-Kisoro, 2100 m, Gj. (205), II, Bufumbira Co., on the saddle between Gahinga and Muhavura, 3100 m, Gj. (253), II.

Uredinia with hyaline, capitate or clavate, often curved paraphyses, thickened at apex. Urediniospores 18-23 x 17-19 µm, obovoid, wall 1.5-2 µm thick, hyaline, echinulate and with scattered, obscure pores.

This var. is circumglobal on *Poa* spp. and several other host genera. On *P. annua* it is reported as *P. poae-nemoralis* from Morocco, Algeria and S. Africa. It is a new member of the rust flora of Uganda.

Puccinia cenchri Diet. & Holw. var. africana Cumm. Bull. Torrey Bot. Club 79: 217, 1952.
Syn. *Uredo cenchricola* P. Henn. Congo Anal. 2: 223, 1908.
On *Cenchrus ciliaris* L.
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (274), II, and Kabanyolo, 1200 m, Gj. (467), II; Toro Distr., Busongora Co., Mweya Lodge, 930 m, Gj. (155), II.
Pennisetum clandestinum Chiov.
No data given, Uganda Agric. Dept., (Ex herb. Makerere), II (det. G.B.Cummins).

Uredinia without paraphyses. Urediniospores 28-36(-41) x (19-)25-29 µm globoid to obovoid. Wall 1.5-2 µm thick, golden to cinnamon-brown, echinulate, with mostly 4, rarely 5, equatorial pores.

Cummins (1943) and later Wakefield & Hansford (1949) listed this fungus as *U. cenchricola* on *C. ciliaris* from Kawanda in W. Mengo. Later the var. *africana* was described from the same locality. *Pennisetum* is a new host genus for this var., but it has been reported as a host for var. *cenchri* in the Americas.

Puccinia chaseana Arth. & Fromme. Torreya 15: 264, 1915.
On *Anthephora truncata* Robyns (syn. *A. gracilis* Stapf & Hubb.)
Tanzania. W. Province, near Tabora, c. 1200 m, 29.4.1962, A.C. Tallantire (401) II + III.

Uredinia with straight or incurved, thin-walled, hyaline paraphyses. Urediniospores 25-32 x 22-25 µm, ellipsoid to globoid, wall 1.5-2 µm thick, yellow to cinnamon-brown, echinulate, and with 4 equatorial pores. Telia long covered by epidermis, blackish, with dark brown paraphyses. Teliospores 45-50 x 16-23 µm, clavate, wall 1 µm thick at the sides, at apex thickened up to 5 µm, chestnut-brown, smooth. Pedicel short, yellowish.

P. chaseana is a new rust species to Africa, and *A. truncata* is a new host for this rust. It has previously been reported on *A. hermaphrodita* (L.) Kze. from Jamaica (type locality) and Cuba to Guatemala and Colombia.

Puccinia coronata Cda. Icon. Fung. 1: 6, 1837, var. coronata.
On *Helictotrichon milanjianum* (Rendle) Hubb.
Kigezi Distr., Bufumbira Co., N of Gahinga, in the Forest Reserve, 2600 m, Gj. (251), II.

Uredinia with a few, clavate, thin-walled paraphyses. Urediniospores 20-28 x 18-23 µm, broadly ellipsoid to nearly globoid, wall 1.5-2 µm thick, yellowish to nearly hyaline, echinulate and with scattered, obscure pores.

The worldwide distributed crown rust alternating with *Rhamnus* spp., has been found on several host genera in Africa, but the only record from Uganda is on *Helictotrichon lachnanthum* (A. Rich.) Hubb. from Kabale in Kigezi (Wakefield & Hansford 1949). *H. milanjianum* is a new host for the crown rust.

Puccinia cynodontis Lacroix ex Desm. Pl.Crypt.Ser. III, No. 655, 1859.
Syn. *P. cynodontis* Fuck. Symb. Mycol. Nachr. 2: 16, 1875.
On *Cynodon aethiopicus* Clayton & Harlany (syn. *C. glabratus* Steud.)
Ankole Distr., Kashari Co., Kamatalis, ca 1200 m, 8.2.1950, T. Janett (509), II.

Uredinia without paraphyses. Urediniospores broadly ellipsoid to obovoid, 23-27 x 18-24 µm. Wall cinnamon-brown, verrucose, 2-3(-3.5) µm thick with 2-3 equatorial pores.

This rust which is circumglobal and especially widespread in Africa, mainly on the type host *Cynodon dactylon* (L.) Pers. (type locality France), was reported on *C. plectostachyus* (K. Schum.) Pilger from Fort Portal by Wakefield & Hansford (1949). The present host might have been included in *C. dactylon* from which it has been segregated. The rust species is also reported on *Setaria viridis* (L.) P. Beauv., but as this belongs to another tribe in the Poaceae, the record might be doubtful.

The aecial stage, described as *Aecidium plantaginis*

Ces., which occurs on plants belonging to several host families, has been found on *Adonis* sp. in Tunis and on *Plantago coronopus* L. in Algeria.

Puccinia digitariae-velutinae Vien.-Bourg. Bull.Soc. mycol. Fr. 67: 431, 1951.
Syn. *P. digitariae-vestitae* Ramachar & Cumm. Mycopath. Mycol. appl. 25: 18, 1965.
On *Digitaria abyssinica* (A. Rich.) Stapf (syn. *D. vestita* Fig. & de Not. var. *scalarum* (Schweinf.) Henr.)
W. Mengo Distr., Kyandondo Co., Makerere, 1200 m, Gj. (95 and 115), II; Busoga Distr., Butembe Bunya Co., Jinja, near Freshwater Station, 1150 m, Gj, (100), II; Mubende Distr., Buwekula Co., Mubende Centrum, 1300 m, Gj. (164), II; Toro Distr., Burahya Co., Fort Portal Center, 1500 m, Gj. (165), II; Ankole Distr., Nyabushozi Co., Ruhengere Research Station, 1300 m, Gj. (124), II.
On *Digitaria ciliaris* (Retz.) Koel. (syn. *D. adscendens* Henr.)
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (263), II.
Tanzania. Iringa Distr., Ruaha National Park, 5 km NE of Msembe, 800 m, (undated) 1971, A. Bjørnstad (816), II + III.
On *Digitaria longiflora* (Retz.) Pers.
Ankole Distr., Bunyaruguru Co., Kalinzu Forest, 1400 m, Gj. (142), II.
On *Digitaria ternata* (A. Rich.) Stapf
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (291), II; Bugisu Distr., Central Bugisu Co., Mbale, at the golf course, 1200 m, Gj. (434), II; E. Mengo Distr., Buruli Co., Mile 125 from Kampala on the Masindi road, 1250 m, Gj. (359), II.
On *Rhynchelytrum repens* (Willd.) Hubb.
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (275), II (+ III), (det. G.B.Cummins).

Uredinia with hyaline paraphyses. Urediniospores on *Digitaria* 18-25(-32) x 16-24(-27) µm, on *Rhynchelytrum* 28-36 x 21-25 µm, wall 2-2.5 µm thick, yellow-brown, densely echinulate and with scattered pores. Telia blackish, compact, exposed. Teliospores 33-44 x 17-23 µm, clavate, side wall 1-1.5 µm, at apex thickened to 3.5 µm, cinnamon-brown. Pedicel thin-walled, slightly coloured.

From Uganda *P. digitariae-velutinae* has previously been recorded on *Digitaria merkeri* Mez (= *D. abyssinica* (A. Rich.) Stapf) and *D. vestita* var. *scalarum* (= *D. abyssinica*), the latter from Kigezi as type of *P. digitariae-vestitae*. *D. longiflora* and *D. ternata* are new host species and *Rhynchelytrum repens* represents a new host genus for this rust. *D. adscendens* (= *D. ciliaris*) has also been reported as a host from Tanzania and India, and *D. vestita* including var. *scalarum* (= *D. abyssinica*) from Kenya and Zambia. This rust, described on *D. velutina* (Forssk.) P. Beauv. from Ivory Coast, is also reported on the same host from Kenya.

Puccinia dietelii Sacc. & Syd. in Sacc. Syll. Fung. 14: 358, 1899.
Syn. *P. chloridis* Diet. Hedwigia 31: 290, 1892 (non Speg. 1891); *P. chloridina* Bacc. Annali Bot. 4: 269, 1906.
On *Chloris gayana* Kunth
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (482), II; Toro Distr., Busongora Co., Mweya Lodge, 930 m, Gj. (157), II.
On *Chloris pilosa* Schumach.
E. Mengo Distr., Buruli Co., near Kafu Bridge, 1050 m, Gj. (365), II.
On *Chloris pycnothrix* Trin.
Toro Distr., Busongora Co., Mweya Lodge, 930 m, Gj. (152), II.

Uredinia without paraphyses. Urediniospores obovoid, (16-)2-24 x (13-)15-20 µm. Wall hyaline, 1.5-2.5 µm thick, at apex thickened to 8 µm, densely echinulate, pores obscure.

This rust species is reported in Africa from Sudan and Ethiopia to S. Africa, often as *P. choridis* Speg. According to Cummins (1971) *P. chloridis* Speg. is an entirely American rust species while *P. choridis* Diet. (= *P. dietelii*) is known both in the Americas and in Africa. In most cases there is no description, so the rust cannot with certainty be verified without a re-examination of the specimens. However, following the statement by Cummins, this rust has been recorded as common in Uganda by Wakefield & Hansford (1949) on *C. gayana*, *C. pycnothrix*, *C. virgata* Sw. and *C.* sp. Also Ebbels (1972) reported this rust on *C. gayana*. A record by Angus (1966) on *Andropogon gayanus* Kunth from Zambia might be doubtful as *Andropogon* belongs to another tribe of the Poaceae.

Cummins (1963) proved this rust to be host alternating with *Acalypha* spp. in U.S.A., and he indicated that *Aecidium acalyphae* P. Henn., reported from Zaire, might be similar to the American aecial stage. To my knowledge, no inoculation experiments have been carried out with African material.

Puccinia duthiae Ell. & Tracy in Ellis & Everh. Bull. Torrey Bot. Club 24: 283, 1897.
Syn. *P. amphilophidis* Doidge. Bothalia 3: 496, 1939.
On *Bothriochloa bladhii* (Retz.) S.T. Blake (syn. *B. glabra* (Roxb.) A. Camus)
Tanzania. Iringa Distr., c 2 km E of Kidatu Dam site, 14.7. 1970, A. Bjørnstad (437), II+III.
On *Chrysopogon serrulatus* Trin. (syn. *C. aucheri* (Boiss.) Stapf)
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (272), II, and Kabanyolo, 1200 m, Gj. (469), II + III.

Uredinia with hyaline to pale yellow paraphyses. Urediniospores 27-33 x 21-25 µm, mostly obovoid, wall 2-2.5 µm thick, cinnamon-brown, slightly darker at apex, echinulate and with 4-5 mostly equatorial pores. Telia blackish, exposed, compact. Teliospores 34-38(-44) x 23-27 µm, broadly ellipsoid, slightly constricted at septum, wall brown, 2-2.5 µm thick, at apex thickened to 7 µm. Pedicel long, pale brown near the spore, nearly hyaline further down.

P. duthiae has been reported on *Bothriochloa* spp. from Kenya, Tanzania, Zambia and S. Africa. It is new to the rust flora of Uganda and *Chrysopogon* is a new host genus for the rust. In Asia and Australia also *Andropogon* and *Dichanthium* are recorded as host genera.

Narasimhan (1965) proved the rust in India to be host alternating with *Barleria cuspidata* Heyne mentioning the aecial stage, "previously named *Aecidium barleriae*, *Ae. salamii*, etc.". However, Laundon (1963) kept the two aecial stages separate, *A. barleriae* Doidge 1948 (non Salam & Ramachar 1956) occurring on *Barleria crassa* C.B. Cl., reported from Zambia only, while *Ae. salamii* Laundon occurs on *B. cuspidata* in India. To my knowledge no inoculation experiments have been carried out with the African rust.

Puccinia emaculata Schw. Proc. Am. Phil. Soc. II, 4: 295, 1832.
Syn. *P. panici* Diet. Erythea 3: 80, 1895.
On *Paspalum scrobiculatum* L. (syn. *P. commersonii* Lam.)
W. Mengo Distr., Buruli Co., Mile 70 from Masaka on road to Mbarara, 1400 m, Gj. (294), II.

Uredinia without paraphyses. Urediniospores 22-28 x (17-)19-25 µm, irregularly obovoid to globoid, wall 1.5 -2 µm thick, slightly thickened at apex, cinnamon-brown, densely echinulate, and with 3 equatorial pores.

P. emaculata is a new rust species in Africa. Earlier it has been reported from U.S.A. east of Rocky Mountains, N. Mexico, and it may also occur in Chile (Cummins 1971). It is also reported as *P. panici* Diet. from Portugal (Sousa da Camara 1958).

Puccinia eritraeensis Paz. Bot. Jahrb. 17: 14, 1893.
On *Andropogon chinensis* (Nees) Merr. (syn. *A. schinzii* Hack.)
Kenya, Kitale G.R.S. Nursery, 1.2.1955, Alibytekerwa, II + III.
On *Hyparrhenia collina* (Pilger) Stapf
W. Mengo Distr., Kyadondo Co., Mbuja Hill, 1200 m, 3.8.1969, leg. P.K. Rwaburindore (89), II.
On *Hyparrhenia cymbaria* (L.) Stapf
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (271), II, Kabanyolo, 1200 m, Gj. (478), II, and Bombo Road, 1200 m, 6.10.1961, R.M. Sawaki, II; Bunyoro Distr., Bugahya Co., Hoima, 1500 m, Gj. (327a), II.
On *Hyparrhenia diplandra* (Hack.) Stapf
W. Mengo Distr., Busiro Co., Zika Forest, 1160 m, Gj. (78), II + III.
On *Hyparrhenia filipendula* (Hochst.) Stapf
Masaka Distr., Kalunga Co., 3 km S of W. Mengo Border, 1140 m, 5.6.1971, K.A. Lye (M 106), II; Bunyoro Distr., Bujenje Co., Itutwe Borehole near Biso, 1050 m, Gj. (339), II.

On *Hyparrhenia hirta* (L.) Stapf
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (476), II.
On *Hyparrhenia papillipes* (A. Rich.) Stapf
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (476), II.
On *Hyparrhenia* sp.
Bunyoro Distr., Bujenje Co., Itutwe Borehole near Biso, 1050 m, Gj. (337), II.

Uredinia with capitate, thick-walled, hyaline to pale yellow paraphyses. Urediniospores (21-)23-32(-34) x 19-25 (-27) µm, ellipsoid to nearly globoid, wall 2-3 µm thick, dark cinnamon-brown, echinulate and with scattered pores. Telia blackish brown, compact, exposed. Teliospores 30-40 x 19-26(-28) µm, broadly ellipsoid, slightly constricted at the septum, wall 2-2.5 µm thick at apex thickened to 6(-9) µm, smooth. Pedicel long, thin-walled, hyaline.

Wakefield & Hansford (1949) reported this rust species on *Cymbopogon afronardus* Stapf (= *C. nardus* (L.) Rendle) from Kampala and on *H. cymbaria*, *H. filipendula* and *H. pilgeriana* Hubb. from several localities in the Bunyoro and Kigezi Districts.

H. collina and *H. papillipes* are both new hosts for this rust species, while the other hosts have been reported from several countries in Africa, and also from Mallorca (Spain), China and Australia.

This species, described from Ethiopia on *Andropogon* sp., is widespread in Africa, and it is also known in Australia and Honduras. Without teliospores it is doubtful if it can be distinguished from *P. andropogonis-hirti* Beltrán and *P. hyparrheniicola* Jørst. & Cumm. The reason for placing the specimens lacking telia listed above in *P. eritraeensis* is that *P. andropogonis-hirti* has a Mediterranean distribution while *P. hyparrheniicola* is known only from Macaronesia.

Puccinia eucomi Doidge. Bothalia 3: 497, 1939.
On *Hyparrhenia filipendula* (Hochst.) Stapf
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (474), II.

Uredinia without paraphyses. Urediniospores 25-29(-32) x (18-)20-23 µm, mostly obovoid, sometimes subgloboid, wall hyaline, 1.5-2 µm thick at the sides, at apex thickened to 11 µm, echinulate and with equatorial, obscure pores.

Hyparrhenia represents a new host genus for this rust, only known from S. Africa on *Andropogon eucomus* Nees (type host) and *A. huillensis* Rendle (= *A. laxatus* Stapf).

P. eucomi differs from *P. hyparrheniae* Cumm. having narrower urediniospores which are less thickened at the apex than are those of *P. hyparrheniae*.

Puccinia flaccida Berk. & Br. in Berkeley, J. Linn. Soc. 14: 91, 1873.
Syn. *Diorchidium flaccidum* (Berk. & Br.) Kze. Rev.Gen. 3: 468, 1898; *D. levigatum* Syd. & Butl. Annls mycol. 5: 500, 1907.

On *Oplismenus hirtellus* (L.) P. Beauv.
Busoga Distr., Bukoli Co., Lolui Island, 1150 m, 19.5.1964, G. Jackson (124), II.

Uredinia without paraphyses. Urediniospores 23-27(-30) x 18-23 µm, obovoid or ellipsoid, wall 1.5-2.5 µm thick, dark brown, scattered echinulate with 3 equatorial pores.

P. flaccida is a new species to the African rust flora and *O. hirtellus* is a new host for this rust which has been reported on other *Oplismenus* spp. from Sri Lanka (type locality), India and Japan.

The urediniospores in the present specimen are slightly narrower than given by Cummins (1971) and they are not so densely echinulate as he has shown in his drawings. However, it is closer to *P. flaccida* than to any other rust species reported for this host genus.

Puccinia fragosoana Beltrán. Mem. R. Soc. Esp. Hist. Nat. 50:249, 1921.
On *Imperata cylindrica* (L.) Raeuschel
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (273), II.

Uredinia with capitate, brownish paraphyses, often strongly thickened at the apex. Urediniospores 29-36 x 20-27 µm, obovoid or ellipsoid, wall 2 µm thick at the sides, thickened up to 8 µm at the apex, cinnamon-brown, apex darker, echinulate and with 4-5 equatorial pores.

This rust, widespread in Africa on the same host, is new to the flora of Uganda. It is also reported on this host from Spain (type locality) and Israel. Other African hosts are *Schizachyrium sanguineum* (Retz.) Alst. (syn. *S. semiberbe* Nees) and *Loudetia simplex* (Nees) Hubb. (syn. *Trichopteryx simplex* (Nees) Engl.).

P. fragosoana differs from *P. rufipes* Diet. on the same host having urediniospores thickened at the apex.

Puccinia hyparrheniae Cumm. Bull. Torrey Bot. Club 83: 226, 1956.
On *Hyparrhenia* cf. *diplandra* (Hack.) Stapf
W. Mengo Distr., Busiro Co., Zika Forest, 1160 m, Gj. (81), II.

Uredinia without paraphyses. Urediniospores 25-29(-33) (18-)20-25(-26) µm, mostly obovoid, wall 1-1.5 µm thick, at apex thickened up to 16 µm, pores equatorial, obscure, probably 3 or 4.

This rust has previously been reported from Malawi only where *H. rufa* (Nees) Stapf (type host) and *H. variabilis* Stapf are the hosts. *H. diplandra* is a new host for this rust species.

P. hyparrheniae differs in the uredinial state from *P. eucomi* having urediniospores more thickened at the apex.

Puccinia levis (Sacc. & Bizz.) Magn. var. panici-sanguinalis (Rangel) Ramachar & Cumm. Mycopath. Mycol.Appl. 25: 44, 1965.
Syn. *Diorchidium brachiariae* Wakef. & Hansf. Proc. Linn. Soc. Lond., Sess. 161 (1948-49) pt. 2: 167, 1949.

On *Brachiaria brizantha* (A. Rich.) Stapf
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (3), II; Masaka Distr., Kalungo Co., near Kasasa N of Mukoko, 1180 m, 5.6.1971, K.A. Lye (M 110), II.

Uredinia without paraphyses. Urediniospores 27-36 x 21-25 µm, obovoid or oval, sometimes angularly globoid, wall 1.5-2 µm thick, echinulate, dark brown and with mostly 3, occasionally 2, equatorial pores.

Wakefield & Hansford (op.cit.) described this rust as *Diorchidium brachiariae* on *Brachiaria* sp. from Serere, Teso Distr. On the present host it has been reported from Malawi and Zambia, from Malawi also on *B. decumbens* and *B.* sp.

In this variety Cummins (1971) has united several forms, often described as species, occurring on several host genera of the Andropogonoideae and Panicoideae tribes of Poaceae in Asia and America.

Puccinia levis (Sacc. & Bizz.) Magn. var. tricholaenae
(H. & P. Syd.) Ramachar & Cumm. Mycopath. Mycol. appl. 25: 44, 1965.
Syn. *Diorchidium tricholaenae* H. & P. Syd. Annls mycol. 10: 33, 1912.
On *Rhynchelytrum repens* (Willd.) Hubb. (syn. *Tricholaena rosea* Nees)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (466), II, Namulonge, 1180 m, Gj. (90), II; W. Nile Distr., Vurru Co., 3 km NW of Uleppi, 1100 m, K.A. Lye & R.N. Lester (2189), II.

Uredinia without paraphyses. Urediniospores 20-32 x (17-)21-25 µm, broad ellipsoid to subgloboid, wall 1.5-2 µm thick, echinulate, dark brown and with 2 equatorial pores.

Wakefield & Hansford (1949, as *D tricholaenae*) found this var. common everywhere in Uganda. Cummins (1971) recognized it as circumglobal in warmer areas, with *R. repens* as the only host.

Puccinia loudetiae Wakef. & Hansf. Proc. Linn. Soc. Lond.,
Sess. 161,1948-49: 183, 1949.
Syn. *P. trichopterygis* Wakef. & Hansf. E. Afr. agric. J. 3: 323, 1938, nom. nud.
On *Loudetia kagerensis* (K. Schum.) Hutch.
W. Mengo Distr., Kyadondo Co., Kazi, 1160 m, Gj. (50), II; Masaka Distr., Buddu Co., Masaka. 1150 m, Male, II.

Uredinia with capitate paraphyses, thickened at apex. Urediniospores 23-35 x 17-24 µm, obovoid or ellipsoid, wall dark brown, 1.5 µm thick, echinulate and with 3 equatorial pores.

P. loudetiae was described on *L. phragmitoides* (Peter) Hubb. from Kampala. Other hosts mentioned by Wakefield & Hansford (op. cit.) were *L. arundinacea* (A. Rich.) Hubb. and *L. kagerensis*, the former also reported from Kenya and Sierra Leone. Yen (1971) collected this rust on *L. flammida* (Trin.) Hubb. in Gabon, a host sometimes recognized synonymous with *L. phragmitoides*, but in Flora of Tropical East

Africa, Gramineae (Part 2) *L. flammida* is said to be a tropical S. American species, to which *L. phragmitoides* is closely allied.

Puccinia melanocephala Syd. in Syd. & Butl. Annls mycol. 5: 500, 1907.
Syn. *P. erianthi* Padw. & Kahn. Mycol. Pap. 10: 32, 1944.
On *Saccharum officinarum* L.
W. Mengo Distr., Kyadondo Co., Kawanda Research Station, 1180 m, 4.11.1970, J. Mukiibi, II, Gj. (490), II.

Uredinia with capitate paraphyses, hyaline to golden brown, thickened at apex. Urediniospores 25-38 x 18-23 µm, obovoid or ellipsoid, wall 1.5-2 µm thick, golden cinnamon-brown, echinulate and with mostly 4, rarely 5 or 6 equatorial pores.

This originally East Asian rust species (type locality India), recently spread to South and Central America, was reported as *P. erianthi* from Malawi by Peregrine & Siddiqi (1972) and from Tanzania by Ebbels (1974). It is a new member of the Ugandan rust flora.

P. melanocephala differs from *P. kuehnii* Butl. on the same host in having urediniospores not thickened at apex.

Puccinia nakanishikii Diet. Bot. Jahrb. 34: 585, 1905.
On *Cymbopogon nardus* (L.) Rendle (syn. *C. afronardus* Stapf)
W. Mengo Distr., Busiro Co., Zika Forest, 1160 m, Gj. (75), II (+III), Kyadondo Co., Makerere, 1200 m, ex herb. Makerere, II, Mawokota Co., Mpanga Forest, 1150 m, Gj. (70) II; Ankole Distr., Nyabushozi Co., Muko and Ruhengere Research Stations, 1300 m, Gj. (118,123), II; Toro Distr., Kyaka Co., Mile 127 on Kampala-Fort Portal Road, between Nabingoa and Kyegegwa, 1500 m, Gj. (169), II.
On *Sorghum almum* L.
W. Mengo Distr., Kyadondo Co., Kabanyolo 1200 m, Gj. (461), II.
On *Sorghum arundinaceum* (Desv.) Stapf (syn. *S. verticilliflorum* (Steud.) Stapf)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (460), II, Busiro Co., Entebbe 1150 m, Gj. (40) II.
On *Sorghum* sp. cult.
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (262), II; Teso Distr., Serere Co., Serere Research Station, 1150 m, Gj. (426), II, Soroti Co., Arapai Research Station, 1100 m, Gj, (417), II.

Uredinia with capitate paraphyses, yellowish to brownish, thickened at the apex. Urediniospores 23-34(-39) x 18-24(-26) µm, obovoid or ellipsoid, wall 1.5-2 µm thick, dark brown, echinulate, and with 4-5 equatorial pores, in some spores very low, hyaline papillae are visible. Teliospores (on *Cymbopogon*) 38-45(-52) x 20-24 µm, clavate to ellipsoid, slightly constricted at septum, wall dark brown, 1.5 µm thick at sides, thickened up to 7 µm at apex, smooth. Pedicel brownish, darkest near the spore.

P. nakanishikii, described from Japan and widespread in Asia, especially on *Cymbopogon* spp., was reported by Wakefield & Hansford (1949) on *C. excavatus* (Hochst.) Stapf (= *C. caesius* (Hook. & Arn.) Stapf) in Kigezi, and on *C.* sp. in Teso. They also reported it on *C. martinii* (Roxb.) W. Wats. "ex India" while Cummins (1945) listed the same specimens from Kawanda in W. Mengo. Ebbels (1972) published *C. afronardus* (= *C nardus*) as a host in Ankole. The rust is also reported from Libya, Zaire and Ethiopia.

Sorghum almum is a new host for this rust.

Puccinia oahuensis Ell. & Ev. Bull. Torrey Bot. Club 22: 435, 1895.
Uredo digitariaecola Thuem. Myc. Univ. No. 2041, 1882;
P. digitariae Pole Evans. Ann. Bolus Herb. 2: 111, 1917.
On *Digitaria ciliaris* (Retz.) Koel. (syn. *D. adscendens* (Kunth) Henr.)
Teso Distr., Serere Co., Serere, 1150 m, 15.11.1968, K.A. Lye (339), II; Kigezi Distr., Rubanda Co., Nyamabale, 2100 m, Gj. (221), II.
On *Digitaria decumbens* Stent.
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (465), II.
On *Digitaria ternata* (A. Rich.) Stapf
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (293), II.
On *Digitaria velutina* (Forssk.) P. Beauv.
Ankole Distr., Bunyaruguru Co., Kalinzu Forest, 1400 m, Gj. (143), II.

Uredinia with thin-walled, hyaline paraphyses. Urediniospores 21-28 x (16-)18-25 µm, obovoid to globoid, wall 1.5 -2 µm thick, yellowish to cinnamon-brown, young spores nearly hyaline, echinulate and with 4 equatorial pores.

P. oahuensis described from Hawaii, is circumglobal on *Digitaria* spp. in warm regions. In Uganda Wakefield (1920) reported it as *Uredo digitariaecola* on *D. digitata* Stapf from Bukedi and on *D.* sp. from Kipayo. Later, Wakefield and Hansford (1949) placed both specimens within *P. oahuensis*, the former host now as *D. velutina*; other hosts were *D. abyssinica* (A. Rich.) Stapf, *D. marginata* Link var. *fimbriata* (Link.) Stapf (= *D. ciliaris* (Retz.) Koel.) and *D.* spp. from several localities scattered over the country. Several other *Digitaria* spp. are known as hosts for this rusts in Africa. To my knowledge *D. decumbens* is a new African host for the rust species in question, but it is reported as so from Asia and French West Indies.

Puccinia polysora Underw. Bull. Torrey Bot. Club 24: 86, 1897.
On *Zea mays* L.
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, 12.11. 1970, G. Taksdal, II.

Uredinia without paraphyses. Urediniospores 27-41 x 20-26 µm, ellipsoid or obovoid, wall 1-1.5 µm thick, pale yellow to yellowish brown and with 4(-5) equatorial pores.

This rust is widespread on the present host, in the Americas also on other graminicolous genera (type on *Tripsacum dactyloides* L., U.S.A.). In Africa it was found for the first time in 1949 in Sierra Leone (Padwick 1956). Later it has spread to several African countries, and it was found in Uganda in 1952 (Wiltshire 1953). Now it is also known from Asia and the Oceania.

Puccinia pseudechinolaenae sp.nov. (Fig. 1).

Pycnia atque aecia non visa. Uredinia in pagina adaxiali foliorum, rotundata vel ellipsoidea, cinnamomea, sine paraphysibus. Urediniosporae 20-23 x 17-21 µm, pro parte maxima ellipsoideae, parietibus 1.5 µm crassis, cinnamomeis, dense echinulatis, poris tribus equatorialibus instructis. Telia in pagina abaxiali foliorum, rotundata vel ellipsoidea, exposita, compacta, atrate fusca. Teliosporae diorchidioideae, 18-23 x 23-27 µm, late ellipsoideae, parietibus lateralibus 1 µm crassis, ad apicem versus usque ad 4.5 µm incrassatis, laevibus. Pedicellus hyalinus, parietibus tenuibus, collabentibus, longitudine 50 µm excedens.

Holotype: K.A. Lye 3339 (MHU), 26.6.1969, Uganda, Mubende Distr., Buwekula Co., 1-3 km E of Mubende Centrum, 1300 m, on *Pseudechinolaena polystachya* (Kunth) Stapf. Isotype in NPPI.

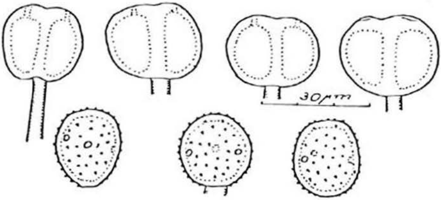

Fig. 1. *Puccinia pseudechinolaenae*, teliospores and urediniospores, from type.

Cummins (1971) did not list any rust species on *Pseudechinolaena*.

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

Syn. *P. bromina* Eriks. Annls Sci.nat. 8. ser., 9: 271, 1899.

On *Bromus leptoclados* Nees

Kigezi Distr., Rubanda Co., Echuya Forest Reserve, Mile 34-35 from Kabale, 2100 m, Gj. (232), II.

Uredinia without paraphyses. Urediniospores 21-27 x 20-24 µm, ellipsoid to globoid, wall 1.5-2 µm thick, pale yellowish brown, echinulate and with 7-10 scattered pores.

The brown rust is an aggregate species embracing several specialized forms, often recognized as species, and widespread especially in temperate climates (Cummins 1971). The aecial stage of the f.sp. on *Bromus* occurs on hosts belonging to Boraginaceae.

This form of the brown rust is new to Uganda, but it has been found on *Bromus* spp. in several African countries. *B. leptoclados* is a new host for it.

Puccinia sorghi Schw. Trans. Amer. Phil. Soc. II, 4: 295, 1832.

On *Zea mays* L.

W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, 4.11. 1970, I. Mukibii, II + III.

Uredinia without paraphyses. Urediniospores 27-35 x 25-30 µm, ellipsoid to globoid, wall 2 µm thick, yellowish cinnamon-brown, echinulate with 3 equatorial pores. Telia blackish brown, compact, exposed. Teliospores 38-45 x 18-24 µm, ellipsoid, slightly constricted at the septum, wall 1.5-2 µm thick, at apex thickened up to 7 µm, cinnamon-brown, slightly paler at apex. Pedicel hyaline to yellowish. One-celled teliospores occur.

This rust, which is widespread in Asia and Africa, was reported from Uganda for the first time by Wakefield (1920). The aecial stage, described as *Aecidium oxalidis* Thuem., occurs on *Oxalis* spp.

Puccinia versicolor Diet. & Holw. in Holway, Bot. Gaz. 24: 28, 1897.

On *Heteropogon melanocarpus* (Ell.) Benth.

Tanzania. Kilosa Distr., 3 km S of Great Ruaha River, Yovi River confluence, 450-500 m, 15.7.1970, A. Bjørnstad (441), (II+)III; Iringa Distr., Ruaha National Park, 7 km SW of Msembe, 900 m, 3.5.1971, A. Bjørnstad (977), III.

On *Hyparrhenia* aff. *variabilis* Stapf

W. Mengo Distr., Mawokota Co., Mpanga Forest, 1150 m, Gj. (184), II.

On *Hyperthelia dissoluta* (Steud.) Clayton (syn. *Hyparrhenia dissoluta* (Steud.) Hubb.)

Tanzania. Iringa Distr., Ruaha National Park, Isiki River at Magangwe Ranger Post, 1320 m, 9.5.1972, A. Bjørnstad (1680), II+III.

Uredinia without paraphyses. Uredinia 24-28 x 18-24 µm, broadly ellipsoid, wall irregularly thick, 1.5-6 µm, making the lumen of the spore more or less stellate, hyaline, echinulate and with scattered, obscure pores. Telia dark brown, compact, exposed. Teliospores 34-43 x 26-30 µm, obovoid to ovoid, wall 3-5(-7) µm, chestnut-brown, smooth.

Pedicel long, hyaline, thinwalled.

P. versicolor has been reported in Uganda on *Heteropogon contortus* (L.) Roem. & Schult. from Mt. Elgon and from the Lake Albert Escarpment, and on *Themeda triandra* Forssk. var. *hispida* Stapf from Kigezi (Wakefield & Hansford 1949). *H. dissoluta* seems to be a new host for this rust, and *H. melanocarpus* is a new host in Tanzania, but it has been reported from Sudan, Zimbabwe, Malawi and Zambia. *H. variabilis* is a new host for the rust in Uganda, but it has been reported from Zambia. The rust, described from Mexico on *Heteropogon melanocarpus*, is widespread in Africa, Asia and America on several host genera. In India the aecial stage, *Aecidium plectroniae* Cke., has been found on species of *Canthium* and *Lantana*.

Uredo kabaleensis sp.nov. (Fig. 2).

Uredinia in pagina adaxiali foliorum, ovalia, 0.5 mm longa, epidermi tam diu obtecta, pallide lutea, sine paraphysibus. Urediniosporae 22-29 x 18-23 µm globoideae, ellipsoideae vel obovoideae, parietibus 1.5-2 µm crassis, hyalinis, echinulatis, verosimiliter tribus poris equatorialibus instructis, interdum parum depressis, indistinctis.

Holotype, H.B. Gjærum 201 (MHU), 30.9.1970, Uganda, Kigezi Distr., Rubanda Co., White Horse Inn, 1900 m, on *Sporobolus agrostoides* Chiov. (syn. *S. filipes* Napper). Isotype in NPPI.

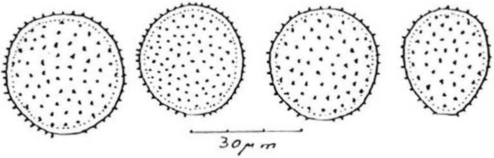

Fig. 2. *Uredo kabaleensis*, urediniospores from type.

Uredo sporoboli-pyramidalidis sp.nov. (Fig. 3).
On *Sporobolus pyramidalis* P. Beauv.

Uredinia sine paraphysibus. Urediniosporae 21-30(-32) x 20-23 µm, ellipsoideae vel globoideae, parietibus 1.5-2 µm crassus, cinnamomeus, echinulatus, poribus (3-)4-5 equatorialibus instructus.

Holotype: H.B. Gjærum 156 (MHU), 21.9.1970, Uganda, Toro Distr., Busongora Co., Mweya Lodge, 930 m, on *Sporobolus pyramidalis* P. Beauv. Isotype in NPPI.

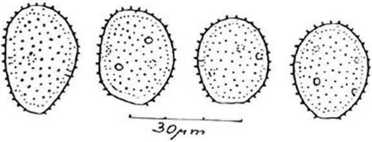

Fig. 3. *Uredo sporoboli-pyramidalidis*, urediniospores from type.

Uredo sp.
On *Eragrostis kiwuensis* Jedw.
Kigezi Distr., Bufumbira Co., Lake Mutanda, Mushungero Hill, 1800 m, and at Lake Bunyonyi, 1800 m, 1. 1963, E.A. Calder (12, 13), II.

Uredinia pale yellow, without paraphyses. Urediniospores 17-22 x 13-18 μm, ellipsoid to subgloboid, wall 1-1.5 μm thick, yellowish, very densely and finely echinulate, and with 4 equatorial pores.

The urediniospores do not fit into any rust listed by Cummins (1971) for the host genus in question. The rust described from Kabale in Kigezi by Cummins (1943) as *Uredo kigeziensis* (= *Puccinia eragrostidis* Petsch.) on *E. macilenta* (A. Rich.) Steud. has nearly the same size of spores, but they have scattered pores.

As the material, just fragments of leaves picked out from the phanerogam sheets, is very scanty, and also heavily parasitized by *Darluca filum* (Fr.) Cast., I do not intend to describe it as a new rust species.

Uromyces clignyi Pat. & Har. J. Bot. 14: 237, 1900.
Syn. *Uredo themedicola* Cumm. Mycologia 33: 151, 1941.
On *Bothriochloa insculpta* (A. Rich.) A. Camus
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (468), II; Masaka Distr., Kalungo Co., 5 km S of W. Mengo border, 1140 m, 5.6.1971, K.A. Lye (6194) II, Buddu Co., on Masaka-

Mbarara road, Mile 70 from Masaka, 1400 m, Gj. (295), II; Toro Distr., Busongora Co., Equator at the Fort Portal - Mweya road, 950 m, Gj. (168) and at Mweya Lodge 930 m, Gj. (159), II.

Tanzania. Iringa Distr., Ruaha National Park, 1 km SW of Magangwe Ranger Post, 1320 m, 11.3.1973, A. Bjørnstad (2589), II.

On *Hyparrhenia papillipes* (A. Rich.) Stapf (syn. *H. lintonii* Stapf)

W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, leg. Gj. (471), II.

on *Schizachyrium brevifolium* (Sw.) Büse

Masaka Distr., Bukoto Co., 1-2 km W of Bunado, 1160 m, 11.8.1971, K.A. Lye & A.B. Katende (6558), II.

On *Themeda triandra* Forssk.

W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (270), II, Kabanyolo 1200 m, Gj. (470), II; Mubende Distr., Singo Co., Mile 70 from Kampala on the Hoima road, 1400 m, Gj. (304) II; Masaka Distr., Buddu Co., Bugabo, SW of Lake Nabugabo, 1240 m, 1.2.1969, K.A. Lye (1805) II.

Uredinia without paraphyses. Urediniospores 20-27(-29) x (18-)20-26 µm, ellipsoid to subgloboid, wall 1.5-2.5 µm thick, cinnamon-brown, echinulate with several scattered pores.

Wakefield & Hansford (1949) reported it on *Andropogon abyssinicus* Fresen., *A.* ? *pilosellus* Stapf (= *A. amethystinus* Steud.) and *Exotheca abyssinica* (A. Rich.) Anderss. from Kigezi and on *Bothriochloa insculpta* and *Themeda triandra* from Kawanda, W. Mengo, on the latter as *Uredo themedicola*. *H. papillipes* is a new host for this rust, and *S. brevifolium* is a new host for the rust in Uganda. The rust might be new to Tanzania.

In India Narasimhan & Thirumalachar (1966) showed experimentally that the aecial stage of *U. clignyi* occurs on *Chlorophytum* spp. This stage was found to be morphologically identical with *Aecidium hartwegiae* Thuem., described from South and Central Africa and also recorded in Zimbabwe.

U. clignyi has a wider host range than any other *Uromyces* spp. on the tribe Andropogoneae (Hennen 1965), and is known from Africa to India and China, New Guinea, Mexico, Central America and the British West Indies.

Uromyces hyparrheniae sp.nov. (Fig. 4).

Pycnia atque aecia non visa. Uredinia in superficiebus ambis foliorum, 0.5 mm longa, cinnamomea, sine paraphysibus. Urediniosporae 18-23 x 16-20 µm, subgloboideae vel globoideae, parietibus 1.5-2 µm crassis pallide luteis vel cinnamomeis, echinulatis, 4-7 poris dispersis instructis. Telia in pagina abaxiali foliorum, exposita, compacta, fusca, 0.5 mm. longa. Teliosporae valde irregulares, anguläriter obovoideae, ellipsoideae vel globoideae, interdum valde latiores quam longae, 20-28 x 19-27 µm, pariete 2.5-3.5(-4) µm crasso, apice usque ad 6 µm incrassato, aureobrunneo vel atrate cinnamomeo, plerumque papillis hyalinis super poram instructo. Pedicelli usque ad 30 µm longi, pro maxima parte effracti (ergo breviores), hyalini, parietibus tenuibus, collabentibus.

Holotype: H.B. Gjærum 199 (MHU), 29.9.1970, Uganda, Ankole Distr., Mashari Co., Mbarara, 1200 m, on Hyparrhenia filipendula (Hochst.) Stapf. Isotype in NPPI.

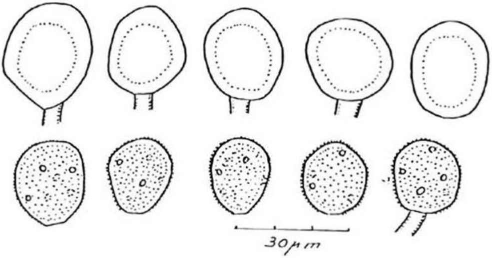

Fig. 4. Uromyces hyparrheniae, teliospores and urediniospores, from type.

U. hyparrheniae differs from U. clignyi Pat. & Har., which also occurs on Hyparrhenia sp., in having more densly echinulate urediniospores with a lower number of spores. The teliospores of U. hyparrheniae have thinner and less pigmented walls than U. clignyi.

Uromyces kenyensis Hennen in Hennen & Cummins, Mycologia 48: 158, 1956.
On Chloris roxburghiana Schult. (syn. C. myriostachya Hochst.)
Karamoja Distr., Mathenico Co., between Rupa and Nakiloro, 1400 m, K.A. Lye & A.B. Katende (5674), II + III.

Uredinia without paraphyses. Urediniospores nearly globoid, 20-27 x 20-26 μm. Wall cinnamon-brown, 2-2.5 μm thick, with several scattered pores, echinulate. Telia blackish brown, compact, exposed. Teliospores ellipsoid to globoid, chestnut-brown, 26-29 x 25-27 μm. Wall 2-3 μm, at the apex thickened to 9 μm, smooth. Pedicel hyaline, thin-walled, often collapsed, long.

This rust is new to the rust flora of Uganda. It is described from Kenya on C. myriostachya. Another Kenyan host is C. gayana Kunth (Robinson 1960).

Uromyces linearis Berk. & Br. J. Linn. Soc. London, 14:
92, 1875.
On *Panicum coloratum* L.
W. Mengo Distr., Kyadondo Co., Kabanyolo 1200 m, Gj. (479),
II + III.

Uredinia without paraphyses. Urediniospores 23-27 x 21-25 µm, globoid or sometimes slightly ellipsoid, wall 2.5 µm thick, densely and finely echinulate and with 2-4 pores, slightly superequatorial. Telia dark brown, compact, exposed. Teliospores globoid or broadly ellipsoid, 23-27 x 21-23 µm, wall chestnut-brown, sides 1.5-2 µm thick, at apex thickened to 5 µm, smooth. Pedicel thin-walled, hyaline.

This specimen differs slightly from the description given by Cummins (1971). Some urediniospores have only two pores, and the teliospore pedicels are thin-walled while in typical specimens, urediniospores have 3 or 4 pores and the teliospore pedicels are thick-walled. However, it is so close to this species that I see no reason for describing a new taxon.

U. linearis has been reported by Wakefield and Hansford (1949) on *P. repens* L. from Kawanda, W. Mengo. It is widespread on this host from Africa eastwards to China and Japan. Several other *Panicum* spp. are recorded as hosts within the same area. On *P. coloratum* it is previously reported from Kenya. Other hosts reported are *Digitaria sanguinalis* (L.) Scop. in Hong Kong and *Urochloa panicoides* P. Beauv. (syn. *U. helopus* (Trin.) Stapf var. *borziana* (Mattei) Chiov.) in Somalia. However, Cummins (1971) has listed only *P. repens* as host for this rust which is described from Sri Lanka.

Uromyces pegleriae Pole Evans ex Syd. Annls mycol. 12:
263, 1914, var. pegleriae.
On *Digitaria ternata* (A. Rich.) Stapf
W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (12),
II + III; Mubende Distr., Singo Co., swamp W. of Kiboga,
1300 m, Gj. (315); Teso Distr., Serere Co., Serere Research
Station, 1200 m, Gj. (437), II + III.
On *Digitaria thouaresiana* (Fluegge) A. Camus (syn. *D. melanochila* Stapf non W.D. Clayton)
W. Mengo Distr., Kyadondo Co., Namulonge Research Station,
1180 m, Gj. (89), II.

Uredinia without paraphyses. Urediniospores 21-27 x (18-)21-25 µm, ellipsoid, wall 1.5-2 µm thick, yellowish, echinulate, and with scattered pores. Telia blackish brown, covered. Teliospores (22-)25-32(-36) x 17-23(-25) µm, angularly obovoid or ellipsoid, wall 1.5-2 µm thick, at apex thickened to 4-4.5 µm, brown, smooth. Pedicels hyaline, but slightly yellowish near the spore.

Wakefield & Hansford (1949) reported this rust species, described from S. Africa on *D. ternata*, from several localities in Uganda on *D. gazensis* Rendle, *D. ternata*, *D. velutina* (Forssk.) P. Beauv. and *Digitaria* sp. *D. melanochila* is a new host for this rust. The rust is widespread in

Africa, described from S. Africa, and it is also reported from New Guinea, the Philippines and Brazil.

Uromyces setariae-italicae Yosh. Bot. Mag. Tokyo, 20:247, 1906.

Syn. *U. leptodermus* H. & P. Syd. Annls mycol. 4: 430, 1906; *U. eriochloa* H. & P. Syd. & Butl.. Ibid. 5: 492, 1907; *Uredo melinidis* Kern. Mycologia 30: 550, 1938.

On *Brachiaria brizantha* (A. Rich.) Stapf

W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (474), II.

On *Brachiaria comata* (A. Rich.) Stapf (syn. *B. kotschyana* (Steud.) Stapf

Bunjoro Distr., Bujenje Co., Bukumi, on the escarpment down to Lake Albert, 900 m, Gj. (341), II.

On *Brachiaria eminii* (Mez) Robyns

Mubende Distr., Buwekula Co., Mubende Centrum, 1300 m, 13.6.1969, K.A. Lye (3315a), II.

On *Brachiaria humidicola* (Rendle) Schweick.

W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (485), II.

On *Brachiaria jubata* (Fig. & de Not.) Stapf (syn. *D. fulva* Stapf, *B. soluta* Stapf)

Teso Distr., Serere Co. (no more data given), 1150 m, ex herb. Makerere (235), II.

Kenya. Pokot Distr., Wien, below Turkwell Gorge, 900 m, 9.8.1970, K.A. Lye (9050) II + III.

On *Brachiaria platynota* (K. Schum.) Robyns

W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (486), II.

On *Brachiaria scalaris* Pilger

Bunyoro Distr., Buruki Co., Bunyoro Ranching Schem Area, c. 1100 m, 3.1.1962, B.J. Turner (491), II.

On *Eriochloa fatmensis* (Hochst. & Steud.) W.D. Clayton (syn. *E. nubica* (Steud.) Thell.)

Tanzania. W. Province Tabora, 1200 m, A.C. Tallantire (339), II + III; Iringa Distr., Ruaha National Park, 1 km E of Msembe, 800 m, 11.4.1971, A. Bjørnstad (752), III.

On *Eriochloa procera* (Retz) Hubb.

Tanzania. Kilosa Distr., 3 km S of Great Ruaha confluence, 450-500 m, 15.7.1970, A. Bjørnstad (456), II.

On *Melinis minutiflora* P. Beauv.

Kigezi Distr., Bufumbira Co., Mushungero Hill, c. 2000 m. 1.1963, Dr. Calder, II.

On *Panicum maximum* Jacq.

W. Mengo Distr., Kyadondo Co., Makerere, 1200 m, Gj. (3) II + III, Namulonge 1180 m, Gj. (83) II, Kabanyolo, 1200 m, Gj. (289, 481), II, Mawokota Co., Mpanga Forest, 1150 m, Gj. (173), II, Busiro Co., Entebbe, 1150 m, Gj. (24a), II, Zika Forest, 1150 m, Gj. (70), II; E. Mengo Distr., Bulemezi Co., Bugomba, Semuto, ca 1050 m, 12.8.1962, G.F. Ganzi (7), II; W. Nile Distr., Madi Co., Arua, ca 1300 m, 15.1.1965, Buruga (33), II.

Tanzania. Iringa Distr., at Kidatu Dam Site, 450 m, 16.7.1970, A. Bjørnstad (464), II.

On *Panicum* sp.
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (480), II + III; Toro Distr., Busongora Co., Kasese, 1000 m, Gj. (167), II.
On *Setaria verticillata* (L.) P. Beauv.
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (489), II.

Uredinia without paraphyses. Urediniospores (19-)23-32(-37) x (14-)16-28(-32) µm, obovoid to broad ellipsoid, sometimes angular, wall 1.5-2 µm thick, cinnamon-brown, echinulate and with 3 pores, equatorial or slightly above. Telia blackish, covered by epidermis, inconspicuous. Teliospores 19-24 x 15-20 µm, ovoid or irregularly angular, wall 1 µm thick, cinnamon-brown, smooth. Pedicel hyaline, thin-walled, short.

U. setariae-italicae, described from Japan and circumglobal in warmer regiones, is common in Uganda where it occurs on several hosts (cf. Wakefield & Hansford 1949). New hosts for this rust seem to be *B. jubata* and *E. procera*. *B. eminii*, *B. humidicola* and *B. scalaris* are new hosts in Uganda. *E. fatmensis* is a new host for this rust in Tanzania.

Uromyces tenuicutis McAlp. Rusts of Australia p. 87, 1906.
On *Sporobolus agrostoides* Chiov. (syn. *S. filipes* Napper)
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (458) II.
On *Sporobolus pyramidalis* P. Beauv.
W. Mengo Distr., Kyadondo Co., Kabanyolo, 1200 m, Gj. (459), II; Teso distr., Serere Co., Serere Research Station, 1150 m, Gj. (160), II; Ankole Distr., Bunyaraguru Co., Kalinzu Forest, 1350 m, Gj. (128), II + III.

Uredinia without paraphyses. Urediniospores 23-34(-37) x (16-)18-25 µm, ellipsoid to obovoid, wall 1-1.5 µm thick, pale yellow-brown to cinnamon-brown, echinulate and with (3-)4 equatorial pores. Telia covered by epidermis, inconspicuous, with paraphyses. Teliospores 23-29(-32) x 16-21(-25) µm, irregularly ellipsoid or obovoid, sometimes wider than long, wall 1 µm at sides, up to 3(-4) µm at apex, cinnamon-brown, darker at apex, smooth. Pedicel short, cinnamon-brown.

This rust,widely distributed in Africa and also in warmer regions in Asia, Australia (type locality), Oceania and South America, has been reported by Wakefield & Hansford (1949) on *Sporobolus festivus* Hoechst. ex A. Rich., *S. pyramidalis* and *S.* sp. from several localities in Uganda. It seems to be common on *S. pyramidalis*. *S. agrostoides* is a new host for this rust.

References

Angus, A. 1966. Annotated list of plant pest diseases and fungi in Zambia. Supplement. St. Andrews. (Mimeographed).

Cummins, G.B. 1943. Descriptions of tropical rusts - VI. Bull. Torrey Bot. Club 70: 517-530.

- 1945. Descriptions of tropical rusts - VII. Bull. Torrey Bot. Club 72: 205-222.

- 1953. The species of Puccinia parasitic on the Andropogoneae. Uredineana 4: 5-90, pl. I-XI.

- 1956. Descriptions of tropical rusts - VIII. Bull. Torrey Bot. Club 83: 221-233.

- 1957. The graminicolous species of Angiopsora and Phakopsora. Sydowia, Beiheft I. Festschr. Franz Petrak, pp. 26-32.

- 1963. Life cycles of southwestern rust fungi. Mycologia 55: 73-78.

- 1971. The rust fungi of cereals, grasses and bamboos. Berlin, Heidelberg, New York.

Ebbels, D.L. 1972. Additions to the mycoflora of south-western Uganda. Jl. E. Africa nat. Hist. Soc. Nat. Mus. No. 133.

- 1974. A secondary supplementary checklist of Tanzanian plant diseases. Agric. Res. Inst., Ukiriguru. Progress Rep. No. 18. (Mimeographed).

Hennen, J.F. 1965. The species of Uromyces parasitic on the grass tribe Andropogoneae. Mycologia 57: 104-113.

Laundon, G.F. 1963. Rust fungi 1: On Acanthaceae. Mycol. Pap. No. 89.

Narasimhan, M.J. 1965. Study of heteroecious life-cycles of rusts in India. Indian Phytopath. 18: 107-115.

Padwick, G. Watts. 1956. Losses caused by plant diseases in the Colonies. Phytopath. Pap. No. 1.

Peregrine, W.T.H. & Siddiqi. 1972. A revised and annotated list of plant diseases in Malawi. Phytopath. Pap. No. 16.

Riley, E.A. 1960. A revised list of plant diseases in Tanganyika Territory. Mycol. Pap. No. 75.

Robinson, R.A. 1960. Notes on Kenya Agriculture VIII: Important plant diseases. E. Afr. agric. J. 25: 131-146.

Sousa da Camara, E. de. 1958. Catalogus systematicus fungorum omnium Lusitaniae. I Basidiomycetes, Pars II: Gasterales, Phalloidales, Tremelloidales, Uredinales et Ustilaginales. Lisboa.

Wakefield, E.M. 1920. Fungi exotici: XXV. Notes on Uganda fungi. Bull. misc. Inf. R. bot. Gdns Kew 9: 289-300.

- & Hansford, C.G. 1949. Contribution towards the fungus flora of Uganda. IX. The Uredinales of Uganda. Proc. Linn. Soc. Lond. Sess. 161, 1948-49, pt. 2: 162-198.

Wallace, G.B. & Wallace, M.M. 1949. A list of plant diseases of economic importance in Tanganyika Territory. Mycol. Pap. No. 26.

Wiltshire, S.P. 1953. Uganda. Outbreaks of new diseases. Pl. Prot. Bull. F.A.O. 1: 62.

Yen, J.M. 1971. Les Urédinées du Gabon VI. Revue Mycol. 36: 96-113.

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IN VITRO HAIR PERFORATION BY A NEW SUBVARIETY OF *TRICHOPHYTON TONSURANS* VAR. *SULFUREUM*

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ABSTRACT

The *in vitro* hair perforation test, as described by Ajello and Georg, was applied to 44 known species belonging to the genera *Epidermophyton*, *Microsporum*, and *Trichophyton*. Under the original test conditions, the ability or inability to perforate hair was found to be a species-specific character that did not vary among the isolates of a species. *Trichophyton tonsurans* var. *sulfureum* was found to be the only exception in which 6 of 35 isolates of this variety were found to perforate hair.

The perforating isolates were identical with the non-perforating ones in their colonial and microscopic morphology, as well as their deficiency for thiamine. We propose that the perforating isolates be recognized as a subvariety of the *sulfureum* variety of *T. tonsurans* under the name of *T. tonsurans* var. *sulfureum* subvar. *perforans*.

INTRODUCTION

Differences in the ability to perforate hair *in vitro* among the species of *Trichophyton* was first put to diagnostic use by Ajello and Georg (1). They showed that this property could be used to differentiate atypical isolates

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of *T. mentagrophytes* and *T. rubrum*. All isolates of *T. mentagrophytes*, whether morphologically typical or atypical, penetrated hair segments forming wedge-shaped perforations. On the other hand, none of the *T. rubrum* isolates did so. In 1980, the *in vitro* hair perforation test was used to characterize 44 species belonging to the genera *Epidermophyton*, *Microsporum*, and *Trichophyton* (8). The ability to perforate hair *in vitro* was manifested by 24 of the 44 species. Under the original test conditions as stipulated by Ajello and Georg (1), the ability or inability to perforate hair was found to be a species-specific character that did not vary among the isolates of a given species. Since it was manifested by sporulating as well as nonsporulating isolates of a given species, the test was considered to be a valuable tool, especially for those species that do not sporulate readily and thus are difficult to identify by morphological criteria.

In the present study, 35 isolates of *T. tonsurans* var. *sulfureum* were tested for their ability to perforate hair *in vitro* using the Ajello and Georg test procedure. The isolates of *T. tonsurans* var. *sulfureum* fell into two groups: perforators and non-perforators. Six of the 35 isolates were found to perforate hair in contrast to the remaining 29. Since the difference is considered to be of taxonomic significance, it is proposed that the perforating isolates of *T. tonsurans* var. *sulfureum* be formally recognized as a subvariety.

MATERIALS AND METHODS

Cultures. The 35 isolates included in this study were received as reference diagnostic specimens by the Fungus Reference Laboratory of the Division of Mycotic Diseases, Centers for Disease Control. Thirty-one of the isolates were from the United States, 3 were from Egypt, and 1 had been isolated in Japan. Thirty-three of the 35 cultures were isolated from cases of endothrix tinea capitis and two had caused lesions of the glabrous skin.

Morphology. The isolates were grown on modified Sabouraud dextrose agar containing chloramphenicol (Sab + C) (neopeptone 1%, dextrose 2%, agar 1.8%, chloramphenicol 0.05 mg/ml). Observation of colonial morphology was made at 25°C on Sab+C after 2 weeks of incubation. Their microscopic morphology was studied on potato dextrose agar (Difco) in slide cultures. Inocula from 10-day-old colonies on Sab+C were used for the slide cultures.

Nutritional test for thiamine. An inoculum of approximately 2 mm in diam. from 10-day-old colonies of each isolate growing on Sab+C was transferred to tubes containing casein basal agar + thiamine (Trichophyton agar No. 4) and casein basal agar (Trichophyton agar No. 1, Difco). The cultures were incubated at 25°C in the dark for 8 days and their growth was evaluated qualitatively as follows: (-) none, (±) slight, (1+) poor, (2+) fair, (3+) good, and (4+) excellent.

In vitro hair perforation test. Growth from 10-day-old colonies of each isolate was used to inoculate the Petri plates containing hair. Short segments (15-20 mm) of human hair were first autoclaved separately in Petri plates (25-30 hair pieces per plate) at 120°C for 15 minutes. Following sterilization, the plates were allowed to cool. To each plate containing hair, 20 ml of sterilized distilled water and 0.15 ml of 10%yeast extract (sterilized by filtration) were added aseptically. Several fragments 2-3 mm in diameter from the 10-day-old colonies of each isolate were inoculated onto the hairs in these plates. They were incubated at 25°C in the dark and examined after 1, 2, and 3 weeks of growth. Hair segments covered with mycelium were removed from the plates with sterile forceps, placed in lactophenol cotton blue, heated gently over a flame and examined microscopically for the presence or absence of perforations.

RESULTS

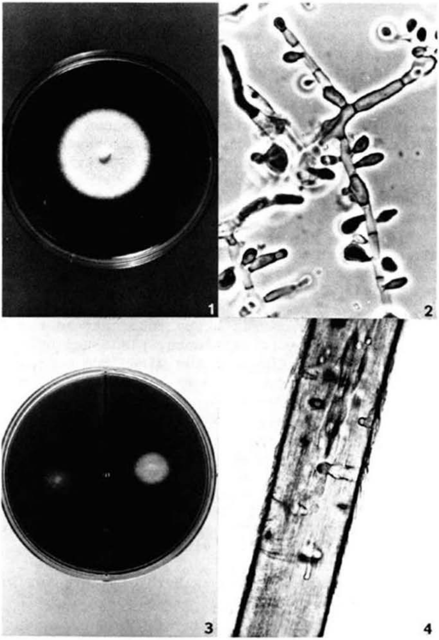
Morphology. The colonies of the 35 isolates on Sab+C at 25°C after 2 weeks were velvety to powdery, flat, centrally umbonate, folded, heaped or radially striated, white at first but becoming yellow to orange yellow (Fig. 1). The reverse of the colonies was yellow to mahogany red. In 3- to 4-week-old colonies the surface became tan, flaky, or cracked. The mycelium was found to be narrow (1.5- 2 µm) and uniform in diameter. In young cultures, the microconidia were delicate, numerous, pyriform to clavate, hyaline, 1-celled, smooth, 3-6 X 1.5-2 µm; and were borne singly along the sides of hyphae. They were either sessile or borne on short conidiophores that arose at right angles to the axis of the parent hyphae (Fig. 2). Some terminal clusters of microconidia were also observed. In 3-week-old colonies, the mycelium was thick and irregular with swellings along its length. Chlamydospores, either intercalary or terminal in position, were present in the older cultures. Macroconidia were produced only by three of the isolates and then only on wort agar (Difco). They were smooth, cylindrical to clavate, irregular in shape, and 3-5 celled.

Nutritional test for thiamine. All of the 35 isolates were found deficient for thiamine. Growth on Trichophyton agar No. 1 after 8 days of incubation at 25°C was ± to 1+. On the other hand, on Trichophyton agar No. 4 the colonies of all had 3+ to 4+ growth (Fig. 3).

In vitro hair perforation test. The 35 isolates grew well in the Petri plates of sterile distilled water and hair. Within a few days, mycelial growth was visible around the hair segments. Hair perforations were detected generally after two weeks of incubation when hair segments were examined microscopically. Six of the 35 isolates perforated hair (Fig. 4). The hair perforation test was repeated three times in order to confirm the perforating ability of these six isolates and the inability of the other isolates to perforate the hair. Even after three weeks of incubation the same 29 isolates failed to perforate.

DISCUSSION

Following Ajello and Georg's report, many investigators evaluated the *in vitro* perforation of hair by various dermatophyte species (2-4,6). Unfortunately, these investigators employed either modifications of the Ajello-Georg procedure or developed new ones. These modifications have given rise to contradictory results. Pinetti and Lostia (9), in their masterly monograph on the *in vitro* growth of dermatophytes on hair, showed that procedural variations significantly influenced the ability of the fungi to perforate hair.



Figures 1-4: *Trichophyton tonsurans* var. *sulfureum* subvar. *perforans*. 1. Two-week-old colony on Sabouraud dextrose agar. 2. Variable size and shape of microconidia borne singly, mycelium becoming thick-walled with irregular swellings, X 1400. 3. Eight-day-old growth on Trichophyton agar No. 1 (left) and growth stimulation evident on Trichophyton agar No. 4 (right). 4. Wedge-shaped perforations of hair seen after 2 weeks incubation, X 1400.

In the present study, Ajello and Georg's procedure was followed strictly. The six perforating isolates were identical to the nonperforating isolates in colonial and microscopic morphology and in thiamine deficiency. They differed only in their ability to perforate hair *in vitro*. Our carefully controlled studies have shown that *T. tonsurans* var. *sulfureum* is the only dermatophyte species in which the ability to perforate hair is a variable characteristic. We therefore propose that perforating isolates of *T. tonsurans* be recognized as a subvariety of the *sulfureum* variety. The nomenclature is thus:

Trichophyton tonsurans Malmsten 1845 var. *sulfureum* (Sab.) Mackenzie 1961 subvar. *perforans* subvar. nov. Matsumoto, Padhye et Ajello

Colonia in Sabouraudii agaro cum dextroso composito crescens velutina vel pulverulenta, plana vel centrum versus plicata, post diem quintum vicesimum sub calore 25°C crescens diametrum 33-35 mm attingens, primum album, demum flavum ("Naples yellow" - Ridgway Pl. XVId, ad "Strontian yellow" - Ridgway Pl. XVIb). Microconidia hyalina, clavata vel pyriformia, continua, in culturis veteribus forma et magnitudine irregularia, 3-6 X 1.5-2.5 µm. Macroconidia rara, plerumque in Sabouraudii agaro cum dextroso composito haud producta, in mediis thiamino opimis factis incitata. Chlamydosporae crebre in culturis vetustioribus observatae, intercalares vel terminales. Incrementum a thiamino auctum. Capillas in vitro perforans.

Holotypus: colonia exsiccata ex Herb. Centers for Disease
Control B-3220

Living cultures of our six perforating isolates of the subvariety *perforans* (B-3210, B-3220, B-3325, B-3408, B-3409, and B-3616) have been deposited in the American Type Culture Collection.

Trichophyton sulfureum Sabouraud was originally described by Sabouraud in 1910 (10). Georg (5) treated *T. sulfureum* Sab. as a facultative synonym of *T. tonsurans* Malmsten 1845. Mackenzie (7) proposed the combination *T. tonsurans* Malmsten var. *sulfureum* (Sab.) Mackenzie 1961 but never designated a type. We therefore designate a neotype B-3631 for *T. tonsurans* Malmsten var. *sulfureum* subvar. *sulfureum*. Dried colonies of subvar. *sulfureum* B-3631 and subvar. *perforans* B-3220 are preserved in the Division of Mycotic Diseases' Culture Collection, Centers for Disease Control, Atlanta, Georgia 30333.

ACKNOWLEDGEMENTS

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LITERATURE CITED

1. Ajello, L. and L. K. Georg. 1957. *In vitro* hair cultures for differentiating between atypical isolates of *Trichophyton mentagrophytes* and *Trichophyton rubrum*. Mycopath. Mycol. Appl. 8:3-17.
2. Friedrich, E. 1964. Perforation von Frauenhaar durch Dermatophyten. I. Mitteilung. Zeitschr. fur Haut. und Gesch. 36:39-44.
3. Friedrich, E. 1964. Perforation von Frauenhaar durch Dermatophyten II. Mitteilung. Mykosen 7:53-63.
4. Galgoczy, J. and E. K. Novak. 1966. Investigation of the hair digestion by dermatophyta. Mycopath. Mycol. Appl. 28:71-76.
5. Georg, L. K. 1956. Studies on *Trichophyton tonsurans* I. The taxonomy of *T. tonsurans*. Mycologia 48:65-82.
6. Lu, Y. C. 1962. A new method for the study of hair digestion by dermatophytes. Mycopath. Mycol. Appl. 17:225-235.
7. Mackenzie, D. W. R. 1961. The extra-human occurrence of *Trichophyton tonsurans* var. *sulfureum* in a residential school. Sabouraudia 1:58-64.
8. Padhye, A. A., C. N. Young and L. Ajello. 1980. Hair perforation as a diagnostic criterion in the identification of *Epidermophyton*, *Microsporum* and *Trichophyton* species. In Superficial, Cutaneous and Subcutaneous Infections. Pan American Health Organization Sci. Publ. No. 396, Washington, D. C. pp. 115-120.

9. Pinetti, P. and A. Lostia. 1966. L'infezione Dermatofitica del Pelo *in vitro*. Monograph No. 13 from Rassegna Medica Sarda, Cagliari, pp. 128-137.
10. Sabouraud, R. 1910. Les Teignes. Masson et Cie, Paris, pp. 317-318.

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ANNELLIDIC (PERCURRENT) AND SYMPODIAL PROLIFERATION IN CONGENERIC HYPHOMYCETES, AND A NEW SPECIES OF **SPORIDESMIELLA**

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ABSTRACT

The conidiophores of five species of the recently described hyphomycete genus **Sporidesmiella** are annellidic -- they undergo repeated short percurrent proliferations during conidiation. The sixth species has two varieties, one annellidic, the other sympodial. We have isolated both varieties, and a similar but apparently undescribed taxon which is consistently sympodial. An examination of the possible causes and taxonomic consequences of plasticity and/or mutability in modes of conidiogenesis leads us to describe our new sympodial fungus as the seventh species of **Sporidesmiella.**

INTRODUCTION

Kirk (1982), taking his cue from Hughes (1979), described **Sporidesmiella** Kirk as a new generic segregate from **Sporidesmium** Link, and included six species (two of them new, a third divided into two varieties). The members of this new genus differed from other species of **Sporidesmium** in their cuneate to obovoid, few-septate conidia. Unfortunately, Kirk neglected to explain how his new generic concept differed significantly from that of **Brachysporiella** Batista. Admittedly, the conidiophores of **B. gayana** Batista, the type species of **Brachysporiella**, have one or two side branches, but in all other major characteristics -- conidial shape, number and kind of conidial septa, pigmentation, and the regularly annellidic proliferation of the conidiophore -- **Sporidesmiella** does not appear to differ greatly from **Brachysporiella.**

The conidiophores of five of the six species attributed to **Sporidesmiella** appear to be consistently annellidic. The sixth species, **S. hyalosperma** (Corda) Kirk, is divided into two varieties, one of which, var. **hyalosperma**, is annellidic (Fig.1 A-E), while the other, var. **novae-zelandiae**, is sympodial (Fig. 2 A-C). This appears to be a major breach of current taxonomic practice, since different modes of conidiation are commonly used to separate genera. But there may in fact be a rather interesting link between these two superficially very different modes of proliferation. Madelin (1979) suggested that "the behaviour and properties of the delimiting septum are crucial in determining subsequent development". He showed how, if the septum delimiting a conidium forms early in the conidiogenous cycle, but remains perforate until late in the cycle, the septum itelf may become so thickened as to preclude any subsequent full-width proliferation through it. In such cases, an initially annellidic conidiophore may adopt sympodial proliferation as an alternative way of producing a plurality of conidia.

There is some evidence to support Madelin's hypothesis. Sutton and Laut (1970), and Fletcher (1975) observed both annellidic and sympodial proliferation in species of **Graphium** Corda. One of us (B.K., unpubl.) has seen a similar duality in some species of **Verticicladiella** Hughes, a genus that is nominally exclusively sympodial. Subtle evolutionary pressures may lead to the more or less complete adoption of one or the other mode of proliferation -- Kendrick (1962) discussed annellidic and sympodial analogues (**Leptographium** Lagerb. & Mel., and **Verticicladiella** Hughes, respectively) among the diverse anamorphs of **Ceratocystis** Ell. & Halst. Upadhyay and Kendrick (1975) subsequently compiled the full range of anamorphs of **Ceratocystis**, and noted that there were similar analogues among both the mononematous and the synnematous series. In the latter, the genera **Graphium** and **Pesotum** Crane and Schoknecht are the annellidic and sympodial equivalents. We may also note that the **Spilocaea** Fries anamorphs of **Venturia** Sacc. are annellidic, while the **Fusicladium** Bon. anamorphs of **Venturia** are sympodial.

Even allowing for the possibility that some of these similarities are due to convergent evolution, the examples given above lead to some interesting speculations. Perhaps the interconversion of annellidic and sympodial modes of proliferation may sometimes be brought about by environmental conditions, and have no genetic basis. But perhaps this change can under some conditions be selected for, and become genetically fixed. The fact remains that some fungi are always sympodial, and others invariably annellidic, and that there is a clearly visible difference between the two, which is made use of by pragmatic mycologists in the erection of morphologically

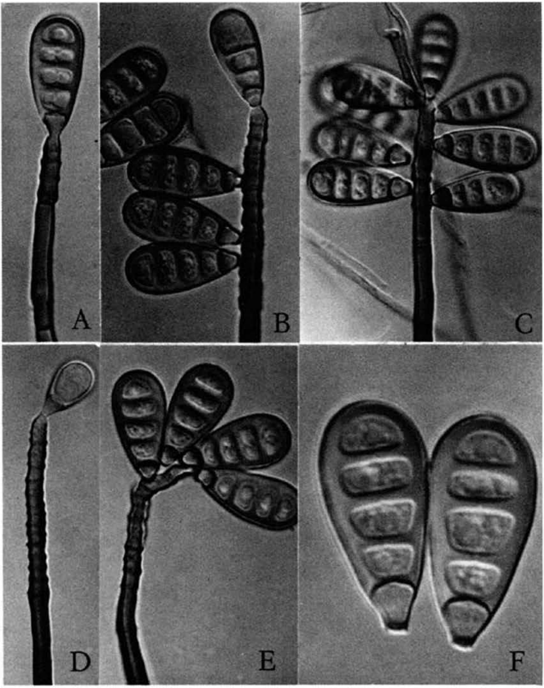


Figure 1. **Sporidesmiella hyalosperma** var. **hyalosperma**. A-E: Conidiophores with conidia, 1000X. F: Conidia, 2000X. (All Nomarski interference contrast).

distinguishable form (or anamorph) genera. If we abandoned this distinction because of a few vacillating fungi, we would lose a great deal of useful taxonomic information, and make the practice of hyphomycete taxonomy even more complex and difficult than it is.

Returning to the ambivalent **Sporidesmiella hyalosperma**, the foregoing discussion has left us in something of a quandary. Is it logical to include both percurrent and sympodial varieties in the same form genus, let alone the same form species? Our decision is given additional significance by our isolation in pure culture, not only of both varieties of **S. hyalosperma**, which differ exactly as described by Hughes (1979) and Kirk (1982) (Fig. 1 A-F, 2 A-D), but also of an undescribed taxon which fitted into **Sporidesmiella** except for the consistently sympodial proliferation of its conidiophores (Figs. 3, 4 A-I, 5 A-P). Were it not for the existence of **S. hyalosperma** var. **novae-zelandiae** we would be unable to contemplate disposing our undescribed sympodial species in **Sporidesmiella**, and would be more likely to compare it with species of **Drechslera** Ito (though it differs significantly from them). We might still have considered establishing a new genus for this fungus, except for the fact that it and **S. hyalosperma** share a number of other features, described below, which convinced us that they are congeneric.

We note that all the fungi transferred by Kirk to **Sporidesmiella** were formerly disposed in **Endophragmia** or **Sporidesmium**, genera whose conidiophores by definition proliferate percurrently. We are convinced that most people would not have thought of describing, or looking for, our new species in either of those genera.

Although the storage and retrieval of taxonomic information about these hyphomycetes would in some ways be made easier by segregating these two modes of proliferation into two generic concepts, our decision to concur with Kirk and keep them together within a single genus better reflects the reality of the fungi -- 'a treacherous and mutable tribe' -- and brings some important taxonomic questions out in the open. Sympodial and annellidic fungi are not the only ones to be linked in this way. There are also developmental connections between other apparently very different modes of producing a plurality of conidia.

Since there are relatively few ways in which a hypha can proliferate, we cannot rule out the possibility of convergence, but it seems probable that annellidic ontogeny is also related

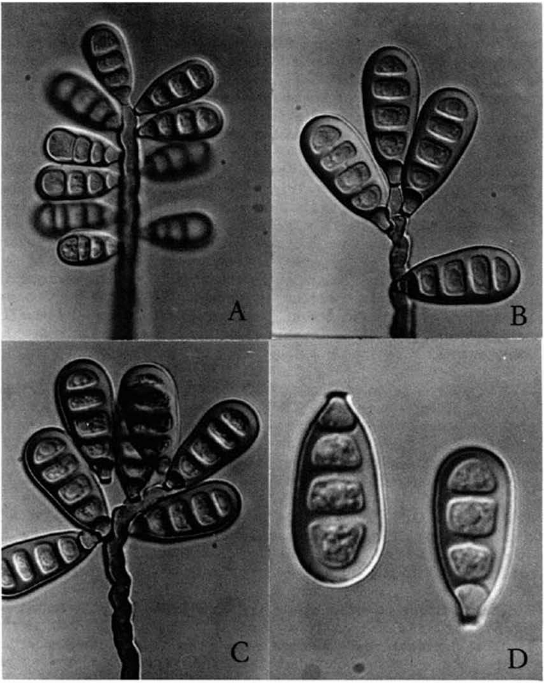


Figure 2. **Sporidesmiella hyalosperma** var. **novae-zelandiae.**
A-C: Fertile regions of conidiophores with conidia, 1000X.
D: Conidia, 2000X. (All Nomarski interference contrast).

to phialidic ontogeny. This has been suggested by the studies of Cole and Samson (1979), and Minter et al. (1982). What we mean by 'related' in this context is basically that one of these modes may have evolved from the other or from some common ancestor. In annellidic conidiogenous cells, a percurrent proliferation occurs between the formation of successive conidia, so the conidiogenous cell elongates during conidiation. In the typical phialide, there is no extension growth between successive conidia. Yet after many conidia have been produced, a refractive internal thickening is seen to have developed just inside the neck of many phialides, for example, those of various species of **Goidanichiella, Ciliciopodium, Crinula, Dendrodochium** and **Tubercularia** (Carmichael et al., 1980). These thickenings can be resolved by the transmission electron microscope into a series of wall layers (Hammill, 1974). Each layer may be equivalent to one of the brief percurrent proliferations in the annellide. A new layer is laid down each time a conidium is formed. The annellide becomes longer, the phialide does not. The two kinds of cell are usually morphologically distinguishable, yet on close examination the developmental differences between them do not seem profound.

Sometimes an accumulation of these layers may actually plug the opening of a phialide. In this case, if the phialide is to produce more conidia it must develop a new conidiogenous aperture. This is sometimes achieved by sympodial proliferation which, when repeated, eventually produces the structure known as a polyphialide.

The phialide, which seems to us the most sophisticated and economical way of producing conidia, also has connections in other directions. Species of **Trichothecium** and **Cladobotryum** exhibit what has been called 'retrogressive' conidiogenesis (Kendrick & Cole, 1969; Cole & Kendrick, 1971; Kendrick, 1971). Their conidiogenous cells gradually become shorter as a result of repeated conidium formation. A careful analysis of the events involved suggests that in this case also there is a similarity to the phialidic process, but that the position of the septum delimiting the conidium, and the point of secession of the conidium, are successively lower, giving rise to a gradual abbreviation of the conidiogenous cell.

We will mention one last example which probably involved interconversion of modes of conidiogenesis. Earlier, we cited the annellidic and sympodial anamorphs of **Venturia** species as probably representing an example of this process. We must now point out that **Venturia carpophila** Fisher has an anamorph that produces conidia in branched acropetal (apically extending) chains. We can relate this to the other anamorphs mentioned

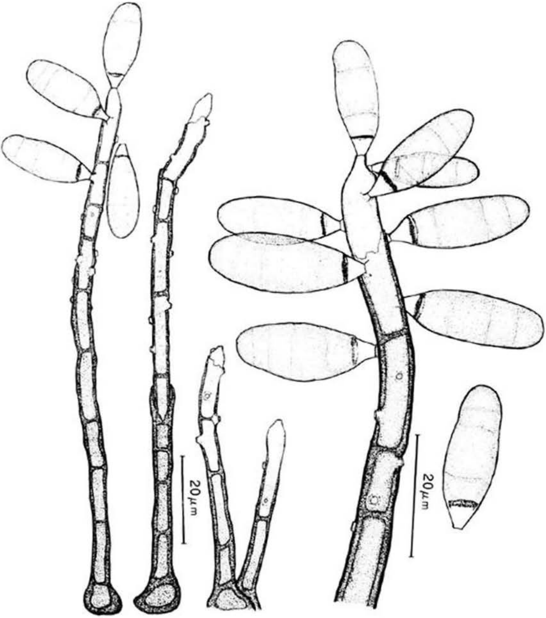


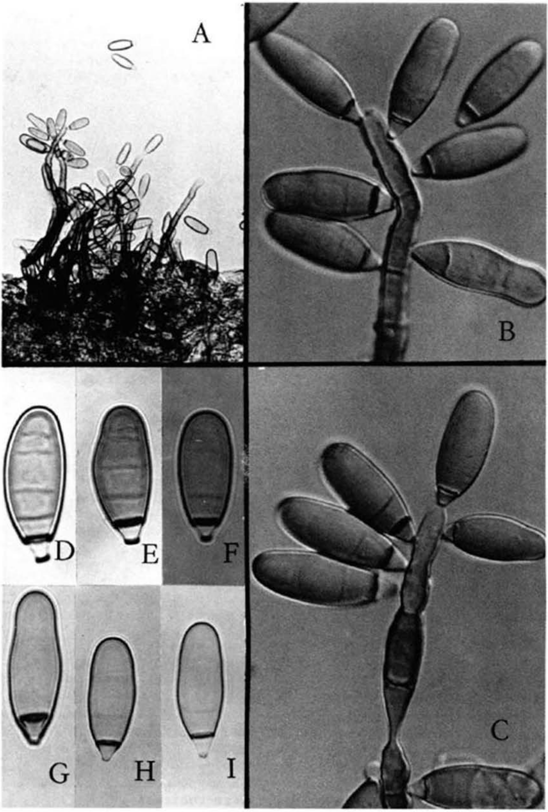
Figure 3. **Sporidesmiella brachysporioides.**
Conidiophores and conidia

above only by suggesting that it is relatively unsophisticated, a kind of ancestral stock from which the others may well have arisen. Those anamorphs producing acropetal chains face some potentially serious problems that have been circumvented by the other, presumably more advanced, modes of conidiogenesis. In acropetal chains, the nutrients destined to form each new conidium must be translocated along the entire length of the chain, passing though all extant conidia, before reaching the new conidium initial. This places the developing conidium in a rather delicate situation. Anything that disrupts the chain will also perforce bring its extension to an end, interrupting the production of new conidia. In other modes of conidium formation, each new conidium arises directly from a conidiogenous cell that is firmly connected to the vegetative mycelium, and is therefore a reliable conduit for metabolites. It does not matter if any or all of the previously formed conidia are dislodged -- the production of new ones will not be interrupted.

But how can we derive the more advanced forms from this rather hypha-like forebear? As Madelin suggested, the key seems to lie in the nature of the septum that is laid down as conidia are delimited. If the septal pore remained open indefinitely, the acropetal chain could be produced. We note that many fungi which form acropetal chains tend in fact not to deposit septa to delimit conidia until one or several conidia have been partially differentiated at the tip of the chain. But if each septal pore became sealed off when the conidium matured, the fungus would have to evolve another way of producing a plurality of conidia. Once this end was achieved, in the variety of ways we now recognize, the new methods would also be selected for because of their greater reliability, economy and security.

Thus, from one basic theme may arise a set of variations which can, by producing morphological differences, tend to obscure underlying relationships. The implications of all this for hyphomycete systematics are clear -- we must adjust our thinking to allow for these recently discovered linkages, adopting such stratagems as keying out some genera under different described categories of conidiogenesis; and we must keep searching for new characters that will help us produce a truly rational classification.

Figure 4. **Sporidesmiella brachysporioides.**
A: Conidiophores on the natural substrate, 200X.
B,C: Apical portions of conidiophores with conidia, 1000X.
D-I: Conidia, 1000X. (A, D-I, bright field; B,C, Nomarski).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TAXONOMIC PART

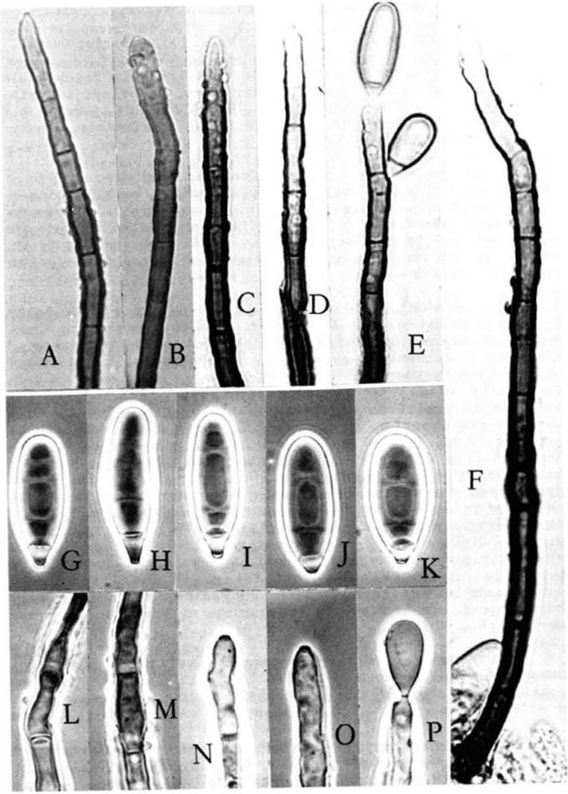
Two of the fungi we have collected in Ontario appear to be **Sporidesmiella hyalosperma** (Corda) Kirk var. **hyalosperma** and **S. hyalosperma** var. **novae-zelandiae** Hughes. The other fungus appears to represent an undescribed taxon.

Sporidesmiella brachysporioides Zhang et Kendrick sp. nov.
Figs. 3, 4 A-I, 5 A-P.

Conidiophora macronemata, singulatim vel gregem pusillum enascentia, recta vel leniter curva, non ramosa, infra brunnea ad atrobrunnea et crasse tunicata, versus apicem tenue tunicata et pallescentia, 2-13-septata, 40-225 µm long., ad basim 5-7 µm lat., super 4-5.5 µm lat.; pars sporifera sympodialis, denticulae apicales applanatae, 1.5 µm alt., 1.5-2 µm lat. Conidiophora interdum post disrumpentia percurrenter prolificantes. **Conidia** obovoidea, ellipsoidea vel late clavata, apice rotundato, base truncato, sicca, singulatim apicaliter producentia, sed secus lateres conidiophori adhaerentia, laevia, 3-4(-5)-septata, 15-35 X 7.5-13 µm, plerumque 24-32 X 10 µm; cellulae superne plusminusve distoseptatae, crassitunicatae, pallide brunneae, cellula basalis tenuitunicata, subhyalina vel hyalina; septum supernae cellulae basalis magis atratum quam ceteri.

Conidiophores well-differentiated, arising singly or in small clusters, erect or suberect, straight or slightly bent, unbranched, brown to dark brown and thick-walled below, paler and thinner-walled above; 2-13-septate, 40-225 µm long, 5-7 µm wide at the base, tapering to 4-5.5 µm above. Conidiogenous region proliferating sympodially during conidiation, and bearing flat-topped lateral denticles 1.5 µm high and 1.5-2 µm wide. Occasionally a broken-off conidiophore will resume vegetative growth by proliferating percurrently. **Conidia** obovoid or ellipsoid or broadly clavate, with a rounded apex and a truncate base, dry, produced singly from successive apices of the conidiophore, but remaining attached by their bases along the sides of the conidiophore; smooth-walled, 3-4(-5)-septate, 15-35 X 7.5-13 µm, mostly 24-32 X 10 µm; the upper cells more or less distoseptate and thick-walled, pale brown; the basal cell thin-walled and subhyaline or colourless; the septum separating

Figure 5. **Sporidesmiella brachysporioides**
A-F: Conidiophores with denticles, 800X. G-K: Conidia, 1000X.
L,M: Parts of conidiophores showing denticles.
N-P: Apices of conidiophores, one with a young conidium, 1000X.
(A-F, bright field; G-P, phase contrast).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the basal cell from those above it much darker than the others.

Habitat: decaying bark of **Acer** sp., Waterloo, Ontario, Canada.

Specimens examined: HOLOTYPE: DAOM 186229; beech-maple woodland, Laurel Creek Conservation Area, Waterloo, Ontario, Canada. October 1981. T.Y. Zhang. PARATYPE: UW, beech-maple woodland, Laurel Creek Cons. Area, Waterloo, Ontario, Canada. July 1982. T.Y. Zhang.

S. brachysporioides differs from all but one species of **Sporidesmiella** in the consistently sympodial proliferation of its conidiophores. It can be distinguished from S. **hyalosperma** var. **novae-zelandiae** by the distinct denticles on its conidiophores, by the fact that its conidia are broadest in the middle, rather than just below the apex, and by the darker colour of their subbasal septum.

Kirk (1982) gave descriptions of **Sporidesmiella hyalosperma** (Corda) Kirk var. **hyalosperma** and var. **novae-zelandiae** (Hughes) Kirk, derived from examination of herbarium specimens on a variety of substrates, but does not appear to have observed the organism in culture. We were fortunate enough to isolate both the percurrently and sympodially proliferating varieties in axenic culture, which gave us the opportunity to examine their development as it happened. As Figs. 1 and 2 make clear, the morphologies of their conidia are basically identical, while their modes of conidiophore proliferation are clearly different. These differences are expressed, not only in nature, where they might be caused by variations in environmental conditions, but also in virtually identical cultural conditions. We are carrying out a variety of experiments in an attempt to induce either morph to shift its mode of conidiogenesis. If one or both can be persuaded to do this by some change in nutrition or in environmental conditions, Madelin's hypothesis will be greatly strengthened, and hyphomycete taxonomists will be faced with new challenges.

S. **hyalosperma** var. **hyalosperma** (annellidic) grows but does not normally sporulate in PDA. It will, however, sporulate readily on media containing cellulose*, and also when grown on sterilized **Acer** bark. S. **hyalosperma** var. **novae-zelandiae**

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*Cellulose medium: alpha-cellulose, 10 g; $(NH_4)_2SO_4$, 1.5 g; urea, 0.4 g; KH_2PO_4, 2 g; $MgSO_4.7H_2O$, 0.2 g; $CaCl_2$, 0.2 g; distilled water to one litre.

(sympodial) sporulates on PDA and on sterilized **Acer** bark. The cultural characteristics of these organisms are described below.

Sporidesmiella **hyalosperma** (Corda) Kirk var. **hyalosperma**.
Fig. 1 A-F.

Colonies on PDA slow-growing, 1.5 cm diam after 3 wk at 25°C under normal room lighting; immersed mycelium brown; aerial hyphae light brown. **Conidiophores** usually absent but occasionally developing if colonies are wounded.

Colonies on a synthetic medium * containing alpha-cellulose also slow-growing and sparse, but sporulating regularly. **Conidiophores** well-differentiated, arising singly, erect or suberect, straight or slightly bent, unbranched, brown but paler than on the natural substrate, 2-13-septate, up to 150 µm long, 3-4(-5) µm thick; conidiogenous region proliferating percurrently, when mature bearing up to 15 annellations, usually spaced at intervals of 3-4.5 µm. **Conidia** blastic-annellidic, obovoid or broadly clavate, with a rounded apex and a truncate base; dry, produced singly from successive percurrent proliferations of the apex of the conidiophore, but usually remaining attached to the side of the conidiophore by a fragment of outer wall material; smooth-walled, 3-4-septate (mostly 3-septate), 14-20 X 7-9.5 µm; the upper cells more or less distoseptate and thick-walled, pale brown; the basal cell thin-walled and subhyaline or colourless; the septum separating the basal cell from those above it much darker than the others.

Colonies on sterilized decaying **Acer** bark faster-growing, forming delicate mycelial strands containing several to many parallel hyphae on the surface of the bark; abundant conidiophores and conidia present after 2 wk. **Conidiophores** unbranched, 2-8-septate, up to 180 µm long, 5-8.5(-11) µm thick at the swollen base (mostly 8.5 µm), 3.5-5.5 µm above, with up to 22 annellations spaced 2-3 µm apart. **Conidia** (15-)20-24(-27) X (6-)9-11(-12) µm, (3-)4-septate.

Specimen examined: DAOM 186227; culture isolated from decaying bark of **Acer** sp., Laurel Creek Conservation Area, Waterloo, Ontario, Canada. July 1982. T.Y. Zhang.

Sporidesmiella hyalosperma var. **novae-zelandiae** (Hughes) Kirk
Fig. 2 A-D.

Colonies on PDA slow-growing, 1.2 cm diam after 3 wk at 25°C under normal room lighting; immersed mycelium brown, and a brown pigment diffusing beyond the colony into the medium; aerial hyphae moderately dense to sparse, hyaline, restricted to the centre of the colony. **Conidiophores** well-differentiated, arising singly, erect or suberect, straight or slightly bent, unbranched, subhyaline to light brown, (2-)3-4(-6)-septate, up to 95 µm long, up to 6 µm wide at the swollen base, 3.5-4 µm wide above, tapering to 3-3.5 µm at the tip; conidiogenous region proliferating sympodially. **Conidia** blastic-sympodial, obovoid or broadly clavate, apex rounded, base truncate; dry, remaining attached to the sides of the conidiophore; smooth-walled, 3(-4)-septate, 15-20 X 7-9 µm, upper cells distoseptate and thick-walled, light brown; basal cell thin-walled, subhyaline; the septum separating the basal cell from those above it darker than the others.

Specimen examined: DAOM 186228; culture isolated from snail excreta, Waterloo, Ontario, Canada. August 1982. D. Brubacher.

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We thank Dr. T.R. Nag Raj for correcting the Latin diagnosis; and Dr. Nag Raj and Dr. K.A. Pirozynski for reviewing the manuscript. Financial support in the form of an operating grant from the Natural Sciences and Engineering Research Council of Canada to B. Kendrick, and a visiting scholarship from the People's Republic of China to T.Y. Zhang, is gratefully acknowledged.

LITERATURE CITED

Carmichael, J.W., Kendrick, B., Sigler, L. and Conners, I.L. (1980). 'Genera of Hyphomycetes'. Univ. of Alberta Press, Edmonton. 386 pp.

Cole, G.T. and Kendrick, B. (1971). Conidium ontogeny in hyphomycetes. Development and morphology of **Cladobotryum.** Can.J. Bot. **49**: 595-599.

Cole, G.T. and Samson, R.A. (1979). 'Patterns of development in conidial fungi'. Pitman, London.

Fletcher, H.J. (1975). Conidiophore morphology in **Graphium putredinis.** Trans. Brit. Mycol. Soc. **64**: 67-71.

Hammill, T.M. (1974). Electron microscopy of phialides and conidiogenesis in **Trichoderma saturnisporum.** Am. J. Bot. **61**: 15-24.

Hughes, S.J. (1979). Relocation of species of **Endophragmia** auct. with notes on relevant generic names. N. Z. J. Bot. **17**: 139-188.

Kendrick, B. (1962). The **Leptographium** complex. **Verticicladiella** Hughes. Can. J. Bot. **40**: 771-797.

Kendrick, B. (1971). Discussions on terminology, and Conclusions and recommendations. In 'Taxonomy of Fungi Imperfecti'. Ed. B. Kendrick. Univ. of Toronto Press, Toronto. pp. 228-229, 253-262.

Kendrick, B. and Cole, G.T. (1969). Conidium ontogeny in Hyphomycetes. **Trichothecium roseum** and its meristem arthrospores. Can. J. Bot. **47**: 345-350.

Kirk, P.M. (1982). New or interesting microfungi VI. **Sporidesmiella** gen. nov. (Hyphomycetes). Trans. Brit. Mycol. Soc. **79**: 479-489.

Madelin, M.F. (1979). An appraisal of the taxonomic significance of some different modes of producing blastic conidia. In 'The Whole Fungus' Vol. 1. Ed. B. Kendrick. Nat. Museums Canada, Ottawa. pp. 63-80.

Minter, D.W., Kirk, P.M. and Sutton, B.C. (1982). Holoblastic phialides. Trans. Brit. Mycol. Soc. **79**: 75-93.

Sutton, B.C. and Laut, J.G. (1970). **Graphium penicillioides** on American elm in Manitoba and Saskatchewan. Bi-monthly Res. Notes Can. For. Serv. **26**: 25-26.

Upadhyay, H.P. and Kendrick, B. (1975). Prodromus for a revision of **Ceratocystis** (Microascales, Ascomycetes) and its conidial states. Mycologia **67**: 798-805.

MYCOTAXON

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NEW OR INTERESTING MICROFUNGI

X. HYPHOMYCETES ON *LAURUS NOBILIS* LEAF LITTER

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SUMMARY

Notes on 36 hyphomycetes found to occur on leaf litter of *Laurus nobilis*, the sweet bay, are presented, including *Acrodictyopsis lauri* gen. et sp. nov., *Hemibeltrania mitrata* sp.nov., *Pseudocercospora unicolor* (Sacc. & Penz.) comb.nov., *Pseudomicrodochium lauri* sp.nov., *Pterygosporopsis fragilis* gen. et sp. nov. and *Pyricularia lauri* sp.nov.

INTRODUCTION

Accounts of some microfungi which were found colonizing leaf litter of *Laurus nobilis* L., the sweet bay, have been published earlier (Kirk, 1981, 1982b). In the present contribution thirty-three hyphomycetes which were not previously recorded on this substratum are reported together with additional information on three species reported previously.

From twenty collections examined in the present continuing study a total of 126 microfungi have been recorded comprising 82 (66%) Hyphomycetes, 21 (16%) Coelomycetes, 21 (16%) Ascomycetes, 1 (1%) Basidiomycete and 1 (1%) 'Phycomycete'. The total number of species recorded to date is quite large compared with the numbers obtained (unpubl. data) from the leaf litter of other natural and introduced broad-leaved evergreens growing in the British Isles (e.g. *Quercus ilex* L., *Ilex aquifolium* L., *Rhododendron ponticum* L., *Eucalyptus* spp.). It is significantly larger than the number of species found on broad-leaved deciduous species such as *Fagus sylvatica* L., *Quercus robur* L. and *Betula* spp. Over 180 species have, however, been recorded from litter (needles, cones and small twigs) of *Pinus* spp.in the British Isles (Minter, personal communication).

The proportion of hyphomycetes recorded on *L. nobilis* leaf litter is unusually large when compared with surveys carried out on a geographical basis. Dennis (1973) considered that the approximate proportions of the total numbers of species to be expected in the major groups were 'Phycomycetes' 2–6%. Basidiomycotina 47–57%, Ascomycotina 24–27%, Deuteromycotina 12–20% and Myxomycota 1–5%. Henderson & Watling (in Jermy & Crabbe, 1978) recorded 1,787 species from the Isle of Mull comprising 3% 'Phycomycetes', 48% Basidiomycotina, 30% Ascomycotina, 15% Deuteromycotina and 4% Myxomycota. The large percentage for Hyphomycetes recorded in the present study is perhaps a reflection of their lack of substrate preference when compared with species belonging in the other groups and also their ability to produce recognizable fruiting structures under apparently less exacting conditions and possibly in a shorter period of time.

Of the 83 Hyphomycetes recorded 12 were considered new species. One of these, *Endophragmiella lauri* P.M. & C.M. Kirk (Kirk, 1982b), was subsequently found to have been described earlier (as *Paratrichoconis biseptata* Matsushima, 1975), in what was considered (vide infra) to be an inappropriate genus. Presently, 6 of these species are known only from *L. nobilis* leaf litter. Of the 12 new species, 4 are known from 5 or more collections and could therefore be considered as common on this substratum.

TAXONOMIC PART

ACREMONIUM STRICTUM W. Gams, *Cephalosporium-artige Schimmelpize (Hyphomycetes)*: 42 (1971). (Fig. 1A)

A cosmopolitan species reported from a wide range of substratum types, it is known from Africa, North and South America, Asia, Australasia, Europe, and the Middle East (herb. IMI, unpubl.).

In pure culture the characteristics of IMI 260957 closely agree with those given in the description published by Gams (1971). On the natural substratum, however, the dimensions are somewhat smaller with the phialides only up to 15 µm high and the conidia 2·5–5 x 1–1·5 µm.

Illustrations: Gams (1971).

Specimens examined: Rayleigh, Essex, U.K., 5 July 1981, B.M. Spooner, IMI 261097; Abbotsbury, Dorset, U.K., 13 July 1981, P.M. Kirk, 1066, IMI 260957.

ACRODICTYOPSIS P.M. Kirk, gen.nov.

Coloniae effusae, plerumque inconspicuae. Mycelium partim superficiale, partim in substrato immersum, ex hyphis laevibus, pallide brunneis, ramosis,

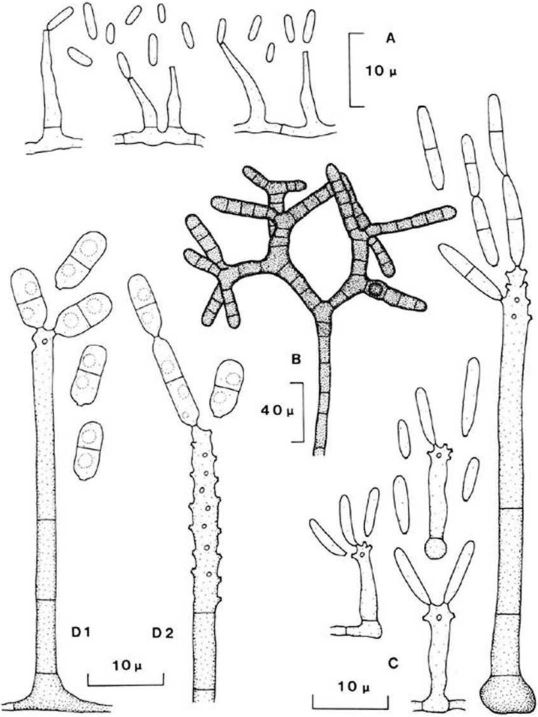

Fig. 1. (A) **Acremonium strictum.** (B) **Anavirga laxa.** (C) **Anungitea fragilis.** C1 – IMI 257101c; C2 – IMI 237285d (see Kirk, 1982a). (D) **Anungitea heterospora.** D1 – IMI 261100; D2 – IMI 260601.

septatis compositum. Conidiophora macronemata, mononemata, solitaria, erecta, simplicia, recta, brunnea, septata, ex mycelio superficiali terminalia et lateralia orientia. Cellulae conidogenae in conidiophoris incorporatae, terminales, monoblasticae, enteroblastice proliferantes. Conidia acrogena, solitaria, sicca, irregularia, globosa ad subglobosa vel late ellipsoidea, septata, in maturitate dictyoseptata visu sed in juvenilitate ut helicosporae adspectu, ad septa constricta, brunnea, secedentia schizolytice.

Species typica *Acrodictyopsis lauri* P.M. Kirk

Colonies effuse, usually inconspicuous. *Mycelium* partly superficial, partly immersed in the substratum, composed of smooth, pale brown, branched, septate hyphae. *Conidiophores* macronematous, mononematous, solitary, erect, simple, straight, brown,septate, arising terminally and laterally from the superficial mycelium. *Conidiogenous cells* integrated, terminal, monoblastic, proliferating enteroblastically. *Conidia* acrogenous, solitary, dry, irregular, globose to subglobose or broadly ellipsoid, septate, appearing dictyoseptate but showing helicosporous affinities during early stages of development, constricted at the septa, brown, seceeding schizolytically.

In the initial stages of conidium development, *Acrodictyopsis* shows distinct affinities with some helicosporous genera of dematiaceous hyphomycetes. The mature conidia are not truly dictyoseptate and although it has not been possible to observe a complete sequence of intermediate stages in conidium development or to interpret accurately mature conidia with respect to their development it is possible that only one growing point is present and that the irregular nature of the mature conidia results entirely from the random and abrupt changes in direction of growth by the apical growing point. In this respect *Acrodictyopsis* is similar to *Zalerion* Moore & Meyer (1962) emend. Anastasiou (1963). It differs from *Zalerion* in forming more robust macronematous conidiophores and conidiogenous cells which proliferate percurrently.

ACRODICTYOPSIS LAURI P.M. KIRK, sp.nov. (Fig. 2)

Coloniae effusae, pilosae, fuscae ad atrae, plerumque inconspicuae. Mycelium partim superficiale, partim in substrato immersum, ex hyphis laevibus, pallide brunneis, ramosis, septatis, 1·5–2·5 μm latis compositum. Conidiophora macronemata, mononemata, solitaria, erecta, simplicia, recta vel leviter curvata, aliquanta subulata, brunnea, 1–4-septata, ex mycelio superficiali terminalia et lateralia orientia, 10–60 (–110) μm alta, 1·5–2·5 μm lata. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, enteroblastice proliferantes. Conidia acrogena, solitaria, sicca, irregularia, septata, in maturitate dictyoseptata visu sed in juvenilitate ut helicosporae adspectu, ad septa constricta, brunnea, cellula basali atrobrunnea, secedentia schizolytice, globosa ad subglobosa vel late ellipsoidea, 8–16 μm diam vel

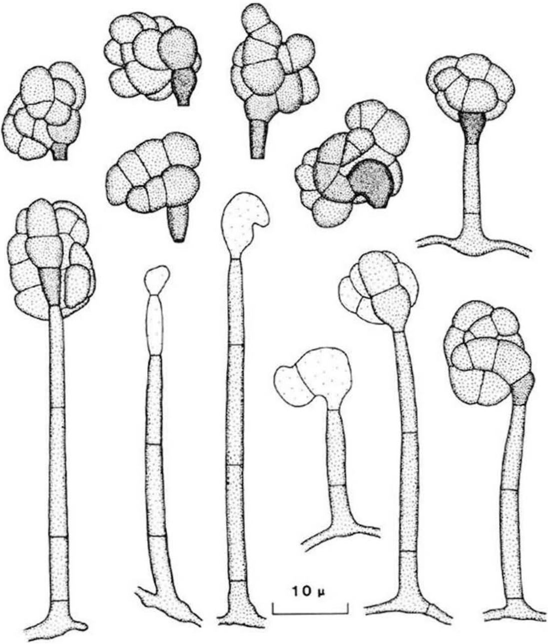

Fig. 2. Acrodictyopsis lauri.

10–16 (–20) µm longa, 8–12 µm lata.

In folio emortuo *Lauri nobilis*, Rayleigh, Essex, U.K., 15 Dec. 1980, B.M. Spooner, IMI 255784, holotypus.

Colonies effuse, hairy, blackish brown to black, usually inconspicuous. *Mycelium* partly superficial, partly immersed in the substratum, composed of smooth, pale brown, branched, septate, 1·5–2·5 µm wide hyphae. *Conidiophores* macronematous, mononematous, solitary, erect, simple, straight or slightly curved, somewhat subulate, brown, 1–4-septate, arising terminally and laterally from the superficial mycelium, 10–60 (–110) µm high, 1·5–2·5 µm wide. *Conidiogenous cells* integrated, terminal, monoblastic, proliferating enteroblastically. *Conidia* acrogenous, solitary, dry, irregular, septate, appearing dictyoseptate but showing helicosporous affinities during early development, constricted at the septa, brown, basal cell dark brown, seceeding schizolytically, globose to subglobose or broadly ellipsoid, 8–16 µm diam or 10–16 (–20) µm long, 8–12 µm wide.

Specimens examined: Rayleigh, Essex, U.K., 25 Dec. 1980, B.M. Spooner, IMI 255784, holotype, 5 July 1981, B.M. Spooner, IMI 261108; Lymington, Dorset, U.K., 10 July 1981, P.M. Kirk 1022, IMI 260809.

It would appear from the illustration proved by Arnaud (1954: Fig. 12 H–K) that *Acrospeira fusca* Arnaud (nom.nud.) is conspecific with *Acrodictyopsis lauri* since morphologically they are remarkably similar and their dimensions are of the same order. No type material of *Acrospeira fusca* is known to exist (Nicot & Charpentié, 1971).

ANAVIRGA LAXA B. Sutton, *Trans. Br. Mycol. Soc.* **64**: 405 (June 1975). (Fig. 1B)

Taeniolella dichotoma Borowska, *Acta mycol.* **11**: 63 (Aug. 1975).

Sutton (1975) described *Anavirga laxa* B. Sutton from decaying cupules of *Castanea sativa* L. and it has subsequently been found on cupules of *Fagus sylvatica* L. and leaves of *Betula* sp., *Fraxinus* sp. and *Quercus* sp. in the British Isles (herb. IMI, unpubl.). Borowska (1975) recorded it from bark of *Quercus robur* L. collected in Poland.

The conidia, evidently, may have a much more complex shape than that illustrated by either Sutton (1975) or Borowska (1975) and are often large, multi-branched structures. As pointed out earlier (Kirk, 1979), they readily fragment into smaller propagules.

Illustrations: Borowska (1975), Sutton (1975).

Specimens examined: Rayleigh, Essex, U.K., 25 Dec. 1980 and 5 July 1981, B.M. Spooner, IMI 255770, 255780b and 261098; Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 987, IMI 260600; Wheatfen Broad, Norfolk, U.K., 24 Aug 1981, M.B. & J.P. Ellis, IMI 261545.

ANUNGITEA FRAGILIS B. Sutton, *Mycol. Pap.* **132**: 10 (1973). (Fig 1C)

The occurrence of *Anungitea fragilis* B. Sutton (1973a) on *Laurus nobilis* leaf litter was reported earlier (Kirk, 1982b). The collections cited below differ from those which could be considered as typical (Kirk, 1982a) in the presence of only relatively short conidiophores (10–15 (–20) x 1·5–2·5 µm) and production of somewhat smaller (5–8 (–10·5) x 1–1·5 (–2) µm),0 (–1)-septate conidia. Evidence which suggests that these collections should be referred to *A. fragilis* is obtained from an examination of the conidia and conidiogenous loci. In both typical and atypical collections the conidiogenous loci consist of cylindrical denticles with distinctly thickened apices with the conidia possessing a sometimes excentric but similarly thickened basal scar. The conidia in the atypical collections have not been observed in the short unbranched chains which are a characteristic of the typical collections.

Specimens examined: Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 907c & 919a, IMI 257101c & 257113a; Achamore, Isle of Gigha, U.K., 11 May 1981, R.W.G. Dennis, IMI 259035b & 259042b; Lymington, Dorset, U.K., 10 July 1981, P.M. Kirk 1015, IMI 260802; Castell, Powys, U.K., 11 July 1981, R.W.G. Dennis, IMI 261119d; East Lulworth, Dorset, U.K., 12 July 1981, P.M. Kirk 1035, IMI 260926; Fleet churchyard, Dorset, U.K., 13 July 1981, P.M. Kirk 1055, IMI 260946; Abbotsbury, Dorset, U.K., 13 July 1981, P.M. Kirk 1070, IMI 260961; Lyme Regis, Dorset, U.K., 15 July 1981, P.M. Kirk 1089, IMI 261287; Christchurch Priory, Dorset, U.K., 17 July 1981, P.M. Kirk 1111, IMI 261265: Tunbridge Wells, Kent, U.K., 2 Oct. 1981, B.M. Spooner, IMI 262737c; Slindon, Sussex, U.K., 3 Apr. 1982, P.M. Kirk 1143, IMI 266740.

ANUNGITEA HETEROSPORA P.M. Kirk, *Trans. Br. Mycol. Soc.* **80**: 449 (1983). (Fig. 1D)

The occurrence of this recently described species (Kirk, 1983) on *Laurus nobilis* leaf litter suggests that it is probably of widespread occurrence throughout the British Isles and is able to colonize a variety of dead leaves and other substrata. Concurrent to its description it was reported on dead stems of *Rosa* sp. and *Rubus fruiticosus* L. agg. and leaves of *Ilex pernyi* Franch. and *Pseudowintera colorata* (Raoul) Dandy. It is also known to occur on dead leaves of *Phormium tenax* J.R. & G. Forst. (herb. IMI unpubl.).

The heterogenous nature of the conidia is evident in the present collections. Thus, in IMI 261100, the conidia are invariably solitary whilst in IMI 260601 both solitary and catenate conidia occur.

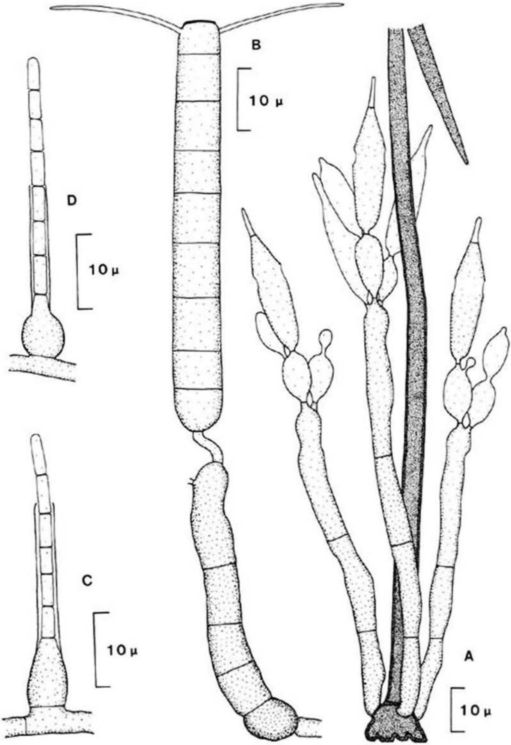

Fig. 3. (A) **Beltrania querna**. (B) **Camposporium antennatum**. (C) **Chalara fungorum**. (D) **Chalara fusidioides**.

Specimens examined: Christchurch Priory, Dorset, U.K., 5 July 1981, P.M. Kirk 963a, IMI 260618a; Rayleigh, Essex, U.K., 5 July 1981, B.M. Spooner, IMI 261100; Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 988, IMI 260601.

BELTRANIA QUERNA Harkn., *Bull. Calif. Acad. Sci.* **1**: 39 (1884). (Fig.3A)

Setae up to 300 µm or more high, 5–9 µm wide above the base, basal cells up to 25 µm wide. *Conidiophores* typically borne on the basal cells of the setae, up to 80 µm or more high, 4–7 µm wide. *Conidia* asymmetrically biconic, rounded at the base, 20–30 µm long, 6–9 µm wide at the broadest point, apical appendage 4–7 µm long.

Specimens examined: Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 903, 904a, 915b, 916b, IMI 257097, 257098a, 257109b, 257110b; Christchurch Priory, Dorset, U.K., 5 July 1981, P.M. Kirk 964, IMI 260619; Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 989, IMI 260602; Christchurch Priory, Dorset, U.K., 17 July 1981, P.M. Kirk 1105, IMI 261259.

The occurrence of *Beltrania querna* in the British Isles was reported by Kirk (1982a) where it was suggested that it probably occurred wherever its then only known substratum, *Quercus ilex* L. leaf litter, was found. That it should be found to occur on *L. nobilis* leaf litter is, perhaps, not too surprising since at all four localities cited above *Q. ilex* trees were either close by or adjacent to the sweet bay.

CAMPOSPORIUM ANTENNATUM Harkn., *Bull. Calif. Acad. Sci.* **1**: 37 (1884). (Fig. 3B)

Conidia cylindrical, pale brown, smooth,(4–) 7–11 (–14)-septate, 45–75 (–85) µm long, 7–10 µm wide, apical cell somewhat flattened and with a thickened wall distally, often bearing laterally 1–3 hyaline, non-septate filiform appendages, basal cell hemispherical, typically with a slightly raised truncate projection at the point of attatchment to the conidiogenous cell.

Specimens examined: Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 905a, 906a, 907a, IMI 257099a, 257100a, 257101a; East Lulworth, Dorset, U.K., 12 July 1981, P.M. Kirk 1029, IMI 260816: Fleet Churchyard, Dorset, U.K., 13 July 1981, P.M. Kirk 1049, IMI 260940; Christchurch Priory, Dorset, U.K., 17 July 1981, P.M. Kirk 1107, IMI 261261.

In the absence of the characteristic lateral appendages the somewhat flattened apical cell with its thickened distal wall serves to distinguish *Camposporium antennatum* from the other two species of *Camposporium* which have been recorded on *L. nobilis* leaf litter (Kirk, 1981).

There appears to be no formal report of the occurrence of *C. antennatum* in the British Isles although the name has appeared in a list of species recorded at a British Mycological Society foray (Moodie, 1981). Matsushima (1975) recorded it from Japan on leaf litter of *Cinnamomum japonicum* Siebold and *Ficus erecta* Thunb.

Illustrations: Ellis (1971), Hughes (1951a), Ichinoe (1971), Matsushima (1975), Peek & Solheim (1958).

CEPHALOTRICHUM STEMONITIS (Pers.) Link, *Magazin Ges. naturf. Fr. Berl.* 3: 20 (1809). (Fig. 4A)
Doratomyces stemonitis (Pers.) Morton & G. Sm., *Mycol. Pap.* **86**: 70 (1963).
Synanamorph: *Echinobotryum atrum* Corda

Of widespread distribution, known to occur throughout Europe, North America and India, this species has been isolated from dung and soil and has been collected growing on various types of rotten wood and bark (herb. IMI, unpubl.). It does not appear to have been previously recorded from leaf litter.

Illustrations: Ellis (1971), Hennebert (1968), Matsushima (1975), Morton & Smith (1963).

Specimens examined: Christchurch Priory, Dorset, U.K., 17 July 1981, P.M. Kirk 1113, IMI 261267: Slindon, Sussex, U.K., 3 Apr. 1981, P.M. Kirk 1145, IMI 266742.

CHALARA FUNGORUM (Sacc.) Sacc., *Michelia* **1**: 80 (1877). (Fig. 3C).

Phialides pale brown, smooth, 26–38 μm high, comprising an ellipsoid to cylindrical *venter* 10–16 μm long, 6–8 μm wide and a cylindrical *collarette* 16–22 μm long, 2·5–3 μm wide. *Conidia* cylindrical with truncate ends, non-septate, hyaline, smooth, 7–11 μm long, 2–2·5 μm wide.

Specimens examined: Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1980, P.M. Kirk 909, IMI 257103; Achamore, Isle of Gigha, U.K., 11 May 1981, R.W.G. Dennis, IMI 259030; Wheatfen Broad, Norfolk, U.K., 25 June 1981, M.B. & J.P. Ellis, IMI 260107; Christchurch Priory, Dorset, U.K., 5 July 1981, P.M. Kirk 966, IMI 260621; Lymington, Dorset, U.K., 9 July 1981, P.M. Kirk 1008, IMI 260795; East Lulworth, Dorset, U.K., 12 July 1981, P.M. Kirk 1030a, IMI 260817a.

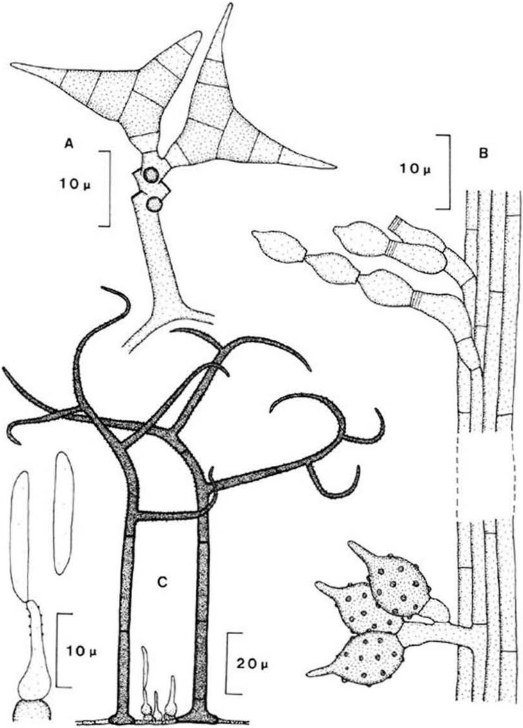

Fig. 4. (A) **Cephalotrichum stemonitis** with **Echinobotryum atrum** synanamorph. (B) **Diplocladiella scalaroides.** (C) **Gyrothrix podosperma.**

Nag Raj & Kendrick (1975) redescribed this species based on an examination of a slide derived from the holotype, on *Hydnum compactum* Pers. : Fr. collected in Italy. No other collections were examined. In addition to the collections cited above, *Chalara fungorum* (Sacc.) Sacc. is also known to occur on decaying leaves of *Rhododendron ponticum* L. and rotten wood of *Fagus sylvatica* from the British Isles (herb. IMI, unpubl.).

Illustrations: Nag Raj & Kendrick (1975).

CHALARA FUSIDIOIDES (Corda) Rabenh., *Duetsch. Kryptfl* **1**: 38 (1844). (Fig. 3D)

Phialides pale brown, smooth, 16-24 μm high, comprising a subglobose to broadly ellipsoid *venter* 4–6 μm long, 4–5 μm wide and a cylindrical *collarette* 12–18 μm long, 2–2·5 μm wide. *Conidia* cylindrical with truncate ends, non-septate, hyaline, smooth, 3–6 μm long, 1·5–2 μm wide.

Specimen examined: Lyme Regis, Dorset, U.K., 15 July 1981, P.M. Kirk 1084, IMI 261282.

Nag Raj & Kendrick (1975) reported this widespread species from Canada, Czechoslovakia, India, Italy and New Zealand on a variety of substratum types. In the British Isles it is known to occur on decaying needles and cones of *Pinus sylvestris* L. and *Pinus nigra* Link (herb. IMI, unpubl.).

Illustrations: Nag Raj & Kendrick (1975).

CRYPTOCORYNEUM CONDENSATUM (Wallr.) Mason & S. Hughes ex S. Hughes, *Can. J. Bot.* **36**: 758 (1958). (Fig. 5A)

This species is presently known only from Europe and North America (herb. IMI, unpubl.) and thus appears to have a more restricted distribution than the closely related *Cryptocoryneum rilstonii* M.B. Ellis (see Kirk, 1982b). Collections from the British Isles in herb. IMI are all on rotten wood from a total of eighteen different tree species. It does not appear to have been previously recorded from leaf litter.

Illustrations: Ellis (1971), Schoknecht & Crane (1977).

Specimen examined: Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 911, IMI 257105.

CYLINDROTRICHUM OLIGOSPERMUM (Corda) Bonorden, *Handb. allg. Mykol.*: 88 (1851). (Fig. 5B)

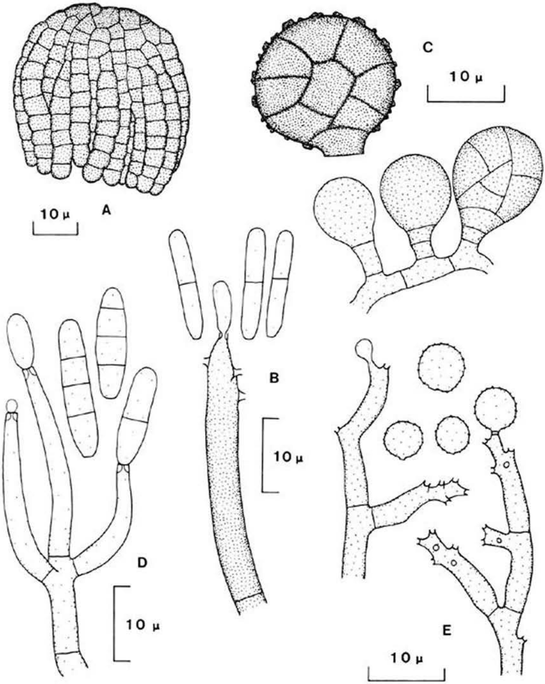

Fig. 5.(A) **Cryptocoryneum condensatum**. (B) **Cylindrotrichum oligospermum**. (C) **Epicoccum nigrum**. (D) **Fusariella hughesii**. (E) **Hansfordia pulvinata**.

Conidia aggregated into a liquid droplet, cylindrical with rounded ends, smooth, hyaline, medianly 1-septate, 12–16 (–20) μm long, 2·5–3 μm wide.

Specimens examined: Achamore, Isle of Gigha, U.K., 11 May 1981, R.W.G. Dennis, IMI 259033b; Christchurch Priory, Dorset, U.K., 5 July 1981, P.M. Kirk 970, IMI 260625; East Lulworth, Dorset, U.K., 12 July 1981, P.M. Kirk 1034, IMI 260836; Lyme Regis, Dorset, U.K., 15 July 1981, P.M. Kirk 1088, IMI 261286; Slindon, Sussex, U.K., 3 Apr. 1982, P.M. Kirk 1149, IMI 266746.

Collections of this species in herb. IMI are from Europe, North America and India but it is likely that the species occurs elsewhere. In the British Isles it is found on a variety of decaying wood types and herbaceous stems and is also known to occur on leaf litter of *Quercus ilex*.

Illustrations: Ellis (1971), Gams & Holubová-Jechová (1976).

DIPLOCLADIELLA SCALAROIDES Arnaud ex M.B. Ellis, *More Dematiaceous Hyphomycetes*: 229 (1975)). (Fig. 4B)

This easily recognised hyphomycete was recorded earlier (Kirk, 1982a) on fallen leaves of *Quercus ilex*. Since Matushima (1980) found it colonizing a variety of fallen leaf types in Taiwan it was not unexpected, therefore, that it should be found on *L. nobilis* leaf litter.

In addition to those illustrations cited earlier (Kirk, 1982a) a collection from *Genista tinctoria* L. was illustrated by O. & R. Hilber (1980).

Specimens examined: Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 906c and 919b, IMI 257100c and 257113b; Slindon, Sussex, U.K., 3 Apr. 1982, P.M. Kirk 1154b, IMI 266751b.

ENDOPHRAGMIELLA LAURI P.M. & C.M. Kirk apud Kirk, *Trans. Br. Mycol. Soc.* 78: 29 (1982).

Paratrichoconis biseptata Matsushima, *Icon. microfung. Matsushima lect.*: 189 (1975, non *Endophragmiella biseptata* (Peck) S. Hughes, *Fungi Canadenses* No. 125, 1978).

Whilst searching the illustrations in Matsushima's book (1975) the author fortuitously turned to Plate 190 and at once noticed the remarkable resemblance of the conidia depicted in fig. 2 of that plate to those of *Endophragmiella lauri* (Kirk, 1982b). Although conidiophore proliferation in *Paratrichoconis biseptata* Matsushima (1975: 106, Plates 189/1-3 and 190/2) was described as sympodial with denticles persisting on the elongating conidiogenous cell the recollection that in *E. hymenochaeticola* S. Hughes a somewhat

similar phenomenon was described (Hughes, 1978) prompted an examination of authentic material of *P. biseptata* because the holotype is lost (Matsushima, pers. comm.). The subsequent examination confirmed that *P. biseptata* and *E. lauri* are conspecific and although the name *P. biseptata* predates *E. lauri* by some seven years the epithet *biseptata* is preoccupied in *Endophragmiella* and therefore the correct name for this species is *E. lauri*.
Illustrations: Kirk (1982b), Matsushima (1975).

Specimens examined: On *Podocarpus macrophylla* D. Don leaves, Hachijo Island, Japan, Sept. 1970, T. Matsushima MFC-3201, IMI 265764, slide ex herb. Matsushima; on leaves of *Laurus nobilis*; Brodick Castle, Isle of Arran, U.K., 8 Sept. 1980, P.M. Kirk 760, IMI 252136, holotype; Christchurch Priory, Dorset, U.K., 5 July 1981, P.M. Kirk 971, IMI 260626; Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 995, IMI 260608; Lymington, Dorset, U.K., 10 July 1981, P.M. Kirk 1016, IMI 260803; East Lulworth, Dorset, U.K., 12 July 1981, P.M. Kirk 1036, IMI 260927.

EPICOCCUM NIGRUM Link, *Magazin Ges. naturf. Fr. Berl.* 7: 32 (1815). (Fig. 5C)
Epicoccum purpurascens Ehrenb., *Sylv. mycol.*: 12 (1818).

This species ranks as one of the most common hyphomycetes, the records in herb. IMI indicating that it occurs on over 200 different substrata, including 178 different plant genera, and that it is cosmopolitan in distribution being known from all the major land masses except Antarctica.

Specimen examined: Tunbridge Wells, Kent, U.K., 2 Oct 1981, B.M. Spooner, IMI 262745a.

FUSARIELLA HUGHESII Chabelska-Frydman, *Can. J. Bot.* 42: 1485 (1964). (Fig. 5D)

Colonies floccose, irregular in outline, olivaceous green to greyish green. *Conidia* cylindrical to narrowly ellipsoid, often somewhat truncate at the base, smooth, hyaline, greyish green in mass, (1–) 3-septate, (10–) 13–24 µm long, 2·5–4 µm wide.

Specimen examined: Abbotsbury, Dorset, U.K., 13 July 1981, P.M. Kirk 1071, IMI 260962.

This species, described from *Phalaris minor* Retz. and *Trigonella arabica* Del. collected in Israel (Chabelska-Frydman, 1964) was recorded from soil collected in Alaska by Matsushima (1975) and collections in herb. IMI extend its range to the British Isles, India and Pakistan. It is known to occur in the British Isles on dead stems of *Anthriscus sylvestris* (L.) Schims., *Dipsacus* sp., *Foeniculum vulgare* Mill., *Heracleum sphondylium* L., *Lupinus polyphyllus* Lindl., *Thalictrum flavum* L. and *Urtica dioica* L., and dead bark of *Sambucus nigra* L.

Illustrations: Chabelska-Frydman (1964), Ellis (1971), Matsushima (1975).

GYROTHRIX PODOSPERMA (Corda) Rabenh., *Deutsch. Kryptfl* **1**: 72 (1844). (Fig. 4C)

Setae up to 170 μm or more high, 3·5–4·5 μm wide just above the swollen base, subdichotomously branched, trunk smooth, branches echinulate. *Conidiogenous cells* solitary, lageniform, 8–12 μm high, 3–4 μm wide at the broadest point, 1·5 μm wide at the apex. *Conidia* accumulating in whitish masses, straight or slightly curved, cylindrical or fusoid, smooth, hyaline, 12–18 μm long, (1·5–) 2 (–2·5) μm wide.

Specimen examined: Lyme Regis, Dorset, U.K., 15 July 1981, P.M. Kirk 1090, IMI 261288.

The occurrence of *Gyrothrix* spp. in the British Isles was discussed by Kirk (1981) where the present species was reported from only two collections, on *Carex riparia* Curt. and *Phragmites* sp. That it should be found on leaf litter of *L. nobilis* is, perhaps, not too surprising when one considers that Saccardo recorded it from this substratum (1878, 1886), although incorrectly referring his Italian collections to the indoubtedly closely related (Kendrick, 1980), but distinct, *Circinotrichum maculiforme* Nees (see Pirozynski, 1962).

Illustrations: Ellis (1971), Pirozynski (1962), Saccardo (1881, as *Circinotrichum maculiforme*).

HANSFORDIA PULVINATA (Berk. & M.A. Curtis) S. Hughes, *Can. J. Bot.* **36**: 771 (1958). (Fig. 5E)

Although of widespread and frequent occurrence in the tropics where it is commonly found overgrowing other fungi, especially species of *Cercospora* sensu lato, *Handsfordia pulvinata* (Berk. & M.A. Curtis) S. Hughes is also known from five collections from the British Isles (herb. IMI, unpubl.). These collections comprise bark of *Acer pseudoplatanus* L., *Ulex europaeus* L. and *Ulmus* sp., and leaves of *Lycopersicon lycopersicum* (L.) Karst. in association with *Fulvia fulva* (Cooke) Ciferri, and *Malus* sp. in association with *Venturia inaequalis* (Cooke) Winter. It does not appear to be associated with any other fungus in the present collection.

Illustrations: Ellis (1971).

Specimen examined: Tunbridge Wells, Kent, U.K., 2 Oct. 1981, B.M. Spooner, IMI 262732.

HEMIBELTRANIA MITRATA P.M. Kirk, sp.nov. (Fig. 6)

Coloniae effusae, pilosae, saepe inconspicuae, pallide brunneae ad brunneae. Mycelium partim superficiale, partim in substrato immersum, ex hyphis laevibus, ramosis, septatis, pallide brunneis, 1·5–2·5 μm latis compositum. Conidiophora macronemata, mononemata, solitaria, simpicia, erecta, ex mycelio superficiali orientia, recta vel leviter flexuosa, pallide brunnea ad brunnea, ad apicem pallidiora, laevia, septata, 35–85 μm alta, 3–4·5 μm lata, ad basem inflata usque ad 12 μm diam vel 16 μm longa, 5μm lata. Cellulae conidiogenae in conidiophoris incorporatae, terminales, polyblasticae, holoblastice proliferantes, sympodiales, interdum geniculatae, denticulatae, denticulis brevibus et conicis, ad apicem nil incrassatis. Conidia acrogena, solitaria, sicca, mitriformia, subhyalina ad pallidissime brunnea, laevia, secedentia schizolytice, inaequaliter 1-septata, 14–17 (–24) μm longa, 4·5–5·5 (–6·5) μm lata maxima in parte, ad basim nonnihil protuberantem et truncatam 1–1·5 μm lata.

In folio emortuo *Elaeagni macrophylla* Thunb., Achamore, Isle of Gigha, U.K., 10 May 1981, R.W.G. Dennis, IMI 259060a, holotypus.

Colonies effuse, hairy, often inconspicuous, pale brown to brown. *Mycelium* partly superficial, partly immersed in the substratum, composed of smooth, branched, septate, pale brown, 1·5–2·5 μm wide hyphae. *Conidiophores* macronematous, mononematous, solitary, simple, erect, arising from the superficial mycelium, straight or slightly flexuous, pale brown to brown, paler towards the apex, smooth, septate, 35–85 μm high, 3–4·5 μm wide, up to 12 μm diam or 16 μm long, 5 μm wide at the swollen base. *Conidiogenous cells* integrated, terminal, polyblastic, proliferating holoblastically, sympodial, sometimes geniculate, denticulate, the denticles short and conical with unthickened apices. *Conidia* acrogenous, solitary, dry, mitriform, subhyaline to very pale brown, smooth, seceding schizolytically, unequally 1-septate, 14–17 (–24) μm long, 4·5–5·5 (–6·5) μm wide at the broadest point, 1–1·5 μm wide at the sometimes protuberant and truncate base.

Specimens examined: On decaying leaves of *Elaeagnus macrophylla*, Achamore, Isle of Gigha, U.K., 10 May 1981, R.W.G. Dennis, IMI 259060a, holotype; on decaying leaves of *Laurus nobilis*, Lyme Regis, Dorset, U.K., 15 July 1981, P.M. Kirk 1095, IMI 261293.

A discussion of the extended concept of the genus *Hemibeltrania* Piroz. has been presented earlier (Kirk, 1983). The distinct shape and 1-septate nature of the conidia in *H. mitrata* at once distinguish it from other species

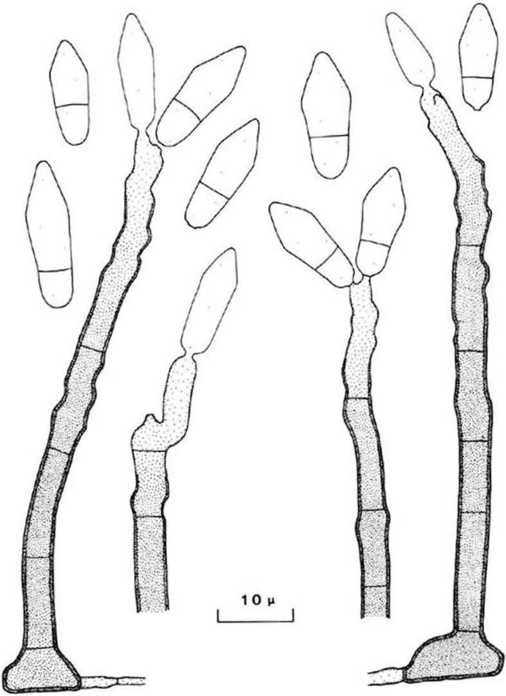

Fig. 6. **Hemibeltrania mitrata.**

of *Hemibeltrania* and those dematiaceous hyphomycetes with which it is probably congeneric and which are presently described in or have been previously referred to other genera.

IDRIELLA GRISEA (B. Sutton, Piroz. & Deighton) von Arx, *Sydowia* **34**: 36 (1981). (Fig. 7A)
Microdochium griseum B. Sutton, Piroz.& Deighton, *Can. J. Bot.* **50**: 1904 (1972).

Conidiophores unbranched, non-septate, smooth, subhyaline to very pale brown at the base, 10–20 µm high, 3–4 µ wide. *Conidia* falcate, non-septate, smooth, hyaline, 14·5–20 (–25) µm long, 2–2·5 µm wide.

Specimen examined: Achamore, Isle of Gigha, U.K., 11 May 1981, R.W.G. Dennis, IMI 259035e.

The genera *Idriella* and *Microdochium* were considered by von Arx (1981) and it was proposed that *Microdochium* should be restricted to those species which lack pigmentation and that *Idriella* should be characterized by species with slightly pigmented conidiophores and mycelium and the presence of a *Trichocladium*-like synanamorph.

In the present collection the synanamorph was not observed but the conidiphores were slightly but distinctly pigmented at their base.

Illustrations: Sutton, Pirozynski & Deighton (1972).

PHAEOISARIA CLEMATIDIS (Fuckel) S. Hughes, *Can. J. Bot.* **36**: 795 (1958). (Fig. 8A)

Synnemata up to 250 µm high, up to 15 µm wide at the base, subulate. *Conidia* ellipsoid, 5–7·5 µm long, 2–2·5 µm wide.

Specimen examined: Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 996, IMI 260609.

A cosmopolitan species which is typically lignicolous but also occurs on dead stems and leaves of a wide range of host plants. In the British Isles it has been recorded on decaying wood of *Acer pseudoplatanus*, *Clematis* sp., *Sambucus nigra* and *Ulmus* sp., and dead stems of *Heracleum* sp. and *Rubus fruticosus* agg. (herb. IMI, unpubl.). There appears to be no records of its occurrence on fallen leaves in the British Isles.

Illustrations: De Hoog & Papendorf (1976), Ellis (1971), Hughes (1978) Matsushima (1975).

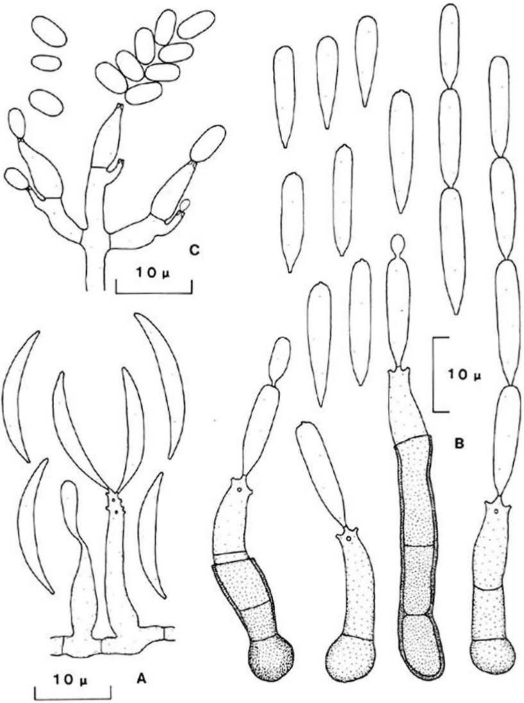

Fig. 7. (A) **Microdochium griseum**. (B) **Pterygosporopsis fragilis**. (C) **Sesquicillium candelabrum**.

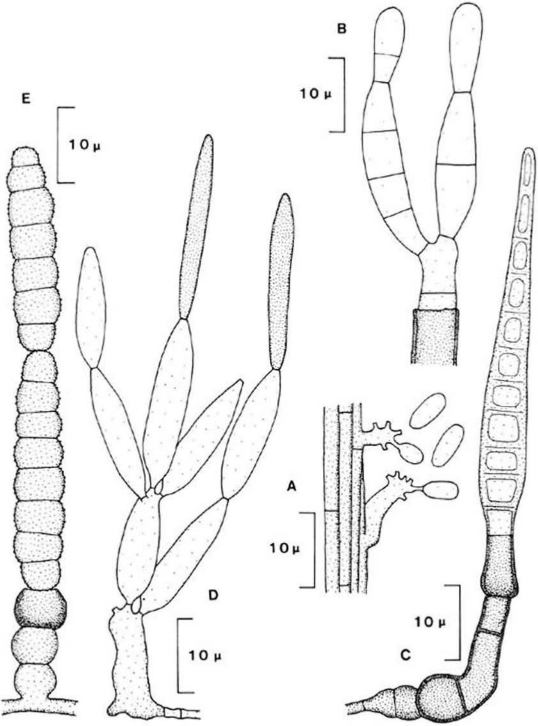

Fig. 8. (A) **Phaeoisaria clematidis.** (B) **Pleurotheciopsis bramleyi.** (C) **Sporidesmium leptosporum** (D) **Subramaniomyces fusisaprophyticus.** (E) **Torula herbarum.**

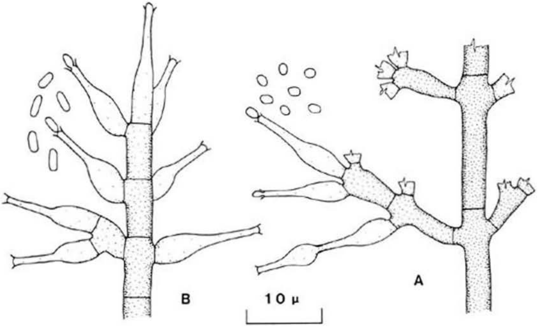

Fig. 9 (A) **Phaeostalagmus cyclosporus.** (B) **Phaeostalagmus tenuissimus.**

PHAEOSTALAGMUS CYCLOSPORUS (Grove) W. Gams apud Gams & Holubová-Jechová, *Stud. Mycol.* 13: 91 (1976). (Fig. 9A)
Stachylidium cyclosporum Grove, *J. Bot., Lond.* 22: 199 (1884).
Verticillium cyclosporum (Grove) Mason & S. Hughes apud Hughes, *Mycol. Pap.* 45: 19 (1951).

Hughes (1978) reports a single collection of this species from New Zealand on rotten wood. Collections in herb. IMI are from Europe only, where it is known to occur on 20 different types of decaying wood and dead herbaceous stems.

Conidiophore morphology in the two collections cited below differ significantly. In IMI 255777 conidiophores are of the normal type as described and illustrated by Ellis (1971) and Gams & Holubová-Jechová (1976). In IMI 260604a, however, only '*Chloridium*-type' conidiophores, as described and illustrated by Kirk (1982c), are present.

Illustrations: Ellis (1971, as *Verticillium cyclosporum*), Gams & Holubová-Jechová (1976), Hughes (1951b, as *V. cyclosporum*, 1978).

Specimens examined: Rayleigh, Essex, U.K., 25 Dec. 1980, B.M. Spooner, IMI 255777: Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 991a, IMI 260604a.

PHAEOSTALAGMUS TENUISSIMUS (Corda) W. Gams apud Gams & Holubová-Jechová, *Stud. Mycol.* **13**: 93 (1976). (Fig. 9B)
Verticillium tenuissimum Corda, *Icon. Fung.* **1**: 20 (1837).

Apparently less common than the previous species, although more frequently encountered on leaf litter, *Phaeostalagmus tenuissimus* (Corda) W. Gams is known to occur in North America and Europe, including the British Isles.

Illustrations: Ellis (1971, as *Verticillium tenuissimum*), Gams & Holubová-Jechová (1975), Hughes (1951b, as *V. tenuissimum*).

Specimens examined: Rayleigh, Essex, U.K., 25 Dec. 1980, B.M. Spooner, IMI 255778; Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 912b, IMI 257106b.

PLEUROTHECIOPSIS BRAMLEYI B. Sutton, *Trans. Br. Mycol. Soc.* **61**: 420 (1973). (Fig. 8B)

Sutton (1973b) described *Pleurotheciopsis bramleyi* B. Sutton from bark of *Ilex* sp. and cited additional collections on the bark of *Betula* sp. and ?*Salix* sp. Recent collections in herb. IMI are on decaying wood and bark of *Corylus* sp. and *Fraxinus* sp. It is presently known only from Europe (herb. IMI, unpubl.) and does not appear to have been previously reported from leaf litter.

Illustrations: Sutton (1973b).

Specimens examined: Christchurch Priory, Dorset, U.K., 5 July 1981, P.M. Kirk 973, IMI 260628; Lymington, Dorset, U.K., 10 July 1981, P.M. Kirk 1018, IMI 260805.

PSEUDOCERCOSPORA UNICOLOR (Sacc. & Penz.) P.M. Kirk, comb. nov. (Fig. 10)
Cercospora unicolor Sacc. & Penz., *Michelia* **2**: 642 (1882).

Leaf spots not distinct or absent. *Colonies* hypophyllous, olivaceous, composed of a lax velutinous tangle of secondary mycelium, conidiophores and conidia, randomly interspersed with loose fascicles of short conidiophores. *Primary mycelium* internal, composed of pale brown, smooth, septate, branced, 1–3 μm wide hyphae. *Stroma* often well developed, substomatal, subglobose, up to 60 μm or more wide, pale brown to brown, darker at the margins, giving rise to a fascicle of 5–9 hyphae which emerge through the stoma to form the superficial mycelium. *Secondary mycelium* superficial, composed of pale brown, smooth, septate, branched, 2–4 μm wide hyphae.

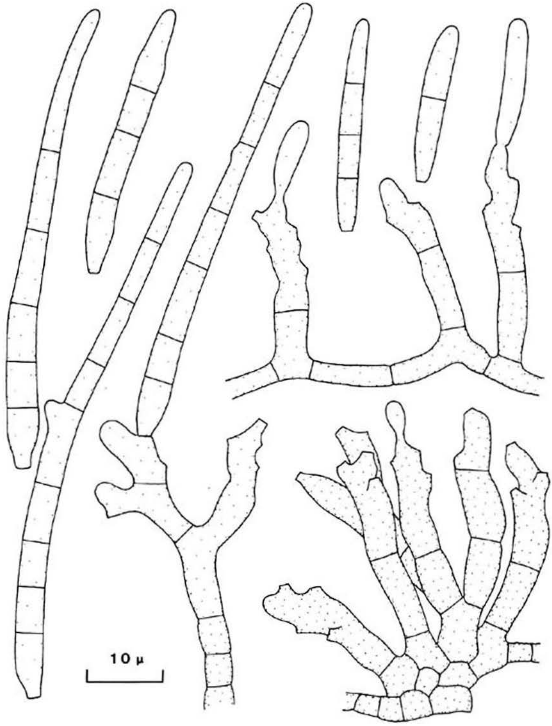

Fig. 10. Pseudocercospora unicolor.

Conidiophores arising terminally and laterally from the secondary mycelium or rarely forming loose fascicles which arise from aggregations of hyphal cells, erect to recumbent, simple or rarely branched, straight or slightly flexuous, septate, pale brown, 20–40 (–60) μm high, 3–5 μm wide, conidial scars 1·5–2·5 μm wide, unthickened, on small shoulders or on short conical denticles. *Conidia* solitary, pale olivaceous brown, smooth or very minutely echinulate or verruculose, cylindric to obclavate-cylindric, straight or slightly curved, (1–) 3–6 (–10)-septate, not constricted at the septa, 30–70 (–95) μm long, 3–4 (–5) μm wide, 1·5–2·5 μm wide at the base which comprises an unthickened scar which is rarely more deeply pigmented than the conidium wall.

Specimen examined: Fleet Churchyard, Dorset, U.K., 13 July 1981, P.M. Kirk 1050, IMI 260941, neotype, designated here.

Saccardo (1882) described *Cercospora unicolor* Sacc. from a faded leaf of *L. nobilis* collected in gardens at Grenoble in July 1881. The fungus was growing on the lower surface of the leaf ('in pag. inf. foliorum') and was distinguished by its branched hyphae and the concolourous conidia and hyphae ('Hyphis longis ramosis, conidiis hyphisque unicoloribus mox dignoscenda species'). The holotype, T [herry, J.J.] N^{o} 6187 preserved in herb. PAD, which is a single leaf, is devoid of any fungus which conforms to that portrayed in the original description. However, a pencil sketch on the label to which the holotype is attached depicts a fungus which is considered to be conspecific with the collection described above.

There are several points upon which the two descriptions differ. The conidia are, on average, somewhat shorter in the present collection as are the conidiophores. Such differences are not, however, considered significant in this group of fungi (Deighton, 1976: 9–10).

Chupp (1954), in his broad concept of the genus *Cercospora*, accepted *C. unicolor* as a distinct species on the strength of the description given by Saccardo since he was unable to study the type. Following Deighton (1976), species of *Cercospora* sensu lato which are characterized by unthickened conidial scars and the production of a superficial secondary mycelium are referred to *Pseudocercospora.*

PSEUDOMICRODOCHIUM LAURI P.M. Kirk, sp. nov. (Fig. 11A)

Coloniae effusae, pulveraceae, albae, saepe inconspicuae. Mycelium plerumque in substrato immersum, ex hyphis pallide brunneis, laevibus, ramosis, septatis, 1–2 μm latis compositum. Conidiophora absentia. Cellulae conidiogenae ex mycelio proxime productae, nonnihil aggregatae, monophialidicae, ampulliformes ad doliiformes, raro cylindricae, hyalinae, laeves, collos indistinctis, 5–7 (–12) μm altae, ad basim 3·5–5 μm latae, ad apicem 1–1·5 μm

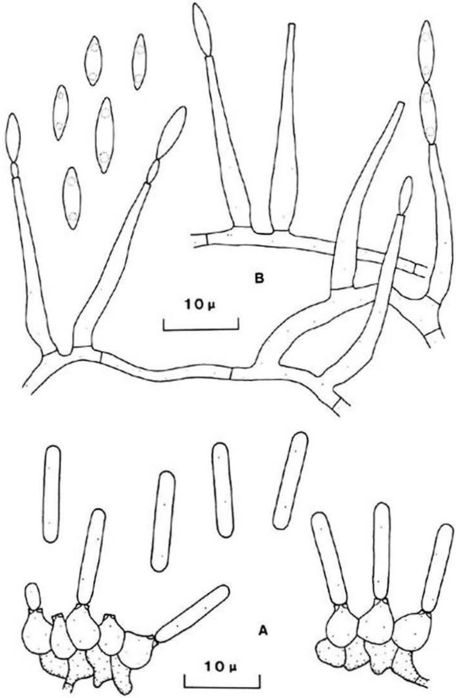

Fig. 11. (A) **Pseudomicrodochium lauri**. (B) **Septofusidium elegantulum**.

latae. Conidia hyalina, laevia, cylindrica cum apicibus rotundatis, non-septata, (10–) 12–14 (–16) µm longa, 2–2·5 µm lata.

In folio emortuo *Lauri nobilis*, Fowey Churchyard, Fowey, Cornwall, U.K., 15 May 1982, P.M. Kirk 1196, IMI 267649, holotypus.

Colonies effuse, powdery, white, often inconspicuous. *Mycelium* mostly immersed in the substratum, composed of pale brown, smooth, branched, septate, 1–2 µm wide hyphae. *Conidiophores* absent. *Conidiogenous cells* produced directly from the mycelium, aggregated into small groups, monophialidic, ampulliform to doliiform, rarely cylindrical, hyaline, smooth, with an indistinct collarette, 5–7 (–12) µm high, 3·5–5 µm wide at the base, 1–1·5 µm wide at the apex. *Conidia* hyaline, smooth, cylindrical with rounded ends, non-septate, (19–) 12–14 (–16) µm long, 2–2·5 µm wide.

Specimens examined: Achamore, Isle of Gigha, U.K., 11 May 1981, R.W.G. Dennis, IMI 259042a; Fowey Churchyard, Fowey, Cornwall, U.K., 15 May 1982, P.M. Kirk 1196, IMI 267649, holotype.

Pseudomicrodochium was established by Sutton (1975) for two minute hyaline hyphomycetes, *P. aciculare* B. Sutton and *P. cylindricum* B. Sutton which were found on decaying cupules of *Castanea sativa* Mill., and was characterized by the presence of discrete monophialidic conidiogenous cells borne directly on the vegetative hyphae. The present species differs from *P. aciculare* and *P. cylindricum* in the production of a pigmented immersed mycelium. It would appear to be closed to *P. cylindricum*, differing from it in the formation of shorter and broader symmetrical conidia which lack septa.

PTERYGOSPOROPSIS P.M. Kirk, gen.nov.

Coloniae effusae, pilosae, interdum inconspicuae. Mycelium partim superficiale, plerumque in substrato immersum, ex hyphis laevibus, pallide brunneis, ramosis, septatis compositum. Conidiophora macronematosa, mononematosa, solitaria vel fasciculata, erecta, simplicia, recta vel flexuosa, pallide brunnea ad brunnea, septata, ex mycelio immerso orientia. Cellulae conidiogenae in conidiophoris incorporatae, terminales, polyblasticae, holoblastice proliferantes, sympodiales, denticulatae, cylindricis cum denticulis quibus sunt apices truncati et nil incrassati. Conidia acrogena, breviter catenata, sicca, late fusiformia ad ellipsoidea vel clavata ad angusti obovoidea, sine septis, laevia vel minute echinulata, hyalina ad pallidissime brunnea, secedentia schizolytice.

Species typica *Pterygosporopsis fragilis* P.M. Kirk

Colonies effuse, hairy, sometimes inconspicuous. *Mycelium* partly superficial, mostly immersed in the substratum, composed of smooth, pale brown, branched, septate hyphae. *Conidiophores* macronematous, mononematous, solitary or fasciculate, erect, simple, straight or flexuous, pale brown to brown, septate, arising from the immersed mycelium. *Conidiogenous cells* integrated, terminal, polyblastic, proliferating holoblastically, sympodial, denticulate, the denticles cylindrical with unthickened apices. *Conidia* acrogenous, shortly catenate, dry, broadly fusiform to ellipsoid or clavate to narrowly obovoid, non-septate, smooth or minutely echinulate, hyaline to very pale brown, seceeding schizolytically.

PTERYGOSPOROPSIS FRAGILIS P.M. Kirk, sp.nov. (Fib. 7B)

Coloniae effusae, pilosae, interdum inconspicuae, pallide brunneae ad albae, colore obnoxio numeris sporarum. Mycelium partim superficiale, plerumque in substrato immersum, ex hyphis laevibus, pallide brunneis, ramosis, septatis, 2·5–4 μm latis compositum. Conidiophora macronemata, mononemata, plerumque fasciculata, erecta, simplicia, recta vel flexuosa, pallide brunnea, septata, 20–70 μm alta, 3·5–5 μm lata, ex mycelio immerso orientia. Cellulae conidiogenae in conidiophoris incorporatae, terminales, polyblasticae, holoblastice proliferantes, sympodiales, denticulatae, cylindricis cum denticulis quibus sunt apices truncati et nil incrassati. Conidia acrogena, catenata, catenis e 2–4 (–5) conidiis compositis, sicca, late fusiformia ad ellipsoidea vel clavata ad angusti obovoidea, sine septis, laevia, hyalina, secedentia schizolytice,(10–) 12–16 (–19) μm longa, 2–3 μm lata.
In folio emortuo *Lauri nobilis*, Tunbridge Wells, Kent, U.K., 2 Oct. 1981, B.M. Spooner, IMI 262741, holotypus.

Colonies effuse, hairy, sometimes inconspicuous, pale brown to whitish depending on the amount of sporulation. *Mycelium* partly superficial, mostly immersed in the substratum, composed of smooth, pale brown, branched, septate, 2·5–4·5 μm wide hyphae. *Conidiophores* macronematous, mononematous, usually fasciculate, erect, simple, straight or flexuous, pale brown, septate, 20–70 μm high, 3·5–5 μm wide, arising from the immersed mycelium. *Conidiogenous cells* integrated, terminal, polyblastic, proliferating holoblastically, sympodial, denticulate, denticles cylindrical with unthickened truncate apices. *Conidia* acrogenous, in chains of 2–4 (–5), dry, broadly fusiform to ellipsoid or clavate to narrowly obovoid, non-septate, smooth, hyaline, seceding schizolytically, (10–) 12–16 (–19) μm long, 2–3 μm wide.

Specimen examined: Tunbridge Wells, Kent, U.K., 2 Oct. 1981, B.M. Spooner, IMI 262741, holotype.

The combination of characters exhibited by *Pterygosporopsis fragilis* do not fit exactly those of any previously described genus of dematiaceous hyphomycetes. There are, however, several genera with which *Pterygos-*

poropsis shares some characteristics. The short unbranched chains of conidia borne on persistent cylindrical denticles recall those of *Anungitea fragilis* B. Sutton (1973a). However, here the scar at the apex of the denticles and at the ends of the conidia are conspicuously thickened and although some other species subsequently referred to *Anungitea* do not appear to have such thickened scars (Kirk, 1983, Matsushima, 1975) the inclusion of the present species in that genus would further extend the concepts of what is probably already a somewhat heterogeneous genus.

In terms of conidium morphology, conidium ontogeny and proliferation of the conidiogenous cell, *P. fragilis* is similar to *Subramaniomyces fusisaprophyticus* (Matsushima) P.M. Kirk (1982a and vide infra). The morphologically distinct terminal conidia and formation of proximally branched chains of the latter species, however, suggest that the two taxa are not closely related and should not, therefore, be considered congeneric.

Amongst the catenate amerosporous genera of hyphomycetes illustrated by Carmichael, Kendrick, Conners & Sigler (1980) only *Denticularia* Deighton (1972) could be considered close to the present genus differing, essentially, by its sporodochial nature. If the catenate nature of *Pterygosporopsis* were not considered significant *Dactylaria* Sacc. (Saccardo, 1880) would appear to be an appropriate genus for *P. fragilis* although *Dactylaria* is essentially a genus of didymosporous or phragmosporous hyphomycetes.

PYRICULARIA LAURI P.M. Kirk, sp.nov. (Fig. 12)

Coloniae effusae, pilosae, pallide rubrobrunneae. Mycelium partim superficiale, partim in substrato immersum, ex hyphis pallide brunneis, laevibus, septatis, ramosis, 1·5–2·5 µm latis compositum. Conidiophora macronemata, mononemata, solitaria, erecta vel ascendentia, recta vel leviter flexuosa, simplicia vel inferiore in parte ramosa, pallide brunnea ad pallide rubrobrunnea, ad apicem pallidiora, laevia, septata, 60–150 µm alta, 2–3 (–3·5) µm lata. Cellulae conidiogenae in conidiophoris incorporatae, terminales, polyblasticae, holoblastice proliferantes, sympodiales, denticulatae, denticulis quibusque cylindricis, tenuitunicatis cellulam intercalarem producentibus. Conidia acrogena, solitaria, secedentia rhexolytice, ellipsoidea, laevia, pallidissime brunnea, (0–) 1-septata, (8·5–) 9·5–14·5 µm longa, (3·5–) 4–5 µm lata, ad basem distincte fractam ob partem cellulae intercalaris superiorem fimbriata.

In petioli folii emortui *Lauri nobili*, Rayleigh, Essex, U.K., 5 July 1981, B.M. Spooner, IMI 261103, holotypus.

Colonies effuse, hairy, pale reddish-brown. *Mycelium* partly superficial, partly immersed in the substratum, composed of pale brown, smooth, septate, branched, 1·5–2·5 µm wide hyphae. *Conidiophores* macronematous, mononematous, solitary, erect or ascending, straight or slightly flexuous, simple or proximally branched, pale brown to pale reddish-brown, paler towards the

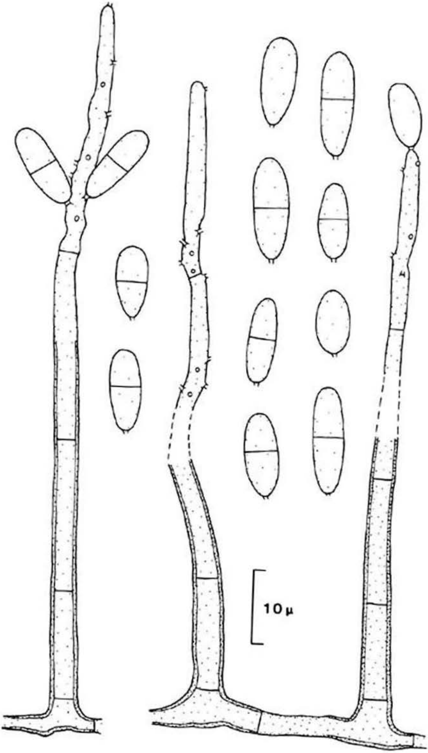

Fig. 12. **Pyricularia lauri.**

apex, smooth, septate, 60–150 μm or more high, 2–3 (–3·5) μm wide. *Conidiogenous cells* integrated, terminal, polyblastic, proliferating holoblastically, sympodial, denticulate, each denticle cylindrical, thin-walled and forming a separating cell. *Conidia* acrogenous, solitary, seceeding rhexolytically, ellipsoid, smooth, very pale brown, (0–) 1-septate, (8·5–) 9·5–14·5 μm long, (3·5–) 4–5 μm wide, with a distinct basal frill derived from the distal part of the separating cell.

Specimen examined: Rayleigh, Essex, U.K., 5 July 1981, B.M. Spooner, IMI 261103, holotype.

Although in terms of conidiogenesis and conidium secession *Pyricularia lauri* is clearly similar to *P. grisea* Sacc., the type species of *Pyricularia* Sacc. (Saccardo, 1880), in other respects the two species are quite different and appear not to be closely related. It is therefore with some reservation that the species described above is referred to *Pyricularia*. *Pyricularia grisea* is not easily distinguished from *P. oryzae* Cavara (1891), the causal agent of rice blast, and the two species should probably be regarded as one (Yaegashi & Udagawa, 1978). If this synonymy is accepted, *P. grisea* becomes the correct name for the rice blast pathogen. However, such an obviously unwelcome name change can be avoided since conservation of specific epithets is now possible under the International Code of Botanical Nomenclature and this case would perhaps be one of the most obvious candidates. The present species does not appear to be pathogenic and as such differs significantly from *P. grisea* and some other species of *Pyricularia* (Ellis, 1971, 1972). Whether pathogenicity is a significant character at the generic level of classification is uncertain at present. Perhaps a more important characteristic would be the nature of the teleomorph which has been shown to be a *Magnaporthe* for *P. grisea*. Another hyphomycete genus, *Nakataea* Hara, should be regarded as a synonym of *Pyricularia* because its type species, *N. sigmoidea* Hara (1939), is morphologically close to *P. grisea* and has *Magnaporthe salvinii* (Cattaneo) Krause & R. Webster (1972) as its teleomorph. This species is also pathogenic. A more natural classification of *P. lauri* will, perhaps, only be possible when its teleomorph is discovered.

SEPTOFUSIDIUM ELEGANTULUM (Pidopl.) W. Gams, *Cephalosporium-artige Schimmelpilze (Hyphomycetes)*: 147 (1971). (Fig. 11B)

Colonies white, floccose, growing on and amongst the setae of *Circinotrichum britannicum* P.M. Kirk. *Mycelium* composed of smooth, branched, septate, hyaline hyphae 1·5–2·5 μm wide. *Phialides* sessile, solitary, arising as lateral branches of the aerial hyphae and delimited at the base by a single septum, subulate, smooth, hyaline, 20–36 μm high, 2–3 μm wide in the broadest part, c. 1 μm wide at the apex. *Conidia* dry, sometimes in short chains of 2 or 3, hyaline, smooth, sometimes with an inconspicuous scar at the poles, non-septate, fusiform, 7–10 μm long, 1·5–2·5 μ wide.

Specimen examined: Abbotsbury, Dorset, U.K., 13 July 1981, P.M. Kirk 1077, IMI 260968.

Gams (1971), in a revision of the genus *Acremonium* and related genera, established *Septofusidium* for a single species, *Fusidium elegantulum* Pidopl., characterized by its catenate conidia, irregularly branched conidiophores and parasitism on various foliicolous fungi. The present specimen resembles IMI 91373, a collection growing on the setae of *Meliola argentina* Speg. on *Cyperus* sp. from Uganda. It is apparently the first record of this species from the British Isles.

Illustrations: Gams (1971).

SESQUICILLIUM CANDELABRUM (Bonorden) W. Gams, *Acta Bot. Neerl.* 17: 457 (1968). (Fig. 7C)

Gams (1968) established *Sesquicillium* for hyphomycetes characterized by verticillate conidiophores, the ultimate branches of which terminate in a tapered phialide and a subterminal cell with a lateral conidiogenous locus near the apex. He designated as a neotype of *S. candelabrum* (Bonorden) W. Gams a collection on *Laurus nobilis* leaves, made by Saccardo in Italy, which was issued as Rabenhorst's Fungi europaei N^{o} 2148.

In the British Isles *S. candelabrum* is known to occur on decaying needles of *Picea excelsa* Link, *Pinus nigra* and *P. sylvestris*, *Pteridium aquilinum* stems and wood of *Taxus baccata* L. It has also been isolated from soil and leaf litter and is known to occur in Australia and India in addition to other regions of Europe (herb. IMI, unpubl.).

Illustrations: Gams (1968).

Specimens examined: Tunbridge Wells, Kent, U.K., 2 Oct. 1981, B.M. Spooner, IMI 262736; Slindon, Sussex, U.K., 3 Apr. 1982, P.M. Kirk 1153, IMI 266750.

SPORIDESMIELLA PARVA (M.B. Ellis) P.M. Kirk, *Trans. Br. Mycol. Soc.* 79: 486 (1982). (Fig. 13)

Ellis (1976) described *Endophragmia parva* M.B. Ellis from dead stems of *Rubus fruticosus* agg. Hughes (1979), in a revision of the genus *Endophragmia*, demonstrated that the genus as then conceived was heterogeneous and that it could not be satisfactorily typified. He referred the majority of species to *Endophragmiella* B. Sutton (1973). *Endophragmia parva* was not considered to

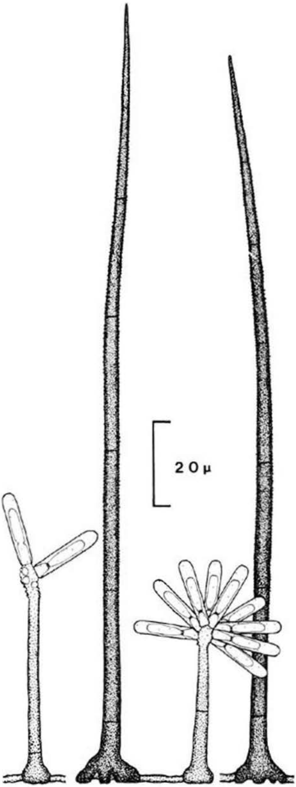

Fig. 13. **Sporidesmiella parva.**

be congeneric with the type species of *Endophragmiella* and because the mode of proliferation of the conidiogenous cell was found to be similar to that in species then referred to *Sporidesmium* he transferred it there as *S. parvissimum* S. Hughes, the epithet *parva* being preoccupied. Kirk (1982c) established *Sporidesmiella* for those species of *Sporidesmium* forming cuneiform or obovoid to narrowly clavate distoseptate conidia which clearly differed from those species belonging in the genus *Sporidesmium* as originally conceived.

The present collection is, except for the presence of thick-walled subulate setae, indistinguishable from those of *Sporidesmiella parva* (M.B. Ellis) P.M. Kirk cited earlier (Kirk, 1982b). The occurrence of setae in an otherwise typical collection is reminiscent of the situation found in *Anungitea fragilis* where setae or apically setiform conidiophores may or may not be present in what are otherwise identical collections (Kirk, 1982a). In a genus apparently close to *Anungitea, Hormiactella*, two species are distinguished essentially on the presence, *H. fusca* Preuss, or the absence, *H. asetosa* Hol.-Jech., of setae although in this case there are also small but distinct differences in the dimensions of the conidia (Holubova-Jechova, 1978).

In the apparent absence of any other distinguishing feature, the separation of the present collection from those without setae would seem unjustified.

Specimen examined: Rayleigh, Essex, U.K., 5 July 1981, B.M. Spooner, IMI 261105.

SPORIDESMIUM LEPTOSPORUM (Sacc. & Roum.) S. Hughes, *Can. J. Bot.* 36: 808 (1958). (Fig. 8C)

Conidiophores macronematous, erect, septate, 15–40 μm high, 3–5 μm wide, brown, slightly swollen at the base, with up to 3 proliferations at the apex. *Conidia* narrowly obclavate, pale straw-coloured to pale olivaceous brown, darker at the truncate base, 8–13-distoseptate, 30-52 μm long, 6–7 μm wide, 3–4 μm wide at the base.

Specimens examined: Studland, Dorset, U.K., 9 July 1981, P.M. Kirk 991b, IMI 260604b; Slindon, Sussex, U.K., 3 Apr. 1982, P.M. Kirk 1154a, IMI 266751a.

A species of widespread distribution, known to occur in Africa, North and South America, Asia, Europe and Indonesia, and most frequently found on dead grass stems in the British Isles (herb. IMI, unpubl.). It does not appear to have been previously reported from leaf litter.

Illustrations: Ellis (1971).

SUBRAMANIOMYCES FUSISAPROPHYTICUS (Matsushima) P.M. Kirk, *Trans. Br. Mycol. Soc.* 78:71 (1982). (Fig. 8D)

This distinct foliicolous dematiaceous hyphomycete with its characteristic terminal conidia, morphologically distinct from the basal and intercalary conidia, has only recently been recorded as occurring in the British Isles (Kirk, 1982a). This record was based on a collection of *Quercus ilex* leaf litter from Devon and it was therefore, perhaps, not surprising to find the same species growing on fallen leaves of *L. nobilis* since at the present locality the leaf litter was intimately mixed with leaves of *Q. ilex* originating from adjacent trees. Indeed, a concurrent collection of *Q. ilex* leaf litter yielded excellent, densely sporulating collections of *S. fusisaprophyticus* (IMI 261279) confirming its presence as a notable member of the British mycoflora.

Specimens examined: Christchurch Priory, Dorset, U.K., 5 & 17 July 1981, P.M. Kirk 975 & 1115, IMI 260630 & 261269.

TETRAPOSPORIUM RAVENELII (Cooke) S. Hughes, *Mycol. Pap.* **46**: 28 (1951). (Fig. 14A)
Triposporium ravenelii Cooke, *Grevillea* **12**: 30 (1883).

Hughes (1951c) redescribed *T. ravenelii* (Cooke) S. Hughes based on his examination of an isotype, associated with a filamentous alga, on bark of *Platanus occidentalis* L. from South Carolina, U.S.A., preserved in herb. K. There can be little doubt that the present collections are conspecific with the isotype examined by Hughes and would therefore appear to constitute the first collections of this distinctive fungus to be recorded since its description.
Illustrations: Hughes (1951c).

Specimens examined: Brodick Castle Grounds, Isle of Arran, U.K. 8 Sept. 1980, P.M. Kirk 771a, IMI 252147a; Royal Botanic Gardens, Kew, Surrey, U.K., 3 Apr. 1981, P.M. Kirk 906b, IMI 257100b.

TORULA HERBARUM (Pers.) Link, *Magazin Ges. naturf. Fr. Berl.* 7: 40 (1815). (Fig. 8E)

Conidia (2–) 5–11 (–17)-septate, (15–) 24–60 (–100) μm long, 6–10 μm wide.

Specimen examined: Abbotsbury, Dorset, U.K., 13 July 1981, P.M. Kirk 1074, IMI 260965.

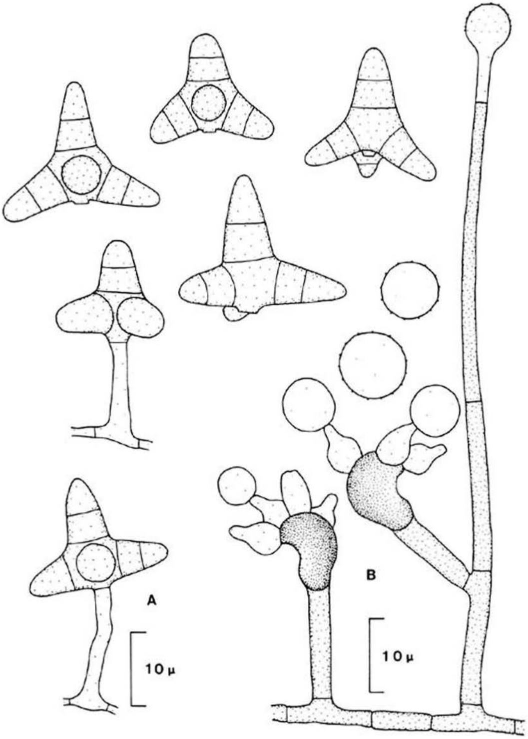

Fig. 14. (A) **Tetraposporium ravenelii.** (B) **Zygosporium echinosporum.**

Perhaps most frequenly regarded as a typical caulicolous hyphomycete, *Torula herbarum* (Pers.) Link is also known to occur on bark and dead wood, decaying cupules of *Aesculus hippocastanum* L., leaves of several Cyperaceae and Gramineae (*Carex* sp., *Glyceria* sp. and *Phragmites* sp.) and from a single collection of *Quercus ilex* leaves (herb. IMI, unpubl.). In the tropics *T. herbarum* and its 'forma' *quaternella* Sacc., characterized by mostly 2-septate conidia, are often found on leaf spots associated with other fungi as secondary invaders.

Illustrations: Ellis (1971), Ellis & Griffiths (1975).

ZYGOSPORIUM ECHINOSPORUM Bunting & Mason apud Mason, *Mycol. Pap.* 5: 135 (1941). (Fig. 14B)

Many of the conidiophores in the present collections arise singly from the superficial mycelium and are morphologically similar to those in *Z. gibbum* (Sacc., Rousseau & E. Bommer) S. Hughes which has previously been reported on *Laurus nobilis* leaf litter (Kirk, 1981; Sutton & Pirozynski, 1963). Some are disposed as lateral branches on the capitate sterile elements which also arise from the superficial mycelium. Also present, although apparently rarely, are capitate sterile elements without lateral conidiophores, and conidiophores where the short sterile projection at the apex of the vesicle has developed into an otherwise typical capitate sterile element. Although the presence of capitate sterile elements at once distinguishes *Z. echinosporum* from *Z. gibbum* if they are poorly developed, or overlooked, the two species may be distinquished on the basis of other differences. The vesicles bearing the conidiogenous cells in *Z. gibbum* are more robust than those in *Z. echinosporum*, 9–14 μm long and 6–8 μm wide at the broadest point in the former compared with 8–11 x 5–6 μm in the latter, whilst the conidia are smaller in the former, 4–6 μm diam compared with 6–8 μm diam.

However, Matsushima (1971) reported that conidia in a collection determined as *Z. gibbum* were 5·5–7 μm diam on the host and 7·5–9 μm diam. in culture (sterile *Musa* leaves on corn meal agar). These results appear to suggest that conidium size may not be a reliable criterion to distinguish *Z. gibbum* and *Z. echinosporum*.

The distribution and substratum range of *Zygosporium* spp. in the British Isles has been discussed previously (Kirk, 1981). An additional collection of *Z. minus* S. Hughes on *Phormium tenax* J.R. & G. Forst from Dorset confirms the presence of this species in the British Isles.

Specimens examined: Rayleigh, Essex, U.K., 5 July 1981, B.M. Spooner, IMI 261107; Lymington, Dorset, U.K., 10 July 1981, P.M. Kirk 1021, IMI 260808; Abbotsbury, Dorset, U.K., 13 July 1981, P.M. Kirk 1076, IMI 260967; Lyme Regis, Dorset, U.K., 15 July 1981, P.M. Kirk 1094, IMI 261292; Christchurch Priory, Dorset, U.K., 17 July 1981, P.M. Kirk 1119, IMI 261273.

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REFERENCES

ANASTASIOU, C.J. (1963). The genus *Zalerion* Moore & Mayers. *Canadian Journal of Botany* **41**, 1135–1139.

ARNAUD, G. (1954). Mycologie concrete: Genera II (suite et fin). *Bulletin trimestriel de la Societe Mycologique de France* **69**, 265–306.

BOROWSKA, A. (1975). New species of *Bactrodesmium, Corynespora, Septonema* and *Taeniolella. Acta Mycologica* **11**, 59–65.

CARMICHAEL, J.W., KENDRICK, W.B., CONNERS, I.L. & SIGLER, L. (1980). *Genera of Hyphomycetes*. Edmonton: The University of Alberta Press.

CAVARA, F. (1891). Fungi Longob. exsicc. N^{o} 49.

CHABELSKA-FRYDMAN, C. (1964). A new species of *Fusariella* from Israel. *Canadian Journal of Botany* **42**, 1485–1487.

CHUPP, C. (1954). *A monograph of the fungus genus Cercospora*. Ithaca: Chupp.

DE HOOG, G.S. & PAPENDORF, M.C. (1976). The genus *Phaeoisaria. Persoonia* **8**, 407–414.

DEIGHTON, F.C. (1972). Four leaf-spotting hyphomycetes from Africa. *Transactions of the British Mycological Society* **59**, 419–427.

DEIGHTON, F.C. (1976). Studies on *Cercospora* and allied genera. VI. *Pseudocercospora* Speg., *Pantospora* Cif. and *Cercoseptoria* Petr. *Mycological Papers* **140**, 1–168.

DENNIS, R.W.G. (1973). The fungi of southeast England. *Kew Bulletin* 28, 133–139.

ELLIS, D.H. & GRIFFITHS, D.A. (1975). The fine structure of conidial development in the genus *Torula*. 1. *T. herbarum* (Pers.) Link ex S.F. Gray and *T. herbarum* f. *quaternella* Sacc. *Canadian Journal of Microbiology* **20**, 1161–1175.

ELLIS, M.B. (1971). *Dematiaceous Hyphomycetes*. Kew: Commonwealth Mycological Institute.

ELLIS, M.B. (1972). Dematiaceous Hyphomycetes XI. *Mycological Papers* **131**, 1–25.

GAMS, K.W. (1968). Die systematische Stellung der Schimmelpilze *Fusidium buxi* und *Verticillium candelabrum. Acta Botanica Neerlandica* **17**, 455–460.

GAMS, K.W. (1971). *Cephalosporium-artige Schimmelpilze (Hyphomycetes)*. Stuttgart: Gustav Fischer.

HARA, K. (1939). *Diseases of the rice plant.* 2nd Edition.

GAMS, K.W. & HOLUBOVÁ-JECHOVÁ, V. (1976). *Chloridium* and some other dematiaceous hyphomycetes growing on decaying wood. *Studies in Mycology* **13**, 1–99.

HENNEBERT, G.L. (1968). *Echinobotryum, Wardomyces* and *Mammaria. Transactions of the British Mycological Society* **51**, 749–762.

HILBER, O. & R. (1980). Beitrag zur pilzflora des Nsg Keilstein (2). *Denkschriften der Regensburgischen Botanischen Gesellschaft* **39**, 107–111.

HOLUBOVÁ-JECHOVÁ, V. (1978). Lignicolous Hyphomycetes from Czechoslovakia. 5. *Septonema, Hormiactella* and *Lylea. Folia Geobotanica & Phytotaxonomica* **13**, 421–442.

HUGHES, S.J. (1951a). Studies on micro-fungi. III. *Mastigosporium, Camposporium* and *Ceratophorum. Mycological Papers* **36**, 1–43.

HUGHES, S.J. (1951b). Studies on micro-fungi. XI. Some hyphomycetes which produce phialides. *Mycological Papers* **45**, 1–36.

HUGHES, S.J. (1951c). Studies on micro-fungi. XIII. *Triposporium, Tripospermum, Ceratosporella,* and *Tetraposporium* (gen.nov.). *Mycological Papers* **46**, 1–35.

HUGHES, S.J. (1978). New Zealand Fungi. 25. Miscellaneous species. *New Zealand Journal of Botany* **16**, 311–370.

ICHINOE, M. (1971). *Camposporium* species from Japan. *Transactions of the Mycological Society of Japan* **12**, 79–88.

JERMY, A.C. & CRABBE, J.A. (1978). *The Island of Mull, a survey of its flora and environment.* British Museum (Natural History): London.

KENDRICK, W.B. (1980). The generic concept in Hyphomycetes – A reappraisal. *Mycotaxon* **11**, 339–364.

KIRK, P.M. (1979). A new Dematiaceous Hyphomycete from leaf litter. *Transactions of the British Mycological Society* **73**, 75–79.

KIRK, P.M. (1981). New or Interesting Microfungi. III A preliminary account of the microfungi colonizing *Laurus nobilis* leaf litter. *Transactions of the British Mycological Society* **77**, 457–473.

KIRK, P.M. (1982a). New or Interesting Microfungi. IV Dematiaceous Hyphomycetes from Devon. *Transactions of the British Mycological Society* **78**, 55–74.

KIRK, P.M. (1982b). New or Interesting Microfungi. V Microfungi colonizing *Laurus nobilis* leaf litter. *Transactions of the British Mycological Society* **78**, 293–303.

KIRK, P.M. (1982c). New or Interesting Microfungi. VI *Sporidesmiella* gen.nov. (Hyphomycetes). *Transactions of the British Mycological Society* **79**, 479–489.

KIRK, P.M. (1983). New or Interesting Microfungi. IX Dematiaceous Hyphomycetes from Esher Common. *Transactions of the British Mycological Society* **80**, 449–457.

KRAUSE, R.A. & WEBSTER, R.K. (1972). The morphology, taxonomy, and sexuality of the rice stem rot fungus, *Magnaporthe salvinii* (*Leptosphaeria salvinii*). *Mycologia* **64**, 103–114.

MATSUSHIMA, T. (1971). *Microfungi of the Solomon Islands and Papua-New Guinea.* Kobe: Matsushima.

MATSUSHIMA, T. (1975). *Icones microfungorum a Matsushima lectorum.* Kobe: Matsushima.

MATSUSHIMA, T. (1980). Saprophytic microfungi from Taiwan. Part 1. Hyphomycetes. *Matsushima Mycological Memoirs* **1**, 1–82.

MOODIE, W.T. (1980). Spring Foray. *Bulletin of the British Mycological Society* **14**, 89–96.

MOORE, R.T. & MEYER, S.P. (1962). Thalassiomycetes III. The genus *Zalerion. Canadian Journal of Microbiology* **8**, 407–416.

MORTON, F.J. & SMITH, G. (1963). The genera *Scopulariopsis* Bainier, *Microascus* Zukal, and *Doratomyces* Corda. *Mycological Papers* **86**, 1–96.

NAG RAJ, T. & KENDRICK, W.B. (1975). *A Monograph of Chalara and Allied Genera.* Waterloo: Wilfred Laurier University Press.

NICOT, J. & CHARPENTIÉ, M.-J. (1971). Index des fungi imperfecti decrits par G. Arnaud (Mycologie Concrete. Genera I et II). *Bulletin trimestriel de la Société Mycologique de France* **87**, 25–38.

PEEK, C.A. & SOLHEIM, W.G. (1958). The hyphomycete genera of H.W. Harkness and the ascomycete genus *Cleistosoma* Harkn. *Mycologia* **50**, 844–861.

PIROZYNSKI, K.A. (1962). *Circinotrichum* and *Gyrothrix. Mycological Papers* **84**, 1–28.

SACCARDO, P.A. (1978). Fungi Veneti, novi vel critici vel mycologiae venetae addendi. *Michelia* **1**, 239–275.

SACCARDO, P.A. (1880). Conspectus generum fungorum italiae inferiorum. *Michelia* **2**, 1–38.

SACCARDO, P.A. (1881). Fungi Italici. Plate 756.

SACCARDO, P.A. (1882). Fungi Gallici. *Michelia* **2**, 583–648.

SACCARDO, P.A. (1886). *Sylloge fungorum* **4**, 1–807.

SCHOKNECHT, J.D. & CRANE, J.L. (1977). Revision of *Torula* and *Hormiscium* species. *Torula occulta, T. diversa, T. elasticae, T. bigemina* and *Hormiscium condensatum* reexamined. *Mycologia* **69**, 533–546.

SUTTON, B.C. (1973a). Hyphomycetes from Manitoba and Saskatchewan, Canada. *Mycological Papers* **132**, 1–143.

SUTTON, B.C. (1973b). Some hyphomycetes with holoblastic sympodial conidiogenous cells. *Transactions of the British Mycological Society* **61**, 417–429.

SUTTON, B.C. (1975). Hyphomycetes on cupules of *Castanea sativa. Transactions of the British Mycological Society* **64**, 405–426.

SUTTON, B.C. & PIROZYNSKI, K.A. (1963). Notes on British Microfungi I. *Transactions of the British Mycological Society* **46**, 505–522.

SUTTON, B.C., PIROZYNSKI, K.A. & DEIGHTON, F.C. (1972). *Microdochium* Syd. *Canadian Journal of Botany* **50**, 1899–1907.

YAEGASHI, H. & UDAGAWA, S. (1978). The taxonomic identity of the perfect state of *Pyricularia grisea* and its allies. *Canadian Journal of Botany* **56**, 180–183.

MYCOTAXON

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TRICHOLOMA MANZANITAE - A NEW SPECIES FROM CALIFORNIA

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SUMMARY

Tricholoma manzanitae Baroni & Ovrebo, a new species of the subgenus *Tricholoma* section *Genuina* (Agaricales), is described from northern California. This large fleshy terricolous agaric was collected numerous times under *Arctostaphylos manzanita* or near *Arbutus menziesii* and is suspected of forming mycorrhizal associations with these ericaceous plants.

Numerous collections of an undescribed species of *Tricholoma* were made during December and January of 1980-1981, 1981-1982 and 1982-1983 in the foothills around Healdsburg in Sonoma Co., California. This *Tricholoma* was fruiting on soil under more or less pure stands of *Arctostaphylos manzanita* Perry or in some cases under mixed stands of *Arbutus menziesii* Pursh., *Pseudotsuga menziesii* (Mirb.) Franco, and *Quercus spp.* The fruiting bodies were typically found in clusters or partial fairy rings about the root zone of individual manzanita shrubs or under madrone. We suspect *T. manzanitae* to be mycorrhizal with *A. manzanita* and possibly *A. menziesii* of the Ericaceae.

All microstructures were measured in 3% KOH. The length of basidiospores includes the hilar appendix; the length of basidia does not include the sterigmata. Drawings were produced with the aid of a camera lucida. Color notations and names in parentheses were taken from Kornerup and Wanscher (1978), e.g. (6B6 - caramel). Colors of microstructures were recorded from sections observed in 3% KOH unless otherwise noted.

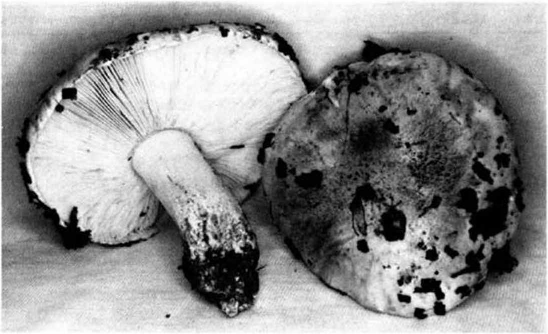


Fig. 1. Basidiocarps of *Tricholoma manzanitae* (Baroni 4233), X 1.

Tricholoma manzanitae Baroni & Ovrebo, sp. nov. Figs. 1-3.

Pileus 50-100 mm latus, primum convexus tum plano-convexus, viscidus, glaber, primum albus ubique tum salmoneo-bubalinus vel pallido-aurantiacus plerumque super disco demum brunneo-aurantiacus vel brunneolus, typice labibus rufis dispersis. Contextus albus, firmus, inodorus et insipidus. Lamellae sinuatae, confertae, albae tum flavescentes et typice labibus rufis. Stipes 30-45 mm longus, apice 15-30 mm crasso, superne flavido-pruinatus, inferne albidus et glaber et typice labibus rufis dispersis. Contextus albus, firmus. Sporae albae, 5-7 x 4-5 µm, ellipsoideae, laeves, paries acyanophilus, inamyloideus. Basidia sine corporibus siderophilis. Cheilocystidia et pleurocystidia nulla. Pileipellis bistratae, suprapellis gelatinosa, hyphae subpellis repentes filamentosae, cum vel sine incrustatis. Hyphae efibulatae.

HOLOTYPUS *legit T. J. Baroni 4084 (MICH), prope Healdsburg, Sonoma Co., California, USA. 3 January 1982. (Isotypus, SFSU)*

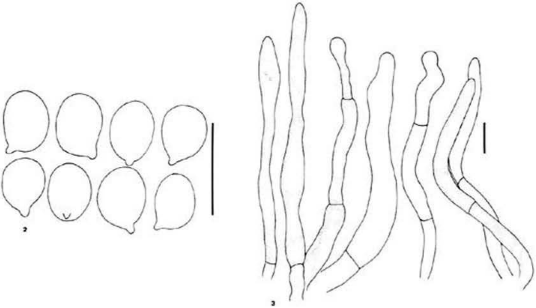
PILEUS 50-100 mm broad, convex then plano-convex, margin inrolled at first and soft-cottony, becoming decurved, entire or irregular undulate with age; surface viscid when fresh, glabrous or with brownish agglutinated appressed fibrillose scales over disc; white when young but soon near pale salmon buff (5A2 - orange white) to pale orange (5A3) over disc and nearly to margin, eventually becoming brownish orange (6C3-4) or brown (6E5) over the disc with age, often developing irregularly scattered rufescent stains; context up to 20 mm thick, firm, white; taste and odor not distinctive. Lamellae sinuate, 13-14 mm broad, crowded, edges entire at first, eroded with age; white when young, soon with a pale salmon buff cast (5A2), becoming pale yellowish with age, eventually turning light grayish salmon (6B2 - birch bark) or darker (6C2) when overmature, often with scattered sordid rufescent stains at all color stages. STIPE 30-45 mm long, apex 15-30 mm thick, short, tapered toward the base or occasionally equal; pruinate-furfuraceous over upper 1/3, glabrous and smooth or irregularly bumpy to base; pale yellow (3-4A2 - yellowish white) pruinate-furfuraceous over white ground color on upper 1/3, white over lower 2/3, often developing rufescent stains over base, especially after handling; context solid, white.

SPORE DEPOSIT white. SPORES 5-7 x 4-5 µm, ellipsoid in profile and face view, round in polar view, smooth, walls acyanophilic, inamyloid, hyaline, typically with one large central guttule. BASIDIA 25-36(-45) x 5-8 µm, 4-sterigmate, clavate or narrowly clavate, lacking cyanophilic and siderophilic bodies, hyaline. HYMENIAL CYSTIDIA not differentiated. HYPHAE OF LAMELLAR TRAMA parallel, 5-12 µm in diam, cylindric to slightly inflated, hyaline; hyphae of subhymenium tightly interwoven, 2-4 µm in diam, cylindric. HYPHAE OF PILEAL CONTEXT interwoven for the most part, but radially arranged just above lamellar attachment, 5-20 µm in diam, cylindric or inflated, hyaline. PILEIPELLIS two layered: suprapellis of hyaline loosely interwoven hyphae embedded in a gelatinous matrix; hyphae 1.5-6 µm in diam, cylindric or collapsed, smooth to slightly roughened, some with granular contents in KOH or Melzer's; subpellis a layer of brownish or pale golden brown procumbent, interwoven hyphae; hyphae 4.5-8 µm in diam, cylindric, walls evenly thickened and sordid yellow in KOH, distinctly wavy-corrugated and yellowish in Melzer's. STIPITIPELLIS of repent, parallel or occasionally interwoven hyphae; hyphae 2.5-8 µm in diam, smooth, thin-walled, hyaline, producing caulocystidia. CAULOCYSTIDIA mostly on upper 1/3 of stipe surface, 35-170 x 3-7 µm, loosely entangled, in fascicles, pyramidal clusters or frequently as a trichodermium; individual cells filiform, cylindric or flexuous and with apices strangulated, tapered slightly or swollen; hyphal walls smooth or incrusted; aggregations of caulocystidia hyaline or some clusters bright golden in KOH and Melzer's. HYPHAE OF STIPE CONTEXT parallel, 3-14 µm in diam, cylindric or inflated, hyaline or occasionally with scattered golden intracellular pigments. HYPHAE OF STIPE BASE interwoven, 3-6 µm in diam, cylindric, smooth, thin-walled, hyaline.

Terricolous or on leaf duff, scattered or clustered, under *Arctostaphylos manzanita*, or under *Arbutus menziesii*, *Pseudotsuga menziesii* and *Quercus spp.* (live oaks). December and January.

Material studied: USA: CALIFORNIA: Sonoma Co., Healdsburg, Oak Pond Ranch, Baroni 3928, 3929, 3931, 4094, 4228, 4233 (all FH), 4095 (MICH), 4084 (Holotype, MICH; Isotype, SFSU).

Tricholoma manzanitae belongs in subgenus *Tricholoma* section *Genuina* (Fr.) Sacc. (Singer, 1975). The brown colorations and discolorations of the carpophore are characteristic of the species in this



Figs. 2-3. *Tricholoma manzanitae* (Baroni 4084, Holotype). 2. Basidiospores. 3. Caulocystidia. Scale lines 10 µm.

section. The dramatic changes in the colors of both the pileus and lamellae characterize *T. manzanitae* and clearly set it apart from other species in the section. The pileus starts out white, becomes pale orange and finally brown; the coloration develops either in the central area or nearly overall. With the lamellae, the color is white initially, develops a pale pinkish orange cast and finally becomes yellow in age. Rufescent stains can develop in all parts of the carpophore during any stage of development. Other distinctive characteristics of this species are the dense yellowish pruina over the apex of the stipe and the exceptionally long caulocystidia. The elongate caulocystidia (up to 170 µm) are among the longest observed to date in the genus.

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LITERATURE CITED

Kornerup, A., and J. H. Wanscher. 1978. *Methuen handbook of colour*. 3rd. ed. E. Methuen, London. 252 p., 30 pl.

Singer, R. 1975. *The Agaricales in modern taxonomy*. 3rd. ed. J. Cramer, Vaduz. 912 p.

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ON THE SCHIZOPORA PARADOXA COMPLEX (BASIDIOMYCETES)

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ABSTRACT. Schizopora radula (Pers.: Fr.) Hallenb. is segregated from S. paradoxa (Schrad.: Fr.) Donk on basis of incompatibility. Separating characters in basidiocarps and cultures are reported.

INTRODUCTION. Schizopora paradoxa has been regarded as a variable species - both with regard to micro- and macrostructure. There are forms with rounded - angular - split pores as well as almost hydnoid forms; the pores may be large to relatively small; the pore walls may be thin to relatively thick. In the microstructure there is a variation in the size of basidiospores, in the occurrence of very thick-walled skeletals with a narrow lumen, capitate hyphal endings (allocysts), and incrustations on the hyphal tips in the pore mouths.

Intercompatibility tests have been done between 12 specimens, collected in different parts of Europe, as well as in Canada. Two intercompatibility groups have been found.

The variation within each compatibility group and separating characters between the groups are used to split the S. paradoxa complex into S. radula and S. paradoxa s. str. Within each group the microstructure seems to be uniform while the hymenophore is more variable.

However, in C and S Europe there are some specimens which seem to intergrade and the problem correctly to determine all specimens within the complex is far from solved.

The result presented here does not either exclude the possibility of the existence of still more intersterile groups within the complex.

NOMENCLATURE. S. paradoxa in the old, broad sense, was described under several names in Fries (1821). Donk (1967) discussed different nomenclatural possibilities and selected Hydnum paradoxum Schrad.: Fr. as name for the species and made the combination Schizopora paradoxa. As synonyms Donk listed H. obliquum Schrad.: Fr. and Poria radula Pers. Younger synonyms are Polyporus versiporus Pers. - earlier a common used name for the species - and Polyporus laciniatus Vel., the type species of Schizopora.

When regarding S. paradoxa as a complex consisting of (at least) two species in Europe it has been necessary to consider available authentic material and the original descriptions. In the Fries herbarium (UPS) there is one specimen named "Irpex paradoxum?": Though in a bad condition it is identifiable and is here selected as the type for one of the species within the complex (see below).

In the Fries herbarium there are also some specimens named Hydnum obliquum. Even in the restricted sense of S. paradoxa adopted here, H. obliquum (selected lectotype - see below) is a synonym of S. paradoxa.

The second species within the complex - distinguished in the present study - includes the type (designated by Donk, 1967) of Poria radula Pers. and Schizopora radula is here proposed as a new combination for that species.

BASIDIOCARP MORPHOLOGY AND NOTES ON DISTRIBUTION; WITH EMPHASIS ON SEPARATING CHARACTERS.

Key to the species:

Hymenophore hydnoid-denticulate-labyrinthiform; dimitic, skeletals with a narrow lumen; capitate hyphal endings few............................S. paradoxa

Hymenophore poroid, with angular pores, sometimes lacerate; monomitic; capitate hyphal endings frequent in the hymenium and in the pore mouths....................................S. radula

Schizopora paradoxa (Schrad.: Fr.) Donk s. str. Fig. 1 A, 2 D, E, F, J, K.

Selected lectotype: Irpex paradoxus ? Schrad./Sweden, Femsjö/ Ex herb. E. Fries (UPS). A minor part of the collection belongs to Hyphodontia quercina (Fr.) John Erikss.

Syn.: Hydnum obliquum Schrad.: Fr. Selected lectotype: Irpex obliquus Fr./Sweden, Södermanland, Tvetaberg/ 1860-01/ Coll. C.P. Laestadius. Ex herb. E. Fries (UPS).
Poria laciniata Vel.!

Fruitbody resupinate, whitish - creamcoloured, irregularly hydnoid - denticulate - labyrinthiform, denticles thin - rather thick, often provided with small projections.

Hyphal system dimitic; skeletals very thick-walled with a narrow lumen, not branched, acyanophilous, generally abundant; generative hyphae with clamps, more or less thick-walled. The presence of skeletals is most easily observed in byssoid margins of the fruitbody or in the trama; capitate cystidia rare, incrustation of hyphae in the pore mouth variable, often absent; spores ellipsoid, 5—5.3—5.5x3.3—3.6—4 µm, when measured from spore prints.

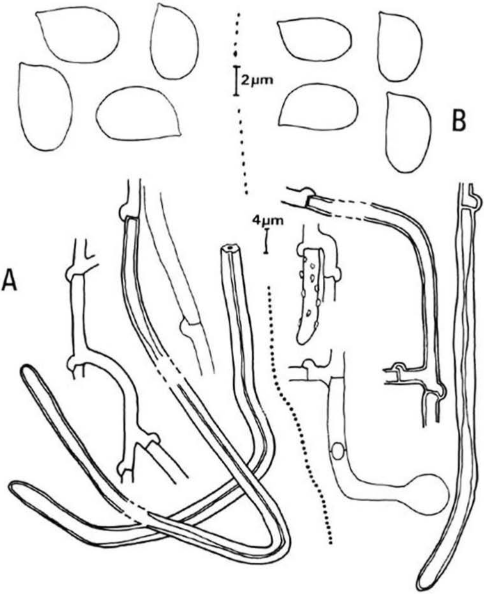
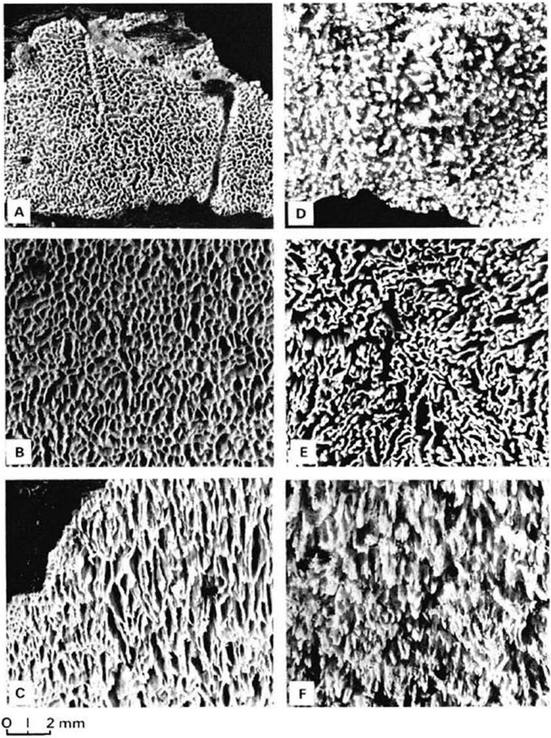


Fig. 1. A) S. paradoxa, spores, hyphae and skeletals (GB 482). B) S. radula, spores, hyphae, capitate cystidium and "skeletocystidium" (GB 222).


A
D
B
E
C
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0 1 2 mm

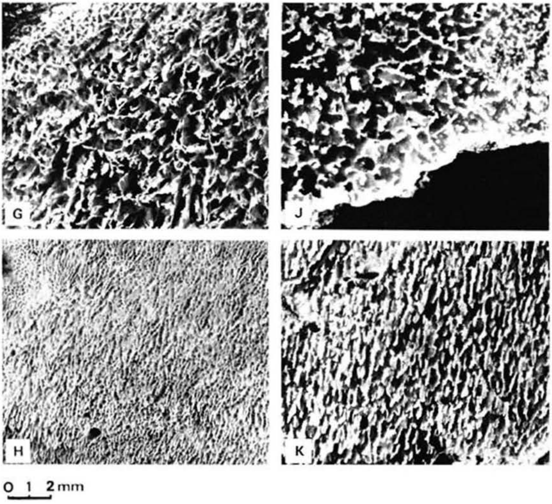

Fig. 2. A) S. radula /Sweden, Halland/ K. Hjortstam 14678. B) S. radula /Sweden, Halland/ N. Hallenberg GB 222. C) S. radula /Austria, Steiermark/ L. & N. Hallenberg, J. Poelt GB 409. D) S. paradoxa /Sweden, Uppland/ T. Hallingbäck GB 359. E) S. paradoxa /Sweden, Västergötland/ K. Hjortstam 17682. F) S. radula /Sweden, Västergötland/ K. Hjortstam 17680. G) S. radula /Sweden, Småland/ N. Hallenberg 22422. H) S. radula /Canada, B.C./ N. Hallenberg GB 718. J) S. paradoxa /Sweden, Småland/ J. Eriksson 5409. K) S. paradoxa /Norway, Trondheim/ K. Hjortstam GB 482. Photo T. Hallingbäck.

Schizopora radula (Pers.: Fr.) Hallenb. comb. nov. Fig. 1 B, 2 A, B, C, G, H.

Basionym: *Poria radula* Persoon: Obs. mycol. 2, p. 14 (1799).

Syn.: *Polyporus versiporus* Pers.!
      Daedalea mollis Vel.!

Fruitbody resupinate, creamcoloured - ochraceous - pale reddish brown, poroid; pores of variable size, 1—3/mm, angular, in some specimens strongly lacerate; pore walls thin, in old specimens sometimes rather thick.

Hyphal system monomitic; hyphae regularly with clamps, more or less thick-walled; some hyphal endings in the trama are - in limited parts - very thick-walled, with a narrow, but unevenly wide lumen; hyphal endings in the pore mouth generally thin-walled, much incrusted; capitate cystidia frequent, spores ellipsoid, 4—4.6—5x2.8—3.1—3.8 µm.

DISCUSSION. Usually there are no problems in distinguishing the two species just by a look at the hymenophore (25 X) - at least for C. and N. European specimens. However, there are also specimens which are difficult to interpret, especially among perennial ones or when the fruitbody has grown on a vertical substrate. In these cases the microstructure is distinctive.

The true skeletals with very thick walls and narrow lumina are usually frequent in *S. paradoxa*, the capitate hyphal endings are much fewer and the spores are somewhat larger than in *S. radula*. Generative hyphae of the latter species are thick-walled and could be mistaken for skeletals. However, the cell lumen in those hyphae is wide and the septa are clamped.

Just as in the closely related genus *Hyphodontia*, there is a gradual transition from moderately thick-walled, generative hyphae into more thick-walled hyphal endings (cystidia or "skeletocystidia").

Judging from material used in the compatibility tests there are no noticeable differences in the colour of the fruitbodies. *S. paradoxa* seems to be more frequent in the E. parts of Central Sweden. There are many collections on Corylus from Uppland and on Betula from Dalarna. On the W. coast it is almost absent, while *S. radula* is very common here. In many places both species occur. Within a small area on E. Jutland (Denmark) both species were collected several times. *S. paradoxa* was found there on wood in a dry heath locality while *S. radula* only was collected in various kinds of humid, deciduous forests.

Most collections (in herb. GB) from C. Europe belong to *S. radula* as well as all from N. Iran.

In B.C., Canada, all collections seen from the Vancouver area belong to *S. radula* while one from the interior (Wells Gray Nat. Park) belong to *S. paradoxa*.

A third species of *Schizopora* that also occurs in C and S Europe is *S. carneolutea* (Rodw. & Clel.) Kotl. & Pouz. *S. carneolutea* differs from *S. radula* and *S. paradoxa* by having smaller and regular pores and by smaller spores. Further, it is a more thermophilic species. Good descriptions of *S. carneolutea* are given in Kotlaba & Pouzar (1979) and Domanski (1969 b, under the synonymous name *S. phellinoides* (Pil.) Dom.).

CULTURAL STUDIES

Single- or poly-spore cultures from the following specimens were used in intercompatibility tests:

GB 57	*Schizopora paradoxa* /Denmark, Jylland, Mols Bjerge/ On a dead Rosa-stem in a heath/ N. Hallenberg.
GB 358	*S. paradoxa* /Sweden, Uppland, N. Varleda/ On Corylus/ T. Hallingbäck.
GB 359	*S. paradoxa* /Sweden, Uppland, N. Varleda/ On Corylus/ T. Hallingbäck.
GB 482	*S. paradoxa* /Norway, Trondheim, Almelia/ On deciduous wood/ K. Hjortstam.
GB 206	*S. radula* / Sweden, Göteborg/ On deciduous wood/ N. Hallenberg.
GB 222	*S. radula* /Sweden, Halland, Särö/ On Quercus/ N. Hallenberg.
GB 258	*S. radula* /Denmark, Jylland, Mols Bjerge/ On Fraxinus/ N. Hallenberg.
GB 318	*S. radula* /Sweden, Västmanland, Högholmsskär/ On deciduous wood/ N. Hallenberg.
GB 409	*S. radula* / Austria, Steiermark, Hohenberg/ On Abies/ L. & N. Hallenberg, J. Poelt.
GB 412	*S. radula* /Austria, Steiermark, Schwanberg/ On Castanea/ L. & N. Hallenberg, S. Michelitsch.
GB 678	*S. radula* /Canada, B.C., Vancouver Island/ On Alnus/ N. Hallenberg.
GB 718	*S. radula* /Canada, B.C., Vancouver/ On deciduous wood/ N. Hallenberg.
LY 742	*S. carneolutea* /France/ On Fagus/ A. David.
LY 3057	*S. carneolutea* /France/ On Quercus/ A. David.

METHODS. Common malt agar was used as medium; drop-tests for extra-cellular oxidases followed Marr's directions (1979); nuclear staining was done according to Boidin (1958); culture codes are from Nobles (1965) with emendations by Boidin (1966).

INTERCOMPATIBILITY TESTS

	GB 57/1	GB 57/3	GB 358/1	GB 358/2	GB 359/1	GB 359/2	GB 482/1	GB 482/6	GB 206/1	GB 206/2	GB 222/1	GB 258/1	GB 258/2	GB 318/1	GB 318/2	GB 409/1	GB 409/2	GB 412/1	GB 412/2	GB 718/2	GB 718/3	LY-AD 742/2	LY-AD 3577/1	LY-AD 3577/2	LY-AD 3577/3
GB 57/1		-	+	+	+	+			-	-						-	-	-	-						
GB 57/3			+	+	+	+			-	-						-	-	-	-						
GB 358/1				-	+	+			-	-	-	-	-	-	-	-	-	-	-				-	-	
GB 358/2					+	+			-	-	-	-	-	-	-	-	-	-	-				-	-	
GB 359/1						+	+	+						-	-	-	-	-	-	-	-				
GB 359/2							+	+						-	-	-	-	-	-	-	-	-	-	-	-
GB 482/1								+						-	-										
GB 482/6														-	-										
GB 206/1										+	+	+	+	+		+	+			+	+	-		-	-
GB 206/2											+	+	+	+		+	+			+	+	-		-	-
GB 222/1												+	+	+		+	+						-	-	
GB 258/1													+	+	+	+	+			+	+				
GB 258/2														+	+	+	+			+	+				
GB 318/1															-	+	+	+	+				-	-	
GB 318/2																+	+	+	+				-	-	
GB 409/1																	-	+	+						
GB 409/2																		+	+						
GB 412/1																			-						
GB 718/2																					+		-	-	
GB 718/3																							-	-	
LY-AD 742/2																							+	+	+
LY-AD 3577/1																								+	-
LY-AD 3577/2																									-

Di-mon matings gave the following results:
(Dicaryotic x monocaryotic mycelia)

GB 678 x GB 718/2,3= +
GB 678 x GG 409/2 = +
GB 678 x GB 318/1 = +
GB 678 x GB 359/1 = -

From above it is obvious that S. paradoxa is incompatible with S. radula and there also seem to be complete compability between different specimens within each species. Further, it is shown that S. carneolutea is incompatible with S. radula and S. paradoxa (see also Domanski, 1969 b).

CULTURAL CHARACTERISTICS

Schizopora radula (GB 206, GB 678). Fig. 3 A, B.
(S. paradoxa s.l. has earlier been thoroughly investigated in culture by Domansky, 1969 a. Judging from photos and descriptions he has been dealing with S. radula).

Aerial mycelium rather scanty, cottony - downy, margin even, somewhat raised; hyphae with clamps, ordinarily branched, 1.5—4 µm wide, some narrow hyphae densely ramified and irregularly curved; in old mycelium gloeocystidia, clavate - capitate - constricted, 18—50x8—10 µm, with a yellowish, oily content.

Code: 2a. 3c. 15. 32. 36. 38. 45. 54. 60. 61.

Oxidase reactions:

Syringaldazine	(+)	1-Naphtol	+
Gum Guaiac	+	Guaiacol	+
p-cresol	-	L-Tyrosine	-

Cytology: Monosporous mycelia with uninucleate cells.

Polarity

GB 206 A_1B_1: 1; A_2B_2: 3,4,6; A_1B_2: 5,8

GB 412 A_1B_1: 4; A_2B_2: 2,3; A_1B_1: 1

Tetrapolarity is indicated.

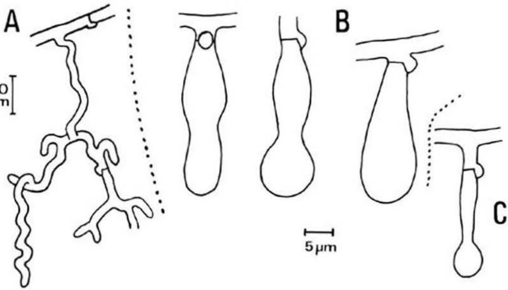

Fig. 3. Microscopical details from polysporous cultures.
A) S. radula densely ramified hyphae (GB 206). B) S. radula, gloeocystidia (GB 678). C) S. paradoxa, capitate cystidium (GB 482).

S. paradoxa (GB 358, GB 359). Fig. 3 C.

Aerial mycelium downy, margin even; hyphae with clamps, ordinarily branched, 2—5 µm wide, some of the aerial hyphae with long and slightly thick-walled cells; few capitate cystidia present, up to 6 µm wide, with a yellowish, oily content.

Code: 2a. 3c. (7). (26). 32. 36. 38. 45. 54. 60. 61.

Oxidase reactions:

Syringaldazine	-	1-Naphtol	(+)
Gum Guaiac	+	Guaiacol	(+)
p-cresol	-	L-Tyrosine	-

Cytology: Monosporous mycelia with uninucleate cells.

Polarity:

GB 359 A_1B_1: 1; A_2B_2: 2,3; A_1B_2: 4; A_2B_1: 5,6

DISCUSSION

The two species are close to each other also in culture characters, but the occurrence of thin, densely ramified hyphae and gloeocystidia in *S. radula* makes it possible to separate this species from *S. paradoxa* in culture. It is, however, difficult to estimate the constancy of certain cultural characters. Domanski (1969a) mentions the occurrence of thick-walled skeletals in *S. paradoxa* s.l., a structure not found in the present investigation.

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REFERENCES

Boidin, J. 1958. Essai biotaxonomique sur les Hydnés resupinés et Corticiés. Rev. Mycol. Mem. hors. Sér. 6, 388 pp.

1966. Basidiomycétes Corticiaceae de la République Centrafricaine. I, Le genre *Gloeocystidiellum* Donk. Cah. Maboké 4(1): 5—17.

Domanski, S. 1969 a. Wood-inhabiting fungi of Bialowieza virgin forests in Poland. VII. *Schizopora paradoxa* (Schrad. ex Fr.) Donk and its diagnose. Acta Soc. Bot. Poloniae 38(1): 69—81.

Domanski, S. 1969 b. Wood-inhabiting fungi in Bialowieza virgin forests in Poland. VIII. *Schizopora phellinoides* (Pil.) comb. nov. and its diagnose. Acta Soc. Bot. Poloniae. 38(2): 255—269.

Donk, M.A. 1967. Notes on European Polypores - II. Notes on Poria. Persoonia 5(1): 47—130.

1974. Check list of European Polypores.

Fries, E.M. 1821. Systema mycologicum. I.

Kotlaba, F., & Pouzar, Z. 1979. *Schizopora carneo-lutea*, mycogeographically interesting species of fungi. Ceska Mykologie 33(1): 19—35.

Marr, C.D. 1979. Laccase and tyrosinase oxidation of spot test reagents. Mycotaxon IX(1): 244—276.

Nobles, M.K. 1965. Identification of cultures of wood-inhabiting Hymenomycetes. Can. Journ. Bot. 43: 1097—1139.

Persoon, C.H. 1825. Mycologia europaea. 2.

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ISOLATION AND IDENTIFICATION OF *EUTYPA ARMENIACAE* FROM *MALUS DOMESTICA* IN WASHINGTON STATE

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Eutypa armeniacae Hansf. & Carter *ex* Carter (anamorph: *Cytosporina* sp.), the causal agent of canker and dieback diseases of apricot (*Prunus armeniaca* L.), grapevine (*Vitis labrusca* L. and *V. vinifera* L.), and other hosts, is common on grapevines in the Yakima Valley of Washington state (Glawe *et al.*, 1982). The teleomorph of *E. armeniacae* is not known to form in dry areas, such as the Yakima Valley, or in artificial culture, and lack of a monograph of *Cytosporina* prevents identification of the *Cytosporina* state of *E. armeniacae* based solely on morphology. Thus, *E. armeniacae* was identified in the Yakima Valley on the basis of disease symptomatology on grapevines, formation of a *Cytosporina* state in artificial culture, and pathogenicity on apricot, upon which *E. armeniacae* produces characteristic vascular lesions (Glawe *et al.*, 1982). During a survey conducted by one of us (M. A. D.) of fungi associated with apple (*Malus domestica* Borkh.) trees in Washington, two isolates were obtained of a fungus which resembled *E. armeniacae* in cultural characteristics. This paper reports the results of cultural and pathogenicity studies which were undertaken to identify this fungus.

The two isolates, designated YG7-A and YG7-C, were

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[1] Deceased.

obtained from discolored heartwood of two healthy-appearing 25-40 yr old 'Golden Delicious' apple trees growing in an orchard near Yakima, Yakima Co., WA, IX.1977. The fungus was isolated using techniques described earlier (Dilley and Covey, 1981). The isolates were cultured on Difco potato-dextrose agar in nine-cm-diam plastic Petri plates at room temperature (approximately 22 C) on a laboratory bench where they were subject to fluorescent room lighting, or in darkness. Pathogenicity tests on 'Tilton' apricot trees were conducted at Davis, CA, 28.V.1980-21.XI.1980, using a procedure described earlier (Glawe *et al.*,1982). Inoculum consisted of mycelial discs cut from agar plates; sterile agar discs were used as inoculum in the control treatment. Pathogenicity test results were evaluated by splitting inoculated branches longitudinally, measuring internal xylem discoloration, and attempting to reisolate the fungus by placing surface-sterilized wood chips on potato-dextrose agar.

Appearance of the fungus in culture was as follows: Enlarging colonies white, cottony, with diffuse margins. Covering plates in approximately 10 da. Month-old colonies gray to dark gray, felty; reverse coloration yellow. Pycnidia subconical, black, approximately 1 mm diam, producing yellow conidial masses. Conidiogenous cells cylindrical, tapering, proliferating sympodially and possibly percurrently, 10-18 X (1.5-)2(-3) µm. Conidia hyaline, filiform, moderately curved, single-celled, 41-55(-60) X 1-2 µm. Neither isolate sporulated in darkness.

Results of the pathogenicity test are presented in Table 1. Both isolates produced more xylem discoloration than the control treatment.

Results of both the cultural observations and the pathogenicity test indicate that this fungus is very similar to *E. armeniacae* isolates from Washington grapevines (Glawe *et al.*, 1982). In culture, the apple isolates were indistinguishable from grapevine isolates previously studied, and like the grapevine isolates produced conidia larger than those usually reported for *E. armeniacae* (see Glawe *et al.*, 1982, and references therein). Conidial ontogeny in the apple isolates was similar to that reported in an authenticated *E. armeniacae* isolate (Glawe and Rogers, 1982b), where conidiogenous cells were found to proliferate both percurrently and sympodially. Annellations indicative of percurrent proliferation were not found on conidiogenous cells of the apple isolates, but the tapering apices of some cells suggested that percurrent proliferation might sometimes occur. As discussed elsewhere (Glawe and Rogers,

Table 1. Pathogenicity of two isolates of *Eutypa armeniacae* from apple (*Malus domestica*) on apricot (*Prunus armeniaca*).

Isolate	Successful reisolations[x]	Average length internal discoloration (Cm)[x,y]
Control	0	4.1 a
YG7-A	5	11.0 b
YG7-C	4	11.1 b

[x] Five replications per treatment.

[y] Values followed by the same letter are not significantly different from each other (P=0.05) according to Duncan's multiple range test.

1982a; Glawe, 1983),resolution of annellations in diatrypaceous anamorphs is often very difficult. Sympodially proliferating conidiogenous cells were common. Light was required for sporulation, as was reported previously for *E. armeniacae* (Glawe *et al.*, 1982). The pathogenicity test results indicate that both isolates may be regarded as pathogenic on apricot, a characteristic associated with *E. armeniacae* and used to help distinguish it from other species (Glawe *et al.*, 1982, and references therein). Because of the great similarity of the apple isolates to Washington grapevine isolates of *E. armeniacae* we believe that the apple isolates are, in fact, *E. armeniacae*.

This apparently is the first record of *E. armeniacae* on apple in North America. *Eutypa armeniacae* previously was reported from apple in Australia (Carter, 1960). Although Carter (1960) was able to recover *E. armeniacae* from inoculated apple limbs 5-18 months after inoculation, his report did not mention any disease symptoms on inoculated trees, and it is uncertain whether the fungus is pathogenic on this host. Judging from its pathogenicity on a variety of woody angiosperms (Carter and Moller, 1977), it appears that *E. armeniacae* might also be pathogenic on apple. However, the fungus apparently grows saprophytically on a number of hosts (Carter and Moller, 1977), and may have been growing saprophytically on the trees from which it was isolated in this study. Pathogenicity tests should be undertaken to determine if *E. armeniacae* can be pathogenic on apple trees.

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LITERATURE CITED

CARTER, M. V. 1960. Further studies on *Eutypa armeniacae* Hansf. & Carter. *Austral. J. Agric. Res.* 11: 498-504.

CARTER, M. V., and W. J. MOLLER. 1977. *Eutypa* canker and dieback of apricots. *EPPO Bull.* 7: 85-94.

DILLEY, M. A., and R. P. COVEY. 1981. Association of *Coriolus versicolor* with a dieback disease of apple trees in Washington state. *Plant Dis.* 65: 77-78.

GLAWE, D. A. 1983. Observations on the anamorph of *Eutypella parasitica*. *Mycologia* 75: In press.

GLAWE, D. A., and J. D. ROGERS. 1982a. Observations on the anamorphs of six species of *Diatrype* and *Diatrypella*. *Canad. J. Bot.* 60: 245-251.

GLAWE, D. A., and J. D. ROGERS. 1982b. Observations on the anamorphs of six species of *Eutypa* and *Eutypella*. *Mycotaxon* 14: 334-346

GLAWE, D. A., C. B. SKOTLAND, and W. J. MOLLER. 1982. Isolation and identification of *Eutypa armeniacae* from diseased grapevines in Washington state. *Mycotaxon* 16: 123-132.

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TEN NEW SPECIES OF USTILAGINALES

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ABSTRACT

The following new species of Ustilaginales are described: *Anthracoidea curvulae* on *Carex curvula*, *Anthracoidea humilis* on *Carex humilis*, *Entyloma arctotheca* on *Arctotheca calendula*, *Entyloma sonchi* on *Sonchus asper*, *Entyloma taraxaci* on *Taraxacum megalorrhizon*, *Schroeteria poeltii* on *Veronica cymbalaria*, *Sporisorium chrysopogonis* on *Chrysopogon montanus*, *Urocystis ranunculi-aucheri* on *Ranunculus aucheri*, *Ustilago arenariae-bryophyllae* on *Arenaria bryophylla*, and *Ustilago cephalariae* on *Cephalaria humilis*. Three new combinations are proposed: *Sporisorium andropogonis-aciculati* (Petch) Vánky, *Sporisorium polliniae* (P. Magnus) Vánky, and *Sporisorium tumefaciens* (McAlpine) Vánky.

During the past years I have collected, revised or obtained from colleagues and friends for determination, as exchange, or for distribution in my Ustilaginales exsiccata, numerous samples of smut fungi. Some of these proved to be unknown taxa and consequently they are here described as new.

Anthracoidea curvulae Vánky & Kukkonen, sp. nov.

Typus: *Carex curvula* All. (Cyperaceae), Helvetia, Kt. Graubünden, Albula-Pass, mt. Crap Alv, inter "Weissenstein" et lacus infra "Fourcla Crap Alv". 46°34'20'' N, 09°48'15'' E, alt. 2300 m.s.m., 27.VII.1979, leg. E. Müller et K. Vánky. Holotypus in Herbario Ustilaginales Vánky (HUV 10858, in UPS), isotypi in H et in Vánky, Ustilaginales 378.

Sori in ovariis. Sporae a fronte circulares, subcirculares usque parum irregulares, 15-21,5 x 17-23 (-24,5) µm, ab acie ellipsoideae usque elongatae, 11-14,5 µm latae, mediocriter rufo-brunneae; pariete aequaliter 1-1,5(-2,5) µm crasso, sine incrassationibus internis atque areis refractivis, superficie minute, irregulariter et densiuscule verruculosa, in extrema linea minutissime undulata usque minute serrulata, in partibus planis saepe pileolis hyalinis tenuibusque instructa; sub SEM superficie verrucis 0,15-1 µm altis, rotundatis, remotiuscule usque dense dispositis, raro partim confluentibus instructa, inter verrucas lenissime asperula.

Sori in scattered ovaries forming black, globose, hard, 2-4 mm diam bodies, when young covered by a thin membrane which flakes away to expose the black, agglutinated spore mass. Spores (Figs 1, 2) medium-sized, flattened, in plan view circular, subcircular to slightly irregular, 15-21.5 x 17-23(-24.5) µm, in side view ellipsoidal to elongated, 11-14.5 µm wide, medium reddish-brown; wall evenly thickened, 1-1.5(-2.5) µm, lacking internal swellings or light-refractive areas; surface finely, irregularly, moderate densely verruculose making the spore profile to appear just very finely wavy to finely serratulate, often with two hyaline capses on the flat sides; by SEM provided with sparsely to densely situated, rarely partly confluent, rounded warts, 0.15-1 µm high, surface between the warts very finely rough, with rests of the hyaline capses on the flat sides forming irregular pattern. Germination unknown.

SPECIMENS EXAMINED:
On Carex curvula All. (subgen. Vignea, sect. Baldenses): AUSTRIA: Tirol: Alptriften in Tristen in Weissenbach, 2300-2700 m, 23.VII.1892, G. Treffer (UPS); Ostalpen, Hohe Tauern, Sadnig-Gruppe, Fragant, 2200 m, 4.VIII.1949, F.J. Widder (7196; GZU); Nordwand des Schwärzenkammes, Gurglertal/Ötztal, 26.VII.1959, D. Podlech (M). ITALY: Prov. Bozen, Taufererertal/Ahrntal, Rein Rieserfernergruppe, Knuttental, oberhalb Sossen-Alm am Weg zum Pass nach den Kofler-Seen, 2400 m, 2.VIII.1979, K.P. Buttler & A. Zierold (HUV 9461). SWITZERLAND: Kt. Graubünden: Albula-Pass, VIII.1880, G. Winter, in Winter, Fgi. helv. Suppl. No. 2 (as Ustilago caricis; HUV 79, UPS); Albula Mt., 2400 m, VIII.1881, H. Wegelin (S); see also the type; Bernina-Gebiet, Sassal Massone, 28.VII.1904, H.C. Schellenberg (UPS); Bernina, Isla Persa, 2730 m, 9.VIII.1905, I. Rübel

(UPS); Bergell, Sciora Hütte S.A.C., 5.VIII.1952, S. Blumer (UPS). Kt. Wallis: Maniboden, Binnthal, 13.VIII.1922, A. Volkart (UPS, ZT).

The host ranges of *Anthracoidea* in relation to the taxonomy of the hosts have been discussed by Savile (1952), Savile & Calder (1953), Nannfeldt & Lindeberg (1957, 1965), Kukkonen (1963, 1972), Nannfeldt (1977, 1979), and Vánky (1979). As a result, it was concluded tat the evolution within *Anthracoidea* has in many cases reached the species level when the parallel evolution of the hosts has reached the level of sections. In other words, most of the *Anthracoidea* species parasitic on *Carex* are confined to hosts belonging to a certain section, or closely related sections.

The systematic position of *Carex curvula* is still uncertain. Kükenthal (1909) included it in the subgenus *Vignea*, sect. *Curvulae*. However, he suggested affinities with subgenus *Carex*, sect. *Frigidae*. Ivanova (1939) transferred *C. curvula* to the genus *Kobresia*. Chater (1980) treated it within the sect. *Baldenses*, together with *Carex baldensis* L.

Both *Carex baldensis* and *C. curvula* are parasitized by *Anthracoidea* species. *A. baldensis* Vánky differs from *A. curvulae* i. a. by usually rounded polyangular to irregular spores, by unevenly thickened spore wall (up to 3.5 um), by the presence of light-refractive spots and sometimes even 1-2 internal swellings, and by the spore surface with densely situated warts, often arranged in short rows or groups. *A. curvulae* also differs from *A. lindebergiae* (Kukk.) Kukkonen on *Kobresia simpliciuscula* (Wahlenb.) Mack. (Kukkonen 1963:69), by having larger spores and spore walls more clearly papillate.

Anthracoidea humilis Vánky, sp. nov.

Typus: *Carex humilis* Leyss (Cyperaceae), Romania, Transylvania, Odorhei (Székelyudvarhely), mt. Kuvar, 46°18' N, 25°19' E, alt. cca. 500 m.s.m., 12.V.1962, leg. K. Vánky. Holotypus in Herbario Ustilaginales Vánky (HUV 100, in UPS), isotypi in Vánky, Ustilaginales exs. 22 (as *Cintractia caricis*).

Sori in ovariis. Sporae magnitudine mediae, deplanatae, a fronte irregulariter rotundato-angulares, (14,5-)16-21 (-22,5) x (17,5-)19-25,5(-27) µm, ab acie ellipsoideae, rotundato-cuneiformes vel parum irregulares, 10-14 µm latae, atro-rufobrunneae, pariete inaequaliter incrassato, (1-) 1,5-4(-5) µm crasso, protuberantiis et areis refractivis atque 1-3 incrassationibus internis tenuibus instructo; superficie dense verruculoso, in extrema linea parum undulato usque parum serrulato; sub SEM verruculi rotundati, nonnunquam 2-5 eorum congregati vel partim confluentes, cca. 0,7 µm alti.

Sori in the ovaries forming black, hard, globose, 1.5-3 mm diam bodies. Spores (Figs 3, 4) medium-sized, flattened, in plan view rounded angularly irregular, (14.5-)16-21 (-22.5) x (17.5-)19-25.5(-27) µm, in side view ellipsoid, rounded cuneiform or slightly irregular, 10-14 µm wide, dark reddish-brown; wall unevenly thickened, (1-)1.5-4(-5) µm, protuberances and light-refractive areas present and also 1-3 weak internal swellings; surface densely verruculose, the spore profile appear finely wavy to finely serratulate; by SEM the warts are rounded, sometimes 2-5 grouped or partly confluent, c. 0.7 µm high. Germination unknown.

SPECIMENS EXAMINED:
On *Carex humilis* Leyss (subgen. *Carex*, sect. *Digitatae*): AUSTRIA: Kärnten: Loibltal, 27.V.1917, F.J. Widder (GZU); Südtirol: Ueberetsch, Trockenhänge über Porphyr bei Oberplanitzing, 3.V.1965, J. Poelt (GZU). GERMANY: Rheinland, Gau-Algesheim, in Fuckel, Fgi. rhenani exs. 2510 (as *Ustilago urceolorum*; HUV 9168); (?), May, in Klotzsch, Herb. viv. myc. 195 (as *Caeoma caricis* on *Carex clandestina*; UPS). ROMANIA: Transylvania: see the type; -, 2.V.1963, K. Vánky, in Herb. myc. rom. 1957 (as *Cintractia caricis*); mt. Budvár, 21.V.1962, K. Vánky (HUV 103); -, Porumbeni Mari (Nagygalambfalva), 27.V.1962, K. Vánky (BP, HUV 104); Decea (Marosdécse) near Aiud (Nagyenyed), 16.VII.1978, G. Negrean & K. Vánky (BUCM, HUV 8121); Mt. Retezat, mt. Scorota, 12.VII.1980, K. Vánky (BP, HUV).

Anthracoidea humilis has much more regular and rounded spores than *A. irregularis* (Liro) Boidol & Poelt, which also parasitizes members of the section *Digitatae*: *Carex digitata*, *C. ornithopoda* and *C. pediformis*.

Entyloma arctotheca Vánky, sp. nov.

Typus: *Arctotheca calendula* (L.) Levyns (Compositae), Lusitania: Beira Litoral: cca. 45 km W oppid. Coimbra, pr.

pag. Tocha, 40°19' N, 8°45' W, alt. cca. 20 m.s.m., 15.V.1980, leg. U. & K. Vánky. Holotypus in Herbario Ustilaginales Vánky (HUV 9000, in UPS), isotypi in BP, BPI, BUCM, S, UPS.

Sori formantes maculas 1-2 mm latas, primo flavidulas, serius brunneas, rotundas usque partim angulares foliorum. Sporae in contextu matricis immersae, sat dense collocatae, globosae, ovoideae usque irregulariter polyangulares, 10-14 x 11-16(-17) µm, subhyalinae usque pallide flavae; pariete aequaliter crasso usque inaequaliter incrassato, (1-)1,5-3(-4) µm crasso, levi, 1- vel 2-stratoso.

Sori in the leaves forming at first yellowish, later brown, round to partly angular, 1-2 mm wide spots, sometimes larger by confluence, slightly swollen when dried. Spores (Fig. 5) embedded in the host tissue, rather densely situated, globose, ovoid to irregularly polyangular, 10-14 x 11-16(-17) µm, subhyaline to pale yellow; wall uniform to unevenly thickened, (1-)1.5-3(-4) µm wide, one- or two-layered, smooth.

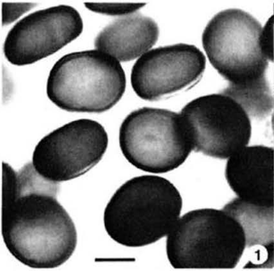
Known only from the type locality.

Entyloma sonchi Vánky, sp. nov.

Typus: Sonchus asper (L.) Hill. (Compositae), France, Bretagne, la Baule, Beslon, 31.V.1943, leg. H. Buhr. Holotypus in Herbario Ustilaginales Vánky (HUV 8790, in UPS), isotypus in BUCM.

Sori in foliis, rotundato-polyangulares, a venis limitati, 1-2,5 mm diametro vel confluentes majores, brunnei, parum pustulati. Sporae rotundae usque elongatae, irregulariter polyangulares, (9-)10,5-16,5(-18,5) x (9,5-)10,5-21(-22,5) µm, dense distributae, flavae. Paries sporarum levis, e stratis 2 compositus; endosporium cca. 1 µm crassum, exosporium inaequaliter incrassatum, 2-4,5(-7) µm crassum.

Sori in the leaves, rounded polyangular, vein limited, 1-2.5 mm in diam, or more by confluence, brown, slightly pustular. Spores (Fig. 6) rounded to elongated, polyangularly irregular, (9-)10.5-16.5(18.5) x (9.5-)10.5-21(-22.5) µm, densely situated, yellow; wall smooth, two-layered, endospore c. 1 µm thick, exospore unevenly thickened, 2-4.5(-7) µm wide.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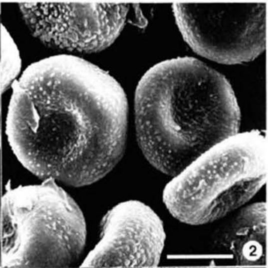
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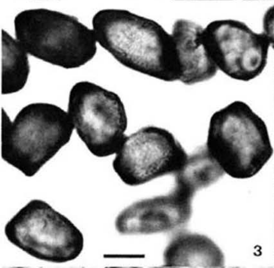
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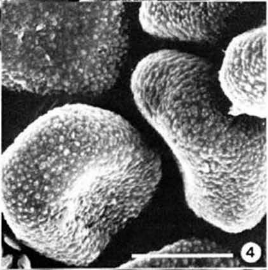
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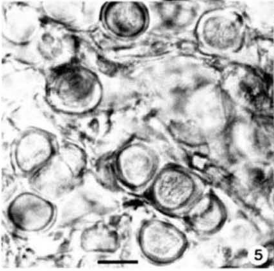
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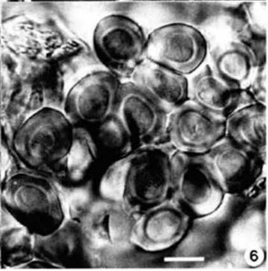
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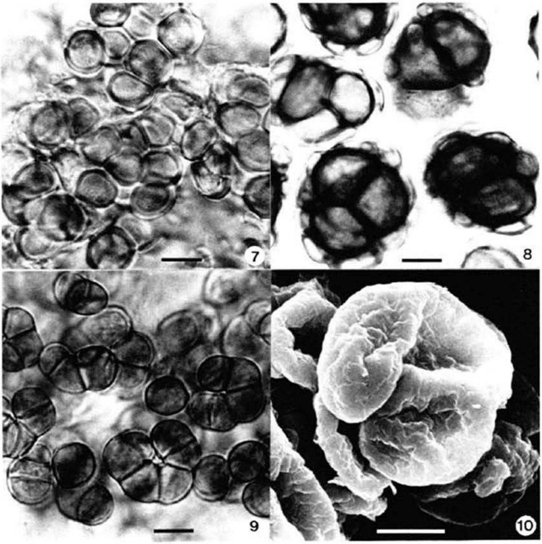


Figs 1--10. Spores of different species.

1 & 2. Anthracoidea curvulae (type).
3 & 4. Anthracoidea humilis (type).
5. Entyloma arctotheca (type).
6. Entyloma sonchi (type).
7. Entyloma taraxaci (type).
8. Urocystis ranunculi-aucheri (type; spore balls).
9 & 10. Schroeteria poeltii (type).
Figs 1,3,5-9 in LM; 2,4,10 in SEM.
Bars = 10 µm, except for fig. 10, where it represents 5 µm.

Entyloma bullatum, described by Ciferri (1933:252) on Sonchus oleraceus L., from Dominican Republic, differs from E. sonchi by greyish-yellow, rounded sori and by globose to subglobose, rarely subangular, 10-14 µm diam spores, with 2-2.5 µm thick wall.

Entyloma taraxaci Vánky, sp. nov.

Typus: Taraxacum megalorrhizon (Forskål) Hand.-Mazz. (Compositae), Israel: Jerusalem, 25.II.1936, leg. ?Jardens. Holotypus in Herbario Ustilaginales Vánky (HUV 7955, in UPS), isotypus in BUCM.

Sori formantes maculas brunneas, rotundas, 2-5 mm latas foliorum. Sporae in contextu matricis immersae, sat dense collocatae, globosae, subglobosae usque irregulariter rotundato-polyangulares, 9-14 x 10-15 µm; pariete aequali usque inaequaliter incrassato, 1,5-2,5(-3,5) µm crasso, levi, 2-stratoso.

Sori in the leaves forming brown, round, 2-5 mm wide spots. Spores (Fig. 7) embedded in the host tissue, rather densely situated, globose, subglobose to rounded polyangularly irregular, 9-14 x 10-15 µm; wall uniform to unevenly thickened, 1.5-2.5(-3.5) µm wide, two-layered, smooth.
Known only from the type locality.

Schroeteria poeltii* Vánky, sp. nov.

Typus: Veronica cymbalaria Bodard (Scrophulariaceae), France: dept. Alpes Maritimes, tract Ste. Agnès, pr. oppid. Menton, 43°47' N, 7°30' E, alt. cca. 600 m.s.m., 20.VI.1962, leg. H. Teppner. Holotypus in Herbario Ustilaginales Vánky (HUV 10800, in UPS), isotypus in GZU.

Sori loco seminum sicut massa rufo-brunnea, pulverea, e sporis 2-6(-7) plerumque in seriebus tortuosis permanenter coacervatis composita. Sporae subglobosae usque cuneiformes, (5,5-)6,5-12 x 6,5-13 µm, pallide flavo-brunneae; pariete fere levi usque leniter undulato in parte convexa libera superficiei, in parte autem rotunda plana contactus levi, cca. 0,7-1 µm crasso; sub SEM incrassationibus latis, irregularibus humilibus instructo.

Sori in the capsules replacing the seeds by a reddish-brown, powdery spore mass composed of permanent, 2-6(-7)-spored groups of spores, usually arranged in twisted rows. Spores (Figs 9, 10) subglobose to cuneiform, (5.5-)6.5-12 x 6.5-13 µm, light yellowish-brown; wall almost smooth to finely undulate on the free, rounded surface, smooth on the flattened, contact surfaces, c. 0.7-1 µm thick; by SEM provided with wide, irregular, low thickenings.

Known only from the type locality.

* Dedicated to Professor J. Poelt (Graz, Austria), who after the publication of my monograph of Schroeteria (Vánky 1982), kindly sent me a few samples of Veronica cymbalaria, heavily infected by this smut.

Sporisorium chrysopogonis Vánky, sp. nov.

Typus: Chrysopogon montanus Trin. (Gramineae), Sri Lanka (Ceylon), North Central Province, distr. Polonnaruwa, pag. Habarane, alt. cca. 250 m.s.m., 18.III.1974, leg. K. Vánky. Holotypus in Herbario Ustilaginales Vánky (HUV 6685, in UPS), isotypi in Vánky, Ustilaginales exsiccatae 407.

Sori totam inflorescentiam, rarissime spiculas tantum inflorescentiae nonnullas destruentes, partim a vagina foliorum cooperti, elongato-cylindrici, (3-)10-40 mm longi, 1-2 mm lati, membrana crassa, dilute flavo-brunnea, origine fungali, composita ex seriebus longis cellularum hyalinarum e longatarum, magnitudine 4-9 x 4-22 µm induti. Massa glomerulorum sporarum nigra, granulosa, pannulis fibrosis brunneis, origine matricalibus immixtis. Glomeruli sporarum globosi, ovoidei usque aliquantulum irregulares, satis permanentes, atrobrunnei, opaci, 32-56 x 36-80(-88) µm, e sporis (6-)10-75(-?) compositi. Sporae globosae, subglobosae, ovoideae usque forma irregulares. Sporae superficiales glomerulorum sub microscopio consueto in superficie extrorsa verrucosae, atrobrunneae, pariete crassae (1-1,5 µm), 8-13 x 9-14(-16) µm, sub SEM verrucis dense dispositis, nonnunquam confluentibus, rotundatis, diametro 0,15-0,6(-1) µm, altitudine 0,1-0,6(-0,8) µm ornatae. Sporae internae leves, subhyalinae usque dilute brunneae, pariete tenues (0,5 µm), subangulares, diametro 8-12(-14) µm.

Sori (Fig. 11) destroying the entire inflorescence, exceptionally confined to the individual spikelets, partially concealed by the leaf sheath, elongated cylindrical, 1-2 x (3-)10-40 mm, covered by a light yellowish-brown, thick membrane of fungal origin (perigonium) composed of long chains of hyaline, elongated cells, 4-9 x 4-22 µm. The perigonium split and flakes away from its distal part, often from the apex, revealing the black, granular mass of spore balls, interspersed with brown, fibrous shreds of host tissue origin. Spore balls (Figs 12, 13) globose, ovoid to somewhat irregular, rather permanent, dark brown, opaque, 32-56 x 36-80(-88) µm in diam, composed of (6-)10-75(-?) spores. Spores globose, subglobose, ovoid to irregular; outher spores by LM verruculose on the free surface, dark brown, thick-walled (1-1.5 µm), 8-13 x 9-14(-16) µm in diam; by SEM provided with densely situated, sometimes confluent, rounded warts, 0.15-0.6(-1) µm wide and 0.1-0.6(-0.8) µm high; inner spores smooth, subhyaline to light brown, thin-walled (0.5 µm), subangular, 8-12(-14) µm.

SPECIMENS EXAMINED:
On *Chrysopogon fulvus* (Spreng.) Choiv.:
SRI LANKA (CEYLON): see the type.
On *Chrysopogon* sp.
PAKISTAN: Swat: Barikot, 19.IV.1954, col. S. Ahmad (HUV 8983).

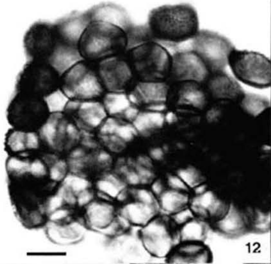
There are three or four more species of *Sporisorium* which parasitize *Chrysopogon* spp.:

Sporisorium andropogonis-aciculati (Petch) Vánky, comb. nov., basionym *Ustilago andropogonis-aciculati* Petch, in Ann. Roy. Bot. Gard. (Peradeniya) 4:303, 1909, on *Chrysopogon aciculatus* (Retz.) Trin. *Sporisorium andropogonis-aciculati* differs from *Sporisorium chrysopogonis* by the relatively small (4-5.5 x 5-6.5 µm), apparently smooth spores.

Sporisorium tumefaciens (McAlpine) Vánky, comb. nov, basionym *Sorosporium tumefaciens* McAlpine, The Smuts of Australia, p. 184, 1910, on *Chrysopogon* sp., wrongly identified by McAlpine as *Stipa* sp. and. *S. pubescens* R. Br.

Fig. 11. *Sporisorium chrysopogonis* on *Chrysopogon montanus*; a healthy and an attacked plant.

11



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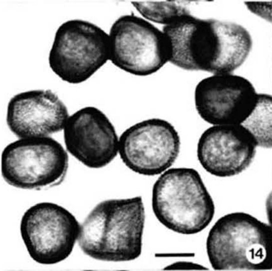

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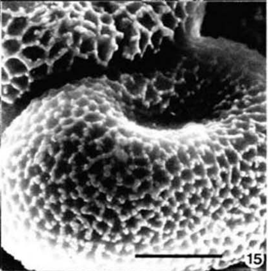

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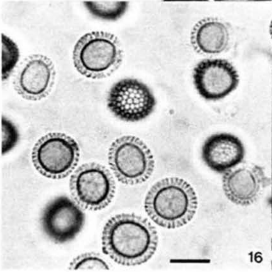

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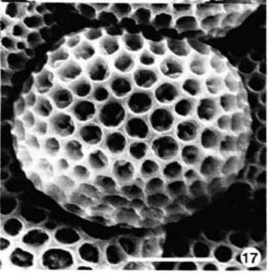

17

(Herbert & Langdon, 1941), syn. *Sorosporium azmatii* Mundkur) on *Chrysopogon coeruleus* (Steud.) Watson, *C. aciculatus* (Retz.) Trin., and *C.* sp. *Sporisorium tumefaciens* differs from *Sporisorium chrysopogonis* by smaller (5.5-8.5 x 5.5-9.5(-11.5) µm), light-brown, and on the free surface only very finely verruculose spores.

Sphacelotheca chrysopogonis-grylli Thirum. & Pavgi, (probably also a member of the genus *Sporisorium*), in the inflorescence of *Chrysopogon gryllus* Trin., has, according to the original description, sori covered by a pinkish pseudo-membrane and in the sori a long, simple columella; spores solitary, 10-15 µm diam, with thick, minutely echinulate wall. The cells of the membrane are irregularly globoid, thick-walled, 8.75-11.25 µm diam.

Sporisorium polliniae (P. Magnus) Vánky, comb. nov., basionym: *Sorosporium polliniae* P. Magnus, in Verh. K.K. Zool.-Bot. Ges. Wien 50:433, 1912, in the spikelets of *Pollinia distachya* (L.) Spreng. (= *Chrysopogon distachyos* (L.) Rossi), has 28-49 µm diam spore balls composed of (7-) 17-25 spores of 8-11.2 µm diam.

According to Fischer (1953:134), *Sphacelotheca chrysopogonis* Clinton on *Chrysopogon nutans* (= *Sorghastrum nutans*) is *Sphacelotheca cruenta* (Kühn) Potter (= *Sporisorium cruentum* (Kühn) Vánky).

Urocystis ranunculi-aucheri Vánky, sp. nov.

Typus: *Ranunculus aucheri* Boiss. (Ranunculaceae), Iran: prov. Fars, 60 km a Abadeh versus Meridiem, mons Kuh-e Bul, prope Aghlid, alt. 2900-3200 m.s.m., 25.V.1975, leg.: H. Foroughi. Holotypus in Herbario Ustilaginales Vánky (HUV 8804, in UPS).

Figs 12--17. Spore balls and spores of different species.

12 & 13. *Sporisorium chrysopogonis* (type; partly crushed spore balls).
14 & 15. *Ustilago arenariae-bryophyllae* (type).
16 & 17. *Ustilago cephalariae* (type).
Figs 12,14,16 in LM; 13,15,17 in SEM.
Bars = 10 µm, except for figs 15 and 17, where they represent 4 µm.

Sori in foliis petiolisve pustulas 1-10 mm longas vel confluentes longiores efformantes. Massa sporarum nigra, granuloso-pulverea. Glomeruli sporarum globosi, ovoidei usque parum irregulares, 20-40(-48) x 22-50(-60) µm, e sporis fertilibus 1-8 et e strato continuo vel fere continuo cellularum sterilium illas circumdantium compositi. Sporae fertiles globosae usque elongatae, plerumque irregulariter rotundato-angulares, contactu deplanatae, 12-17,5 x (13,5-) 15-21(-24) µm, mediocriter usque atro-brunneae, leves. Cellulae steriles semiglobosae, ovoideae usque elongatae, irregulares, 5-15 µm longae, flavae usque dilute flavo-brunneae, leves.

Sori in the leaves and petioles as blister-like swellings, 1-10 mm long, or more by confluence, at first lead-coloured and covered by the epidermis, which soon ruptures irregularly to expose the black, granular-powdery mass of spore balls. Spore balls (Fig. 8) permanent, globose, ovoid to slightly irregular, 20-40(-48) x 22-50 (-60) µm in diam, medium to dark olivaceous brown, composed of 1-8 fertile spores (1=3.5%, 2=25%, 3=36%, 4=18%, 5=12%, 6=4.5%, 7=0.5%, 8=0.5%) invested by a completely or nearly completely layer of sterile cells. Spores globose to elongated, usually rounded angularly irregular and flattened on the contact sides, 12-17.5 x (13.5-)15-21(-24) µm, medium to dark olivaceous brown, smooth. Sterile cells hemispherical, ovoidal to elongated, irregular, 5-15 µm long, yellow to light yellowish-brown, smooth.

The following Urocystis species have been described on Ranunculus: (1) Ur. anemones (Pers.) Winter, (2) Ur. ficariae (Liro) Moesz, (3) Ur. nivalis (Liro) Zundel (including Ur. murashinskyi (Cif.) Zundel), (4) Ur. novae-zealandiae (G.H. Cunningh.) Zundel, (5) Ur. ranunculi (Libert) Moesz, (6) Ur. ranunculi-auricomi (Liro) Zundel, (7) Ur. ranunculi-bullatae (Cif.) Zundel, (8) Ur. ranunculi-lanuginosi (DC.) Zundel, and (9) Ur. ranunculi-muricati (Viennot-Bourgin; as Tuburcinia).

Most of these species (1,3,5,6,8,9) have spore balls with only a few sterile cells which form a discontinuous layer around the spores. In some species (2,4,7) the outer layer of sterile cells may be discontinuous to continuous. Ur. ranunculi-aucheri has spores mostly completely surrounded by well-developed sterile cells. Few-spored balls formed of

1-3(-4) spores occur in species 1,2,3,5,8,9, whereas species 4 and 7 have 2-20-spored balls, and species 6 has 1-7(-10)-spored balls. Ur. ranunculi-aucheri, having spore balls composed of 1-6(-8) spores surrounded by a continuous layer of sterile cells, differs from all known Urocystis species parasitic Ranunculus.

Ustilago arenariae-bryophyllae Vánky, sp. nov.

Typus: Arenaria bryophylla Fernald (= A. musciformis Wall. ex Edgew. & Hooker fil.; Caryophyllaceae), India, Jelep La pass, 27°22' N, 88°51' E, alt. cca. 4760 m.s.m., IX.1938, leg.: ?. Holotypus in Herbario Ustilaginales Vánky (HUV 9045, in UPS).

Sori semina in multitudinem sporarum purpureo-nigram, prius conglutinatam serius pulveream, transformantes. Sporae globosae, ovoideae usque irregulariter rotundato-polyangulares, 12-17,5 x 13,5-24 µm, mediocriter usque atro-rubrobrunneae. Paries sporarum 1-1,5 µm crassus, sub microscopio consueto foveolatus superficiem leniter reticulatam marginemque undulatum usque subtiliter serratulatum efficiens, sub SEM leniter, nonnunquam incomplete reticulatus; reticulum e verrucis anastomosantibus, tenuibus, 0,8-1 µm altis compositum.

Sori in the capsules transforming the seeds into a purplish-black, first agglutinated, later powdery spore mass. Spores (Fig. 14, 15) globose, subglobose, ovoid to rounded polyangularly irregular, 12-17.5 x 13.5-24 µm in diam, medium to dark reddish-brown; wall 1-1.5 µm thick, by LM the surface is very finely foveolat-reticulate, and the spore profile wavy to finely serratulate; by SEM finely, sometimes incompletely, verruculosely-reticulate; reticulum composed by anastomosed, thin, 0.8-1 µm high warts.

There are ten species of Ustilago parasitic on Caryophyllaceae. Some occur in the anthers, have light violet spore mass and small, reticulate spores: (1) Ustilago clintoniana Cif. (7-12 µm), (2) U. major Schröt. (8-11 µm), and (3) U. violacea (Pers. : Pers.) Roussel s. lat. (6-11 um). Others, such as (4) Ustilago violaceo-verruculosa Brandenb. & Schwinn (4.5-8 µm) and (5) U. violaceo-irregularis Brandenb. & Schwinn (6-9 µm), in the anthers of Silene spp., have finely verruculose, respectively verruculose-reticulate spores. The following species destroy the ovaries, have dark, purplish-brown coloured spore mass and finely to distinctly reticulate, medium-sized spores: (6) U. alsineae Clint. & Zundel (9.5-14 µm), (7) U. duriaeana Tul. (including U. ducellieri R. Maire; 11-15 µm), (8) U. holostei de Bary (10-16 µm), (9) U. jehudana Zundel (10.5-15 µm; not in the anthers as originally given), and (10) U. moenchiae-manticae Lindtner (9-16 µm).

Ustilago arenariae-bryophyllae differs from all known Ustilago species on Caryophyllaceae by the great dimensions of the spores and by the finely verruculosely-reticulate spore surface.

Ustilago cephalariae Vánky, sp. nov.

Typus: Cephalaria humilis (Thünb.) Roem. & Schult. (Dipsacaceae; det. M. Welman 8541), South Africa: Lesotho: Butha-Buthe distr., Oxbow Tourist Lodge, 28°45' S, 28°40' E, alt. cca. 2460 m.s.m., 26.I.1982, leg. O. Hedberg (82001/b). Holotypus in Herbario Ustilaginales Vánky (HUV 10980, in UPS).

Sori in antheris, loco pollinum multitudo brunneolo-violacea, pulverea sporarum. Sporae et forma et magnitudine variae, globosae, ellipsoideae usque rotundate irregulares, 8-15 x 8-16 µm, flavidulae usque flavidulo-brunneae cum tinctu violaceo, leniter reticulatae, cum 8-14 maculis in diametro, regulariter cum appendice brevi, lato hyalinoque, residuo hyphae sporogenae; paries tenuis (cca. 0,2 µm crassus), reticulum 1,5-3 µm altum, sub SEM interstitiis verruculosis. Sporae acervatim in apicibus hypharum breviter ramificatarum formatae.

Sori in the anthers, replacing the pollen grains by a brownish-violet, powdery spore mass. Spores (Figs 16, 17) variable in form and size, globose, ellipsoid to rounded irregular, 8-15 x 8-16 µm, pale yellow to violet tinted yellowish-brown, finely reticulate, often with a short, wide, hyaline appendage (the rest of the sporogenous hypha), 8-14 meshes per spore diameter, meshes 1.5-3 µm high; by SEM interspaces verruculose. The spores are formed in groups, on the top of shortly ramified hyphae.

Known only from the type locality.

The following six *Ustilago* species are known on Dipsacaceae: *U. cephalariae* Vánky, *U. flosculorum* (DC.) Fr., *U. intermedia* Schröter, *U. morinae* Padw. & A. Khan, *U. scabiosae* (Sow.) Wint., and *U. succisae* P. Magn. They can be distinguished by using the key below.

1 Spore mass light (white, pale ochraceous or pale flesh) 2
1 Spore mass dark (purplish-brown, dark violet or brown-vinaceous) 3

2 Spore diam 12-17(-19) um; marginal wings conspicuous (1.5-2.5 um). (On *Succisa*) *U. succisae*
2 Spore diam 7.5-11(-13.5) um; marginal wings not conspicuous (c. 0.8 um). (On *Knautia*) *U. scabiosae*

3 Spores in the ovaries. (On *Morina*) *U. morinae*
3 Spores in the anthers 4

4 Meshes per spore diam 6-10. (On *Scabiosa*) *U. intermedia*
4 Meshes per spore diam 9-16 5

5 Spore diam 8-16 um. (On *Cephalaria*) *U. cephalariae*
5 Spore diam 12-18(-20) um. (On *Knautia*, *Succisa*) *U. flosculorum*

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LITERATURE CITED.

Chater, A.O., 1980. Carex L., in Tutin, T.G. & al. (eds), Flora Europaea 5:230-323. University Press, Cambrige.

Ciferri, R., 1933. Ustilaginales esotici nuovi o rari. I. Nuovo Giorn. Bot. Ital. N.S. 40:252-268.

Fischer, G.W., 1953. Manual of the North American Smut Fungi. Ronald Press Co, New York, 343 pp.

Herbert, D.A. & Langdon, R.F., 1941. Records of Queensland Fungi III. - Univ. Queensland Dept. Biol. Papers 2(1):2.

Ivanova, N.A., 1939. The genus Kobresia Willd., its morphology and systematics. - Botan. Zhur. 24:455-503. (In Russian with English summary).

Kükenthal, G., 1909. Cyperaceae - Caricoideae. Das Pflanzenreich 4.20(38), Leipzig, 824 pp.

Kukkonen, I., 1963. Taxonomic studies on the genus Anthracoidea (Ustilaginales). Ann. Bot. Soc. Vanamo 34(3), 122 pp.

----, 1972. Micro- and macro-ecological factors in the speciation of obligate parasites. - Ann. Bot. (London), N.S., 36:1029-1040.

Nannfeldt, J.A., 1977. The species of Anthracoidea (Ustilaginales) on Carex subgen. Vignea with special regard to the Nordic species. - Bot. Not. 130:351-375.

----, 1979. Anthracoidea (Ustilaginales) on Nordic Cyperaceae - Caricoideae, a concluding synopsis. -Symb. Bot. Upsal. 22(3):1-41.

---- & Lindeberg, B., 1957. Taxonomic studies on the ovariicolous species of Cintractia on Swedish Caricoideae. I. - Svensk Bot. Tidskr. 51:493-520.

---- & ----, 1965. Taxonomic studies on the ovariicolous species of Cintractia on Swedish Caricoideae. II. - Svensk Bot. Tidskr. 59:189-210.

Savile, D.B.O., 1952. A study of the species of Cintractia on Carex, Kobresia, and Scirpus in North America. - Canad. J. Bot. 30:410-435.

---- & Calder, J.A., 1953. Phylogeny of Carex in the light of parasitism by the smut fungi. - Canad. J. Bot. 31:164-174.

Vánky, K., 1979. Species concept in Anthracoidea (Ustilaginales) and some new species. - Bot. Notiser 132:221-231.

----, (1981)1982. The genus Schroeteria Winter (Ustilaginales). - Sydowia 34:157-166.

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THE GENERA *ARDHACHANDRA* AND *RHINOCLADIELLA*, THEIR SYNONYMY

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Summary

In this paper the synonymy of the genus *Ardhachandra* Subram. et Sudha (1978), and *Rhinocladiella* Nannfeldt (1934), (Deuteromycotina, Hyphomycetes) is discussed. *Rhinocladiella selenoides* (de Hoog) comb.nov. is published. Scanning electron micrographs of this species are provided. The species *Rhinocladiella cristaspora* Matsushima (1971) is considered validly published under this name.

In 1971, Matsushima published the new species *Rhinocladiella cristaspora*. In his description the author described the conidia as "22-25 µm longa, (6.5-)7-7.6 µm lata, 5-6 µm crassa, unilateraliter graciliora et ad marginem crista 1.2-1.4 µm lata formata".

In 1972 Pirozynski described, under the name *R. critaspora* Matsushima, a Tanzanian fungus similar to that one described by Matsushima, but different in the presence of two kind of spores: "lenticular or selenoid, bicorne-shaped conidia". In his discussion Pirozynski (1972) affirmed: "This fungus is not a *Rhinocladiella*. It probably deserves to be classified in a new genus but until other congeneric species are found, or the dimorphism of its conidia satisfactorily explained, the species is recorded here under the original binomial".

De Hoog (apud de Hoog and Hermanides-Nijhof, 1977) proposed that the fungi of Matsushima and of Pirozynski be considered as two different species of the same genus. He proposed the inclusion of the two species in the genus *Pseudobeltrania* P. Hennings, with the new combination *P. cristaspora* (Matsushima) de Hoog and the new species *P. selenoides* de Hoog, contrary to Pirozynski in creating a new genus. De Hoog (1977) justified the inclusion in this genus only because of the similarity between these two species and *P. chumrungensis* Sutton (1970). We believe that this reason is inadequate, also because the attribution of this last species to the genus *Pseudobeltrania* is doubtful.

De Hoog (1977) described only 1 type of spores for each species.

Subramanian and Sudha (1978) published the collection at Tabaram (Madras, India) of a fungus described as being morphologically identical to the Tanzanian one described by Pirozynski (1972) and gave a detailed description of its morphology and conidial dimorphism. Subramanian and Sudha (1978) considered, citing many and valid reasons, the inclusion of the species P. selenoides and of R. cristaspora in the genus Pseudobeltrania incorrect, and proposed for P. selenoides the new genus Ardhachandra, with the type species A. selenoides (de Hoog) Subram. et Sudha. They included in this genus also the fungus of Matsushima with the name A. critaspora, and reported the presence of dimorphism of its conidia in some strains of this species, even if it is lacking in the original collection.

It is necessary here to point out the fact that Matsushima (1971) published his fungus under the name R. cristaspora and not critaspora: therefore we believe that the name cristaspora (according to ICBN, Art. 73) must be mantained.

Subramanian and Sudha (1978), as Pirozynski (1972) and de Hoog (1977), did not explain the reasons of the exclusion of the two species here treated, from the genus Rhinocladiella, but we believe that the differences lie in the occasional presence of a stromatic disc, in the dimensions of the denticles, in the spore shape and, mainly, in the dimorphism of the conidia.

We believe that it is not possible to segregate species from a genus on the basis of the presence or the absence of the stroma, expecially when, as in this case, the stroma is not present in pure culture.

Differences in dimensions, even of the denticles, must be considered only at the specific level.

The conidia, in the two species, are peculiar in shape, but we do not believe the monothetical segregation of two genera is proposable only on the basis of the shape of the spores, expecially when they are both amerosporous.

There remains the dimorphism of the conidia.

During a work on the ecology of the microfungi of the forest litter and soil in the Tai National Park in Ivory Coast (Rambelli et al., 1983), we were able to observe 142 strains of A. selenoides and 59 strains of R. cristaspora (collected between January 1979 and January 1980, on dead leaves from the litter) and 5 strains of A. selenoides isolated in pure culture from the soil in the same period: in all of them we have found only 1 kind of conidia.

Through the courtesy of Dr. K.A. Pirozynski and Dr. P.M. Kirk, we were able to examine a slide made from the Tanzanian collection of Pirozynski (IMI 107006IIe), correctly labelled as Ardhachandra cristaspora and not as A. selenoides, as published by Subramanian and Sudha (1978).

In this slide there are really two kinds of conidia. As described also by Subramanian and Sudha (1978) there is a great preponderance of lenticular conidia. We think that it is possible that the few selenoid conidia derive from a colony of A. selenoides, present on the same leaf,

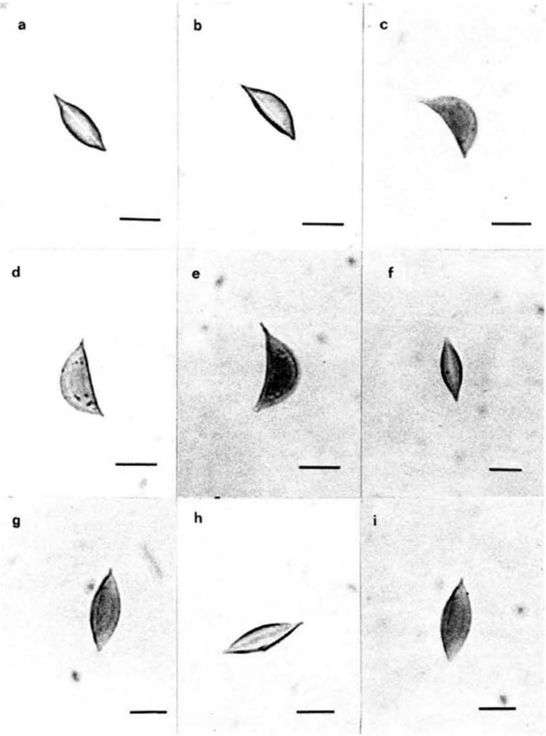

Fig. 1 - Rhinocladiella selenoides: a. conidium in face view; b. c. the same conidium in side view; d. e. conidia in side view; Rhinocladiella cristaspora: f. conidium in face view; g. h. the same conidium in side and in face view; i. conidium in side view. Bar = 10 μm.

near the colony of A. cristaspora: in fact on the same slide there are also spores of Beltrania rhombica Penzig and other conidia, probably of Phaeotrichoconis aurata Rambelli (apud Onofri et al., 1981).

As far as the collection of A. selenoides of Subramanian and Sudha (1978) is concerned, we think that the pictures given by these authors of the "lenticular" conidia refer to conidia in face view: in fact the "germ slit" described and illustrated for this kind of conidia actually is the crista as view in front, as demonstrated by the scanning electron and light microscopy micrographs (Fig. 1 a, b, c and Fig. 2 b, c, d).

In A. selenoides all the spores, which appear lenticular and with a "germ slit" at the microscope, after micromanipulation, turned at 90°, appear to be selenoid (Fig. 1 a, b, c). In R. cristaspora all the spores are lenticular, and all of them that appear different from the others and with a "germ slit", turned at 90°, then appear to be identical to the others and without any "germ slit" (Fig. 1 h, g).

At the scanning electron microscope, A. selenoides shows only selenoid conidia, which turned at 85°, appear lenticular (Fig. 2 b, c, d, e, f). The conidia appear verruculose, with a small flat scar at the base and a papillate apex (as described by Pirozynski, 1972). The crista is formed by a pronounced and regular diminution of the thickness of the spore, with a continuous sporal wall. The germ slit, described by Subramanian and Sudha (1978), is not visible (Fig. 2 c).

Based upon that which is cited above, we think that in these two species the dimorphism of the conidia probably does not exist.

Therefore we consider the species R. cristaspora Matsushima (1971) validly published under this name:

Rhinocladiella cristaspora Matsushima

Microfungi of the Solomon islands and Papua-New Guinea, Kobe, Japan, p. 49. 1971.

=Pseudobeltrania cristaspora (Matsushima) de Hoog apud de Hoog, G.S. and E.J. Hermanides-Nijhof, Stud. Mycol. 15:199. 1977.

=Ardhachandra cristaspora (Matsushima) Subramanian, C.V. and K. Sudha, Can. J. Bot. 56:729-731. 1978.

Collection examined: H. B. R. 38A, on unidentified leaves in litter, Tai, Ivory Coast, April 1979; IMI 107006IIe, on indetermined leguminous leaves (?Baphia sp.) Kakombe, Kigome, Tanzania, 4 Mar. 1964.

We propose for A. selenoides (de Hoog) Subram. et Sudha, the new combination:

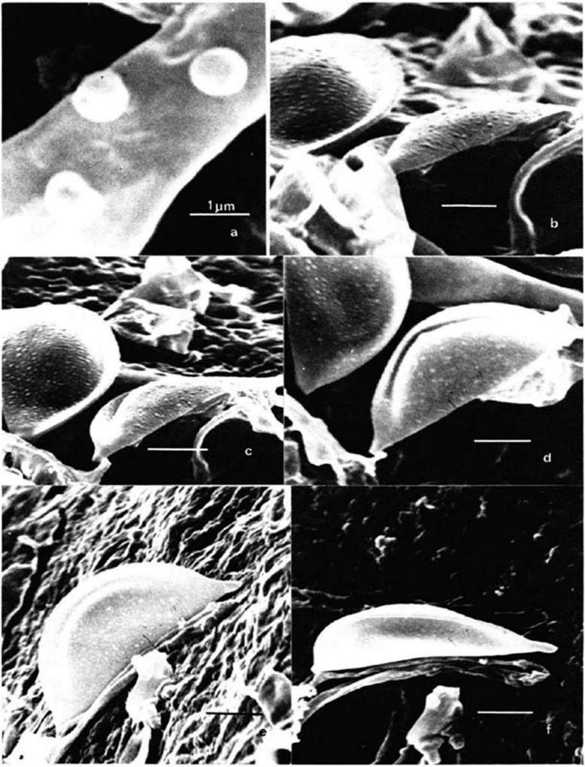

Fig. 2 - Rhinocladiella selenoides: a. denticles of the conidiogenous cell; b. c. d. the same conidium in face and in side view; e. f. the same conidium in side and in face view. Bar = 5 μm.

Rhinocladiella selenoides (de Hoog) comb. nov.

=Pseudobeltrania selenoides de Hoog
apud de Hoog, G. S. and E. J. Hermanides-Nijhof, Stud. Mycol. 15:199-200. 1977.

=Ardhachandra selenoides (de Hoog) Subramanian, C. V. and K. Sudha, Can. J. Bot. 56:729-731. 1978.

We give here a new latin diagnosis of the species, because we consider that the diagnosis published by de Hoog (1977) is incomplete in description of morphology and dimensions of conidiophores and conidia.

Coloniae amphigenae, brunneo-nigrae, effusae, subtiles. Mycelium superficiale. Hyphae septatae, hyalinae vel pallide brunneae, ramosae, 1,5 µm circiter latae. Stroma e cellulis brunneis irregulariter lobatis compositum. Conidiophora macronematosa, mononematosa, erecta, simplicia, recta vel leviter flexuosa, 0-3 septata, pallide brunnea, levia, 30-55 µm longa et 3,5-5 µm lata. Cellulae conidiogenae polyblasticae, integratae, terminales vel intercalares, sympodiales, denticulatae (denticuli cylindrici vel conici, saepe retrocurvati; 1-1,5x0,5-0,75 µm). Conidia sicca, solitaria, crassitunicata, ex dentibus cellulae conidiogenae singulatim acropleurogene formata, apice apiculata et basi cicatrice plana praedita, aseptata, lunata, guttulata, brunnea, 23-25 µm longa, 9-9,5 µm lata, 7 µm crassa, unilateraliter graciliora et ad marginem crista praedita.

Collection examined: H. B. R. 40A, on unidentified leaves in litter, Tai, Ivory Coast, May 1979; H. B. R. 20S from soil of the Tai forest, Ivory Coast, January 1979.

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We would like to thank Dr. K. A. Pirozynski and Dr. P. M. Kirk for the slide of the Pirozynski's fungus and Prof. A. Rambelli, Dr. A. M. Persiani and Dr. O. Maggi for their help and suggestions. We also thank Prof. O. Verona, Istituto di Microbiologia Agraria e Tecnica, Università di Pisa, Italy, for kindly reviewing the manuscript and the Minister of Scientific Research of the Ivory Coast, for his valuable assistance.

REFERENCES

de Hoog, G. S. and E. J. Hermanides- Nijhof. 1977. Survey of black yeast and allied Hyphomycetes. Stud. Mycol. 15:199-200.

Matsushima, T. 1971. Microfungi of the Solomon islands and Papua-New Guinea. Kobe, Japan. p. 49.

Nannfeldt, J.A. 1934. in: E. Melin and J.A. Nannfeldt. 1934. Researches into the blueing of ground wood-pulp. Svenska Skogsvårdsforen. Tidskrift 32: 397-616.

Onofri, S., D. Lunghini, A. Rambelli and L. Lustrati. 1981. New Dematiaceous Hyphomycetes from tropical rain forest litter. Mycotaxon 13:331-338.

Pirozynski, K.A. 1972. Microfungi of Tanzania. Mycol. Pap. 129:44.

Rambelli, A., A.M. Persiani, O. Maggi, D. Lunghini, S. Onofri, S. Riess, G. Dowgiallo and G. Puppi. 1983. Comparative studies on microfungi in tropical ecosystems. Mycological studies in South Western Ivory Coast forest. Report n. 1. MAB. UNESCO. Rome, Italy.

Subramanian, C.V. and K. Sudha. 1978. Ardhachandra, a new genus of the Hyphomycetes. Can. J. Bot. 56:729-731.

Sutton, B.C. 1970. Two Hyphomycetes new to Nepal. Trans. Br. mycol. Soc. 55(3):504-506.

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BASIDIOSPORE GERMINATION IN SPECIES OF BOLETACEAE

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Abstract

Basidiospore germination was obtained in 23 of 25 tested Boletaceae species with *Rhodotorula* yeast, own mycelium, or pine seedlings as inducing organisms, provided the medium was treated with activated charcoal. Mycelium of the same species as the tested spores was the most efficient germination inducer in *Leccinum*, while pine seedling roots proved active almost only in *Suillus*. *Rhodotorula* induced germination in all species tested, except three, but the response was usually slow and sparse. Different morphological modes of germination (polar versus lateral germ hypha or vesicle) occurred among the Boletaceae species studied.

INTRODUCTION

It has been shown that in vitro basidiospore germination in some species of the Boletaceae is strongly enhanced by the presence of certain microorganisms. The red yeast *Rhodotorula glutinis* gives such an effect in *Suillus luteus* and *S. granulatus* (Fries 1976), while basidiospore germination in certain *Leccinum* species is greatly increased by its own or a taxonomically closely related mycelium (Fries 1979, 1981).

The possibility of similar reactions operating in other species of the Boletaceae prompted the present study of basidiospore germination in which species of *Boletus* and *Tylopilus* were included as well as additional species of *Suillus* and *Leccinum*. As possible germination inducers, *Rhodotorula glutinis* and mycelium from the same species as the spores (=own mycelium) were utilized. The effect of living pine roots was also examined because of the positive results with *Hebeloma* spp. and *Thelephora terrestris* Ehr.: Fr. recently reported (Fries & Birraux 1980, Birraux & Fries 1981).

Although the principal aim of this study was to work out conditions permitting basidiospore germination, the solution of this problem in most of the species studied revealed the existence of certain species characters, notably as regards mode of germination and mode of response to charcoal, which seemed to be of potential taxonomic significance. The possibility to obtain numerous single-spore isolates of many Boletaceae species has added taxonomic implications, since mating systems and interpopulation crosses can be investigated, as has already been shown in some species of *Leccinum* (Fries 1981). This experimental approach should be particularly called for in taxonomic studies of ectomycorrhizal Homobasidiomycete species with several different species of host trees, the possible influence of which on the morphology of the basidiocarp is still unknown.

The results reported are based on experiments performed during the years 1975-1981.

MATERIAL AND METHODS

Three or more different spore collections were tested from most species. Ninety-six collections were utilized, 62 of which belonged to *Leccinum*. The spores, preserved in darkness at 4°C, usually retained their viability for five to ten months.

The nomenclature follows Watling (1970) with the additions of *Leccinum corsicum* (Roll.) Sing. and the two American species *L. rugosiceps* (Peck) Sing. and *L. insigne* Smith, Thiers & Watling.

All germination experiments were made on nutrient agar in plastic 9 cm diameter Petri dishes. The spores to be tested were plated out as a suspension in 0.1 ml distilled water on the surface of the plate, ca. $5 \cdot 10^5$ spores per plate (for further technical details see Fries 1978).

Spores of most of these boletaceous fungi did not germinate on this agar medium unless two particular conditions were fulfilled.

First, certain inhibitory substances in the agar medium must be removed. Most of the species tested are highly sensitive to an inhibitor (or several inhibitors) formed in the agar during autoclaving. This inhibitor was removed by adsorption to activated charcoal or Porapac (Q or T) (Fries 1978). The inhibitory effect of the ammonium ion, demonstrated in species of *Suillus* (Fries 1976), was eliminated by keeping the ammonium concentration low in the medium.

Secondly, in many species germination can be induced through metabolites exuded from other organisms in the vicinity of the spores. Three types of inducers were tested: (1) colonies of the red yeast, *Rhodotorula glutinis* (Fres.) Harrison, (2) mycelium representing the same or a closely related species as that of the spores, and (3) growing roots of pine seedlings (*Pinus sylvestris* L.). These inducers had earlier proved active in certain groups of Hymenomycetes other than the boleti.

Since spore germination in many species of Boletaceae proceeds very slowly and at a low percentage, the agar plates had to be stored for repeated inspections during several months. To avoid desiccation the Petri dishes were closed by parafilm and kept under bell jars. The incubation temperature was 25°C and illumination was avoided, except for the weekly or monthly inspections of the plates under the microscope.

Germination was considered "spontaneous" if it occurred on a nutrient agar plate in the absence of any other living organisms and their exudates.

Photographs were taken either through the bottom of the closed Petri dish or directly over the agar surface (Figs. 1-12).

RESULTS

The main results are summarized in Table 1.

Spontaneous germinations were only observed in the species of *Suillus* and, very rarely, in *B. badius*. Removal of the inhibitory substance formed from agar during autoclaving proved necessary for germination in all tested *Leccinum* species and probably also in most other species. However, in *Suillus granulatus*, *S. luteus*, and *S. variegatus* the spores were evidently insensitive to this inhibitor.

The three inducer organisms tested all proved active at least to some of the species. *Rhodotorula glutinis* stimulated germination in all species except *L. corsicum* and

Table 1. Germination induction in spores of *Leccinum* (L.), *Boletus* (B.) *Suillus* (S.) and *Tylopilus* (T.) with different inducer organisms. Nutrient agar medium always treated or pretreated with activated charcoal powder.

Species tested	Percentage and rate of germination 1) 2) 4)				Mode of germination 3)4)	Fig.
	Spontaneous	Induced by				
		Rhodotorula	Own mycelium	Pine roots		
L. scabrum	0	II b	III a	0	P	1
L. holopus	0	I c	II b	-	P	
L. aurantiacum	0	II b	III a	0	P	
L. versipelle	0	II b	III a	0	P	2
L. vulpinum	0	II b	III a	-	P	
L. variicolor	0	II b	II b	-	P	
L. insigne	0	II b	III a	-	P	
L. crocipodium	0	0	-	0	-	
L. corsicum	0	0	-	-	-	
L. carpini	0	I c	I c	-	P	
L. rugosiceps	0	I c	I c	0	P	3
B. edulis	0	I c	0	0	L or P	
B. pinicola	0	I c	0	-	L or P	4
B. calopus	0	I c	-	-	L	5
B. luridus	0	0	III b	0	P	6
B. piperatus	0	I c	0	0	P	
B. subtomentosus	0	II c	II c	0	P	7
B. badius	I c	I c	I c	I b	P	
S. luteus	I b	III a	III b	II b	L	8
S. granulatus	I b	III a	III b	II b	L	9
S. viscidus	I c	II b	I b	I b	P or L	10
S. grevillei	I c	II b	0	-	L	
S. variegatus	0 or I c	II b	III a	I b	L or P	11
S. bovinus	0 or I c	II b	II b	I b	L or P	12
T. felleus	0	I c	I c	0	P	

1) I = less than 100 germinations per million spores; II = between 100 and 10 000 per million spores; III = more than 10 000 per million spores.

2) a = germination starts within a week; b = within a month; c = after more than a month; 0 = no germinations.

3) P: polar germ hypha or vesicle; L: lateral germ hypha or vesicle.

4) - : not tested.

L. crocipodium, which never germinated, and *B. luridus* which only germinated, although capriciously, under the influence of a growing mycelium. The *Rhodotorula* effect was generally rather slow, the germinations sometimes not becoming visible until the incubation had lasted for two months or more. A mycelium representing the same species as the spores was highly efficient as a germination inducer in *Leccinum*, where its effect was species-group specific in the way described earlier (Fries 1981). In several species of *Boletus* and *Suillus* no specificity of this sort was found. A germination response to roots of pine seedlings was found only in *Suillus* and *B. badius*.

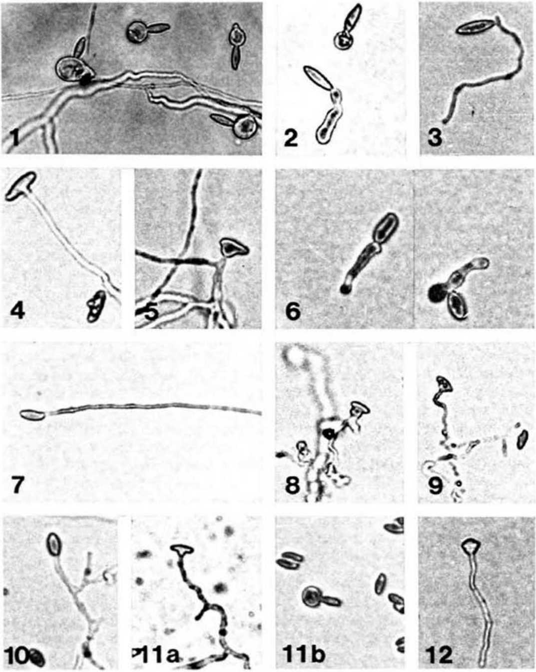
It should be added that finally, and irrespectively of the inducer organism used, the small mycelia developed from the germinated spores served as additional inducers for the surrounding spores.

Germination usually started close to the inducing organism present. Germinating spores then appeared at a gradually increasing distance from the inducer until they occurred over the entire surface of the plate. The tested species reacted differently on an agar surface, half of which had been dusted with charcoal powder. Briefly it can be stated that the presence of charcoal particles always favoured germination in the *Leccinum* species as well as in *B. luridus*. In the other species, germinations usually started first in the border zone between the charcoal-free and the charcoal-dusted parts of the plates. In *S. luteus* and *S. granulatus*, however, charcoal seemed to delay the beginning of germination.

Signs of autointoxication were visible in *B. calopus*, *B. luridus* and *B. piperatus*. In these species the mycelium died before having covered the whole surface of the plate. It produced a brown exudate (Modess 1942), and finally killed germinating spores and small mycelia in its vicinity.

DISCUSSION

The principal aim of this investigation - to find out methods for inducing in vitro germination in spores of Boletaceae - was reached in so far as germination was achieved in 23 of the 25 tested species. In the species of *Leccinum* and *Tylopilus* germination had not earlier been observed, despite several forceful attempts (for older references, see Fries 1943). In *Boletus*, germination was de-



Figs. 1-12. Germinating spores of the following species: 1: *Leccinum scabrum*; 2: *L. versipelle*; 3: *L. rugosiceps*; 4: *Boletus pinicola*; 5: *B. calopus*; 6: *B. luridus*; 7: *B. subtomentosus*; 8: *Suillus luteus*; 9: *S. granulatus*; 10: *S. viscidus*; 11: *S. variegatus* (a: lateral, b: polar germination); 12: *S. bovinus*. x 450.

scribed for *B. edulis* by Orlos & Twarowska (1965), who also published photographs of germinated spores. Basidiospores of the *Suillus* species germinate more readily than those of the other genera. Occasional germinations were seen and mentioned by Hammarlund (*S. grevillei*, 1923), Melin (*S. luteus*, 1962), and Orlos & Twarowska (*S. luteus*, 1965). However, none of these earlier studies led to the establishment of reproducible methods for the induction of spore germination.

It is possible that a different composition of the synthetic nutrient medium will be elaborated in the future, which permits a higher percentage germination without any inducer organism present. This has indeed already been found to be the case in *S. luteus*, *S. granulatus*, and *S. variegatus*, where an amino-acid mixture of known composition added to the medium considerably enhanced the percentage germination in the absence of an inducer organism (Fries 1976). In species of *Leccinum* the same effect can be produced by adding an exudate from a mycelium representing the same (or a closely related) species as that of the spores (Fries 1981). In this case the active compound has not yet been identified.

There are four reasons for the successful performance and repetition of germination experiments now possible with these boleti: (1) the development of methods to remove the previously unknown inhibitory agar-product by means of activated charcoal, (2) the finding that certain living organisms present among the spores induce germination, (3) the use of chemically identified media, and (4) the realization that germination in many cases takes place very slowly and sparsely.

A general conclusion that can be drawn from these studies is that in vitro conditions for germination and modes of germination differ considerably within Boletaceae, not only from one species (or species group) to another, but also from one spore collection to another within the same species. This may reflect differences among basidiocarps as regards, for instance, age, habitat or genetic constitution.

On a charcoal-treated agar medium *R. glutinis* stimulates germination in almost all tested boletaceous species, but the response is slow and the percentage germination, except in *S. luteus* and *S. granulatus*, very low. This may show that *R. glutinis* is a "false key" or a picklock for the release of the germination mechanism. In contrast, "self"-mycelium in most tested *Leccinum* species triggers, within a week or two, a germination of more than 50 %. In these species the remarkable taxon-specificity also supports the conclusion that induction by a self-mycelium is the "right key" to release germination.

In the other genera of Boletaceae tested no similar taxon-specificity has been encountered, although self-mycelia, as well as various other mycelia, may stimulate germination, sometimes even strongly, as in some *Suillus* species.

From this point of view *B. luridus* is still an enigmatic case. Self-mycelium from various stock cultures (and also mycelia of certain other species) sometimes induced germination in single spores after a long period of incubation. As soon as a young mycelium had developed, it triggered an almost general spore germination in its surroundings. This might indicate the existence of a taxon-specific reaction like that in *Leccinum*, the release of which, however, is usually inhibited in older mycelia in a so far unknown way.

The mode of germination depends on the taxonomic position of the species and probably also on the environmental conditions (Figs. 1-12). In the *Leccinum* species, germination began with the formation of a terminal germ hypha if induced with *Rhodotorula*, but with the formation of a big germ vesicle if induced with own mycelium. From this vesicle hyphae usually developed later on. In the other species of Boletaceae germination usually started with the development of a germ hypha, which grew out either from one end or from the side of the spore, i.e. polar or lateral germination, respectively.

In *Suillus* an earlier study (Fries 1943) comprising the same six species as in the present paper (plus *S. flavidus*) showed lateral germination all through. This can still be said to represent the most common mode of germination in this genus under the experimental conditions tested, although single cases of polar germinations were noticed (Fig. 11 b).

The species of *Boletus* differed more from one another in mode of germination. Polar germination prevailed in *B. luridus*, *B. subtomentosus* and *B. badius* (Figs. 6 and 7), whereas the very few germinations in *B. calopus* were of the lateral type (Fig. 5). In *B. edulis* and the closely related *B. pinicola* both types were observed. In *Tylopilus* *felleus* only polar germination seemed to occur.

It must remembered that all these spore germinations took place under conditions very different from those in nature. This could mean that the differences in mode of germination found in the experiments, although apparently correlated with the species, so not necessarily occur in nature.

The only published and illustrated observations which to my knowledge have been made on spore germination in Boletaceae under at least seminatural conditions were those of Orlos and Twarowska (1965) with *B. edulis* and *S. luteus*. They obtained, although irregularly, germinations of spores from these two species by placing the spores on glass slides in dry forest humus for about 10 days. Unfortunately the contours in their pictures are rather diffuse, but in *B. edulis* most germinations appeared to be of the polar type by the formation of either a vesicle or a germ hypha. Consequently the lateral germinations observed in some of my experiments may have been abnormal and caused by the artificial environmental conditions. From the only picture by Orlos & Twarowska (1965) on germinating spores of *S. luteus* it appears that the germ hypha developed in some cases from the end of the spore and in others from the side.

REFERENCES

Birraux, D. and N. Fries. 1981. Germination of *Thelephora terrestris* basidiospores. Can. J. Bot. 59: 2062-2064.

Fries, N. 1943. Untersuchungen über Sporenkeimung und Mycelentwicklung bodenbewohnender Hymenomyceten. Symb. Bot. Upsal. 6(4): 1-81.

Fries, N. 1976. Spore germination in *Boletus* induced by amino acids. Proc. K. Ned. Akad. Wet., Ser. C, Biol. Med. Sci. 79: 142-146.

Fries, N. 1978. Basidiospore germination in some mycorrhiza-forming Hymenomycetes. Trans. Br. Mycol. Soc. 70: 319-324.

Fries, N. 1979. The taxon-specific spore germination reaction in *Leccinum*. Trans. Br. Mycol. 73: 337-341.

Fries, N. 1981. Recognition reactions between basidiospores and hyphae in *Leccinum*. Trans. Br. Mycol. Soc. 77: 9-14.

Fries, N. and D. Birraux. 1980. Spore germination in *Hebeloma* stimulated by living plant roots. Experentia 36: 1056-1057.

Hammarlund, C.T.W. 1923. *Boletus elegans* Schum. und *Larix*-Mycorrhiza. Bot. Notiser 305-326.

Melin, E. 1962. Physiological aspects of mycorrhiza of forest trees. In: T.T. Kozlowski (Ed.): Tree growth, pp. 247-263. The Ronald Press Co. New York.

Modess, O. 1941. Zur Kenntnis der Mykorrhizabildner von Kiefer und Fichte. Symb. Bot. Upsal. 5(1): 1-147.

Orlos, H. and I. Twarowska. 1965. Investigations on the germination of spores of *Boletus edulis* Bull. ex Fr. and *Suillus luteus* (L. ex Fr.) S.F. Gray. (Transl. from Polish by U.S.D.A., Washington, D.C., USA). Prace Instytutu, Badawczego Leśnictwa, No. 282: 63-100.

Watling, R. 1970. 1. Boletaceae: Gomphidiaceae: Paxillaceae. In *British Fungus Flora, Agarics and Boleti* (ed. D.M. Henderson, P.D. Orton & R. Watling), pp. 1-125. Edinburgh: Royal Botanic Garden.

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NEW RECORDS OF FLESHY FUNGI FROM VENEZUELA

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On a floristic basis, the fleshy fungi of Venezuela are well documented. This is due principally to the extensive work of Dennis (1970).

In this paper, seven new records are reported from Venezuela. The fungi were collected in a part of the central llanos region of Venezuela which is flooded intermittently during the wet season. The fungi were collected primarily in unflooded, raised, sandy areas dominated by shrubs and occasional trees.

All collections listed below were made about 44 km south-southwest of Calabozo, Estado Guarico. Each collection made was divided in half. One-half of each is deposited either at the Field Museum of Natural History (F) or at The University of Michigan (MICH), the other half is at the Instituto Botanico, Caracas (VEN). The new records are as follows:

BOLETACEAE

Phlebopus brasiliensis Singer, Beih. Nova Hedwigia 77: 43, in press. On sandy soil under *Citrus* cultivar, 22 July 1980, Ovrebo 1160A (MICH) & Ovrebo 1160B (VEN): on base of dead palm and stem of *Hecatostemon completus*, 13 Aug. 1980, Ovrebo 1200A (MICH) & Ovrebo 1200B (VEN).

CORTINARIACEAE

Gymnopilus croceoluteus Hesler, North American species of *Gymnopilus*. 64. 1969. On well-rotted twigs, 17 Aug. 1980, Ovrebo 1215A (F) & Ovrebo 1215B (VEN).

HYDNACEAE

Steccherinum crassiusculum Harrison, Can. J. Bot. 42: 1207. 1964. Attached at base of *Citrus* cultivar, 9 July 1980, Ovrebo 1137A (MICH) & Ovrebo 1137B (VEN), 29 July 1980, Ovrebo 1179A (MICH) & Ovrebo 1179B (VEN). (Discussed previously, Harrison and Ovrebo, 1982.)

TRICHOLOMATACEAE

Crinipellis sublivida Murrill, North Amer. Flora 9: 287. 1915. On leaf litter, twigs and *Albizia* fruits, 26 July 1980, Ovrebo 1167A (F) & Ovrebo 1167B (VEN).

Lactocollybia angiospermarum Singer, Sydowia 2: 32. 1948. On base of fencepost, 12 July 1980, Ovrebo 1148A (F) & Ovrebo 1148B (VEN).

Marasmius bezerrae Singer, Flora Neotropica 17: 185. 1976. On dead *Copernicia tectorum* (palm) fronds, 21 Aug. 1980, Ovrebo 1217A (F) & Ovrebo 1217B (VEN).

Marasmius phaeocystis Singer, Flora Neotropica 17: 221. 1976. On leaf litter, 20 July 1980, Ovrebo 1156A (F) & Ovrebo 1156B (VEN).

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REFERENCES CITED

Dennis, R. W. G. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bulletin Additional Series III. London. 531 p.

Harrison, K. A., and C. Ovrebo. 1982. Further notes on *Steccherinum crassiusculum* (Hydnaceae). Contr. Univ. Mich. Herb. 15: 177-179.

MYCOTAXON

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CHEMOTAXONOMIC SIGNIFICANCE OF ANTHRAQUINONE DERIVATIVES IN NORTH AMERICAN SPECIES OF DERMOCYBE, SECTION SANGUINEAE

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ABSTRACT

Sporocarps of red gilled species of Dermocybe, section Sanguineae, collected in North America, were examined for the presence of anthraquinone derivatives by means of thin layer chromatography. A comparison of pigmentation data shows more or less specific pigment patterns and two types of pigmentation within the species employed in this study. The importance of pigmentation and its relevance to the classification of species are discussed.

INTRODUCTION

In the light of the significant chemotaxonomic results from studies of European species of Dermocybe (Fr.) Wünsche an examination was made of the pigmentation of North American Dermocybes in the section Sanguineae Kühn. and Romagnesi in Moser (Moser 1978). Our principal knowledge of the chemical structure of Dermocybe pigments is derived from the works of Kögl

Table 1. The *Dermocybe* species included in this study and their origin.

Dermocybe species examined	number of collection	herbarium	date of collection	Site of collection	Collector
Dermocybe semisanguinea	80/77	IB	1980-11-13	Mason Lake, Mason Co., Washington	G. Keller
Dermocybe semisanguinea	8292	WTU	1978-09-16	Baraga Pine Plains, Baraga Co., Michigan	J.F. Ammirati
Dermocybe semisanguinea	86579	MICH	1975-09-17	Lupton, Ogemaw Co., Michigan	A.H. Smith
Cortinarius phoeniceus var. *occidentalis*	80/74	IB	1980-11-13	Mason Lake, Mason Co., Washington	G. Keller
Cortinarius phoeniceus var. *occidentalis*	80/33	IB	1980-10-25	Redmond, King Co., Washington	G. Keller
Cortinarius phoeniceus var. *occidentalis*	56282	MICH	1956-12-04	Trinidad, Humboldt Co., California	A.H. Smith
Cortinarius aspenensis	7226	MICH	1976-08-12	Aspen, Pitkin Co., Colorado	D.H. Mitchel
Cortinarius sanguineus var. *sierraensis*	32671	SFSU	1974-08-17	Blue Lakes, Alpine Co., California	H.D. Thiers

Cortinarius marylandensis	7936	WTU	1977-08-26	Gainesvile, Alachua Co., Florida	J.F. Ammirati
Cortinarius marylandensis	7940	WTU	1977-08-27	Gainesville, Alachua Co., Florida	J.F. Ammirati
Dermocybe sanguinea	80/155	IB	1980-12-13	Pacific Co., Washington	S. Rehner
Dermocybe sanguinea	80/160	IB	1980-12-13	Pacific Co., Washington	J.F. Ammirati
Dermocybe sanguinea	6187	MICH	1971-12-03	Jackson State Forest, Mendocino Co., California	J.F. Ammirati
Cortinarius californicus	80/1	IB	1980-11-10	Umatilla National Forest, Columbia Co., Washington	J.F. Ammirati
Cortinarius californicus	6185	MICH	1971-12-03	Jackson State Forest, Mendocino Co., California	J.F. Ammirati
Cortinarius californicus	717	SFSU	1967-01-15	Jackson State Forest, Mendocino Co., California	J.F. Ammirati
Cortinarius hesleri	81624	MICH	1972-08-22	Washtenaw Co., Michigan	A.H. Smith
Cortinarius hesleri	86257	MICH	1975-09-07	Highland Lake, Livingston Co., Michigan	A.H. Smith
Dermocybe cinnabarina	70/267	IB	1970-09-20	Hillerod, Nordseeland, Denmark, Europe	K. Haslwandter

and Postowsky (1925), Steglich and Austel, 1966; Steglich et al., 1969; Steglich and Lösel, 1972; and Steglich and Reininger, 1972. Kögl and Postowsky (1925) were the first to ascertain the anthraquinonic nature of the pigments in *Dermocybe sanguinea* (Wulf: Fr.) Wünsche. Studies done by Steglich et al. (1969) and Steglich and Lösel (1972) have shown that a variety of anthraquinone pigments are present in *Dermocybe sanguinea* and *D. semisanguinea* (Fr.) Mos.. Moreover, Steglich and Lösel (1972) showed that some pigments are present in the form of their corresponding 1-glucosides. Additional anthraquinonic pigments were found by Steglich and Reininger (1972) in sporocarps of *Dermocybe cinnabarina* (Fr.) Wünsche.

Early chemotaxonomic studies in *Dermocybe* by Gabriel (1960a, 1960b, 1961) and Gruber (1970) included European species; Gruber (1975) considered species from Europe and South America. These chemotaxonomic studies showed that the species had more or less specific pigment patterns and that pigmentation was very useful in differentiating infrageneric taxa. The systematic arrangement of *Dermocybe* species proposed by Moser (1972) is in agreement with the results of the chemotaxonomic studies, especially with those of Gruber (1970, 1975). Further pigment studies in *Dermocybe*, using thin layer chromatography, were done by Keller (1979, 1982). In view of the importance of anthraquinone pigments in the systematics of *Dermocybe*, the present study was done to determine pigments and pigment patterns of North American Dermocybes, in the section *Sanguineae*.

EXPERIMENTAL

Fungal Material. Several collections used in this study were made by the authors in the fall of 1980 in the Pacific Northwest. These and additional collections are listed in Table 1, with collection number, date of collection, collector, collection site and location of voucher specimens. Herbaria are indicated by the appropriate abbreviations from *Index Herbariorum*.

Extraction and Chromatography of Pigments. 0.5 g (dry weight) of finely powdered, dried sporocarps of each collection were extracted with 30 ml of ethanol (96%). The samples were heated to boiling for 2 min.

Filtrates of the extracts were evaporated to dryness under reduced pressure. The residues were redissolved in 1.0 ml of ethanol. Pigment separation was done with thin layer chromatography (TLC). Quantities (20 µl) of the extracts and standard solutions were spotted on TLC plates. Chromatography was done on precoated TLC plates (Silica Gel Type 60). Five solvent systems were employed to detect pigment patterns of each species. For further chromatographical data see Table 2. The developed chromatograms were dried and examined in daylight and UV light (λ = 365 nm). To more clearly define color reactions of the pigments, the TLC plates were sprayed with the reagents KOH (5% in methanol) and magnesium acetate (5% in methanol).

Chromatographic system	Solvent system (v/v)
I	benzene : acetic acid (glacial) 2 : 1
II	ethyl acetate : methanol : water 100 : 16.5 : 13.5
V	benzene : ethyl formate : formic acid 65 : 25 : 10
VI	toluene : ethyl formate : formic acid 50 : 40 : 10
VII	ethyl acetate : ethylmethylketone : formic acid : water 50 : 30 : 10 : 10

Table 2. Chromatographic systems. Layer: precoated TLC plates silica gel 60 (Merck), thickness of layer: 0.25 mm.

Dermocybe versus Cortinarius

The first author, following the classification of M. Moser, Innsbruck, Austria, prefers the use of Dermocybe as a genus, while the second author uses the genus

Table 3. Chromatographical data of anthraquinone and anthraquinoid pigments of *Dermocybe sanguinea*, *D. semisanguinea* and related species. Chromatographical conditions given in Experimental section and in Table 2.$^{x)}$RS indicates identification of pigment by comparison with authentic reference sample in cochromatography.

No.	Pigment	x)	R_f values in chromatographic systems					Colour of pigment in daylight on TLC plates	Colour of pigment under UV light on TLC plates	Colour reaction of pigment, reagent: KOH on TLC plates
			I	II	V	VI	VII			
1			0.80	0.84	0.76	0.78	0.99	pink	pink	violet
			0.78	0.83	0.72	0.72	0.99	yellow	ochreous orange	blue purple
			0.77	0.82	0.73	0.74	0.99	yellow	ochreous	orange
			0.59					yellow		pink
23	AFDM		0.56	0.73	0.35	0.47	0.95	yellow	dark	blue purple
21	Emodin	RS	0.54	0.79	0.52	0.61	0.98	yellow	ochreous orange	purple red
25	Dermoglaucin	RS	0.45-0.52	0.00-0.30	0.40	0.40-0.50	0.94	brown	dark	brownish gray
32	Dermocybin	RS	0.25-0.48	0.00-0.30	0.41	0.40-0.50	0.85-0.95	purple	dark purple	violet

37	FDM	RS	0.32	0.63	0.21	0.34	0.90	yellow, lemon	dark	yellow
			0.30		0.22	0.43		yellow	ochreous range	purple red
41	Endocrocin	RS	0.28	0.23	0.29	0.39	0.86	yellow	ochreous	pink
45			0.19	0.12				yellow	pink	pink
46	5-chloro-dermorubin	RS	0.18	0.10				pink	purple	purple violet
47	Dermolutein	RS	0.14	0.14	0.16	0.33	0.88	yellow	ochreous orange	orange red
49	Dermorubin	RS	0.11	0.12	0.15	0.32	0.86	pink	red orange	purple violet
56	Emodinglucoside	RS	0.04	0.40	0.02	0.05	0.60	yellow	ochreous orange	red
57	Dermoglaucin-glucoside (?)		0.02	0.00 -0.20	0.00	0.03	0.38	brown	dark	blue gray
58	Dermocybin-glucoside	RS	0.02	0.00 -0.18	0.00	0.03	0.40	purple	dark purple	violet
63	Endocrocin-glucoside (?)		0.02	0.06	0.00		0.48	yellow	ochreous	red orange
64	Dermolutein-glucoside (?)		0.02	0.04	0.00		0.38	yellow	red orange	pink
65	Dermorubin-glucoside (?)		0.02	0.03	0.00		0.37	pink	purple	purple

Cortinarius. In the latter case Dermocybe would become a subgenus. In both systems the taxa treated here are placed in the section Sanguineae (Sanguinei). In this paper the genus Dermocybe is used for all taxa except those described from North America. Provisional names (nom. prov.), refer to taxa that will be described in a forthcoming paper by Ammirati and Smith (1984).

RESULTS

Chromatographic examination of ethanolic extracts of sporocarps of North American red gilled Dermocybes revealed the presence of a number of anthraquinone and anthraquinoid pigments. The anthraquinone carboxylic acids endocrocin, dermolutein, dermorubin, 5-chlorodermorubin, cinnalutein and cinnarubin were identified with authentic reference samples, as well as the phenolic anthraquinone derivatives emodin, emodinglucoside, physcion, dermoglaucin, dermocybin, dermocybinglucoside and fallacinol, and the dimeric hydroanthracene flavomannin-6.6'-dimethylether. More than 21 pigments were distinguished on chromatograms of Dermocybe semisanguinea, Cortinarius phoeniceus var. occidentalis Smith, C. aspenensis, nom. prov., C. sanguineus var. sierraensis nom. prov., Dermocybe sanguinea and Cortinarius marylandensis, nom. prov. The pigments of this group are shown in Table 3. Pigment investigation of Cortinarius californicus Smith and C. hesleri, nom. prov., revealed more than 20 pigments, which are listed in Table 4 with their chromatographical data. With the exception of flavomannin-6.6'-dimethylether all pigments show a positive color reaction to the reagent KOH (and magnesium acetate), which indicates the anthraquinonic character of the identified pigments as well as of the unknown colored compounds. It is apparent from the chromatographical data that many of the unknown pigments seem to be glucosides of anthraquinone derivatives.

Dermocybe semisanguinea and Cortinarius phoeniceus var. occidentalis

The data presented in Table 5 reveal that the phenolic anthraquinone derivatives dermocybin and dermoglaucin are the predominant pigments in Dermocybe semisanguinea and Cortinarius phoeniceus var. occidentalis. The pigment patterns of these two species are appreciably similar, they only differ by larger amounts of

Table 4. Chromatographical data of anthraquinone pigments of *Cortinarius californicus*, *C. hesleri* and *Dermocybe cinnabarina*. Chromatographical conditions given in Experimental section and in Table 2.x)RS indicaters identification of pigment by comparison with authentic reference sample in cochromatography.

No.	Pigment	x)	R_f values (ave.) in chromatographic systems					Colour of pigment in daylight on TLC plates	Colour of pigment under UV light on TLC plates	Colour reaction of pigment, reagent: KOH on TLC plates
			I	II	V	VI	VII			
			0.78	0.83	0.80	0.78	0.99	yellow	ochreous yellow	pink
3	Physcion	RS	0.72	0.78	0.72	0.70	0.98	yellow	ochreous yellow	orange
			0.60	0.45	0.50	0.52	0.93	yellow	ochreous yellow	pink
			0.58	0.72	0.44	0.50	0.93	yellow	orange	pink
			0.58	0.72	0.41	0.50	0.93	pink	purple	violet
			0.56	0.72	0.37	0.47	0.92	yellow	orange	purple red
26	Fallacinol	RS	0.53	0.72	0.44	0.48	0.95	yellow	orange yellow	purple red
			0.52	0.27	0.52	0.53	0.91	pink	purple	violet
31	Cinnalutein	RS	0.50	0.25	0.46	0.49	0.90	yellow	orange	red orange
33	Cinnarubin	RS	0.48	0.23	0.45	0.50	0.90	red	orange	violet
41	Endocrocin	RS	0.29	0.25	0.29	0.39	0.86	yellow	ochreous	pink
			0.28	0.15	0.30	0.40	0.87	pink	purple	pink
			0.25	0.19	0.26	0.37	0.86	yellow	orange	violet
			0.23	0.20	0.27	0.38	0.85	pink	orange	violet
			0.09					pink	ochreous orange	pink
59			0.08	0.38			0.58	yellow	ochreous	pink
61			0.04	0.34	0.00	0.03	0.41	yellow	pink	purple red
67			0.03	0.33	0.00	0.00	0.40	pink	purple	violet
			0.02				0.52	yellow	orange	pink
			0.02				0.44	yellow	ochreous	orange

Table 5. Distribution of pigments and pigment patterns in Dermocybe sanguinea, D. semisanguinea and related species. Symbols: +, ++, +++, ++++ indicate relative intensity, (+) indicates traces of pigment detectable, - indicates pigment not detected, (?) identity of pigment not certain

No.	Pigment	R_f values in system I (ave.)	Colour of pigment in daylight	Relative intensity of pigments and pigment patterns					
				semi-sanguinea	phoeniceus var. occcidentalis	aspenensis	sanguineus var. sierraensis	sanguinea	mary-landensis
		0.80	pink	+	-/+	-	-	-	-
1		0.78	yellow	(+)	+	+	-	-	-
		0.77	yellow	+	(+)	-	-	-	(+)
		0.59	yellow	-	-	(+)	-	+	-
23	AFDM	0.56	yellow	+	(+)/+	+++	-	-	-
21	Emodin	0.54	yellow	-	-	++	++	++++	-
25	Dermoglaucin	0.45 -0.52	brown	+++	++++	+	++	++	++
32	Dermocybin	0.25 -0.48	purple	+++	++++	++	+++	++++	+++

37	FDM	0.32	yellow	+	+	++	-	-	-
		0.30	yellow	-	-	-	-	++	-
41	Endocrocin	0.28	yellow	+	+	(+)	-	-	+
45		0.19	yellow	+	+	+	-	-	+
46	5-chloro-dermorubin	0.18	pink	+	+	(+)	+	+	+
47	Dermolutein	0.14	yellow	+++	+++	++	+	+	++
49	Dermorubin	0.11	pink	++	+	(+)	++	++	++
56	Emodinglucoside	0.04	yellow	-	-	++	+++	++++	-
57	Dermoglaucin-glucoside (?)	0.02	brown	++	+++	+	++	+++	++
58	Dermocybin-glucoside	0.02	purple	++	++++	+	+++	++++	++
63	Endocrocin-glucoside (?)	0.02	yellow	+	(+)	(+)	-	-	-
64	Dermolutein-glucoside (?)	0.02	yellow	+	+	+	(+)	+	+
65	Dermorubin-glucoside (?)	0.02	pink	+	+	+	+	+	+

dermocybin and dermoglaucin in *C. phoeniceus* var. *occidentalis*. In addition, dermorubin was observed with somewhat higher intensities on chromatograms of *D. semisanguinea*. Most other pigments, including the anthraquinone carboxylic acids endocrocin, dermolutein, dermorubin, 5-chloro-dermorubin and their presumable glucosidic forms as well as the dimeric pigment flavomannin-6.6'-dimethylether were recognized on the chromatograms of these two species with corresponding intensities. No emodin or emodinglucoside were detected in collections examined. There is no significant difference between pigment patterns of North American collections of *D. semisanguinea* and those found in Europe, Steglich et al., (1969) Steglich and Lösel (1972), Gabriel (1960a, 1960b, 1961), Gruber (1970) and Keller (1979, 1982). There is some quantitative variation and a few minor pigments may be present or disappear in the pigment patterns of North American and European collections, but the specific features of the pigmentation always are detectable.

Cortinarius aspenensis

Chromatographic examination of *Cortinarius aspenensis* showed that flavomannin-6.6'-dimethylether is the major coloring compound in the pigment pattern of this species, particularly with the presence of its oxidation product anhydroflavomannin-9.10-quinone-6.6'-dimethylether. Dermoglaucin, dermoglaucinglucoside (?), dermocybin and dermocybinglucoside were detected with lower intensities than on chromatograms of other members of *Sanguineae*. Furthermore, emodin and emodinglucoside are typical pigments with medium intensities on chromatograms of *C. aspenensis*, and, dermolutein was readily detected, whereas dermorubin and endocrocin were observed with lower intensities.

Dermocybe sanguinea and *Cortinarius sanguineus* var. *sierraensis*

The major pigments of *Dermocybe sanguinea* have been identified as emodin and dermocybin, which were detectable on the chromatograms as aglucones and glucosides with particular high intensities. Dermoglaucin and dermoglaucinglucoside were found with medium chromatographic intensities. An unidentified yellow pigment with R_f value 0.30 in chromatographic system I was detected with medium intensities and seems to be specific for collection G. Keller 80/155. Of the endocrocin type pigments, endocrocin itself was not detectable, but its derivatives dermolutein and dermorubin were observed on the chromatograms. No flavomannin-6.6'-dimethylether was found in collections of *D. sanguinea*. For *D. sanguinea* there are no significant differences in pigment patterns between North American and European collections. Chromatographic examination of European collections of *D. sanguinea* showed some quantitative and less qualitative variation. Steglich et al. (1969), Gruber (1970) and Keller (1982) report similar pigment patterns for European collections of this species. The pigment patterns of *Cortinarius sanguineus* var. *sierraensis* and *Dermocybe sanguinea* are remarkably similar, but emodin and dermocybin are not predominant pigments in var. *sierraensis* as they are in *D. sanguinea*.

Cortinarius marylandensis

Chromatographic examination of *Cortinarius marylandensis* revealed a *sanguinea*-type of pigmentation. With the exception of emodin and emodinglucoside which were not detectable, most pigments typical of *D. sanguinea* were found in fruiting bodies of *C. marylandensis*. However, no flavomannin-6.6'-dimethylether was observed on chromatograms of this species.

Cortinarius californicus and *Cortinarius hesleri*

It is apparent from the data in Table 6 that *Cortinarius californicus* and *C. hesleri* are complexly colored Dermocybes. Thirteen pigments of yellow, pink and red colors were distinguished on the chromatograms of *C. californicus*. Twelve pigments were observed on chromatograms of *C. hesleri*, ten of these had homologues in the chromatograms of *C. californicus*. Three pigments were identified, endocrocin, cinnalutein and cinnarubin, by comparison with authentic reference samples. All other pigments remain unidentified, although they were compared chromatographically with further reference samples, see Table 3. There is chemotaxonomic evidence that *C. californicus* and *C. hesleri* have individually distinct pigment patterns. As compared to *C. hesleri*, endocrocin and cinnarubin were observed with higher intensities in *C. californicus*, which also contains pink pigments with R_f values 0.23 and 0.09 in chromatographic system I. More of the yellow pigment with R_f value 0.60 (system I) was present in collections of *C. hesleri*. A somewhat larger amount of the pigments with R_f values 0.56 and 0.52 in chromatographic system I

Table 6. Distribution of pigments and pigment patterns in *Cortinarius californicus*, *C. hesleri* and *Dermocybe cinnabarina*. Symbols: +, ++, +++, ++++ indicate relative intensity of pigment, (+) indicates traces of pigment detectable, - indicates pigment not detected.

No.	Pigment	R_f values in system I (ave.)	Colour of pigment in daylight on TLC plates	Relative intensity of pigments and pigment patterns		
				californicus	hesleri	cinnabarina
		0.78	yellow	-	-	++
3	Physcion	0.72	yellow	-	-	(+)
		0.60	yellow	(+)/+	+++	+
		0.58	yellow	+	+	-
		0.58	pink	+/++	++	(+)
		0.56	yellow	+++	++	-
26	Fallacinol	0.53	yellow	-	-	++++
		0.52	pink	++	(+)	-
31	Cinnalutein	0.50	yellow	+/++	++	++
33	Cinnarubin	0.48	red	++++	+++	++++
41	Endocrocin	0.29	yellow	++	+	(+)
		0.28	pink	++	+	-
		0.25	yellow	+	(+)	-
		0.23	pink	++	-	-
		0.09	pink	+	-	-
59		0.08	yellow	-	-	++
61		0.04	yellow	++	+	-
67		0.03	pink	-	+	+
		0.02	yellow	-	-	+/++
		0.02	yellow	-	-	+

was detectable in fruiting bodies of *C. californicus*. As shown in Table 6 it is particularly clear that pigmentation of *C. californicus* and *C. hesleri* is remarkably similar to that of *Dermocybe cinnabarina*, which is an European species that contains several corresponding pigments.

DISCUSSION

The chemotaxonomical data from this investigation of North American species in the section *Sanguineae* gave no unexpected or new arrangements in infrageneric taxa. Furthermore, no inconsistencies with morphological data were found in North American taxa. The chemotaxonomic relationships of the species are shown in Table 7. Two supraspecific levels of pigmentation were found in the species employed in this study. Pigment patterns of *Cortinarius californicus* and *C. hesleri* are related to the *cinnabarina*-type of pigmentation. All other species have a *sanguinea*-type of pigmentation.

Cortinarius sanguineus var. *sierraensis* and *C. marylandensis* are chemotaxonomically close to *Dermocybe sanguinea*, with no significant difference between *Cortinarius sanguineus* var. *sierraensis* and *Dermocybe sanguinea*. Chromatographic examination of the pigment patterns of *C. sanguineus* var. *sierraensis* show a somewhat lower intensity of emodin and dermocybin than in *D. sanguinea* but pigment patterns of both species are of the same specificity. Morphological differences between *C. sanguineus* var. *sierraensis* and *D. sanguinea* var. *sanguinea* are the basis for separating these taxa (Ammirati & Smith, 1984, in preparation).

Pigment similarities of *Dermocybe sanguinea* and *Cortinarius marylandensis* support the idea that these taxa are related, while affinities of *C. marylandensis* with *Cortinarius californicus* and *C. hesleri* could not be detected. In contrast to *Dermocybe sanguinea* var. *sanguinea* no emodin was found in *C. marylandensis*. Keller (1982) reports similar results from his study on *Dermocybe sanguinea* var. *vitiosa* Mos., which is an European taxon also lacking emodin. *Cortinarius marylandensis* and *Dermocybe sanguinea* var. *vitiosa*, are closely related but these two taxa are geographically separated, have different ecological requirements and exhibit mor-

Table 7. Chemotaxonomic relationships of species employed in this study. Position of species can be seen as a result of their specific pigment patterns.

<table>
<tr><td colspan="3"></td><td colspan="4">anthraquinone carboxylic acids</td></tr>
<tr><td colspan="3"></td><td rowspan="2">cinnalutein and cinnarubin present
dermolutein and dermorubin absent</td><td colspan="3">dermolutein and dermorubin present
cinnalutein and cinnarubin absent</td></tr>
<tr><td colspan="3"></td><td>dermorubin with high intensities</td><td colspan="2">dermolutein with high intensities</td></tr>
<tr><td rowspan="3">phenolic anthraquinone derivatives</td><td rowspan="2">dermocybin and dermoglaucin present</td><td>emodin present</td><td></td><td>sanguinea
sanguineus var. sierraensis</td><td></td><td>aspenensis</td></tr>
<tr><td>no emodin</td><td></td><td>marylandensis</td><td>phoeniceus var. occidentalis
semisanguinea</td><td></td></tr>
<tr><td colspan="2">dermocybin and dermoglaucin absent</td><td>hesleri
californicus</td><td></td><td></td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="2">flavomannin-6.6'-dimethylether absent</td><td>with low intensities</td><td>with high intensities</td></tr>
<tr><td colspan="3"></td><td colspan="2">flavomannin-6.6'-dimethylether present</td></tr>
</table>

phological differences.

Of the taxa studied *Cortinarius aspenensis* revealed one of the most interesting pigment patterns. The most characteristic pigment being the dimeric compound flavomannin-6.6'-dimethylether, found with high intensities on the chromatograms. This pigment, which up to now has not been reported in red gilled Dermocybes with such high intensities, is the pigment most characteristic of species in section *Malicoriae* Mos. and in section *Dermocybe* (Fr.) Wünsche (Moser 1972, 1973, 1974a, 1974b, 1976; Steglich et al. 1972; Keller 1982). Since *C. aspenensis* shares important pigments with the section *Sanguineae sensu strictiori* and the species of section *Malicoriae* and section *Dermocybe*, it is considered to provide a phylogenetic connection between these groups. Considering its overall pigmentation a chemotaxonomic position between section *Sanguineae* and section *Malicoriae* is proposed for *C. aspenensis*.

Chromatographic examination of *Dermocybe semisanguinea* and *Cortinarius phoeniceus* var. *occidentalis* revealed that the same type of pigmentation is present in North American and European collections of these species. There is no significant difference between North American and European collections of *D. semisanguinea*. The pigment patterns of variation of *C. phoeniceus* var. *occidentalis* and its European counterpart *D. phoenicea* var. *phoenicea* are similar, however, somewhat larger amounts of dermocybin and dermoglaucin are present in *C. phoeniceus* var. *occidentalis*. This chemotaxonomic feature corroborates the morphological evidence. These taxa differ primarily in pileus color. *C. phoeniceus* var. *occidentalis* has a rich red to dark brilliant red pileus and the pileus color of *D. phoenicea* var. *phoenicea* ranges from reddish brown to reddish cinnamon-brown.

The pigment patterns of *Cortinarius californicus* and *C. hesleri* are similar but they differ by some quantitative and qualitative variation, indicating specific profiles in pigmentation. On the basis of their pigment patterns as well as their morphological affinities to *Dermocybe cinnabarina*, it is obvious that these species are related to the later taxon. The same conclusion is reached for *Dermocybe cramesina* Horak, ined., a species associated with *Nothofagus* (Fagaceae) and described from New Zealand, which shows morphological and chemotaxonomical affinities with *D. cinnabarina* (Horak, ined.; Keller, ined.). The close relationship between *C. californicus*, *C. hesleri*, *D. cinnabarina* and *D. cramesina* are apparent by their content of cinnalutein and/or cinnarubin. Up to now these pigments are known to occur only in the *Cinnabarinae*; they have not been observed in species such as *Dermocybe sanguinea* or *D. semisanguinea*. Therefore, the occurrence of these and their related compounds appear to be a useful chemotaxonomic criterion, on which to base a distinction between the *Cinnabarinae* and the *Sanguineae sensu strictiori*. *Cortinarius californicus* and *C. hesleri* are morphologically very close to *D. cinnabarina*, but they have different ecological requirements and grow in different geographical areas. *C. hesleri* amd *D. cinnabarina* are symbiotically associated with the Fagaceae. Ammirati & Smith (1983) report that *C. hesleri* fruits in eastern North American hardwoods and appears to be associated with *Quercus* L. *Dermocybe cinnabarina*, which grows in European hardwoods, is associated with *Fagus sylvatica* L. and *Quercus* (Moser 1972). A different mycorrhizal relation is found in *C. californicus*, which is associated with conifers (Pinaceae) and fruits along the Pacific coast and in the western mountainous regions of North America (Smith 1939, Ammirati and Smith 1983). This information regarding ecological requirements and geographical distribution of these three species corroborates the chemotaxonomic evidence. Examination of collections of *D. cinnabarina* reveals a rather basic and specific pigment pattern, whereas *C. hesleri* and especially *C. californicus*, have a more complex type of pigmentation. This indicates that both North American species probably evolved as a part of or parallel with *D. cinnabarina*. According to the chemotaxonomic resemblance of *C. hesleri*, *D. cinnabarina* and especially of *D. cramesina* the association with the Fagaceae might be considered as an ancient mycorrhizal relationship. In this respect it seems remarkable that *C. californicus* recruits different phanerogamic partners, which belong to the Pinaceae. Although there has been a change in partners by *C. californicus*, *C. hesleri* remains in association with the Fagaceae. This evidence clarifies the problem of a species complex, apparently produced by geographical and ecological isolation mechanisms, which could not be solved easily by conventional taxonomic methods alone, since there are no strong differences in morphological characters.

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REFERENCES

Ammirati, J. F. and A. H. Smith. 1984. A taxonomic study of Cortinarius, subgenus Dermocybe, section Sanguinei in North America (in prep.).

Gabriel, M. 1960a. Pigments des Cortinaires des Cinnamomei et Sanguinei. Bull. Soc. Myc. Fr. 76: 208-215.

Gabriel, M. 1960b. Deuxième contribution a la connaissance de la pigmentation des Cortinaires des groupes Sanguinei et Cinnamomei. Ann. Univ. Lyon 11-12: 67-76.

Gabriel, M. 1961. Troisième contribution à l'étude des pigments des groupes Sanguinei et Cinnamomei. Bull. Soc. Myc. Fr. 77: 262-272.

Gruber, I. 1970. Anthrachinonfarbstoffe in der Gattung Dermocybe und Versuch ihrer Auswertung für die Systematik. Zeitschr. Pilzk. 36: 95-112.

Gruber, I. 1975. Papierchromatographische Pigmentanalyse von südamerikanischen Dermocyben und Cortinarien. In: Moser, M. and Horak, E. 1975 Cortinarius Fr. und nahe verwandte Gattungen in Südamerika. Beihefte zur Nova Hedwigia 52: 524-540.

Keller, G. 1979. Chemotaxonomische Pigmentationsuntersuchungen in der Gattung Dermocybe (Fr.) Wünsche. Thesis. Innsbruck, Austria, 287 pp.

Keller, G. 1982. Pigmentationsuntersuchungen bei europäischen Arten aus der Gattung Dermocybe (Fr.) Wünsche. Sydowia 35: (in press).

Kögl, F. and J. Postowsky. 1925. Über die Farbstoffe des blutroten Hautkopfes (Dermocybe sanguinea Wulf.). Liebigs Ann. Chem. 444: 1-7.

Moser, M. 1972. Die Gattung Dermocybe (Fr.) Wünsche (Die Hautköpfe). Schweiz. Zeitschr. Pilzk. 50: 153-167.

Moser, M. 1973. Die Gattung Dermocybe (Fr) Wünsche

(Die Hautköpfe). Schweiz. Zeit. Pilzk. 51: 129-142.

Moser, M. 1974a. Die Gattung Dermocybe (Fr.) Wünsche. (Die Hautköpfe).
Schweiz. Zeit. Pilzk. 52: 97-108.

Moser, M. 1974b. Die Gattung Dermocybe (Fr.) Wünsche. (Die Hautköpfe). Schweiz. Zeit. Pilzk. 52: 129-142.

Moser, M. 1976. Die Gattung Dermocybe (Fr.) Wünsche. (Die Hautköpfe). Schweiz. Zeit. Pilzk. 54: 145-150.

Moser, M. 1978. Basidiomyceten II: Die Röhrlinge und Blätterpilze. In Gams Kleine Kryptogamenflora. Fischer, Stuttgart, p. 346.

Smith, A.H. 1939. Studies in the genus Cortinarius I. Cont. Univ. Mich. Herb. 2: 5-42 + 12 plt.

Steglich, W. and V. Austel. 1966. Die Struktur des Dermocybins und des Dermoglaucins. Tetrahedron Letters 26: 3077-3079.

Steglich, W., W. Lösel and V. Austel. 1969. Anthrachinonpigmente aus Dermocybe sanguinea (Wulf. ex Fr.) Wünsche und Dermocybe semisanguinea (Fr.) Mos.. Chem. Ber. 102: 4104-4118.

Steglich, W. and W. Lösel. 1972. Anthrachinonglucoside aus Dermocybe sanguinea (Wulf. ex Fr.) Wünsche. Chem. Ber. 105: 2928-2932.

Steglich, W. and W. Reininger. 1972. Anthrachinon-Pigmente aus Dermocybe cinnabarina (Fr.) Wünsche. Chem. Ber. 105: 2922-2927.

Steglich, W., E. Töpfer-Petersen, W. Reininger, K. Gluchoff, and N. Arpin. 1972. Isolation of flavomannin-6.6'-dimethylether and one of its racemates from higher fungi. Phytochemistry 11:3299-3304.

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NEW SPECIES OF LYOPHYLLUM (AGARICALES) FROM NORTH AMERICA AND A KEY TO THE KNOWN STAINING SPECIES.

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SUMMARY

The following new species of Lyophyllum (Agaricales, Basidiomycetes) are described from the United States of America: L.acutipes, biconicosporum, candidum, canescentipes, chamaeleon, chondrocephalum, conoideospermum, corrugatum, fistulosum, furfurellum, geminum var. geminum and var. olens, gracile, investitum, leptosarx, lubricum, luteogriseascens, lutescens, ochrocinerascens, pallidum, piceum, pusillum, rugulosum, scabrisporum, solidipes and stenosporum. They all stain on the gills when bruised, from yellow to brown or from grey or blue to blackish, but they do not form a natural group. No attempt has been made at this time to arrange these species into a natural system. An artificial key to the known staining species of Lyophyllum is given.

Of the numerous collections of Lyophyllum made mainly by A. H. Smith we studied the staining species first, because the genotype and the species of the type section are blackening when touched. Due to the type studies of staining species of Lyophyllum described in literature (Clémençon 1982) we are now able to present some of these collections as new species. It has become clear during this study that the sections Difformia, Tephrophana and Lyophyllum (Singer 1975) must be revised since we met several species that combine key characters of two or three of these sections. We refrain from proposing a new classification until all our collections of staining as well as non staining species will have been studied in sufficient detail.

Colour citations in quotation marks refer to Ridgway 1912.

KEY TO THE KNOWN STAINING SPECIES OF LYOPHYLLUM

The species described in this paper are marked by an asterisk. With figures A - R.

1. Spores punctuate-rough, finely warted or spiny.
 2. Habit tricholomatoid, pileus 3 - 10 cm broad. Spores cylindrical, 2.7-3.7 µm thick; wall warty; Figures A,B.
  3. Basidia 17-20 µm long. Gill edges even. Figure A.
  L. leucophaeatum (Karst.) Karst.

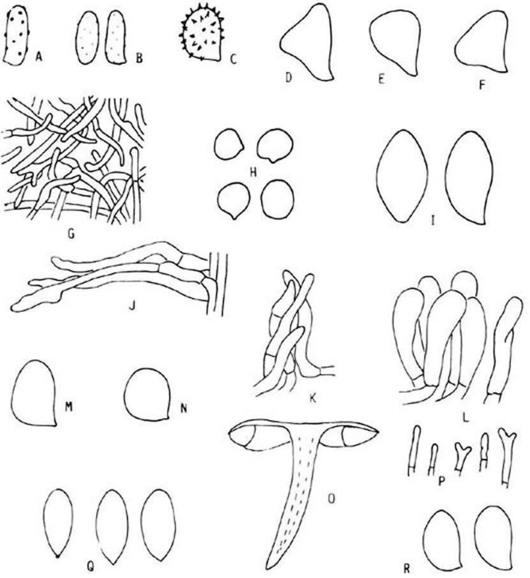
  3' Basidia 25-34 µm long. Gill edges eroded. Figure B.
  * L. scabrisporum Clç. & A.H. Smith

 2' Habit mycenoid, pileus 1-2.5 cm broad. Spores regularly ellipsoidal and thicker than 4,5 µm; Figure C.
 L. oldae (Svrcek) Clç.

1' Spores smooth.
 4. Spores with an enormous abaxial hump, looking more or less triangular in side view (Figures D,E,F). Habit tricholomatoid, often cespitose.
  5. Pileipellis a naked cutis of interwoven, straight or slightly curved, cylindrical hyphae.
   6. Spores with a hump located in the middle of the abaxial side, hump not thicker than the main body of the spore and not higher than the length of the spore. Spore resembles a short banana with a dorsal cone. Figure D. L. transforme (Britz.) Sing.

   6' Spores with a broad abaxial thickening near the top end making it widest near the apex. Spore resembles a fig with a flattened side. Figure E.
   L. sykosporum Hongo & Clç.

  5' Pileipellis at first finely felty, then compressed



Figures A - R used in the key. A: Lyophyllum leucophaeatum. B: L. scabrisporum. C: L. oldae. D: L. transforme. E: L. sykosporum. F: L. rhopalopodium. G: L. rhopalopodium, pileipellis. H: L. cossonianum. I: L. infumatum. J: L. furfurellum, hairs from the stipe. K: L. furfurellum, hairs from pileus. L: L. investitum, hairs form pileus. M: L. conoideospermum. N: L. amariusculum. O: Tapering stipe. P: L. fistulosum, hairs on pileus. Q: L. semitale. R: L. fuligineum.

into an irregular, dense layer impregnated with a brown, extracellular, resinous pigment cementing the intertwisted hyphae together (Figure G). Spores bearing an enormous cone in the middle of the abaxial side; cone often higher than the length of the spores (Figure F). L. rhopalopodium Clç.

4' Spores not triangular, but sometimes a moderate abaxial hump present.

7. Gills more or less lilac, very crowded. Odour strong, fruitlike but disagreeable. Spores irregularly subspherical, 3.7-5.2 x 3.0-4.5 µm, Q = 1.0-1.4 (Figure H). L. cossonianum (Mre.) Konr. & Maubl.

7' Gills, odour and spores different.

8. Spores under 6.5 µm long and under 3.7 µm thick.

9. Gills golden yellow to bright ochre-yellow.

10. Gills rapidly staining red then black when bruised. Pileus deep ochraceous or slate blue. Odour indistinct to fungoid.

11. Pileus greyish blue, stipe whitish.
L. favrei Haller & Haller

11' Pileus and stipe ochraceous to ochraceous-yellow.
L. ochraceum (Haller) Schwöbel & Reutter in Schwöbel

10' Gills staining grey, then black when bruised. Pileus whitish to pale brownish. Odour farinaceous-rancid. L. buxeum (Mre.) Konr. & Maubl.

9' Gills white, grey, buff, olive-umber.

12. Pileus dirty rose to fleshy pink, 3-4 cm broad.
L. musashiense Hongo

12' Pileus of a different colour.

13. Pileipellis gelatinous, cap surface smooth and shiny. L. tenebrosum Clç.

13' Pileipellis a dry tomentum, cap surface minutely felty.

14. Stipe 2-3 mm thick, pileus 10-20 mm broad, "olive brown" to "buffy brown".
* L. pusillum Clç. & A.H. Smith

14' Stipe and pileus bigger, whithish, grey, greyish brown.

15. Gills whithish or pale cream colour.

16. Spores 3.6-5.1 x 1.9-2.4 µm. Basidia 16-21 x 4-5 µm. * L. candidum Clç. & A.H. Smith

16' Spores 5.3-6.7 x 2.5-3.2 µm. Basidia 20-26 x 5-6 µm. L. fumescens (Peck) Clç.

15' Gills mouse grey to olive-umber.

17. Gills mouse grey. Stipe 3 - 5 mm thick. Odour none. Cystidia and marginal cells numerous and big. L. konradianum (Mre.) Konr. & Maubl.

17' Gills olive-umber. Stipe 6 - 8 mm thick. Odour acidulous. Cystidia and marginal cells absent. L. fragile J. Schäffer

8' Spores longer than 6.5 µm or thicker than 3.7 µm, or both.

18. Adaxial spore face rhomboidal. Supra-apicular plane or depression usually well developed (Figure I).

19. Gills staining bluish then black when bruised. Odour none or subfarinaceous.

20. Pileipellis a regular ixocutis 25-40 µm thick, hyphae 1-2 µm wide. Odour not distinct. Hyphae of the mediostratum of the gills 3-8 µm wide. L. infumatum (Bres.) Kühn.

20' Pileipellis not gelatinous except perhaps an outermost, subgelatinous layer 3-5 µm thick. Hyphae of the mediostratum of the gills 5-18 µm wide.

21. Odour distinctly subfarinaceous. Stipe 10-20 mm thick. Pileus surface uneven on the disk, areolate, rimose and slightly reticulate near the margin. Hyphae of the pileipellis 1-4 µm wide. * L. corrugatum Clç. & A.H. Smith

21' Odour not distinct. Stipe 8-10 mm thick. Pileus surface smooth. Hyphae of the pileipelleis 3 - 8 µm wide. * L. biconicosporum Clç. & A.H. Smith

19' Gills staining yellow or grey before black when bruised.

22. Pileus creamy white. Odour of green corn. Gills staining yellow then grey when bruised. * L. luteogriseascens Clç. & A.H. Smith

22' Pileus honey brown, smoky grey to fuliginous.

Gills directly staining grey when bruised.

23. Pileus bright honey coloured, darker innate radially fibrillous. Stipe below the gills covered with a dense, felty tomentum.
<u>L. macrosporum</u> Sing.

23' Pileus pale smoky grey fading to pallid, glabrous. Stipe below the gills covered with erect knots of intertwisted hyphae.
* <u>L. geminum</u> Clç. & A.H. Smith

24. Odour not distinct: * var. geminum
24' Odour of green corn: * var. olens

18' Adaxial spore face round to elliptic, with round or pointed base, but not rhomboidal.

25. Superficial hyphae of the stipe frequently agglutinated into massive, erect fascicules (Figure J). Pileipellis 30-60 µm thick, gelatinous, with erect, isolated, clustered or intertwisted hairs. Spores long ellipsoidal, 7.7-10.3 x 3.8-5.6 µm, Q = 1.6-2.5, with supra-apicular plane or depression.

26. Pileus densely covered with erect, complex knots of braided hyphae (Figure K).
* <u>L. furfurellum</u> Clç. & A.H. Smith

26' Pileus without such knots.

27. Pileipellis with a few scattered, cylindrical, short and inconspicuous hairs.
* <u>L. stenosporum</u> Clç. & A.H. Smith

27' Pileipellis with separated, dense clusters of small, repent to erect, contorted, clavate, irregular hairs with colourless or brown walls (Figure L). * <u>L. investitum</u> Clç. & A.H. Smith

25' Superficial hyphae if the stipe different; when arranged in erect groups or tufts, then not intertwisted and pileipellis not gelatinous.

28. Spores asymmetrically ovate in side view, thickest towards the apicular end, thinner at the apex (Figure M), dimensions in the range 6.2 - 8.7 x 4.3 - 5.9 µm, Q = 1.3-1.8. Pileipellis an ixocutis, 30 - 45 µm thick. Basidia 25 - 35 µm long. Pileus hygrophanous, margin striatulate when wet.

29. Odour distinctly of potatoes. Pileus dark fuli-

ginous except at the margin, fading to greyish brown, surface uneven, pitted.
* L. conoideospermum Clç. & A.H. Smith

29' Odour not distinct. Pileus very pale watery grey with pallid margin, pallid over all when faded. Surface smooth.
* L. pallidum Clç. & A.H. Smith

28' Spores of different shape, or basidia longer than 35 µm, of pileipellis different (i.e. ixocutis thicker than 45 µm, or pileipellis not gelatinous).

30. Stipe canescent over a pale blue-grey surface by long, cylindrical-wavy hairs; hollow. Basidia 36-40 x 7-8 µm. Ixocutis 60-80 µm thick. Odour strongly disagreeable rancid-farinaceous.
* L. canescentipes Clç. & A.H. Smith

30' Stipe different. Other combination of characters.

31. Odour spermatic, Inocybe-like. Pileus 1-2.5 cm broad, very cartilaginous. Spores short ellipsoidal without supra-apicular depression, 5.7 - 8.0 x 4.7 - 5.5 µm, Q = 1.2 - 1.6. Pileipellis gelatinous.
* L. chondrocephalum Clç. & A.H. Smith

31' Odour not spermatic. Pileus bigger.

32. Spores spherical to short ellipsoidal: all of the following criteria apply simultaneously to at least 90% of the spores of a preparation: Q = 1-1.45, difference between spore-length and thickness maximum 2 µm, supra-apicular depression absent. Figure N.

33. Gills short decurrent, pallid. Spores spherical to subglobose, 5.7-6.8 x 5.6-6.5 µm, Q = 1 - 1.1. Stipe hollow, enlarged below. Cespitose.
* L. ochrocinerascens Clç. & A.H. Smith

33' Gills adnate to adnexed or emarginate. When gills slightly decurrent, then stipe not hollow. Other combination of characters.

34. Stipe tapered below to a pointed and often subrooting base, stuffed, then hollow (Figure O). Odour farinaceous to rancid.

35. Gills dark grey, Pileus and stipe whithish to light greyish cream, base of stipe beco-

ming fuliginous. L. eustygium (Cooke) Clç.

35' Gills whitish to pallid greyish, staining blue when bruised. Pileus dark ochraceous, stipe whitish, ochraceous brown at the base. L. caerulescens Clç.

34' Stipe equal.

36. Pileus 1-4 cm broad. Odour of green corn. Stipe naked. * L. leptosarx Clç. & A.H. Smith

36' Pileus bigger or stipe not naked. Odour different or indistinct.

37. Basidia 27-31 x 6-8 µm. Pileipellis gelatinous.

38. Odour not distinct. Pileus smoky umber to blackish. L. laticeps (Kauffm.) Clç.

38' Odour farinaceus. Pileus pallid. L. helvella (Boud.) Clç.

37' Basidia 33-48 x 8-11 µm. Pileipellis not gelatinous.

39. Stipe tomentose under the gills, glabrescent. Odour rancid, disagreeable, taste bitterish. L.amariusculum Clç.

39' Stipe naked. Odour farinaceous, agreeable, taste not bitter at all. L. paelochroum Clç.

32' Spores elongate ellipsoidal, frequently asymmetrical: at least one of the following criteria applies to at least half of the spores of a preparation: either Q over 1.45, or difference between spore length and thickness over 2 µm, or spores with a supra-apicular depression.

40. Stipe naked, even under the gills. Odour farinaceous-rancid. Pileus 2.5-4 cm broad, hygrophanous, dark fuliginous, thin. Lamellae adnate, subdistant. Spores 6.5-8.7 x 3.5-5.3 µm, with rounded base, without supra-apicular depression (but frequently with supra-apicular plane). Basidia 27-33 µm long. Marginal cells hyphoid, 3-6 µm broad, scattered to rare.

41. Pileipellis not gelatinous, hyphae 2-4 µm

thick, smooth, hyaline, radially arranged, covered with a few interwoven hyphae 5-8 µm wide and with brown incrusting pigments and with numerous hyaline, smooth, contorted or ramified, erect, 2-3 µm broad hairs (Figure P). * <u>L. fistulosum</u> Clç. & A.H. Smith

41' Pileipellis gelatinous, superficial hyphae 2 to 3 µm broad and smooth; hairs rare, scattered, inconspicuous.
* <u>L. gracile</u> Clç. & A.H. Smith

40' Not all above characters simultaneously present. Stipe covered with some hairs or even a tomentum, at least below the gills.

42. Spores with a pointed apicular base (Figure Q), 6.7 - 9.3 x 3.3-5.0 µm, Q = 1.6-2.2. Cap margin translucent striate. Stipe hollow, pruinose at apex.

43. Pileipellis gelatinous, 20-30 µm thick, hyphae 0.5-2 µm broad, radially fasciculate. Gills dark grey-brown, pileus cinnamon-red-brown. Spores with two nuclei.
<u>L. subsimulans</u> (Karst.) Clç.

43' Gelatinous layer of the pileipellis absent or under 10 µm thick, hyphae 2-4 µm thick. Gills pallid or greyish, pileus fuliginous. Spores predominantly uninucleate.
<u>L. semitale</u> (Fr.) Kühn.

42' Other combination of characters. Spore base round.

44. Pileipellis not gelatinous.

45. Odour none. Basidia 23-30 µm long. Spores long ellipsoidal, Q = 1.7-2.3, without supra-apicular depression.
<u>L. ignobile</u> (Karst.) Clç.

45' Odour farinaceous or pungent. Basidia 29-45 µm long. Spores less elongate or with supra-apicular depression.

46. Odour farinaceous. Pileus dark brown. Hyphae of pileipellis 3 - 8 µm wide.

47. Basidia 37 - 45 x 5 - 7 µm. Spores long ellipsoidal with supra-apicular depression, Q = 1.7-2.3, difference between

length and thickness = 3 - 4.8 µm.
* L. chamaeleon Clç. & A.H. Smith

47' Basidia 29 - 35 x 7 - 9 µm. Spores less elongate, without depression, Q = 1.3 - 1.9, difference between length and thickness = 2-3.7 µm (Figure R).
L. fuligineum (Peck) Sing.

46' Odour earthy, pungent, disagreeable. Pileus whitish, smoky grey. Hyphae of the pileipellis 2-4 µm wide.
L. subnigricans (Peck) Bigelow

44' Pileipellis gelatinous.
48. Odour and taste not distinct.
49. Spores 6-7.7 x 3.4-4.7 µm.
* L. rugulosum Clç. & A.H. Smith

49' Spores 9-11.1 x 4.5-5.7 µm.
* L. piceum Clç. & A.H. Smith

48' Odour farinaceous.
50. Basidia 37-42 µm long. Hyphae of the pileipellis interwoven.
* L. lubricum Clç. & A.H. Smith

50' Basidia under 37 µm long.
51. Basidia 22 - 30 µm long. Stipe hollow. Gills staining yellow when bruised.
* L. lutescens Clç. & A.H. Smith

51' Basidia 29 - 36 µm long. Stipe solid. Gills staining grey and black when bruised.
52. Pileus with erect, cylindrical to slightly irregular hairs, 30-40 x 3-4 µm. * L. acutipes Clç. & A.H. Smith

52' Pileus without erect hairs.
* L. solidipes Clç. & A.H. Smith

DESCRIPTION OF THE NORTH AMERICAN NEW SPECIES

LYOPHYLLUM ACUTIPES spec. nov. (Figures 1,33)

Pileus 3-8 cm latus, convexus, glaber, lubricus, ad marginem incurvatus, cartilagineus, saepe leviter striatus, pallide fuligineus demum fuscus, hygrophanus, demum pallide griseus; caro tenuis, grisea, tactu nigrescens, cartilaginea, sapor farinaceus. Lamellae confertae, angustae, demum latae, adnatae demum adnexae, subgriseae demum atromaculatae. Stipes 5-8 cm longus, sursum 8-16 mm crassus, deorsum angustatus, solidus, albidus vel pallidus, impolitus, demum atromaculatus. Sporae 7.2-8.5 x 4.2-4.8 µm, Q = 1.6-2.4, inaequilaterales, uninucleatae vel binucleatae, inamyloideae, cyanophilae. Pileipellis gelatinosa, 35-45 µm crassa, hyphis fibulatis. Cheilocystidia nulla, basidia tetrasporigera, 29-35 x 7-8 µm, cum siderophilis granulis.
Hab.: Ad terram inter muscos.
Holotypus: A. H. Smith 19394 (MICH).

PILEUS 3-8 cm broad, convex with an incurved to inrolled margin, glabrous, lubricous, cartilaginous, margin even to very faintly striatulate, colour pale grey-brown becoming blackish, hygrophanous, fading to sordid pale grey where not blackened. CONTEXT thin but pliant and cartilaginous, darkening where bruised; odour farinaceous, taste slightly so. LAMELLAE close, 3 tiers of lamellulae, narrow but finally becoming broad in large caps (ca. 5-10 mm near stipe), tapered evenly from stipe to margin, adnate at first, finally adnexed, evenly pale putty colour (dingy grey) when young, black-spotted in age. STIPE 5-8 cm long, 8-16 mm thick at apex, narrowed downward to a pointed base, solid, surface evenly whitish (varying to greyish white), dry, unpolished (silky fibrillose under a lens), soon darkening where handled or bruised.

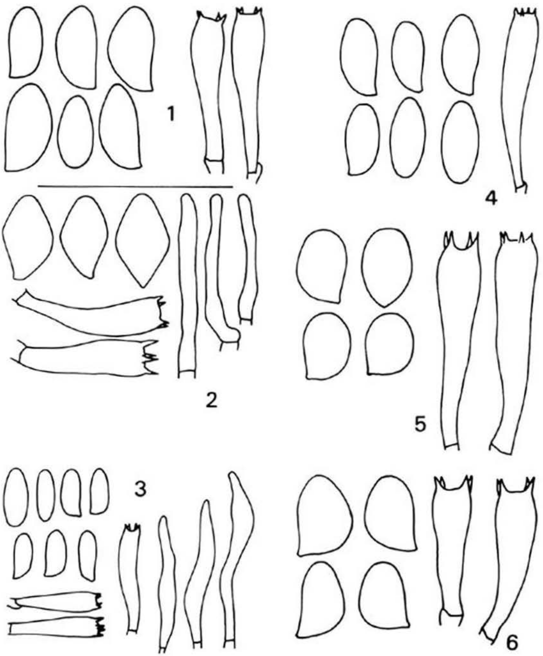
SPORES 7.2-8.5 x 4.2-4.8 µm, Q = 1.6 - 2.4, with one or two nuclei, long asymmetrically ellipsoidal to inequilateral in side view, with slight to marked supra-apicular depression, rounded diamond shaped with pointed base when immature, then ovoid, finally regularly elliptical at maturity in face view; wall smooth, inamyloid, strongly cyanophilous and siderophilous. BASIDIA 29-35 x 7-8 µm, 2-3.5 µm wide at the base, club-shaped, four-spored, with basal clamp; siderophilous granules abundant, round, 1/4 to 1/3 µm in diameter, not clumping. CYSTIDIA and marginal cells absent. PILEIPELLIS a gelatinized cutis, 35-45 µm

thick, hyphae interwoven on the disc, more or less radially arranged towards the margin, cylindrical, with clamps, 2-3 um thick, smooth; with some erect, cylindrical to slightly irregular, smooth, thin-walled, hyaline hairs measuring 30-40 x 3-4 µm. HYMENOPHORAL TRAMA regular, hyphae 4-10 µm thick, cylindrical, the thicker ones constricted at the septa, clamped, smooth, hyaline, cells 30-150 µm long; gloeoplerous hyphae frequent, 3-7 µm thick. SUBHYMENIUM indistinct. STIPITEPELLIS a regular, non gelatinized cutis of parallel, clamped, smooth, cylindrical, hyaline, 2-5 µm thick hyphae covered by a thin and loose tomentum of similar hyphae beneath the gills. BASAL TOMENTUM of the stipe with cylindrical, smooth, clamped, yellowish, 3-5 µm thick hyphae.
HABITAT: Gregarious in moss under Pinus monticola and P. contorta.
HOLOTYPE: Lyophyllum acutipes Clç. & A. H. Smith, leg. A. H. Smith 19394 (MICH), East Fork, Salmon River, Mt.Hood, Oregon USA. ISOTYPE in LAU.

LYOPHYLLUM BICONICOSPORUM spec. nov. (Figure 2)

Pileus 3-6 cm latus, convexus, ad marginem involutus, demum late convexus vel planus, glaber, subviscidus, pallidus in siccati sordide brunneus. Caro tenuis, flexilis, pallida, tactu fusca; odor et sapor mites. Lamellae subdistantes, adnatae, pallidae, tactu griseo-caeruleae. Stipes 3-5 cm longus, 8-10 mm crassus, glaber vel sursum furfuraceus, pallidus. Sporae 8.4-10.1 x 4.6-6.5 µm, Q = 1.5 - 1.9, laeves, inamyloideae, cyanophilae, uninucleatae, biconicae. Basidia 24-31 x 7-9 µm, tetrasporigera, cum siderophilis granulis. Cheilocystidia rara, plus minusve cylindracea, 24-38 x 1.5-4 µm. Subhymenium subgelatinosum. Pileipellis sicca vel subgelatinosa, hyphis intertextis fibulatis.
Hab.: ad terram in silvis frondosis.
Holotypus: A. H. Smith 32792 (MICH).

PILEUS 3-6 cm broad, convex with an inrolled margin, expanding to plane or nearly so; surface naked and lubricous, pallid (known only in faded condition) drying a dingy brown. CONTEXT thin, pliant, pallid, darkening when bruised; odour and taste not distinct. LAMELLAE moderately broad, subdistant, bluntly adnate or with a decurrent tooth, pallid but readily staining bluish grey. STEM 3-5 cm long, 8-10 mm thick at apex, enlarged downward, naked or



Figures 1-6: Spores (2000:1), basidia and marginal cells (1000:1). 1: Lyophyllum acutipes. 2: L. biconicosporum. 3: L. candidum. 4: L. chamaeleon. 5: L. chondrocephalum. 6: L. conoideospermum.

faintly scurfy near apex, pallid over all.

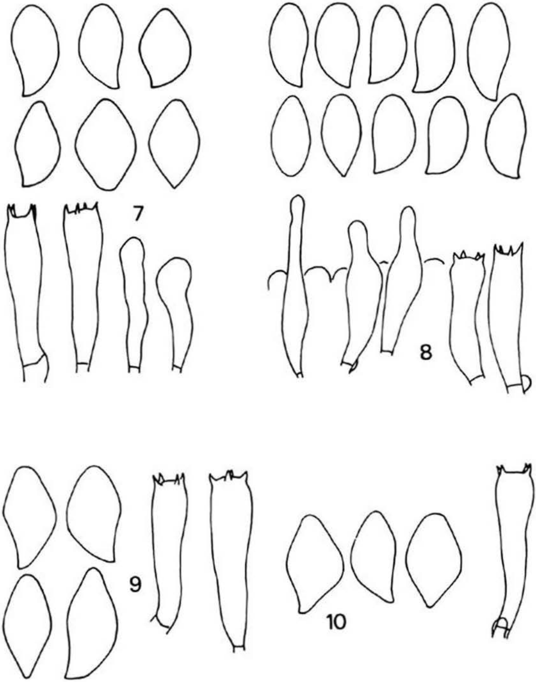
SPORES 8.4 - 10.1 x 4.6-6.5 µm, Q = 1.5 - 1.9, biconical, rhomboidal diamond shaped in face view, rhomboidal with supra-apicular plane in side view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 24-31 x 7-9 µm, 3-4 µm wide at the base, four-spored, clamped; siderophilous granules abundant, 1/4 to 1/2 µm, round, not clumping. MARGINAL CELLS scatterd, single to fasciculate, hyphoid, irregularly cylindrical, 24-38 x 1.5-4 µm, projecting 10-20 µm, smooth, hyaline. HYMENOPHORAL TRAMA regular, subregular towards the edge; hyphae 5-18 µm broad, with short cells, inflated, clamped, smooth, hyaline, with gloeoplerous hyphae. SUBHYMENIUM about 10 µm thick, subgelatinized; hyphae 2-4 µm broad, interwoven. PILEIPELLIS not gelatinized except outermost layer which is 3-5 µm thick, with scattered, cylindrical, short, erect hairs; hyphae completely interwoven on the disc, interwoven with radial tendency elsewhere, cylindrical without or with slight constriction at the septa, clamped, smooth, hyaline, 3-8 µm broad. STIPITEPELLIS a regular cutis, not gelatinized; hyphae cylindrical or slightly constricted at the septa, clamped, smooth, 3-5 µm thick; bearing single hairs similar to the marginal cells. Hyphae of the BASAL TOMENTUM fasciculate, smooth, hyaline, clamped, cylindrical, 2-3 µm broad.

HABITAT: Single on humus under hardwoods.

HOLOTYPE: Lyophyllum biconicosporum Clç. & A. H. Smith, leg. A. H. Smith, 30. Jul. 1949, Mackinaw City hardwoods, Michigan USA (AHS 32792, MICH).

LYOPHYLLUM CANDIDUM spec. nov. (Figure 3)

Pileus 2-4 cm latus, convexus, ad marginem involutus, demum late convexus vel subplanus, siccus, impolitus, candidus demum subcinereus, tactu subfuscus. Caro pallida vel grisea, firma sed fragilis, inodora; sapor subnauseosus (non farinaceus). Lamellae angustae, adnatae vel adnexae, confertae, luteogriseae, tactu nigrescentes. Stipes 3-6 cm longus, 4-7 mm crassus, aequalis, solidus, albidus, demum luteogriseus deinde atromaculatus, impolitus, deorsum albostrigosus. Sporae 3.6-5.1 x 1.9-2.4 µm, Q = 1.7-2.4, cylindraceae vel ellipsoideae, inamyloideae, cyanophilae, laeves, uninucleatae. Basidia 16-21 x 4-5 µm, tetrasporigera, cum granulis siderophilis, pleuroystidia et cheilocystidia 29-36 x 2-5 µm, anguste fusiformia. Pileipellis sicca, 40-60 µm crassa, hyphis intertextis, fibulatis.



Figures 7-10: Spores (2000:1), basidia and marginal cells (1000:1). 7: *Lyophyllum corrugatum* . 8: *L. furfurellum*. 9: *L. geminum* var. *geminum*. 10: *L. geminum* var. *olens*.

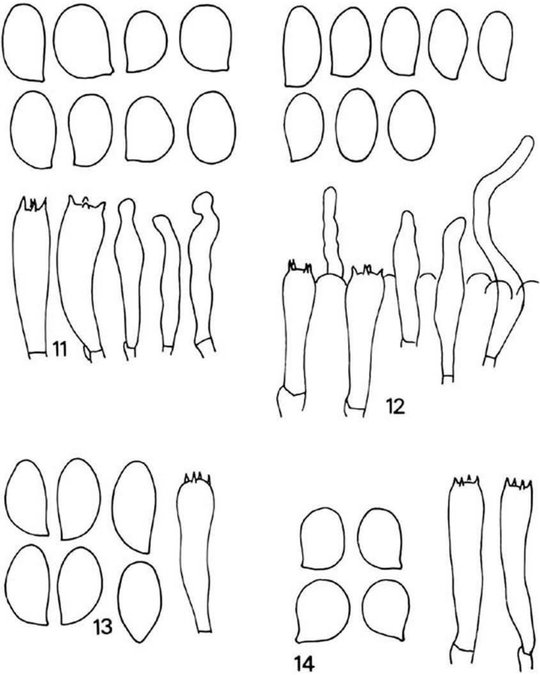
Hab.: Ad terram in locis humidis, caespitosum.
Holotypus: A. H. Smith 63931 (MICH).

PILEUS 2-4 cm broad, convex with an inrolled margin, expanding to broadly convex or more or less plane; surface dry and unpolished, snow-white becoming pallid to greyish and soon stained "hair brown" to blackish where bruised, opaque at all times. CONTEXT pallid to greyish, firm but brittle; odour none; taste slightly disagreeable but not farinaceous. LAMELLAE narrow, adnate, adnexed, crowded, pallid yellowish grey from beginning and staining blackish in age, edges even. STIPE 3-6 cm long, 4-7 mm thick, equal, solid, white and becoming yellowish grey and then blackish like the pileus, unpolished over all to the white strigose base and with copious white mycelial strands surrounding debris. Ferrous sulphate blue-green on the pileus and on the gills, but not in the context, no reaction with KOH.

SPORES cylindrical to long ellipsoidal, 3.6-5.1 x 1.9-2.4 µm, Q = 1.7 - 2.4, uninucleate; wall smooth, cyanophilous and siderophilous, inamyloid. BASIDIA four-spored, 16-21 x 4-5 µm, 1.5-2.5 µm wide at the base, with clamp connection and abundant siderophilous granules. PLEUROCYSTIDIA and MARGINAL CELLS numerous, long fusiform to irregular, thin walled, colourless, unicellular, 29-36 x 2-5 µm, projecting beyond the level of the basidia. HYMENOPHORAL TRAMA subregular, hyphae cylindrical, 2-5 µm thick, hyphal cells 20-40 µm long, with clamps, smooth; gloeoplerous hyphae rare. SUBHYMENIUM indistinct. PILEIPELLIS a dense, aeriferous, 40-60 µm thick cutis composed of cylindrical, 2-4.5 µm thick hyphae with clamp connections and smooth, colourless walls, interwoven over the whole surface of the cap. STIPITEPELLIS below the gills similar to the covering layer of the pileus. Deeper hyphae cylindrical, parallel, with clamps, smooth, 2-4 µm thick. Hyphae of the BASAL TOMENTUM of the stipe 1-2.5 µm thick, thin to moderately thick walled, cylindrical, smooth, colourless, clamped.
HABITAT: Cespitose-gregarious in a Thuja-swamp.
HOLOTYPE: Lyophyllum candidum Clç. & A. H. Smith, leg. Virginia Charleton Aug. 17, 1961, Garden Peninsula, Lake Michigan, Michigan, USA (= A.H. Smith 63931, MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM CANESCENTIPES spec. nov. (Figures 21,29)

Pileus 4-10 cm latus, convexus, demum planus, glaber, fuliginosus, demum sordide griseus, udus leviter striatus,

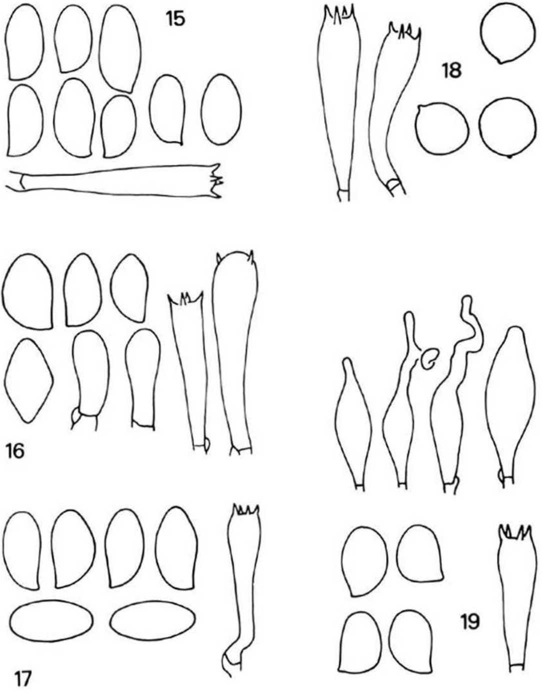


Figures 11-14: Spores (2000:1), basidia and marginal cells (1000:1). 11: *Lyophyllum fistulosum.* 12: *L. gracile.* 13: *L. investitum.* 14: *L. leptosarx.*

tactu griseo-caeruleus demum atratus. Odor valde subfarinaceus vel subrancidus. Lamellae pallide griseae, adnatae, latae, confertae vel subdistantes. Stipes 4-8 cm longus, 5-11 mm crassus, deorsum albo-myceliosus. Sporae in cumulo albae, 6.9-9.1 x 4.7-6.4 µm, Q = 1.3-1.6, breviter ellipsoideae, inamyloideae, cyanophilae. Basidia 36-40 x 7-8 µm, tetrasporigera, cum siderophilis granulis. Cystidia nulla. Pileipellis gelatinosa, 60-80 µm crassa, hyphis fibulatis, intertextis.
Hab.: Ad terram, ceaspitosum.
Holotypus: A. H. Smith 82764 (MICH).

PILEUS 4-10 cm broad, convex becoming plane, margin finally spreading; surface glabrous and naked, dark fuliginous with faintly striate margin when wet, dirty gray with opake margin when dry, staining bluish grey to black immediately when broken. ODOUR and TASTE strongly disagreeable farinaceous, more or less rancid. LAMELLAE pale grey, adnate, moderately broad, close to subdistant, edges even to undulating. STIPE 4-8 cm long, 5-11 mm thick, equal, hollow, canescent over a pale blue-grey surface, scarcely darkening below, base white-mycelioid. SPORE DEPOSIT white.

SPORES 6.9-9.1 x 4.7-6.4 µm, Q = 1.3-1.6, short asymmetrically ellipsoid without supra-apicular depression, mostly uninucleate, more rarely binucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 36-40 x 7-8 µm, 2.5-3.5 µm wide at the base, four-spored, clamped; siderophilous granules abundant, fine, 1/4 to 1/2 µm, round, not clumping. CYSTIDIA and marginal cells absent. HYMENOPHORAL TRAMA regular; hyphae 5-12 µm wide in the mediostratum, inflated, colourless, smooth, clamped; some gloeoplerous hyphae present but rare. SUBHYMENIUM indistinct, not gelatinized; dense, 10-12 µm thick. PILEIPELLIS 60-80 µm thick, gelatinized; uppermost hyphae scattered to fasciculate, interwoven on the disc, more radially arranged towards the margin, cylindrical, clamped, smooth or with fine to extended brown incrustations, 1-3 µm wide; deeper hyphae predominantly radially arranged, mostly smooth and colourless, 2-5 µm wide. STIPITEPELLIS a regular cutis; hyphae parallel, cylindrical, clamped, 2-6 µm wide, wall smooth, hyaline to faintly yellowish, tomentum from below the gills consisting of intervowen, long filamentous, cylindrical to undulating hyphae 2-4 µm wide with homogenous, hyaline content. Hyphae of the BASAL TOMENTUM fasciculate, cylindrical or slightly irregular, 2-4 µm wide, clamped, wall smooth, thin or moderately thick, hyaline.
HABITAT: Clustered-gregarious in masses, on soil.



Figures 15-19: Spores (2000:1), basidia and marginal cells (1000:1). 15: Lyophyllum lubricum. 16: L. luteogriseascens. 17: L. lutescens. 18: L. ochrocinerascens. 19: L. pallidum.

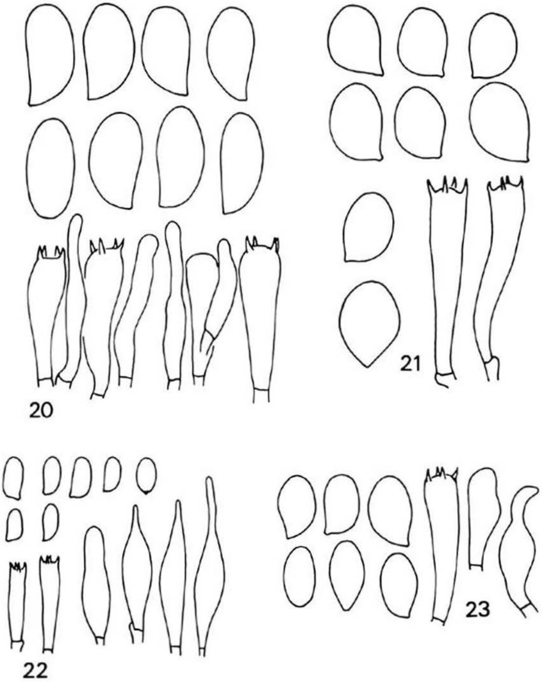
HOLOTYPE: Lyophyllum canescentipes Clç. & A. H. Smith, leg. A. H. Smith 82764, Upper Priest Lake, Bonner County, Idaho, USA, Oct. 10, 1972 (MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM CHAMAELEON spec. nov. (Figures 4,30,35)

Pileus 3 - 4.5 cm latus, late convexus, ad marginem involutus, glaber, udus, hygrophanus, atrobrunneus demum olivaceo-brunneus vel pallidior, haud striatus, cartilagineus. Caro pallide cinerea, tactu tarde grisea demum subfusca. Sapor farinaceus. Lamellae pallidae demum grisea, adnato-subdecurrentes, confertae, angustae, tactu luteolae dein sordide subcaeruleae. Stipes 6-10 cm longus, 10-15 mm crassus, subaequalis vel deorsum attenuatus, albocinereus, subfibrillosus, longe striatus, tactu sordide griseus. Sporae 7.1-8.8 x 3.5-4.4 µm, Q = 1.7 - 2.3, ellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia tetrasporigera, 37-45 x 5-7 µm, cum granulis siderophilis. Cystidia nulla. Pileipellis 50-70 µm crassa, leviter subgelatinosa, hyphis fibulatis intertextis.
Hab.: Ad terram, caespitosum.
Holotypus: A. H. Smith 24303 (MICH).

PILEUS 3-4.5 cm broad, obtuse to broadly convex with inrolled margin, glabrous, moist, margin slightly pubescent at first, hygrophanous, near "mummy brown" to "clove brown" when moist, slowly fading to near "olive brown" or greyer, not striate, rigid-cartilaginous because of thick cuticle; cuticle concolourous with surface. CONTEXT pallid greyish, slowly staining grey or darker when cut; odour and taste farinaceous. LAMELLAE pale when young, "drab" near maturity, broadly adnate - subdecurrent, close, narrow, with slightly uneven edges, staining yellowish and then bluish. STIPE 6-10 cm long, 10-15 mm thick, nearly equal, some narrowed downward, stuffed, cortex greyish, pith pallid, surface whitish grey, silky fibrillous to unpolished, more or less longitudinally striate from many fibrils of the separating pileipellis, soon dingy grey where handled.

SPORES 7.1-8.8 x 3.5-4.4 µm, Q = 1.7 - 2.3, ellipsoidal with supra-apicular plane or depression in side view, ellipsoidal in face view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA clavate, slender, 37-45 x 5-7 µm, 2-3 µm at the base, four-spored, clamped; siderophilous granules numerous, fine, 1/5 to 1/3 µm, round, not clumping. CYSTIDIA and MARGINAL CELLS absent. HYMENOPHORAL TRAMA subregular and slightly diver-



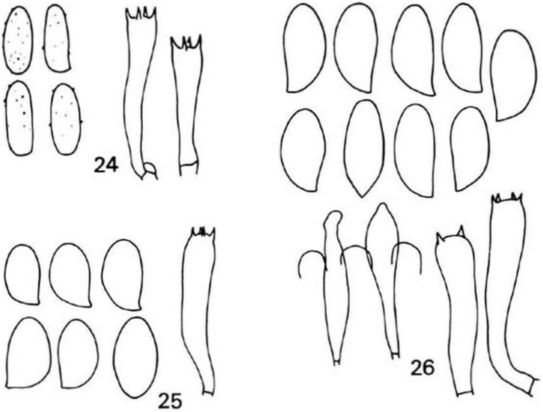
Figures 20-23: Spores (2000:1), basidia and marginal cells (1000:1). 20: Lyophyllum piceum. 21: L. canescentipes. 22: L. pusillum. 23: L. rugulosum.

gent when young, subregular at maturity; hyphae 3-7 µm broad, cylindrical with slight constrictions at the septa, clamped, smooth, hyaline; gloeoplerous hyphae locally abundant, tortuous, 3-7 µm broad; trama with a few cristal masses. SUBHYMENIUM dense, 10-15 µm thick. PILEIPELLIS 50-70 µm thick, dense, very slightly subgelatinized in the uppermost layer, grading evenly into the pileus trama but distinct by its very numerous gloeoplerous hyphae; surface hyphae intervowen on the disc, less so towards the margin where they occurr frequently in interwoven to irregularly radially arranged bundles, cylindrical, smooth, hyaline, clamped, 3-6 µm broad. STIPITEPELLIS below the gills a regular cutis of parallel, cylindrical, smooth, hyaline, clamped hyphae 3-6 µm broad, covered with numerous hyaline, irregularly contorted, smooth, erect cells measuring 30-80 x 3-6 µm and locally forming dense tufts. Hyphae of the BASAL TOMENTUM of the stipe 2.5-4 µm broad, moderately thick-walled, smooth, cylindrical, clamped, tomentose or fasciculate.
HABITAT: Cespitose under Pinus. All young specimens.
HOLOTYPE: Lyophyllum chamaeleon Clç. & A. H. Smith, leg. A. H. Smith 24303, Frog Lake, Mt. Hood, Mt. Hood National Forest, Oregon, USA, Oct. 8. 1946 (MICH). ISOTYPES in MICH et LAU.

LYOPHYLLUM CHONDROCEPHALUM spec. nov. (Figures 5,27,28,34)

Pileus 1 - 2.5 cm latus, convexus, ad marginem involutus, glaber, udus, fuligineus vel atrofuligineus demum sordide luteo-griseus. Caro tenuis, lenta, cartilaginea, fuliginosa demum pallida, tactu plus minusve nigrescens; sapor nauseosus. Lamellae griseae, glaucae, latae, subdistantes, plus minusve adnatae, tactu nigrescentes. Stipes 2-3 cm longus, 4-8 mm crassus, deorsum incrassatus, saepe compressus, cavus, intus griseus, tactu nigrescens; tenuiter fibrillosus; fibrillis griseis. Sporae 5.7-8.0 x 4.7-5.5 µm, Q = 1.2-1.5, subellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia 39-46 x 9-10 µm, tetrasporigera, cum granulis siderophilis. Cystidia nulla. Pileipellis gelatinosa, 25-35 µm crassa, hyphis intertextis, fibulatis.
Hab.: Ad terram, caespitosum.
Holotypus: A. H. Smith 30719 (MICH).

PILEUS 1-2.5 cm broad, convex with inrolled margin, surface glabrous and moist, dark fuliginous to blackish when moist, hygrophanous, fading to dingy yellowish grey from



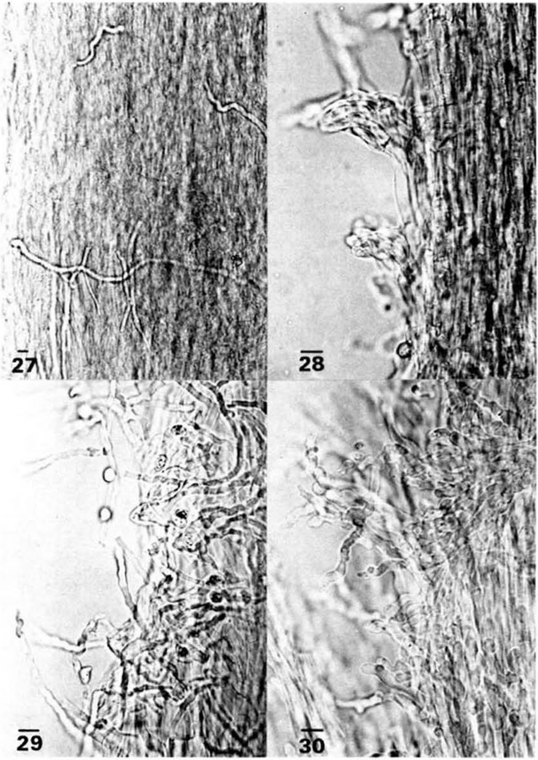
Figures 24-26: Spores (2000:1), basidia and marginal cells (1000:1). 24: Lyophyllum scabrisporum. 25: L. solidipes. 26: L. stenosporum.

disc outward; cuticle very cartilaginous, evenly fuliginous throughout, fading to pallid and then blackening where cut or bruised. CONTEXT thin and pliant; odour spermatic, Inocybe-like; taste disagreeable. LAMELLAE "drab" or nearly so when young, glaucous, broad, subdistant, somewhat adnexed, blackening where bruised, subdistant, edges even. STIPE 2-3 cm long, 4-8 mm thick at the apex, enlarged downward, often compressed, hollow, greyish and fibrillose within, cortex fuliginous and blackening, surface concolourous with or paler than the pileus, with a thin coating of greyish silky fibrils giving it a canescent subpruinose appearance at first, naked in age.

SPORES 5.7-8.0 x 4.7-5.5 µm, Q = 1.2 - 1.5, short cylindrical to short ellipsoidal, without supra-apicular depression, but frequently with a supra-apicular plane, uninucleate; wall smooth, inamyloid, strongly cyanophilous and siderophilous. BASIDIA 39-46 x 9-10 µm, 3-4 µm wide at the base, club-shaped, clamped, four-spored, incrusted with a thin, brown resinous matter through which the sterigmata emerge; siderophilous granules abundant, fine, not clumping. CYSTIDIA and marginal cells absent. HYMENOPHORAL TRAMA dense, subregular and slightly divergent when young, subregular in age, becoming bidirectional towards the edge, with masses of colourless cristals embedded between the hyphae; hyphae 3-10 µm thick, cylindrical, smooth, hyaline, clamped; some gloeoplerous hyphae present but indistinct. SUBHYMENIUM dense, about 15 µm thick. PILEIPELLIS a 25-35 µm thick ixocutis with more or less radially arranged or locally interwoven hyphae or hyphal fascicules in a dense but colourless gelatinous matrix; hyphae thin-walled, smooth or finely incrusted with a brown pigment, cylindrical, 3-5 um thick, with clamp connections; with a few short, erect, peg-like cells at the cap surface. PILEITRAMA subregular with more or less radially arranged, 3-8 µm thick, hyaline, smooth, clamped hyphae; some gloeoplerous hyphae present. STIPITEPELLIS below the gills composed of smooth, hyaline, cylindrical, 4-5 µm thick, parallel hyphae with clamps; not gelatinized; covered with numerous erect hyphae of the same type. BASAL TOMENTUM of the stipe consisting of cylindrical, moderately thick-walled, smooth to finely roughened hyphae with a pale ochre intraparietal pigment and prominent clamps.

HABITAT: Cespitose along an old road on soil.

HOLOTYPE: Lyophyllum chondrocephalum Clç. & A. H. Smith, leg. A. H. Smith 30719, Mt. Rainier National Park, Oregon, USA, Aug. 28, 1948 (MICH). ISOTYPE in LAU.



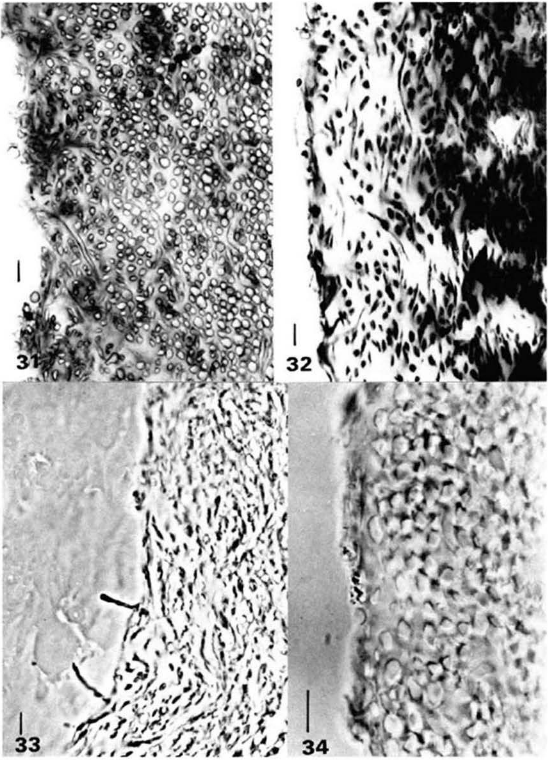
Figures 27-30: Stipe surfaces. Bar = 10 µm. 27,28: L. chondrocephalum, 27: gloeoplerous hyphae, 28: fascicules of hairs below the gills. 29: L. canescentipes, hairs below the gills. 30: L. chamaeleon, hairs below the gills.

LYOPHYLLUM CONOIDEOSPERMUM spec. nov. (Figure 6)

Pileus plus minusve 9 cm latus, ad marginem involutus, ad centrum late depressus, glaber, ad marginem aquose griseus, leviter striatus, hygrophanus, fuligineus, demum sordide griseo-brunneus. Caro tenuis, grisea, cartilaginea, tactu griseo-caerulea, dein atrata; odor subfragrans. Lamellae latae (plus minusve 10 mm), adnatae, subdecurrentes, pallide griseae, tactu nigrescentes. Stipes 13 cm longus, 15 mm crassus, interne griseus, externe pallide griseus, glaber, striatus. Sporae 7.0-8.7 x 4.3-5.9 µm, Q = 1.3-1.8, laeves, inamyloideae, cyanophilae, uninucleatae, inaequilaterales. Basidia tetrasporigera, cum siderophilis granulis, 26-33 x 8-9 µm. Cheilocystidia nulla. Subhymenium haud gelatinosum. Pileipellis gelatinosa, 35-45 µm crassa, hyphis intertextis fibulatis.
Hab.: caespitosum, ad terram.
Holotypus: A. H. Smith 19816 (MICH).

PILEUS 9 cm broad , with a slightly depressed disc, with margin arched and edge inrolled, glabrous, moist, with a cartilaginous feel; the margin watery grey and very faintly striate; hygrophanous, dark fuliginous except at the margin, fading to sordid greyish brown; surface uneven, pitted and with a depressed zone. CONTEXT thin, grey, cartilaginous, changing to bluish grey and blackish when cut or bruised; odour distinctly of potatoes; taste slightly disagreeable to mild. LAMELLAE broadly adnate to subdecurrent, broad (about 10 mm), broadest in the middle and tapering both ways, pale drab, staining blackish, moderately close, 3 tiers of lamellulae, edges even and staining blackish. STIPE 13 cm long, 15 mm thick, nearly equal, stuffed with a fibrous pith, greyish within, surface pale grey, glabrous or long-striate.

SPORES 7.0 - 8.7 x 4.3 - 5.9 µm, Q = 1.3 - 1.8, ovate to ellipsoidal in face view, broadly inequilateral with supra-apicular plane in side view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 26-33 x 8-9 µm, 2.5-4 µm wide at the base, four-spored, clamped; siderophilous granules abundant, round, 1/4 to 1/2 µm, not clumping. MARGINAL CELLS absent. HYMENOPHORAL TRAMA subregular; hyphae cylindrical to inflated, with short cells, clamped, smooth, hyaline, 6-15 µm broad, without gloeoplerous hyphae. SUBHYMENIUM about 10 µm thick, not gelatinized; hyphae interwoven, 1-3 µm broad. PILEIPELLIS a 35-45 µm thick, gelatinized cutis grading evenly into the



Figures 31-34: Pileipelles, transverse sections perpendicular to the radius of the pileus. Bar = 10 µm. 31: *L. ochrocinerascens.* 32: *L. solidipes.* 33: *L. acutipes.* 34: *L. chondrocephalum.*

pileus context, without hairs, but with a few rudimentary, short, peglike cells; hyphae interwoven over all of the cap surface, single or rarely in small bundles, clamped, cylindrical or slightly inflated, smooth or with a few low incrustations, 2-6 µm broad. STIPITEPELLIS a regular cutis, not gelatinized; hyphae 2-4 µm broad, cylindrical or slightly inflated, clamped, smooth, hyaline. Hairs under the gills rare, short, inconspicuous, irregularly cylindrical or clavate, hyphal ends mostly repent. Hyphae of the BASAL TOMENTUM 3-6 µm wide, cylindrical, clamped, fasciculate; wall smooth, hyaline to brownish.
HABITAT: Single to gregarious on humus.
HOLOTYPE: Lyophyllum conoideospermum Clç. & A. H. Smith, leg. Wm. Gruber and A. H. Smith, 16. Oct. 1944, Warm Springs Area on Skyline Road, Mt. Hood National Forest, Oregon, USA (AHS 19816, MICH).

LYOPHYLLUM CORRUGATUM spec. nov. (Figure 7)

Pileus 5-9 cm latus, late convexus, demum plus minusve planus, glaber, pallide olivaceo-griseus, demum subalbidus, ad centrum subreticulatus, ad marginem areolatus, demum rimosus. Caro albida, subcrassa, tarde caeruleo-grisea vel atrata; odor subfarinaceus, sapor mitis. Lamellae latae (plus minusve 1 cm), late adnatae vel leviter decurrentes, subdistantes, subalbidae, tactu griseae demum nigrescentes. Stipes 3-4 cm longus, 1-2 cm crassus, aequalis vel bulbosus, subalbidus, impolitus, solidus, tactu tarde atratus. Sporae 7.6-9.8 x 4.4-5.7 µm, Q = 1.5-2.0, latae inaequilaterales, uninucleatae, inamyloideae, cyanophilae. Basidia 28-34 x 7-9 µm, tetrasporigera, cum granulis siderophilis. Pleurocystidia nulla, cheilocystidia inconspicua. Pileipellis subgelatinosa, hyphis fibulatis.
Hab.: Ad terram, subcaespitosum.
Holotypus: A. H. Smith 15151 (MICH).

PILEUS 5-9 cm broad, broadly convex, often irregular in outline, becoming flat, or the margin slightly uplifted; surface glabrous, uneven to slightly reticulate on disc, areolate or rimose near the margin, slightly lubricous and "pale olive buff" when moist, hygrophanous, fading to whitish; with age staining blackish along the edge and on the disc. CONTEXT white, moderately thick, tapering evenly to the margin, slowly changing to bluish grey or finally black; odour distinctly subfarinaceous; taste mild. LAMELLAE broad (ca. 1 cm), broadly adnate to slightly decurrent,

Figure 35: *Lyophyllumm chamaeleon,* holotype, AHS 24303.
Photo A.H. Smith.

subdistant, 1-3 tiers of lamellulae, whitish, staining grey to blackish, edges uneven to eroded. STIPE 3-4 cm long, 1-2 cm thick, equal or bulbous, whitish, unpolished, solid, slowly blackening where bruised.

SPORES 7.6-9.8 x 4.4-5.7 µm, Q = 1.5 - 2.0, broadly inequilateral with well marked supra-apicular depression or plane in side view, diamond shaped in face view, uninucleate; wall smooth, inamyloid, strongly cyanophilous and siderophilous. BASIDIA 28-34 x 7-9 µm, 3-5.5 µm wide at the base, club-shaped, four-spored, clamped; siderophilous granules abundant, fine, 1/5 to 1/3 µm, round, not clumping. CYSTIDIA lacking. MARGINAL CELLS numerous but inconspicuous, not projecting, irregularly club-shaped to cylindrical, hyaline, 19-30 x 4-7 µm. HYMENOPHORAL TRAMA regular, becoming bidirectional towards the edge; hyphae cylindrical to long fusoid, the broader ones constricted at the septa, smooth, colourless, with clamp connections; gloeopleerous hyphae present. SUBHYMENIUM dense, not gelatinized, indistinct, 5-10 µm thick. PILEIPELLIS subgelatinized, composed of single, interwoven hyphae or anastomosing and ramifying fascicules of smooth, cylindrical, colourless, 14 µm thick hyphae with clamps (some septa seem to be clampless, but clamps are difficult to see in the type material); with numerous erect, cylindrical or irregular hyphal ends projecting up to 25 µm above the cap surface. STIPITEPELLIS a dry cutis of parallel, cylindrical, thin-walled, 3-5 µm thick hyphae with clamps, bearing below the gills a few isolated or fasciculate, cylindrical to slightly irregular, erect or semi-erect, peg-like or filamentous, 3-10 µm long, unicellular hairs. Hyphae of the BASAL TOMENTUM of the stipe smooth, 3-5 µm thick, cylindrical, clamped; wall moderately thick and hyaline.
HABITAT: Subcespitose on humus.
HOLOTYPE: L. corrugatum Clç. & A. H. Smith, leg. A. H. Smith 15151, Silver Lake, Washtenaw County, Michigan, USA, June 28, 1940 (MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM FISTULOSUM spec. nov. (Figure 11)

Pileus 2.5 - 4 cm latus, convexus demum ad centrum depressus, ad marginem undulatus, glaber, hygrophanus, fuliginosus, demum sordide brunneus, ad marginum opacus. Caro tenuis, cartilaginea, aquose fuliginosa, tarde atrata; odor et sapor nauseosi, subfarinacei. Lamellae latae, adnatae, subdistantes, dilute griseae, tactu nigrescentes. Stipes 2-5 cm longus, 4-10 mm crassus, cavus, undulatus,

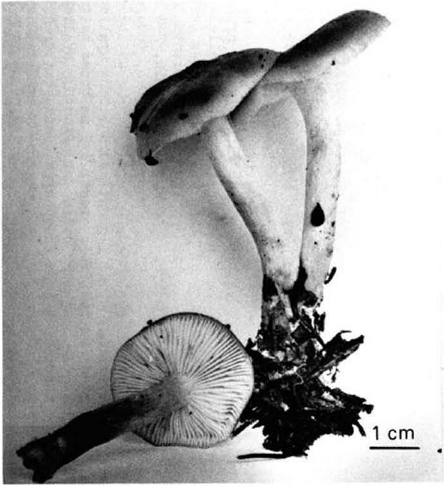


Figure 36: Lyophyllum lutescens holotype AHS 36046. Photo A.H. Smith.

Figure 37: Lyophyllum gracile holotype AHS 24983. Photo A.H. Smith.

fragilis, glaber, pallide griseus, tactu atratus. Sporae 6.5 - 8.7 x 4.1 - 5.3 µm, Q = 1.3 - 1,9, ellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia 28-33 x 8-11 µm, tetrasporigera, cum granulis siderophilis. Cheilocystidia inconspicua. Pileipellis subgelatinosa vel sicca, hyphis intertextis, fibulatis.
Hab.: Ad terram, caespitosum.
Holotypus: A. H. Smith 47032 (MICH).

PILEUS 2.5-4 cm broad, convex becoming depressed, convex to plane with a depressed disc, margin becoming elevated and very wavy to irregular; surface glabrous, moist, hygrophanous, dark fuliginous, gradually fading to a dingy brown, margin opaque at all times. CONTEXT thin, cartilaginous, watery fuliginous and slowly staining black; odour and taste disagreeable, somewhat farinaceous. LAMELLAE broad, adnate, subdistant, dingy grey, paler than the cap, edges soon staining black where bruised. STIPE 2-5 cm long, 4-10 mm thick, hollow, undulating and compressed or grooved, fragile, naked and concolourous with the gills, without pruinosity at apex, blackening in age.

SPORES 6.5-8.7 x 4.1-5.3 µm, Q = 1.3 - 1.9, ellipsoidal without supra-apicular depression in side view, ellipsoidal to slightly ovoidal in face view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA club shaped, 28-33 x 8-11 µm, 3-4 µm wide at the base, four-spored, with clamp connection; siderophilous granules abundant, fine, round, 1/5 to 1/3 µm, not clumping. MARGINAL CELLS scattered to rare, not or only slightly projecting, irregularly cylindric to fusoid, mostly capitate or with a subapical constriction, hyaline and thin walled, 27-32 x 4-6 µm. HYMENOPHORAL TRAMA regular, becoming subregular and bidirectional towards the edge; hyphae inflated, with septal constrictions, smooth, hyaline, with clamps, 3-13 µm broad; some gloeoplerous hyphae present. SUBHYMENIUM 5-8 µm thick, indistinct, subcellular, not gelatinized. PILEIPELLIS with uppermost layer very slightly gelatinized, else dry, dense; hyphae interwoven on the disc, more radially arranged towards the margin, 2-4 µm thick, cylindrical, with clamps, smooth, hyaline, covered with a few straight, interwoven, clamped, 5-8 µm broad hyphae with incrusting, brown pigment and numerous hyaline, smooth, contorted or ramified, erect, 2-3 µm broad hairs. STIPITEPELLIS a dry, regular cutis of smooth, hyaline, cylindrical, clamped, 3-6 µm broad hyphae and scattered to rare, only up to 5 µm long, erect, peglike ramifications, elsewhere completely naked. Hyphae of the BASAL TOMENTUM of

Figure 38: Lyophyllum lubricum, holotype AHS 27687.
Photo A.H. Smith.

the stipe cylindrical to slightly irregular, 1-4 µm broad, walls thin to slightly thickend, hyaline.
HABITAT: Cespitose on soil.
HOLOTYPE: Lyophyllum fistulosum Clç. & A. H. Smith, leg. H. E. Bigelow, Aug. 29 1954, Payette Lakes, Idaho, USA = A. H. Smith 47032, (MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM FURFURELLUM spec. nov. (Figure 8)

Pileus 3-9 cm latus, late convexus demum planus, ad marginem undulatus, glaber, subviscidus, fuligineus, demum sordide griseus. Caro tenuis, flexilis, fuliginea demum pallida, tactu subatrata; odor farinaceus. Lamellae latae (plus minusve 1 cm), late adnatae vel subdecurrentes, confertae, griseae, tactu atratae. Stipes 3-8 cm longus, (6-) 8-15 mm crassus, fibrillosus demum glaber. Sporae 7.8-9.8 x 3.8-4.6 µm, Q = 1.8-2.4, ellipsoideae, uninucleatae, rare binucleatae, laeves, inamyloideae, cyanophilae. Basidia 27-31 x 7-9 µm, tetrasporigera, cum siderophilis granulis. Cheilocystidia plus minusve cylindracea. Pileipellis gelatinosa, 40-60 µm crassa, hyphis fasciculatis fibulatis.
Hab.: Ad terram, caespitosum.
Holotypus: A. H. Smith 20032 (MICH).

PILEUS 3-9 cm broad, broadly convex, expanding to plane or the margin remaining decurved, in age the margin sometimes wavy or lobed and the disc depressed; surface glabrous, lubricous when moist, dark fuliginous, hygrophanous, fading to dark sordid grey with a cinnamon buff tinge at least over the disc. CONTEXT thin but cartilaginous from the rigid pileipellis, fuliginous and then pallid, darkening at least slightly where bruised; odour faintly farinaceous; taste mild. LAMELLAE broad (about 1 cm in large caps), broadly adnate to subdecurrent at first, adnexed in age, seceding in old caps, moderately close, 3 tiers of lamellullae, pallid sordid ash grey, becoming blackish where bruised or in age, edges uneven to eroded. STIPE 3-8 cm long, (6-) 8-15 mm wide at the apex, more or less equal, whitish grey at first, darkening when bruised, hollow; cortex subcartilaginous, surface appressed fibrillose to lacerate-fibrillose, more or less glabrescent.

SPORES 7.8-9.8 x 3.8-4.6 µm, Q = 1.8 - 2.4, elongate ellipsoidal with supra-apicular plane or depression in side view, ovoidal to elliptic in face view, with 1 or 2 nuclei; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA clavate, 27-31 x 7-9 µm, 3-4 µm wide at the base,

Figure 39: *Lyophyllum ochrocinerascens,* holotype, AHS 62472. Photo A.H. Smith.

four-spored, clamped; siderophilous granules abundant, 1/4 to 1/2 µm, round to slightly elongate, not clumping. MARGINAL CELLS frequent, scattered, smooth, thin-walled, hyaline, projecting with a fingerlike to filamentous appendage, main body 5-8 µm broad, appendage 2-4 µm thick. HYMENOPHORAL TRAMA subregular; hyphae 3-10 µm wide, cylindrical, the thicker ones constricted at the septa, clamped, smooth, hyaline; some gloeoplerous hyphae present but rather rare. SUBHYMENIUM indistinct, hyaline, about 10 µm thick. PILEIPELLIS 40-60 µm thick, gelatinized; covered with very numerous, erect, dense, complex, not gelatinized knots of hyphae escaping the gelatinous matrix of the pileipellis; hyphae 1-2 µm thick, cylindrical, smooth, colourless, fasciculate; fascicules running in all directions and anastomosing over the entire surface of the pileus; cuticle STIPITEPELLIS below the gills a regular cutis; hyphae cylindrical, not constricted, clamped, hyaline, 2-4 µm wide, smooth, with slightly thickened wall; coverd with numerous erect, cylindrical to irregular, hyaline, 2-4 µm wide, smooth hairs occurring singly or in dense knots. Hyphae of the BASAL TOMENTUM of the stipe in fascicules, hyaline, cylindrical or irregular, smooth, clamped, 1-2.5 µm wide, walls slightly thickened.
HABITAT: Cespitose under pine on soil.
HOLOTYPE: Lyophyllum furfurellum Clç. & A. H. Smith, leg. A. H.Smith, 20. Oct. 1944, East Fork, Salmon River, Mt. Hood, Oregon, USA, (AHS 20032, MICH). ISOTYPE in LAU.

LYOPHYLLUM GEMINUM spec. nov., var. GEMINUM (Figure 9)

Pileus 3-6 cm latus, obtusus, demum convexus, ad marginem involutus, demum planus vel late umbonatus, udus, glaber, fumosus, cinereus, hygrophanus, demum pallidus. Caro flexilis, tarde griseo-maculata; oder et sapor mites. Lamellae confertae, subdistantes, latae, late adnatae, albidae, tactu ad acies grisellae. Stipes 3-4 cm longus, 8-12 mm crassus, aequalis vel anguste clavatus, albidus, tactu griseopallidus, glaber. Sporae 8.8-11.6 x 4.1-6.2 µm, Q = 1.6 - 2.4, late ventricosae, inaequilaterales, laeves, inamyloideae, cyanophilae, uninucleatae. Basidia tetraspora, 31-36 x 7-9 µm, cum siderophilis granulis. Cheilocystidia nulla. Subhymenium gelatinosum, 10-15 µm crassa. Pileipellis gelatinosa, 30-40 µm crassa, hyphis subintertextis fibulatis.
Hab.: Ad terram.
Holotypus: A. H. Smith 29015 (MICH).

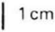


Figure 40: Lyophyllum ochrocinerascens, holotype, AHS 62472. Photo A.H. Smith.

PILEUS 3-6 cm broad, obtuse to convex with an incurved margin, expanding to plane or slightly umbonate; surface glabrous and moist, hygrophanous, pale smoky grey, fading to pale alutaceous. CONTEXT thin, pliant, pallid, slowly staining grey when bruised; odour and taste not distinct. LAMELLAE close to subdistant, broad, broadly adnate, whitish, edges staining greyish. STIPE 3-4 cm long, 8-12 mm thick at apex, equal to narrowly clavate, whitish throughout but greyish where handled, surface glabrous.

SPORES 8.8-11.6 x 4.1-6.2 µm, Q = 1.6 - 2.4, broadly fusoid-ventricose in face view, inequilateral and hump-backed in side view, with supra-apicular plane or depression, uninucleate; wall smooth, inamyloid, outer layer strongly cyanophilous and siderophilous. BASIDIA 31-36 x 7-9 µm, 3-4.5 µm wide at the base, four-spored, clamped; siderophilous granules abundant, round, 1/4-1/2 um, not clumping. MARGINAL CELLS absent. HYMENOPHORAL TRAMA regular; hyphae 4-11 µm broad, inflated, clamped, smooth, hyaline, gloeoplerous hyphae absent. SUBHYMENIUM 10-15 µm thick, gelatinous; hyphae 2-4 µm broad, interwoven. PILEIPELLIS 30-40 µm thick, weakly gelatinized; hyphae of the disc of the pileus in interwoven fascicules, elsewhere predominantly radially arranged, 3-5 µm thick, smooth or with fine, brownish incrustations, cylindrical, clamped; without gloeoplerous hyphae. STIPITEPELLIS a regular cutis; hyphae smooth, cylindrical, 3-5 µm broad, with clamps; hairs are elongated, hyaline knots of intertwisted hyphae 3-5 µm broad; gloeoplerous hyphae absent. Hyphae of the BASAL TOMENTUM 1-3 (-7) µm broad, hyaline, smooth, cylindrical, clamped.

HABITAT: Single to scattered on sandy soil.

HOLOTYPE: Lyophyllum geminum Clç. & A. H. Smith var. geminum, leg. Wm. B. Gruber, July 14, 1948, Longmire, Mt. Rainier National Park, Washington, USA. (AHS 29015, MICH).

LYOPHYLLUM GEMINUM var. OLENS nov. var. (Figure 10)

Pileus 3-5 cm latus, late convexus demum subplanus, udus, glaber, subhygrophanus, fuligineus demum cinereus. Caro tenuis, flexilis, pallida, tactu grisea; odor valde Zeae maydis; sapor mitis. Lamellae confertae, latae, late adnatae, pallidae, tactu atrogriseae. Stipes 3-5 cm longus, 5-9 mm crassus, anguste clavatus, pallidus, sericeus. Sporae 8.4 - 10.1 x 4.8 - 6.4 µm, Q = 1.4 - 1.9, late ventricosae, uninucleatae vel binucleatae, laeves,

inamyloideae, cyanophilae. Basidia 28-33 x 7-9 µm, cum siderophilis granulis, tetraspora. Subhymenium gelatinosum, 10-15 µm crassum. Pileipellis gelatinosa vel subgelatinosa, 20-40 µm crassa, hyphis subintertextis fibulatis.
Hab.: Ad terram.
Holotypus: A. H. Smith 32381 (MICH).

PILEUS 3-5 cm broad, broadly convex with an inrolled margin, expanding to broadly convex or near plane; surface moist, subhygrophanous, fuliginous fading to cinereous. CONTEXT thin and pliant, pallid, staining grey when bruised; odour strong and resembling that of fresh green corn; taste mild. LAMELLAE close, broad, broadly adnate, pallid, staining dark grey. STIPE 3-5 cm long, 5-9 mm thick at apex, narrowly clavate, pallid, appressed silky over all when young.

SPORES 8.4 - 10.1 x 4.8 - 6.4 µm, Q = 1.4 - 1.9, broadly ventricose-fusoid to rhomboidal in face view, inequilateral-ventricose to hump-backed in side view, uninucleate, rarely binucleate; with a few small siderophilous granules; wall smooth, inamyloid, outer layer strongly cyanophilous and siderophilous. BASIDIA 28-33 x 79 µm, 3-4 µm wide at the base, four-spored, with clamp connections; siderphilous granules abundant, round, 1/4 to 1/2 µm, not clumping. MARGINAL CELLS lacking. HYMENOPHORAL TRAMA regular, near the gill's edge subregular to bidirectional; hyphae cylindrical with constricted septa, clamped, smooth, hyaline, 3-8 µm wide; hyphae from the center of the mediostratum up to 12 µm wide; gloeoplerous hyphae lacking or very rare. SUBHYMENIUM 10-15 µm thick, gelatinous; hyphae interwoven, 3-4 µm broad. PILEIPELLIS 20-40 µm thick, weakly gelatinized; hyphae on the disc in interwoven fascicules, elsewhere radially arranged, 3-7 µm broad, cylindrical with no or only faint constrictions at the septa, clamped, smooth or finely incrusted with a brown pigment; gloeoplerous hyphae lackig. STIPITEPELLIS a regular cutis of strictly parallel, cylindrical, smooth and hyaline, clamped hyphae 3-5 µm broad; hairs of the stipe are elongated, tight knots consisting of intertwisted, smooth, hyaline hyphae 3-5 µm wide; gloeoplerous hyphae absent. Hyphae of the BASAL TOMENTUM of the stipe 1-3 µm broad, smooth, hyaline or faintly yellow, clamped, cylindrical to slightly irregular, isolated or in fascicules.
HABITAT: Gregarious on humus in deciduous woods mixed with conifers.
HOLOTYPE: Lyophyllum geminum Clç. & A. H. Smith, var. olens, leg. D.E. Stuntz 29. Jun. 1949, Douglas Lake, Michi-

gan, USA (AHS 32381, MICH).

LYOPHYLLUM GRACILE spec. nov. (Figures 12,37)

Pileus 2.5-3 cm latus, convexus, ad marginem involutus, late convexus, glaber, hygrophanus, ad centrum fuliginosus, ad marginem "Buffy Brown"; caro pilei fuliginosa. Lamellae 5-8 mm latae, ventricosae, adnatae demum adnexae, subdistantes, pallidae, tactu griseo-caeruleae. Stipes 3-5 cm longus, 3.5-5 mm crassus, plus minusve aequalis, subradicatus, sursum pallide griseus, deorsum fuligineus, laevis, deorsum leviter fibrillosus, demum fibroso-striatus. Sporae 6.8-8.6 x 3.5-5.0 µm, Q = 1.45-2.2, ellipsoideae vel ovatae, uninucleatae, vel raro binucleatae, laeves, inamyloideae, cyanophilae. Basidia tetraspora, 27-32 x 7-9 µm, cum siderophilis granulis. Cheilocystidia fusoidea. Subhymenium gelatinosum, 10-15 µm crassum. Pileipellis gelatinosa, 40-60 µm crassa, hyphis subintertextis fibulatis.
Hab.: Ad terram, gregarium. In silvis coniferis.
Holotypus: A. H. Smith 24983 (MICH).

PILEUS 2.5-3 cm broad, convex with an inrolled margin, becoming broadly convex, glabrous, moist, hygrophanous, disc dark fuliginous, margin near "buffy brown", faintly striatulate on extreme margin, fading to dingy greyish brown. CONTEXT thin, concolourous with surface; odour and taste rancid-farinaceous; no colour change seen on bruising or cutting. LAMELLAE 5-8 mm broad, ventricose, bluntly adnate to depressed-adnate, subdistant, pallid "tilleul buff" when young, becoming only slightly darker, staining bluish grey when cut or bruised, edges even. STIPE 3-5 cm long, 3.5-5 mm thick at apex, equal down to a tapered subrooting base, solid or with a slight tubule, pallid watery grey above, darker below; surface at first smooth and glabrous, with a few appressed silvery fibrils near the base, in age stipitepellis shredding to give a longidtudinally fibrous-striate appearance.

SPORES 6.8-8.6 x 3.5-5.0 µm, Q = 1.45-2.2, elliptical to ovoid with a supra-apicular plane in side view, elliptical to ovoid in face view, mostly uninucleate, more rarely binucleate; wall smooth, inamyloid, cyanophilous, siderophilous. BASIDIA 27-32 x 7-9 µm, 3-4.5 µm wide at the base, four-spored, clamped; siderophilous granules abundant, round, 1/4 to 1/2 µm, not clumping. MARGINAL CELLS scattered but locally frequent, projecting 5-50 µm with a hyphoid

appendage 3-5 µm wide, narrowly fusoid; wall smooth and hyaline. HYMENOPHORAL TRAMA regular to subregular, becoming subregular and wavy towards the edge; hyphae 5-12 um broad, cylindrical, the thicker ones constricted at the septa, clamped, smooth, hyaline; gloeoplerous hyphae rare. SUBHYMENIUM 10-15 µm thick, gelatinized, filling the gill's edge which thus appears gelatinized; hyphae interwoven, 1-2 µm broad. PILEIPELLIS 40-60 µm thick, gelatinized, vaguely two-layered, upper layer 6-10 um thick, with superficial hyphae 2-3 µm broad over an intermediate layer of more or less empty gel, lower layer grading into the pileus trama; hyphae 3-5 µm wide, cylindrical, clamped, smooth, rarely faintly incrusted with a brownish pigment in the deeper zones, not or only slightly constricted at the septa, fasciculate-interwoven at the disc, interwoven to subregularly radially arranged elsewhere. Hairs rare, scatterd, inconspicuous, erect, one-celled. STIPITEPELLIS a regular cutis; hyphae 1-3 µm wide, cylindrical, smooth, clamped, not constricted at the septa, densly packed into a solid rind, not gelatinized, naked; gloeoplerous hyphae absent. Hyphae of the BASAL TOMENTUM fasciculate, 1-3 µm broad, smooth, hyaline or brownish by an intraparietal pigment, clamped.
HABITAT: Closely gregarious on soil under conifers in mixed woods.
HOLOTYPE: Lyophyllum gracile Clç. & A.H. Smith, leg. A. H. Smith, 26. Oct. 1946, Mt. Wilson Road, Bear Springs, Mt. Hood National Forest, Oregon, USA (AHS 24983, MICH). ISOTYPES in MICH and in LAU.

LYOPHYLLUM INVESTITUM spec. nov. (Figure 13)

Pileus 3 - 4.5 cm latus, demum planus vel ad discum leviter depressus, glaber, subviscidus, ad marginem substriatus, fuliginosus, 2-3 mm crassus, aquose pallidus, tactu sordide griseus; odor et sapor mites. Lamellae plus minusve 5 mm latae, subdistantes, pallide cinereae, tactu ad marginem griseae. Stipes 5-8 cm longus, 4-7 mm crassus, cavus, fragilis, canescens demum griseopallidus, deorsum albostrigosus; dense gregarius. Sporae 7.7-9.5 x 4.0-5.6 µm, Q = 1.85-2.0, ellipsoideae vel ovatae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia tetraspora, 30-36 x 8-9 µm, cum siderophilis granulis. Cheilocystidia nulla. Subhymenium haud gelatinosum. Pileipellis gelatinosa, 30-40 µm crassa, hyphis intertextis fibulatis.
Hab.: Ad terram in silvis coniferis, caespitosum.
Holotypus: A. H. SMITH 19533 (MICH).

PILEUS 3 - 4.5 cm broad, convex, becoming plane or disc slightly depressed, glabrous, lubricous, margin faintly striatulate, evenly drab when moist, hygrophanous, fading to cinereous. CONTEXT 2-3 mm thick, equal, watery, becoming dingy grey when bruised; odour and taste indistinctive, mild. LAMELLAE about 5 mm broad, subdistant, horizontal, 2 tiers of lamellulae, "pale smoke grey" (cinereous), edges even and darkening to dingy grey when bruised. STIPE 5-8 cm long, 4-7 mm thick at apex, hollow, fragile, surface pallid from a thin hoary coating, pallid greyish at maturity, pale watery grey within, bases white strigose and arising in large numbers from a common area of origin, not arising from one point and not attached to a fleshy mass.

SPORES 7.7-9.5 x 4.0-5.6 µm, Q = 1.85-2.0, ovoid with narrower base or elliptical in face view, elliptical with supra-apicular plane or slight depression in side view, uninucleate, rarely binucleate; wall smooth, inamyloid, cyanophilous and siderphilous. BASIDIA 30-36 x 8-9 µm, 2-3.5 um wide at the base, clamped, four-spored; siderophilous granules abundant, round, 1/3 to 1/2 µm, not clumping. MARGINAL CELLS absent. HYMENOPHORAL TRAMA regular, becoming subregular towards the edge, hyphae 3-15 µm wide, inflated, clamped, smooth, hyaline; gloeoplerous hyphae rare. SUBHYMENIUM 10-15 µm thick, indistinct, not gelatininzed; hyphae 1-2 µm broad, interwoven. PILEIPELLIS 30-40 µm thick, gelatinized, with separated, dense clusters of small, repent to erect, contorted, clavate, irregular hairs with hyaline to brown walls; hyphae interwoven to fasciculate-interwoven, 1.5-4 µm wide, cylindrical without constrictions at the septa, smooth, hyaline, clamped. STIPITEPELLIS a regular cutis of inflated, clamped hyphae 3-6 µm wide, completely covered with a dense tomentum of similar but somewhat more irregular hyphae frequently braided into erect hair-knots; walls hyaline and smooth; gloeoplerous hyphae absent. Hyphae of the BASAL TOMENTUM of the stipe irregularly cylindrical, not constricted at the septa, clamped, wall smooth, hyaline to slightly brownish, slightly thickened; often in fascicules.

HABITAT: Cespitose unter Larix and Pinus.

HOLOTYYPE: Lyophyllum investitum Clç. & A. H. Smith, leg. A. H. Smith 7. Oct. 1944, Clear Lake, Mt. Hood National Forest, Oregon, USA (AHS 19533, MICH). ISOTYPE in LAU.

LYOPHYLLUM LEPTOSARX spec. nov. (Figure 14)

Pileus 1 - 4 cm latus, convexus demum late convexus, glaber, hygrophanus, udus, leviter striatus, fuligineus vel brunneo-fuligineus demum griseopallidus; sapor mitis, odor valde Zeae maydis. Caro tactu caerulescens dein nigrescens. Lamellae latae, confertae, adnatae, pallide griseae demum subolivaceae, tactu nigrescentes. Stipes 2-3.5 cm longus, 3-10 mm crassus, cavus, fragilis, glaber, griseus sursum demum olivaceo-brunneus. Sporae 5.4-7.2 x 4.5-5.9 µm, Q = 1.1-1.3, breviter ellipsoideae, uninucleatae vel binucleatae, laeves, inamyloideae, cyanophilae. Basidia 28-40 x 7-11 µm, tetrasporigera, cum granulis siderophilis. Cystidia nulla. Pileipellis gelatinosa, 30-40 µm crassa, hyphis fibulatis.
Hab.: Ad terram, subcaespitosum vel caespitosum.
Holotypus: A. H. Smith 69022 (MICH).

PILEUS 1-4 cm broad, convex, expanding to broadly convex, surface moist and hygrophanous, pale fuliginous to fuliginous-brown, obscurely translucent striate before fading, streaked with greyish pallid in fading. CONTEXT thin, odour strong of green corn; taste mild; staining blue and finally black when injured. LAMELLAE broad, close, adnate, pallid greyish brown, becoming near "olive buff" but browner, spotted blackish in age. STIPE 2-3.5 cm long, 3-10 mm thick, hollow, fragile, concolourous with cap margin, naked, darkening to olive brown from base up, apex naked. Iron sulphate not reacting on pileus.

SPORES 5.4 - 7.2 x 4.5 - 5.9 µm, Q = 1.1 - 1.3, short ellipsoidal without supra-apicular depression, mostly uninucleate, rarely binucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 28-40 x 7-11 µm, 2-4 µm wide at the base, clamped, four-spored; siderophilous granules abundant, 1/4 to 1/3 µm, round, not clumping. CYSTIDIA and marginal cells absent. HYMENOPHORAL TRAMA regular, hyphae cylindrical, 3-10 µm thick, cells 30-60 µm long, with clamps, colourless, smooth; gloeoplerous hyphae absent or rare. SUBHYMENIUM not gelatinized, inconspicuous, about 10 µm thick. PILEIPELLIS 30-40 µm thick, a gelatinized cutis composed of fascicules of cylindrical to slightly inflated, smooth, hyaline, clamped hyphae 2.5-6 µm broad; fascicules interwoven on the disc, more radially arranged towards the margin. STIPITEPELLIS a regular cutis of parallel, cylindrical to slightly inflated, colourless, smooth, thin-walled hyphae with clamps, 2-4 µm broad. No

hairs present.
HABITAT: Cespitose to scattered on soil.
HOLOTYPE: Lyophyllum leptosarx Clç & A. H. Smith, leg. A. H. Smith 69022, Brundage Mts., McCall, Idaho, USA, Aug. 8, 1946 (MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM LUBRICUM spec. nov. (Figures 15,38)

Pileus 4-7 cm latus, convexus demum subplanus, ad marginem demum undulatus, aquose griseus, demum fuligineus, subviscidus, hygrophanus, demum brunneo-griseus. Caro avellanea vel sordide grisea, tactu nigrescens; odor et sapor farinacei. Lamellae pallide griseae, tactu nigrescentes, confertae vel subdistantes, latae (plus minusve 1 cm), adnatae. Stipes 6-11 cm longus, 10-16 mm crassus, subradicatus, demum cavus, adpresse fibrillosus, demum plus minusve furfuraceus. Sporae 6.8-9.2 x 3.5-4.7 µm, Q = 1.7-2.2, ellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia 36-42 x 7-8 µm, tetraspora, cum siderophilis granulis. Cheilocystidia nulla. Subhymenium gelatinosum. Pileipellis gelatinosa, 50-70 µm crassa, hyphis intertextis fibulatis.
Hab.: Ad terram in silvis coniferis.
Holotypus: A. H. Smith 27687 (MICH).

PILEUS 4-7 cm broad, convex, expanding to nearly plane, margin wavy and lobed in age, surface dark to light watery grey and soon becoming dark fuliginous, surface lubricous but not viscid, hygrophanous, fading to near wood brown but dingier. CONTEXT avellaneous to dingy grey, watery grey when moist, staining black in age or where bruised; odour and taste farinaceous. LAMELLAE pale grey, staining black, close to subdistant, about 1 cm broad near stipe, rounded adnate to narrowly adnexed, seceding, edges eroded. STIPE 6-11 cm long, 10-16 mm thick at apex, narrowed downward to a pointed subrooting base, stuffed, becoming hollow, greyish wood-brown within, surface pallid but soon darkening and dingy, innately fibrillose and stipitepellis often lacerating into squamules which become "cinnamon buff".

SPORES 6.8 - 9.2 x 3.5 - 4.7 µm, Q = 1.7 - 2.2, elongate ellipsoid with supra-apicular depression or plane in side view, ellipsoid to slightly ovoid in face view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 36-42 x 7-8 µm, 2-3.5 µm wide at the base, clamped, four-spored; siderophilous granules abundant, round to slightly elongate, 1/3 to 1/2 µm, not clumping. MARGINAL

CELLS absent. HYMENOPHORAL TRAMA subregular, pale dingy brownish in KOH and contrasting with the hyaline, gelatinized subhymenium; hyphae cylindrical, 3-8 µm broad, the thicker ones slightly constricted at the septa, clamped, smooth, hyaline (the pale dingy colour could not be located); gloeoplerous hyphae present. PILEIPELLIS an ixocutis, 50-70 µm thick; surface hyphae interwoven over the entire surface of the pileus, 2-5 µm wide, cylindrical, slightly constricted at the septa, with clamps, walls brownish from an incrusting pigment usually forming a continuous layer, pigment more rarely broken into small fragments; deeper hyphae predominantly radially arranged near the margin. Some hyphae with a brown, intracellular pigment. STIPITEPELLIS not gelatinized; hyphae parallel, 3-8 µm wide, cylindrical with slightly constricted septa, clamped, smooth, hyaline; hairs scattered to locally abundant, 3-4 µm wide, filamentous up to 50 µm long, cylindrical to irregular and sometimes branched, hyalin, thin-walled, smooth.
HABITAT: Gregarious under conifers on soil.
HOLOTYPE: Lyophyllum lubricum Clç & A.H. Smith, leg. A. H. Smith, 13. Oct. 1947, Twin Bridges, Mt. Hood, Oregon, USA, (AHS 27687, MICH). ISOTYPE in LAU.

LYOPHYLLUM LUTEOGRISEASCENS spec. nov. (Figure 16)

Pileus 3-6 cm latus, obtuse conicus vel convexus, demum plus minusve planus vel obscure umbonatus, ad marginem involutus, glaber, subalbidus, tarde lutescens. Lamellae pallidae, tactu aurantioluteae, dein griseae, late adnatae, subdistantes. Stipes 2-4 cm longus, sursum circa 1 cm crassus, subclavus, albidus, in siccate fuligineus, glaber, apice leviter pruinosus. Sporae 6.0-10.2 x 3.6-6.0 µm, Q = 1.2 - 2.3, late fusoideae, laeves, inamyloideae, cyanophilae. Basidia tetraspora vel bispora, 28-31 x 6-8 µm, cum siderophilis granulis. Cheilocystidia clavata, 18-30 x 7-9 µm. Pileipellis sicca, hyphis intertextis fibulatis.
Hab.: Ad terram in silvis frondosis.
Holotypus: A. H. Smith 32684 (MICH).

PILEUS 3-6 cm broad, obtuse to convex, expanding to plane or nearly so, margin inrolled at first; surface moist, glabrous, creamy white, gradually staining darker yellow and finally greyish over all; subhygrophanous. CONTEXT pallid but changing to yellowish and then greyish when bruised; taste mild; odour very distinctly resembling fresh green corn. LAMELLAE creamy white, staining orange yellow and then grey, broadly adnate, subdistant, edges even. STIPE 2-4 cm long, about 1 cm thick at apex, clavate to nearly equal, creamy white but staining like the gills and fuliginous when dried; surface naked but faintly pruinose at apex.

SPORES 6.0-10.2 x 3.6-6.0 µm, Q = 1.2 - 2.3, broadly fusoid to rhomboidal in face view, hump-backed inequilateral in side view, polymorphic; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA mostly four-spored, rarely two-spored, 28-31 x 6-8 µm, 2-3 µm wide at the base, the two-spored basidia up to 41 µm long, both types of basidia clamped; siderophilous granules scattered to abundant, 1/4 to 1/2 µm, round, not clumping. MARGINAL CELLS numerous, clavate, thin-walled, empty, 18-30 x 7-9 µm, 3-4 µm wide at the base, clamped (could easily be mistaken for empty basidioles, but their presence is restricted to the gill's edge, and the occurrence of very similar cells on the pileus confirms their nature as marginal cells). HYMENOPHORAL TRAMA regular to subregular, wavy towards the edge; hyphae 3-10 µm broad, smooth, hyaline, clamped, cylindrical without constrictions at the septa or faintly constricted, with numerous gloeoplerous hyphae. SUBHYMENIUM indistinct. PILEIPELLIS not gelatinized; hyphae repent, interwoven and mostly fasciculate over the entire surface or the pileus, fascicules often circling small, elliptical depressions; hyphae smooth, hyaline, cylindrical or slightly constricted at the septa, clamped, bearing terminal or lateral hairs which are clavate, often curved, hyaline, more or less erect and which are more frequent in the depressions between the fascicules of hyphae; gloeoplerous hyphae frequent in the deeper layers. PILEITRAMA regular; hyphae radially arranged. STIPITEPELLIS regular; hyphae parallel, 2-3 µm broad, cylindrical, clamped, smooth, gloeoplerous hyphae frequent; apex of the stipe with a tomentum of cylindrical, smooth, hyaline, clamped hyphae 2-4 µm broad; end cells irregularly cylindrical to calvate, erect, 4-7 µm wide at the apex, smooth and hyaline, frequently interwoven or twisted around each other. Hyphae of the BASAL TOMENTUM of the stipe hyaline, smooth, clamped, cylindrical, 2-3 µm wide, often in fascicules.

HABITAT: Single in hardwood forest.

HOLOTYPE: Lyophyllum luteogriseascens Clç. & A. H. Smith leg. A. H. Smith 25 Jul. 1949, MacKinaw City Hardwoods, Michigan, USA, (AHS 32684, MICH).

LYOPHYLLUM LUTESCENS spec. nov. (Figures 17,36)

Pileus 3 - 4 cm latus, late convexus, ad marginem involutus, demum planus, striatulus, fuscus, demum fuligineus vel fumoso-brunneus, dein sordide pallidus, hygrophanus, subviscidus, glaber; sapor farinaceus. Lamellae confertae, 3-4 mm latae, horizontalis, late adnatae, pallide, tactu ochraceae. Stipes 6-8 cm longus, 3-5 mm crassus, undulatus, aequalis, argentatus, sursum punctatus. Sporae 7.5-8.9 x 3.6-4.9 µm, Q = 1.7-2.2, anguste ovatae vel rare ellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia tetraspora, 22-30 x 6.5-7.5 µm, cum siderophilis granulis. Cheilocystidia nulla. Pileipellis gelatinosa, 35-45 um crassa, hyphis intertextis fibulatis.
Hab.: Ad terram, subcaespitosum, in silvis coniferis.
Holotypus: A. H. Smith 36046 (MICH).

PILEUS 3-4 cm broad, broadly convex with an inrolled margin, expanding to plane with a spreading or decurved, striatulate margin, fuscous when young, pale smoky brown, becoming fuliginous, hygrophanous fading to dingy pallid, surface glabrous, lubricous. CONTEXT with a farinaceous odour and taste. LAMELLAE close, 3-4 mm broad, horizontal, broadly adnate, pallid when young, staining yellowish when bruised. STIPE 6-8 cm long, 3-5 mm thick, undulating, equal, hollow, surface silvery from a thin fibrillose coating, grey beneath, apex punctate.

SPORES 7.5 - 8.9 x 3.6 - 4.9 µm, Q = 1.7 - 2.2, narrowly ovate to elliptical with supra-apicular plane or depression in side view, regularly elliptical in face view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 22-30 (-32) x 6.5-7.5 µm, 3-4 µm wide at the base, four-spored, clamped; siderophilous granules abundant, 1/4-1/2 x 1/4-1 µm, round to elongate, not clumping. MARGINAL CELLS absent. HYMENOPHORAL TRAMA subregular, becoming parallel-wavy towards the edge; hyphae 3-10 µm wide, clamped, cylindrical, the wider ones constricted at the septa, smooth, hyaline, cells 40-150 µm long. SUBHYMENIUM not gelatinized, indistinct; hyphae 1-2 um wide. PILEIPELLIS gelatinized, 35-45 µm thick, without hairs; hyphae intricately interwoven, somewhat fasciculate on the disc, 1-3 µm wide, cylindrical, clamped, smooth, hyaline. STIPITEPELLIS a regular cutis with a few gloeoplerous hyphae; hyphae 2.5-3.5 µm wide, cylindrical, smooth, hyaline, with clamp connections; at apex covered with a thin tomentum of similar hyphae, naked below.

HABITAT: Gregarious to subcespitose under Pinus resinosa. HOLOTYPE: Lyophyllum lutescens Clç. & A. H. Smith, leg. A. H. Smith, 22. Sept. 1950, Pellston, Michigan, USA, (AHS 36046, MICH). ISOTYPE in LAU.

LYOPHYLLUM OCHROCINERASCENS spec. nov. (Fig. 18,31,39,40)

Pileus 5-10 cm latus, late convexus vel subplanus, saepe lobatus, albopruinosus, demum plus minusve luteolus vel griseus, tactu griseo-brunnescens. Caro alba; sapor mitis. Lamellae confertae, angustae, breviter decurrentes, albae vel pallide luteolae, ad aciem tactu luteolo-griseascentes. Stipes 8-12 cm longus, 15-20 mm crassus, cavus, deorsum vel sursum incrassatus, fibrosus, albus, tarde luteomaculatus vel brunneo-maculatus. Sporae 5.7-6.8 x 5.6-6.5 µm, Q = 1-1.1, subglobosae vel globosae, uninucleatae, rare binucleatae, laeves, inamyloideae, cyanophilae. Basidia 32-38 x 7-9 µm, tetrasporigera, cum granulis siderophilis. Cystidia nulla. Pileipellis gelatinosa, 90-150 µm crassa, hyphis intertextis, fibulatis.
Hab.: Ad terram prope lignum, subcaespitosum.
Holotypus: A. H. Smith 62472 (MICH).

PILEUS 5-10 cm broad, broadly convex to nearly plane; margin inrolled at first, often becoming lobed and uneven; surface moist beneath a white pruinose covering and fading as if subhygrophanous, whitish at first but gradually more yellowish, grey in aging and staining dark greyish brown along margin which is opaque when moist. CONTEXT white, fibrous; odour fungoid; taste mild or nearly so. LAMELLAE close, narrow, short decurrent, white, becoming cream colour and edges staining yellowish grey when bruised, edges even. STIPE 8-12 cm long, 15-20 mm thick, widest at apex, hollow, enlarged below, white, naked, in age staining yellowish to brownish; context finally rather fibrous. SPORE DEPOSIT white.

SPORES 5.7-6.8 x 5.6-6.5 µm, Q = 1.0-1.1, subglobose to globose, with one, rarely with two nuclei; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA club-shaped, 32-38 x 7-9 µm, 3-4 µm wide at the base, four-spored, clamped; siderophilous granules abundant, fine, 1/5 to 1/2 µm, round, not clumping. CYSTIDIA and marginal cells absent. HYMENOPHORAL TRAMA regular, towards the edge subregular; hyphae 3-6 µm wide, smooth, clamped, cylindrical, slightly or not constricted at the septa, hyaline; locally with some gloeoplerous hyphae. SUBHYMENIUM about 15 µm

thick, dense; hyphae strongly interwoven, 1-3 µm wide. PILEIPELLIS gelatinized, 90-150 µm thick, evenly grading into the trama of the pileus, the upper half composed of strongly interwoven hyphae over the entire surface of the pileus, intermixed with many gloeoplerous segments, the lower half with predominantly radially arranged hyphae and almost no gloeoplerous segments; the surface hyphae 2-3 µm wide, cylindrical, smooth, colourless, clamped, with a few inconspicuous, erect end cells. STIPITEPELLIS below the gills a regular cutis of thin-walled, clamped, smooth, hyaline, slightly infalted, 3-8 µm wide hyphae covered with many erect, smooth, colourless, cylindrical, filamentous hyphae 2-3 µm thick and up to 100 µm long. Hyphae of the BASAL TOMENTUM of the stipe 1-3 µm thick, cylindrical, colourless, smooth, with clamps.
HABITAT: Clustered on soil near hardwood stumps.
HOLOTYPE: Lyophyllum ochrocinerascens Clç. & A.H. Smith, leg. A.H. Smith 62472, Gorman Lake, Washtenaw County, Michigan USA, June 25, 1960 (MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM PALLIDUM spec. nov. (Figure 19)

Pileus 3-6 cm latus, convexus, ad marginem involutus, saepe late umbonatus, glaber, subviscidus vel lubricus, striatulus, hygrophanus, pallide cinereus sed ad marginem pallidus, demum subalbidus. Caro tenuis, flexuosa, pallida, tacu caeruleo-grisea. Lamellae confertae, latae (5-7 mm), adnatae, albidae, tactu caeruleo-griseae. Stipes 5-8 cm longus, 8-10 mm crassus, saepe deorsum attenuatus, cavus, pallidus, obscure striatus. Sporae 6.2-7.4 (-8.5) x 4.5-5.2 (-6.5) µm, Q = 1.3-1.5, irregulariter subellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia 25-32 x 8-10 µm, tetrasporigera, cum granulis siderophilis. Cystidia inconspicua. Pileipellis gelatinosa, 30-40 µm crassa, hyphis fibulatis.
Hab.: Ad terram, subcaespitosum.
Holotypus: A. H. Smith 19809 (MICH).

PILEUS 3-6 cm broad, convex with an inrolled margin, becoming nearly plane or broadly umbonate; surface glabrous and shining, lubricous to viscid when wet, margin striatulate; hygrophanous, colour very pale watery grey on disc, the margin pallid, pallid over all when faded. CONTEXT very thin and pliant, more or less concolourous with the surface, changing to bluish grey when cut or bruised. LAMELLAE moderately close, 2 tiers of lamellulae, moderately broad (5-7 mm), bluntly adnate, broadest at stipe and tapering to cap margin, white to pallid and staining pale bluish grey when cut or bruised, edges even. STIPE 5-8 cm long, 8-10 mm thick, equal or attenuate at the base, hollow, more or less pliant, whitish grey, paler than the cap and with a drier appearance, obscurely longitudinally striate, not discolouring noticeably where bruised.

SPORES 6.2-7.4 (-8.5) x 4.5-5.2 (-6.5) µm, Q = 1.3-1.5, asymmetrically ellipsoidal with slightly narrower apex in side view, ellipsoidal in face view, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA club-shaped, 25-32 x 8-10 µm, 4-5 µm wide at the base, clamped, four-spored; siderophilous granules abundant, fine, 1/4 to 1/3 µm, round and not clumping. MARGINAL CELLS absent or rare near the pileus margin, more and more abundant towards the stipe, fusiform to lageniform, 6-8 µm broad and mostly appendiculate with a long, mostly tortuous, sometimes branched filament 1-3 µm wide and 4-30 µm long. HYMENOPHORAL TRAMA regular, subregular towards the edge; hyphae 4-9 µm thick, cylindrical, not or only slightly constricted at the septa, smooth and colourless, clamped; gloeoplerous hyphae present but rare. SUBHYMENIUM about 10 µm thick, dense. PILEIPELLIS 30-40 thick, a gelatinized cutis grading evenly into the pileus context; hyphae interwoven on the disc, subregular to more or less radially arranged towards the margin, 2-5 µm broad, cylindrical, smooth, colourless, clamped. STIPITEPELLIS below the gills not gelatinized; hyphae parallel, cylindrical, 2-4 µm broad, not constricted at the septa, smooth, clamped, bearing more or less erect, cylindrical to elongate-polymorphous end cells which are either isolated or occur in small groups. Hyphae of the BASAL TOMENTUM of the stipe cylindrical, smooth, 2-3 µm broad, with clamps, colourless.
HABITAT: Gregarious under conifers, on soil.
HOLOTYPE: Lyophyllum pallidum Clç. & A. H. Smith, leg. A. H. Smith 19809, Ollalie Lake, Mt. Hood National Forest, Oregon, USA, Oct. 16, 1944 (MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM PICEUM spec. nov. (Figure 20)

Pileus 4-8 cm latus, convexus, ad marginem incurvatus, ad centrum depressus, glaber, hygrophanus, striatulus, fusco-fuligineus, demum griseo-brunneus vel pallide cinereus; caro cartilaginea, aquose grisea, demum pallide cinerea,

tactu nigrescens; sapor et odor mites. Lamellae subdecurrentes, confertae vel subdistantes, angustae (5-8 mm latae), griseae, tactu nigrescentes. Stipes 4-8 cm longus, 1-2 cm crassus, impolitus, pallidus vel fusco-griseus, substriatus. Sporae 9.0-11.1 x 4.5-5.7 µm, Q = 1.7-2.3, ovatae vel ellipsoideae, uninucleatae vel binucleatae, laeves, inamyloideae, cyanophilae. Basidia 25-31 x 7-9 um, tetraspora, cum siderophilis granulis. Cheilocystidia anguste fusoidea, apice dactyloidea, 20-40 x 3-5 um. Pileipellis gelatinosa, 30-45 µm crassa, hyphis intertextis vel subintertextis fibulatis.
Hab.: Ad terram in silvis coniferis.
Holotypus: A. H. Smith 19820 (MICH).

PILEUS 4-8 cm broad, convex with an incurved pruinose margin, disc soon depressed and margin spreading or uplifted; surface glabrous, hygrophanous, becoming striatulate on margin before fading; dark fuliginous over all, becoming paler and finally fading to dingy greyish brown, eventually pale cinereous. CONTEXT thin, pliant cartilaginous, watery grey becoming pallid, changing to blackish when bruised or cut; odour and taste none. LAMELLAE subdecurrent, close to subdistant, 2-3 tiers of lamellulae, narrow, becoming moderately broad, 5-8 mm, broadest near the stipe, pale drab and blackening when bruised, edges even. STIPE 4-8 cm long, 1-2 cm thick, unpolished, pallid to dark grey, paler above, more or less longitudinally striate from checking of pileipellis; apex sometimes scurfy.

SPORES 9.0 - 11.1 x 4.5 - 5.7 µm, Q = 1.7 - 2.3, ovate to long elliptical with supra-apicular plane or slight depression in side view, elliptical in face view, with a pointed base when immature, uninucleate or binucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 25-31 x 7-9 µm, 3-4 µm wide at the base, four-spored, clamped; siderophilous granules abundant, round, 1/4 to 1/2 um, not clumping. MARGINAL CELLS scatterd to abundant, irregularly and narrowly fusoid, mostly with a fingerlike appendage, scarcely to prominently projecting, 20-40 x 3-5 um, neck 2-3 µm, thin-walled, hyaline, smooth, clamped. HYMENOPHORAL TRAMA subregular, more so towards the edge; hyphae 2-8 µm broad, cylindrical, the broader ones with slight constrictions at the septa, smooth, hyaline, clamped; with numerous gloeoplerous hyphae. SUBHYMENIUM 10-12 µm thick, not dense, but not gelatinized, hyphae interwoven, 1-2 µm broad. PILEIPELLIS 30-45 µm thick, gelatinized, without hairs; hyphae 2.5-5 µm broad, cylindrical or slightly constricted at the septa, clamped, smooth, rarely with faint, brownish

incrustations, some with brownish intracellular pigment, interwoven on the disc, subregular to interwoven elsewhere; gloeoplerous hyphal segments present in the deeper layers of the ixocutis. STIPITEPELLIS a regular cutis, almost naked, only a very few, scattered, short, more or less erect, cylindrical cells present; below the gills with local patches of a thin and poorly developed tomentum of hyphae similar to those of the stipitepellis; hyphae cylindrical, 2-3 µm broad, clamped, smooth; Hyphae of the BASAL TOMENTUM of the stipe hyaline, smooth, clamped, thinwalled, 1.5-2.5 µm broad, often in fascicules.
HABITAT: Single to scattered under conifers.
HOLOTYPE: Lyophyllum piceum Clç. & A. H. Smith, leg. A. H. Smith, 16. Oct. 1944, Skyline Road, Warm Springs, Mt. Hood National Forest, Oregon, USA, (AHS 19820, MICH).

LYOPHYLLUM PUSILLUM spec. nov. (Figure 22)

Pileus 10-20 mm latus, convexus vel abrupte umbonatus, ad marginem involutus, glaber, olivaceo-brunneus, demum griseo-brunneus, opacus. Caro mitis, inodora. Lamellae perconfertae, angustae, sinuatae, crassiusculae, pallide demum avellaneae, tactu nigrescentes. Stipes 2-3 cm longus, 2-3 mm crassus, aequalis, pileo concolor, minute furfuraceus, firmus, nigrescens. Sporae 3.0-4.5 x 1.7-2.3 µm, Q = 1.5-2.2, subcylindraceae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia 16-20 x 4-4.5 µm, tetrasporigera, cum granulis siderophilis. Cystidia 30-37 x 6-9 µm, clavata vel fusoide ventricosa. Pileipellis gelatinosa, hyphis intertextis, fibulatis.
Hab.: Ad terram, subcaespitosum.
Holotypus: A. H. Smith 9671 (MICH).

PILEUS 10-20 mm broad, broadly convex or with an abrupt umbo, sometimes almost papillate, margin inrolled for a long time, but when finally expanded more or less undulate; glabrous and smooth, moist, "olive brown" to "buffy brown" becoming dingy greyish brown, not striate. CONTEXT thick, firm, coloured like the surface; without odour or taste. LAMELLAE very crowded, narrow, sharply sinuate, thickish, pallid "tilleul buff" when young, near avellaneous at maturity or tinged "cinnamon buff"; edges eroded and blackening when bruised. STIPE 2-3 cm long, 2-3 mm thick, equal, concolourous with the pileus or paler, pruinose-fibrillose at first, soon glabrescent, blackening in age especially at the base, cartilaginous, rigid and firm, often compressed.

SPORES 3.0 - 4.5 x 1.7 - 2.3 µm, Q = 1.5 - 2.2, rounded-cylindrical to elongate ellipsoidal, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 16-20 x 4-4.5 µm, 2-2.5 µm wide at the base, four-spored, rarely two-spored; siderophilous granules abundant, 1/4 to 1/3 µm, round, not clumping. PLEUROCYSTIDIA and MARGINAL CELLS 30-37 x 6-9 µm, fusoid, clavate to ventricose with the tip extended to a long, fingerlike projection, hyaline, smooth, thin-walled. HYMENOPHORAL TRAMA bister to dingy yellow in KOH, regular to subregular; hyphae 4-10 µm wide, cells 30-70 µm long, slightly constricted at the septa, smooth, clamped; without gloeoplerous hyphae. SUBHYMENIUM thin and indistinct. PILEIPELLIS dense, subgelatinized, evenly grading into the pileus trama; hyphae interwoven over the entire surface of the pileus, 2-4 µm broad, smooth or finely incrusted, cylindrical or slightly inflated, clamped. STIPITEPELLIS a regular cutis; hyphae parallel, 2-4 µm broad, smooth, cylindrical, with clamp connections and scattered, erect end cells. Hyphae of the BASAL TOMENTUM of the stipe 2-3 µm thick, cylindrical, clamped, hyaline to brownish; deeper brown, thick-walled and agglutinated in the scale-like bundles of the surface of the base.
HABITAT: Gregarious under Tsuga.
HOLOTYPE: Lyophyllum pusillum Clç. & A. H. Smith, leg. A. H. Smith, Keener House, Great Smoky Mountains National Park, USA, Aug. 3, 1938 (AHS 9671, MICH). ISOTYPES in MICH and LAU.

LYOPHYLLUM RUGULOSUM spec. nov. (Figure 23)

Pileus 3-9 cm latus, convexus vel ad centrum leviter depressus, glaber, subviscidus, saepe rugulosus, pallide griseus, demum atromaculatus, ad marginem involutus. Caro tactu nigrescens; odor et sapor mites. Lamellae confertae, demum subdistantes, 5-8 mm latae, late adnatae vel subdecurrentes, griseo-pallidae, tactu nigrescentes. Stipes 6-12 (-15) cm longus, 8-16 mm crassus, leviter fibrillosus, demum striatus. Sporae 6.0-7.7 x 3.4-4.7 µm, Q = 1.5-1.9, ellipsoidea vel subovoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia tetraspora, cum siderophilis granulis, 25-30 x 7-9 µm. Cheilocystidia subfusoidea, 20-40 x 5-10 µm, apice dactyloidea. Pileipellis gelatinosa, 30-40 µm crassa, hyphis intertextis fibulatis.
Hab.: Ad terram in silvis coniferis.
Holotypus: A. H. Smith 9002 (MICH).

PILEUS 3-9 cm broad, convex with a flattened or slightly depressed disc, glabrous, lubricous when moist, surface often rugulose, pale watery grey becoming blackish in spots or generally clouded with umber, margin incurved at first and in age often wavy. CONTEXT "pale olive buff", blackening when bruised; odour and taste not distinct. LAMELLAE close to subdistant (L = 46-77), 5-8 mm broad, broadly adnate becoming subdecurrent, "pale olive buff" but soon blackening on edges or where bruised, gradually becoming fuliginous over all. STIPE 6-12 (-15) cm long, 8-16 mm thick, more or less appressed-fibrillose and sometimes innately longitudinally striate, dull and unpolished.

SPORES 6.0-7.7 x 3.4-4.7 µm, Q = 1.5-1.9, ellipsoid to slightly ovoid with supra-apicular plane or slight depression, elliptic in face view, uninucleate, rarely binucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 25-30 x 7-9 µm, 3-4 µm wide at the base, clamped, four-spored; siderophilous granules abundant, 1/4 to 1/2 µm, round, not clumping. MARGINAL CELLS scattered, inconspicuous, slightly to prominently projecting with a fingerlike appendage, irregularly fusoid, 20-40 x 5-10 µm, appendage 2-4 µm broad, smooth, hyaline, thin-walled. HYMENOPHORAL TRAMA regular, becoming subregular towards the edge; hyphae 3-7 µm broad, cylindrical with constricted septa, clamped, smooth, hyaline; with numerous gloeoplerous hyphae. SUBHYMENIUM 5-10 µm thick, not gelatinized; hyphae interwoven, 2-3 µm broad. PILEIPELLIS 30-40 µm thick, gelatinized, grading evenly into the pileus trama, many gloeoplerous hyphal segments present in the deeper layers, without hairs, but with a few free hyphal end cells; hyphae cylindrical with no or slight constriction at the septa, clamped, hyaline, smooth, 2-5 µm wide, interwoven to fasciculate-interwoven on the disc, more radially arranged elsewhere. STIPITEPELLIS a regular cutis, not gelatinized; with numerous gloeoplerous hyphal segments; hyphae cylindrical with faint constrictions at the septa, clamped, smooth, hyaline, 3-5 µm broad. A few clavate, more or less erect hyphal end cells present below the gills. Hyphae of the BASAL TOMENTUM cylindrical without constrictions, clamped, smooth, hyaline to brownish, slightly thick-walled, 2-4 µm broad.

HABITAT: Scattered on soil under Pinus.

HOLOTYPE: Lyophyllum rugulosum Clç. & A. H. Smith, leg. A. H. Smith, 22. Nov. 1937, Crescent City, California, USA, (AHS 9002, MICH). ISOTYPE in LAU.

LYOPHYLLUM SCABRISPORUM spec. nov. (Figure 24)

Pileus 4 - 9.5 cm latus, convexus, siccus, ad marginem decurvatus pallidusque, ad centrum sordide griseus, tactu atratus. Caro 5-6 mm crassa, pallide cinerea, tactu fuscescens; sapor mitis, odor subnauseosus. Lamellae confertae, latae (6-10 mm), ventricosae, sinuatae, obscure brunneae, tactu subcaeruleae dein atratae. Stipes 3-5 cm longus, 10-13 mm crassus, deorsum angustior, farctus, cartilagineus, pallidus, tactu fuscescens, fibrillosus. Sporae 6.2-7.9 x 2.7-3.5 µm, Q = 1.8-2.8, cylindraceae, uninucleatae, punctatae, inamyloideae, cyanophilae. Basidia 25-35 x 6-8 µm, tetrasporigera, cum siderophilis granulis. Cystidia nulla. Cuticula pilei sicca, hyphis intertextis, fibulatis.
Hab.: Ad terram, subcaespitosum.
Holotypus: A. H. Smith 2777 (LAU).

PILEUS 4-9.5 cm broad, convex to obtuse when young, margin decurved at first and sometimes with one or more concentric creases; surface dry, disc streaked but no fibrils visible, growing margin minutely pubescent, margin pallid, more or less "tilleul buff", center pallid to dingy grey and darker in age, becoming blackish when bruised, opaque at all stages. CONTEXT 5-6 mm thick in disc, tapering slightly to the cap margin, pale cinereous but darker where bruised; odour faint and disagreeable; taste not distinct. LAMELLAE close, sinuatae-adnate, moderately broad (6-10 mm), ventricose, colour near "buffy brown" but paler, olive-cinereous, staining bluish and then black, readily separable from the pileus, edges decidedly eroded. STIPE 3-5 cm long, 10-13 mm thick, equal above a narrow base, solid, stuffed by a thick pith which is concolourous with the pileus context, cortex subcartilaginous and darker grey, colour evenly pallid "tilleul buff" but darker where handled or in age, surface appressed fibrillose, fibrillose-scurfy toward the apex.

SPORES 6.2 - 7.9 x 2.7 - 3.5 µm, Q = 1.8 - 2.8, cylindrical with rounded ends, uninucleate; wall finely punctate, roughened, but not warty, outer layer and the ornamentation cyanophilous and siderophilous, inamyloid. BASIDIA club-shaped, 25-35 x 6-8 µm, 2-3.5 µm broad at the base, four-spored, clamped; siderophilous granules abundant, 1/3 to 1/2 µm, round to slightly elongate, not clumping. MARGINAL CELLS absent. HYMENOPHORAL TRAMA regular; hyphae cylindrical or slightly inflated, clamped, hyaline, smooth, 5-10 µm broad, cells 25-35 µm long. PILEIPELLIS a dry cutis;

hyphae intervowen, cylindrical or slightly inflated, smooth, clamped, 2-5 µm broad. STIPITEPELLIS regular; hyphae parallel, cylindrical, smooth, clamped, 2-5 µm thick, with numerous erect, cylindrical or branched end cells 20-100 µm long. Hyphae of the BASAL TOMENTUM of the stipe thin-walled to moderately thick-walled, smooth, cylindrical, colourless, with clamp connections.
HABITAT: Subcespitose under conifers and Alnus, on soil.
HOLOTYPE: Lyophyllum scabrisporum Clç. & A. H. Smith, leg. A. H. Smith 2777, Joyce, Washington, USA, Oct. 2, 1935 (LAU). ISOTYPES in MICH.

LYOPHYLLUM SOLIDIPES spec. nov. (Figures 25,32)

Pileus (3.5-) 5-11 cm latus, late convexus, ad marginem involutus, tarde expansus, subviscidus, glaber, hygrophanus, ad marginem aquose griseus, udus, striatulus, demum sordide brunneus, tactu nigrescens. Lamellae confertae, latae (plus minusve 1 cm), adnexae, pallide olivaceo-griseae, tactu griseae. Stipes 7-12 cm longus, 8-15 mm crassus, solidus, leviter fibrilloso-punctatus, griseus, tactu atratus, rimosellus. Caro tenuis, grisea, tactu nigrescens; odor et sapor farinacei. Sporae 6.5-8.1 x 3.7-4.7 µm, Q = 1.5-1.9, ellipsoideae vel subellipsoideae, uninucleatae, laeves, inamyloideae, cyanophilae. Basidia 30-36 x 7-8 µm, tetrasporigera, cum granulis siderophilis. Cystidia nulla. Pileipellis gelatinosa, 20-90 um crassa, hyphis intertextis, fibulatis.
Hab.: Ad terram, caespitosum.
Holotypus: A. H. Smith 24944 (LAU).

PILEUS (3.5-) 5-11 cm broad, broadly convex with an inrolled margin, expanding to plane, the margin often irregular to wavy; surface lubricous to subviscid when wet, glabrous, moist, hygrophanous; margin pale watery grey and more or less striatulate, disc darker buffy brown to olive brown and soon with blackish areas in age, sometimes near "mummy brown" over all. CONTEXT thin, evenly tapered towards the margin , pliant, concolourous with the surface, gradually staining dark gray to black when cut or bruised; odour and taste farinaceus. LAMELLAE moderately close, with 2-3 tiers of lamellulae, broad near stipe (about 1 cm), abruptly adnexed, tapering towards the margin, pale olive buff and gradually darker grey, staining dark grey where cut or bruised, edges becoming uneven in age. STIPE 7-12 cm long, 8-15 mm thick at apex which is sometimes slightly enlarged, equal downward to a narrow base, solid, pale watery grey whithin; surface glabrous, or merely slightly fibrillose punctate above, stipitepellis splitting longitudinally to give a long-striate effect; pallid, becoming greyish and blackening when bruised.

SPORES 6.5-8.1 x 3.7-4.7 µm, Q = 1.5-1.9, asymmetrically ellipsoidal or ovoidal in side view, with supra-apicular plane but without depression, ellipsoidal in face view, uninucleate, rareley with two nuclei; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 30-36 x 7-8 µm, 2-3 um wide at the base, regularly club-shaped, four-spored, clamped; siderophilous granules abundant, fine, 1/5 to 1/3 um, round, not clumping. CYSTIDIA and marginal cells absent. HYMENOPHORAL TRAMA regular; hyphae cylindrical to slightly inflated, clamped, smooth, hyaline, 3-9 µm broad; gloeoplerous hyphae numerous, 3-6 µm broad, clamped. SUBHYMENIUM dense and indistinct. PILEIPELLIS 20-90 µm thick, gelatinized, grading into the pileus context; hyphae cylindrical, isolated or in fascicules, 2-4 µm wide, smooth and colourless or very finely incrusted with a pale pigment, clamped, interwoven on the disc, more or less radially arranged towards the margin; erect hairs absent. STIPITEPELLIS from below the gills a regular, not gelatinized cutis of parallel, cylindrical, clamped, smooth, hyaline hyphae 3-5 um wide; gloeoplerous hyphae frequent; erect filamentous hyphae 1-3 µm wide, smooth and colourless, interwoven and locally tomentous. Hyphae of the BASAL TOMENTUM of the stipe fasciculate, cylindrical, smooth and colourless, clamped, 2-3 µm broad.

HABITAT: Cespitose along a trail amongst Pseudotsuga douglasii, on soil.

HOLOTYPE: Lyophyllum solidipes Clç. & A. H. Smith, leg. A. H. Smith 24944, Still Creek Trail, Camp Creek Forest Camp, Mt. Hood National Forest, Oregon, USA, Oct. 24, 1946 (LAU). ISOTYPES in MICH.

LYOPHYLLUM STENOSPORUM spec. nov. (Figure 26)

Pileus 3-5 cm latus, convexus, ad marginem involutus, tarde subplanus, glaber, subviscidus, nitens, hygrophanus, fuligineus demum cinereo-brunneus. Caro tactu caeruleo-grisea, insipida. Lamellae breviter decurrentes, latae, subdistantes, pallide griseo-brunneae, albidae, tactu caeruleo-griseae. Stipes 2-3 cm longus, 5-8 mm crassus, clavatus, albus. Sporae 8.3-10.3 x 4.0-4.7 µm, Q = 1.8-2.4, anguste ellipsoideae, uninucleatae, laeves, inamyloideae,

cyanophilae. Basidia tetraspora vel rare bispora, cum siderophilis granulis, 33-40 x 7-9 µm. Cheilocystidia inconspicua, apice dactyloidea. Pileipellis gelatinosa, 30-40 µm crassa, hyphis intertextis vel subintertextis fibulatis.
Hab.: Ad terram in silvis coniferis, gregarium.
Holotype: A. H. Smith 30871 (MICH).

PILEUS 3-5 cm broad, convex with an inrolled margin, expanding to nearly plane; surface glabrous, lubricous and shiny, hygrophanous, fuliginous fading to ashy brown and drying dingy alutaceous. CONTEXT staining bluish grey; odour and taste not distinct. LAMELLAE short decurrent, broad, distant to subdistant, pale grey to dingy brown, near wood brown, staining when bruised. STIPE 2-3 cm long, 5-8 mm thick at apex, clavate, whitish, pruinose at the apex, naked below.

SPORES 8.3-10.3 x 4.0-4.7 µm, Q = 1.8-2.4, narrowly ellipsoidal to narrowly ovoidal with supra-apicular plane or depression, uninucleate; wall smooth, inamyloid, cyanophilous and siderophilous. BASIDIA 33-40 x 7-9 µm, 3.5-4.5 µm wide at the base, clamped, four-spored, rarely two-spored; siderophilous granules abundant, round to elongate, 1/4-1/2 x 1/4-1 µm, not clumping. MARGINAL CELLS rare, scatterd and inconspicuous, easily missed, some projecting beyond the basidia with a fingerlike appendage 3-10 x 2-3 µm, smooth, hyaline, thin-walled. HYMENOPHORAL TRAMA regular, subregular towards the edge, finally becoming more or less bidirectional in the edge; hyphae 3-10 µm broad, cylindrical or slightly inflated, smooth, hyaline, clamped; with a few gloeoplerous hyphae. SUBHYMENIUM 10-15 µm thick, not gelatinized, indistinct; hyphae 1-2 µm thick. PILEIPELLIS a 30-40 µm thick ixocutis with a few scattered, cylindrical, short and inconspicuous hairs; hyphae 2-5 µm thick, smooth or faintly incrusted, cylindrical or slightly inflated, clamped, interwoven over the disc, radially subregular to interwoven elsewhere. STIPITEPELLIS a regular cutis, hyphae 3-5 µm thick, cylindrical to slightly inflated, hyaline, smooth, clamped, covered by a tomentum of hyaline, smooth, clamped, cylindrical to slightly inflated hyphae 2-5 µm broad frequently braided and twisted into massive, elongate, erect knots forming the furfuraceous covering of the stipe apex, getting more scatterd below. Hyphae of the BASAL TOMENTUM 1-2 µm broad, smooth, hyaline, cylindrical to frequently slightly wavy, not constricted at the septa, clamped, very often in fascicules.
HABITAT: gregarious under conifers.
HOLOTYPE: Lyophyllum stenosporum Clç. & A. H. Smith, leg.

D .E. Stuntz, 1. Sept. 1948, Rampart Ridge, Mt. Hood National Park, Washington, USA (AHS 30871, MICH). ISOTYPES in MICH and LAU.

BIBLIOGRAPHY

Clémençon, H., 1982: Type Studies and Typifications in Lyophyllum. I. Staining Species. MYCOTAXON XV: 67-94.

Ridgway, R., 1912: Color Standards and Color Nomenclature. Washington DC.

Singer, R., 1975: The Agaricales in Modern Taxonomy. 3rd edition, Cramer, Vaduz.

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"CERATOBASIDIUM FIBULATUM" AN INVALID NAME

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SUMMARY

The name *Ceratobasidium fibulatum* is not validly published because the authors failed to clearly designate a holotype. In the absence of an adequately documented specimen to serve as holotype and the presence of confusing, conflicting, and erroneous items in the protologue and on the packet label, which would cause consternation to future mycologists, I felt it would be improper to validate the name.

Tu and Kimbrough (1978, p. 457) studied "One isolate of *Rhizoctonia globularis* Saksena and Vaartaja (IMI 138790)," which produced basidiospores and "proposed for the perfect state of *R. globularis*" the name *Ceratobasidium fibulatum* Tu and Kimbrough. Data concerning the isolate was cited as "Habitat: on roots of *Pinus banksiana* Lamb., Ontario, Canada. Type: *Rhizoctonia globularis* Saksena and Vaartaja (IMI 138790) and University of Florida (FLAS F50272)."

Errors and problems exist which cause confusion over the species concept, the name of the anamorph and the specimens said to be type. IMI 138790 is a *Fusarium* sp. isolated from *Hibiscus manihot* by Hicks and Chan 6433 from Papua-New Guinea (B. C. Sutton, in litt.). The only material at FLAS of *Ceratobasidium fibulatum* is a packet labelled: "F50277, *Ceratobasidium fibulatum*, culture induced to form basidia, from *Pine* tree, Ontario, Canada, Coll. Luella Weresub, April 1, 1974 (cultured), Ident. C. C. Tu." Several of these items are inaccurate and will be discussed below. Thus both IMI 138790 and FLAS 50272 are errors.

In packet FLAS 50277 there were only two microscope slides. One was labelled: "138190. *R. globularis*. Basidia. Basidiospores. Tu, C. C., April 23, 1973," and the other slide was labelled: "138190, *R. globularis* (= *C. cornigerum*). Basidia, 4-22-73." Both preparations have dried and no microscopic features could be discerned. The loan form accompanying this specimen when sent in 1982 carried the note "We are unable to find the dried down cultures of this fungus." Thus there is no specimen of *C. fibulatum*.

In attempting to clarify the status of the type specimen cited (Tu and Kimbrough 1978) for *C. fibulatum*, as well as the collection data to be associated with the specimen, I consulted the correspondence of the late Dr. Luella K. Weresub of Ottawa. First, it became apparent that Tu and Kimbrough's citation of IMI 138790, is clearly a *lapsus calami* for DAOM 138190. The slides under F50277 are numbered 138190, not 138790 and Tu and Kimbrough (1975) cited 138190 as *C. fubilatum* (presumably a misspelling of *C. fibulatum*). DAOM 138190 was an isolate sent to Tu and Kimbrough in 1973 (Weresub, in litt.). It was received at DAOM from O. Vaartaja labelled 2616D. There was neither a name, a habitat nor locality attached to this isolate. Regarding 2616D, Vaartaja wrote of it (Weresub, in litt.) "unknown species and origin from a preliminary multiple mating involving several sterile isolates, now lost, including *R. globularis* ...." To me "origin" includes habitat and geographic locality. Thus it seems improper to assign to this isolate the habitat "on roots of *Pinus banksiana*" and locality "Ontario" given by Tu and Kimbrough (1978) or "from *Pine* tree, Ontario" as given on the packet F50277. The significance of the letter "D" suffix on the isolate at DAOM is unknown. Based on our knowledge of Vaartaja's methods, I suspect it refers to the fourth or D isolate from a particular sample.

Weresub (in litt.), presumably on the basis of Vaartaja's comment (quoted above) linking 2616D with *R. globularis*, labelled the isolate *Rhizoctonia ?globularis*, when assigning it the DAOM number 138190.

Next, several items on the label of the packet F50277 are misleading and differ from or did not appear in the published description. The number cited by Tu and Kimbrough (1978) was F50272 (apparently a typographical error for F50277). The original isolate number 2616D does not appear on the packet or in the published description. The habitat for the specimen given on the packet differs from and is more general in nature than that in the description. The habitat seems to have been taken from the paper by Saksena and Vaartaja (1960) who gave data for 2616, a paratype of *R. globularis*, as "from mycorrhizal rootlets of seedlings of *Pinus banksiana*, ..., Manitoba, Canada, 1956 ..." Even with this source, the locality given in the description is incorrectly cited. Presumably because Tu and Kimbrough cited Luella Weresub as the collector, when she served only as a communicator, they surmised that the collection came from Ontario where she worked. The date 1974 on the packet label contradicts the 1973 date on the slides, therein.

Finally Tu and Kimbrough's (1978) conclusion that *C. fibulatum* was the holomorph name for *R. globularis* is in error. They evidently assumed isolate 138190 to be *R. globularis* despite the fact that it was sent (Weresub, in litt.) to them as 2616D *R. ?globularis*. Earlier Warcup and Talbot (1966) had shown that the isolate which was the basis for the holotype 2287 and the isolate that formed the paratype 2616 specimen of *R. globularis* were not conspecific. Isolate 2287 was identified as a *Sebacina* sp. based on a teleomorph produced in culture and isolate 2616 was identified as *Ceratobasidium cornigerum* (Bourd.) Rogers based on its teleomorph in culture. Thus the holomorph name for *R. globularis* is *Sebacina* sp., not *C. fibulatum*.

In summary the errors in the protologue (citing IMI 138790 instead of DAOM 138190, F50272 instead of F50277, and habitat and locality not directly connected with the original isolate), failure to cite the original isolate number, lack of a type specimen, failure to clearly cite the holotype (the citing of two herbaria and two accession numbers), which places *C. fibulatum* in the status of NOT VALIDLY PUBLISHED according to the Botanical Code's requirement that the type specimen be clearly designated (Articles 7.3, 9.1 and 37), improper and erroneous data on the only packet labelled *C. fibulatum* (e.g., Weresub as collector, locality as Ontario, date as 1974) and a faulty taxonomic conclusion (i.e., *C. fibulatum* purported to be the holomorph for *Rhizoctonia globularis*) led me to conclude that the name should not be validated.

LITERATURE CITED

Tu, C.C. & J.W. Kimbrough. 1975. Morphology, development, and cytochemistry of the hyphae and sclerotia of species in the *Rhizoctonia* complex. Can. J. Bot. 53: 2282-2296.

Tu, C.C. & J.W. Kimbrough. 1978. Systematics and phylogeny of fungi in the *Rhizoctonia* complex. Botanical Gaz. 139: 454-466.

Saksena, H.K. & G. Vaartaja. 1960. Descriptions of new species of *Rhizoctonia*. Can. J. Bot. 38: 931-943.

Warcup, J.H. & P.H.B. Talbot. 1966. Perfect states of some Rhizoctonias. Trans. Brit. Mycol. Soc. 49: 427-435.

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TAXONOMIC CONCEPTS IN THE ENDOGONACEAE: SPORE WALL CHARACTERISTICS IN SPECIES DESCRIPTIONS

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SUMMARY

A new, standardized, terminology for use in descriptions of endogonaceous spore walls is suggested. Four wall types are described and illustrated with photographs and line-drawing A stylized graphic representation of wall structure (named a *murograph*) is proposed and illustrated.

Recent descriptions of species in the Endogonaceae have increasingly relied upon spore wall structure for separation of species within a genus (eg Ferrer and Herrera, 1981; Nicolson and Schenck, 1979; Rose, Daniels and Trappe, 1979; Schenck and Smith, 1982; Walker and Trappe, 1981) and some keys to the group rely heavily on wall characteristics (eg Hall and Fish, 1979; Nicolson and Schenck, 1979). However, the terminology used in species descriptions has not been consistent, possibly resulting in confusion when attempts are made to identify species in the family. In this paper, I describe the different kinds of walls and offer suggestions for a consistent use of terminology in future species descriptions and keys. In addition, a standardized form of graphic representation of wall structure (the "murograph") is proposed.

OBSERVATION OF SPECIMENS

The wall structures used in taxonomy are those relatively easily observed by light microscopy in good, well-preserved specimens. In some instances, the use of differential interference microscopy can be of considerable help in locating and recognizing wall structures, though Koehler-illuminated brightfield optics of good quality should allow observation of all features mentioned in species descriptions. An oil-immersion 100X objective is essential for resolving the details of wall structure. The use of scanning electron microscopy (SEM) is a well-established technique (Ames and Linderman, 1976; Rose, Daniels and Trappe, 1979; Walker and Trappe, 1981), but such work should be used in species descriptions only to clarify or better illustrate structures that can be observed by light microscopy.

Spore walls may have complex ornamentation (eg Gerdemann and Trappe, 1974; Rothwell and Trappe, 1979; Walker and Trappe, 1981). Careful light microscopy normally will reveal the nature of such ornamentation, but where resolution limits are reached, SEM can reveal more details. However, in descriptions of species with such characteristics, it would be useful to illustrate their appearance through the light microscope, as SEM facilities may not be available to all.

The structures discussed here can be observed on spores in a semi-permanent mountant such as polyvinyl-alcohol lactophenol (PVL) or polyvinyl-alcohol/lactic acid/glycerol (PVLG) (Omar, Bolland and Heather, 1979; Salmon, 1954; Trappe and Schenck, 1982; Walker, 1979). These mountants allow the slides to be cleaned after use without damage to the spores. Both PVL and PVLG can be mixed with stains such as cotton blue and reagents such as Melzer's reagent. Such stains can make observation of wall structures easier by enhancing contrast. More detailed instructions for preparing and observing taxonomic characteristics in the Endogonaceae can be found in a recent paper by Trappe and Schenck (1982).

Walls may not be easy to observe in whole spores, especially as the diffraction caused by their structure can be misleading. Slight pressure on the cover slip will usually crush the spores sufficiently to overcome these problems, and to allow good observation (Figure 1A). At least some spores, however, should be left whole for measurement and to allow plasmolysis to reveal the presence of any thin, membranous walls that may be present (Figure 1B).

WALL GROUPS

Most species in the Endogonaceae have several walls surrounding the contents of their spores, and these may be grouped in ways that usually become evident upon crushing (Figure 2). For example, *Gigaspora gilmorei* Trappe and Gerdemann (Gerdemann and Trappe, 1974) has its wall layers in two groups, the outer with two distinct walls and the inner with four. The chlamydospores of *Glomus geosporum* (Nicol. & Gerdemann) Walker, in contrast, have three walls in only a single group (Walker, 1982). A wall group, therefore, is an aggregation of walls that are either adherent, or that remain close together when a spore is crushed. For convenience of definition, a single wall that separates readily from other walls may be considered a "group", especially if the wall is separated clearly in intact spores.

INDIVIDUAL WALL TYPES (Figures 3 and 4)

The types of walls that can be found in endogonaceous spores can be divided into UNIT WALLS, LAMINATED WALLS, EVANESCENT WALLS and

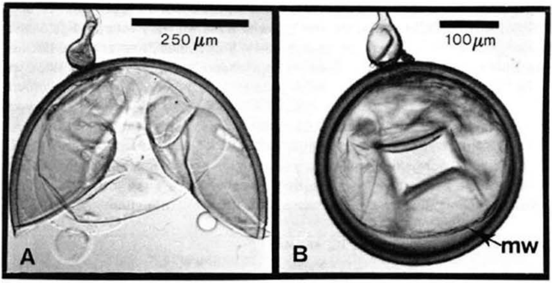


Figure 1: Spores mounted on microscope slides

A. a *Gigaspora* spore crushed to show wall-features

B. a similar spore left intact for measurement and to allow plasmolysis to reveal a membranous wall (mw)

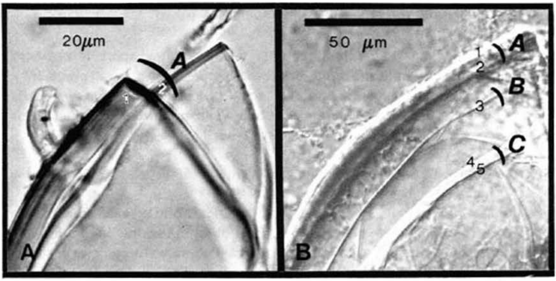


Figure 2: Wall groups

A. spore of an undescribed *Glomus* sp. with two walls (1&2) in a single group (*A*)

B. an undescribed *Gigaspora* sp., showing five walls (1-5) in three groups (*A*, *B*, *C*).

MEMBRANOUS WALLS. Not all of these walls can be found in each species, and in some instances, the numbers and types of walls will vary with the age of the spore. Such information should be included in the species description (eg Becker and Gerdemann, 1977; Rose, Daniels and Trappe, 1979; Walker and Rhodes, 1981; Walker, 1982).

Brief definitions of the walls, and a list of some species exhibiting them, are given in Table 1. Satisfactory categorization of walls will usually be possible, although it will normally be necessary to examine several spores to be sure that all walls have been observed. The definitions in Table 1 are in their simplest forms, and some discussion is necessary for further clarification.

THE UNIT WALL (Figures 3A, 3C, and 4A)

The unit wall as defined in Table 1 is clearly distinguishable and is always present in spores of the same state of maturity from any particular taxon. Its thickness may vary among spores, but not relative to other walls in the same spore. In some instances, a unit wall may form late in the life of a spore, and thus may be missing from young specimens. Some unit walls are so thin that they may become extremely difficult or impossible to see on older spores as laminations are laid down on neighboring walls. *Glomus geosporum* has such a unit wall as an outer layer, (see Fig 3E in Walker, 1982) as does *Gigaspora gigantea* (Nicol. and Gerd.) Gerd. and Trappe. Unit walls often are particularly evident around the subtending hypha at the spore base.

Often, unit walls separate from other walls when a spore is crushed. In species where unit walls are tightly adherent to other walls in a wall group, they may be distinguished by color or structure (eg the outer wall on *Glomus caledonium* (Nicol. and Gerd.) Trappe and Gerd. Most unit walls are brittle, and crack open when a spore is crushed.

THE LAMINATED WALL (Figures 3A, 3B and 4B)

The laminated wall is recognized as a single, brittle wall, constructed of more or less tightly fused layers that do not differ in texture, but are evident because of slight differences in refringence. Laminated walls begin as a single layer, and become thicker with age by deposition of additional laminae (Mosse, 1970; Sward, 1981) (Figure 4B). The number of laminae and the relative thickness of the wall therefore will vary from specimen to specimen, depending on the age and condition of the spore. In some species laminae are extremely difficult to see, and can only clearly be observed at high magnification or on specimens that have been vigorously crushed by rotation of the cover slip under pressure. Application of stains and reagents can also be useful in such cases. By contrast, in some other species, they may be readily distinguished even to the point of separating when a spore is crushed. Laminae that separate in this way can give the erroneous impression of a number of unit walls. However, the number of laminae will vary from spore to spore in such instances, whereas spores with numerous unit walls will have the same number of walls among all mature spores in a collection.

TABLE 1: Wall types found in endogonaceous spores with examples of species in which they may be found.

Wall type	Definition	Found in
Unit	A single-layered, rigid wall clearly distinguishable from others and consistent among spores of the same state of maturity within a species	*Glomus caledonium* *Gigaspora gigantea* *Acaulospora trappei* *Glomus geosporum*
Laminated	A wall made of several layers laid down as the spore matures. Such a wall will have an increasing number of layers as the spore ages	*Gigaspora margarita* *Gigaspora gigantea* *Glomus etunicatum* *Glomus macrocarpum* *Glomus geosporum*
Evanescent	A unit or laminated wall that breaks down and sloughs as the spore matures	*Glomus gerdemannii* *Glomus albidum* *Glomus occultum* *Glomus etunicatum*
Membranous	A very thin wall that often wrinkles and collapses in hypertonic solutions. Not normally rigid, and therefore usually not breaking when a spore is crushed	*Acaulospora laevis* *Acaulospora spinosa* *Gigaspora pellucida* *Gigaspora calospora* *Gigaspora gilmorei* *Gigaspora heterogama* *Gigaspora reticulata*

THE EVANESCENT WALL (Figure 3B and 4C)

Unless a relatively large series of spores including all ages is studied, evanescent walls can be incorrectly identified as unit (or rarely, laminated) walls, and specimens from which the wall has been sloughed may be misidentified. Thus Becker and Gerdemann (1977) wrote about *Glomus etunicatum*: "... Because of the extreme variability of spores with age, at one time we assumed that more than one species was represented ...". Often, as in *Gl. albidum* Walker and Rhodes (1981) and *Gl. etunicatum*, only the outer wall is evanescent, but *Gl. gerdemannii* Rose, Daniels and Trappe has two such walls.

THE MEMBRANOUS WALL (Figures 3C and 4D)

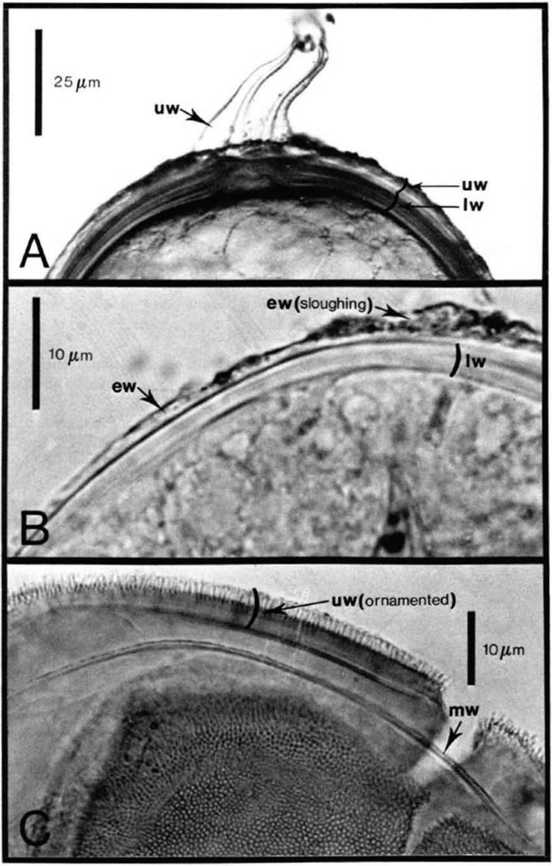
Many species, especially from the genera *Gigaspora* and *Acaulospora* have inner walls that are relatively thin and flexible These are termed "membranous walls" and are to be found enclosing other, similar walls or the spore contents. The term "membrane" is not intended to imply a cellular or subcellular membrane, but is used in the broader sense to indicate a thin, more-or-less elastic covering. Membranous walls often do not break easily when a spore is crushed, and they usually shrink as the spore contents plasmolyze in mounting media. It is not always possible to be certain whether a wall is membranous, or a very thin unit wall, or simply a loose inner lamina of a laminated wall. In the last case, observation of a number of specimens should resolve the problem, since unit or membranous walls usually will be consistent on mature spores, whereas a detached lamina will occur only on occasional specimens. Membranous walls may be single, or in groups. In the latter instance, they may be clearly separate, more or less tightly fused, or in pairs apparently separated slightly by an amorphous cement-like layer. The presence of this cement layer is not sufficiently consistent to be regarded as a wall-type in its own right.

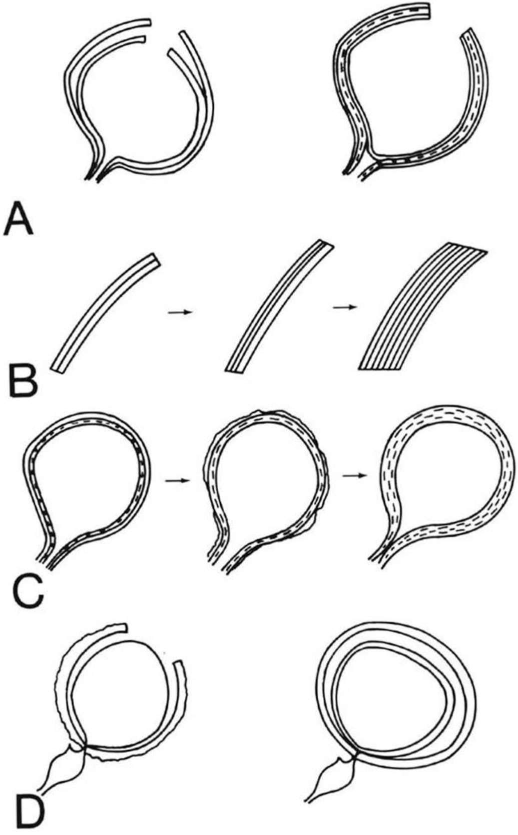
Figure 3: Types of wall in endogonaceous spores

A. This *Glomus* spore shows the laminated wall (lw) and the unit wall (uw). The unit wall is particularly evident where the subtending hypha joins the spore (arrowed)

B. In *Glomus occultum*, the inner, laminated wall (lw) is covered, in this specimen, by an outer, evanescent wall (ew). The evanescent wall can be seen sloughing at the upper right (arrowed). In fully mature spores, this outer wall may be completely lost

C. *Acaulospora spinosa* spores have an ornamented, outer unit wall (uw) and two inner, membranous walls (mw). This photograph demonstrates a common artefact of light microscopy on such spores leading to the outer wall appearing laminated


A
25 μm
uw
uw
lw
B
10 μm
ew (sloughing)
lw
ew
C
uw (ornamented)
10 μm
mw


A
B
C
D

THE MUROGRAPH (Figure 5)

In an electron microscopic study of the walls of an *Acaulospora* sp., Mosse (1970) illustrated the wall structure by a diagram. It seems useful to adopt a similar, but standardized form of graphic representation (the murograph) of the wall structure of spores as seen through the light microscope. The inclusion of such a diagram or diagrams could improve the clarity of species descriptions.

As a standard, I propose the following representations:

1. all walls to be represented by outline blocks, joined or separated as is the case in the species under discussion

2. unit walls to be left unshaded

3. laminated walls to be shaded by vertical dashed lines, preferably with the breaks in the lines alternating

4. evanescent walls to be shaded by dots. Laminated walls that are evanescent could be shaded by a combination of dashed lines and dots

5. membranous walls to be shaded with cross-hatching at 45°

6. amorphous cement layers to be shaded by horizontal lines

7. a peridium of hyphae around individual spores to be represented by vertical, wavy lines, and labelled with a 'P'

Figure 4: Stylized drawings of spores in the Endogonaceae with different kinds of walls

A. **Unit wall** Two unit walls of approximately equal thickness have separated on crushing (left). Two thin unit walls sandwiching a laminated wall have not separated on crushing, but are distinguishable structurally and are consistant among specimens (right)

B. **Laminated wall** This diagram illustrates the gradual increase in the number of laminae as the spore matures and the wall thickens

C. **Evanescent wall** An evanescent wall surrounds a laminated wall in this species. The progressive breakdown of the evanescent wall and the simultaneous thickening of the laminated wall is shown from left to right.

D. **Membranous wall** In a fresh, crushed specimen (left), the brittle, ornamented, unit wall has broken, but the thin inner membrane remains intact. In a preserved, intact specimen, the two inner, membranous walls have shrunk away from the outer wall as the spore contents became plasmolyzed

8. walls to be numbered with Arabic numerals, beginning with the outside of the spore (no 1) at the left of the murograph

9. wall groups to be bracketed and lettered alphabetically from left to right

10. walls that are extremely difficult to see to be marked with an asterisk beneath their number on the murograph

11. walls not present on all specimens to be indicated by drawing additional murographs, reserving the number for that missing wall (Figure 7)

12. ornamented walls to be indicated by the letter "O" beneath the wall (Figures 5 and 8), to be in parentheses if the ornamentation is to be found on only some specimens (ie at different stages of maturity). If desired, the ornamentation could be represented stylistically on the relevant wall

13. the murograph to be drawn with walls having more or less their correct relative thicknesses

Figure 5 is a murograph of a hypothetical spore possessing all four types of wall and a hyphal peridium, arranged in three groups, with wall 4 being difficult to observe, and membranous walls 5 and 6 joined by a cement-like layer. Figures 6-8 are murographs of some recently described species.

Adoption of this standard representation of wall structure would allow much greater ease of comparison among species than exists at present, and would act as a guide to the observer attempting to identify specimens. Where spore walls are difficult to see, or where they appear or disappear with increasing age, more than one murograph could be drawn to illustrate the different stages, with such uncertainty being discussed in the text (Walker, 1982). If the consistent lettering and numbering system is adopted, discussion of the walls would be facilitated. Finally, later ultrastructural studies, which are likely to reveal a more complex organization, could be superimposed on the murograph drawn from studies under the light microscope.

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I wish to thank Dr S Gregory (Forestry Commission), Dr R E Koske (University of Rhode Island), Dr N C Schenck (University of Florida), and Dr J M Trappe (USDA, Forest Service) for kindly reviewing the manuscript, and for their helpful suggestions. I wish also to thank Mrs L Barr and Mrs A S Craig for preparing the camera-ready copy, and Mr J Williams for drawing Figure 4.

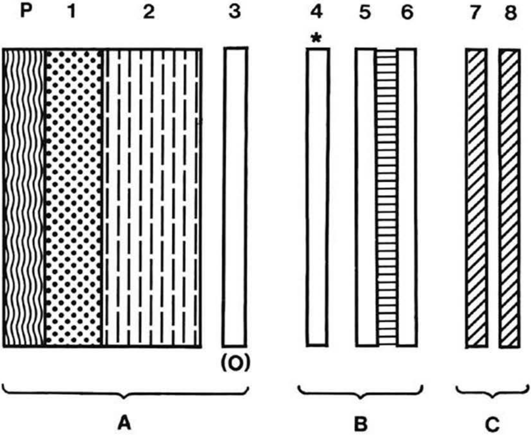

Figure 5: Murograph (stylized wall diagram) of a hypothetical endogonaceous spore. This wall structure is complex, with a hyphal peridium (P) surrounding a spore with 8 walls (1-8) in 3 groups (A, B, and C). Wall 3 is marked with an "O" in parentheses to indicate that it is ornamented in some specimens, but not all. Wall 4 is marked with an asterisk (*) to indicate that it is difficult to observe. Walls 5 and 6 are joined by an amorphous "cement" layer, indicated by horizontal shading.

The shading of the different wall types is as suggested in the text. Wall 1 is evanescent. Wall 2 is laminated. Walls 3-6 are unit walls. Walls 7 and 8 are membranous.

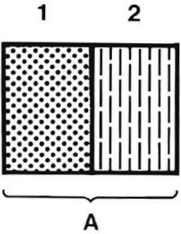

Figure 6: Murograph of *Glomus albidum*

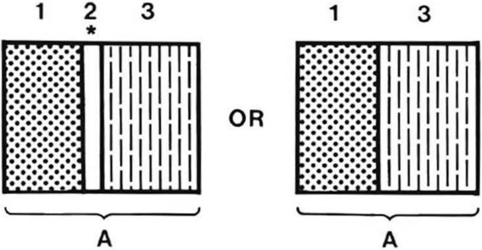

Figure 7: Murograph of *Glomus occultum*

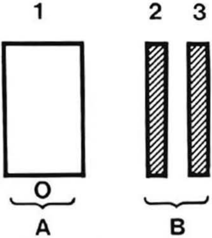

Figure 8: Murograph of *Acaulospora spinosa*

LITERATURE CITED

Ames, R N and R G Linderman (1976). *Acaulospora trappei* sp. nov. *Mycotaxon* **3:** 565-569.

Becker, W N and J W Gerdemann (1977). *Glomus etunicatus* sp. nov. *Mycotaxon* **6:** 29-32.

Ferrer, R L and R A Herrera (1981). El genero *Gigaspora* Gerdemann et Trappe (Endogonaceae) en Cuba. Rev Jardin Botanico Nacional, Habana **1(1):** 43-66.

Gerdemann, J W and J M Trappe (1974). The Endogonaceae in the Pacific Northwest. *Mycologia Memoir* No 5, 76pp.

Hall, I R and B J Fish (1979). A key to the Endogonaceae. *Transactions of the British Mycological Society* **73:** 261-270.

Mosse, B (1970). Honey-coloured, sessile *Endogone* spores. III. Wall structure. *Archiv Fur Mikrobiologie* **74:** 146-159.

Nicolson, T H and N C Schenck (1979). Endogonaceous mycorrhizal endophytes in Florida. *Mycologia* **71:** 178-198.

Omar, M B, L Bolland and W A Heather (1979). A permanent mounting medium for fungi. *Bulletin of the British Mycological Society* **13:** 31-32.

Rose, S, B A Daniels and J M Trappe (1979). *Glomus gerdemannii* sp. nov. *Mycotaxon* **8:** 297-301.

Rothwell, F M and J M Trappe (1979). *Acaulospora bireticulata* sp. nov. *Mycotaxon* **8:** 471-475.

Salmon, J T (1954). A new polyvinyl alcohol mounting medium. *The Microscope* **10:** 66-68.

Schenck, N C and G Smith (1982). Additional new and unreported species of mycorrhizal fungi (Endogonaceae) from Florida. *Mycologia* **74:** 77-92.

Sward, R J (1981). The structure of the spores of *Gigaspora margarita*. I. The dormant spore. *New Phytologist* **87:** 761-768.

Trappe, J M and N C Schenck (1982). Taxonomy of the fungi forming endomycorrhizae. In: Schenck, N C, ed. *Methods and principles of mycorrhizal research*. St Paul, Minnesota: American Phytopathological Society; 1-9.

Walker, C (1979). The mycorrhyzast and the herbarium: the preservation of specimens from VA mycorrhizal studies. In: *Program and Abstracts, 4th N. American Conference on Mycorrhiza*. Fort Collins, Colorado.

Walker, C (1982). Species in the Endogonaceae: a new species (*Glomus occultum*) and a new combination (*Glomus geosporum*). *Mycotaxon* **15:** 49-61.

Walker C and L H Rhodes (1981). *Glomus albidus*: a new species in the Endogonaceae. *Mycotaxon* **12:** 509-514.

Walker C and J M Trappe (1981). *Acaulospora spinosa* sp. nov. with a key to the species of *Acaulospora*. *Mycotaxon* **2:** 515-521.

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DESCRIPTION AND IDENTIFICATION OF SELECTED MYCORRHIZAL FUNGI IN PURE CULTURE

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SUMMARY

Fourteen species of ectomycorrhizal fungi were grown and described in pure culture. Two selective media and three chemical spot tests (Table 1) were used to separate the fungal taxa with a laccase extracellular enzyme system from those which have none or produce tyrosinase. Eleven stains (Table 2) were employed to differentially stain cell walls, protoplasmic contents, and lipoidal material in order to further characterize individual species. In addition, mycelia were scanned with U. V. light to record those that fluoresced. Lastly, pigmentation, smell, and total macro- and microscopic characteristics were recorded for each species. Using this set of characteristics it was possible to distinguish all of the taxa, and a key to the species based upon these characteristics as recorded on day 30 at 25°C is provided.

INTRODUCTION

Determination of ectomycorrhizal relationships by correlating sporocarp occurrence with a particular host provides only circumstantial evidence at best (Hueck, 1953) and may in fact result in misleading conslusions (Trappe, 1967). Zak and Bryan (1963) and Watling (Pers. Comm.) have also suggested that erratic fruiting of ectomycorrhizal fungi hinders cataloguing of the mycorrhizal flora of a particular host. Pantidou (1961a) has suggested that a standardized method for identifying mycorrhizal fungi from cultural characteristics would be an invaluable contribution to mycorrhizal research. Such a method for identifying mycorrhizal fungi from cultural characteristics is presented in this paper. A list of additional microchemical tests is provided to aid in the identification of mycelia of ectomycorrhizal fungi in pure culture. This represents a modification of the techniques commonly used for wood decay fungi (Nobles, 1965 and Davidson, Campbell, and Vaughn, 1942) and limited groups of ectomycorrhizal species (Campbell and Petersen, 1975; Laut, 1966; Pantidou and Groves, 1966). The ultimate objective is to design a computerized numerical key system for identification of mycelia isolated from ectomycorrhizae on the roots of woody plants.

METHODS AND MATERIALS

One isolate of each of 14 mycorrhizal fungi was selected from the following orders of Eumycota: Agaricales, Aphyllophorales, Sclerodermatales, Hymenogastrales, and Eurotiales. Authorities for each binomial are listed in the cultural description. The taxa were chosen, for the most part, because of their wide use in ectomycorrhizal research. The general procedures from Davidson, Campbell, and Vaughn (1942) and Nobles (1965) were followed to provide the basic growth, incubation, and examination data. However, Hagem's agar modified by Modess (1941) was used for all growth data. Modifications included 1.2 ml of a 1% solution of ferric chloride, 1 ug/l of thiamin, and 0.05 ug/l of biotin. Four replicates of isolates in Petri plates were grown at 15°C, 20°C, 25°C, and 30°C at least twice, and radial growth was measured in centimeters.

Descriptions of the anamorph are based on observations of 5-10 Petri plate cultures of each of the 14 species. Observations were made over a four week period, but cultures were allowed to mature for an additional 8 weeks in the event that further differentiation occurred. Terminology used to describe microscopic characters is that commonly used by others (Nobles, 1965; Pantidou, 1961a, 1961b, 1962; Semerdzieva, 1966; Miller, 1971; Laut, 1966; Campbell and Petersen, 1975). Tests for extracellular enzyme production included growth on gallic and tannic acid agars (Davidson, Campbell, and Blaisdell, 1938) as well as chemical spot tests utilizing syringaldazine, gum guaiac, and phenol (Marr, 1979) (Table 1). A complete list of the microchemical staining reagents is provided in Table 2 along with the results of the tests on hyphae of each species.

The formation of a dark zone just under or surrounding the mycelial plug or mat on tannic acid and gallic acid agar was recorded positive for extracellular oxidase. The size of the zone after 14 days was used to delineate four intensities of oxidase production (Davidson, Campbell, and Vaughn, 1942). Since we find this to be quite variable from isolate to isolate or in replicates of the same isolate, we have only recorded a positive or negative test result. A positive gum guaiac reaction yields a blue color in 30 seconds to several minutes following the application of several drops (usually four) to the surface of the colony near the growing margin after four weeks of growth. However, tyrosinase, which can also oxidize furoguaiacin and yield a blue color, is sometimes present and may provide a false positive test with gum guaiac. Consequently, several drops of 0.1% solution of syringaldazine in ethyl alcohol is also applied to the surface of the mycelium. The appearance of a pink, red, or purple reaction, according to Harkin et al. (1974), is a positive test for laccase. All drawings were made with the aid of a Leitz drawing tube using an oil immersion (X100 objective) and a X 10 eyepiece. Colors are those used by Kornerup and Wanscher (1967).

KEY TO THE SPECIES AT 30 DAYS AT 24°C

1. Culture mycelium white, predominantly white, or very light colored------------------------------------2

1. Culture mycelium pigmented, solidly colored, or pigment developing in age (after one month)------------------10

    2. Cultural mycelium mostly submerged; texture velvety, powdery, felty; aerial mycelium sparse-----------3

    2. Cultural mycelium mostly above agar; texture fluffy or floccose; aerial mycelium obvious-------------8

3. Mycelial surface characteristically with radial furrows---4

3. Mycelial surface upraised or irregular, but never radially furrowed-----------------------------------6

4. Culture odor sweet, fruity; papillate hyphae absent; negative in Sudan IV--------10. *Suillus cothurnatus*

4. Culture odor not distinctive; papillate hyphae present (Fig. 16); lipoidal material or oil bodies in hyphae stain red in Sudan IV--------------------5

5. Pseudoclamps abundant; cystidia stain dark red in phloxine-----------------------12. *Suillus granulatus*

5. Pseudoclamps absent; cystidia not stained in phloxine-----------------------------------11. *Suillus placidus*

6. Irregular twisted, flexuous hyphae present (Fig. 20)-------------------------14. *Suillus tomentosus*

6. Irregular twisted, flexuous hyphae absent--------7

7. Moniliform hyphae and vesicular cells abundant (Fig. 1) throughout colony; red in syringaldazine; smell unpleasant, plasticlike----------------1. *Amanita rubescens*

7. Vesicular cells frequent (Fig. 17), only in area of the margin, rarely becoming catenulate; negative in syringaldazine; smell sweet, fruity---13. *Suillus punctipes*

8. Clamp connections abundant; no smell; oleiferous bodies unstained in Sudan IV---5. *Thelephora terrestris*

8. Clamp connections absent; smell sweet or musty; oleiferous bodies staining red in Sudan IV-------9

9. Refractive hyphal elements present; vesicular cells absent; smell sharp, musty-----7. *Rhizopogon roseolus*

9. Refractive hyphal elements absent; subglobose vesicular cells frequent (Fig. 12); smell sweet---9. *Rhizopogon nigrescens*

10. Culture mycelium submerged or slightly upraised; texture fleshy, rubbery, slightly compact; clamps or pseudoclamps absent--------------------------11

10. Culture mycelium clearly above agar; texture of mat fuzzy or fluffy; clamp connections or pseudoclamps (Fig. 5) abundant-------------------------------12

11. Mycelial mat brownish-black; hyphae incrusted (Figs. 2, 21); no stain in Sudan Black-B--2. *Cenococcum graniforme*

11. Mycelial mat pinkish to flesh colored; hyphae with chlamydospores (Fig. 11), not incrusted; surface deeply furrowed or convoluted; oleiferous bodies stain black in Sudan Black-B-------------8. *Rhizopogon rubescens*

    12. Mycelial mat bright canary yellow; hyphae stain red in Ruthenium Red, dusky rose-red under U. V. light-------------------3. *Piloderma bicolor*

    12. Mycelial mat pastel yellow, buff to yellow-brown or butterscotch; hyphae stain purple with Ruthenium Red, not fluorescing rose-red under U. V. light--13

13. Mycelial mat buff to pastel yellow; hyphae often forming corded strands (Fig. 24) not inflated; smell strong sweet-------------------------6. *Scleroderma aurantium*

13. Mycelial mat yellow-brown to butterscotch or mustard-yellow; hyphae not forming corded strands, but inflated cells present at the septum (Fig. 6); smell not distinctive-----------------------4. *Pisolithus tinctorius*

DESCRIPTIONS OF CULTURES

1. *Amanita rubescens* (Pers.:Fr.) S. F. Gray Fig. 1
VT 990

MACROSCOPIC CHARACTERISTICS: Mycelial mat white to light cream or slightly rosey, under U. V. Light light purple submerged hyphae form a yellow-green ring; reverse[1] cream to orange-beige; mat primarily submerged, aerial mycelium sparse, surface velvety, margin even, grows submerged in agar; maximum browth rate 4.2-4.5 cm in one month at 25°C; smell slightly unpleasant, plasticlike.

MICROSCOPIC CHARACTERISTICS: Hyphae mostly 3-5 um wide, thin-walled, smooth, vesicular hyphae 3-12 um wide, subglobose to irregular, forms long, catenulate chains (Fig. 1);

---

1. reverse refers to the bottom of the Petri plate where the submerged hyphae may be observed and the characteristic color recorded.

septae single, common, contents extremely granular; branching simple, frequent; clamp connections absent.

MICROCHEMICAL REACTIONS:[2] Oleiferous granules in cylindrical and moniliform hyphae black in Sudan Black-B but negative in Sudan IV.

EXTRACELLULAR OXIDASE PRODUCTION:[3] Gum guaiac, syringaldazine and phenol were positive.

2. *Cenococcum graniforme* Fr. Figs. 2, 21
VT 715

MACROSCOPIC CHARACTERISTICS: Mycelial mat dark brownish-black to black; often dusted with dark brownish-orange powder, under U. V. light intense bluish black; reverse black to dark bluish-black; mat fluffy at first, becomes submerged, surface velvety, rubbery, tightly compacted, often forming fine, radiating, stringlike ornamentations from plug, maximum growth rate 2.2-2.4 cm in one month at 25°C; smell not distinctive.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-7 um wide, thick-walled, stiff, bristly, densely papillate, papillae dark brown to black (Figs. 2, 21), minute to conspicuous; hyphae form a tissue composed of a mosaic of stellate clusters (Trappe Figs. 4, 5, 1971) occasionally swollen at septations; branching simple; septae simple; clamps absent.

MICROCHEMICAL REACTIONS: Hyphae yellow to yellow-brown in Sulfovanillin, Sulfoformol, and concentrated H_2SO_4; dark brown in concentrated NH_4OH; oleiferous bodies negative in both Sudan IV and Sudan Black-B.

EXTRACELLULAR OXIDASE PRODUCTION: Tannic and gallic acid agar and gum guaiac were positive.

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[2] eleven microchemical stains were used (Table 2): only positive reactions are listed.

[3] five tests were used (Table 1): only positive reactions are listed.

3. *Piloderma bicolor* (Pk.) Julich Figs. 3, 4, 22
VT 987

MACROSCOPIC CHARACTERISTICS: Mycelial mat bright canary-yellow when young, becomes dull yellow, reddish yellow or yellow-orange with age, under U. V. light dusty rose-red; reverse orange-cinnamon to orange-brown; mat velvety to fuzzy when young, becomes looser, more spread with age, aerial mycelium profuse on newly transferred plug, spreads slowly to fresh medium but eventually covering entire plate with sparse, loosely woven hyphae; maximum growth rate 1.9-2.0 cm in one month at 25°C; smell sharp, musty.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-4 um wide, thin-walled; extremely papillate, papillae light yellow and refractive, moderate in size (Figs. 3, 22), angular, remaining attached; branching infrequent, simple; younger hyphae smooth with frequent anastomoses (Fig. 4), true clamps apparently absent; pseudoclamps abundant, never associated with septations; older cultures with numerous large, yellow crystals in agar under colony, 10-35 um wide, rough, angular, strongly dextrinoid in Melzer's solution.

MICROCHEMICAL REACTIONS: Hyphae deep purple in Cresyl Blue; reddish-yellow in concentrated H_2SO_4; dark red in Ruthenium Red; oleiferous bodies negative in both Sudan IV and Sudan Black-B.

EXTRACELLULAR OXIDASE PRODUCTION: Gallic and tannic acid agar and gum guaiac were positive.

4. *Pisolithus tinctorius* (Pers.) Coker & Couch
VT 716 Figs. 5, 6, 23

MACROSCOPIC CHARACTERISTICS: Mycelial mat yellow-brown or butterscotch at first, becomes dark red-brown in age, under U. V. light dark purple; reverse gold, cinnamon or dark red-brown; mat fluffy at first, later thick, velvety to feltlike; aerial mycelium short, abundant; colony spreads rapidly and covers plate with thick furry layer, agar becomes dark yellow-brown around colony; maximum growth rate 8 cm in two weeks at 25°C; smell not distinctive.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-4 um, moderately thin-walled, minutely papillate, papillae remain on wall, hyphal system simple, branches rarely paarige (Figs. 5, 23); hyphae occasionally inflated to swollen at the septae (Fig. 6), occasionally with large, irregular, refractive, utriform elements; septae simple or clamped; clamps common throughout; all branches originate from clamps.

MICROCHEMICAL REACTIONS: Hyphae dark reddish to golden brown in Sulfovanillin, Sulfoformol, contentrated H_2SO_4; light purple in Ruthenium Red; oleiferous bodies negative in Sudan IV and Sudan Black-B.

EXTRACELLULAR OXIDASE PRODUCTION: Gum guaiac, syringaldazine and phenol were positive. The gallic and tannic acid agar tests were very weakly positive in some cases.

5. *Thelephora terrestris* Ehrl. per Fr. Fig. 7
VT 986

MACROSCOPIC CHARACTERISTICS: Mycelial mat white to cream colored, submerged hyphae greyish-buff to grey-yellow, under U. V. light aerial hyphae light purple, submerged hyphae bright yellow-green; reverse cream to buff, occasionally mottled caramel or vinaceous brown; mat extremely floccose, appressed, grows well into agar; margin irregular, feathery, and almost pulpy in appearance; maximum growth rate 2.6-2.9 cm in one month at 25°C; smell not distinctive.

MICROSCOPIC CHARACTERISTICS: Hyphae mostly 2-6 um wide, thin-walled, smooth, frequently swollen, flexuous and irregularly inflated cells (Fig. 7), 10-32 um, thin-walled, often swollen at the septum, filled with granular material, single or catenulate; branching usually occurs near vesicular cells; hyphae in older regions often contain regularly spaced, rough, angular granules, dark brown or blackish in KOH, 3-5 um wide; septae simple or clamped; clamps abundant.

MICROCHEMICAL REACTIONS: Large and small oleiferous granular material in the cylindrical hyphae stain black in Sudan Black-B, negative in Sudan IV.

EXTRACELLULAR OXIDASE PRODUCTION: Gum guaiac and syringaldazine were positive.

6. *Scleroderma aurantium* Pers. Figs. 8, 9, 24
VT 988

MACROSCOPIC CHARACTERISTICS: Mycelial mat pale to pastel yellow, older portions become orange-yellow or brownish-yellow, under U. V. light light yellow to pale yellow; reverse pastel yellow to brownish-yellow, dark caramel brown near plug; mat fluffy, reaches Petri plate lid, margin regular, radiating, grows primarily on surface, eventually covers plate with a thin, woolly growth; maximum growth rate 2.4-2.8 cm in one month at 30°C; smell strong, earthy, sweet.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-4 um wide, thin-walled, smooth when young, minutely papillate (Fig. 9) in older portions of culture, with frequent anastomoses; characteristically corded, vinelike, intertwined hyphae (Figs. 8, 24) abundant, branching simple; Clamps numerous.

MICROCHEMICAL REACTIONS: Oleiferous bodies in the hyphae, especially near septae, are black in Sudan Black-B, negative in Sudan IV.

EXTRACELLULAR OXIDASE PRODUCITON: A positive gum guaiac reaction and a negative syringaldazine reaction indicates tyrosinase only.

7. *Rhizopogon roseolus* Corda Figs. 10, 25
VT 941

MACROSCOPIC CHARACTERISTICS: Mycelial mat initially white to light pinkish-white, becomes cream, pale greyish-buff to pale lilac brown in age, margin light reddish-purple or purple-brown in age, under U. V. light lilac; reverse tan, creamy brown to golden brown, forms concentric ridges in agar; colony fluffy at first; aerial mycelium reaches the Petri plate lid, becomes matted, dense, cottony; margin even, aerial mycelium thin toward edge, often with colorless droplets of exudation on older portion of culture; maximum growth rate 3.5-3.8 cm in one month at 20°C; smell sharp, musty.

MICROSCOPIC CHARACTERISTICS: Hyphae mostly narrow, 1.5-3 um wide, thin-walled; branching simple or occasionally paarige (Fig. 10), large, non-septate hyphal elements prominant, 5-7 um wide, thick-walled, refractive, occasionally inflated or swollen, contorted into various shapes, distinctly different from surrounding hyphae (Figs. 10, 25); simple septate; clamps absent.

MICROCHEMICAL REACTIONS: Hyphae and hyphal elements dark orange-red in Congo Red with large oleiferous bodies which are red in Sudan IV, black in Sudan Black-B.

EXTRACELLULAR OXIDASE REACTION: Tannic and gallic acid agar, syringaldazine and phenol were positive. Some isolates were weakly positive for tannic and gallic acid agar while others were negative. These are repeatable for a given culture isolate.

8. *Rhizopogon rubescens* Tul. Fig. 11
VT 1298

MACROSCOPIC CHARACTERISTICS: Mycelial mat white at first, center becomes cream, margin darker, often buff to pale yellowish-brown, under U. V. light center pale purple, margin purple-brown; reverse pale caramel, center darker brown, evenly furrowed forming star pattern; center of mat slightly upraised, margin lower, grows well into the agar, mat felty to tomentose, radially furrowed from plug; rhizomorphic strands abundant, radiates from plug into the margins; margins not entire, dissected into small, featherlike fans; mat surface exudes colorless droplets; smell musty; mat bruising brick red where crushed; maximum growth rate 2.9-3.6 cm in one month at 20°C.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-7 um wide, hyaline in KOH and Melzer's solution, moderately thin-walled, smooth branched, often appearing wavy or contorted, anastamoses common; paarige branching abundant, septae common, irregular fingerlike branches common at septations; rhizomorphic strands frequent, tightly clustered; large vesiculose hyphae common on older portion of mat, variously shaped, subglobose, elongated to pyriforme; walls thin or thick, often refractive and refractive hyphal elements present.

MICROCHEMICAL REACTIONS: Vesicular cells rose-red to pinkish-red in 15% KOH, phloxine, Ruthenium Red, and Sulfovanillin. Hyphae with large, globose, oleiferous bodies which are hyaline in Sudan IV but some were black in Sudan Black-B.

EXTRACELLULAR OXIDASE REACTION: Syringaldazine and gum guaiac were positive. Gallic and tannic acid agar were weakly positive.

9. *Rhizopogon nigrescens* Coker & Couch Fig. 12
VT 942

MACROSCOPIC CHARACTERISTICS: Mycelial mat beige, greyish-orange to brownish-orange, in age forms dark purple-brown patches near the plug or on the margin, under U. V. light light purple with dark purple patches; reverse caramel brown to dark brownish orange, forming concentric rings in agar; mycelial mat low, floccose, dense, felty in age; margin regular, aerial mycelium sparser toward edge; small droplets of colorless exudate forming on older parts of mat; maximum growth rate 3.0-3.4 cm in one month at 25°C; odor strong, sweet and pleasant.

MICROSCOPIC CHARACTERISTICS: Hyphae mostly 3-7 um, thik-walled, smooth, frequently swollen at septations or forming vesiculose, catenulate cells, 6-33 um wide (Fig. 12) thin-walled, easily collapsing; branching mostly simple, paarige infrequent; dendritic hyphae common; septae simple; clamps absent.

MICROCHEMICAL REACTIONS: Hyphae with large and small oleiferous bodies which are red in Sudan IV, negative in Sudan Black-B.

EXTRACELLULAR OXIDASE REACTION: Tannic and gallic acid agar and gum guaiac positive but syringaldazine negative which indicates the presence of tyrosinase.

10. *Suillus cothurnatus* Sing. Figs. 13, 26
VT 946

MACROSCOPIC CHARACTERISTICS: Mycelial mat light buff, cinnamon buff to light vinaceous brown, darker near the plug, under U. V. light light purple with dark purple patches; reverse light cinnamon tan, buff or caramel colored, often with sculptured, concentric zonations in agar; mat dense, feltlike, radially furrowed; aerial mycelium sparse, more so toward edge, grows well into agar; margin irregular, submerged, feathery; maximum growth rate 2.5-3.5 cm in one month at 25°C; smell sweet, fruity, similar to apple cider.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-5 um wide, thin-walled, smooth, terminal or subterminal; chlamydospores (Fig. 13) infrequent 10-15 um wide, globose or utriform, thin-walled with or without granular or lipoidal contents (Fig. 26); dendritic hyphae (Fig. 13) common throughout culture; hyphal branches short, stubby, fingerlike; paarige branches confined to older portion of mat; septae simple; clamps absent.

MICROCHEMICAL REACTIONS: Hyphae with oleiferous bodies which are black in Sudan Black-B, negative in Sudan IV.

EXTRACELLULAR OXIDASE REACTIONS: Gum guaiac and phenol were positive. It must be noted that the tannic acid agar was positive while the gallic acid agar was weakly positive. It is most likely that tyrosinase is present since the syringaldazine is negative.

11. *Suillus placidus* (Bonorden) Sing. Figs. 14, 15
VT 945

MACROSCOPIC CHARACTERISTICS: Mycelial mat light lilac brown, mottled with areas of white or darker vinaceous brown, dark lilac brown in age, under U. V. light pale purple with patches of dark purple-brown; reverse buff to darker lilac brown with concentric zonations of color; mat felty, compact, generally with radiating furrows, center upraised, margin irregular, feathery, and yeastlike, grows slightly into the agar; maximum growth rate 2.2-2.6 cm in one month at 20°C; smell not distinctive.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-5 um wide, thin-walled, often ending in gloeoplerous, obclavate to lanceolate, cystidial end-cells (Fig. 14) frequent terminal or intercalary chlamydospores (Fig. 15) usually single or in pairs, thin-walled, globose, subglobose or slightly elongated, 10-25 um, filled with refractive, granular material or appearing empty; papillate hyphae abundant, more pronounced in 3% KOH; paarige branching conspicuous; dendritic hyphae common; septae simple; clamps absent.

MICROCHEMICAL REACTIONS: Hyphae with oleiferous bodies red in Sudan IV and black in Sudan Black-B.

EXTRACELLULAR OXIDASE REACTIONS: Tannic and gallic acid agar, gum guaiac, and syringaldazine were all positive.

Replicates yielded a negative gallic acid agar test but all else remained unchanged.

12. *Suillus granulatus* (L.:Fr.) Kuntze Fig. 16
VT 991

MACROSCOPIC CHARACTERISTICS: Mycelial mat white, mottled light grey or cinnamon-brown, darker brown in age, under U. V. light light purple with dark purple patches in age, submerged hyphae form a yellow ring; reverse mottled buff to greyish-brown, vinaceous brown or cinnamon; mat feltlike, with either moundlike cones or irregular mounds and often with radiating furrows, which grow well into agar; submerged margin feathery; maximum growth rate 2.5-3 cm in one month at 20°C; smell not distinctive.

MICROSCOPIC CHARACTERISTICS: Hyphae 2-5 um wide, thin-walled, often swelling between septations or terminally to form cystidialike cells, 15-27 um wide, often filled with granular material or empty; gloeoplerous hyphae scattered, thin, refarctive, highly anastomosing; papillate hyphae abundant (Fig. 16), particles variously 2-4 um, angular to smooth, staining brown in 3% KOH, breaking free, numerous; paarige branches (Fig. 16) common; dendritic hyphae predominant in margin; septae simple; pseudoclamps abundant; clamps absent.

MICROCHEMICAL REACTIONS: Cystidialike cells dark red in phloxine with large oil bodies which are red in Sudan IV and black in Sudan Black-B. Culture turning tan, then dark reddish-brown where touched with 3% KOH.

EXTRACELLULAR OXIDASE REACTIONS: Tannic and gallic acid agar, gum guaiac and syringaldazine were all positive.

13. *Suillus punctipes* (Pk.) Sing. Fig. 17
VT 944

MACROSCOPIC CHARACTERISTICS: Mycelial mat white at first; older cultures develop light grey-brown or tawny-olive patches, under U. V. light intense purple; reverse buff, light creamy tan, dark tan, or dark cinnamon brown near plug; mat cottony at first, in age compact, felty to almost powdery, center of colony upraised; margin irregular, radially feathering, grows primarily on the surface;

maximum growth rate 2.8-3.0 cm in one month at 25°C; smell sweet, fruity.

MICROSCOPIC CHARACTERISTICS: Hyphae 3-5 um wide, thin-walled, smooth, chlamydospores intercalary (or rarely terminal); frequent in margin, 5-20 um, thin-walled, globose, subglobose or elongated (Fig. 17), often readily collapsing, single or catenulate, containing granular material or appearing empty; branching simple; dendritic hyphae common; hyphal anastamoses abundant (Fig. 17) usually associated with septae; septae mostly simple; clamps infrequent, only on older main hyphae.

MICROCHEMICAL REACTIONS: Hyphae with oleiferous bodies in both the hyphae and vesicular cells which are black in Sudan Black-B and negative in Sudan IV.

EXTRACELLULAR OXIDASE REACTIONS: Tannic and gallic acid agar, gum guaiac and phenol were positive. The negative syringaldazine could indicate that tyrosinase in present. Older cultures fail to yield a positive test for tannic and gallic acid agar.

14. *Suillus tomentosus* (Kauff.) Sing.
VT 493 Figs. 18, 19, 20, 27

MACROSCOPIC CHARACTERISTICS: Mycelial mat white at first, slightly pinkish in age, under U. V. light purple; reverse buff to creamy tan, darker tan toward center, occasionally slightly zonate; mat fluffy at first, felty to powdery in older cultures, slight upraised, margins translucent, feathery, submerged; maximum growth rate 3.0-3.5 cm in one month at 20°C; smell sharp, metallic.

MICROSCOPIC CHARACTERISTICS: Hyphae 1-4 um wide, thin-walled, often irregularly swollen at the septae, gloeoplerous hyphae present, terminal or intercalary, refractive with large, yellowish granules, arthrospores dedevelop from these cells in age (Figs. 19, 26); vesicular cells frequent in the margins (Fig. 18), terminal and intercalary, 7-25 um, thin-walled, globose, subglobose or irregularly elongated, usually empty; branching simple; dendritic hyphae common, helicoid, irregular, twisted, flexuous hyphae abundant (Fig. 20) in the older portions of the mat; septae simple; clamps absent.

MICROCHEMICAL REACTION: Large and small hyphae with oleiferous bodies which are red in Sudan IV and black in Sudan Black-B.

EXTRACELLULAR OXIDASE REACTIONS: Tannic and gallic acid agar, gum guaiac and syringaldazine were positive.

CONCLUSIONS AND DISCUSSION

To simplify identifications, only the most obvious characteristics were utilized. However, enough flexibility is present in the system to allow the inclusion of more cultures which will have sufficient variability to enable the anamorphs to be distinguished. As additional species are added to the system additional microchemical tests will become useful. For example, Melzer's solution produced no reactions on the 14 isolates tested. In addition, further use of combinations of characteristics will also have to be made. The next step, now in progress, is to establish a computer program to facilitate the entry and retrieval of data necessary in the process of identification.

We conclude that gallic and tannic acid agars cannot be reliably used to distinguish taxa of mycorrhizal fungi. Discoloration of the agar by a single isolate is sometimes inconsistent. It is also necessary to record the time it takes to achieve a blue (positive) gum guaiac reaction. A reaction which slowly occurs over a period of 30 minutes to 1 hour may well be the product of an inducible enzyme system and does not represent the ongoing production of a functioning extracellular oxidase system. It is also important to have fresh gum guaiac because the strength of the reaction diminishes with increasing age of the reagent. However, the majority of the microchemical reactions are discrete, and the total characteristics presented here is sufficient to distinguish anamorphs. A rigorous test of the system is underway with the addition of characters for closely related mycorrhizal taxa. Data are being computerized to provide quick and accurate identification of anamorphs and to accomodate an increasing number of combinations of characteristics.

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Table 1. Selective media and chemical spot tests indicating production of extracellular oxidase.

			Indicators				
Isolate	Tannic Acid Agar	Gallic Acid Agar	Gum Guaiac	Syring-aldazine	Syring-aldazine + H_2O_2	Phenol	
1. *Amanita rubescens*			B	R		R/V	
2. *Cenococcum graniforme*	Br	Br	B				
3. *Piloderma bicolor*	Br	Br	B				
4. *Pisolithus tinctorius*			B	R	P	R/V	
5. *Thelephora terrestris*			B	R			
6. *Scleroderma aurantium*			B				
7. *Rhizopogon roseolus*	Br	Br		R	P	R/V	
8. *Rhizopogon rubescens*	Br	Br	B	R	P		
9. *Rhizopogon nigrescens*	Br	Br	B				
10. *Suillus cothurnatus*	Br	Br	B			R/V	
11. *Suillus granulatus*	Br	Br	B	R	P		
12. *Suillus placidus*	Br	Br	B	R	P		
13. *Suillus punctipes*	Br	Br	B		P	R/V	
14. *Suillus tomentosus*	Br	Br	B	R			

Legend: Positive reactions are indicated by the following colors: Br = brown stain in agar B = blue, R = red, P = purple, R/V = red or violet

Table 2. Microchemical Staining Reactions

	Stain										
Isolate	Cresyl Blue	Sulfovanillin	Sulfoformol	Concentrated H_2SO_4	15% KOH	Phloxine	Ruthenium Red	Congo Red	Concentrated NH_4OH	Sudan IV	Sudan Black-B
1. *Amanita rubescens*											H,V,O B
2. *Cenococcum graniforme*		H YB	H Y	H YB					H Br		
3. *Piloderma bicolor*	H P			H RO			H R				
4. *Pisolithus tinctorius*		H RB	H RB	H Br			H P				
5. *Thelephora terrestris*											H,V,O B
6. *Scleroderma aurantium*											H,O B
7. *Rhizopogon roseolus*								H RO		H,O R	H,V,O B
8. *Rhizopogon rubescens*					V R	V R	V P				H,V,O B
9. *Rhizopogon nigrescens*										H,C R	
10. *Suillus cothurnatus*											H,V,O B
11. *Suillus granulatus*						C R				H,O R	H,V,O B
12. *Suillus placidus*										H,O R	H,V,O B
13. *Suillus punctipes*											H,V,O B
14. *Suillus tomentosus*										H,V,O R	H,V,O B

Legend: Structures--C = cystidia, H = hyphae, V = swollen or vesicular cells, O = small or large oleiferous bodies within cells.

Colors--B = black, Br = brown, P = purple, R = red, RB = reddish-brown, RO = reddish-orange, Y = yellow, YB = yellowish-brown.

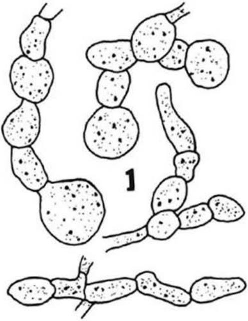
Fig. 1. *Amanita rubescens*, vesiculose cells in catenulate chains. Fig. 2. *Cenococcum geophilum*, hyphae with black papillate patches. Figs. 3-4. *Piloderma bicolor*. Fig. 3. Hyphae with minute granular incrustations. Fig. 4. Smooth, young, anastamosing hyphae. Figs. 5-6. *Pisolithus tinctorius*. Fig. 5. Paarige branching and clamp sonnections. Fig. 6. Cells inflated at the septum.

Fig. 7. *Thelephora terrestris*, flexuous and irregularly inflated hyphal cells. Figs. 8-9. *Scleroderma aurantium*. Fig. 8. Intertwining or corded hyphae. Fig. 9. Minutely papillate hyphae. Fig. 10. *Rhizopogon roseolus*, occasional paarige branching and infrequent coiled refractive cells with yellow contents. Fig. 11. *Rhizopogon rubescens*, terminal or intercalary vesiculose cells. Fig. 12. *Rhizopogon nigrescens*, vesiculose, catenulate, thin-walled cells.

Fig. 13. *Suillus cothurnatus*, narrow dendritic hyphae with terminal and intercalary chlamydospores. Figs. 14-15. *Suillus placidus*. Fig. 14. Obclavate to lanceolate end-cells. Fig. 15. Terminal or intercalary chlamydospores. Fig. 16. *Suillus granulatus*, papillate hyphae with paarige branching. Fig. 17. *Suillus punctipes*, anastomosing hyphae and chlamydospores.

Figs. 18-20. *Suillus tomentosus*. Fig. 18. Terminal and intercalary vesiculose cells. Fig. 19. Arthrospore initials. Fig. 20. Irregular, twisted, flexuous hyphae.

Fig. 21. *Cenococcum geophilum*, black incrustations and papillate particles. Fig. 22. *Piloderma bicolor*, minute granular incrustations. Fig. 23. *Pisolithus tinctorius*, paarige branching and multiple clamp connections. Fig. 24. *Scleroderma aurantium*, corded hyphae. Fig. 25. *Rhizopogon roseolus*, coiled refractive cell with yellow contents. Fig. 26. *Suillus cothurnatus*, hyphae with granular or lipoidal contents. Fig. 27. *Suillus tomentosus*, arthrospores shown in phase contrast.



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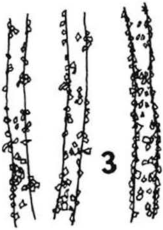

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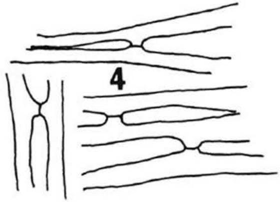

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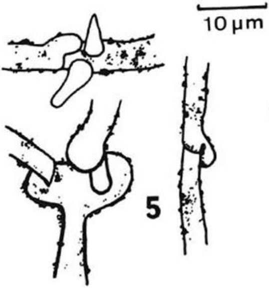

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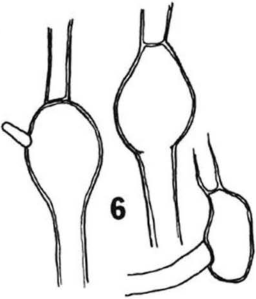

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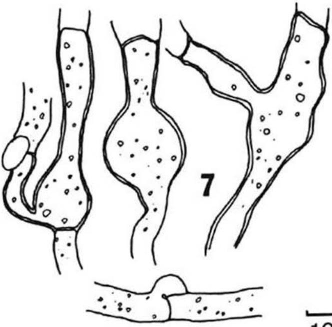
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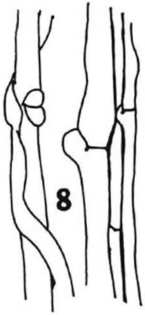
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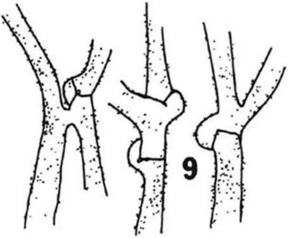
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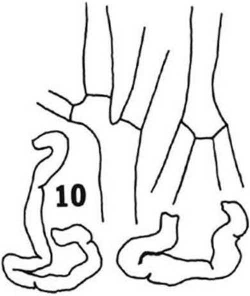
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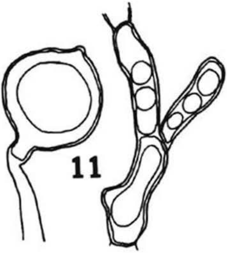
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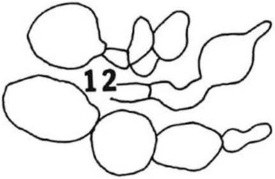
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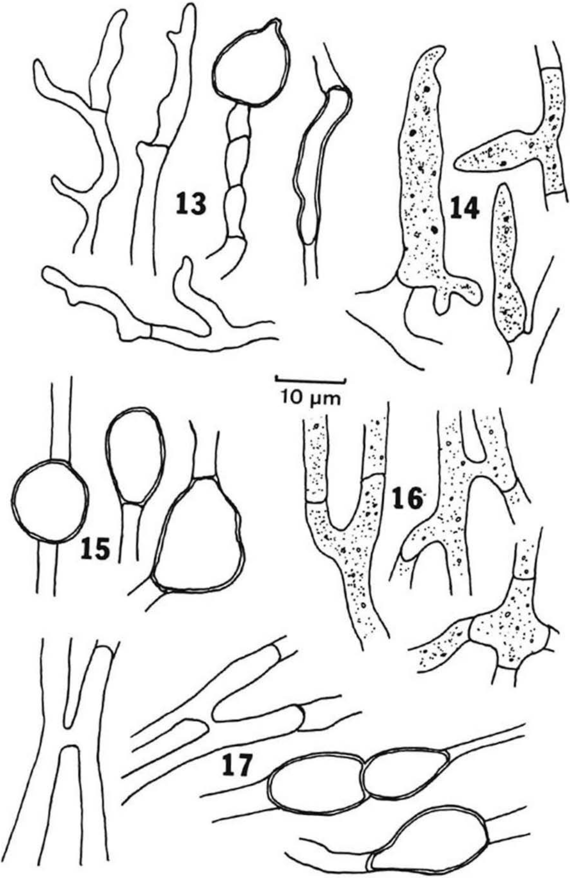
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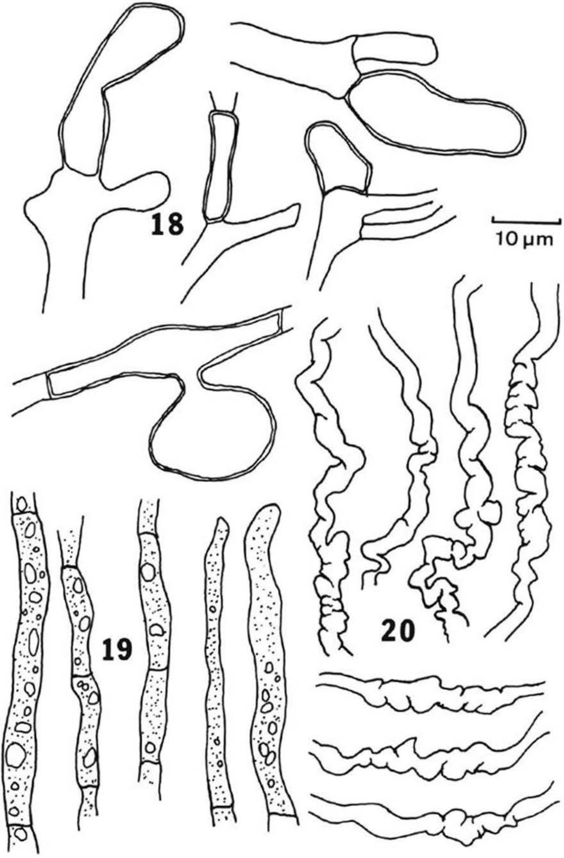
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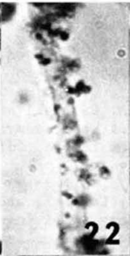
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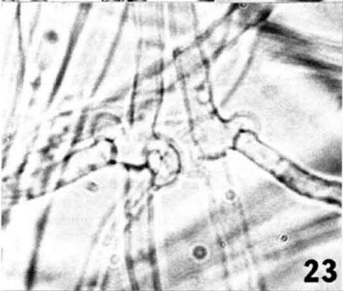
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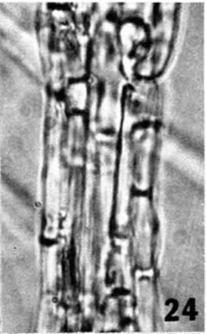
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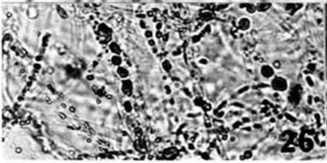
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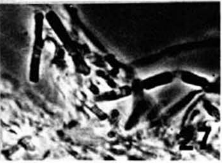
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LITERATURE CITED

Campbell, M. P. and R. H. Petersen. 1975. Cultural characters of certain *Amanita* taxa. Mycotaxon 1:239-258.

Davidson, R., W., W. A. Campbell and D. J. Blaisdell. 1938. Differentiation of wood-decaying fungi by their reactions on gallic or tannic medium. J. Agr. Res. 57: 683-695.

Davidson, R. W., W. A. Campbell and D. B. Vaughn. 1942. Fungi causing decay of living oaks in the eastern United States and their cultural identification. USDA Tech. Bull. 785:1-65.

Harkin, J. M., M. J. Larsen and J. R. Obst. 1974. Use of syringaldazine for detection of laccase in sporophores of wood rotting fungi. Mycologia 66:469-476.

Hueck, H. J. 1953. Myco-sociological methods of investigation. Vegetaro Acta Geobotanica 4:84-101.

Kornerup, A. and J. H. Wanscher. 1967. Methuen Handbook of Colour. 3rd Ed. Eyre Methuen, London, 252p.

Laut, J. G. 1966. Cultural characteristics of three species of *Boletinus*. Can. J. Bot. 44:395-402.

Marr, C. D. 1979. Laccase and tyrosinase oxidation of spot test reagents. Mycotaxon 9:244-276.

Miller, O. K. 1971. The Relationship of Cultural Characters to the Taxonomy of the Agarics, p. 197-215. (IN: Evolution in the Higher Basidiomycetes, R. H. Petersen, ED.) Univ. of Tenn. Press.

Modess, O. 1941. Zur kenntnis der mycorrhizabildner von diefer und fichte. Symb. Bot. Ups. 5:1-146.

Nobles, M. K. 1965. Identification of cultures of wood inhabiting hymenomycetes. Can. J. Bot. 43:1097-1139.

Pantidou, M. E. 1961a. Cultural studies of Boletaceae-*Gyrodon meruliioides* and four species of *Boletinus*. Can. J. Bot. 39:1149-1162.

Pantidou, M. E. 1961b. Carpophores of *Polyporus sulphureus* in culture. Can. J. Bot. 39:1163-1167.

______. 1962. Cultural studies of Boletaceae--carpophores of *Phlebopus lignicola* in culture. Can. J. Bot. 40: 1313-1319.

______ and J. W. Groves. 1966. Cultural studies of Boletaceae--some species of *Suillus* and *Fuscoboletinus*. Can. J. Bot. 44:1371-1392.

Semerdzieva, M. 1966. Morphological observation of some *Pleurotus* mycelium. Sydowia Ann. Mycol. 19:250-258.

Trappe, J. M. 1967. Principles of classifying ectotrophic mycorrhizae for denitrification of fungal symbionts. Proceedings of the 14th Congress of International Union of Forest Research Organizations, Munich, Part V, Sec. 24:46-59.

Zak, B. and W. C. Bryan. 1963. Isolation of fungal symbionts from pine mycorrhizae. For. Sci. 9:270-278.

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ADDITIONS TO THE LICHEN FLORA OF GREENLAND

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SUMMARY

12 species of lichens are reported as additions to the known lichen flora of Greenland, viz. Arctomia interfixa (Nyl.) Vain., Aspicilia aquatica Körb., Cladonia ochrochlora Flörke, C. strepsilis (Ach.) Vain., C. symphycarpa (Ach.) Fr., Lecanora chloroleprosa (Vain.) Magn., L. reagens Norm., L. subradiosa Nyl., Lecidea furvella Nyl. ex Mudd, L. nigroleprosa (Vain.) Magn., Squamarina lentigera (Web.) Poelt and Verrucaria erichsenii Zsch. Short descriptions and comments on the ecology and distribution of the various species are provided.

INTRODUCTION

New additions to the Greenland lichen flora still appear during the continuous revisions of the extensive collections of lichens deposited in Copenhagen (C).

Among the more recent collections from Greenland those of Dr. Paul Gelting, who was the scientific leader of the Arctic Station on Disko Island in West Greenland in the years of 1946 - 54, are particularly rich in interesting species. At present the most critical part of his material are under revision by the present author and by several specialists on various groups at home and abroad, a "sine qua non" for a more complete survey of the lichen flora of Greenland, undertaken by the author of this paper. Some results of this revision work are presented here.
All specimens dealt with in this paper can be found in herb. C.

TAXONOMIC PART

ARCTOMIA INTERFIXA (Nyl.) Vain.

Description: Thallus crustose, rosulate, dark red-brown, distinctly lobate. Lobes of the present specimen up to 0.4 mm long. Cortex consisting of one cell layer. Algae: Nostoc filaments. Ascocarps (Fig. 2) sessile, lecideine, reddish brown. Hymenium I+ blue (asci amyloid). Paraphyses netlike with thickened ends. Spores (Fig. 1) hyaline, 3(-7)- septate, acicular, with one end rounded and the other pointed, 26-44 x 4.5-6µm.

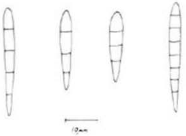


Fig. 1. Arctomia interfixa (Nyl.) Vain. Ascospores from Coll. no. 14397a (scale = 10 µm).

Arctomia interfixa can easily be confounded with A. delicatula Th. Fr., which is known from a few localities in South West Greenland (Dahl 1950) and Disko in Central West Greenland (unpublished collections deposited in herb. C). The spores of A. delicatula are, however, usually longer than 50µm and 6-13-septate, and its lobes are shorter than 0.2 mm.

Distribution: A. interfixa is very rare in Greenland. The species is previously known from northernmost Scandinavia, Novaya Zemlya and Spitzbergen (Poelt & Vězda 1977).

Specimens studied: C.W. Greenland: Disko I., Blåfjeld, Nuk kitleq, 69°22'N 54°15'W, 15 m, on Andreaea on boulder in snowbed, 1951 Gelting 14397a (det. Aino Henssen); Godhavn, near the Arctic Station, on mosses on gneissic rock, and on twigs of Dryas integrifolia, 1982 Poelt & Ullrich (2 specimens).

ASPICILIA AQUATICA Körb.

(Syn. A. amphibola (Vain.) Arn.)

Description: Thallus crustose, chinky-areolate, grey-bluish grey with a yellowish tinge. Cells of upper cortex in perpendicular rows. Thallus K-. Apothecia 1-3 per areole (Fig. 3), immersed; disc to 1 mm broad, black; margin thick, grey. Epithecium greenish olive; hypothecium brownish. Hymenium I+ blue. Paraphyses branched toward the apices. Spores hyaline, simple, broadly ellipsoid, 22-35 x 14-18µm.

Distribution: Aspicilia aquatica occurs occasionally on Disko. In Greenland the species has not been found outside this island. It is comparatively common in Lapland (Magnusson 1952).

Specimens studied: C.W. Greenland: Disko I., Diskofjord, eastern coast of Storø (Qeqertaq), 69°31'N 54°06'W, 10 m, on basaltic boulder in brook, 1950 *Gelting*; east side of Tuno, c. 69°30'N 53°W, on basaltic rock in brook, 1949 *Gelting*. - Mellemfjord, Narsarssuaq, 69°44'N 54°38'W, 15 m, on basaltic boulder in brook, 1949 *Gelting*. - Godhavn, Quvnermiut, 69°15'N 53°36'W, 6-8 m, on gneissic boulder in brook, 1953 *Gelting* 20673; the Arctic Station, 69°15'N 53°32'W, 60 m, on basaltic rock, 1952 *Gelting* 18677.

CLADONIA OCHROCHLORA Flörke

Description: Primary squamules of the present specimens 1-6 mm long and up to 5 mm broad, broadening from the base, laciniately lobed or incised crenate, flat, ascending, the margin crenate; upper side glaucescent, underside white; esorediate. Podetia up to 2 cm tall, cupless and subulate or with narrow cups, which are flaring gradually, the interior closed. The base of the podetium corticate with small squamules, glaucescent, the upper part decorticate and farinose sorediate. Thallus K-, C-, KC-, P+ red, containing fumarprotocetraric acid. Greenland specimens sterile.

Prof. Teuvo Ahti, Helsinki, has revised the Greenland collections of "Cladonia coniocraea (Flörke) Spreng." mentioned in Dahl (1950) and deposited in herb. C. Although the podetia of these specimens are comparatively small, he found that the specimens show some diagnostic characters of C. ochrochlora, for example, the corticate patches and corticate sheath, which extends fairly high up at the podetia. The "true" C. coniocraea is corticate at the base of the podetia only. Contrary to this species the European distribution of C. ochrochlora shows clear oceanic tendencies.

Specimens studied: S.W. Greenland: Julianehåb District, Qordlortorssuaq, 60°45'N 45°10'W, on old fragments of *Betula*, 1937 *Dahl* (det. *Teuvo Ahti*).

CLADONIA STREPSILIS (Ach.) Vain.

Description: Primary squamules densely tufted, up to 4 mm long and broad, moderately incised; upper side olivaceous, ± areolate; underside greyish white; esorediate. Thallus P+ yellow, K-, C+ blue-green, KC+ brownish-green, containing squamatic acid, baeomycesic acid, barbatic acid and strepsilin. Podetia and apothecia not found in the present collections. Pycnidia on the primary squamules.

Distribution: Cladonia strepsilis is very rare in Greenland. According to Poelt & Vězda (1977) C. strepsilis is distinctly oceanic and frequently occurring in Western Europe, but it is rare in alpine areas. The species is widely distributed in Eastern United States (Thomson 1968) up to Newfoundland (Ahti 1983).

Specimens studied: C.W. Greenland: Arfersiorfik, Itivdliarssuk, 67°55'N 50°40'W, on soil in heath together with, e.g., Coelocoulon aculeatum and Cladonia pleurota, 1951 Gelting 15889, 15894, 15903, 15922 & 15926.

CLADONIA SYMPHYCARPA (Ach.) Fr.

Description: Primary squamules horizontal with ascending or reflexed margins, up to 6 mm long and 4 mm broad, rounded or incised-lobate; upper side greyish brown to olive green; underside white, darkening towards the base; esorediate. Podetia up to 1.5 cm, richly branched, the sides distinctly fissured; cortex areolate to verrucose with small squamules, exposing the inner medullary layer. Thallus P+ golden yellow, K+ yellow, C-, KC-, containing atranorin. Apothecia abundantly on the apices of the podetia - branches, dark brown, up to 4 mm, sublobate and fissured. Pycnidia on the primary squamules.

Prof. Ahti has confirmed the determination of the species, which possibly is more common in Greenland than previously supposed. The more precise relationship between Cladonia cariosa (Ach.) Spreng. and C. symphycarpa (inclusive of C. dahliana H. Krist.) is, however, still to be settled as regards the Greenland populations.

Distribution: C. symphycarpa is widely distributed in Central and Northern Europe, but is most frequent in areas with extensive occurrences of basic rocks and soils and in steppe-like areas (Poelt & Vězda 1977).

Specimens studied: C.W. Greenland: Disko I., Diskofjord, Orpit qaqa, 69°35'N 53°25'W, 20 m, calcareous soil together with Cladonia pocillum, 1950 Gelting.

LECANORA CHLOROLEPROSA (Vain.) Magn.

(Syn. L. chlorophaeodes Nyl. subsp. chloroleprosa Vain.)

Description: Thallus crustose, dispersed, granulose or verrucose-areolate (globulose in some specimens, e.g., Gelting 19982c) ± sorediate, pale sulphur-coloured, KC+ yellow, containing usnic acid and zeorin. Greenland specimens sterile. Immature ascocarps were, however, observed in no. 18573, leg. Gelting.

Mr. Heino Vänskä, Helsinki, has kindly confirmed the determination of this and the following species (L. reagens).

The colour of the thallus of *Lecanora atrosulphurea* (Wahlenb.) Ach. is much like that of L. chloroleprosa, but the former species differs by its areolate, chinky-globulose thallus without soredia and its contents of thiophanic acid (C+ red) in addition to usnic acid, zeorin and fatty acids. Contrary to L. chloroleprosa, Greenland collections of L. atrosulphurea is usually richly fertile, and moreover this species has a wider distribution in Greenland (SE, SW, CW).

Distribution: Lecanora chloroleprosa is very rare in Greenland, known only from some localities around Godhavn, Disko. It is previously known from, e.g., Lapland and North East Finland.

Specimens studied: C.W. Greenland: Disko I., Godhavn, Røde Elv, 69°15'N 53°32'W, 15 m, 1950 *Gelting* ; Elvestubben (Røde Elv), 15 m, 1952 *Gelting* 18189; Storstubben, 1953 *Gelting*; Lyngmarksbugten, 30 m, 1950 & 1952 *Gelting* 18573); Lange Kær, 25 m, 25 m SE of Point 28.5, 24 m, on occasionally moistened gneissic rock together with *Ephebe lanata*, 1952 *Gelting* 17405; Østerdalen, 25 m, 1951 *Gelting* 15735); 40 m W. of watercourse, 20 m, 1953 *Gelting* 19982c; Claus Vævers væg, 18 m, 1953 *Gelting* 20133; 100 m, 1953 *Gelting* 19982a; in fissures in S.-exposed gneissic rock at the Arctic Station, 15 m, 1951 *Gelting* 13975. - 29 July 1982 *J. Poelt* & *H. Ullrich* collected sterile Lecanora chloroleprosa on basaltic rocks east of the entrance to Røde Elv (Godhavn).

LECANORA REAGENS NORM.

Description: Thallus crustose, dispersed to almost continuous, consisting of yolk yellow, convex granules and lobes, which develop into deeply concave soralia up to 1 mm broad and of the same colour as the thallus, K+ cinnamon (the sparse Greenland material did not allow further chromatographic analysis). All specimens sterile.

Distribution: At present Lecanora reagens is known only from the Godhavn area, but the species has probably been somewhat neglected in Greenland because of its inconspicuous appearance and very special habitat. It has previously been recorded from Fennoscandia and the Alps (Poelt 1969).

Specimens studied: C.W. Greenland: Disko I., Godhavn, Quvnermiut, 25 m, on occasionally inundated, S.-exposed gneissic cliff, partly on mosses, partly on rock in association with

Thyrea radiata, Collema glebulentum, Toninia caeruleonigricans and Vestergrenopsis isidiata,1952 Gelting 18636f; Lange Kær, 300 m W. of eastern edge of fen, 21 m, over gloeolichens on temporarily moist, S.-exposed gneissic rock, 1952 Gelting 17322 & 22 m, on mosses, 1952 Gelting; rocky cave, nesting site of snow buntings, 27 m, on mosses on E. -exposed surface, 1952 Gelting 17298; overhanging, gneissic rock moistened by percolating water, 20 m, 1953 Gelting 19583; rocky cave, 25 m, on mosses on S.-exposed surface, 1953 Gelting 19798b; on mosses on W.-exposed surface of rock, 26 m, 1953 Gelting 19696d; gneissic rock, 1953 Gelting 19723; rocky cave close to the Arctic Station, on mosses and dead plant fragments, 1952 Gelting 17351.

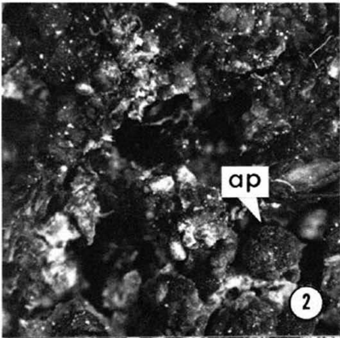
LECANORA SUBRADIOSA Nyl.

Description: Thallus crustose, areolate, esorediate, forming rounded, straw yellow (cream-coloured in shadow forms) patches, which are sometimes confluent. Areolae convex-verruculose uneven, knotted. Hypothallus cream-coloured, radiating along the margin of thallus. Thallus P+ yellow, K+ yellow, C+ orange,I-, (the sparse material did not allow further chromatographical investigation). Apothecia aggregated, to 1.5 cm broad, constricted at the base; disc flat or convex, grey with a rose tinge, pruinose; margin thick, straw yellow, later becoming flexuose and excluded; epithecium and hypothecium pale; paraphyses unbranched; spores 8, hyaline, simple, 11-15/5-8 μm.

Lecanora subradiosa has a number of characters in common with the alpine species L. lojkaeana Szat. (for example, the constricted base of the ascocarps and the highly convex areoles), but is never sorediate like the latter species.

Distribution: L. subradiosa is widely distributed in Central and North Europe (Poelt & Vězda 1981), but has presumedly been somewhat neglected in many areas because of its very special ecological conditions. It is very rare in Greenland, known so far from a few localities near Godhavn (69°15'N 53°32'W) on Disko in Central West Greenland only.

Fig. 2: Arctomia interfixa (Nyl.) Vain. Fertile thallus (ap = apothecium) growing on Andraea on a boulder on Blåfjeld. Coll. no. 14397a (x 40). 3: Aspicilia aquatica Körb. Central part of thallus with numerous apothecia from a gneissic boulder in a brook at Quvnermiut, Godhavn. Coll. no. 20673 (x 12). 4: Lecanora chloroleprosa (Vain.) Magn. Sterile thallus growing on a gneissic rock in Lyngmarksbugten. Coll. no. 18573 (x 7). 5-6: Lecanora reagens Norm. 5: Sterile thallus growing on mosses in a rocky cave close to nesting site of snow buntings near Godhavn. Coll. no. 17298 (x 7). 6: Different stages of development of soralia from Coll. no. 17298 (x 40).



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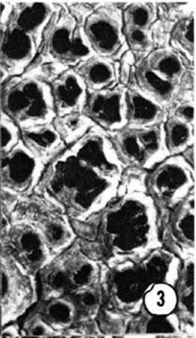

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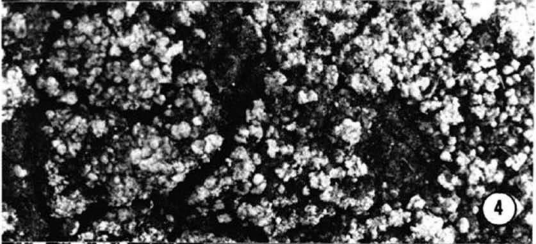

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Specimens studied: C.W. Greenland: Disko I., Godhavn, the Arctic Station, 20 m, on the underside of overhanging, gneissic rocks below nesting sites of snow buntings (Plectrophenax nivalis), growing together with Xanthoria elegans, X. candelaria, Rhizocarpon geminatum and Umbilicaria decussata, 1952 Gelting 17286 & 145 in "Lichenes Groenlandici Exsiccati", Fasc. III; 1953 Gelting 19656; 24 m, 1953 Gelting 19767; Fortunebay, 2-10 m, on shady surfaces of gneissic rocks near the coast, 1982 Poelt & Ullrich.

LECIDEA FURVELLA Nyl. ex Mudd

Description: Thallus crustose, moderately thick, deeply cracked. Areoles up to 1 mm broad; the surface verruculose-isidiate, dark brown to almost black (thallus of the Greenland specimens is without the characteristic reddish tinge sometimes found by plants collected in, for example, Sweden and Germany, cf. Wirth (1980)). Thallus K-, C-, I-. Present specimens sterile.

Distribution: The species appears to be rather common in the Disko Bay area. Possibly it has been somewhat neglected in other parts of Greenland. L. furvella is widely distributed in North and Central Europe. Outside Europe the species is known from one locality only, viz. Cape Breton Island, Canada (Hertel 1970).

Specimens studied: C.W. Greenland: Arfersiorfik Fjord, Eqaluarssuit, c. 68°N 51°W, 6 m, parasitically on Rhizocarpon sp. and other crustaceous lichens on gneissic rock, 1951 Gelting 15860a. - Christianshåb, Ikamiut, 68°38'N 51°50,W, 25 m, on Lecidea sp. on NW.-exposed, gneissic rock, 1952 Gelting; Kangersuneq Fjord, 68°49'N 50°47'W, 15 m, on Lecidea on gneissic boulder, 1949 Gelting. - Disko I., Godhavn, 20 m, on Lecidea sp. on gneissic rock at the Arctic Station, 1950 Gelting; Disko Fjord, V. Kuánit, 69°34'N 54°18'W, 35 m, on Aspicilia sp. and Lecanora polytropa on basaltic boulder, 1950 Gelting 13821 (vidi A.H. Magnusson); Storø (Qeqertaq), 69°31'N 54°06'W, 15 m, on Rhizocarpon sp. on basaltic boulder, 1950 Gelting; Mellemfjord, Narsarssuaq, 69°44'N 54°38'W, 20 m, on Rhizocarpon geographicum on basaltic rock, 1949 Gelting; Nordfjord, Kugsinerssuaq, east of delta, 69°55'N 54°23'W, on Rhizocarpon jemtlandicum on basaltic boulder on slope, 1949 Gelting; N. Laksebugt, 69°38'N 54°48'W, 10 m, on Lecidea sp., 1949 Gelting.

Fig. 7: Lecanora subradiosa Nyl. Fertile thallus growing on overhanging rock in Godhavn. Coll. no. 19767 (x 8). 8: Lecidea furvella Nyl. ex Mudd growing parasitically on a species of Aspicilia on a basaltic boulder at Kuánit in Disko Fjord. Coll. no. 13821 (x 20). 9: Lecidea nigroleprosa (Vain.) Magn. Fertile thallus growing on a basaltic rock at Nordfjord. Coll. no. 18436 (x 6). 10: Lecidea nigroleprosa (Vain.) Magn. Different stages of development of sorelia from Coll. no. 18436 (x 30).


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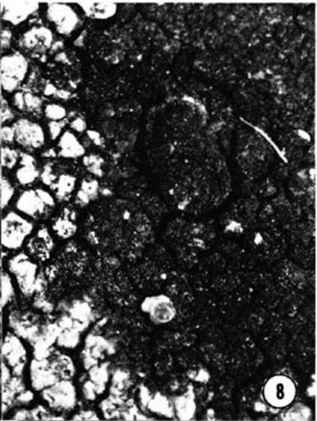
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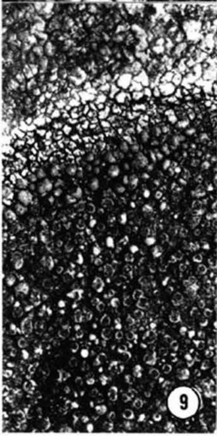
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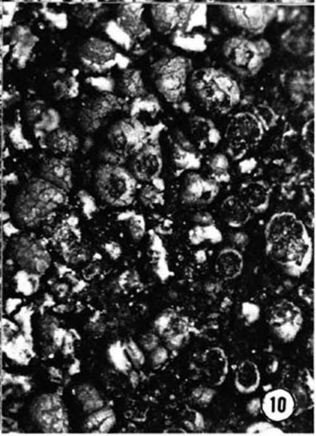
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LECIDEA NIGROLEPROSA (Vain.) Magn.

Description: Thallus over a black hypothallus, crustose, grey, areolate. Areolae flat to bullate convex, breaking up into soralia producing greyish black-black soredia. Thallus K-, C-, I-. Present specimens sterile.

Distribution: Lecidea nigroleprosa is a rare species in Greenland, known only from a few localities on S. and W. Disko, viz. the Godhavn area (c. 69°15'N 53°32'W) and Nordfjord (c. 69°55'N 54°25'W). It is widely distributed in the mountainous parts of North and Central Europe (Wirth 1980).

Specimens studied: C.W. Greenland: Disko I., Godhavn, Claus Vævers Væg, 18 m, 1953 Gelting 20131b; Runde Kær, 30 m, on vertical surface of gneissic boulder, 1952 Gelting 18332a). - Nordfjord, on basaltic rock, 1952 Gelting 18436.

SQUAMARINA LENTIGERA (Web.) Poelt

(Syn. Lecanora lentigera (Web.) Ach.)

Description: Thallus squamulose-areolate in the centre, closely adnate to the substrate forming up to 1 cm broad rosettes, the squamules chalky white, pruinose, distinctly lobate towards the edges of the thallus. Lobes rounded and pale below. (The lobes of the closely related, alpine species, Squamarina nivalis Frey et Poelt, are also purely chalk -white, but their ends are often curved downwards contary to S. lentigera, which has ± ascending lobe ends). Medulla K-, P-. Thomson (1979) found, however, a yellow colour reaction with K in material of S. lentigera collected on the North Slope of Arctic Alaska (68°40'N 141°W) and reported on the occurrence of usnic acid and atranorin.

The present specimen is sterile. The ascocarps of S. lentigera are up to 2 mm broad with reddish brown disc and pale margin; epithecium, hypothecium and hymenium are yellowish; paraphyses are unbranched, non-capitate. According to Thomson (1979) the ascospores are hyaline and simple, 9-14 x 4.5 - 5.5 µm.

Habitat, distribution and specimens studied: Squamarina lentigera was found growing on alkaline soil on a river plain (marine foreland), c. 2 km S. of the head of Frankfield Bay (c. 82°07'N 55°00'W) in Nyeboes Land in North Greenland, alt. c. 10 m a.s.l., 3 August 1981, leg. Eigil Knuth. The species is circumpolar. Outside the arctic regions L. lentigera is known from the western plains in North America and from steppe- and desert-like areas in, for example, Central Europe, the Mediterranean area and Southeastern Russia.

VERRUCARIA ERICHSENII Zsch.

Description: Thallus crustose, very thin, black, minutely dotted and wrinkled (scattered fissures may be present, but the thallus cannot be characterized as areolate). Perithecia usually abundant, to 0.2 mm broad, regularly hemispherical or somewhat deformed, wrinkled or nearly smooth (Galløe 1972: Plate 124). Ostioles indistinct. Spores hyaline, simple, ellipsoid, 8-12 x 5-7 µm.

Distribution: V. erichsenii is supposed to be more common in Central West Greenland than indicated by the comparatively few localities. The role of lichens in the zonation along the rocky shores of Greenland needs further investigation. V. erichsenii occurs more or less frequently along the coasts of Sweden, Norway and Denmark.

Specimens studied: C.W. Greenland: Arfersiorfik Fjord, Iterfiluk, 68°12'N 52°30'W, 0 m, gneissic boulder, just above the barnacle zone, 1951 Gelting 15767: Eqaluarssuit, 68°05' N 51°00'W, - 0.4 m, gneissic boulder in Fucus-Verrucaria mucosa zone, 1951 Gelting 15874; Itivdliarssuk, western part, 67°55'N 50°40'W, 0.3 m, S.-exposed, gneissic rocks, 30 cm above the Fucus zone (V. erichsenii is partly overgrown by V. degelii), 1951 Gelting 16003. - Christianshåb, Sarpiussât, Tinâ, 68°34'N 51°20'W, 1-1.2 m, gneissic rocks, 100-120 cm above the Fucus zone, 1952 Gelting 19199a. - Disko, S. Laksebugt, 69°19'N 53°55'W, exoskeletons of acorn barnacle above the Fucus zone, 1951 Gelting. - All specimens have previously been determined by Prof. Rolf Santesson, Stockholm

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I am greatly indebted to Aino Henssen (Marburg/Lahn), Teuvo Ahti and Heino Vänskä (Helsinki) for confirmation of the determination of some of the specimens and to Teuvo Ahti for reading the manuscript. I also wish to thank Josef Poelt (Graz) and Hans Ullrich (Goslar) for providing me with additional collections from the Godhavn area (Disko). The photographs were made by Finn N. Rasmussen, who used a Wild Photomakroskop M 400 granted to him by the Danish Natural Science Research Council.

LITERATURE CITED

Ahti, T. 1983. 8. Lichens - Biogeography and Ecology of the Island of Newfoundland, edited by G.R. South: 319-360.

Dahl, E. 1950. Studies in the macrolichen flora of South West Greenland. Meddr. Grønland 150 (2). 176 pp.

Galløe, O. 1972. Natural history of the Danish lichens 10. Copenhagen.

Hertel, H. 1970. Parasitische lichenisierte Arten der Sammelgattung Lecidea in Europa. Herzogia 1 (4): 405-438.

Magnusson, A.H. 1952. Lichens from Torne Lappmark. Ark. Bot. 2 (2): 45-249.

Poelt, J. 1969. Bestimmungsschlüssel europäischer Flechten. Cramer, Lehre. 757 pp.

Poelt, J. & Vězda, A. 1977. Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft I. Cramer, Vaduz. 258 pp.

Poelt, J. 1981. Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft II. Cramer, Vaduz. 390 pp.

Thomson, J.W. 1968 ('1967'). The Lichen Genus Cladonia in North America. University of Toronto Press. 172 pp.

Thomson, J.W. 1979. Lichens of the Alaskan Arctic Slope. University of Toronto Press. 314 pp.

Wirth, V. 1980. Flechtenflora. Eugen Ulmer, Stuttgart. 552 pp.

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REDISPOSITION OF SOME FUNGI REFERRED TO *OIDIUM MICROSPERMUM* AND A REVIEW OF *ARTHROGRAPHIS*

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ABSTRACT

The type and several other collections of *Oidium microspermum* were examined. A new combination is proposed in *Arthropsis*. The form-genus *Arthrographis* is briefly reviewed; a key to the species is provided; several isolates from wood are described in the new species *Arthrographis lignicola*; and connections to teleomorphs are discussed.

INTRODUCTION

We previously reviewed the history of the name *Oidium microspermum* Berk. & Br. 1873 (see Sigler & Carmichael 1976, p. 388). On the basis of the two collections of *O. microspermum* then at hand, we listed the species as a probable synonym of the *Oidiodendron* anamorph of *Myxotrichum setosum*. Because we had not seen the type specimen of *O. microspermum* we indicated that the disposition was questionable.

The recent acquisition of a culture identified as *Oidium microspermum* obtained from the Northern Forest Research Centre, Edmonton prompted us to obtain the type of *O. microspermum* and seven additional specimens preserved under that name at the National Mycological Herbarium, Ottawa (DAOM). Examination of the named specimens and cultures showed that only one of them was conspecific with the type of *O. microspermum*. A culture isolated from hay by Lacey was also identified by us as *O. microspermum*, and it is the only living strain now available. This species is herein transferred to *Arthropsis* and illustrated and redescribed.

Two of the named cultures (DAOM 144716 =UAMH 3835; DAOM 175101 =UAMH 4535) were identified as *Myxotrichum setosum*, which we previously described and illustrated (Sigler & Carmichael 1976, pp. 386-390). Four of the named collections were judged to be an undescribed species. These collections plus a culture isolated from wood chips and bark by Sigler are herein described as *Arthrographis lignicola*. The other species of *Arthrographis* are reviewed; the limits of the form-genus are discussed, and a key to the species is provided. Evidence for the connection of these arthroconidial anamorphs to teleomorphs is also discussed.

TAXONOMIC PART

I. **Arthropsis microsperma** (Berk. & Br.) Sigler comb. nov.
≡*Oidium microspermum* Berkeley & Broome 1873, in Ann. Mag. Nat. Hist. 4, ser. II, 346
≡*Oospora microspermum* (Berk. & Br.) Sacc. & Vogl. 1886, Syll. Fung. 4:22
Teleomorph not known.

A. Description on the Host

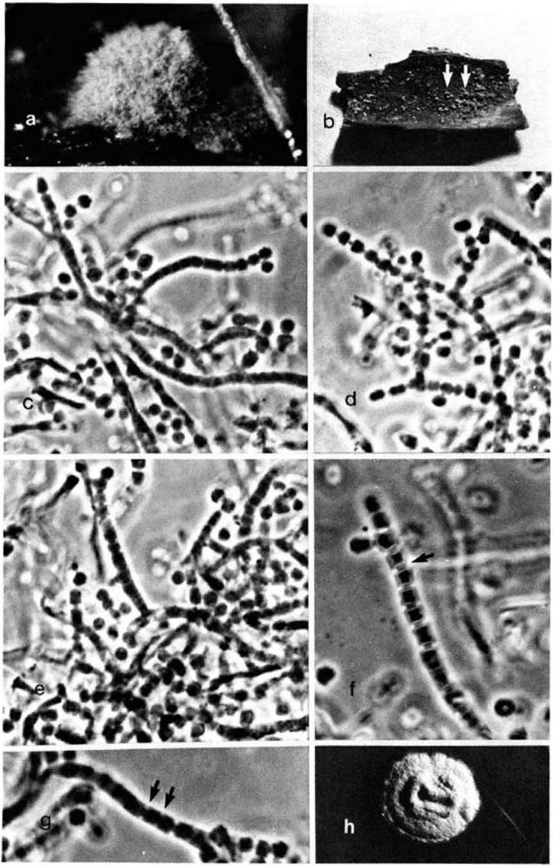
Two collections have been examined. Both the type from *Pinus sylvestris* and DAOM 83063 from *Larix* occur as orange-tan pustular tufts of hyphae on the underside of the bark (Fig. 1 a-b,arrows). The tufts consist of branched hyphae 2.5-3µm wide. The hyphae divide by basipetal septation to form arthroconidia which are joined at the end walls by prominent connectives (Fig. 1 c-f,arrow). Initially remnants of the outer wall can also be seen between developing arthroconidia (Fig. 1 g,arrows), but these disappear in chains of mature conidia. Mature arthroconidia are initially hyaline, then tan, smooth, verruculose in age, sharply truncate at both ends, cylindrical or sometimes broader than long, 2.5-3 x 1.5-4.5µm. Detached conidia round up only slightly.

B. Description in Culture

The following description is based on UAMH 4290. After two weeks growth on phytone yeast extract agar (PYE,BBL) and Pablum cereal agar (CER), colonies (Fig. 1 h) on cellophane are moderately slow growing (24-28mm in diameter), raised in the center, dark ochre-yellow and powdery. A brown pigment diffuses into the medium. On oatmeal agar (OAT), colonies are flatter and grow more rapidly (40 mm diameter after 2 weeks). There is no growth at 37°C.

Arthroconidia develop as on the host by fragmentation of undifferentiated, branched hyphae (Fig. 2 a-e). The arthroconidia of UAMH 4290 are longer than those of the type, measuring 2.5-3 x 2.5-5.5(6.5)µm and tend to round up in older cultures. In addition, the connectives (Fig. 2

Fig. 1. *Arthropsis microsperma*. (a,f-FH,b-e,g-DAOM 83063). a-b. Pustular tufts (b,arrows) of hyphae on the underside of conifer bark. a, x40, b, x0.5. c-e. Segmentation of branched fertile hyphae into arthroconidia, x1095. f. Arthroconidia joined at the end walls by prominent connectives (arrow), x1390. g. Thin-walled remnants of the outer wall (arrows) visible between developing arthroconidia, x1390. h. Two-week-old colony of 4290 on PYE, x0.65.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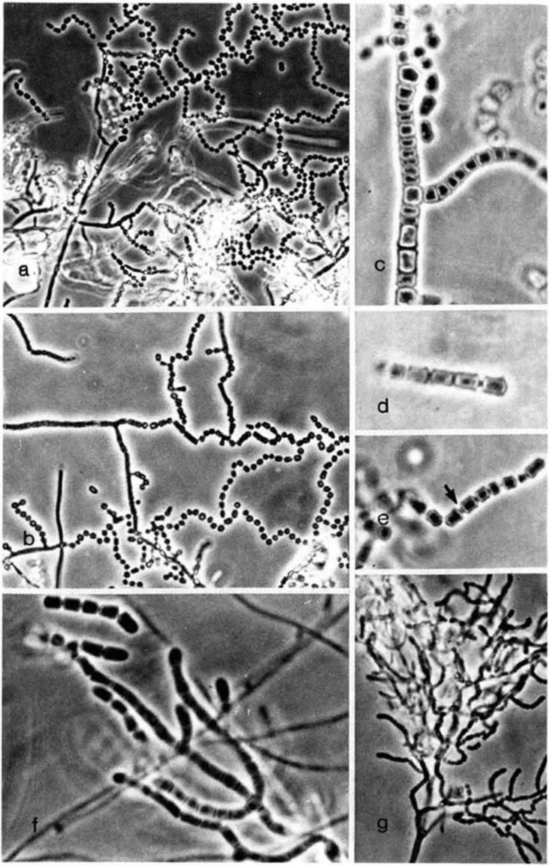
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e,arrow) are not as prominent. Whether these differences are significant enough to exclude 4290 from the species is difficult to determine until more isolates are seen.

Specimens examined: exsiccati type material, Rabenh. Fungi europ. 1577, bark of *Pinus sylvestris*, Batheaston, 1871, C.E. Broome (K, FH); DAOM 83063 (IMI 60290), bark *Larix*, Cloughton Woods, Yorks., coll. by C. Booth, Apr. 16, 1955. Living strain: UAMH 4290 was isolated as a single colony from an experimental grass hay treated with ammonium bis-propionate (ABP) and 8-quinolinol (10 parts ABP to 1 part 8-quinolinol), made at National Institute of Agricultural Engineering, Silsoe, England, 1978. Water content at baling was 28% (fresh weight basis) and the treatment was insufficient to prevent spontaneous heating. *Aspergillus glaucus* group predominated in the hay which reached a maximum temperature of 43°C nineteen days after baling. Received from CMI as 235598 (Lacey C2428).

C. Discussion

Arthropsis microsperma is included in *Arthropsis* because the arthroconidia develop from undifferentiated hyphae and are joined by prominent connectives. *A. truncata*, the type species, differs in having pigmented conidia and in having a *Humicola* synanamorph (Sigler, Dunn & Carmichael, 1982). The arthroconidia of *A. truncata* are initially yellow becoming pale brown in age. The *Humicola* conidia are brown. Despite the difference in color, the similarity in arthroconidium development warrants the disposition of both species within the same form-genus, at least until additional isolates are examined. Both pigmented and non-pigmented conidial types occur in *Oidiodendron*. Differences between *Arthropsis* and other arthroconidial form-genera have been discussed previously (Sigler, Dunn & Carmichael, 1982).

II. **Arthrographis** Cochet 1939 ex Sigler & Carmichael 1976

A. Discussion of the Genus

In 1976 we validated Cochet's genus *Arthrographis* for fungi which bear conidiogenous hyphae in dendroid tufts. The fertile hyphae are narrow, generally 1.5-3µm in width, branched or unbranched and divide basipetally or randomly to form arthroconidia which secede by schizolysis. There are no separating cells, disjunctors or connectives between seceding conidia and these characteristics distinguish *Arthrographis* from *Geomyces* (separating cells) and

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Fig. 2. a-e. *Arthropsis microsperma* (4290). f-g. *Arthrographis kalrae* (f-4653,g-2610). a-c. Branched fertile hyphae dividing to form arthroconidia. a, x335, b, x445, c, x1095. d-e. Prominent connectives between developing arthroconidia. d, x1390, e, x1095. f-g. Arthroconidia developing by schizolysis of dendroid fertile hyphae. f, x1390, g, x560.

Oidiodendron (disjunctors or connectives). *Oidiodendron* is further differentiated by its conidiophores and conidia which are usually pigmented.

Two species were included: *A. kalrae* (Tewari & Macpherson) Sigler & Carmichael, the type, and *A. cuboidea* (Sacc. & Ell.) Sigler. A new species, *Arthrographis lignicola*, is described here for some fungi previously mis-determined as *Oidium microspermum*.

B. Key to the Species of *Arthrographis*

1. Colonies growing rapidly, filling a petri dish in 2 weeks; fertile hyphae unbranched; conidia often broader than long .... *A. cuboidea* (2)

1. Colonies slower-growing (30 mm or less in 3 weeks); fertile hyphae branched 2

2. Colonies in shades of buff, tan, pale yellow; initially mucoid;
arthroconidia 1.5-2µm broad .... *A. kalrae* (1)

2. Colonies lemon-yellow to olive-green, with diffusing brown pigment;
arthroconidia 2.5-3µm broad .... *A. lignicola* (3)

C. Description of the Species

1. *Arthrographis kalrae* (Tewari & Macpherson) Sigler & Carmichael 1976
≡*Oidiodendron kalrae* Tewari & Macpherson 1971 (as '*kalrai*')
=*Arthrographis langeroni* Cochet 1939 non rite publ.
?=*Arthrographis* anamorph of *Pithoascus langeronii* von Arx 1978

In 1978, von Arx described *Pithoascus langeronii* as the teleomorph of *Arthrographis kalrae*. The teleomorph was observed by him in a culture (CBS 203.78 = UAMH 4234) isolated as a contaminant from the type culture (CBS 129.78) of *Petriellidium fimeti* von Arx & Moustafa (now *Pseudallescheria fimeti* (von Arx & Moustafa) McGinnis, Padhye & Ajello). Von Arx reported that the ascomata of *Pithoascus langeronii* developed readily in cultures grown on oatmeal agar incubated in the dark at 25°C. When we received the type culture of *P. langeronii* in 1979, we were also able to obtain ascomata after 4 weeks incubation. The ascomata occur submerged in the agar. Recently we attempted to obtain ascomata in 12 isolates of *Arthrographis kalrae* by growing them under the same conditions. No ascomata were obtained although cultures were held 10-16 weeks before being discarded as negative. Since the morphs have been found to occur together only in one strain, the affiliation between the strictly anamorphic isolates and the teleomorph remains somewhat doubtful (Kendrick & DiCosmo, 1979).

Arthrographis kalrae, described and illustrated previously (Sigler & Carmichael 1976; p. 360-363) is recognizable by its rather slow-growing, buff or tan, velvety colonies. Young colonies often appear mucoid and older cultures may develop sectors of different color (yellow) or texture (spiny fascicles of hyphae). The most distinctive microscopic characteristic is the arborescent branching of the conidiophores (Fig. 2 f-g). The fertile branches divide schizolytically (Fig. 2 f) to form arthroconidia which measure 1.5-2 x 2.5-4.5(5)µm. In degenerate cultures, arthroconidia frequently develop by fragmentation of undifferentiated hyphae and they are longer and narrower. Single-celled globose or subglobose conidia (Fig. 3 b) (*Trichosporiella* synanamorph) also occur and are prominent in submerged hyphae. They occur directly on the sides of the hyphae or on short pedicels or are terminal.

Arthrographis kalrae has been reported occasionally as an opportunistic pathogen of man and animals (Cochet, 1939; Tewari & Macpherson, 1968; Sigler & Carmichael, 1976; Carmichael, 1983; de Vries, 1983). One of our recent acquisitions (UAMH 4472) was cultured repeatedly from sputum and from aspirates from a draining lung lesion. The chest infection developed in a 21-year-old New Zealand woman following a ruptured ectopic pregnancy.

Arthrographis kalrae is only weakly keratinolytic; many isolates are unable to digest hair. It appears to be weakly cellulolytic (for methodology, see Sigler & Carmichael 1976).

2. *Arthrographis cuboidea* (Sacc. & Ell.) Sigler 1976
≡*Oospora cuboidea* Saccardo & Ellis 1882
For further synonymy refer to Sigler & Carmichael (1976)

A. cuboidea is differentiated by its fertile hyphae which are predominantly unbranched (Fig. 3 a,e) The fertile hyphae arise in tufts (Fig. 3 c) from scarcely differentiated hyphae. *A. cuboidea* grows rapidly, forming pale yellow flocculent colonies which often produce a diffusing pink pigment. It is cellulolytic. The pattern of septation of the fertile hyphae is unusual and has been described previously (Sigler & Carmichael, 1976; p. 364). The fertile hyphae divide schizolytically (Fig. 3 d-e) to form arthroconidia which are frequently broader than long, yellow, 1.5-2.5 x 2-3.5µm.

The disposition of this species in *Arthrographis* has been questioned by von Arx (1978) on the basis of 1) its rapid growth rate, 2) cellulolytic ability, 3) unbranched fertile hyphae, 4) arthroconidia separated by disjunctive structures. These fungi are not closely related phylogenetically and it may be suitable to exclude *A. cuboidea* from *Arthrographis* on the basis of the first three characters. However, we have not observed disjunctors between arthroconidia (Fig. 3 d). This suggests *A. cuboidea* is better maintained in *Arthrographis* than in *Coremiella* (separating cell, dematiaceous) or *Briosia* (dematiaceous thallic meristem conidia) (von Arx, 1973; von Arx, 1978; Sigler, Dunn & Carmichael, 1982). There is no other suitable form-genus currently available for *A. cuboidea*.

A. cuboidea causes pink stain in heartwood and sapwood of conifers and deciduous trees. In a recent report, Schmidt, Dietz & Hartmann (1983) noted development of the pink stain in red oak lumber which had been treated with sodium pentachlorophenate.

3. **Arthrographis lignicola** Sigler sp. nov.

Coloniae in agaro ad 25°C moderatim lente crescunt, sulphureae vel citreae vel olivaceae, velutinae, densae, circa elevatae, convolutae. Incrementum nullum ad 37°C.
Hyphae hyalinae, ramosae, 1.5-3µm latae. Conidiophora brevia, 1.5-3µm lata, hyalina. Hyphae conidiogenae ramosae, septatae. Arthroconidia laevia, flava, cylindrica, truncata, schizolytica, 2.5-3 x (1.5)2-4(5)µm. Reproductio sexualis ignota.
Typus: UAMH 4095, colonia exsiccata ex ramentis corticibusque, Alberta, L. Sigler, 1978.

Colonies (Fig. 3 g) on cellophane on PYE are slow growing (20 mm in 28 days), raised, velvety, initially yellow then darkening after 4-6 weeks to olive-green. Colonies on potato dextrose agar (Difco) are similar but turn green more rapidly. Colonies (Fig. 3 h) on cellophane on CER are initially flat with a tan pigmentation to the surface growth and scant aerial growth. More aerial growth develops in older cultures (4-5 weeks) and the colonies become similar in color and texture to those on PYE. On OAT agar, the colonies are notable for their lack of pigmentation, remaining off-white or pale yellow, and for their sparse aerial growth. A yellow or brown pigment diffuses into all media.

Conidiophores are narrow (1.5-3µm in width), hyaline and branch repeatedly (Fig. 3 f, 4 a-b). The fertile branches divide by basipetal or random septation to form arthroconidia which secede by schizolysis (Fig. 4 c). Arthroconidia also develop by fragmentation of more or less undifferentiated hyphae. Arthroconidia are smooth, yellow, cylindrical, truncate, 2.5-3 x (1.5)2-4(5)µm. Teleomorph not

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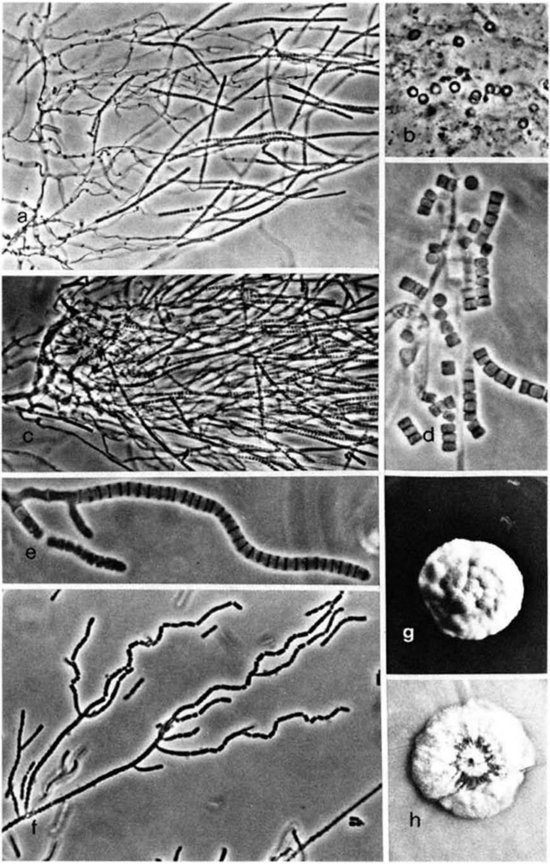
Fig. 3. a,c-e. *Arthrographis cuboidea* (a,c-3792, d-676, e-3101). b. *Arthrographis kalrae*(2617). f-h. *Arthrographis lignicola* (f,g-4095, h-4516). a. Unbranched fertile hyphae borne on more or less undifferentiated hyphae, x335. b. Conidia of *Trichosporiella* synanamorph, x560. c. Tuft of fertile hyphae, x335. d. Arthroconidia seceding by schizolysis, x1095. e. Fertile hypha dividing by random septation, x1095. f. Secession of arthroconidia by schizolysis of branched fertile hyphae, x445. g-h. Five-week-old colonies on PYE and CER agar respectively, x0.65.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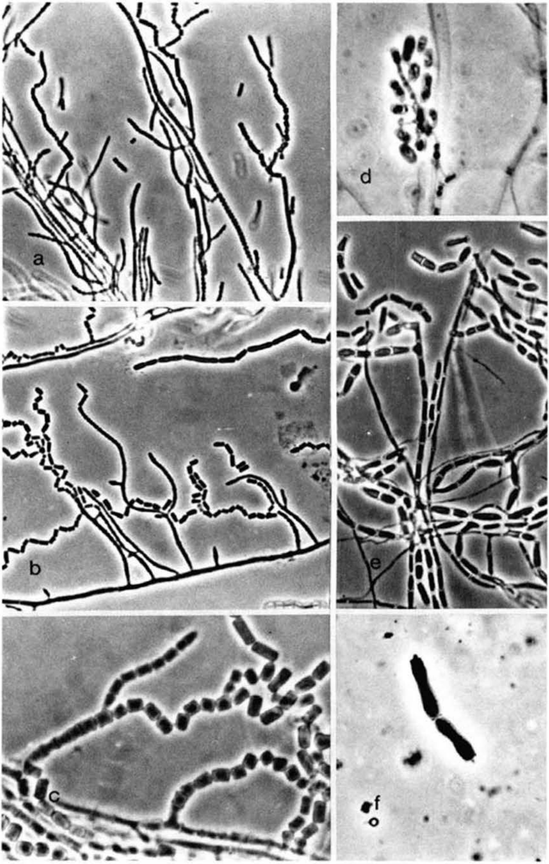
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observed.

Habitat: on wood of *Pinus*, *Picea*. Slightly cellulolytic.

Specimens examined from DAOM as *Oidium microspermum*: 37243 (UAMH 1174), *Picea glauca* -perennial branch canker, coll. Saskatoon, Sask., by R.D. Whitney (S-319), May, 1953; 66375 (UAMH 4537) yellow string rot of *Picea mariana*, coll. by W.B.G. Dwyer (S-132), Little Bear Lake, Sask., 1958; 50028 (UAMH 4540), *Picea*, coll. by V.J. Nordin (S-11-4) Sundance Canyon, Alberta, 1956.
Living strains: UAMH 4095 conifer wood chips and bark, coll. from an Alberta logging truck, L. Sigler, Feb., 1978; UAMH 4516, red stained wood of *Pinus contorta*, coll. by J. Nighswander, Hinton, Alberta, 1960, rec'd from Northern Forest Research Centre, Edmonton, as *Oidium microspermum* C-497.

Discussion

Arthrographis lignicola is easily recognizable by its brightly pigmented, yellow to yellow-green colonies. It differs from *A. kalrae* in having broader conidia and from *A. cuboidea* in having branched fertile hyphae and in its slower growth rate.

D. Connections to Teleomorphs

Recently von Arx (1981) has suggested that the anamorphs of *Pithoascus langeronii*, *Pseudallescheria desertorum*, *Faurelina indica* and *Diplogelasinospora* are related and belong in *Arthrographis*. The anamorph of *Pithoascus* is accepted here as a species of *Arthrographis*.

The anamorphs of *Pseudallescheria* belong in *Scedosporium* and *Graphium*. *P. desertorum* (von Arx & Moustafa) McGinnis et al. was reported to have an *Arthrographis* anamorph (von Arx, 1973; 1981). Our own observation of the type culture (UAMH 4993 = CBS 489.72) however indicated a *Scedosporium* state to be present (Fig. 4 d). The culture is degenerate but there is little doubt that the conidia are formed successively.

The arthroconidia of *Faurelina indica* von Arx, Mukerji & Singh are formed by septation and schizolytic division of undifferentiated, branched hyphae (Fig. 4 e). The arthroconidia are large, 3.5 x 10-14µm, barrel-shaped, frequently 1-septate. Upon schizolysis, septal plugs can sometimes be

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Fig. 4. a-c. *Arthrographis lignicola* (a-4095,b-c-4516). d. *Pseudallescheria desertorum* (3993). e-f. *Faurelina indica* (4235). a-c. Arthroconidia formed by schizolysis of branched fertile hyphae, a,b, x445, c, x1095. d. Conidia of *Scedosporium* anamorph, x600. e. Schizolytic division of branched fertile hyphae to form 0-1 septate arthroconidia, x445. f. Arthroconidia with septal plugs, x600.

observed (Fig. 4 f). The arthroconidia of *Arthrographis* species are notable for their small size, and their uniformity of shape; furthermore no protrusions or connectives have yet been observed on their end walls.

In their description of Japanese isolates of *Diplogelasinopora princeps* Udagawa & Horie and *D. grovesii* Cain, Udagawa and Horie (1972) reported that undifferentiated hyphae divided to form large cylindrical arthroconidia. In *D. grovesii* the arthroconidia were reported as slimy. When we grew the type cultures (NHL 2502 =UAMH 3672; NHL 2504 =UAMH 3673) we were unable to obtain any arthroconidia, but rhexolytic lateral conidia (*Trichosporiella* anamorph) could be seen. Judging from the published descriptions, the arthroconidial anamorphs of *Diplogelasinospora* appear closer to *Geotrichum* than to *Arthrographis* in conidiogenesis.

The form-genus *Geotrichum* was previously used as a dumping ground for a variety of arthroconidial fungi. There is currently no suitable form-genus to accommodate non-slimy *Geotrichum*-like fungi which produce large cylindical or barrel-shaped arthroconidia by schizolytic division of undifferentiated, determinate hyphae. We think it is undesirable to broaden *Arthrographis* to incorporate them.

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REFERENCES

Arx, J.A. von. 1973. The genera *Petriellidium* and *Pithoascus* (Microascaceae). Persoonia 7:367-375.

Arx, J.A. von. 1978. Notes on Microascaceae with the disposition of two new species. Persoonia 10:23-31.

Arx, J.A. von. 1981. On *Monilia sitophila* and some families of Ascomycetes. Sydowia 34:13-29.

Arx, J.A. von, K.G. Mukerji & N. Singh. 1981. *Faurelina indica* spec. nov. Sydowia 34:39-41.

Carmichael, J.W. 1983. Miscellaneous Hyphomycetes and Coelomycetes. In *Fungi Pathogenic for Humans and Animals*. Part A. Biology (D.H. Howard, ed.), Marcel Dekker, New York, pp. 217-226.

Cochet, G. 1939. Sur un nouveau champignon arthrospore (*Arthrographis langeroni*) agent pathogen d'une onychomycose humaine. n.g., n. sp. Ann. Parasit. Hum. Comp. 17:98-101.

Kendrick, W.B. & F. Di Cosmo. 1979. Teleomorph-Anamorph Connections in Ascomycetes. In *The Whole Fungus*. Vol I (W.B. Kendrick, ed.), National Museums of Canada, pp. 283-410.

McGinnis, M.R., A.A. Padhye & L. Ajello. 1982.

Pseudallescheria Negroni et Fischer, 1943 and its later synonym *Petriellidium* Malloch, 1970. Mycotaxon 14:94-102.

Schmidt, E.L., M.G. Dietz & F.E. Hartmann. 1983 (Abstract) *Geotrichum* pink stain of pentachlorophenate-treated red oak. Abstracts of the Annual Meeting of the APS-SON-MSA 73(5):837.

Sigler, L. & J.W. Carmichael 1976. Taxonomy of *Malbranchea* and some other Hyphomycetes with arthroconidia. Mycotaxon 4:349-488.

Sigler, L., M.T. Dunn & J.W. Carmichael. 1982. *Arthrocristula* and *Arthropsis*, two new Hyphomycetes with dematiaceous arthroconidia. Mycotaxon 15:409-419.

Tewari, R.P. and C.R. Macpherson. 1968. Pathogenicity and neurological effects of *Oidiodendron kalrai* for mice. J. Bact. 95:1130-1139.

Udagawa, S.-I. & Y. Horie. 1972. *Diplogelasinospora* and its conidial state. Journ. Jap. Bot. 47:297-306.

Vries, G.A. de. 1983. Ascomycetes: Eurotiales, Sphaeriales and Dothideales. In *Fungi Pathogenic for Humans and Animals*. Part A. Biology (D.H. Howard, ed.), Marcel Dekker, New York, pp. 81-111.

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LOS HONGOS DE COLOMBIA
VII: SOME APHYLLOPHORACEOUS WOOD-INHABITING FUNGI

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The rapid disappearance of natural tropical forests has provided the impetus for more intensive field investigations of the little-known fungi in the neotropics. Several trips to Colombia by K.P. Dumont of the New York Botanical Garden yielded substantial collections of wood-inhabiting fungi. This paper deals mostly with the poroid members of the Aphyllophorales; however, collections of Dictyopanus pusillus (Lév.) Sing. (Agaricaceae), Filoboletus gracilis (Klotzsch: Berk.) Sing. (Tricholomataceae), Aporpium caryae (Schw.) Teix. & Rog. (Tremellaceae), Fuscocerrena portoricensis (Fr.) Ryv., and Stereum australe Lloyd also are listed because of their inclusion in the collection.

The most recent enumerations of Homobasidiomycetes of Colombia were given by Overholts (1930). Also Dennis (1970) treated the fungi of Venezuela and adjacent areas. The specimens reported here are fertile for the most part and, therefore, constitute valuable collections for future studies. Names that represent new records for Colombia are indicated by an asterisk. The names under each genus are listed in alphabetical order according to species epithet. The collectors, referred to by their initials, are as follows: P. Buritica (PB), S. Carpenter

(SC), K. Dumont (KD), R. Fonnegra (RF), E. Forero (EF), J. Haines (JH), J. Idrobo (JI), J. Luteyn (JL), M. Luteyn (ML), L. Molina (LM), M. Sherwood (MS), M. Umaña (MU), and L. Velasquez (LV). Distances and elevations are approximate.

AGARICACEAE

Dictyopanus pusillus (Lév.) Sing.

CO-27 - El Bosque de Tibabita, E. Jardines de la Paz, elev. 2740 m, Dpto. Cundinamarca, by KD, JH, JI and LV, 28 Jun. 1974. CO-121 and 178 - El Bosque de las Mercedes, Boyaca, Dpto. Cundinamarca, by KD, JH, JI and LV, 29 Jun. 1974. CO-1149 - vicinity km 20 from Cali, road between Cali and Buenaventura, elev. 1070 m, Dpto. Valle del Cauca, by KD, JI, and JH, 13 Jul. 1974. CO-1247 and 1273 - finca A. Castro, 5 km W. Popayan, road between Popayán and El Tambo, elev. 1830 m, Dpto. Cauca, by KD, JH, JI and LV, 14 Jul. 1974. CO-2077 - 28 km from Mosquera, on the Mosquera-La Mesa road, Dpto. Cundinamarca, elev. 2010 m, by KD, JL and ML, 3 Jan. 1976. CO-3430 - vicinity km post 14 from Pasto, on the road from Pasto to Airport, Dpto. Nariño, elev. 2620 m, by PB, KD, JL and LM, 24 Jan. 1976. CO-3933 - vicinity km posts 129-130 from Pasto, on the Pasto-Tumaco road, elev. 1280 m, Dpto. Nariño, by PB, KD, JL and LM, 30 Jan. 1976. CO-3978 - 26 km. from El Colegio, on the Bogotá-El Colegio road, via Salto del Tequendama, elev. 1520 m, Dpto. Cundinamarca, by KD, 28 Feb. 1976. CO-6634 - Oak forest Chaquirí, 1 km off the Medellin-Yarumal road, at a point 83 km from Medellín, elev. 2800 m, Dpto. Antioquia, by KD, MS and LV, 17 Aug. 1976.

CORTICIACEAE

**Grammothele setulosa* (Henn.) Ryv.

CO-4681A - vicinity km post 94, on the Chocontá-Aguaclara road, elev. 1220 m, Dpto. Boyacá, by KD, SC, LM and MS, 10 Jun. 1976.

**Porogramme albocinta* (Cke. & Massee) Lowe

CO-5937 - on Quibdó-Medellín road, at a point 167 km from the intersection with Medellín-Anserma road, elev. 370 m, Dpto. Chocó, by KD, SC, and MS, 10 Aug. 1976. CO-

7824 - along the Tunja-Ramiriquí-Páez road, in the vicinity of km post 86 from the crossing of the Tunja-Nuevo Colón road, elev. 1560 m, Dpto. Boyacá, by KD, PB, and MU, 13 Sept. 1976.

CYPHELLACEAE

Porotheleum poriaeforme (Pers.) Cke.

CO-4454 - between km posts 35-36 from Zipaquirá, on the Zipaquirá-Pacho road, elev. 2840 m, Dpto. Cundinamarca, by SC, KD, LM, and MS, 9 Jun. 1976.

GANODERMATACEAE

Amauroderma cf. *camerarium* (Berk.) Furtado

CO-678 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH, and LV, 5 Jul. 1974.

A. schomburgkii (Mont. & Berk.) Torrend

CO-817 and 818 - Popales, Providencia, Anorí, above Quebrada La Tirana, elev. 430 m, Dpto. Antioquia, by KD, RF, JH, and LV, 6 Jul. 1974.

**Ganoderma amazonense* Weir

CO-5788 - 45 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 210 m, Dpto. Chocó, by KD, SC and MS, 9 Aug. 1976.

G. applanatum (Pers.: S.F. Gray) Pat.

CO-2425 - 45 km from San Juan de Arama, on the San Juan de Arama-Vista Hermosa road, elev. 640 m, Dpto. Meta, by KD, PB and JL, 10 Jan. 1976. CO-2809 - 60 km from Florencia, on the Florencia-Belén road, elev. 430 m, Intendencia del Caquetá, by KD, PB, JL and LM, 16 Jan. 1976. CO-3949 - vicinity km posts 129-130 from Pasto, on the Pasto-Tumaco road, elev. 1280 m, Dpto. Nariño, by KD, PB, JL and LM, 30 Jan. 1976. CO-6770 - 110 km from Tunja, on the Puerto-Berrío-Barbosa-Tunja road, elev. 2290 m, Dpto. Santander del Sur, by KD, MS and LV, 19 Aug. 1976.

G. applanatum var. tornatum (Pers.) Humphrey

CO-3042 - 45 km from Florencia, on the Florencia-El Doncello road, Intendencia del Caquetá, elev. 463 m, by KD, PB, JL and LM, 18 Jan 1976.

*G. coffeatum (Berk.) Furtado

CO-4762 - vicinity km post 165, on the Chocontá-Aguaclara road, elev. 430 m, Dpto. Boyacá, by KD, SC, LM and MS, 11 Jun. 1976. CO-5680 and 5683 - 30 km from Quibdó, on the Quibdó-Istmina road, elev. 60 m, Dpto. Chocó, by KD, SC and MS, 8 Aug. 1976.

G. tornatum (Pers. ex Fr.) Pat.

CO-14 - el Bosque de Tibabita, E. Jardines de la Paz, elev. 2740 m, Dpto. Cundinamarca, by KD, JH, JI and LV, 28 Jun. 1974. The concept and circumscription of G. tornatum, G. applanatum var. tornatum and G. applanatum were given recently by Steyaert (1975). Because we have not given these groups enough study, the above species merely represent temporary placements for fungi whose tropical biology is imperfectly understood.

HYMENOCHAETACEAE

*Fuscocerrena portoricensis (Fr.) Ryv.

CO-7809 - along the Tunja-Ramiriquí-Páez road, in the vicinity of km post 86 from the crossing of the Tunja-Nuevo Colon road, elev. 1560 m, Dpto. Boyacá, by KD, PB and MU, 13 Sept. 1976.

Cyclomyces tabacinus (Mont.) Pat.

CO-42 and 47 - el Bosque de Tibabita, E. Jardines de la Paz, elev. 2740 m, Dpto. Cundinamarca, by KD, JH, JI and LV, 28 Jun. 1974. CO-2401 - 15 km from Granada, on the Granada-San Juan de Arama road, elev. 730 m, Dpto. Meta, by PB, KD and JL, 9 Jan 1976. CO-7311 - 62 km from Ansermanuevo, on the Ansermanuevo-San José del Palmar road, Boundary of Valle del Cauca and Chocó, elev. 640 m, by KD, RF and LM, 26 Aug. 1976.

*<u>Phellinus</u> <u>callimorphus</u> (Lév.) Ryv.

CO-2400 - 16 km from Granada, on the Granada-San Juan de Arama road, elev. 730 m, Dpto. Meta, by KD, PB and JL, 9 Jan. 1976.

*<u>P</u>. <u>cinchonensis</u> (Murr.) Ryv.

CO-3209 - Parque Arqueológico Nacional de San Agustín, 55 km from Pitalito, elev. 150 m, Dpto. Huila, by KD, PB, JL and LM, 20 Jan. 1976.

*<u>P</u>. <u>contiguus</u> (Pers.: Fr.) Pat.

CO-1068 - vicinity Pance, above Rio Pance, elev. 460 m, Dpto. Valle del Cauca, by KD, JH, JI and LV, 12 Jul. 1974.

*<u>P</u>. <u>fastuosus</u> (Lév.) Ryv.

CO-4367 - vicinity km post 36 from Zipaquirá, on the Zipaquirá-Pacho road, elev. 2680 m, Dpto. Cundinamarca, by KD, SC, LM and MS, 9 Jun. 1976. CO-5739 - 47 km from Quibdó, on the Quibdó-Istmina road, elev. 140 m, Dpto. Chocó, by KD, SC and MS, 8 Aug. 1976.

*<u>P</u>. <u>ferrugineo-velutinus</u> (Henn.) Ryv.

CO-2883 - 45 km from Florencia, on the Florencia-El Doncello road, elev. ca. 370 m, Intendencia del Caquetá, by PB, KD, JL and LM, 17 Jan. 1976.

*<u>P</u>. <u>ferruginosus</u> (Schrad.: Fr.) Pat.

CO-1386 - finca "El Bosque", vereda Guazabarita, El Tambo, elev. 910 m, Dpto. Cauca., by KD, JH, JI and LV, 15 Jul. 1974.

<u>P</u>. <u>gilvus</u> (Schw.) Pat.

CO-798 - Aljibe, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, JH, LV and RF, 5 Jul. 1974.

<u>P</u>. <u>gilvus</u> (Schw.) Pat. var. <u>licnoides</u> Corner

CO-2420 and 2434 - 41 km from San Juan de Arama on the San Juan de Arama-Vista Hermosa road, elev. 640 m, Dpto. Meta, by PB, KD and JL, 10 Jan. 1976.

*P. pectinatus (Kl.) Quél.

CO-2366 - 29 km from Granada, on the Granada-San Juan de Arama road, elev. 580 m, Dpto. Meta, by PB, KD and JL, 9 Jan. 1976.

*P. punctatiformis (Murr.) Ryv.

CO-2895 - 45 km from Florencia, on the Florencia-El Doncello road, elev. 370 m, Intendencia del Caquetá, by PB, KD, JL and LM, 17 Jan. 1976.

P. punctatus (Fr.) Pilát

CO-294 - on culm of Chusauea sp., Alto de San Miguel, road between Sibaté and Fusagasugá, elev. 1830 m, Dpto. Cundinamarca, by KD, JH and JI, 1 Jul. 1974.

POLYPORACEAE

Ceriporia xylostromatoides (Berk.) Ryv.

CO-6532 - 19 km from Dabeiba, on the Dabeiba-Turbo road, elev. 180 m, Dpto. Antioquia, by LV, KD and MS, 20 Aug. 1976.

Coriolopsis byrsina (Mont.) Ryv.

CO-2360 - 29 km from Granada on the Granada-San Juan de Arama road, elev. 730 m, Dpto. Meta, by PB, KD and JL, 9 Jan. 1976.

C. caparatus (Berk.) Murr.

CO-166 - el Bosque de las Mercedes, Boyacá, Dpto. Cundinamarca, by KD, JH, JI and LV, 29 Jun. 1974. CO-2437 - ca. 41 km from San Juan de Arama, on the San Juan de Arama-Vista Hermosa road, elev. 640 m, Dpto. Meta, by PB, KD and JL, 10 Jan 1976.

C. occidentalis (Kl.) Murr.

CO-7749 - along the Tunja-Ramiriquí-Páez road, in the vicinity of km post 74 from the crossing of the Tunja-Nuevo Colón road, elev. 1280 m, Dpto. Boyacá, by PB, KD and MU, 13 Sept. 1976.

Coriolus pavonius (Hook.) Murr.

CO-577 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 5 Jul. 1974. CO-261 - on wood of *Solanum* sp., El Robledal, 12 km from Pacho, road between Zipaquirá and Pacho, Dpto. Cundinamarca, by KD, JH and JI, 30 Jun 1974. CO-1354 - finca "El Bosque", vereda Guazabarita, El Tambo, elev. 910 m, Dpto. Cauca, by KD, JH, JI and LV, 15 Jul. 1974.

C. pinsitus (Fr.) Pat.

CO-4579 - vicinity km post 94, on the Chocontá-Aguaclara road, elev. 1370 m, Dpto. Boyacá, by SC, KD, LM and MS, 10 Jun. 1976.

**C. pubescens* (Schum.: Fr.) Quél.

CO-1714 - Boquerón, Medellín, elev. 3050 m, Dpto. Antioquia, by KD, JH and LV, 20 Jul. 1974.

C. sector (Ehrenb.: Fr.) Pat.

CO-3174 - Parque Arqueológico Nacional de San Agustín, 55 km from Pitalito, elev. 150 m, Dpto. Huila, by PB, KD, JL and LM, 20 Jan. 1976.

C. versicolor (L.:Fr.) Quél.

CO-4133 - vicinity km post 22 from Mosquera, on the Mosquera-La Mesa road, elev. 2560 m, Dpto. Cundinamarca, by SC, KD and MS, 5 Jun. 1976.

**Diachanthodes novo-guineensis* (Henn.) Fidalgo

CO-7653 - 23 km from Cali, on the Cali-Cisneros road, elev. 1220 m, Dpto. Valle del Cauca, by KD and LM, 30 Aug. 1976.

Favolus brasiliensis Fr.

CO-712 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, JH, RF and LV, 5 Jul. 1974. CO-2389 - 15 km from Granada, on the Granada-San Juan de Arama road, elev. 580 m, Dpto. Meta, by PB, KD and JL, 9 Jan. 1976. CO-2436 - 41 km from San Juan de Arama, on the San Juan de Arama-Vista Hermosa road, elev. 640 m, Dpto. Meta., by PB, KD and JL, 10 Jan. 1976. CO-6036 - on the Quibdó-Medellín road at a point 167 km from the intersection with the Medellín-Anserma road, elev. 550 m, Dpto. Chocó, by KD, SC and MS, 10 Aug. 1976.

*Flaviporus liebmanni (Fr.) Ginns

CO-5336 - 63 km from Aguazul, on the Aguazul-Sogamosa road, elev. 1710 m, Dpto. Boyacá, by SC, KD, MS and LM, 14 Jun. 1976. CO-5566 - on the Medellín-Quibdó road, at a point 130 km from the intersection with the Medellín-Anserma road, elev. 1190 m, on the boundary Dptos. Chocó and Antioquia, by SC, KD and MS, 7 Aug. 1976. CO-5804 - 45 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 210 m, Dpto. Chocó, by SC, KD and MS, 9 Aug. 1976. CO-5820 - 37 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 170 m, Dpto. Chocó, by SC, KD and MS, 9 Aug. 1976. CO-6542 - 9 km from Dabeiba, on the Dabeiba-Turbo road, elev. 340 m, Dpto. Antioquia, by LV, KD and MS, 20 Aug. 1976.

*Fomitopsis scutellata (Schw.) Bond. & Sing.

CO-1812 - on culm of Chusquea sp., Hacienda "El Soche", Granada, road between Bogota and Silvania, elev. 910 m, Dpto. Cundinamarca, by KD, JH, JI and LV, 23 Jul. 1974.

F. supina (Sw.: Fr.) Ryv.

CO-3992 - 26 km from El Colegio, on the Bogotá-El Colegio road, via Salto del Tequendama, elev. 1520 m, Dpto. Cundinamarca, by KD, 28 Feb. 1976. CO-5048 - along the Sogamosa-Aguazul road, at a point 38 km from the intersection with the Sogamoso-Aquitania road, elev. 2740 m, Dpto. Boyacá, by KD, SC, MS and LM, 13 Jun. 1976.

Hexagona hydnoides (Sw.: Fr.) Fidalgo

CO-5829 - 45 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 210 m, Dpto. Chocó, by SC, KD and MS, 9 Aug. 1976. CO-6025 - on the Quibdó-Medellín road, at a point 155 km from the intersection with the Medellín-Anserma road, elev. 550 m, Dpto. Chocó, by SC, KD and MS, 10 Aug. 1976. CO-6471 - 9 km from Dabeiba, on the Dabeiba-Turbo road, elev. 340 m, Dpto. Antioquia, by LV, KD and MS, 20 Aug. 1976. CO-7582 - 83 km from Buga, on the Buga-Buenaventura road, elev. 270 m, Dpto. Valle del Cauca, by KD and LM, 30 Aug. 1976.

*_Incrustoporia nivea_ (Jungh.) Ryv.

CO-6063 - 82 km from Medellín, on the Medellín Puerto Valdivia road, elev. 2870 m, Dpto. Antioquia, by SC, KD and MS, 12 Aug. 1976.

Junghuhnia nitida (Fr.) Ryv.

CO-2555 - 33 km from Bogotá, on the Bogotá-El Colegio road, via Salto del Tequendama, elev. 1830 m, Dpto. Cundinamarca, by PB, KD, JL and LM, 13 Jan. 1976. CO-6212 - 102 km from Medellín, on the Medellín-Valdivia road, elev. 2500 m, Dpto. Antioquia, by SC, KD and MS, 12 Aug. 1976.

Laetiporus sulphureus (Bull.: Fr.) Murr.

CO-1525 - western slopes of Cordillera Occidental, road between El Tambo and Veinte de Julio, Dpto. Cauca, by KD, JH, JI and LV, 16 Jul. 1974.

Lenzites elegans (Fr.) Pat.

CO-1077 - vicinity Pance, above Río Pance, elev. 460 m, Dpto. Valle del Cauca, by KD, JH, JI and LV, 12 Jul. 1974. CO-1337 - finca "El Bosque", vereda Guazabarita, El Tambo, elev. 910 m, Dpto. Cauca, by KD, JH, JI and LV, 15 Jul. 1974. CO-4725 - vicinity km post 143, on the Chocontá Aguaclara road, elev. 400 m, Dpto. Boyacá, by SC, KD, LM and MS, 11 Jun. 1976. CO-7381 - 97 km from Ansermanuevo, on the Ansermanuevo-San José del Palmar road, elev. 640 m, Boundary of Valle del Cauca and Chocó Dptos., by KD, RF and LM, 26 Aug. 1976. CO-4150 - vicinity km post 22 from Mosquera, on the Mosquera-La Mesa road, elev. 2560 m, Dpto. Cundinamarca, by SC, KD and MS, 5 Jun. 1976.

Lenzites striata (Sw.: Fr.) Fr.

CO-2291 - 45 km from Florencia on the Florencia-El Doncello road, elev. 1460 m, Dpto. Intendencia del Caquetá, by PB, KD, JL and LM, 18 Jan. 1976.

**Loweporus* *roseo-albus* (Jungh.) Ryv.

CO-2787 - 60 km from Florencia, on the Florencia-Belén road, elev. 430 m, Intendencia del Caquetá, by PB, KD, JL and LM, 16 Jan. 1976.

**Microporellus* *obovatus* (Jungh.) Ryv.

CO-611 and 703 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 5 Jul. 1974. CO-871 - Popales, Providencia, Anorí, above Quebrada La Tirana, elev. 430 m, Dpto. Antioquia, by KD, RF, JH and LV, 6 Jul. 1974. CO-7509 - along road between Pueblorico and Santa Cecilia, elev. 400 m, Dpto., Risaralda, by KD and LM, 29 Aug. 1976.

Nigroporus *vinosus* (Berk.) Murr.

CO-1341 - finca "El Bosque", vereda Guazabarita, El Tambo, elev. 910 m, Dpto. Cauca, by KD, JH, JI and LV, 15 Jul. 1974.

**Pachykytospora* *alabamae* (Berk. & Cke.) Ryv.

CO-7670 - 23 km from Cali, on the Cali-Cisneros road, elev. 1070 m, Dpto. Valle de Cauca, by KD and LM, 30 Aug. 1976.

P. *papyracea* (Schw.) Ryv.

CO-3345 - Universidad de Nariño property, 6 km from a point 7 km from Pasto, on the Pasto-Ipiales road, elev. 2900 m, Dpto. Nariño, by KD, JL and LM, 24 Jan. 1976. CO-3478 - vicinity km posts 13-14 from Pasto, on the Pasto-Mocoa road, elev. 3230 m, Dpto. Nariño, by PB, KD, JL and LM, 25 Jan. 1976.

Perenniporia *medulla-panis* (Jacq.: Fr.) Donk.

CO-156 - El Coque de las Mercedes, Boyaca, Dpto. Cundinamarca, by KD, JH, JI and LV, 29 Jun. 1974.

Polyporus *arcularius* (Batsch): Fr.

CO-1653 and 1709 - Boquerón, Medellín, elev. 3050 m, Dpto. Antioquia, by KD, JH and LV, 20 Jul. 1974.

*_P_. _dictyopus_ Mont.

CO-1158 - vicinity 20 km from Cali, road between Cali and Buenaventura, elev. 1070 m, Dpto. Valle del Cauca, by KD, JI and JH, 13 Jul. 1974. CO-1655 - Boquerón, Mendellín, elev. 3050 m, Dpto. Antioquia, by KD, JH and LV, 20 Jul. 1974. CO-5244 and 5264 - 21 km from Aguazul, on the Aguazul-Sogamosa road, elev. 820 m, Dpto. Boyacá, by KD, LM, MS and SC, 14 Jun. 1976. CO-5623 - 7 km from Quibdó, on the Quibdó-Istmina road, elev. 60 m, Dpto. Chocó, by SC, KD and MS, 8 Aug. 1976. CO-5657 - 30 km from Quibdó, CO-8146 - along the Guasca-Gachalá road, in the vicinity of km post 60 from the Bogotá-Tunja road, elev. 3050 m, Dpto. Cundinamarca by PB, KD and MU, 17 Sept. 1976.

_P_. _guianensis_ Mont.

CO-2329 - 2 km toward San Luis de Cubarral, from the junction of the Villavincencio-San Martín road, elev. 790 m, Dpto. Meta., by PB, KD and JL, 8 Jan. 1976.

*_P_. cf. _hondurensis_ Murr.

CO-2355 - 29 km from Granada on the Granada-San Juan de Arama road, elev. 730 m, Dpto. Meta., by PB, KD and JL, 9 Jan. 1976. This fungus is known only from the type collection. The fragment CO-2355 is very close to the type. Microscopically the fungus is dimitic with skeletal hyphae up to 5.5 μm in diam., and thin-walled, clamped generative hyphae. Gloeopleurous hyphal cystidia were occasionally seen in the hymenium. The spores were nonamyloid, elliptical, and 4.5-6.3 x 2.3-2.7 μm in size.

_P_. _leprieuri_ Mont.

CO-2016 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, JH, RF and LV, 5 Jul. 1974.

_P_. cf. _lignosus_ Kl. complex

CO-687 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, JH, RF and LV, 5 Jul. 1974. CO-5860 - 37 km from Las Animas, on the "carretera Panamericana", from Las Animas toward the coast, elev. 170 m, Dpto. Choco, by SC, KD and MS, 9 Aug. 1976.

P. microstomus (Berk. & Cke.)

CO-2 - el Bosque de Tibabita, E. Jardines de la Paz, elev. 2740 m, Dpto. Cundinamarca, by KD, JH, JI and LV, 28 Jun. 1974. CO-960 - vicinity km 15 from Fomeque, road between Calera and Fomeque, Dpto. Cundinamarca, by KD, JH, JI and LV, 10 Jul. 1974.

P. obolus Ell. & Macbride

CO-2331 - 2 km toward San Luis de Çubarral, from the junction of the Villavicencio-San Martín road, elev. 790 m, Dpto. Meta., by PB, KD, and JL, 8 Jan. 1976. CO-6457 - 9 km from Dabeiba, on the Dabeiba-Turbo road, elev. 340 m, Dpto. Antioquia, by KD, MS and LV, 20 Aug. 1976.

P. rhizomorpha Mont.

CO-1380 - finca "El Bosque", vereda Guazabarita, El Tambo, elev. 910 m, Dpto. Cauca, by KD, JH, JI and LV, 15 Jul. 1974. This collecton is characterized by being stipitate with a dark brown stipe 11 mm long x 1.5 mm wide connected to a similar appearing rhizomorph. The circular pileus is 10 mm across with a pale brown margin surrounding a darker brown center. The pore surface is pale brown and the rounded pore mouths number 6-7 per mm.

Microscopically the trama is dimitic with skeletals and clamped generative hyphae. The few basidia seen were unusually inflated at the base and produced hyaline, non-amyloid broadly ellipsoidal spores about 5.5 x 3.5 μm in size.

P. tricholoma Mont.

CO-6047 - on the Quibdó-Medellín road, at a point 155 km from the intersection with the Medellín-Anserma road, elev. 550 m, Dpto. Chocó, by SC, KD and MS, 10 Aug. 1976.

*Poria albostygia (Berk. & Curt.) Lloyd.

CO-7282 - 62 km from Ansermanuevo, on the Ansermanuevo-San José del Palmar road, boundary of Valle de Cauca and Chocó Dptos., elev. 640 m, by KD, LM and RF, 26 Aug. 1976.

P. cinchonensis (Murr.) Sacc. & Trott.

CO-771 - Aljibe, Providencia Anorí, above Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 6 Jul. 1974.

**P. rickii* Bres.

CO-786 - Aljibe, Providencia, Anorí, above Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 6 Jul. 1976. This fungus is in the same group and perhaps synonymous with *Phellinus ferrugineo-velutinus* whose spore size is unknown. Ryvarden (1980) also placed *Fomitoporia flavomarginata* Murr. in synonymy with *P. ferrugineo- velutinus*; however, the basidiospores of this fungus are smaller than those reported by Lowe (1966) for *Poria rickii*.

Poria spissa (Schw.) Cke.

CO-3774 - vicinity km post 27 from Mocoa on the Mocoa-Puerto Asis road, elev. 670 m, Intendencia del Putumayo, by PB, KD, JL and LM, 27 Jan. 1976.

Pycnoporus sanguineus (L.: Fr.) Murr.

CO-4743 - vicinity km post 143, on the Chocontá-Aguaclara road, elev. 400 m, Dpto. Boyacá, by SC, KD, LM and MS, 11 Jun. 1976. CO-4851 - vicinity km post 165, on the Chocontá-Aguaclara road, elev. 430 m, Dpto. Boyacá, by SC, KD, LM and MS, 11 Jun. 1976. CO-5625 - 7 km from Quibdó, on the Quibdó-Istmina road, elev. 60 m, Dpto. Chocó, by SC, KD and MS, 8 Aug. 1976. CO-7385 - 97 km from Ansermanuevo, on the Ansermanuevo-San José del Palmar road, elev. 640 m, Dpto. Chocó, by KD, EF and LM, 25 Aug. 1976. CO-7840 - along the Tunja-Ramiriquí-Páez road, in the vicinity of km post 86 from the crossing of the Tunja-Nuevo Colón road, elev. 1560 m, Dpto. Boyacá, by PB, KD and MU, 13 Sept. 1976.

Rigidoporus lineatus (Pers.) Ryv.

CO-1194 and CO-1219 - vicinity km 20 from Cali, road between Cali and Buenaventura, elev. 1070 m, Dpto. Valle del Cauca, by KD, JI and JH, 13 Jul. 1974. CO-2335 - 2 km toward San Luis de Cubarral, from the junction of the Villavincencio-San Martín road, elev. 790 m, Dpto. Meta., by PB, KD and JL, 8 Jan. 1976. CO-3786 - vicinity km post

27 from Mocoa, on the Mocoa-Puerto Asis road, elev. 670 m, Intendencia del Putumayo, by PB, KD and LM, 27, Jan. 1976. CO-4803 - vicinity km post 165, on the Chocontá-Aguaclara road, elev. 430 m, Dpto. Boyacá, by SC, KD, LM and MS, 11 Jun. 1976. CO-5717 - 47 km from Quibdó, on the Quibdó-Istmina road, elev. 140 m, Dpto. Chocó, by SC, KD and MS, 8 Aug. 1976. CO-5803 - 45 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 210 m, Dpto. Chocó, by SC, KD and MS, 9 Aug. 1976. CO-6522 and 6524 - 19 km from Dabeiba, on the Dabeiba-Turbo road, elev. 180 m, Dpto. Antioquia, by KD, MS and LV, 20 Aug. 1976. CO-7580 - 83 km from Buga, on the Buga-Buenaventura road, elev. 270 m, Dpto. Valle del Cauca, by KD and LM, 30 Aug. 1976.

R. cf. *microporus* (Fr.) Overeem

CO-5846 - 46 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 170 m, Dpto. Chocó, by SC, KD and MS, 9 Aug. 1976. Rigidoporus represents a highly variable and still largely unknown genus whose species vary by degree. This specimen lacks incrusted skeleto-cystidia and possesses mammillate cytidia whose elongated papillae often appear thickened and yellowish-refractive when viewed with phase contrast optics.

R. *microporus* (Fr.) Overeem

CO-6460 - 9 km from Dabeiba, on the Dabeiba-Turbo road, elev. 340 m, Dpto. Antioquia, by KD, MS and LV, 20 Aug. 1976.

R. *sanguinolentus* (A. & S.: Fr.) Donk

CO-4000 - 26 km from El Colegio, on the Bogotá-El Colegio road, via Salto del Tequendama, elev. 1520 m, Dpto. Cundinamarca, by KD, 28 Feb. 1976. CO-5925 - on the Quibdó-Medellín road, at a point 167 km from the intersection with the Medellín-Anserma road, elev. 370 m. Dpto. Chocó, by SC, KD and MS, 10 Aug. 1976.

R. *vinctus* (Berk.) Ryv.

CO-2807 - 60 km from Florencia, on the Florencia-Belén road, elev. 430 m, Intendencia del Caquetá, by PB, KD, JL and LM, 16 Jan. 1976.

*Schizopora trichiliae (van der Byl) Ryv.

CO-544 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 5 Jul. 1974. CO-917 - vicinity km 44 from Fomeque, road between Calera and Fomeque, Dpto. Cundinamarca, by KD, JH, JI and LV, 9 Jul. 1974. CO-2966 - 45 km from Florencia, on the Florencia-El Doncello road, elev. 370 m, Intendencia del Caqueta, by PB, KD, JL and LM, 17 Jan. 1976. CO-7521 - along road between Pueblorico and Santa Cecilia, elev. 400 m, Dpto. Risaralda, by KD and LM, 29 Aug. 1976. This fungus is very similar to S. paradoxa (Fr.) Donk which is described by Lowe (1966) as Poria versipora (Pers.) Rom.

Tinctoporellus epimiltina (Berk. & Br.) Ryv.

CO-5678 - 30 km from Quibdó, on the Quibdó-Istmina road, elev. 60 m, Dpto. Choco, by KD, SC, and MS, 8 Aug. 1976. CO-5782 - 45 km from Las Animas, on the "carretera Panamericana" from Las Animas toward the coast, elev. 210 m, Dpto. Choco, by SC, KD and MS, 9 Aug. 1976. CO-5845 - 37 km from Las Animas, on the "carretera Panamericana", from Las Animas toward the coast, elev. 170 m, Dpto. Choco, by SC, KD and MS, 9 Aug. 1976. CO-5979 - on the Quibdo-Medellin road, at a point 167 km from the intersection with the Medellin-Anserma road, elev. 370 m, Dpto. Choco, by SC, KD and MS, 10 Aug. 1976.

Trametes scabrosa (Pers.) Cunn.

CO-552 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 5 Jul. 1974. CO-733 and 799 - Aljibe, Providencia, Anorí, above Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 6 Jul. 1974. CO-822 - Popales, Providencia, Anori, above Quebrada La Tirana, elev. 430, Dpto. Antioquia, by KD, RF, JH and LV, 6 Jul. 1974. CO-7558 - 83 km from Buga, on the Buga-Buenaventura road, elev. 270 m, Dpto. Valle del Cauca, by KD and LM, 30 Aug. 1976. CO-7597 - along the old road from Buenaventura to Cali, at a point 8 km from the intersection with the Buenaventura-Cisneros road, elev. 120 m, Dpto. Valle del Cauca, by KD and LM, 30 Aug. 1976. The type of Trametes corrugata Pers. is synonymous with T. scabrosa.

STEREACEAE

Stereum australe Lloyd

CO-582 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 5 Jul. 1974. CO-6104 - 82 km from Medellín, on the Medellín-Puerto Valdivia road, elev. 2870 m, Dpto. Antioquia, by SC, KD and MS, 12 Aug. 1976.

TREMELLACEAE

*Aporpium caryae (Schw.) Teix. & Rog.

CO-698 - Buenos Aires, Providencia, Anorí, Rio Anorí, elev. 370 m, Dpto. Antioquia, by KD, RF, JH and LV, 5 Jul. 1974. This identity is tentative because gloeopleurous hyphae may be present, a character not found in the type of A. caryae.

TRICHOLOMATACEAE

Filoboletus gracilis (Klotzsch.: Berk.) Sing.

CO-1213 - vicinity km 20 from Cali, road between Cali and Buenaventura, elev. 1070 m, Dpto. Valle del Cauca, by KD, JI and JH, 13 Jul. 1974. CO-864 - Popales, Providencia, Anorí, above Quebrada La Tirana, elev. 430 m, Dpto. Antioquia, by KD, RF, JH and LV, 6 Jul. 1974. CO-4846 - vicinity km post 165 on the Chocontá-Aguaclara road, elev. 430 m, Dpto. Boyaca, by SC, KD, LM and MS, 11 Jun. 1976.

ACKNOWLEDGEMENTS

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LITERATURE CITED

DENNIS, R.W.G. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Additional Series III. R. Bot. Gard., Kew, England.

LOWE, J.L. 1966. Polyporaceae of North America. The genus *Poria*. New York State Univ. College of Forestry, Tech. Publ. 90, Syracuse, N.Y. 183 p.

OVERHOLTS, L.O. 1930. Eu-basidiomycetes. pp. 348-356 *In* C.E. Chardon and R.A. Toro, Mycological Explorations of Colombia. J. Dept. Agr., Porto Rico 14(4):195-369.

RYVARDEN, L. 1980. A preliminary polypore flora of East Africa. Fungiflora, Oslo, Norway.

STEYAERT, R.L. 1975. The concept and circumscription of *Ganoderma tornatum*. Trans. Br. Mycol. Soc. 65:451-467.

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PHOMOPSIS GANJAE SP. NOV. ON *CANNABIS SATIVA*

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SUMMARY

In 1983 a species of *Phomopsis* Sacc. parasitizing *Cannabis sativa* L. in Illinois, USA, was reported as *P. cannabina* Curzi 1927 (McPartland, 1983). *Prima facie* diagnosis was not substantiated under more rigorous observation, hence *P. ganjae* sp. nov. is described and illustrated, followed by a discussion.

В 1983 году было сделано сообщение об обнаружении в штате Иллинойс (США) разновидности Phomopsis Sass. паразитирующей на Cannabis sativa L. определенная как P. cannabina Curzi 1927 (McPartland, 1983). Prima facie диагноз не был уточнен более строго, вследствие чего данная работа посвящена обсуждению P. ganjae sp. nov. предваренному описанием и иллюстрациями.

PHOMOPSIS GANJAE McPartland, sp. nov. Figs. 1-5.

Pycnidia solitaria vel aggregata, in pagina superiori foliorum in circulis concentricis vel irregulariter distributa, ab initio subepidermica denique erumpentia, 120-220 X 120-350 µm. Contextus parte superiore niger et carbonaceus, parte inferiore pallide fuligineus et parenchymaticus. Conidiophora hylina, cylindrica, simplicia vel ramosa, 8-15 X 1-2 µm. Cellulae conidiiferae enteroblasticae, phialidicae, cylindricae vel obclavatae. A-conidia (phialosporae) hylina, unicellularia, fusiformia vel elliptica, biguttalata, raro 1-, 3-guttulata vel eguttulata, 5.0-11.5 X 2.0-4.0 µm (7-8 X 2.5 µm). B-conidia (phialosporae) hylina, unicellularia, filiformia, plerumque

curvata, 16.0-22.0 X 1.0 µm.
Holotypus: In foliis vivis, languidis, vel emortuis et siccatus Cannabis sativae, in arvum clandestinum circa Urbem Hanna (Illinois, USA). *ILLS* 43621

Pycnidia solitary or aggregated, distributed irregularly or in concentric rings on the upper surface of the leaves, arising among the cells below the epidermis and becoming erumpent, unilocular or multilocular, stromatic, ostiolate, round to elliptical in outline, 120-220 X 120-300 µm. Apex of pycnidium black and carbonaceous, base pale sooty brown and parenchymous. Conidiophores cylindrical, simple or branched, 8-15 X 1-2 µm. Conidiogenous cells enteroblastic, phialidic, cylindrical to obclavate. A-conidia (phialospores) hyline, unicellular, fusiform to elliptic, 2-guttulate, rarely 1-, 3-guttulate or nonguttulate, 5.0-11.5 X 2.0-4.0 µm (7-8 X 2.5 µm). B-conidia (phialospores) hyline, unicellular, filiform, mostly curved, 16.0-22.0 X 1.0 µm. Holotype: On living, wilted, or dead and dried leaves of *Cannabis sativa* in a hidden field near Hanna City, Illinois, USA. ILLS 43621

ETYMOLOGY: *ganjae* = from ganja, refering to an internationally recognized common name for *Cannabis sativa* L.

COLLECTIONS EXAMINED: United States: Ottawa, Illinois, Leg: G. H. Boewe, 4 October 1934, ILLS 24902. Hanna City, Illinois, Leg: P. L. Pruitt & J. M. McPartland, 8 August 1982, ILLS 43621.
India: Palandri, Kashmir, Leg: A. A. Basit, June 1975, IMI 199412 and BPI 1042-A. Udaipur, Rajasthan, Leg: U. N. Pathak, 4 July 1967, IMI 128315.

DISCUSSION: *Phomopsis ganjae* may be, and has been, confused with *Phomopsis cannabina* (McPartland, 1983; Basit & Ghani 1976), the only other *Phomopsis* reported on *C. sativa*. The taxon *P. cannabina* Curzi 1927 may prove to be rejected as a *nomen dubium*, owing to: 1) the loss of Curzi's holotype (Dr.ssa Vanda Terzo, PAV curator, personal communication), 2) the absence of isotype material (PAD, POR, SIENA, TO,

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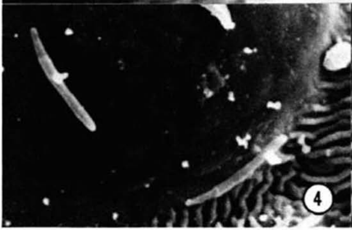
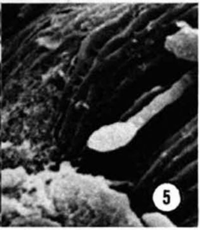
FIGURES 1-5. *PHOMOPSIS GANJAE*. 1. Portion of holotype, x1. 2. Pycnidium, cryostat section, x660. 3. Conidiophores, conidiogenous cells, and conidia, x3040. 4. Germinating B-conidia on host, x2320. 5. Germinating A-conidium on host, x3640.

1

3



4



5

MIPV, IMI, BPI curators, personal communication), 3) an inadequate description, and 4) a lack of illustrations. *P. ganjae* is distinguished from the description of *P. cannabina* by its smaller and less oblong pycnidia, smaller and more elliptic A-conidia, and the presence of B-conidia. Additionally, *P. cannabina* was described as a stem pathogen, while *P. ganjae* is exclusively a leaf pathogen, via both natural infection and laboratory pathogenicity tests. It is the caulicolous nature of *P. ganjae*, and its ability to completely defoliate *C. sativa* at high inoculum levels, that has drawn the attention of biocontrol researchers (Basit & Ghani, 1976).

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BIBLIOGRAPHY

BASIT, A. A. and M. A. GHANI. 1976. Diseases of *Cannabis sativa* L. and *Papaver somniferum* L. in Pakistan. Project Number 14. Annual Report of the Pakistan Station, Commonwealth Institute of Biological Control. p. 64.

CURZI, M. 1927. *De novis eumycetibus*. Atti dell'istituto botanico della Universita di Pavia. Ser. III, No. III. p. 205.

MCPARTLAND, J. M. 1983. Fungal pathogens of *Cannabis sativa* in central Illinois. Phytopathology 72:797.

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ON THE LECTOTYPIFICATION OF RUTSTROEMIA: CAN THIS PATIENT BE SAVED?

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Although the lectotypification of **Rutstroemia** Karsten has been discussed at length by Honey (1928), White (1941), Dumont & Korf (1972), and Holm (1976), as yet no consensus has been reached. Unless the conflict is resolved between the nomenclatural argument supporting the first explicit lectotypification with **Peziza bulgarioides** Rabenh. by Honey in 1928, and the taxonomic argument supporting lectotypification with **Peziza firma** Pers. based on Rehm's emendation in 1893, we must continue to tolerate conflicting applications of the name. Considering the options for lectotypification of **Rutstroemia**, all choices have some undesirable consequences. Honey's lectotypification restricts the generic concept to one species, a species that no taxonomist, including Karsten, has considered central to the circumscription of **Rutstroemia.** That Honey selected **P. bulgarioides** in part because it was the first binomial listed with the original description of the genus (a practice then sanctioned by the American Code of Botanical Nomenclature at a time when the principle of types was not yet treated in the International Code) has probably made this choice all the more repellent to modern taxonomists. Though defended by Dumont & Korf (1972), Honey's lectotypification has been rejected by Nannfeldt (1932), White (1941), Whetzel (1945), and Dennis (1978), all of whom accept the later lectotypification of **Rutstroemia** with **Peziza firma** by

Clements & Shear (**1931**). As Holm (**1976**) has demonstrated, however, **P. firma** is also peripheral to Karsten's circumscription of **Rutstroemia**. **P. firma** is central only to Rehm's emended generic concept; if the name is to be applied in this later, emended sense, formal conservation with **P. firma** as lectotype is necessary. Of the remaining five of Karsten's original species, **R. macilenta** is also of peripheral affinity and lectotypification with any of the other four species would place **Rutstroemia** in synonymy with one of Fuckel's earlier genera, **Sclerotinia** or **Ciboria**. Working within the context of Karsten's own treatments of the genus (Karsten **1871**, **1874**, **1876**, **1885**, **1887**), there are three possible approaches to lectotypifying (and thereby circumscribing) **Rutstroemia**: 1) accept Honey's lectotypification and accommodate species of **Rutstroemia** sensu lato (i.e., sensu White **1941**) in other genera; 2) accept Karsten's apparent emendation in 1885 and lectotypify with **P. amentacea** Balbis : Fr., putting **Rutstroemia** in synonymy with **Ciboria**; 3) reject **Rutstroemia** as a **nomen ambiguum** under Art. 69 of the International Code of Botanical Nomenclature. Working within the concept of Rehm's emendation, the added possibility exists: 4) conserve **Rutstroemia** with **P. firma** for a subset of species within White's concept, presumably synonymous with the later **Poculum** Velen. In this paper we wish to point out the consequences of conservation of **Rutstroemia** with **Peziza firma** and also to reconcile Karsten's original generic concept with his perplexing legacy of emendations, bringing to light the most appropriate solution: 2) the lectotypification of **Rutstroemia** with **P. amentacea**.

Rutstroemia was erected in 1871 to accommodate seven species (see Table 1). Karsten qualified the description to accommodate two species, **R. macilenta** and **R. firma**, implying that they diverge from the main body of species. Karsten's comment on **R. firma** ("rarissimae spurie tenuiter septatae") indicates that the typical **Rutstroemia** produces nonseptate ascospores, without even pseudosepta. On the basis of the original description both **R. macilenta** and **R. firma** are eliminated as appropriate lectotypes of **Rutstroemia** Karsten. Since **R. bulgarioides** was not singled out as differing, Honey's assumption that this species conforms to Karsten's generic concept is acceptable. Holm (**1976**), however, considers the notation under **R. bulgarioides**, "Cum Chl. versiformi, cujus varietatem b. lividam FR. Syst. myc. II, p. 131 forsan sistit, multum commune habet," as yet another

TABLE 1

epithet	Karsten (1871)	Karsten (1874)	Karsten (1876)	Karsten (1885)	Karsten (1887)	Rehm (1891-93)	Honey (1928)	White (1941)
bulgarioides	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	Chlorosplenium	[Chlorospl.]	Ombrophila	**Rutstroemia**	Chlorociboria
tuberosa	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	Sclerotinia	[Sclerotinia]	Sclerotinia	-	Sclerotinia
amentacea	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	**[Rutstr.]**	**[Rutstr.]**	Ciboria	Ciboria	Ciboria
homocarpa	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	Sclerotinia	[Sclerotinia]	Sclerotinia	-	Sclerotinia
curreyana	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	Sclerotinia	[Sclerotinia]	Sclerotinia	Sclerotinia	Sclerotinia
macilenta	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	Helotium	[Helotium]	-	-	Ciboria
firma	**Rutstroemia**	**[Rutstr.]**	**[Rutstr.]**	Ciboria	[Ciboria]	**Rutstroemia**	-	**Rutstroemia**
adusta		**Rutstroemia**	**[Rutstr.]**	Sclerotinia	[Sclerotinia]	-	-	Sclerotinia
gracilipes			**Rutstroemia**	Helotium	[Helotium]	-	-	Ciboria
ciborioides f. ciborioides	-	-	-	-	**Rutstroemia**	-	-	?
ciborioides f. tenella					**Rutstroemia**	-	-	Ciboria
tremellosa	-	-	-	-	-	**Rutstroemia**	-	**?Rutstroemia**
bolaris	-	-	-	-	-	**Rutstroemia**	-	**Rutstroemia**
fruticeti						**Rutstroemia**	-	**?Rutstroemia**
elatina	-	-	-	-	-	**Rutstroemia**	-	**Rutstroemia**
calopus	-	-	-	-	-	**Rutstroemia**	-	**Rutstroemia**
violacea						**Rutstroemia**	-	**?Rutstroemia**

Generic assignment of seven original epithets and some added epithets of **Rutstroemia** in various authors' treatments. A minus sign (-) indicates an untreated, available epithet. Generic names in brackets indicate a previously treated epithet not treated again in that paper.

qualification of the generic description, eliminating **P. bulgarioides** as a suitable lectotype. This is a debatable point and something of a red herring, since the suggested alternative, **P. firma**, is also accommodated with qualification by Karsten; at issue here is not the selection of the most appropriate lectotype but rather the direct circumscription of the genus.

In 1885 (see Table 1), Karsten synonymized **R. bulgarioides** under **Chlorosplenium lividum**, transferred **R. macilenta** to **Helotium**, recognized **R. tuberosa**, **R. homocarpa**, and **R. curreyana** as species of **Sclerotinia**, and recognized **R. firma** as a species of **Ciboria**; **R. amentacea**, which produces nonspetate ascospores, was not treated. Both White (1941) and Holm (1976) suggested that Karsten, unaware of Fuckel's **Ciboria** and **Sclerotinia** when he erected **Rutstroemia**, here acknowledged synonymy with the earlier genera. White proposed that **R. amentacea** was omitted because Karsten did not know the species from Finland. Holm wrote, "Karsten (1885) in a survey of the Finnish ascomycetes completely dropped Rutstroemia. One of the original species, R. amentacea, is omitted, apparently by oversight...."

But in 1887, Karsten made a new combination in **Rutstroemia**, simultaneously proposing a new infraspecific taxon, **R. ciborioides** (Fr.) Karst. forma **tenella** Karst. This at least implies that he had not abandoned **Rutstroemia** in 1885; in this light, the 1887 treatment may have been an explicit emendation of both **Rutstroemia** Karst. (for nonseptate-spored species, based on **R. amentacea**) and of **Ciboria** Fuckel (for septate-spored species, such as **C. firma**). The footnote accompanying the description of the new form, "A **Ciboria** Fuck. sporis continuis, a **Sclerotinia** Fuck. sclerotio deficiente diversa," has been interpreted by subsequent workers in the context of Fuckel's generic circumscriptions, obfuscating Karsten's apparent intentions. Holm (1976) described it as "a bit confused, as the true Ciboriae have continuous ascospores. Nevertheless it meant an emendation of Rutstroemia, excluding the sclerotiaceous species." Kohn (1979) wrote, "it is Ciboria that has continuous spores, and Rutstroemia that has septate spores, and by some abberation Karsten has reversed the two. Since he clearly intended to refer this species and his new form to the non-septate-spored genus, I treat the combinations in Rutstroemia as errors that can be corrected." Because recent authors (Kohn 1979; Carpenter 1981) have been unable to locate type or authentic material of either Pe-

ziza ciborioides Fr. or **R. ciborioides** f. **tenella** Karst., efforts to clarify Karsten's intentions have remained at an impasse. Recently the junior author located the holotype of **R. ciborioides** f. **tenella** at Helsinki. This specimen consists of a fusiform sclerotium embedded in the stem fragments of a species of **Juncus** giving rise to an apothecium with nonseptate ascospores. We have found this forma to be synonymous with the older **Peziza juncifida** Nyl., which Palmer (1969) transferred to **Myriosclerotinia.** It would therefore appear that Karsten emended **Rutstroemia** in 1887 (perhaps in 1885) to include species producing nonseptate ascospores but not producing sclerotia. Interestingly, Karsten had examined and annotated Nylander's holotype of **P. juncifida,** which he redetermined to be **Sclerotinia curreyana;** we assume that Karsten simply failed to observe the sclerotium of his forma **tenella,** otherwise he would have referred the material to **Sclerotinia.** Of Karsten's original species, only **R. amentacea** fits within this final emendation of **Rutstroemia.** Holm (1976) suggested the possibility of lectotypification with **R. amentacea** but rejected the idea because **Rutstroemia** would then be reduced to synonymy under **Ciboria.** Based on Karsten's description and emendations, however, **Rutstroemia** is indeed synonymous in part with **Ciboria** and in part with **Sclerotinia.** Lest modern workers cite the hallowed status of **Rutstroemia** in the pantheon of well-accepted genera, we hasten to point out that Saccardo (1889) placed the genus in synonymy with both of Fuckel's genera.

Rehm (1891-93), presumably recognizing a phyletic group distinct from **Ciboria,** emended **Rutstroemia** to include just one of Karsten's original species, **R. firma,** transferring or describing as new six additional species (see Table 1). This dramatic departure from the emended generic concept of Karsten (1885, 1887), perhaps most accurately designated **Rutstroemia** Rehm*, was essentially the circumscription (based on **P. firma**) accepted by Nannfeldt (1932) and codified by White (1941) in his comprehensive monograph of **Rutstroemia.** While Dennis (1978) recognized **Rutstroemia** in the broad sense of White for a fairly large group of species characterized by an indeterminate substratal stroma on wood or leaves and in many cases by ascospores which become septate and "bud" within the ascus, "Korf and his pupils" (i.e., Dumont

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* Or, as Seaver (1942) put it, "White's **Rutstroemia.**"

1972, 1976a, 1976b, 1978; Dumont & Korf 1973; Korf 1973; Korf & Gruff 1978; Kohn 1979, 1982) segregate these species, and new, allied species, into at least four genera (**Ciboria** Fuckel, **Lanzia** Sacc., **Moellerodiscus** P. Henn., **Poculum** Velen.), based primarily on apothecial microanatomy and substrate associations. Even if **Rutstroemia** is conserved for **Peziza firma**, there can be no return to the broad concept of White, save perhaps for the most conservative or complacent of workers. At present many species assigned by White and others to **Rutstroemia** hang in limbo, not yet transferred to acceptable and more taxonomically precise generic names; a comprehensive, monographic revision of **Rutstroemia** sensu White is long overdue. Those who wish to conserve the genus for **P. firma** should expect to accommodate only a comparatively small group of species, probably reducing **Poculum** to synonymy under **Rutstroemia**.

If all of the approaches to the lectotypification of **Rutstroemia** have undesirable consequences, which solutions will cause the least disruption taxonomically yet conform to nomenclatural precedent? Not conservation based on **Peziza firma**, which is nomenclaturally indefensible and will not preserve the "traditional" grouping of species that its supporters anticipate retaining. Honey's lectotypification has been defended by Dumont & Korf (1972) and Korf & Dumont (1977), who claim there is no nomenclaturally based argument for rejecting **P. bulgarioides** as lectotype. From a philosophical standpoint we agree, but we also concede that this species is peripheral to Karsten's concept and to subsequent emended circumscriptions. **Peziza bulgarioides**, if rejected as lectotype of **Rutstroemia**, would then be accommodated as type species of Svrček's genus, **Piceomphale**. We believe that lectotypification of **Rutstroemia** with **Peziza amentacea** would then be the wisest approach, since it is consistent with Karsten's original concept and his later emendations. The name, thus typified, would essentially be lost in synonymy under **Ciboria**, with other species accommodated in **Ciboria**, **Lanzia**, **Moellerodiscus**, and **Poculum**. It is time now to decide how badly we need **Rutstroemia** and what will be gained by its conservation. A formal proposal to conserve **Rutstroemia** with **Peziza amentacea** as its type species will be published in TAXON. Those committed to "saving" the generic name for those few species centered around **P. firma** may wish to propose conservation with that species as type. Without some formal action, **Rutstroemia** remains a generic name of uncertain application. Conservation of the name to fix the type species seems the only acceptable solution.

LITERATURE CITED

CARPENTER, S. E. 1981. Monograph of *Crocicreas* (Ascomycetes, Helotiales, Leotiaceae). Mem. New York Bot. Gard. **33**: 1-290.

CLEMENTS, F. E. and C. L. SHEAR. 1931. The genera of fungi. The H. W. Wilson Co., New York. 496 p., 58 pl.

DENNIS, R. W. G. 1978. British Ascomycetes, ed. 2. J. Cramer, Vaduz. 486 p., 31 figs., 44 pl.

DUMONT, K. P. 1972. Sclerotiniaceae III. The generic names *Poculum*, *Calycina* and *Lanzia*. Mycologia **64**: 911-915.

——————. 1976a. Sclerotiniaceae XI. On *Moellerodiscus* (= *Ciboriopsis*). Mycologia **68**: 233-267.

——————. 1976b. Sclerotiniaceae XII. On some selected species from India. Mycologia **68**: 842-873.

——————. 1978. Sclerotiniaceae XIII. An undescribed species on *Berberis*. Mycologia **70**: 61-67.

—————— and R. P. KORF. 1971. Sclerotiniaceae I. Generic nomenclature. Mycologia **63**: 157-168.

HOLM, L. 1976. Some notes on Discomycete nomenclature. Trans. Brit. Mycol. Soc. **67**: 333-334.

HONEY, E. E. 1928. The monilioid species of *Sclerotinia*. Mycologia **20**: 127-157.

KARSTEN, P. A. 1871. Mycologia Fennica. I. Discomycetes. Bidrag Kännedom Finlands Natur Folk **19**: 1-264.

——————. 1874. Quaedom ad Ascomycetes fennicos addenda. Not. Sällsk. Fauna Fl. Fenn. Förh. **13**: 448-450.

——————. 1876. Symbolae ad mycologiam fennicam. III. Meddeland. Soc. Fauna Fl. Fenn. **1**: 55-59.

——————. 1885. Revisio monographica atque synopsis Ascomycetum in fennia hucusque detectorum. Acta Soc. Fauna Fl. Fenn. 2(6): 1-174.

——————. 1887. Fragmenta mycologica XXII. Hedwigia **26**: 124-127.

KOHN, L. M. 1979. A monographic revision of the genus *Sclerotinia*. Mycotaxon **9**: 365-444.

——————. 1982. A preliminary Discomycete flora of Macaronesia: Part 5, Sclerotiniaceae. Mycotaxon **16**: 1-34.

KORF, R. P. 1973. Discomycetes and Tuberales, pp. 249-319, *in* G. C. Ainsworth, F. K. Sparrow, and A. S. Süssman [eds.], The Fungi: An Advanced Treatise, vol. **4A**. Academic Press, New York. 621 p.

——— and K. P. DUMONT. 1977. Nomenclatural notes. X. Typification of *Rutstroemia*: a rebuttal. Mycotaxon **5**: 517-518.

——— and S. C. GRUFF. 1978. Discomycetes Exsiccati, fasc. II & III. Mycotaxon **7**: 185-203.

NANNFELDT, J. A. 1932. Studien über die Morphologie und Systematik der nicht-lichenisierten inoperculaten Discomyceten. Nova Acta Regiae Soc. Sci. Upsal. [4]**8**(2): 1-368, 20 pl.

PALMER, J. T. 1969. *Myriosclerotinia juncifida* (Nyl.) comb. nov. A little-known parasite of *Juncus*. Investigations into the Sclerotiniaceae IV. Friesia **9**: 193-201.

REHM, H. 1891-93. Ascomyceten: Hysteriaceen und Discomyceten, *in* L. Rabenhorst [ed.], Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz II, **1**(3)[Lief. 35, 39-40]: 465-528, 721-848.

SACCARDO, P. A. 1889. Sylloge fungorum omnium hucusque cognitarum **8**: 1-1143. Patavii.

SEAVER, F. J. 1942. White's *Rutstroemia*. Mycologia **34**: 598-600.

WHETZEL, H. H. 1945. A synopsis of the genera and species of the Sclerotiniaceae, a family of stromatic inoperculate Discomycetes. Mycologia **37**: 648-714.

WHITE, W. L. 1941. A monograph of the genus *Rutstroemia* (Discomycetes). Lloydia **4**: 153-240.

MYCOTAXON

Vol. XVIII, No. 2, pp. 539-540   October-December 1983

SOME DACRYMYCETACEOUS FUNGI FROM HAWAII

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SUMMARY

Five species of dacrymycetaceous fungi collected in Hawaii are reported. This appears to be the first published record of this group of fungi for the state.

As noted by Ueki and Smith (1973) and Goos (1980), the fungi of Hawaii are still poorly documented. No published record of dacrymycetaceous fungi have been found, although, as the following records will indicate, these fungi appear to be rather well represented in the islands.

The fungi reported were collected during 1968-70, while the junior author was a member of the faculty of the University of Hawaii. The specimens cited represent the results of occasional collections made while in the pursuit of other fungal groups and are not the result of a systematic effort to collect dacrymycetaceous fungi. Thus, this report may list only the most conspicuous portion of the dacrymycetaceous mycota.

1. Calocera furcata Fries. This fungus is represented by a single collection. COLLECTION SEEN: H-218, on dead wood, Manoa Falls Trail, Oahu. July 3, 1969.

2. Dacrymyces deliquescens var. minor (Peck) Kennedy. This species is also represented by a single collection.

COLLECTION SEEN: H-115B, on dead wood, Molokai Forest Reserve. Feb. 7, 1969.

3. Dacrymyces enatus var. macrospora Kennedy. A single collected was made. COLLECTION SEEN: H-66 on dead wood, near Murphy Ranch, Molokai. December 7, 1978.

4. Dacryopinax spathularia (Schw.) Martin. This was the most commonly encountered of all the dacrymycetaceous fungi, which may be simply a reflection of his conspicuous nature. COLLECTIONS SEEN: H-159, Manoa Falls Trail, Oahu, March 8, 1969; H-219, Manoa Falls Trail, Oahu, July 3, 1969; H-255 (coll. by J. Meeker), Pali Trail, Oahu, Oct. 25, 1969; H-266, Manoa Falls Trail, Oahu, Dec. 1, 1969; H-274, Manoa Falls Trail, Dec. 9, 1969; H-284, Kona, Hawaii (coll. by J. Kadooka) January, 1970; H-339, Manoa Falls Trail, Oahu, May 4, 1970.

5. Ditiola radicata Fries. Three specimens at scattered locations were found, all on decaying wood. COLLECTIONS SEEN: H-115, Molokai Forest Reserve, Feb. 7, 1969; H-154, Manoa Falls Trail, Oahu, March 8, 1969; H-343, Nuuanu stream, Nuuanu Pali Drive, Oahu, June 3, 1970.

Specimens cited are in the Herbarium of the Department of Botany, University of Rhode Island.

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LITERATURE CITED

Goos, R. D. 1980. Some helicosporous fungi from Hawaii. Mycologia 72: 595-610.

Ueki, R. and C. W. Smith. 1973. The genus Crepidotus in Hawaii. Canad. J. Bot. 51: 1251-1254.

MYCOTAXON

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NOTES ON BASIDIOMYCETES THAT DECAY BRISTLECONE PINE[1]

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SUMMARY

Twenty-one species of wood-rotting basidiomycetes are reported to decay bristlecone pine. These are mostly from the Dixie National Forest, Utah. Three are heterobasidiocetes and the rest are homobasidiomycetes in the order Aphyllophorales. Four are brown rot fungi. *Aleurodiscus utahensis* is described as new.

In August of 1973 the authors, along with Dr. Kenneth J. Martin, attended the annual D. E. Stuntz Mycological Foray in Cedar City, Utah. Limited collections of wood-rotting basidiomycetes were made from bristlecone pine, *Pinus longaeva* Bailey, in the vicinity of Cedar Breaks, Iron County, in the Dixie National Forest. Additional collections were made in the same locality by Gilbertson in September, 1982. Twenty species are illustrated and described in this paper. The Tremellales are represented by three species, with the other 17 from the Aphyllophorales. One species, *Aleurodiscus utahensis*, is described as new.

Current systematics separates the Great Basin bristlecone pine, *Pinus longaeva*, from the Rocky Mountain bristlecone pine, *P. aristata* Engelm. *Pinus aristata* is distributed in Colorado, New Mexico (mainly the Sangre de Cristo Range), and the San Francisco Peaks in Arizona, while *P. longaeva* is found in Utah, Nevada, and California (Bailey, 1970). In addition to the collections mentioned above from *P. longaeva*, two collections from *P. aristata* are mentioned in this paper.

Of the 20 species collected, only four are brown rot fungi. These are *Chaetoderma luna*, *Tyromyces leucospongia*, *Dacryobolus sudans*, and *Helicobasidium corticioides*. In addition, a deteriorated specimen of *Gloeophyllum odoratum* (Wulf.:Fr.) Imazeki (also a brown rot fungus) was observed on a bristlecone pine log at Cedar Breaks but not collected. Individuals of bristlecone pine, specifically *P. longaeva*, are generally recognized as the oldest living organisms on earth (Ferguson, 1968). The oldest living bristlecone pine known has been dated at 4900 years

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[1] University of Arizona Agricultural Experiment Station Journal Article No. 3780.

(Currey, 1965). This tree is in the Snake Range of east-central Nevada. Other extremely old trees have been found in the White Mountains of California. Dead wood of bristlecone pine has also been determined to be over 8600 years old (Ferguson and Graybill, 1983) by workers from the Dendrochronology Laboratory at the University of Arizona. The occurrence of a significant number of wood-rotting fungi on dead wood of *P. longaeva* suggests that its long survival in a relatively sound condition is due not so much to an inherent resistance to decay as to the severely limiting environmental conditions in most areas in which it grows. Apparently the microenvironment of bristlecone pine wood is generally too dry or too cold (or a combination of both) in these areas to allow active growth of wood-rotting fungi for much of the year. If this were not the case, the brown rot fungi in particular would remove the cellulose and hemicelluloses from the wood in a relatively short time and leave stable brown rot residues composed largely of modified lignin. This is the general pattern of development observed in other high elevation coniferous forest ecosystems where spruces and true firs predominate.

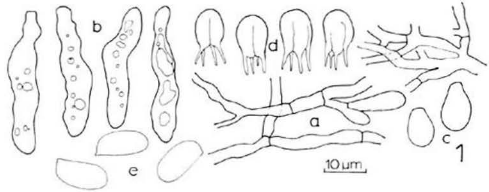
Microscopic observations were made from free-hand sections mounted in 4% KOH and phloxine. Melzer's reagent was used to determine amyloidity and dextrinoidity. Camera lucida drawings were made using an Olympus LHB microscope. Capitalized color names are from Ridgway (1912). Collections of voucher specimens other than those of the authors (JPL and RLG) are by Kenneth J. Martin (KJM) and Robert L. Mathiasen (RLM). All are from *P. longaeva* unless otherwise noted. Dimensions of microscopic structures are given in µm.

Annotated List of Species that Decay Bristlecone Pine

BOURDOTIA CINEREA (Bres.) Bourd. et Galz., Hymen. Fr. p. 49. 1928. Basidiocarps thin, adnate, waxy-arid; hymenial surface smooth, grayish-white; hyphal system monomitic; subicular hyphae simple-septate, 2-2.5 in diam; gloeocystidia mostly imbedded, elongated, with golden yellow refractive contents, 10-20 x 4-5; basidia globose to ovoid, becoming cruciately septate, 4-celled, 11-13 x 9-10, epibasidia stout, up to 2 wide and 6 long; basidiospores broadly ellipsoid, hyaline, negative in Melzer's reagent, smooth, 7-8 x 6-6.5. Associated with a white rot. JPL 238.

BOURDOTIA EYREI (Wakef.) Bourd. et Galz., Hymen. Fr. p. 50. 1928. Basidiocarps thin, adnate, effused, waxy-pruinose; hymenial surface smooth to slightly tuberculate, pale gray to ochraceous-tawny; hyphal system monomitic; subicular hyphae simple-septate, 2-3 diam; gloeocystidia cylindric, imbedded or projecting, with golden, refractive contents, 25-30 x 3-6; basidia globose to ovoid, cruciately septate, epibasidia 4, up to 5 long, 6-7 x 8-11; basidiospores hyaline, negative in Melzer's reagent, subglobose to ovoid, smooth, 5-6 x 4-4.5. Associated with a white rot. JPL 226.

HELICOBASIDIUM CORTICIOIDES Bandoni, Mycologia 47:918. 1955. Basidiocarps annual, resupinate, effused up to 5 cm, hymenial surface cream-colored, smooth; margin fertile; hyphal system monomitic; subicular hyphae simple-septate, thin-walled, 3-6 in diam, with occasional branching; sterile hymenial structures none; basidia elongated, devel-



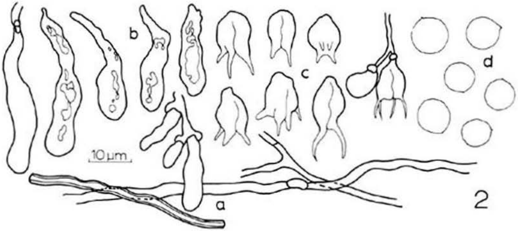


Fig. 1. *Bourdotia cinerea* (JPL 238). a, subicular hyphae; b, gloeocystidia; c, basidioles; d, basidia; e, basidiospores. Fig. 2. *Bourdotia eyrei* (JPL 226). a, subicular hyphae; b, gloeocystidia; c, basidia; d, basidiospores.

oping directly from subhymenial hyphae, becoming coiled and transversely septate, 3-4 celled at maturity, 8-9 in diam and about 150 long; epibasidia arising singly from each basidial cell, stout, straight, 2.5-5 in diam and up to 50 long; basidiospores ellipsoid, hyaline, smooth, 10-17.5 x 7-10, negative in Melzer's reagent, with a large, blunt apiculus. Associated with a brown cubical pocket rot. RLG 14270. This is one of the few lignicolous heterobasidiomycetes known to cause a brown rot. It occurs at high elevations throughout the Rocky Mountains, particularly in the spruce-fir zone.

ALEURODISCUS LIVIDOCOERULEUS (Karst.) Lemke, Can. J. Bot. 42:252. 1964.

Basidiocarps resupinate, corticioid, becoming widely effused, waxy; hymenial surface cream-colored to dark bluish-gray; hyphal system monomitic; subicular hyphae nodose-septate, thin-walled, 2.5-3.5 in diam; gloeocystidia abundant, positive in sulphuric benzaldehyde, cylindric, often moniliform to mammillate, imbedded to projecting, 4-12 x 75-95; acanthohyphidia abundant, clavate, terminally aculeate, 5-6 x 30-40; basidia clavate, 2-4 sterigmate, 30-40 x 7-9, with a basal clamp; basidiospores broadly cylindric, hyaline, smooth, amyloid in Melzer's

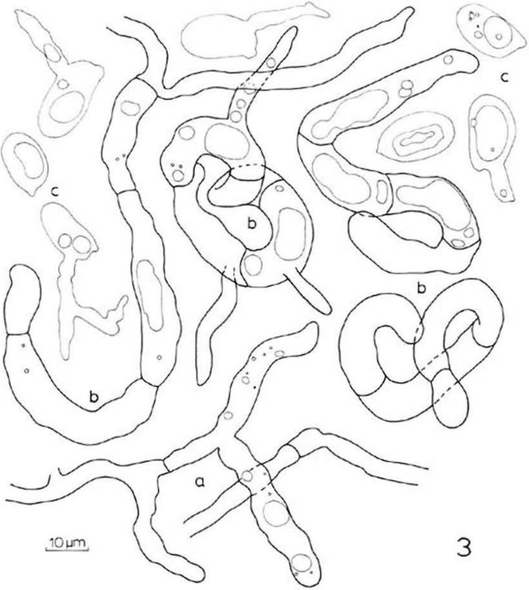
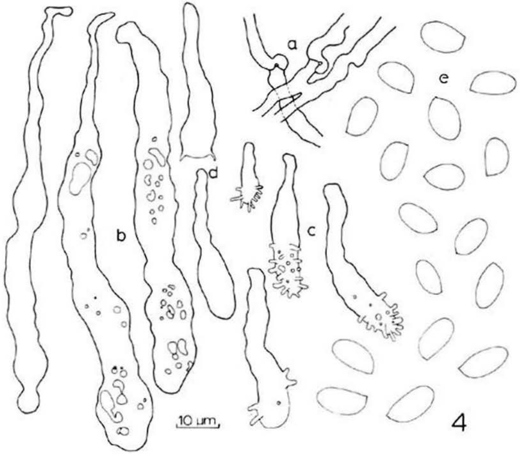


Fig. 3. *Helicobasidium corticioides* (RLG 14270). a, subicular hyphae; b, basidia, some with sterigmata; c, basidiospores, some germinating.

reagent, 3.5-5 x 7.5-9. Associated with a distinctive white pocket rot of conifers. JPL 236.

ALEURODISCUS UTAHENSIS Linds. et Gilbn., sp. nov.
Fructificatio resupinata, cremea vel ochracea; rhizomorphae adsunt; systema hypharum dimitica; hyphae generatoriae fibulatae; gloeocystidia adsunt, mammillata, aurea, 30-40 x 5-7 µm; acanthohyphidia adsunt; basidiosporae oblongae vel ellipsoidae, echinulateae, amyloidae, 4-5.5 x 2-3 µm. Holotypus RLG 11090, legit R. L. Gilbertson, on *Pinus longaeva* Bailey, Bristlecone Pine Trail, Cedar Breaks, Dixie Nat. Forest, Iron County, Utah, Aug. 18, 1973; in herb. National Fungus Collections, Beltsville, MD, USA (BPI).
Basidiocarps effused, adnate, cream to light ochre, slightly farinaceous, rhizomorphic, cracking upon drying; margin diffuse, indistinct;



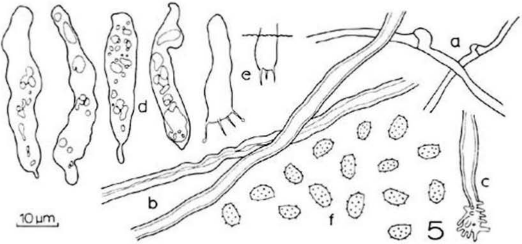


Fig. 4. *Aleurodiscus lividocoeruleus* (JPL 236). a, subicular hyphae; b, gloeocystidia; c, acanthohyphidia; d, basidia; e, basidiospores. Fig. 5. *Aleurodiscus utahensis* (RLG 11090, TYPE). a, generative hyphae; b, skeletal hyphae; c, acanthohyphidia; d, gloeocystidia, some with mucronate apices; e, basidia; f, basidiospores.

hyphal system dimitic; generative hyphae nodose-septate, some with refractive contents, 1.5-2 in diam; skeletal hyphae aseptate, thick-

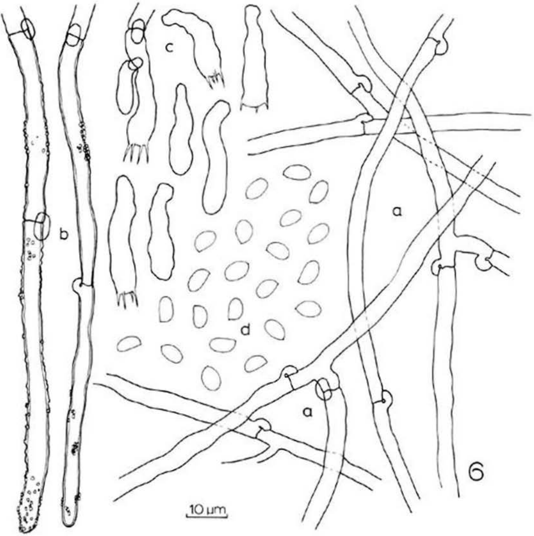


Fig. 6. *Amphinema byssoides* (KJM 433). a, subicular hyphae; b, encrusted cystidia; c, basidia; d, basidiospores.

walled, 2.5-3 in diam; gloeocystidia imbedded or projecting, most with a small mammillate apical projection, with golden, refractive contents, 30-40 x 5-7; acanthohyphidia densely tangled, thick-walled, apically aculeate, with the projections often extending down the sides, aculeate tips often breaking loose and floating free in slide preparations; basidia clavate, 4-sterigmate, 22-25 x 3.5-5, with a basal clamp; basidiospores short-cylindric to broadly ellipsoid, hyaline, finely echinulate, amyloid in Melzer's reagent, 4-5.5 x 2-3. Associated with a white rot. RLG 11090, HOLOTYPE. This species has extremely small spores for an *Aleurodiscus*; it is similar to *A. weirii* Burt, but is decidedly dimitic. Basidiospores are smaller and gloeocystidia more frequently mammillate than indicated by Lemke (1964) for *A. weirii*.

AMPHINEMA BYSSOIDES (Fr.) J. Erikss., Symb. Bot. Upsal. XVI: 1, p. 112. 1958.
Basidiocarps loose, felty, readily separable; hymenial surface Warm

Buff, tomentose, subiculum and margin arachnoid; hyphal system monomitic; subicular hyphae nodose-septate, thin-walled, 3-4.5 in diam; cystidia projecting, nodose-septate, finely incrusted at the tip or often over the entire projecting portion, slightly thick-walled, 4-5 x up to 120; basidia clavate, 4-sterigmate, clamped at the base, 4.5-5 x 20-25; basidiospores ellipsoid to short-cylindric, smooth, hyaline, negative in Melzer's reagent, 2.5-3.5 x 4.5-5. Associated with a white rot of conifers and hardwoods. KJM 423; KJM 427; KJM 433; RLG 14269; RLG 14271; RLG 14273. *Amphinema byssoides* was the most common fungus on *Pinus longaeva* during the collection period.

CHAETODERMA LUNA (Rom.) Parm. Conspectus Syst. Cort., p. 86. 1968. Basidiocarps white to cream-colored, up to 2 mm thick, developing in small patches, these often becoming confluent; hymenium pilose under a 10X lens; hyphal system monomitic; subicular hyphae thin to slightly thick-walled, nodose-septate, 2-4 in diam; cystidia abundant, narrowly clavate, unevenly thick-walled, 5-8 x up to 160; basidia narrowly clavate, 2-4 sterigmate, with a basal clamp, 4.5-7 x up to 140; basidiospores cylindric, slightly allantoid, hyaline, smooth, negative in Melzer's reagent, 4-5 x 13-15.5. Associated with a brown rot. KJM 426; KJM 437; RLG 14268; RLG 14275.

CYLINDROBASIDIUM CORRUGUM (Burt) Ginns, Opera Botanica 61:54. 1982. Basidiocarps annual, becoming widely effused, developing under snow, easily separable; hymenial surface smooth to merulioid, Ochraceous-Tawny to Cinnamon Brown, pellicular on a soft, white, floccose subiculum which extends beyond the hymenial layer marginally; hyphal system monomitic; subicular hyphae nodose-septate, thin-walled, 4-5 in diam; cystidia and other sterile hymenial elements lacking; basidia cylindric, 4-sterigmate, 6.5-9 x 35-55; basidiospores ellipsoid, hyaline, smooth, dextrinoid in Melzer's reagent, 5.5-6.5 x 8-11. Associated with a white rot of dead conifers and hardwoods. JPL 225, RLG 11089.

DACRYOBOLUS SUDANS (Fr.) Fr., Summa Veg. Scand. p. 404. 1849. Basidiocarps resupinate, annual, effused up to several cm; hymenial surface papillose, cream-colored to light buff; papillae wart-like to cylindric or conical, exuding a droplet of viscous, amber liquid that dries to form a resinous bead, often breaking away and leaving a small crater at the apex of the tooth; hyphal system monomitic; subicular hyphae thin to thick-walled, nodose-septate, 1.5-5 in diam; cystidia thin-walled, nodose-septate, simple-septate, or aseptate, clustered at apices of papillae, 70-90 x 3-6; basidia narrowly clavate to cylindric, 4-sterigmate, 20-25 x 3-3.5, with a basal clamp; basidiospores narrowly allantoid, hyaline, smooth, negative in Melzer's reagent, 5-7 x 1-1.5. Associated with a brown cubical rot of dead conifers and hardwoods. RLG 14272A. *Dacryobolus sudans* has a wide ecological amplitude, occurring throughout North America in coniferous and hardwood forest ecosystems.

HAEMATOSTEREUM SANGUINOLENTUM (Alb. et Schw.: Fr.) Pouz., Česka Mykol. 13:13. 1959.
Basidiocarps resupinate to effused-reflexed; upper surface tomentose,

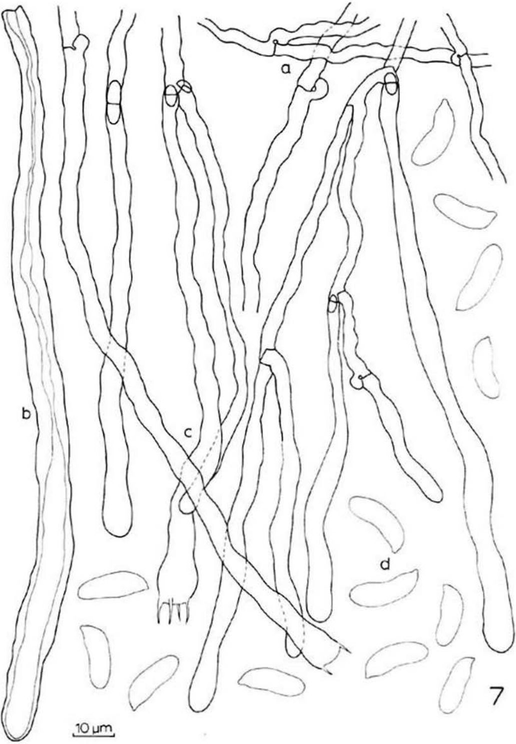
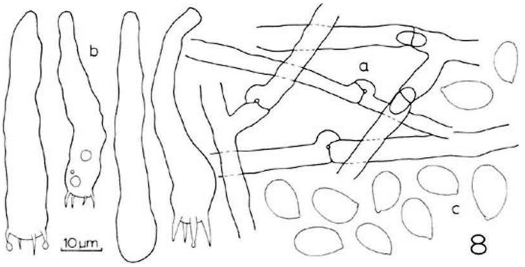


Fig. 7. *Chaetoderma luna* (KJM 437). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

buff to gray; hymenial surface smooth, light buff to gray; with a reddish exudate where bruised; hyphal system dimitic; generative hyphae thin-walled, simple-septate, 2.5-4 in diam; skeletal hyphae thick-wall-



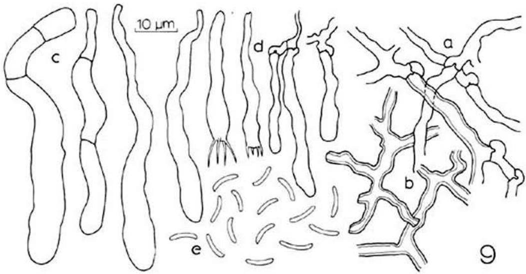


Fig. 8. *Cylindrobasidium corrugum* (JPL 225). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 9. *Dacryobolus sudans* (RLG 14272A). a, subicular hyphae; b, thick-walled skeletal hyphae; c, septate cystidia; d, basidia; e, basidiospores.

ed, rarely septate, 3-4 in diam; cystidia cylindric, embedded, with golden brown contents, 8-9 wide and up to 120 long; acanthohyphidia cylindric, aculeate at the tip, 3.5-4.5 x 20-35; basidia narrowly cylindric, 4-sterigmate, 3-4.5 x 20-35; basidiospores cylindric, hyaline, smooth, amyloid in Melzer's reagent, 2.5-3 x 7-8. Associated with a white rot. RLG 5023, on *Pinus aristata*, Mt. Evans, Clear Creek County, Colorado.

HYMENOCHAETE CINNAMOMEA (Pers.) Bres., I. R. Accad. Agiati Atti III. 3:110. 1897.
Basidiocarps resupinate, widely effused, adnate, velvety, obviosly setose under a 10X lens, becoming rimose on drying, drying a pale dusty brown to rust colored; margin abrupt, concolorous; hyphal system mono-

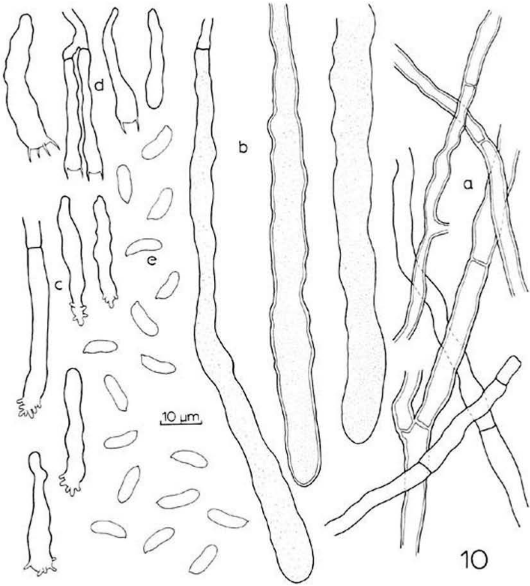


Fig. 10. *Haematostereum sanguinolentum* (RLG 5023). a, subicular hyphae; b, cystidia with golden contents; c, acanthohyphidia; d, basidia; e, basidiospores.

mitic; subicular hyphae simple-septate, thin- to firm-walled, brown, 2-2.5 in diam; setae abundant, subulate, narrowly tapering, mostly straight but a few curved, brown, thick-walled, with a thin, clear, membranous sheath at the base, projecting, 7-11 wide and up to 100 long; basidia cylindric, 4-sterigmate, 4-4.5 x 20-30; basidiospores smooth, hyaline, negative in Melzer's reagent, short-cylindric, 2.5-3.5 x 5-6. Associated with a white rot. RLG 11091

HYPHODONTIA SUBALUTACEA (Karst.) John Erikss., Symb. Bot. Upsal. XVI:1. p. 104. 1958.
Basidiocarps annual, resupinate, effused up to 5 cm; hymenial surface

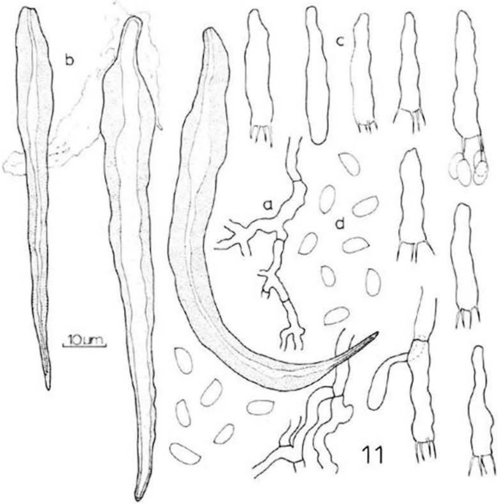


Fig. 11. *Hymenochaete cinnamomea* (RLG 11091). a, subicular hyphae; b, setae, one showing basal sheath; c, basidia; d, basidiospores.

cream-colored to pale buff, smooth, margin thinning out; hyphal system monomitic; subicular hyphae abundantly nodose-septate, firm-walled, with frequent branching, 2-4 in diam; cystidia frequent, cylindric, not incrusted, thick-walled at the base with the wall gradually thinning towards the apex, up to 150 long, 5-7 in diam; basidia clavate, 4-sterigmate, 12-15 x 4-5, with a basal clamp; basidiospores allantoid, hyaline, smooth, negative in Melzer's reagent, 6-7.5 x 1.5-2. Associated with a white rot of dead conifers. RLG 14272. *Hyphodontia subalutacea* is similar to and grades into *H. floccosa* (Bourd. et Galz.) John Erikss. The latter species is differentiated by its hydnaceous hymenial surface.

PENIOPHORA FARINOSA (Bres.) Hoehn. et Litsch., K. Akad. Wiss. Wien. Math.-Nat. Kl. Sitzungsb. 117 (Abt. 1): 1095. 1908.
Basidiocarps effused, adnate, grayish-white; margin pruinose, thinning out; obviously cystidiate under a 10X lens; hyphal system monomitic; subicular hyphae thin-walled, nodose-septate, 2-2.5 in diam; cystidia

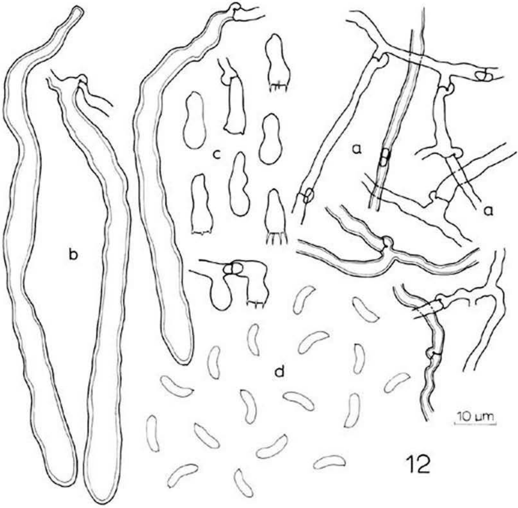


Fig. 12. *Hyphodontia subalutacea* (RLG 14272). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

incrusted from apex to almost half their length, slender, tapering, slightly swollen at the base, thick-walled, 9-12 wide and up to 100 long; basidia clavate, 4-sterigmate, 6.5-8 x 19-20; basidiospores smooth, hyaline, subglobose, negative in Melzer's reagent, 5.5-7.5 x 8-9. Associated with a white rot. KJM 428; KJM 429; KJM 434; JPL 228; JPL 229.

PHELLINUS PINI (Thore:Fr.) Pilát, Atl. Champ. Eur. III (1). p. 517. 1942.
Basidiocarps sessile, effused-reflexed or rarely resupinate; pilei solitary or imbricate, ungulate to applanate, up to 9 x 13 x 8 cm; upper surface blackish-brown, becoming glabrous, zonate, and sulcate with age; margin reddish-brown to Antimony Yellow, hirsute; pore surface Tawny-Olive to Yellow Ocher, the pores circular to angular, 2-3 per mm; dissepiments thick, entire; context reddish-brown to yellowish-brown, up to 3 cm thick, corky; individual tube layers up to 6 mm thick; hyphal system dimitic; generative hyphae hyaline, thin-walled,

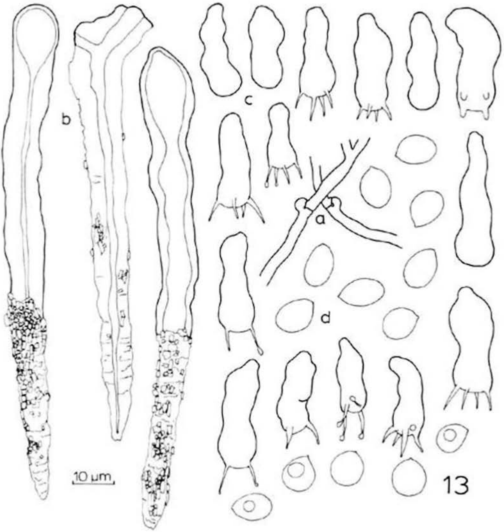
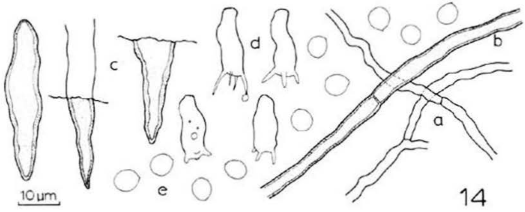


Fig. 13. *Peniophora farinosa* (KJM 434 and JPL 229). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

simple-septate, 2-3 in diam; skeletal hyphae thick-walled, simple-septate, 4-7.5 in diam; setae abundant, subulate to ventricose, 7-8 x 35-50; basidia clavate, 4-sterigmate, 4-4.5 x 14-18; basidiospores subglobose, hyaline, smooth, negative in Melzer's reagent, 3.5-4.5 x 4-5. Causes a white pocket rot of heartwood in living conifers. RLM 7530, on *Pinus aristata*, San Francisco Peaks, Coconino Nat. Forest, Coconino County, Arizona.

PILODERMA BYSSINUM (Karst.) Jülich, Ber. Deutsch. Bot. Ges. 81:418. 1969.
Basidiocarps widely effused, thin, fragile; hymenial surface pellicular, golden yellow to cream colored on a white, arachnoid subiculum, smooth to pitted, often appearing poroid; margin often with white rhizomorphs; hyphal system monomitic, subicular hyphae simple-septate, thin-walled, most incrusted with minute or distinctive, wedge-shaped crystals, 2.5-4 in diam; cystidia or other sterile hymenial elements lacking; basidia clavate, 4-sterigmate with slender sterigmata, 4-5 x



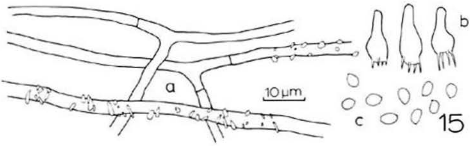


Fig. 14. *Phellinus pini* (RLM 7530). a, subicular hyphae; b, tramal hyphae; c, setae; d, basidia; e, basidiospores. Fig. 15. *Piloderma byssinum* (RLG 11092). a, subicular hyphae; b, basidia; c, basidiospores.

10-12, simple-septate at the base; basidiospores ovoid, smooth, hyaline, negative in Melzer's reagent, 2 x 2.5-3.5. Associated with a white rot. RLG 11092.

TOMENTELLINA FIBROSA (Berk. et Curt.) M. J. Larsen, Mycologia Memoir No. 4, P. 115. 1974.
Basidiocarps effused, up to 1 mm thick, easily separable, hypochnoid, hymenial surface ferruginous (Prout's Brown), margin lighter; hyphal system dimitic; generative hyphae simple-septate, 3 in diam; skeletal hyphae aseptate, thick-walled, yellowish, with occasional fine incrustations, 4-6 in diam; skeletal hyphal cordons also present; cystidia thick-walled, brown, septate, projecting, 5-8 x up to 130; basidia narrowly clavate, 4-sterigmate, 5-8 x up to 90; basidiospores globose to subglobose, yellowish-brown, negative in Melzer's reagent, slightly thick-walled, heavily warted, apiculate, 7-9 x 8-10. Associated rot undetermined. JPL 232; JPL 235.

TRECHISPORA FARINACEA (Pers.:Fr.) Liberta, Taxon 15:318. 1966.
Basidiocarps thin and fragile, effused; hymenial surface white to cream-colored, smooth to slightly hydnoid, farinaceous under 30X lens; subiculum and margin arachnoid; margin with white rhizomorphs; rhizomorphs also visible under the thin basidiocarps; hyphal system mono-

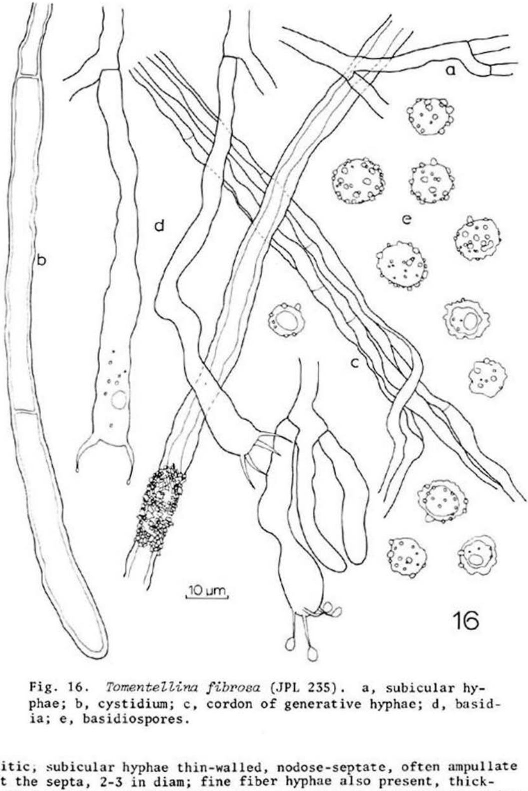
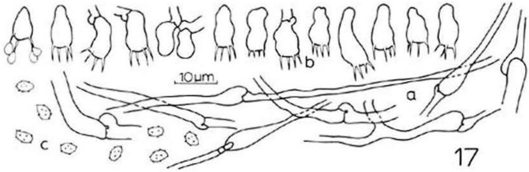


Fig. 16. *Tomentellina fibrosa* (JPL 235). a, subicular hyphae; b, cystidium; c, cordon of generative hyphae; d, basidia; e, basidiospores.

mitic; subicular hyphae thin-walled, nodose-septate, often ampullate at the septa, 2-3 in diam; fine fiber hyphae also present, thick-walled, unbranched, 0.5-1.0 in diam, traceable to thin-walled, nodose-septate hyphae; ampullations up to 8 in diam; cystidia and other sterile hymenial elements lacking; basidia clavate, 4-sterigmate, with a basal clamp, 4-4.5 x 7-12; basidiospores hyaline, ovoid to ellipsoid, irregularly echinulate, negative in Melzer's reagent, 3.5-4 x 2-3.



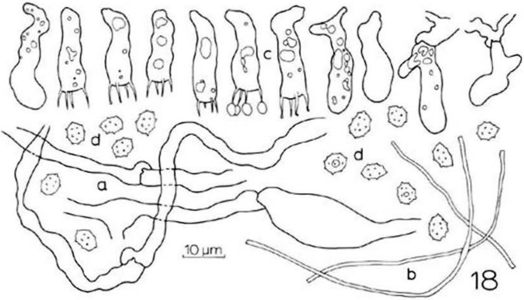
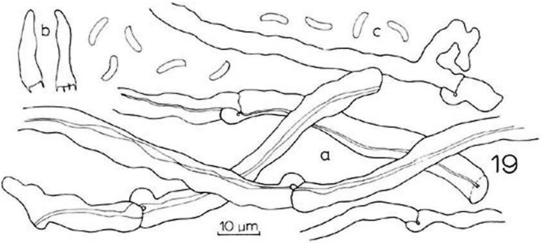


Fig. 17. *Trechispora farinacea* (JPL 234, KJM 431, KJM 435). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 18. *Trechispora vaga* (RLG 14274). a, subicular hyphae; b, fiber hyphae; c, basidia; d, basidiospores.

Associated with a white rot. KJM 431; KJM 435; JPL 234; JPL 239. As Liberta (1973) points out, *T. farinacea* is highly variable in basidiocarp morphology. The four specimens cited here are characterized by their cream-colored farinaceous hymenial surface, conspicuous rhizomorphs, and fine fiber hyphae originating from typical trechisporoid thin-walled, ampullate, nodose-septate generative hyphae.

TRECHISPORA VAGA (Fr.) Liberta, Taxon 15:319. 1966.
Basidiocarps annual, resupinate, becoming widely effused; hymenial surface covering intertwined cordons visible under 10X lens, pale yellowish brown to dark purplish brown; margin cream-colored to yellow or concolorous with hymenial surface, with radiating cordons; tissue red in KOH solution; hyphal system monomitic; subicular hyphae thin-walled, nodose-septate, some ampullate at the clamps, mostly 3-5 in diam with ampullations up to 7 in diam; cordons 45-60 wide; sterile hymenial



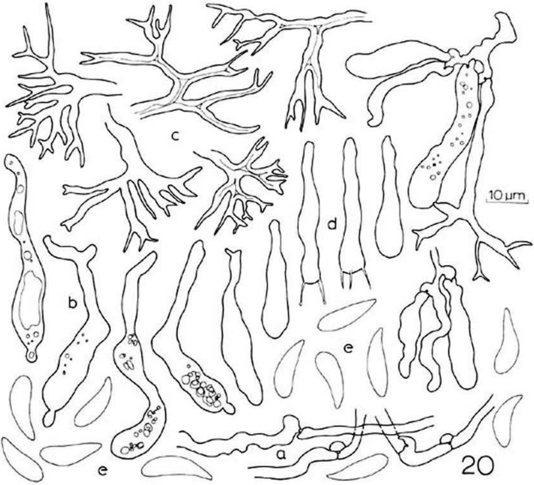


Fig. 19. *Tyromyces leucospongia* (JPL 240). a, thick-walled tramal hyphae; b, basidia; c, basidiospores. Fig. 20. *Vararia athabascensis* (RLG 14276). a, subicular hyphae; b, mammillate gloeocystidia; c, dichohyphidia; d, basidia; e, basidiospores.

structures none; basidia clavate, 4-sterigmate, 15-20 x 5-6, with a basal clamp; basidiospores subglobose to ovoid or broadly ellipsoid, echinulate, hyaline, negative in Melzer's reagent, 4-5 x 3-4. Associated with a white rot of dead conifers and hardwoods. RLG 14274. *Trechispora vaga* is one of the most common corticioid fungi on dead conifers and hardwoods throughout North America. The ropy hymenial surface and the yellowish to purplish-brown color are distinctive field characters

TYROMYCES LEUCOSPONGIA (Cke. et Harkn.) Bond. et Sing., Ann. Mycol. 39:52. 1941.
Basidiocarps annual, sessile to effused-reflexed; pilei solitary, dimidiate to elongate, up to 3 x 7 x 3.5 cm; pileus surface white, felty to papery, azonate, smooth to rugose, soft; margin concolorous, curling down and partially enclosing the pore surface, sterile below; pore surface rough, white to pale buff, pores circular to angular, 2-4 per mm; dissepiments becoming lacerate; context white, azonate, soft, cottony above, firmer near the tubes, duplex, up to 2 cm thick; tube layer hard and brittle, pale buff, up to 5 mm thick; taste mild; hyphal system monomitic; context hyphae nodose-septate with narrow, sinuous lumen and irregularly thickened walls, 4-7 in diam; cystidia and other sterile hymenial elements lacking; hyphal pegs present; basidia narrowly clavate, 4-sterigmate, with a basal clamp, 4-5 x 15-16; basidiospores allantoid, hyaline, smooth, negative in Melzer's reagent, 1-1.5 x 5-8. Associated with a brown cubical rot of fallen conifers and rarely aspen; basidiocarps develop under snow. JPL 240.

VARARIA ATHABASCENSIS Gilbn., Madroño 20:282. 1970.
Basidiocarps annual, resupinate, usually in small patches up to 4 cm; hymenial surface smooth, light buff to pinkish buff; margin fertile, thinning out or abrupt; hyphal system monomitic; subicular hyphae nodose-septate, thin-walled, 2-3.5 in diam; dichohyphidia abundant in the hymenial region and also imbedded, thick-walled, strongly dextrinoid in Melzer's reagent, main branches up to 3.5 in diam, apices tapering; gloeocystidia abundant, embedded or projecting from hymenium, some mammillate, positive in sulfuric benzaldehyde, up to 50 long and 4-10 in diam, with a basal clamp; basidia in a catahymenium, developing from ovoid to spherical probasidia, becoming narrowly clavate, 4-sterigmate, 30-40 x 5-6, with a basal clamp; basidiospores tear-shaped, wide at the distal end and tapering at the apicular end, hyaline, smooth, negative in Melzer's reagent, 10-15 x 4-5. Associated with a white rot of dead conifers and aspen. RLG 14276; KJM 422A. This fungus has previously been collected from Alberta and Arizona and presumably occurs throughout the Rocky Mountains.

Literature Cited

Bailey, D. K. 1970. Phytogeography and taxonomy of *Pinus* subsection *Balfourianae*. Ann. Mo. Bot. Gard. 57:210-249.

Currey, D. R. 1965. An ancient bristlecone pine stand in eastern Nevada. Ecology 46:564-566.

Ferguson, C. W. 1968. Bristlecone pine: science and esthetics. Science 159:839-846.

Ferguson, C. W. and D. A. Graybill. 1982. Dendrochronology of bristlecone pine: a progress report. Univ. Ariz. Tree-Ring Res. Lab. 1 p.

Lemke, P. A. 1964. The genus *Aleurodiscus* (sensu stricto) in North America. Can. J. Bot. 42:213-282.

Liberta, A. E. 1973. The genus *Trechispora* (Basidiomycetes, Corticiaceae). Can. J. Bot. 51:1871-1892.

Ridgway, R. 1912. Color standards and color nomenclature. Washington, D.C. Published by the author.

AUTHOR INDEX, VOLUME EIGHTEEN

ERRATA, VOLUME NINE

Page 405, after line 37 *add:* SPECIMEN EXAMINED: Svrček, 24.iv.1964
[PRM 629537 (Holotype)].

ERRATA, VOLUME ELEVEN

Page 209, line 26: for PTERIDOPYLLUS read PTERIDOPHYLLUS

ERRATA, VOLUME TWELVE

Page 260, line 3: *for* 2900, *read* 2950,

ERRATA, VOLUME SEVENTEEN

Page 46, line 1: *for* Figs. 13-42 *read* Figs 31-42
142 3: *for* subgenus *read* section

ERRATA VOLUME EIGHTEEN

Page 98, line 2: for *P.* read *Psoroma*
192 21: for *A. aurata* read *A. auratus*

INDEX TO FUNGOUS AND LICHEN TAXA, VOLUME EIGHTEEN

This index includes genera, infrageneric taxa, species, and infraspecific taxa. New taxa are underlined as are the pages where they are published.

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