MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Volume XXVIII April-June 1987 No. 2

CONTENTS

[CONTENTS continued overleaf]

ISSN 0093-4666 MYXNAE 28(2) 257-571 1987

Published quarterly by MYCOTAXON, LTD., P.O. Box 264, Ithaca NY 14851
For subscription details, availability in microfilm and microfiche,
and availability of articles as tear sheets, see back cover.

[CONTENTS continued from front cover]

[MYCOTAXON for January-March 1987 (**28:** 1-256) was issued January 14, 1987]

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VOLUME XXVIII, 1987

COMPLETE IN TWO QUARTERLY ISSUES

CONSISTING OF IV + 571 PAGES

INCLUDING FIGURES

TABLE OF CONTENTS, VOLUME TWENTY-EIGHT

No. 1. January-March 1987

No. 2. April-June 1987

MYCOTAXON

Vol. XXVIII, No. 2, pp. 257-259 April-June 1987

FLAVOPARMELIA ECUADORIENSIS, A NEW SPECIES IN THE PARMELIACEAE (ASCOMYCOTINA)

THOMAS H. NASH III

Department of Botany and Microbiology, Arizona State University, Tempe, Arizona 85287, USA

JOHN A. ELIX and JEN JOHNSTON

Department of Chemistry, The Faculties, Australian National University, GPO Box 4, Canberra, ACT, 2601, Australia

ABSTRACT : The species, *Flavoparmelia ecuadoriensis* Nash, Elix & Johnston is described as new from Ecuador. It is most closely related to *F. gerlachei* (Zahlbr.) Hale, but differs in the occurrence of capitate soralia and a number of upper surface characteristics.

Introduction

After reducing the genus *Pseudoparmelia* (Lynge, 1914; Hale, 1976) to four tropical species, Hale (1986) proposed the genus *Flavoparmelia* to accommodate 17 former *Pseudoparmeliae* that all contain usnic acid. Species of *Flavoparmelia* (Elix et al. 1986; Hale 1986) consistently have a black lower surface with simple rhizines, a distinct bare zone marginal and have larger spores than other segregate of *Pseudoparmelia* s. lat. The bifusiform conidia and rotund, broad lobes further separate *Flavoparmelia* from *Relicinopsis*, the only other segregate of this group with usnic acid (Elix et al. 1986). *Flavoparmelia* generally contain the protocetraric acid complex in the medulla.

In the course of examining a large collection of *Flavoparmelia gerlachei* (Zahlbr.) Hale we found a group of collections from Ecuador that were distinctive. Consequently a new species is proposed. The lower surface characteristics are quite similar to *F. gerlachei* and the cortical and medullary chemistry are consistent with *Flavoparmelia*. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982), high performance liquid chromatography (Lumbsch & Elix 1985) and comparison with authentic samples.

Flavoparmelia ecuadoriensis Nash, Elix & Johnston sp.nov. (Fig.1)

Species cum thallo ut in *Flavoparmelia gerlachei* sed ab hac specie soraliis capitatis et superficie superiore differt.
Type. Ecuador. Provincia de Cotopaxi. Cotopaxi National Park, west side of Vulcan Cotopaxi, 3840m, 00° 42'S, 78° 26'30"W, *T.H.Nash* 23,854; ASU-holotype, ANUC -isotype.

Thallus foliose, saxicolous, adnate to loosely adnate, yellow-green in colour, to 8 cm diam.; *lobes* rotund, 1.0-2.5 mm wide, becoming laterally imbricate, ± contiguous, plane to convex. *Upper surface* broadly undulating, rugose at the centre, dull for the most part, shiny at the apices, emaculate, sorediate, *soralia* laminal, orbicular and becoming strongly capitate, *soredia* farinose; medulla white; *lower surface* smooth and irregularly pitted towards the apices, black with a brown naked rim, sparsely rhizinate, rhizines short, simple or tufted at the apices, concolorous with the lower surface. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K- or K+ faint yellow, medulla K-, C-, KC-, P+ orange; containing usnic acid, protocetraric acid (major), virensic acid (trace), unknown (lavender Rfc5-trace), gyrophoric (±), and conprotocetraric (±).

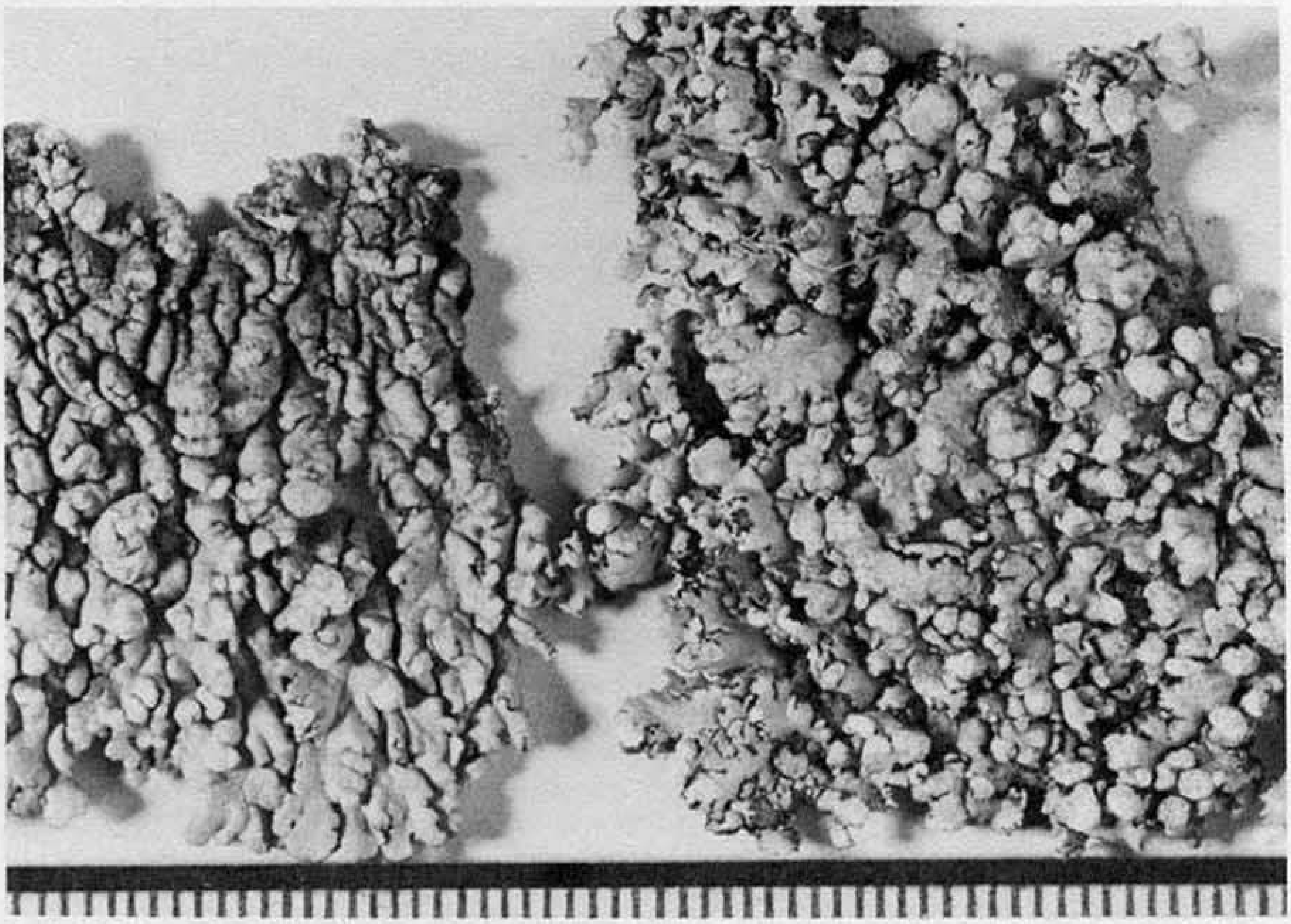

Figure 1. A portion of the holotype of *Flavoparmelia ecuadoriensis* (holotype in ASU). Scale in mm.

F. ecuadoriensis is distinguished by a unique set of characters, principally the production of capitate soralia and a combination of upper surface characteristics that clearly separate it from *F. gerlachei*, the species it most closely resembles. In *F. gerlachei* the soralia are initially pustulate and never become as distinctly capitate as in *F. ecuadoriensis*, where the soredia are more finely farinose. Apothecia are fairly common in *F. gerlachei*, but are so far unknown in *F. ecuadoriensis*. In *F. gerlachei* the upper cortex is strongly rugose-pitted and is usually not cracked, whereas in *F. ecuadoriensis* it is smooth, frequently strongly convex and irregularly cracked. The center of the thallus in *F. gerlachei* is almost always dark-pigmented, but in *F. ecuadoriensis* it is normally concolorous with the lobe apices. The apices of the lobes in *F. gerlachei* are tightly attached to the substrate, but in *F. ecuadoriensis* the tips are frequently free to slightly ascending. The thallus of *F. gerlachei* is more tightly adnate than that of *F. ecuadoriensis*. In addition *F. gerlachei* frequently has physodalic acid as a major medullary constituent but this compound is not known in *F. ecuadoriensis*. Five other sorediate species of *Flavoparmelia* are known: *F. caperata* (L.) Hale, *F. euplecta* (Stirt.) Hale, *F. soredians* (Nyl.) Hale, *F. springtonensis* (Elix) Hale and *F. subamplexa* (Hale) Hale. All of these are quite different as the lobes are broader. Furthermore, *F. caperata* has diffuse soralia, contains caperatic acid and is usually corticolous; *F. euplecta* has pustular soredia and contains the medullary pigment, euplectin; *F. subamplexa* has a velvety black lower surface and is corticolous; *F. soredians* has salazinic acid (major); and *F. springtonensis* has physodalic acid (major) and is corticolous.

Specimens Examined (Paratypes)
ECUADOR. Provincia de COTOPAXI: Cotopaxi National Park, west slope of Vulcan Cotopaxi, 4050m, *Nash* 23,849 (ASU); 3 km E of main road to Quito where the road to Cotopaxi National Park crosses Río Saquimala, 3140m, Nash 23,843 (ASU); Provincia de CHIMBORAZO: 1 km SW of Guano, 2700m, Nash 23,837 (ASU, UPS); 17 km N. of Riobamba along main road to Quito, 3150m, Nash 23,790 (ASU, ANUC, US).

ACKNOWLEDGEMENTS

We wish to thank Mr.I.A.Fox and the staff of the Science Photographic Unit, ANU, for preparing the photographs, Mr.D.Verdon for checking the Latin description and Dr. Marc and Nicole Baker for logistic assistance in the field. This research was made possible by the support of the US-Australia Cooperative Science Grant INT-8412745 administered through the U.S. National Science Foundation.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 261-284 April-June 1987

SPECIES OF HETEROSPHAERIA (DISCOMYCETES) AND THEIR ANAMORPHS

ADRIAN LEUCHTMANN

Mikrobiologisches Institut, ETH Zürich,
CH-8092 Zürich, Switzerland

ABSTRACT

In the genus *Heterosphaeria* Greville eight species have been accepted: *H. alpestris*, *H. intermedia*, *H. lojkae*, *H. ovispora* sp. nov., *H. patella*, *H. pulsatillae* sp. nov., *H. veratri* and *H. viriditingens*. A key to the species described is given. Single-spore-isolates of six species were investigated in culture to study the development of their anamorphs and vegetative cultural characteristics. The anamorph belongs to the form-genus *Heteropatella* Fckl.

INTRODUCTION

The genus *Heterosphaeria* (Ascomycetes, Helotiales) was proposed by Greville in 1824 to accommodate a fungus found mainly on dried stems of Apiaceae and described previously by Tode (1791) as *Sphaeria penetrans* α *patella*. The author recognized its distinct characters (young fruit-bodies globose, later patelliform depressed, with thick coriaceous walls) as "different from *Sphaeria*". The delimination of *Heterosphaeria* from *Peziza* Dill. ex Bull., *Phacidium* Fr. or *Pyrenopeziza* Fckl. however, remained uncertain for a long time. Several species described as, or transferred to, *Heterosphaeria* by Fuckel (1870) and Rehm (1912) are now placed in other genera. The systematic position of *Heterosphaeria* has also long been misinterpreted: Rehm (1896) placed it together with *Odontotrema* Nyl. and *Scleroderris* (Fr.) Bonord. in the family Heterosphaeriaceae, Boudier (1907) in the Patellariaceae and von Höhnel (1918) considered *Pyrenopeziza* Fckl. as its closest related genus. Nannfeldt (1932) recognized the taxonomic importance of the typical structure of the excipulum of *Heterosphaeria*, a tissue of interwoven, very thick-walled, cartilaginous hyphae covered externally by a thin cortex of isodiametrical, dark coloured cells. He placed the genus in the Helotiaceae (now called Leotiaceae) in the monogeneric subfamily Heterosphaerioideae. Later Korf (1973) added two further genera (*Grovesia* Dennis and *Pragmopora* Massal.) to the same subfamily.

The anamorph of *Heterosphaeria* was first discovered by Tulasne & Tulasne (1865); it may form beside the asci in apothecia or in separate conidiomata of almost identical structure. The anamorph belongs to the form genus *Heteropatella* Fckl. and is preceeded in some species by a stage described as *Pseudodiscosia* Hösterm. & Laub.

The first cultural studies with *Heterosphaeria* were done by Brefeld & von Tavel (1891). Other authors (e.g. Vestergren 1900; Buddin & Wakefield 1926, 1929; Wollenweber 1931) considered mainly the anamorphic *Heteropatella*. A more recent study (Gremmen 1970) deals with the anamorph - teleomorph connection of two species in culture.

The distinction of species (or varieties) of *Heterosphaeria* by previous authors was based mainly on external characters of the apothecia and on the host plant. In the last comprehensive representation of the genus Rehm (1912) recognized the following taxa: *H. patella* (Tode:Fr.) Grev. including three varieties and six host forms, of which three taxa (var. *alpestris*, var. *lojkae* and f. *compositarum*) were raised later to specific rank by von Höhnel (1918), *H. linariae* (Rabenh.) Rehm on *Linaria* and two further species (now placed in *Cenangiopsis* Rehm, Dennis 1962). The characters used by these authors did not allow a clear separation of the taxa and made the identification very difficult. In the present study morphological characters of the apothecia (including the structure of the excipulum, the margin, as well as the asci and ascospores) together with anamorph and cultural characteristics are chosen for the species concept.

MATERIALS AND METHODS

Morphological studies were made on dried herbarium specimens from the natural substratum, unless otherwise indicated. Squash mounts and handcut sections, using a razor blade, have been examined. The measurements were taken from specimens mounted in lactic acid. The iodine reaction of the ascus pore was studied in 4 % KOH by adding Melzer's Reagent.

All the strains used for the present study are single spore cultures, isolated from fresh samples following the method of Samuels (1979) and are deposited in the ZT culture collection. Cultures were grown on 2 % malt extract agar (MA) and sterile stems of cereals (straw) with vitamin supplement in erlenmayer flasks, routinely incubated at 15°C under near UV-light (370 nm) and maintained for up to 1 year to facilitate fructification. For further details on culture techniques used see Leuchtmann (1984).

The vegetative growth rates were determined by measuring the colony diameter for 14 days starting with 1 week old cultures on 2 % MA. The descriptions of colonies were made on 3-4 week old cultures growing at the optimum temperature in darkness.

GERMINATION OF ASCOSPORES AND SUCCESSION OF ANAMORPH FORMATION IN PURE CULTURE

The germination of the ascospores and the subsequent early stages of development were studied on MA plates and followed in general the course already described by Brefeld & von Tavel (1891) for *Heterosphaeria patella* and *H. lojkae*.

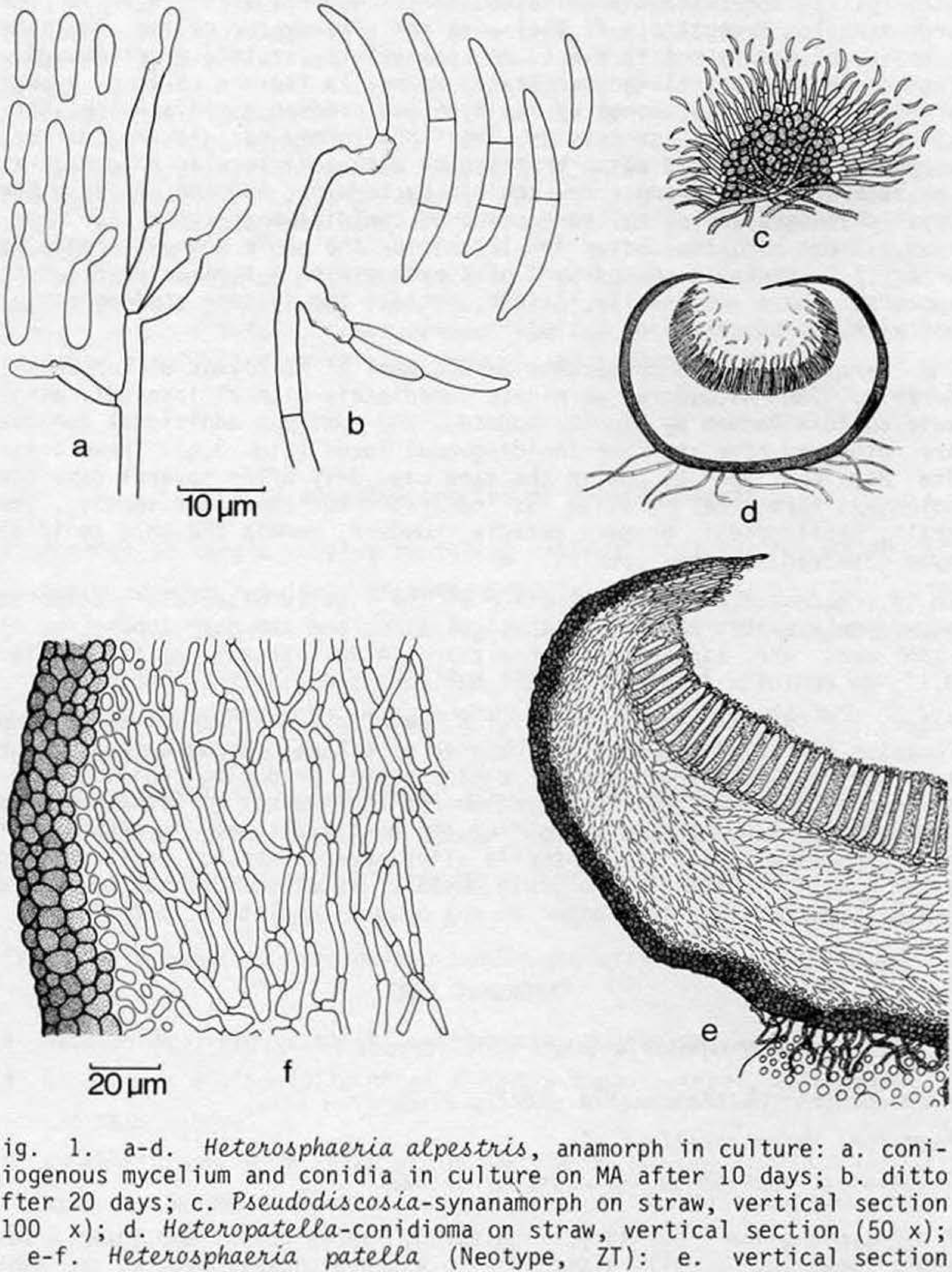

Fig. 1. a-d. *Heterosphaeria alpestris*, anamorph in culture: a. conidiogenous mycelium and conidia in culture on MA after 10 days; b. ditto after 20 days; c. *Pseudodiscosia*-synanamorph on straw, vertical section (100 x); d. *Heteropatella*-conidioma on straw, vertical section (50 x); - e-f. *Heterosphaeria patella* (Neotype, ZT): e. vertical section through half of apothecia (100 x); f. excipulum from the flank.

Ascospores of most species isolated from freshly collected material germinate within 12 h by means of one to several germ tubes at the two ends of the spore. Upon germination the ascospores become much swollen and usually 1-septate, if they were not already two celled. The germ tubes soon ramify and form a loose, colourless, septate mycelium growing on the surface of the substrate. Meanwhile the end cells of hyphae or short lateral branches of the mycelium produce conidia holoblastically in sympodial succession. The first formed conidia are smaller, aseptate, oblong and often truncate or with an irregular appendage at the base. They can produce new conidia by terminal budding. After a few days a yeast-like, slimy, rose coloured conidial mass covers the mycelium, first in the center and later over the whole colony. Generally after 1-2 weeks a second type of conidium with a similar development appears. These are usually falcate, septate and in some species equipped with appendages (Fig. 1,a-b).

The germination and subsequent development of *H. lojkae* differ considerably. The ascospores germinate immediately with ellipsoidal, aseptate conidia formed by bipolar budding, and numerous additional conidia are produced from the same conidiogenous locus (Fig. 3,g). These conidia may continue to bud in the same way. Only after several days the colonies form the mycelium as described for the other species. The small, ellipsoidal primary conidia, however, remain the only conidial type observed for this species.

In *H. pulsatillae* the germination of the finally 3-septate ascospores occurs only within 36 h after the isolation, and the germ tubes (one at each end) are straight and very thin, later sparsely ramifying (Fig. 3,i). No conidium formation at all has been seen in this species.

After 1-2 months some strains of *H. patella* and *H. alpestris* develop roundish acervular structures, composed of a basal, brown-celled tissue and hyaline, simple, septate conidiophores producing conidia of the second type (Fig. 1,c). This synanamorph corresponds to *Pseudodiscosia* Hösterm. & Laub. and is known from the host plant only in the case of *Heterosphaeria veratri*. Eventually after several months, preferably on straw, small, apothecia-like conidiomata of *Heteropatella* may be formed (Fig. 1,d). However, they often do not mature completely in culture.

TAXONOMIC PART

Heterosphaeria Grev. Scot. crypt. Fl. 2:103.1824

Type species: *Heterosphaeria patella* (Tode:Fr.) Grev.

Anamorph: *Heteropatella* Fckl.

Helotiales, Leotiaceae, Heterosphaerioidae.

Apothecia solitary, scattered, subepidermal and later erumpent, sessile, usually attached with a short central plug to the substrate, seated on a more or less distinct subiculum of brown, septate hyphae, which penetrate the host tissue, round to slightly elongated in outline, up to 1200 µm across, brown to black; apothecial margin at the beginning enclosing the hymenium, rupturing with distinct teeth or remaining even, in dry conditions enrolled over the hymenium. Excipulum 2-layered; outer layer crust-like, composed of dark brown, thin-walled, isodiametrical cells forming a textura globulosa to textura angularis, inner layer (at the base and the flanks) cartilaginous, composed of hyaline, very thick-walled, agglutinated, orientated to somewhat interwoven and anastomosing, short celled hyphae, toward the margin turning to thin-walled hyphae forming a textura porrecta, which may end as short, marginal threads; the inside of the apothecial margin with few, free hyphal tips or bordered with regularly arranged, bristle-like hyphae; subhymenium composed of a few layers of small, polyhedric, thin-walled cells or absent. Asci 8-spored, cylindric-clavate, with trapezoidal apex and a broad apical pore blued by Melzer's Reagent. Ascospores biseriate to overlapping uniseriate, ellipsoidal, ovoid or fusiform to almost acicular, straight or slightly inequilateral to curved, hyaline, aseptate or 1-septate. Paraphyses filiform, unbranched, hyaline, septate, apex club-like enlarged and hyaline or rarely brownish, exceeding the asci.

Key to accepted species of Heterosphaeria

1 Apothecial margin usually rupturing with distinct teeth, inside not bordered with regularly arranged bristle-like hyphae. 2

1* Apothecial margin ± even, usually bright coloured, inside bordered with regularly arranged bristle-like hyphae. 6

2 Ascospores submedianly septate when ripe; apex of paraphyses brownish; on *Veratrum*. . . . . **7. H. veratri**

2* Ascospores medianly septate or aseptate; paraphyses hyaline. . 3

3 Apothecial margin ending in long, brownish threads; substrate and parts of fungal tissue blue-green coloured; on *Verbascum*. **8. H. viriditingens**

3* Brownish marginal threads and blue-green staining lacking; plurivorous. 4

4 Ascospores ovoid, straight, uniseriate; subalpine. **4. H. ovispora**

4* Ascospores ellipsoidal, often slightly inequilateral, biseriate (at least above). 5

5 Apothecia dark with thick excipulum (up to 170 µm); conidia (usually also on the host) shortly rostrate, without apical appendages; alpine species. . . . . **1. H. alpestris**

5* Apothecia usually lighter and with thinner excipulum; conidia with long, filiform appendages; lowland species. . . . . **5. H. patella**

6 Apothecia up to 1000 µm diam.; end cells of the marginal border short cylindrical; ascospores ± cylindrical, often arranged in the upper part of the ascus; on *Adenostyles*. . . . . . **3. H. lojkae**

6* Apothecia smaller, up to 500 µm diam.; end cells of the marginal border obpyriform or long tapering; ascospores fusiform to acicular, arranged in the whole length of the ascus. 7

7 End cells of the marginal border obpyriform; ascospores narrowly fusiform to acicular; substrate and parts of fungal tissue blue-green coloured; on alpine species of *Pulsatilla*. **6. H. pulsatillae**

7* End cells of the marginal border long tapering; ascospores fusiform; no blue-green staining; on *Clematis recta*. . . **2. H. intermedia**

Descriptions

1. Heterosphaeria alpestris (Fr.) Höhn. - Fig. 2

Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 127:573.1918

Bas.: *Phacidium patella* Fr. α *alpestris* Fr., Elench. fung. 2:133.1828
Syn.: *Tympanis patella* (Tode:Fr.) Wallr. β *pezizaeformis* Wallr., Fl. crypt. Germ. 2:425.1833
Heterosphaeria patella var. *alpestris* (Fr.) Rehm, Rabenh. Krypt.-Fl. 1(3):203.1896 (1888)
Peziza chailletii Pers., Mycol. eur. p. 288.1822; Fries, Syst. mycol. 2:144.1823
Peziza scleropyxis Pers., Mycol. eur. p. 290.1822
Cenangium patella (Tode: Fr.) Sommerf. [sens. auct.], Suppl. Fl. Lapp. p. 302.1826

Anamorph: *Heteropatella* sp. - Fig. 2,c-g

Apothecia scattered, sessile, seated on an inconspicious subiculum of brown, septate hyphae, which penetrate the host tissue, round in outline or slightly compressed, up to 1200 µm across, dark brown or light brown in moist and mature condition; apothecial margin tearing with distinct teeth. Excipulum 2-layered; outer layer 10-25 µm, composed of isodiametrical, brown, thin-walled, 6-10 µm wide cells, which become rectangular and elongated toward the margin; inner layer up to 160 µm at the base (later often collapsing), composed of hyaline, very thick-walled, cartilaginous, elongated, short-celled hyphae, toward the margin less wide and turning to thin-walled hyphae forming a textura porrecta; subhymenium composed of a few layers of small, hyaline, thin-walled, round to irregularly shaped cells. Asci cylindric-clavate, short stalked, with trapezoidal apex and an apical pore blued by iodine, 50-80 x 7-10.5 µm. Ascospores irregularly biseriate above, uniseriate at the base, ellipsoidal, often slightly inequilateral, hyaline, aseptate or occasionally 1-septate, 8-17 x 3-5 µm, usually with one to several small guttules. Paraphyses filiform, unbranched, hyaline, ca. 1.5 µm wide, septate, apex club-like enlarged, exceeding the asci.

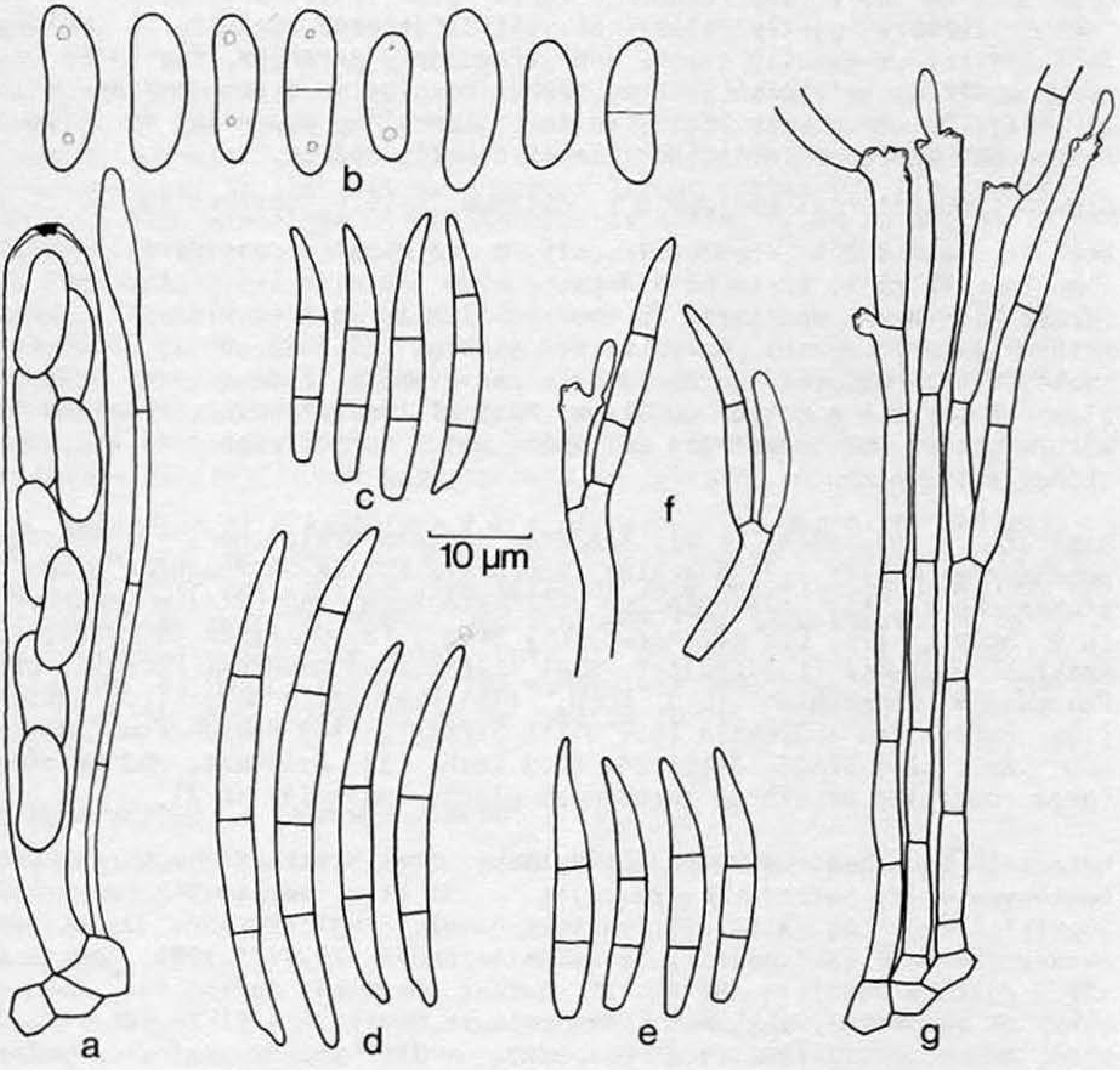

Fig. 2. *Heterosphaeria alpestris*: a. ascus and paraphysis; b. ascospores (different coll.); c-e. conidia of anamorph (ZT 9635): c. from conidioma in culture on straw; d. from mycelium in culture on MA; e. from conidioma on the host plant; f-g. conidiophores and conidiogenous cells from conidioma on the host plant (leg. Petrini 1982, ZT).

The morphology of the conidiomata is almost identical with the apothecia, but they tend to be smaller in size. Conidiophores are often formed within apothecia, usually at the marginal part of the hymenium. Conidiophores cylindrical, straight, up to 70 µm long and 2.5-3 µm wide, hyaline, septate, often branched. Conidiogenous cells holoblastic, sympodial, discrete or integrated with several conidiogenous loci. Conidia hyaline, fusiform, apex shortly rostrate, without appendage, base truncate and rarely with a 1-2 µm long, excentric appendage, 1-3 septate, 15-30 x 23 µm.

Characteristics in culture. - Colonies on MA 3-3.5 cm in diameter after 14 days/15°C; marginal zone (0.5-1 cm) flat, colourless to white, without aerial mycelium; inner zone brownish black to dark olive-green, with usually fibrous and radiating mycelium (pigmentation inconstant, dependant on the strain, often irregularly or in sectors, sometimes absent), surface partly slimy or with scattered pustules of conidia, aerial mycelium usually sparse and irregularly arranged, fluffy to cottony, white to yellowish or grey, near inoculum more abundant and white to grey. On straw very little white, often slimy appearing mycelium is formed and the conidial production is usually sparse.

Growth temperatures: minimum 0°C, optimum 15-18°C, maximum ca. 25°C.

The conidia formed in culture are usually considerably larger than on the host, up to 55 x 4 µm, curved and with 1-4 septa. They are formed both on MA and straw in the mycelium or in acervular structures. After several months only a few strains (ZT 9635, 9642, 9644) form small, fully matured apothecia-like conidiomata. Some strains produced also apothecia on straw. Most of them, however, remained immature except for one strain (ZT 9635) which formed ripe asci and ascospores after 6 months.

Habitat. - Dry stems of (1) *Achillea stricta* Schleicher, (2) *Aconitum pyramidale* Miller, (3) *Angelica silvestris* L., (4) *Astragalus penduliflorus* Lam., (5) *Chaerophyllum villarsii* Koch, (6) *Cirsium eriophorum* (L.) Scop., (7) *C. oleraceum* (L.) Scop., (8) *Gentiana lutea* L., (9) *Knautia arvensis* (L.) Coulter, (10) *Laserpitium gaudinii* Moretti, (11) *Peucedanum ostruthium* (L.) Koch, (12) *Pimpinella major* (L.) Hudson, (13) *Pulsatilla sulphurea* (L.) DT. & Sarnth., (14) *Rhaponticum scariosum* Lam., (15) *Seseli libanotis* (L.) Koch, (16) Apiaceae; and on other large subalpine or alpine herbaceous plants (material in ZT).

Material examined. - NORWAY:(16) Valdery, leg. Blytt (Herb. Fries, UPS, **Lectotype** of *H. patella α alpestris*). - (3) Oslo, Sørkedalen, Finnerud, 20.VIII.1985, leg. A.L. (ZT, culture 9645). - SWITZERLAND: (2) Kt. BE, Berner Oberland, Sefinental, Im feissten Boden, 29.VIII.1985, leg. A.L. (ZT, culture 9684). - (8) Kt. BE, Berner Oberland, Sefinental, Pogang-gen, 29.VIII.1985, leg. A.L. (ZT, culture 9647). - (12) Kt. GL, Braunwald, Gumen, 1.VII.1986, leg. A.L. (ZT). - (16) Kt. GR, Sufers, Prafalva, 1.VI.1983, leg. Petrini (ZT). - (11) Kt. GR, Lukmanierpass, 12. VIII.1984, leg. A.L. (ZT, culture 9635). - (10) Kt. GR, Unterengadin, Ftan, Prui-Laret, 27.VIII.1984, leg. Petrini & A.L. (ZT, culture 9641). - (15) Kt. GR, Unterengadin, Ftan, 27.VIII.1984, Petrini & A.L. (ZT, culture 9642). - (14) Kt. GR, Unterengadin, Ftan, Glui, 27.VIII.1984, leg. Petrini & A.L. (ZT, culture 9644). - (6) Kt. GR, Prättigau, Seewis, Ruod, 27.VIII.1985, leg A.L. (ZT, culture 9646). - (16) Kt. NE, "in culmo umbelliferarum" (probabely *Angelica silvestris*), Mougeot in Herb. Persoon (L, **Lectotype** of *P. chailletii*). - (3) sine loc., Chaillet in Herb. Persoon (L, **Lectotype** of *P. scleropyxis*). - (3,7) Kt. OW, Lungern, Turren, 15.VIII.1984, leg. A.L. (ZT, culture 9636, 9637). - (4,9,12) Kt. OW, Lungern, Schönbühl, 15.VIII.1984, leg. A.L. (ZT, culture 9638-9640). - (1) Kt. TI, Quinto, Piora, 21.VII.1982, leg. Petrini (ZT). - (5,13,16) Kt. TI, Quinto, Piora, 20.VII.1982, leg. Petrini (ZT). - (4) Kt. TI, Quinto, Valle Piora, Orello, 19.VII.1983, leg.

Müller (ZT). - (5) Kt. TI, Quinto, Piora, 23.VII.1984, leg. A.L. (ZT, culture 9630). - (11) Kt. TI, Quinto, Piora, 27.VII.1984, leg. Petrini (ZT, culture 9624). - (13,14) Kt. TI, Quinto, Valle Piora, Cadagno, 27.VII. 1984, leg. A.L. (ZT, culture 9627, 9628).

Notes. - *H. alpestris* was often considered to be a variety of *H. patella*, because the morphology of the teleomorph is very similar, except for the usually darker, almost black apothecia with very thick excipulum (up to 170 µm). The morphological differences in the anamorph however are most striking and justify the specific rank of *H. alpestris*. The conidia (both from the host and in culture) differ from those of *H. patella* in the shape and in the lack of apical appendages. The species seems to be restricted to colder climates (alpine and subalpine) and is very frequent in the Alps on numerous larger herbaceous plants (mainly Apiaceae and Asteraceae). The anamorph is often formed in apothecia and can not be correlated with any of the described *Heteropatella*-species. A different *Heteropatella* with narrow conidia and long, filiform appendages is often found associated with *H. alpestris*. According to our culture experiments this species, described by Lind (1913) as *Heteropatella cercosperma* (Rostr.) Lind and later (Lind 1926) as *Heteropatella umbilicata* (Pers.) Jaap is not the anamorph of *H. alpestris*. A possible teleomorph of *H. umbilicata* has been mentioned but not named by Nannfeldt (1932), but never proved in culture.

The selection of a lectotype for α *alpestris* Fr. among the collections of Fries was not easy, as accurate indications on locality, host plant and anamorph are lacking. The selected type material is labelled "*Heterosphaeria patella* Grev." and includes four stem pieces of an Apiaceae, stuck on the same sheet. Only one of them has ripe apothecia, up to 1 mm in diam., those on the others are immature, somewhat smaller but show the very thick excipulum typical for *H. alpestris*.

2. **Heterosphaeria intermedia** Höhn. - Fig. 3,e-f

Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 127:572.1918

Anamorph: unknown.

Apothecia scattered, subepidermal and later erumpent, sessile, seated on a subiculum of brown hyphae, which penetrate the host tissue, round in outline, up to 650 µm across, dark brown; apothecial margin even or fine fimbriate, usually bright coloured. Excipulum 2-layered; outer layer up to 20 µm thick, composed of brown, thin-walled, isodiametrical, 4-8 µm wide cells, which become rectangular toward the margin; inner layer up to 50 µm, composed of hyaline, thick-walled, cartilaginous, short-celled hyphae, toward the margin turning to thin-walled hyphae, which end above the hymenium as up to 15 µm long, tapering bristle-like cells; subhymenium forming a hyaline, small-celled tissue. Asci cylindric-clavate, short stalked, with trapezoidal apex and an apical pore blued by iodine, 50-60 x 6-7 µm. Ascospores 2-seriate, fusiform to narrow ellipsoidal, hyaline, aseptate, 8-11 x 2-2.5 µm, with small terminal guttules. Paraphyses filiform, unbranched, hyaline, ca. 2 µm wide, septate, apex slightly enlarged, exceeding the asci.

Characteristics in culture. - Species not cultured.

Habitat. - Dry stems of *Clematis recta* L.

Material examined. - AUSTRIA: Petrak, Myc. gen. No 1536, Niederösterreich, Pfaffstätten near Baden, V.1939, leg. Petrak (ZT). - GERMANY: Unterfranken, Güssenheim a.d. Werra, 4.V.1918, leg. ADE (FH, **Type**).

Notes. - *H. intermedia* is morphologically close to *H. pulsatillae*, from which it differs by the cells of marginal border, the shape of ascospores, the lack of a blue-green staining and the host plant, which however belongs to the same family (Ranunculaceae).

3. **Heterosphaeria lojkae** (Rehm ex Winter) Schröt. - Fig. 5,d-g

Cohn's Krypt.-Fl. Schles. 3(2):160.1908

Bas.: *Pyrenopeziza lojkae* Rehm, Ascom. No. 15a, 1870; Winter, Flora Neue Reihe 30:509.1872

Syn.: *Heterosphaeria patella* var. *lojkae* Rehm f. compositarum Rehm, Ber. Bayer. Bot. Ges. 13:164.1912
Heterosphaeria compositarum (Rehm) Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 127:573.1918

Anamorph: Hyphomycetous blastoconidia (cf. *Hyalodendron* Diddens). - Fig. 5,g

Apothecia scattered, subepidermal and later erumpent, sessile, seated on a distinct subiculum of brown hyphae, round in outline or irregularly compressed, up to 1000 µm across, brown, with a usually brighter, almost even apothecial margin. Excipulum 2-layered; outer layer up to 30 µm thick, composed of brown, thin-walled, isodiametrical, 6-10 µm wide cells, which become rectangular toward the margin; inner layer up to 70 µm, composed of hyaline, very thick-walled, cartilaginous, short-celled hyphae, at the flanks turning to thin-walled, parallel orientated hyphae; margin again wider, composed of hyaline, isodiametrical cells, at the inner side regularly bordered with hyaline, cylindrical, bristle-like cells; subhymenium composed of thin-walled round to irregularly shaped cells. Asci cylindric-clavate, broad and short stalked, with trapezoidal tapered apex and an apical pore blued by iodine, 50-70 x 6-7 µm. Ascospores irregularly 2-seriate, often arranged in the upper part of the ascus, ± cylindrical, hyaline, 0-1 septate, 8-14.5 x 2-3 µm, usually with a small guttule in each end. Paraphyses filiform, unbranched, hyaline, 1.5-2 µm wide, septate, apex slightly enlarged, exceeding the asci.

Conidia occasionally found in young apothecia, produced on sterile elements of the hymenium by budding, ellipsoidal, hyaline, one-celled, 5-6 x 1.5-2 µm.

Characteristics in culture. - Colonies on MA 3-3.5 cm in diameter after 14 days/15°C; marginal zone (0.3-0.5 cm) flat, white, without aerial mycelium; inner zone brown-black to olive-black, aerial mycelium very sparse and velvety, light grey to black-grey, surface usually of dry, pruinose appearence due to the conidial formation, not slimy, near the inoculum with more abundant, cottony, grey aerial mycelium.

Growth temperatures: minimum below 0°C, optimum ca. 18°C, maximum 25°C.

The anamorph in culture is hyphomycetous: the conidiophores rising from the substrate are hyphal-like, hyaline, branched and 2-2.5 µm wide. The conidia formed holoblastically, sympodially or in short acropetal chains, which easily separate, are ellipsoidal, often truncate at the base, hyaline, aseptate, 5-8 x 1.5-2.5 µm and sometimes bud at one end. Globular or beaked sclerotia are formed after 2-3 months and are composed of tissues similar to those in apothecia.

Habitat. - Dry stems of (1) *Adenostyles glabra* (Miller) DC. (= *Cacalia alpina* L.), (2) A. *alliariae* (Gouan) Kerner; according to Schröter (1908), Rehm (1912) and Petrak (1936) also on other Asteraceae.

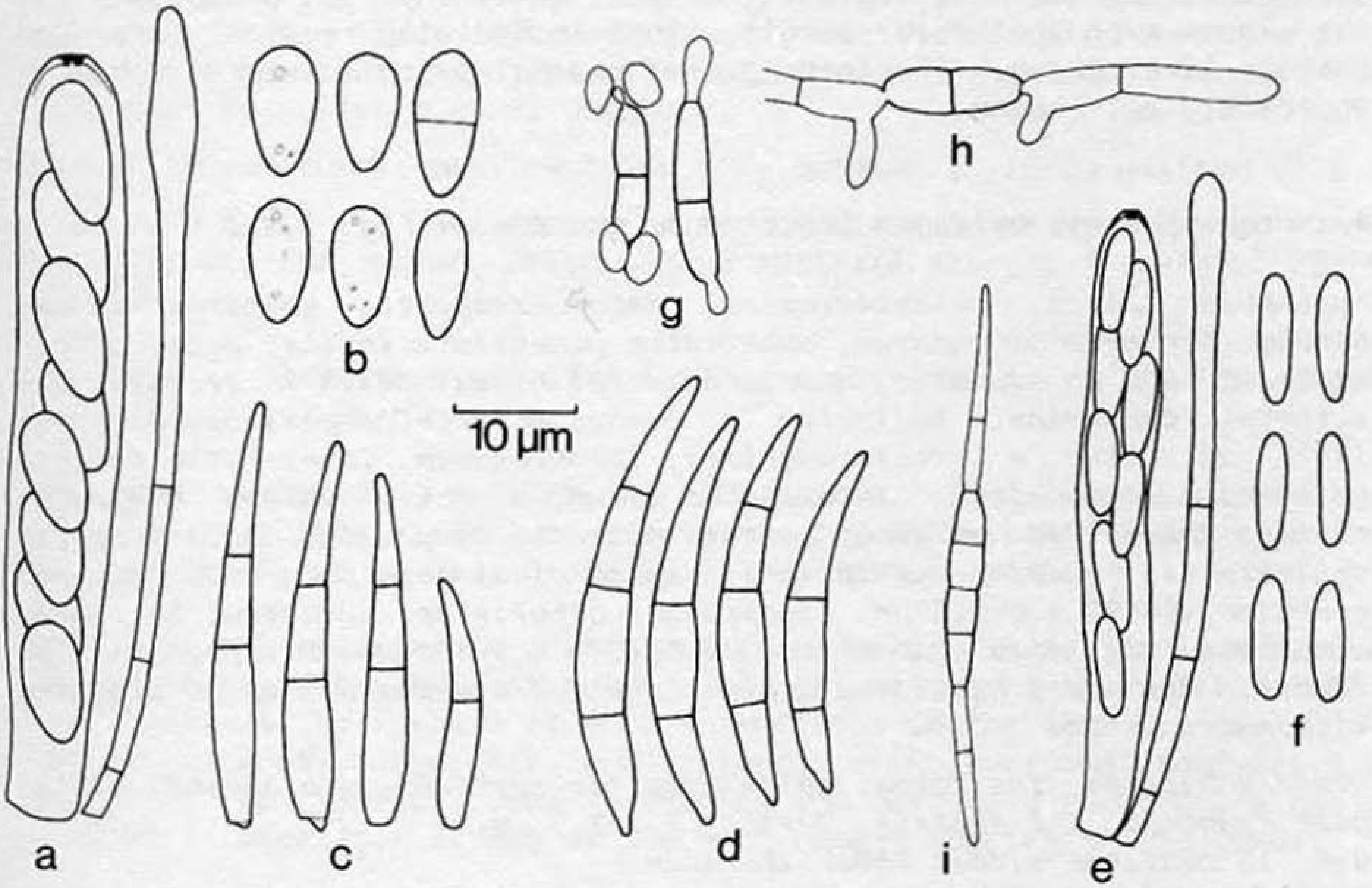

Fig. 3. a-d. *Heterosphaeria ovispora* (Holotype, ZT): a. ascus and paraphysis; b. ascospores; c. conidia of anamorph from conidioma on the host plant; d. ditto from mycelium in culture on straw. - e-f. *Heterosphaeria intermedia* (Type, FH): e. ascus and paraphysis; f. ascospores. - g-i. germinating ascospores: g. *H. lojkae*; h. *H. alpestris*; i. *H. pulsatillae*.

Material examined. - AUSTRIA: (1) Rehm, Ascom. No. 15a, Niederösterreich, am Oetscher, Ochsenhütte, 18.VI.1869, leg. Lojka (S, **Isotype** of *P. lojkae*). - (2) Rehm, Ascom. No. 15b (extra), sub f. *fuscoatra* Hazsl., Tirol, Arlberg Passhöhe, VII.1878, leg. Britzelmayer (S). - SWITZERLAND: (2) Kt. GL, Braunwald, Seblen, 1.VII.1986, leg. A.L. (ZT, culture 9649). - (2) Kt. GR, Engadin, Val Arpiglia, 26.VII.1973, leg. Müller (ZT). - (2) Kt. GR, Engadin, Val Arpiglia, 18.VII.1986, leg. A.L. (ZT, culture 9652). - (2) Kt. GR, Albula, Crap Alv, 22.VII.1986, leg. A.L. (ZT).

Notes. - The definition of *H. lojkae* was confused for a long time because Rehm (1912) reduced his own species to a variety of *H. patella*. This variety included several host forms, of which the one on Asteraceae (= f. *compositarum*) was the type of *P. lojkae*. Later, some authors (e.g. von Höhnel 1918 and Müller 1977) used the name *H. compositarum* (Rehm) Höhn. for collections of *Heterosphaeria* growing on Asteraceae. Study of the type material and other collections demonstrates that *H. lojkae* is a distinct species characterized by its narrow, cylindrical ascospores, by its wide, apically only slightly enlarged paraphyses and the almost even apothecial margin, lined inside with regularly arranged bristle-like cells. The species is found mainly on *Adenostyles* but is apparently not common.

4. Heterosphaeria ovispora Leuchtmann, sp. nov. - Fig. 3,a-d

Apothecia sparsa, subepidermalia, demum erumpentia, sessilia, in subiculo hypharum brunnearum, substratum penetranti insite, patellaeformia, ad 600 µm diametro, atrobrunnea vel nigra; margo in lacinias distinctas dehiscens. Excipulum e duobus stratis compositum: exterius 10-15 µm latum, e textura angulari, atrobrunneum, lateraliter textura prismatica compositum; interius ad 55 µm, e textura oblita, hyalinum, cartilagineum, ad marginem textura porrecta compositum. Asci 8-spori, cylindracei, breviter stipitati, apice iodi ope poro coerulescenti praedito, 60-70 x 8-9.5 µm. Ascosporae uniseriatae, ovoideae, hyalinae, simplices vel rare uniseptatae, 9.5-13 x 4.5-5.5 µm. Paraphyses filiformes, eramosae, hyalinae, 1.5 µm latae, 1-4 septatae, apice clavato, excedentes ascos.

Conidia hyalina, fusiforma, apice breviter rostrato, non appendiculata, base truncata, 1-2 septata, 20-35 x 2.5-3.5 µm.
Hab. in caulibus siccis Umbelliferarum.
Holotypus: ad *Peucedanum ostruthium* (L.) Koch, Helvetia, Kt. GR, Albula, Murtel digl Crap Alv, 30.VIII.1984, leg. A.L. & Petrini (ZT).

Anamorph: *Heteropatella* sp. - Fig. 3,c-d

Apothecia scattered, subepidermal and later erumpent, sessile, seated on a subiculum of brown, thick-walled hyphae, which penetrate the host tissue, round in outline or sometimes slightly compressed, up to 600 µm across, dark brown to black; apothecial margin rupturing with distinct teeth. Excipulum 2-layered; outer layer 10-15 µm thick, composed of isodiametrical, dark brown, 5-6.5 µm wide cells, at the flanks becoming rectangular (textura prismatica); inner layer up to 55 µm, composed of hyaline, very thick-walled, cartilaginous, narrowly elongated to irregularly shaped hyphae, toward the margin turning to thin-walled hyphae forming a textura porrecta; subhymenium composed of a few layers of small, hyaline, thin-walled, round to irregularly shaped cells. Asci cylindrical, base broad and short-stalked, with trapezoidal apex and an apical pore blued by iodine, 60-70 x 8-9.5 µm. Ascospores uniseriate overlapping, ovoid, straight, hyaline, aseptate or rarely 1-septate, 9.5-13 x 4.5-5.5 µm, with usually several, small guttules. Paraphyses filiform, unbranched, sometimes anastomosing at the base, hyaline, 1.5 µm wide, 1- to 4-septate, apex club-like enlarged, exceeding the asci.

Conidiomata not found on the host plant. Conidiophores sometimes within apothecia, as in *H. alpestris*. Conidia hyaline, fusiform, apex shortly rostrate without appendage, base truncate, 1-2 septate, 20-35 x 2.5-3.5 µm.

Characteristics in culture. - Colonies on MA ca. 3.5 cm in diameter after 14 days/15°C; marginal zone (ca. 0.5 cm) flat, white, without aerial mycelium; inner zone dark brown, in some sectors often lighter, surface partly slimy or with scattered pustules of conidia, aerial mycelium sparse, toward the center and near the inoculum more abundant and white to light grey. The clear dark brown pigmentation is distinctive for the cultures of *H. ovispora*.

Growth temperatures: maximum below 0°C, optimum 15-18°C, maximum 25°C.

The conidia are formed on MA and straw in slimy, rose coloured pustules and are curved, often with a rostrate base, 1-3 septate, 23-28 x 3.5-4 µm.

Habitat. - Dry stems of (1) *Laserpitium latifolium* L., (2) *Peucedanum ostruthium* (L.) Koch.

Material examined. - SWITZERLAND: (2) Kt. GR, Albula, Murtel digl Crap Alv, 30.VIII.1984, leg. A.L. & Petrini (ZT, culture 9643; **Holotype**). - (1) Kt. NE, Creux du Van, 21.VI.1936, leg. Blumer (ZT).

Notes. - *H. ovispora* is characterized by ovoid, uniseriately arranged ascospores, and by the distinct textura prismatica of the outer apothecial wall at the flanks. It occurs sometimes on the same substrate together with *H. alpestris*. The apothecia of *H. ovispora*, however, are more mat at surface, usually smaller and obviously rare in the Alps, whereas *H. alpestris* is one of the most common species of the genus.

5. Heterosphaeria patella (Tode:Fr.) Grev. - Fig. 1,e-f; 4

Scot. crypt. Fl. 2:103.1824

Bas.: *Sphaeria penetrans* α *patella* Tode, Fungi mecklenb. 2:45.1791

Syn.: *Sphaeria patella* (Tode) Pers., Syn. meth. Fung. p. 76.1801;
Sphaeria patella (Tode) Fr., Syst. mycol. 2:511.1823
Phacidium patella (Tode:Fr.) Fr. β *campestre* Fr., Elench. fung. 2:134.1828
Tympanis patella (Tode:Fr.) Wallr. α *sphaeriaeformis* Wallr., Fl. crypt. Germ. 2:425.1833
non *Cenangium patella* (Tode:Fr.) Sommerf. [cf. *H. alpestris*]

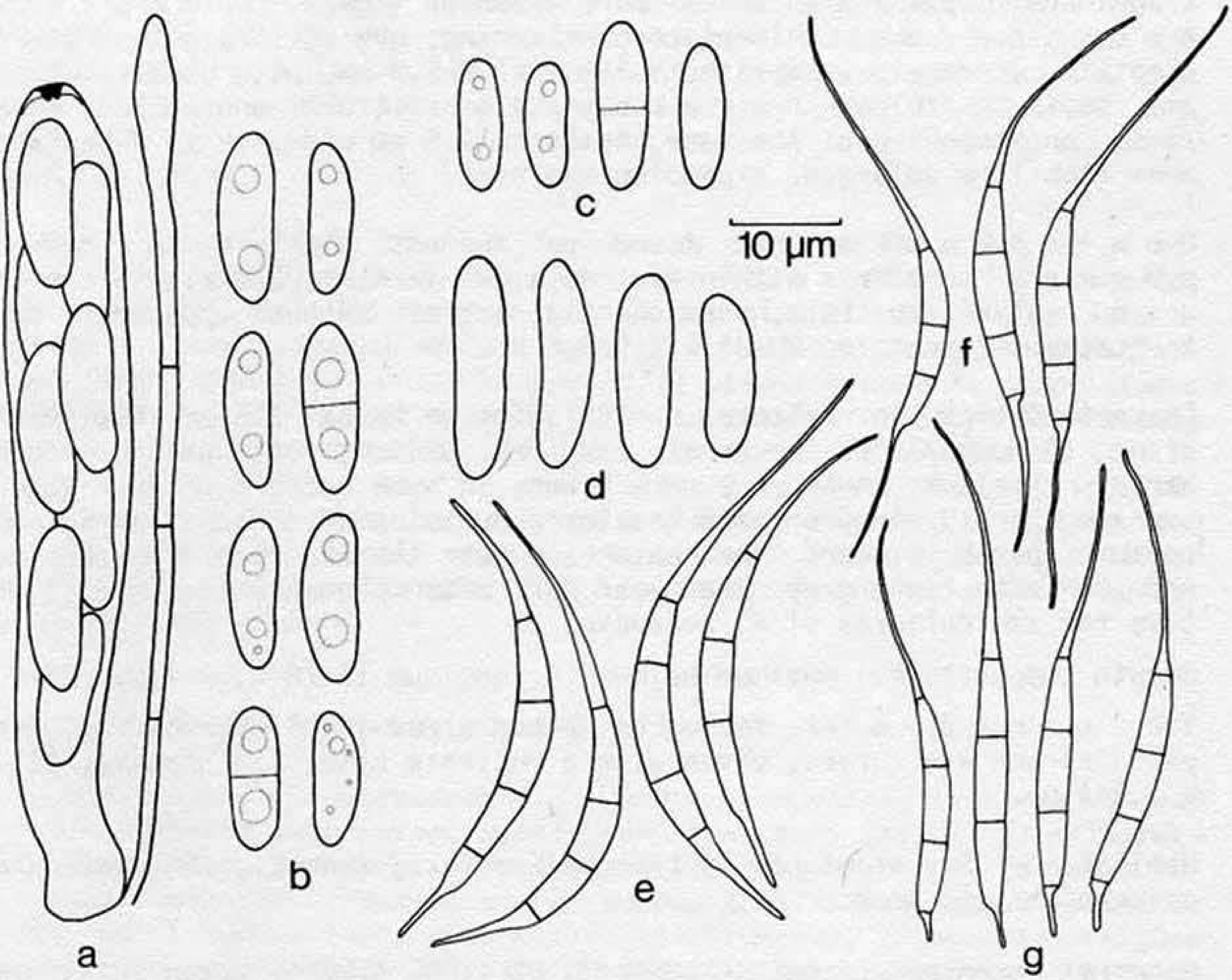

Fig. 4. *Heterosphaeria patella*: a. ascus and paraphysis (Neotype, ZT); b-d. ascospores: b. on *Daucus* (Neotype, ZT); c. on *Linaria* (leg. Piskor 1923, ZT); d. on *Tordylium* (Type of *Pyrenopeziza fuscoatra*, UPS); e-g. conidia of anamorph: e. from mycelium in culture on straw (ZT 9631); f. on *Linaria* (Isotype of *Heteropatella lacera*, G); g. on *Barbarea* (as *Heteropatella bonordenii*, leg. Eliasson 1932, ZT).

Peziza linariae Rabenh., Herb. mycol. I., No. 724.1845
Heterosphaeria linariae (Rabenh.) Rehm, Rabenh. Krypt.-Fl. 1(3):203.1896 (1888)
Pyrenopeziza fuscoatra Hazsl., Verh.K.K.Zool.-Bot. Ges.Wien 23:368.1873

Anamorph: *Heteropatella lacera* Fckl., Symb. mycol. Nachtr. 2:54.1873

Syn: *Excipula bonordenii* Hazsl., Oesterr. Bot. Z. 33:250.1883
Heteropatella bonordenii (Hazsl.) Lind, Dan. Fungi, p.473.1913. - Fig. 4,e-g

Apothecia scattered, sessile, seated on a more or less distinct subiculum of brown, septate hyphae, which penetrate the host tissue, round to slightly elongated, up to 1200 µm across, dark brown to black; apothecial margin tearing with distinct teeth. Excipulum 2-layered; outer layer 20-25 µm, composed of dark brown, thin-walled, isodiametrical, 6-12 µm wide cells; inner layer 80-130 µm at the base and the flanks, composed of hyaline, very thick-walled, cartilaginous short-celled hyphae, toward the margin less wide and turning to thin-walled hyphae forming a textura porrecta; subhymenium composed of a few layers of small, polyhedric, hyaline, thin-walled cells. Asci cylindric-clavate, with trapezoidal apex and an apical pore blued by iodine, 62-70 x 9.5-10.5 µm. Ascospores irregularly biseriate above, uniseriate at the base, ellipsoidal, often slightly inequilateral, hyaline, aseptate or sometimes partly 1-septate, 9.5-14.5(20) x 2.5-4.5 µm, usually with a large guttule at both ends. Paraphyses filiform, unbranched, hyaline, 1.5 µm wide, 1- to 3-septate, apex club-like enlarged, exceeding the asci.

Conidiomata scattered, sessile, black, round in outline, up to 600 µm across; excipulum 2-layered, morphologically similar to the apothecium, up to 110 µm thick at the base. Conidiophores hyaline, cylindrical, 1.5 µm wide and up to 30 µm long, septate, often branched. Conidiogenous cells holoblastic, with several apical conidiogenous loci. Conidia hyaline, fusiform, with a long, filiform, apical appendage up to 25 µm, and a truncate base usually ending with an excentric appendage up to 15 µm, 3-4 septate, 16-24 x 2-3 µm (without appendages).

Characteristics in culture. - Colonies on MA ca. 3 cm in diameter after 14 days/15°C; marginal zone (1-1.5 cm) flat, white, without aerial mycelium; inner zone black-olive, often irregularly pigmented, surface partly slimy or with scattered pustules of conidia, aerial mycelium sparse to rather abundant, white, near the inoculum usually abundant. Colonies are not clearly distinguishable from those of *H. alpestris* apart from the slightly higher maximum growth temperature.

Growth temperatures: minimum below 0°C, optimum 15-18°C, maximum ca. 28°C.

The conidia are formed in the mycelium or later in acervular structures and measure 20-25 x 2.5-3.5 µm (without appendages). The appendages are distinct but usually somewhat shorter than on the host especially on MA. On straw the formation of small apothecia-like conidiomata of *Heteropatella* was observed after 5 months.

Both strains studied (ZT 9631, 9634) also form apothecia after 2 months, which however do not mature even after one year. The hymenium composed of differentiated paraphyses produces only occasional *Heteropatella*-conidia. The formation of asci seems to be suppressed.

Habitat. - Dry stems of (1) *Daucus carota* L., (2) *Barbarea vulgaris* R.Br., (3) *Linaria vulgaris* Miller, (4) *Tordylium* sp., (5) Apiaceae.

Material examined. - CZECHOSLOVAKIA: (3) Mähren, Sternberg, VII.1923, leg. Piskor (ZT). - POLAND: (3) Rabenhorst, Herb. mycol. I., No. 724, near Schwerin, leg. Fiedler (B, **Isotype** of *P. linariae*). - RUMANIA: (4) Soborsin (Săvîrşin), near the river Maros, leg. Hazslinsky (UPS, **Type** of *P. fuscoatra*). - SWEDEN: (2) Reliquiae Petrakianae, No. 183, sub *H. bonordenii*, Jämtland, Åre, 16.VI. 1932, leg. Eliasson (ZT; teleomorph and anamorph). - SWITZERLAND: (3) Kt. GR, Puschlav, near Poschiavo,

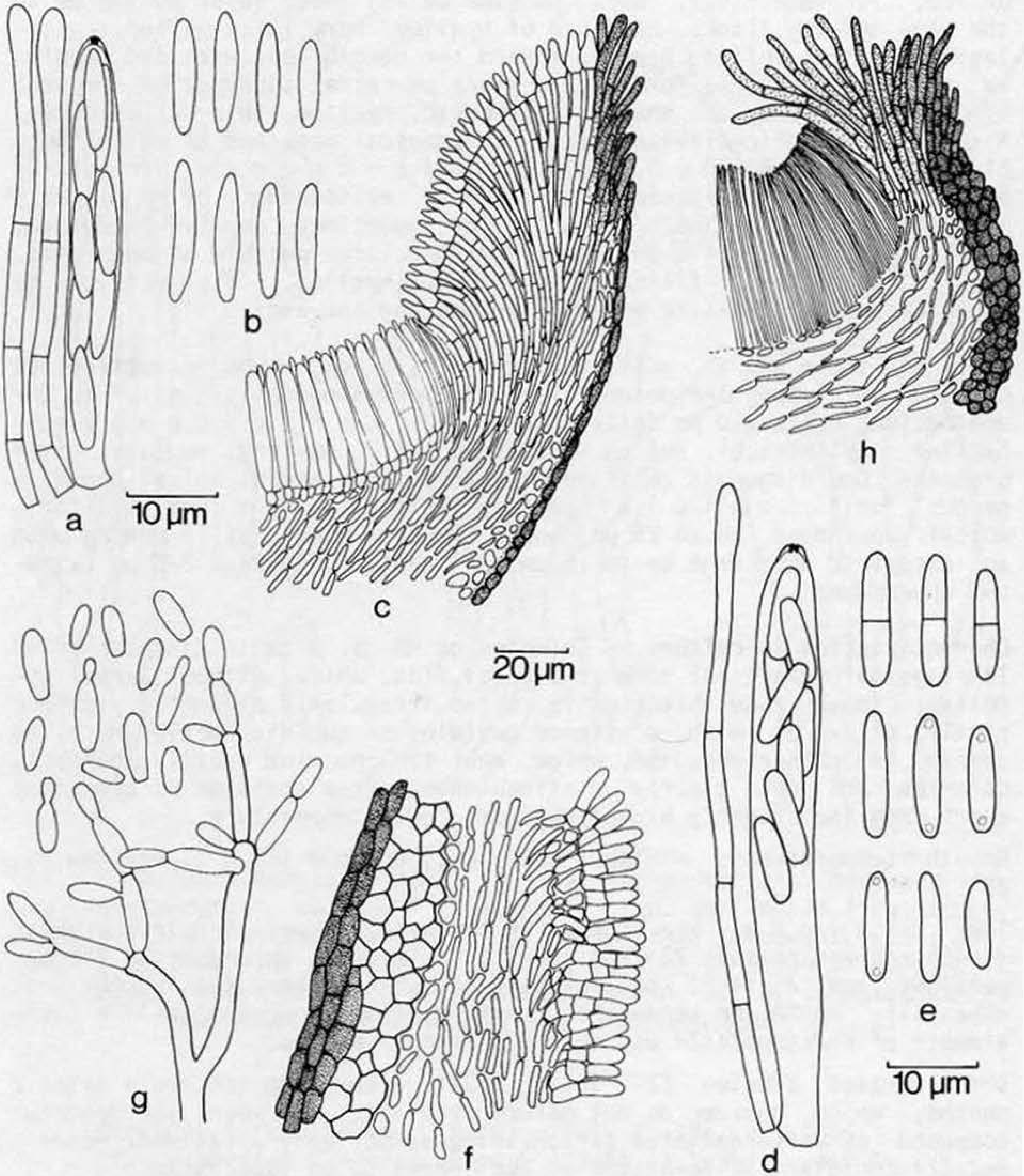

Fig. 5. a-c. *Heterosphaeria pulsatillae* (Holotype, ZT): a. ascus and paraphyses; b. ascospores; c. vertical section through margin of apothecia. - d-g. *Heterosphaeria lojkae*: d. ascus and paraphysis (Holotype, S); e. ascospores (different coll.); f. vertical section through margin of apothecia (Holotype); g. hyphomycetous anamorph in culture on MA (ZT 9652). - h. *Heterosphaeria viriditingens*, vertical section through margin of apothecia (Holotype, W).

26.VII.1986, leg. A.L. (ZT, culture 9654). - (1) Kt. SH, Merishausen, Grätental, 12.VII.1984, leg. Brunner (ZT, culture 9631). - (1) Kt. ZH, Regensberg, Altburg, 7.VIII.1984, leg A.L. (ZT, culture 9634; **Neotype** of *H. patella*). - (5) Kt. ZH, Rudolfingen, 12.XI.1904, leg. Volkart (ZT). - WEST GERMANY: (3) Fuckel, Fung. rhen. No. 2441, sub *H. lacera*, Nassau, Oestrich, in spring, leg. Fuckel (G, only teleomorph). - (3) Fung. rhen., ed. I., No. 2565, Nassau, Oestrich, Dornbachsgraben, in spring, leg. Fuckel (G, **Isotype** of *H. lacera*).

Notes. - *H. patella* is a lowland species found mainly on Apiaceae and is best characterized by its anamorph, whose conidia bear long, filiform appendages. This species is rather common, but usually more often found in its anamorphic state *Heteropatella* (see e.g., Dennis 1978). The type material of *H. linariae* (Rabenh.) Rehm and the other collections on *Linaria* do not differ from *H. patella* apart from the usually slightly smaller apothecia. Because the anamorphs and the cultural characteristics of both species are also indistinguishable, *H. linariae* is considered to be a synonym of *H. patella*.

Pyrenopeziza fuscoatra Hazsl. on *Tordylium*, has somewhat larger (up to 20 x 4.5 µm) ascospores but otherwise can not be distinguished from *H. patella* and is also considered synonymous.

Tode's type material of *H. patella* no longer exists (all his mycological collections have been destroyed). Therefore one of my own collections was selected as neotype. According to the protologue the actual identity of Tode's fungus does not seem to be clearly defined. Greville (1824), in his description of the genus *Heterosphaeria* questioned the identity of *H. patella*, because of the peculiar, globular conidial mass above the ostioles of the fruit bodies described and figured by Tode and proposed *Sphaeria patella* Pers. as a basionym. Persoon (1801), however, saw original material collected by Tode ("in exemplare, ab auctore mecum communicato", Persoon, loc. cit.) and his collections of *Sphaeria patella* in the herbarium Persoon in L fit the description of *H. patella*.

Buddin & Wakefield (1926) described a fungus, parasitic on *Antirrhinum majus*, as *Heteropatella anthirrhini*, for which the teleomorph is not known. The taxon appears to be closely related to *H. lacera* Fckl. on *Linaria*.

6. Heterosphaeria pulsatillae Leuchtmann, sp. nov. - Fig. 5,a-c

Apothecia sparsa, saepe in maculis venetis, subepidermalia demum erumpentia, sessilia, in subiculo inconspicuo hypharum brunnearum vel venetarum insite, patellaeformia, ad 400 µm diametro, atrobrunnea, margine diluto, fimbriato. Excipulum e duobus stratis compositum: exterius ad 8 µm latum, e textura angulari, brunnea vel veneta compositum; interius ad 70 µm, hyalinum e textura oblita, cartilaginea, ad marginem e textura porrecta desinenti in cellulis extremis, obpyriformibus, 7-14 x 2.5-3.5 µm compositum. Asci 8-spori, clavato-cylindracei, apice angustato, iodi ope poro coerulescenti praedito, 42-52 x 5-6.5 µm. Ascosporae biseriatae, fusiformes, hyalinae, aseptatae, 9.5-16 x 2-2.5 µm. Paraphyses filiformes, eramosae, hyalinae, 2 µm latae, 2-3 septatae, apice leviter amplificato, excedentes ascos.

Hab. in caulibus siccis Pulsatillae.

Holotypus: ad *Pulsatillam sulphuream* (L.) Dt. & Sarnth., Helvetia, Kt. BE, Hasliberg, Käserstatt, 1.VIII.1966, leg. E. Müller (ZT).

Anamorph: absent.

Apothecia scattered, often on blue-green coloured spots, subepidermal and later erumpent, sessile, seated on an inconspicuous subiculum of brown or sometimes blue-green stained hyphae, round in outline, up to 400 µm across, dark brown with bright coloured, even or finely fimbriate apothecial margin. Excipulum 2-layered, outer layer ca. 8 µm thick, composed of brown, sometimes blue-green coloured, thin-walled, isodiametrical, 3.5-5 µm wide cells, inner layer up to 70 µm, composed of hyaline, thick-walled, cartilaginous, round (at the base) to narrowly elongated cells, toward the margin turning to thin-walled, parallel orientated hyphae, which end as hyaline or brown (outside) marginal threads with regularly arranged, obpyriform, 7-14 x 2.5-3.5 µm end cells; subhymenium not differentiated. Asci cylindric-calvate, slightly tapered toward the apex, with an apical pore blued by iodine, 42-52 x 5-6.5 µm. Ascospores 2-seriate, narrowly fusiform to acicular, hyaline, aseptate, 9.5-16 x 2-2.5 µm. Paraphyses filiform, unbranched, hyaline, 2 µm wide, 2- to 3-septate, apex slightly enlarged, exceeding the asci.

Characteristics in culture. - Colonies on MA ca. 2.5 cm in diameter after 14 days/15°C; marginal zone (0.5-1 cm) flat, colourless to white, without aerial mycelium; inner zone first light brown, later with a concentric ring of intensive blue-green pigmentation (sometimes irregular or in sectors), but pigments not secreted in the substrate, aerial mycelium sparse, fine cottony and sordid white, near the inoculum more abundant.

Growth temperatures: minimum below 0°C, optimum 15-18°C, maximum ca. 25°C.
No conidial formation has been observed. But after a few weeks numerous, light brown, apothecial primordia are formed in the mycelium; these primordia, however, mature only after several months.

Habitat. - Dry stems and petioles of (1) *Pulsatilla sulphurea* (L.) Dt. & Sarnth. and (2) *P. alpina* (L.) Schrank.

Material examined. - FRANCE: (2) Hautes Alpes, Val Queyras, Aiguilles, 10.VI.1954, leg. Müller (ZT). - (1) Hautes Alpes, Col de Var, 2400 m, 4.VIII.1955, leg. Müller & Schüepp (ZT). - (2) Hautes Alpes, Val Queyras, 26.VI.1958, leg. Müller (ZT). - SWITZERLAND: (1) Kt. BE, Hasliberg, Käserstatt, 1.VIII.1966, leg. Müller (ZT, **Holotype**). - (2) Kt. GL, Braunwald, Gumen, 22.VII.1948, leg. v. Arx (ZT). - (2) Kt. GL, Braunwald, Gumen, 1.VII.1986, leg. A.L. (ZT, culture 9650, 9651; 3 coll.). - (2) Kt. SZ, Rigi, north-west of Stafel, 17.VII.1974, leg. Müller (ZT). - (1) Kt. TI, Quinto, Piora, 20.VII.1982, leg. Müller & Petrini (ZT).

Notes. - *H. pulsatillae* is characterized by the differentiated apothecial margin with striking obpyriform end cells, the shape of the asci and the narrow, almost acicular ascospores, as well as by the lack of an anamorph. An additional character of this species is the blue-green colour, which stains the substrate or parts of the fungal tissue. *H. pulsatillae* seems to be host specific on alpine species of *Pulsatilla*.

7. **Heterosphaeria veratri** Nespiak & Müller - Fig. 6

Beitr. Kryptogamenfl. Schweiz 15:44.1977

Anamorph: *Heteropatella sublineolata* (Thüm.) Leuchtmann, comb. nov.

Bas.: *Septoria sublineolata* Thüm., Bull. Soc. Imp. Naturalistes Moscou 52:128.1877

Syn.: *Cylindrosporium veratrinum* Sacc. & Winter, Hedwigia 22:14.1883
For further synonyms see Müller (1977). - Fig. 6,c-e

Apothecia scattered, erumpent from the epidermis, seated on a dense subiculum of brown, thick-walled hyphae, which penetrate the often dark coloured host tissue, round in outline or irregularly compressed, up to 1000 µm across, dark brown to black, rough, outermost layer usually eroding in small groups of cells; apothecial margin rupturing with distinct teeth. Excipulum 2-layered; outer layer 30-50 µm thick, composed of isodiametrical, dark brown, rather thick-walled, 6-10 µm wide cells, which become lighter, thin-walled and larger (14 µm) towards the interior; inner layer up to 160 µm, composed of hyaline, cartilaginous, very thick-walled, short-celled hyphae, toward the margin turning to rectangular, thin-walled cells; subhymenium thin, composed of small, hyaline, thin-walled cells. Asci cylindric-clavate, broad and short stalked, with trapezoidal apex and an apical pore blued by iodine, 60-85 x 8-11 µm. Ascospores irregularly 2-seriate, long ellipsoidal, often slightly curved, mature spores with one submedian septum, 12-20 x 3.5-4.5 µm. Paraphyses filiform, unbranched, ca. 1.5 µm wide, septate, apex club-like enlarged (4 µm) and brownish, exceeding the asci.

Conidiomata acervular, formed on living leaves, in light coloured, brown bordered spots of different size, or on dry, overwintered stems and leaves. Conidiophores developing from small subcuticular groups of stromatic cells, erumpent in small tufts, cylindrical, hyaline, septate and often branched, 5-8 µm wide. Conidiogenous cells holoblastic, sympodial, with one to several apical conidiogenous loci. Conidia hyaline, fusiform to long clavate, usually curved, apex rostrate and of different lengths, base truncate, 1-3 septate, 25-40 x 3-5 µm.

Characteristics in culture. - Colonies on MA ca. 4 cm diameter after 14 days/15°C; marginal zone (ca. 1 cm) flat, white, without aerial mycelium; inner zone completely black, surface partly slimy or with scattered pustules of conidia, aerial mycelium usually abundant, cottony, light grey, near the inoculum very dense and abundant. Cultures are distinctive because of the strong pigmentation, the abundant aerial mycelium and the relative high growth rate.

Growth temperatures: minimum below 0°C, optimum ca. 20°C, maximum ca. 28°C.

The conidia in culture (see also Gremmen 1970; Müller 1977) are formed in small, slimy pustules in the mycelium within 1-2 months. They are at first small and one-celled, later they change to the typical shape often with a very long tapering apex, 1-2 septa and measure up to 60 x 5 µm. No conidiomata or apothecia have been observed in culture.

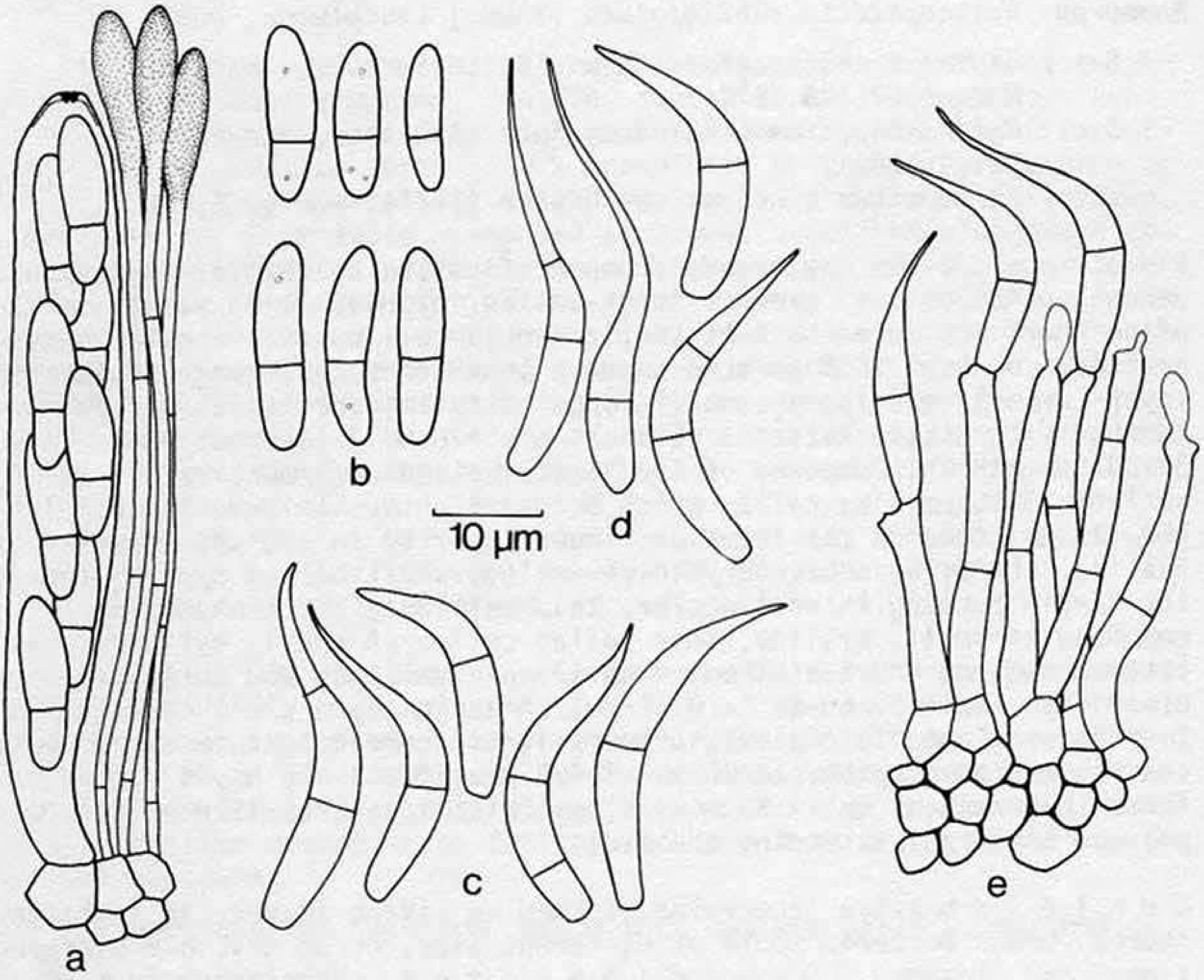

Fig. 6. *Heterosphaeria veratri*: a. ascus and paraphyses; b. ascospores (Holotype, ZT); c-d. conidia of anamorph: c. from conidioma on the host plant (leg. Volkart 1936, ZT); d. from mycelium in culture on MA (ZT 9632); e. conidia and conidiophores from conidioma on the host plant (leg. Müller 1977, ZT).

Habitat. - Dry stems and leaves of *Veratrum lobelianum* Bernh. (and possibly also *V. album* L.).

Material examined. - SWITZERLAND: Kt. BE, Berner Oberland, Hasliberg, Käserstatt, 27.VII.1966, leg. Müller (ZT, **Holotype**). - Kt. GR, Arosa, Prätschwald, 15.VI.1961 und 15.X.1961, leg. Rahm (ZT). - Kt. GR, Albula, Crap Alv, 22.VII.1986, leg. A.L. (ZT, culture 9653, isolated as anamorph). - Kt. TI, Airolo, Val Nante, 3.VIII.1936, leg. Volkart (ZT, only anamorph). - Kt. TI, Quinto, Piora, 27.VII.1984, leg. A.L. (ZT, culture 9629, 9632). - Kt. UR, Urnerboden, 4.VII.1976, leg. Müller (ZT). - Kt. VS, Aletschwald, old Belalpweg, 15.VI.1963, leg. Müller, Flora des Aletschwaldreservats (ZT).

Notes. - *H. veratri* differs in several respects from the other species of the genus. The outer excipulum of the apothecia is much thicker than in other species and consists of large cells, the ascospores are always submedianly septate, often slightly curved, and the paraphyses are brownish. My observations on the ascus pore (blued with iodine) and the paraphyses (unbranched) differ from the description given by Müller (1977).

The anamorph of *H. veratri* is formed on living leaves causing brown spots and is thought to be a pathogen (Müller 1977). The conidiomata are acervular and do not form the apothecia-like stroma of *Heteropatella*. Similar conidiomata are also known from two other foliicolous *Heteropatella*-species (*H. antirrhini* Buddin & Wakefield and *H. valtellinensis* (Trav.) Wollenw.), while its *Heteropatella*-stage was demonstrated in culture (Buddin & Wakefield 1926, 1929). The anamorph of *H. veratri* is therefore transferred to *Heteropatella*.

8. **Heterosphaeria viriditingens** Petr. - Fig. 5,h

Ann. mycol. 34:225.1936

Anamorph: Unknown.

Apothecia scattered on blue-green coloured, longish spots of the substratum, sessile, usually slightly immersed at the base, without subiculum, round or often elongated in outline, 250-400 µm wide and up to 800 µm long, black; apothecial margin completely enrolled. Excipulum 2-layered; outer layer ca. 20 µm thick, composed of isodiametrical, dark brown, partly blue-green stained, thin-walled, 5-8 µm wide cells, toward the margin turning to more elongated cells, which end as brownish up to 20 µm long, free, marginal threads; inner layer up to 65 µm, composed of hyaline, very thick-walled, cartilaginous plectenchyma; subhymenium composed of a few layers of small, isodiametrical or elongated, hyaline, thin-walled cells. Asci cylindric-clavate, short-stalked, 35-40 x 6-8 µm. Ascospores 2-seriate, oblong to fusiform or slightly clavate, hyaline, aseptate, 6-11 x 2-2.5 µm. Paraphyses filiform, hyaline, unbranched, septate, ca. 2 µm wide, apex slightly enlarged.

Characteristics in culture. - Species not cultured.

Habitat. - Dry, decorticated stems of *Verbascum* sp.

Material examined. - GREECE: Mazedonien, Rudoka Planina, Alpe Smereka, 4.VI,1931, leg. Ade (W, **Holotype**).

Notes. - *H. viriditingens* is known only from the unripe type collection (no ascospores have been seen, although Petrak described them), the evaluation of this species is therefore difficult. Distinct characters are the very long, brownish marginal threads of the apothecia and the blue-green colour, which stains parts of the substrate and the fungal tissue. An additional specimen (on *Trollius europaeus* L., Switzerland, Kt. TI, Quinto, Piora, 27.VII.1984, leg A.L.), also unripe, may represent the same species.

Doubtful and excluded species

Heterosphaeria brunaudiana Roum., Fungi sel. Gall. exsicc. No. 1949; Bot. Zeitung 40:254.1882
Type material not studied.

Heterosphaeria galii Gucevicz, Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk SSSR 8:144.1952
Type material not studied:
On *Galium mollugo* L., Sowjetunion, Crimea.
Apothecia 300-500 µm diam.; asci 55-67 x 9-10 µm; ascospores 13-16 x 4-5 µm, 1-septate. Anamorph in ascomata intermixed: Conidia falcate, 1-septate, 15-19 x 2.5 µm.

Heterosphaeria laserpitii Gucevicz, Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk SSSR 8:144.1952
Type material not studied:
On *Laserpitium hispidum* M.B., Sowjetunion, Crimea.
Apothecia 200-300 µm diam.; asci 72 x 12 µm; ascospores not mature. Anamorph in ascomata intermixed: Conidia falcate, with 1-2 apical appendages, 2-3 septate, 24-31 x 2.5-3 µm.

Heterosphaeria morthieri Fckl., Symb. mycol. p. 265.1870; Fung. rhen. No. 1837
= *Pyrenopeziza morthieri* (Fckl.) Rehm, Rabenh. Krypt.-Fl. 1(3): 623.1896 (fide Hütter 1958).
Isotype in G.

Heterosphaeria phacidioides (Fr.) Fr., Summ. veg. Scand. 2:365.1849
= *Pyrenopeziza phacidioides* (Fr.) Rehm, Rabenh. Krypt.-Fl. 1(3): 615.1896
Type in UPS. Probably synonym of *Pyrenopeziza plicata* Rehm

Heterosphaeria poae Fckl., Symb. mycol. p. 266.1870; Fung. rhen. No. 1591
= *Naevia poae* (Fckl.) Rehm, Rabenh. Krypt.-Fl. 1(3):148.1896 (doubtful species).
Isotype in G.

CONCLUSION

As documented in this study, *Heterosphaeria* occurs more frequently in higher mountainous regions than in lowlands, where it is only represented by the plurivorous *H. patella* and the probably host-specific *H. intermedia*. Host specificity is rather restricted in *H. veratri* (to *Pulsatilla alpina* and the closely related *P. sulphurea*), whereas *H. patella* and *H. alpestris* are plurivorous. *H. lojkae* was found only on Asteraceae and the rare *H. ovispora* only on Apiaceae.

The anamorphs are more complex than expressed by the uniform arrangement in the form-genus *Heteropatella* Fckl. For one species (*H. pulsatillae*) no anamorph could be found; in pure culture it soon forms the teleomorph. In most species two conidial types develop: microconidia immediately following germination and macroconidia forming later, usually connected with conidiomata. Two species behave differently: in

H. veratri formation of apothecia-like stromata is suppressed (*Pseudodiscosia* synanamorph) and in *H. lojkae* no macroconidia are formed.

The vegetative growth of *Heterosphaeria* in pure culture shows psychrophilic affinities. All species studied are still able to grow slowly at 0°C. The growth rate is optimal at approximately 15°C or in *H. veratri* at 20°C and decreases rapidly at about 25°C. At 30°C the mycelium of all species, apart from one strain of *H. patella* (ZT 9634) is killed irreversibly. These results agree with those for *Heteropatella*-species studied by Vestergren (1900) and Buddin & Wakefield (1926), and may offer an ecological explanation for the preference of *Heterosphaeria* for colder climates in the mountains.

ACKNOWLEDGEMENTS

For supplying and sending specimens on loan, I express deep appreciation to the curators of the following herbaria: B, FH, G, L, M, S, UPS, W, ZT. I wish to thank Dr. S.M. Francis, CMI, Kew, PD Dr. O. Petrini, Zürich and Dr. J. Stone, Eugene, Oregon, for reviewing the manuscript and for their most valuable suggestions; they particularly improved the English text and the Latin diagnosis. Thank are due also to Prof. E. Müller, Zürich, for many stimulating discussions and his comments on the manuscript. I am grateful to Drs. L. and K. Holm, Uppsala, for giving me some collections and to Mrs. G. Leuchtmann for carefully typing the manuscript.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 285-296 April-June 1987

NEW SPECIES, NEW RECORDS AND A KEY FOR XANTHOPARMELIA (LICHENIZED ASCOMYCOTINA) FROM SOUTH AMERICA

THOMAS H. NASH III

Department of Botany and Microbiology, Arizona State University, Tempe, Arizona 85287, USA

JOHN A. ELIX and JEN JOHNSTON

Department of Chemistry, The Faculties, Australian National University, GPO Box 4, Canberra, ACT, 2601, Australia

ABSTRACT: The species *Xanthoparmelia adleri* Nash, Elix & Johnston, *X. argentinensis* Nash, Elix & Johnston, *X. cotopaxiensis* Nash, Elix & Johnston, *X. ferraroiana* Nash, Elix & Johnston, *X. villamiliana* Nash, Elix & Johnston, and *X. wrightiana* Nash, Elix & Johnston are described as new. In addition twelve species previously unrecorded for South America are reported. The new combination *X. farinosa* (Vainio) Nash, Elix & Johnston is made.

Introduction

Xanthoparmelia, originally proposed as a section of *Parmelia* by Vainio (1890) and later raised to the generic level by Hale (1974b), is a most prominant group of lichens in arid and semi-arid regions of the world where they grow luxuriantly on rocks and less frequently on soil. This yellow-green foliose genus, with apothecial characters typical of the Parmeliaceae, is characterized by the presence of usnic acid in the upper cortex and a combination of upper and lower cortical characters that separate it from the other yellow-green Parmelioid genera of *Flavopunctelia* (Hale, 1984), *Flavoparmelia* (Hale, 1986a) and *Arctoparmelia* (Hale, 1986b), all of which contain at least some saxicolous species. *Flavopunctelia* (Hale, 1984b), typically corticolous, is distinguished by prominent pseudocyphellae in the upper cortex; *Arctoparmelia*, by the velvety lower cortex and consistent production of cortical atranorin in addition to usnic acid; and *Flavoparmelia*, by the corticolous habitat of most species, broad lobes with a naked marginal zone on the lower surface and significantly larger spores than these other genera. Although *Arctoparmelia* and *Xanthoparmelia* are apparently uniquely characterized by the presence of lichenin in the medulla, only *Xanthoparmelia* reacts positively in the presence of chloral hydrate (Hale, 1986b). *Parmotrema* (Massalongo, 1860; Hale, 1974a) and *Hypotrachyna* (Hale, 1976) also contain a few yellow-green saxicolous species, but these are distinguished by the presence of broader lobes, larger spores and ±marginal cilia in the case of the former, and by truncated, linear-elongated lobes and dichotomous rhizines in the latter.

In recent years *Xanthoparmelia* has been studied extensively in Australasia (Elix, *et al.* 1986), North America (Nash, 1974; Egan and Derstine, 1978; Hale 1984a & 1985) and southern Africa (Hale, 1971, 1984, 1985 & 1986c; Knox and Brusse, 1983; Brusse, 1984). Consequence the number of species is now approaching 300. The well studied Euroasian flora is particularly poor in species, but the status of South America is essentially unknown due to limited herbarium records. On the basis of literature (Follman, 1967; Grassi, 1950; Hale, 1984 & 1985; Lamb, 1958; Lynge, 1914; Osorio, 1980 & 1981; and Vainio, 1890), only 20 *Xanthoparmelia* species are reported for South America. However, our preliminary investigations indicate that the South American *Xanthoparmelia* flora is far richer than previously recognized. Five new species and eleven new records are reported in the present paper.

Certainly there is a need for further study, but a preliminary key to the known species is included to summarize the present knowledge and stimulate further research. Although we have examined extensive material of most of the species, a few are included only on the basis of literature reports. Furthermore, there is a need to: (1) reconsider the validity of a couple of Gyelnik names that have not been used in recent years; and (2) critically compare South American material with European and North American material in cases where northern hemispheric names are applied to South American taxa (e.g. *X. conspersa)*. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982), high performance liquid chromatography (Lumbsch & Elix 1985) and comparison with authentic samples.

Xanthoparmelia adleri Nash, Elix & Johnston sp.nov. Fig.1

Species cum thallo ut in *Xanthoparmelia constipata* sed ab hac specie acido salazinico et norlobaridone continens differt.

Type. Argentina. Provincia de SALTA, Las Pailas, 2280m, *M.T.Adler*; ANUC-holotype, BAFC-isotype.

Thallus foliose, terricolous or muscicolous, rarely saxicolous, adnate to loosely adnate, yellow-green in colour, to 5 cm in diameter; *lobes* subirregular to sublinear-elongate, 1.0-2.0(-3.0) mm wide, imbricate or not so. *Upper surface* dull , ±shiny at the apices, emaculate, often black-margined towards the lobe apices, developing numerous wart-like isidia, *isidia* laminal, globose at first, appearing granular, occasionally subcylindrical with short branches, ± becoming dense and subcoralloid, darker at the apices; medulla white; *lower surface* light tan to pale brown throughout, sparsely rhizinate, rhizines short, simple, concolorous with the lower surface. *Apothecia* not seen.

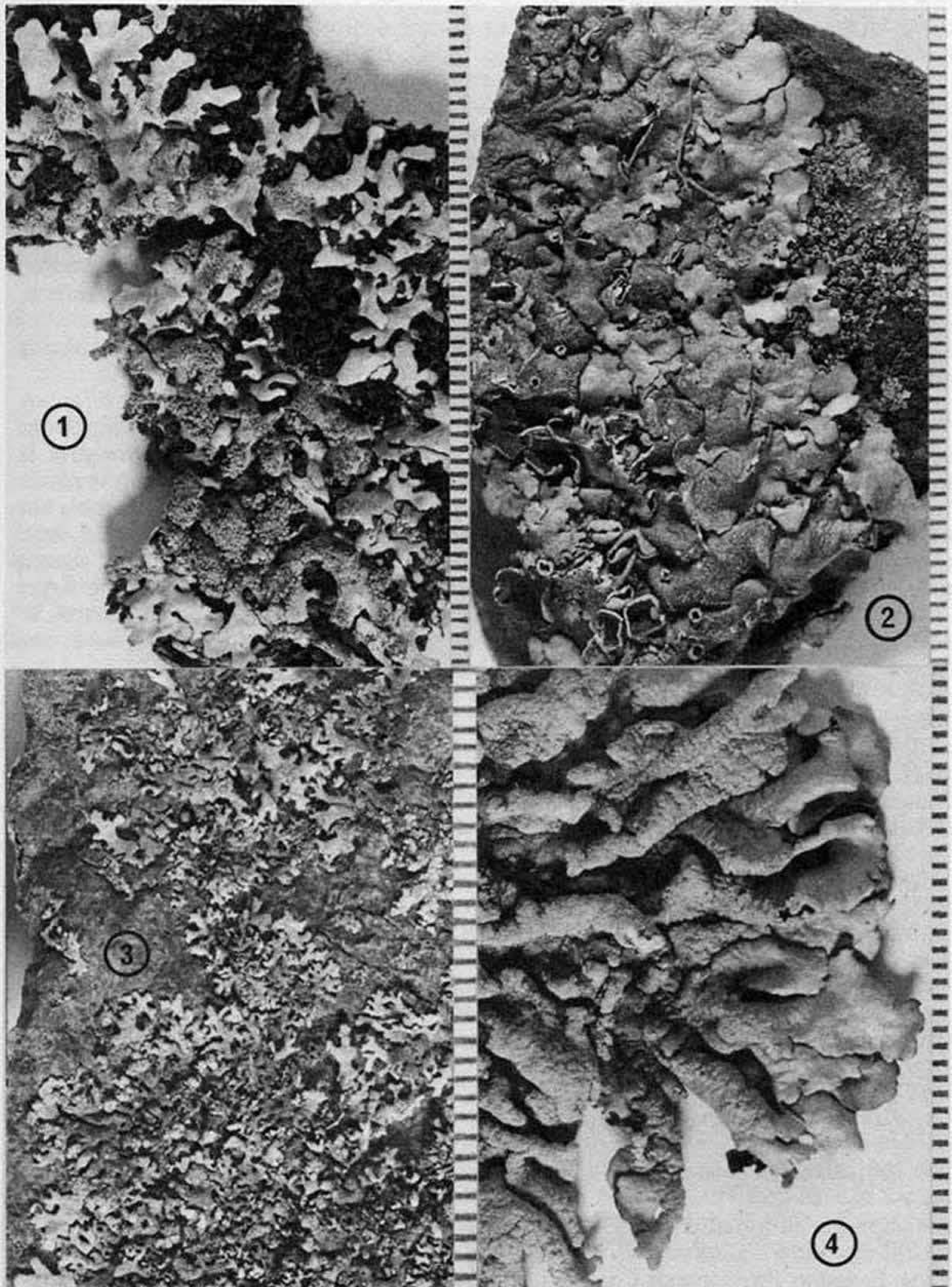
Chemistry. Cortex K-, medulla K+ yellow then red, C-, KC-, P+ orange ; containing usnic acid, salazinic acid (major), consalazinic acid (minor), norlobaridone (minor), protocetraric acid (trace).

In appearance this new species closely resembles *Xanthoparmelia constipata* (Kurok. & Filson) Elix & Johnston as both species are generally terricolous, have comparable thalli and are isidiate. However these species differ in the nature of the isidia and medullary chemistry. In *X. adleri* the isidia are globose, squat and wart-like or developing short, ±dense branches (comparable with those of *X. scabrosa)* while *X. constipata* normally develops elongated cylindrical isidia which are extensively coralloid-branched and become inflated at the apices. Furthermore *X. constipata* contains medullary loxodin, constipatic acid and protoconstipatic acid in addition to norlobaridone while *X. adleri* contains salazinic acid, consalazinic acid and norlobaridone. At present *X. constipata* is known only from arid central Australia while *X. adleri* occurs in Argentina.

This species is named in honor of Mrs. Monica Adler, collector of the new species and currently a doctoral candidate at Universidad de Buenos Aires.

Specimens Examined (Paratypes)

ARGENTINA. Provincia de SALTA: Cachi, 2280m, *M.T.Adler* (ASU, BAFC); Las Pailas, 2280m, *M.T.Adler* (ANUC, BAFC).



Figures 1-4. New species of *Xanthoparmelia* 1, *X. adleri* (holotype in ANUC); 2, *X. argentinensis* (holotype in ASU); 3, *X. cotopaxiensis* (holotype in ASU); 4, *X. ferraroiana* (holotype in ASU). Scale in mm.

Xanthoparmelia argentinensis Nash, Elix & Johnston sp.nov. Fig.2

Species cum thallo ut in *Xanthoparmelia cordillerana* sed ab hac specie colore subtus nigra differt.

Type. Argentina. Provincia de Mendoza, 3 km east of Cacheuta along route 7, *T.H.Nash* 23,915; ASU-holotype, ANUC, BAFC, BM, CTES, US-isotypes.

Thallus foliose, saxicolous, adnate to loosely adnate, yellow-green in colour, to 6 cm in diameter; *lobes* irregular, 2.0-5.0(-8.0) mm wide, imbricate or not so. *Upper surface* broadly undulating, shiny at the margins but appearing subgranulate in the centre, emaculate, often black-margined, developing numerous subpustulate or wart-like isidia; *isidia* laminal, small (*ca*. 0.1mm high and wide) in the centre of the thallus, simple, globose at first then becoming fissured and bursting open apically so that the thallus appears isidiose-pustulate; medulla white; *lower surface* black, shining, moderately to sparsely rhizinate, rhizines short, simple, black. *Apothecia* rare, to 6 mm in diameter, disc convex, brown to dark brown; margin entire, persistent, ± isidiate, amphithecium smooth or isidiate, spores 8.5-10.5 x 4.0-5.3 µm.

Chemistry. Cortex K-, medulla K+ yellow then red, C-, KC-, P+ orange ; containing usnic acid, salazinic acid (major), consalazinic acid (minor).

In appearance this new species closely resembles *Xanthoparmelia cordillerana* (Gyelnik) Hale as both species have broad lobes, develop subpustulate isidia on the upper surface and have identical medullary chemistry. However *X. argentinensis* is clearly distinguished by the black lower surface. By contrast *X. cordillerana* has a pale brown to dark brown lower surface. *X. isidiosa* (Müll.Arg.) Elix & Johnston also has some characters in common with this new species - both produce salazinic acid, have erumpent isidia and a black lower surface. *X. isidiosa* differs in having a tightly adnate, small foliose to subcrustose thallus (lobes 0.7-1.5 mm wide) and in producing larger inflated isidia (to 1 mm) which rarely become erumpent. On the other hand *X. argentinensis* has an adnate to loosely adnate thallus, with broad (3-5 mm) lobes and minute isidia (0.1 mm) which are commonly erumpent.

Specimens Examined (Paratypes)

ARGENTINA. Provincia de BUENOS AIRES: Partido Tornquist, Sierra de la Ventana, *Nash* 23,882 (ASU, ANUC); Provincia de CATAMARCA: east side of Campo de Pucara, ca. 1700m, *Lamb* 5751 (ASU, CANL); Provincia de CÓRDOBA: adjacent Lago San Roque at intersection of routes 20 & 28, *Nash* 23,958 (ASU), 1 km W of El Durazno, *Nash* 23,977B (ASU); 27 km W of El Durazno along route 20 at Río Yuspe *Nash* 23,999 (ASU); 19 km S of Villa Carlos Paz and 3 km E of the Astronomic Observatory, *Nash* 24,007(ASU, ANUC); north slope of Cerro Pan de Azucar, *Nash* 24,052 (ASU, ANUC); Provincia de MENDOZA: 1 km W of Cacheuta along route 7, *Nash* 23,906 (ASU, ANUC, US); 8 km W of Potrerillos, *Nash* 23,919 (ASU, ANUC, BAFC, CTES), 63 km NW of Mendoza, *Nash* 23,924 (ASU, ANUC); 1 km below Hotel Villaricencio, *Nash* 23,930 (ASU, COLO, DUKE); 3 km E of Manzano Histórico, *Nash* 23,948 (ASU, ANUC); Las Heras: Cordon de las Higueras, 1380m, *Leal* 31,148 (CTES); Provincia de SALTA: Las Pailas, 2280m, *Adler* pr.p. (ANUC, BAFC); near Escoipe, Cuesta del Obispo, *Adler* (ANUC, BAFC).

Xanthoparmelia cotopaxiensis Nash, Elix & Johnston sp.nov. Fig.3

Species cum thallo *Xanthoparmeliae ulcerosae* simili sed ab hac specie lobis et lobulis diminutis differt.

Type. Ecuador. Provincia de Cotopaxi, Río Saquimula 3 km W of entrance to Cotopaxi National Park, *T.H.Nash* 23,847; ASU-holotype, ANUC, US-isotypes.

Thallus small foliose, saxicolous, adnate, yellow-green but darkening with age, to 7 cm in diameter; *lobes* sublinear elongate, 0.4-1.0 mm wide, sparingly imbricate or not, developing minute lobulae (0.1-0.2 mm wide) in the centre. *Upper surface* dull for the most part, shiny at the apices, emaculate, sorediate, *soralia* laminal to submarginal,

orbicular at first then coalescing with age, *soredia* farinose; medulla white; *lower surface* brown to dark brown, blackening apically, smooth, moderately rhizinate, rhizines simple or rarely branched, brown to black. *Apothecia* not seen.
Chemistry. Cortex K-, medulla K+ yellow to red, C-, KC-, P+ orange ; containing usnic acid, salazinic acid (major), consalazinic acid (minor), norstictic acid (trace), protocetraric acid (trace).

X. cotopaxiensis is characterised by the production of soredia and its adnate thalli with very narrow lobes and diminutive lobules. In some respects this new species resembles *Xanthoparmelia ulcerosa* (Vainio) Hale as both species are sorediate, have a brown lower surface and identical medullary chemistry. These two species can be most readily distinguished morphologically: *X. cotopaxiensis* has small adnate thalli, narrow (0.4-1 mm) lobes which develop minute lobulae and a dark brown lower surface while *X. ulcerosa* has large thalli with broad (2-6 mm), elobulate lobes with a brown lower surface.

Specimens Examined (Paratypes)
ECUADOR. Provincia de CHIMBORAZO, 1 km SW of Guano, *Nash* 23,839B (ASU).

Xanthoparmelia ferraroiana Nash, Elix & Johnston sp.nov. Fig.4

Species cum thallo ut in *Xanthoparmelia farinosa* sed ab hac specie acido psoromico et acido 2'-O-demethylpsoromico continens differt.
Type. Argentina. Provincia de Mendoza, 18 km south of Potrerillos along road to San Jose, *T.H.Nash* 23,940; ASU-holotype, ANUC-isotype.

Thallus foliose, saxicolous, adnate to loosely adnate, yellow-green in colour, to 8 cm in diameter; *lobes* irregular, 2.0-6.0 mm wide, barely imbricate or not, lobes ± contiguous. *Upper surface* broadly undulating, rugose at the centre, dull for the most part, shiny at the apices, emaculate, sorediate, *soralia* laminal to submarginal, orbicular at first then coalescing with age, *soredia* farinose; medulla white; *lower surface* pale brown to brown, darker apically, densely rhizinate, rhizines short, simple or tufted at the apices, concolorous with the lower surface. *Apothecia* not seen.
Chemistry. Cortex K-, medulla K-, C-, KC-, P+ yellow; containing usnic acid, psoromic acid (major), 2'-O-demethylpsoromic acid (minor).

X. ferraroiana is characterised by the production of soredia and medullary psoromic acid. Morphologically this new species closely resembles *Xanthoparmelia farinosa* (Vainio) Nash, Elix & Johnston as both species have broad lobes, develop farinose soredia on the upper surface and have a brown lower surface. These two species can be most reliably distinguished chemically: the medulla of *X. ferraroiana* reacts K-, P+ yellow due to the presence of psoromic acid; while *X. farinosa* reacts K+ yellow, P+ yellow-orange due to the presence of stictic acid and associated substances.

This species is named in honor of Mrs. Lidia Ferraro, curator of lichens at CTES, who provided several of the specimens cited below.

Specimens Examined (Paratypes)
ARGENTINA. Provincia de LA PAMPA: near Parque Luro, *Ferraro* 1972 (COLO, CTES); Provincia de MENDOZA: 3 km E of Manzano Histórico, *Nash* 23,947 (ASU); 5 km W of Cacheuta along route 7, *Nash* 23,933 (ASU); 3 km E of Cacheuta along route 7, *Nash* 23,914 (ASU), 8 km W of Portrerillos, *Nash* 23,918 (ASU); Las Heras: Cerro de la Gloria, 800m, *Leal* 5968 (CTES); Las Heras: Quebrada de la Mina Atala, *Leal* 5953 (CTES); Provincia de SALTA: Las Pailas, 2280m, *Adler* (ANUC, BAFC).

Xanthoparmelia villamiliana Nash, Elix & Johnston sp.nov. Fig.5

Species cum thallo ut in *Xanthoparmelia australasica* sed ab hac specie arcte adnatos et acido stictico et acido constictico continens differt.

Type. Argentina. Provincia de Mendoza, 1km west of Cacheuta along route 7, *T.H.Nash* 23,907; ASU-holotype, ANUC, BAFC, US -isotypes.

Thallus foliose, saxicolous, adnate, yellow-green in colour, to 5 cm in diameter; *lobes* irregular, 2.0-3.0 mm wide, imbricate, apices rounded or shallowly notched. *Upper surface* dull or shiny at the apices, rugose, emaculate, moderately to densely isidiate, *isidia* laminal, cylindrical, robust (0.1-0.2 mm in diameter and up to 2.0 mm tall), richly coralloid-branched; medulla white; *lower surface* black, sparsely rhizinate, rhizines short, simple, black. *Apothecia* rare, to 4 mm in diameter, concave, brown , margin persistent, amphithecium rarely isidiate; spores colourless, ovate-ellipsoid, 9-11 x 3.5-5.5 µm.

Chemistry. Cortex K-, medulla K+ yellow, C-, KC-, P+ orange ; containing usnic acid, stictic acid (major), constictic acid (minor), norstictic acid (minor), cryptostictic acid (trace).

In appearance this new species resembles *Xanthoparmelia australasica* D. Gall. as both species have comparable thalli with broad lobes, a black lower surface and produce robust, cylindrical-coralloid isidia on the upper surface. However they differ in the degree of adnation, the development of isidia and medullary chemistry. In *X. australasica* the isidia often extend laminally to form a dense, areolate-isidiate mat, a growth form not observed in the new species. Furthermore *X. australasica* contains medullary salazinic and consalazinic acids while *X. villamiliana* contains the stictic acid complex - stictic, constictic, norstictic, and cryptostictic acids.

This new species may be confused with *X. conspersa* (Ach.) Hale as both are isidiate, have a black lower surface and comparable medullary chemistry. *X. villamiliana* has a more tightly adnate thallus with broader lobes (2-3 mm) and thick, robust, branched isidia which often become coralloid whereas *X. conspersa* on the other hand is moderately adnate, with narrower lobes (1-2 mm) and slender, simple or sparingly branched, cylindrical isidia.

This species is named in honor of Drs. Carlos Villamil and Paula Villamil, professors of botany at Universidad de la Sur, whose assistance was invaluable in the collection of the major set of specimens (with T.H.Nash).

Specimens Examined (Paratypes)
ARGENTINA. Provincia de SALTA: Las Pailas, 2280m, *Adler* (ANUC, BAFC).

Xanthoparmelia wrightiana Nash, Elix & Johnston sp.nov. Fig.6

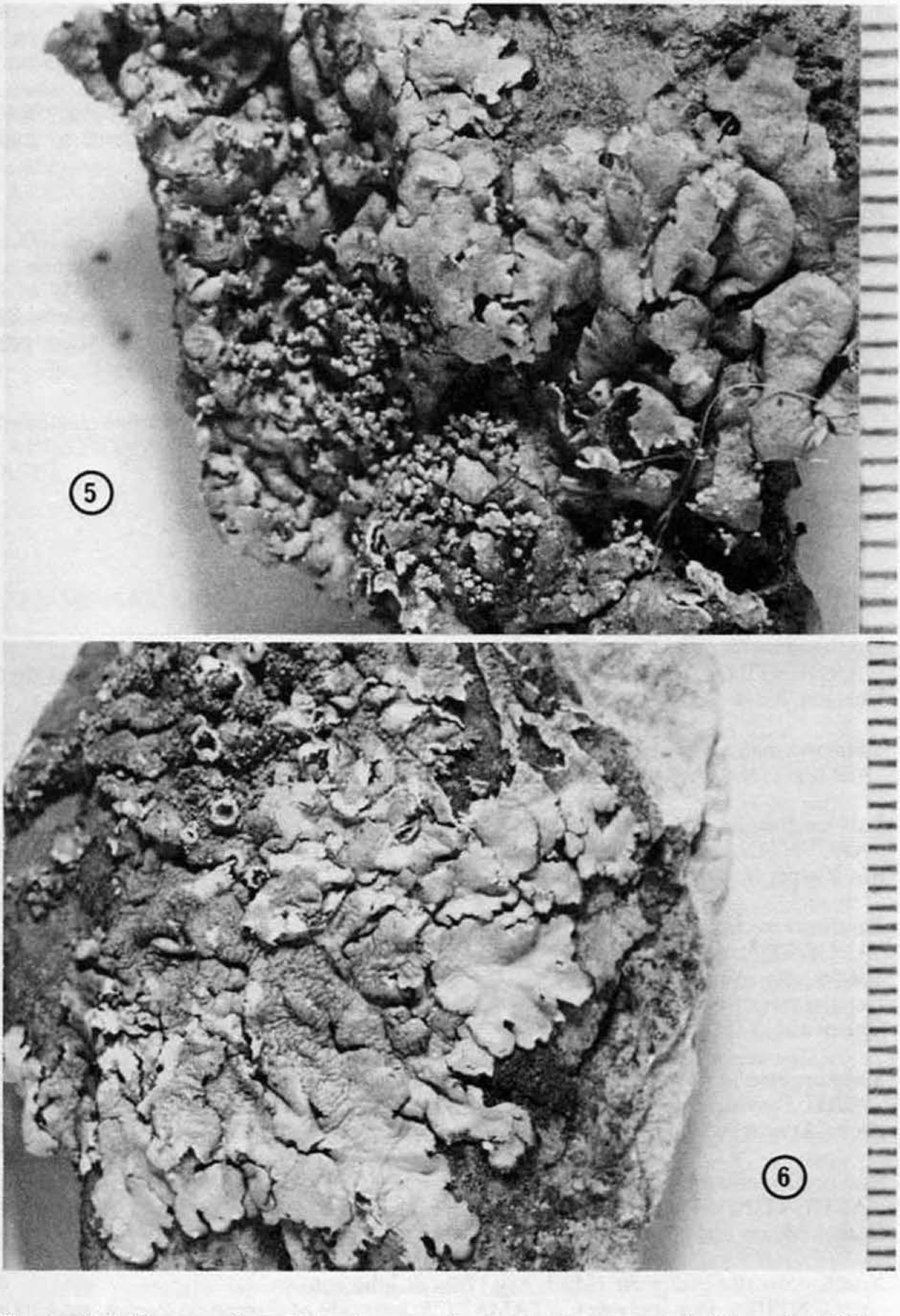
Species cum thallo ut in *Xanthoparmelia cordillerana* sed ab hac specie colore subtus nigra et acido stictico et acido constictico continens differt.

Type. Argentina. Provincia de Buenos Aires, Partido Tornquist, Sierra de la Ventana, *T.H.Nash* 23,878; ASU-holotype, ANUC-isotype.

Thallus foliose, saxicolous, adnate, yellow-green in colour, to 6 cm in diameter; *lobes* irregular, 1.0-3.0 mm wide, imbricate or not. *Upper surface* broadly undulating, shiny at the margins but appearing subgranulate in the centre, emaculate, often black-margined, developing numerous erumpent or wart-like isidia, *isidia* laminal, small (to 0.3 mm high) in the centre of the thallus, simple, globose or short-cylindrical, at first entire but ultimately bursting open apically; medulla white; *lower surface* black, shining, moderately to sparsely rhizinate, rhizines short, simple, black. *Apothecia* rare, to 4 mm in diameter, disc convex, brown to dark brown; margin involute at first, entire, persistent, ± isidiate, amphithecium smooth or isidiate, spores, ellipsoid, 8-10 x 4-6 µm.

Chemistry. Cortex K-, medulla K+ yellow then red, C-, KC-, P+ yellow ; containing usnic acid, stictic acid (major), constictic acid (minor), norstictic acid (minor), cryptostictic acid (trace).

This new species resembles *Xanthoparmelia cordillerana* (Gyelnik) Hale since both develop erumpent isidia on the upper surface and have similar thalli, but these species differ in medullary chemistry and other morphological features. Thus *X. wrightiana* is clearly distinguished by the black lower surface - this being pale brown to dark brown in



Figures 5-6. New species of *Xanthoparmelia* 5, *X. villamiliana* (holotype in ASU); 6, *X. wrightiana* (holotype in ASU). Scale in mm.

X. cordillerana.. Further the lobes of *X. wrightiana* tend to be narrow and the erumpent isidia are not at all sorediate while in *X. cordillerana* the lobes are broader and the isidia pustulate. This new species is more likely to be confused with *X. argentinensis* as both have a black lower surface and produce erumpent isidia. In this case *X. wrightiana* can be distiguished by the narrower lobes (1-2mm), erumpent isidia and the production of the stictic acid complex. By contrast *X. argentinensis* has broader lobes (2-5mm), subpustulate isidia and produces medullary salazinic acid.

This species in named in honor of Dr. Jorge Wright, professor of mycology at the Universidad de Buenos Aires, who has encouraged a number of students to study lichenology.

Specimens Examined (Paratypes)
ARGENTINA. Provincia de CÓRDOBA: 1 km S of Tanti along route 20, *ca*.. 1000m, *Nash* 23,983 (ASU, US); 1 km W of Copina in a narrow canyon with flowing water, *Nash* 24,040 (ASU); 15 km E of Copina, *Nash* 24,012 (ASU); 27 km W of El Durazno where route 20 crosses Río Yuspe, *Nash* 24,000 (ASU); 8 km E of Cerro Pan de Azucar, *Nash* 23,043 (ASU); Provincia de SALTA: Las Pailas, 2280m, *Adler* pr.p. (ANUC, BAFC).

New Combination

Xanthoparmelia farinosa (Vainio) Nash, Elix & Johnston, comb. nov.
Basionym: *Parmelia farinosa* Vainio, Étud. Lich. Brésil, **1**, 62 (1890)

NEW RECORDS FOR SOUTH AMERICA

Xanthoparmelia adhaerens (Nyl.) Hale
ARGENTINA. Provincia de BUENOS AIRES: Partido Tornquist, Sierra de la Ventana, *Nash* 23,876 (ASU).

Xanthoparmelia alternata Elix & Johnston
ARGENTINA. Provincia de SALTA: Las Pailas, *Adler* (ANUC, BAFC).

Xanthoparmelia antleriformis (Elix) Elix & Johnston
ARGENTINA. Provincia de CÓRDOBA, 27 km W of El Durazno along route 20 at Río Yuspe, *Nash* 23,995 (ASU).

Xanthoparmelia australasica D. Gall.
ARGENTINA. Provincia de CATAMARCA: valley of Río Pisavil near Los Rosas, ca 1660m, on granite, *Lamb* 5736 (CANL). PERU. Provincia de CAJAMARCA: Departamento de Cajamarca, between Namorca and Lago San Nicolas, 2600m, *P. Hegewald* (GZU).

Xanthoparmelia flavescentireagens (Gyeln.) D. Gall.
PERU. Provincia de HUAMANGA: Ayacucho Department, Cerra Condorcunca, 2 km above Ayacucho Battle Monument, 3300m, *Wasshausen & Encarnacion* 561 (US).

Xanthoparmelia huachucensis (Nash) Hale
ARGENTINA. Provincia de NEUQUEN: along route 237 above Embalse Ezequiel Ramos Mexía and *ca*. 10 km SSW of Picun Leufu, *Nash* 24,175 (ASU).

Xanthoparmelia isidiigera (Müll. Arg.) Elix & Johnston
ARGENTINA. Provincia de CATAMARCA: east side of Campo de Pucara, *ca*. 1700m, on metamorphic rock, *Lamb* 5751 (CANL).

Xanthoparmelia mexicana (Gyeln.) Hale
ARGENTINA. Provincia de CATAMARCA: east side of Campo de Pucara, *ca.* 1700m, on metamorphic rock, *Lamb* 5746 (CANL); Provincia de CÓRDOBA: 27 km W of El Durazno along route 20 at Río Yuspe, *Nash* 23,996 (ASU); 19 km S of Villa Carlos Paz and 3 km E of the Astronomic Observatory, *Nash* 24,003 (ASU).

Xanthoparmelia oleosa (Elix & Armstrong) Elix & Nash
ARGENTINA. Provincia de SALTA: Cachi, 2280m, *M. T. Adler.* (ANUC).

Xanthoparmelia scabrosa (Taylor) Hale
ARGENTINA. Provincia de NEUQUEN: 15 km S of Alumine along Río Alumine, *Nash* 24,082 (ASU, ANUC, BAFC, CTES, US); Lanco Luan, *Nash* 24,071 (ASU); along route 237 above Embalse Ezequiel Ramos Mexía and *ca.* 10 km SSW of Picun Leufu, *Nash* 24,179 (ASU).

Xanthoparmelia stenophylla (Ach.) Heug.
ECUADOR. Provincia de TUNGARAHUA: 42 km S of Riobamba along the highway to Quito, 3100m, *Nash* 23,787 (ASU, ANUC, US).

Xanthoparmelia tasmanica (J. D. Hook. & Taylor) Hale
ARGENTINA. Provincia de CÓRDOBA: 3 km W of El Durazno, *Nash* 23,977 (ASU).

PRELIMINARY KEY TO THE SOUTH AMERICAN *XANTHOPARMELIAE*

1. Thallus sorediate..........2
1. Thallus lacking soredia..........8

2. Lower surface black..........3
2. Lower surface brown 4

3. Thallus subcrustose, stictic, constictic acids..........*X. mougeotii*
3. Thallus foliose; salazinic acid..........*X. microspora*

4. Lobes narrow (0.5-1mm), salazinic acid..........5
4. Lobes broader (1.5-4mm), lower surface brown, chemistry various..........6

5. Thallus adnate, soralia orbicular then spreading, lower surface dark brown....... ....*X. cotopaxiensis*
5. Thallus loosely adnate, soralia capitate, lower surface pale brown.....*X. wildiae*

6. Medulla K-, psoromic acid ....*X. ferraroiana*
6. Medulla K+yellow or yellow-red, stictic or salazinic acids..........7

7. Soredia farinose, medulla K+ yellow, stictic acid..........*X. farinosa*
7. Soredia granular, medulla K+ yellow-red, salazinic acid..........*X. ulcerosa*

8. Thallus isidiate..........9
8. Thallus lacking isidia.......... 26

9. Isidia pustulate or erumpent..........10
9. Isidia corticate, intact.......... 14

10. Lower surface black..........11
10. Lower surface brown..........12

11. Isidia subpustulate, medulla K+ yellow-dark red, salazinic acid..........
.... *X. argentinensis*
11. Isidia erumpent, esorediate, medulla K+ yellow, stictic acid.......... *X. wrightiana*

12. Medulla K-, KC+ rose, norlobaridone.......... *X. scabrosa*
12. Medulla K+ yellow or yellow-red..........13

13. Isidia subpustulate, medulla K+ yellow-dark red, salazinic acid.. *X. cordillerana*
13. Isidia erumpent, medulla K+ yellow-pale red, hypostictic acid.......... *X. kalbii*

14. Isidia wart-like, thallus generally terricolous, salazinic acid, norlobaridone......
.... *X. adleri*
14. Isidia cylindrical, thallus saxicolous..........15

15. Lower surface black..........16
15. Lower surface brown 21

16. Thallus subcrustose, lobes 0.2-1.0 mm wide..........17
16. Thallus adnate to loosely attached, lobes 1-5 mm wide..........18

17. Medulla K+ yellow, UV-,stictic acid.......... *X. mougeotina*
17. Medulla K-, UV+ blue, alectoronic acid.......... *X. alectoronica*

18. Thallus loosely adnate, isidia branched, dense, salazinic acid...... *X. australasica*
18. Thallus adnate to tightly adnate..........19

19. Medulla K+ yellow-red, isidia simple, sparse, salazinic acid.......... *X. isidiigera*
19. Medulla K+ yellow, isidia simple or branched, stictic acid..........20

20. Thallus tightly adnate, lobes 2-3 mm wide, isidia robust, coralloid..........
.... *X. villamiliana*
20. Thallus adnate, lobes 1-2 mm wide, isidia slender, mainly simple..........
.... *X. conspersa*

21. Lobes narrow, 0.5-1 mm wide, isidia coralloid, salazinic acid... *X. antleriformis*
21. Lobes broader, 1-5 mm wide..........22

22. Medulla K+ yellow or yellow-red..........23
22. Medulla K- 25

23. Medulla K+ yellow-dark red, salazinic acid.......... *X. mexicana*
23. Medulla K+ yellow, stictic acid 24

24. Isidia globose, sparingly branched, apices inflated.......... *X. plittii*
24. Isidia cylindrical, slender, much branched.......... *X. succedans*

25. Medulla containing psoromic acid.......... *X. kurokawae*
25. Medulla containing fumarprotocetraric, succinprotocetraric acids..........
.... *X. subramigera*

26. Thallus terricolous..........27
26. Thallus saxicolous..........33

27. Lobes convolute, revolute or canaliculate at least in part........................28
27. Lobes more or less plane..30

28. Lobes convolute, stictic acid..*X. vagans*
28. Lobes or lobules revolute..29

29. Primary lobes ± plane, lobules revolute, salazinic acid................*X. alternata*
29. Primary lobes revolute, lobules terete, stictic acid..................*X. molliuscula*

30. Lower surface black, stictic acid................................*X. austroamericana*
30. Lobes surface brown...31

31. Medulla K-, KC+ rose, norlobaridone.......................*X. flavescentireagens*
31. Medulla K+ yellow or yellow-red..32

32. Medulla K+ yellow, lobes narrow (0.5-1 mm), stictic acid..........*X. standaertii*
32. Medulla K+ yellow-red, lobes broad (1.5-5 mm), salazinic acid.......*X. taractica*

33. Lower surface black...34
33. Lower surface brown 37

34. Thallus loosely adnate, salazinic acid..................................*X. tasmanica*
34. Thallus adnate, lacking salazinic acid..35

35. Thallus subcrustose, lobes 0.5-1 mm wide, psoromic acid......*X. huachucensis*
35. Thallus foliose, lobes 1-4 mm wide, psoromic acid lacking.......................36

36. Lobes 2-4 mm, apically rotund, medulla K+ yellow, stictic acid...*X. hypopsila*
36. Lobes 1-2 mm, elongate, medulla K- or K+ pale brown, fumarprotocetraric acid, succinprotocetraric acid...*X. hypomelaena*

37. Medulla K+ yellow-red, salazinic acid.. 38
37. Medulla K-..39

38. Lobes narrow, 1-2 mm wide, elobulate, sparsely rhizinate..........*X. stenophylla*
38. Lobes broad, 2-5 mm wide, commonly lobulate, densely rhizinate...*X. taractica*

39. Thallus loosely adnate, medulla KC+ rose, loxodin, norlobaridone...*X. flavescentireagens*
39. Thallus tightly adnate, medulla KC-, constipatic acid, protoconstipatic acid...*X. oleosa*

ACKNOWLEDGEMENTS

We wish to thank Mr.I.A.Fox and the staff of the Science Photographic Unit, ANU, for preparing the photographs, Mr.D.Verdon for checking the Latin descriptions and Dr. G.A.Jenkins who determined the chemistry of many specimens. We thank the following colleagues for making collections available: Mrs.M.T.Adler (BAFC), Dr.M.E.Hale (US), Dr. W.A.Weber (COLO), Dr. I.M.Brodo (CANL), Dr. J. Poelt (GZU), and Mrs.L.Ferraro (CTES). This research was made possible by the support of the US-Australia Cooperative Science Grant INT-8412745 administered through the U.S. National Science Foundation. We also thank the Australian National University for financial assistance through the Faculties Research Fund.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 297-302 April-June 1987

DIPLOCLADIELLA APPENDICULATA SP. NOV. A NEW AERO-AQUATIC HYPHOMYCETE

A. NAWAWI

Department of Botany, University of Malaya,
59100 Kuala Lumpur, Malaysia.

A species of *Diplocladiella* collected on pieces of submerged bark from Malaysia is described and illustrated as *D.appendiculata* sp. nov. The 8-celled, Y-shaped, sympodially produced conidia bear 2 hair-like appendages at the tip of each arm. A key to the known species is also provided.

The genus *Diplocladiella* was erected by Arnaud(1954) with *D.scalaroides* Arnaud as the type species. Ellis(1976) validated the taxon by giving it a latin diagnosis. It appears to be common occurring on a variety of leaf-litter and has been reported from many parts of the world including Japan(Tubaki,1958), England(Ellis,1976; Kirk,1982) and Taiwan (Matsushima,1980). Although *D.scalaroides* has been recorded mainly from terrestrial habitats its characteristics conidia are of frequent occurrence in foam samples (Gönczöl,1976; Marvanová,1984; Shearer & Webster,1985; Nawawi,1985a). These conidia may have had a terrestrial origin and may well be washed into a stream in spate from leaf-litter flooded by the risen water. Ingold(1975) found conidia of this fungus throughout the year in foam from a stream in Kent and remarked that, "it is likely that the fungus is at least capable of aquatic existence". A second species *D.tricladioides* Nawawi, considered as an aero-aquatic was described from Malaysia (Nawawi,1985b). It was found on pieces of bark incubated in shallow water. The bark pieces were originally obtained from a submerged log. Its conidia have also been seen in a foam sample sent to me from Bombay, India by Dr. A.M. Kelkar. A third species whose conidia have been known for some time occurring in foam samples from several Malaysian streams (Nawawi,1985a) is described in this paper as a new species.

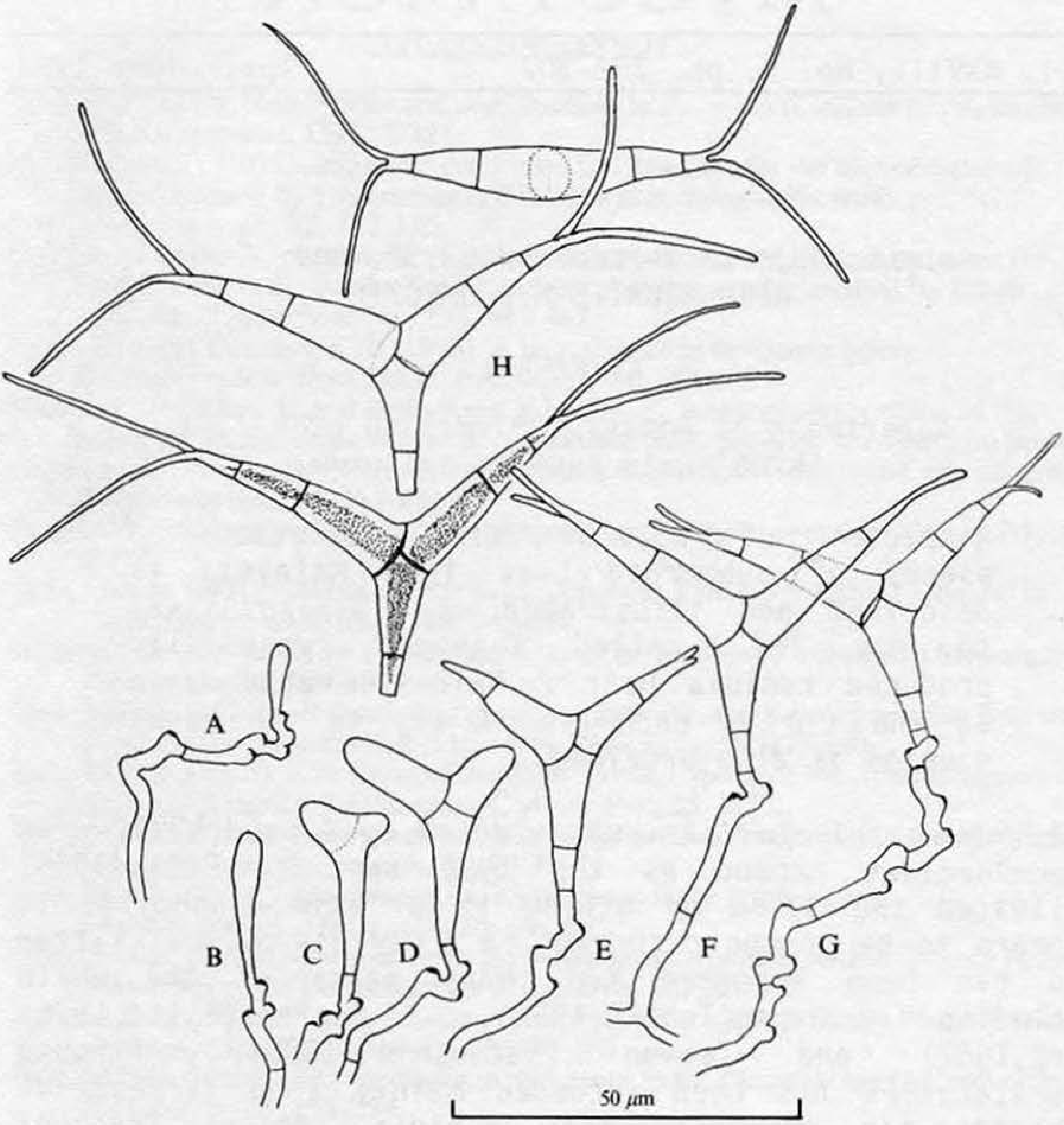

Fig.1. *Diplocladiella appendiculata*. (A-G) Stages in conidial formation from bark; (H) typical Y-shaped, 8-celled conidia with two appendages at the apex of each arm; one viewed from above.

Diplocladiella appendiculata sp.nov. (Figs 1-2)

Mycelium partim superficiale, partim in substrato, laevibus, fuscis vel brunneis, ramosis, septatis, 2-3 µm latis hyphis. Conidiophori dispersi, singuli, macronemati, mononemati, simplices, septati, flexuosi vel dejecti, laeves, brunnei et in apice brunneoli, 40-90 x 2-3 µm. Cellulae conidiogenae integratae, terminales, geniculatae, sympodiales, cicatricibus conidiorum in geniculationibus rotundatis. Conidia holoblastica, solitaria, Y-formata, fusca vel atrogrisea, ramis 2 divergentibus, symmetrica et bilateralia, octocellularia, distoseptata; axis principalis 26-31 µm latis, rami apicem versus deminuti 2 µm, 26-33 µm longi, usque ad 10 µm crassi; appendice apicalibus 20-33 x 1 µm.

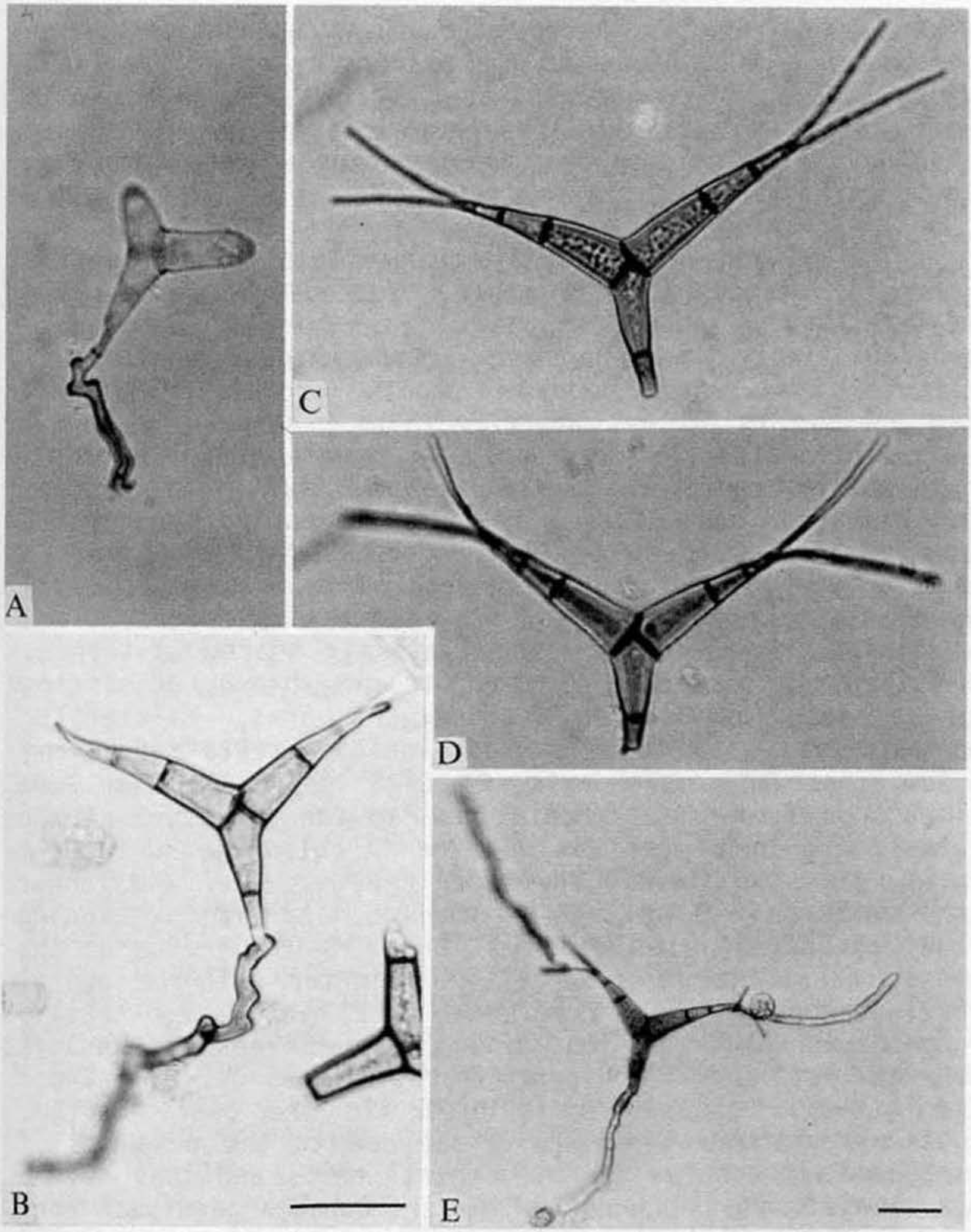

Fig.2. *Diplocladiella appendiculata*. (A-B) Two stages in conidial formation from bark; (C-D) typical conidia with apical appendages; (E) a conidium germinating. Bars=20 µm.

Habitat saprophytice in cortice decidui trunci in Gombak flumine immersi, Malaya Universitatis Regionale Studiorum Centro, Julii 1986, A. Nawawi (IMI 309529 holotypus).

This fungus was found growing and sporulating on pieces of decaying bark in moist chamber. The bark pieces were taken from a submerged log of an unidentified tree along the Gombak river at the University of Malaya Field Study Centre. On incubation at 20° in a Petri dish with some water this fungus sporulated continuously for more than 8 weeks. Conidiophores bearing conidia were formed on the exposed parts of the substrate.

The *mycelium* was partly superficial and partly immersed, composed of smooth, fuscous to pale-brown septate, 2-3 µm wide hyphae. *Conidiophores* scattered, arising singly, macronematous, mononematous, unbranched, septate, flexuous to pendent, smooth, brownish, paler at the apex up to 90 µm long x 2.5-3 µm wide. *Conidiogenous cells* integrated, terminal, sometimes becoming intercalary, confined to the apex of the conidiophores, polyblastic, geniculate, sympodial, bearing up to 13 prominent flat to round scars which give the cell a regularly geniculate, zig-zag appearance. *Conidia* holoblastic, produce singly from successive apices, often remaining attached to the lateral scars, Y-shaped, 8-celled, distoseptate, fuscous to grey-brown, consisting of a main axis with 2 divergent arms, bilaterally symmetrical, with the two middle oblique septa separating the arms. The main axis is 2-celled, 26-31 µm long (measured from the truncate base to the curvature of the arms). The basal cell is lighter in colour measuring 6-7 µm long x 2-3 µm wide. The upper cell is wider and longer and measures 6-9 µm wide at the top. The arms (excluding the appendages) are 26-33 µm long x 8-10 µm wide at the base, narrowing to 2 µm at the lighter coloured apical cell which forks to give rise to 2 hyaline non-septate appendages 20-33 µm long x 1 µm wide. These appendages curved out and lie in different planes to the arms. Conidia are released by a break in the basal septum. Detached conidia generally float due to the presence of trapped air bubbles in the central cells and they seldom germinate while suspended in water. Conidia germinate very slowly on 2% MA by producing germ-tubes from the truncate basal cell and also from the tips of the apical cells or anywhere along the appendages. On 2% MA colonies are very slow growing, restricted, compact and dark. No sporulation occurred.

In terms of conidiogenesis, spore morphology and colour, *D.appendiculata* is very similar to *D.scalaroides*. Arnaud(1954) gave excellent illustrations of the stages in conidial formation in *D.scalaroides* and these differ little from *D.appendiculata*. However, there are essential differences between the two species. Conidia of *D.scalaroides* are smaller rarely exceeding 30 µm across between the tips of the extended arms, compares to 48-60 µm across (excluding the appendages) and up to 105 µm across (including the appendages) in *D.appendiculata*. The cells making up the conidium in *D.appendiculata* are wider and longer. The other obvious difference is that the apical cell of each arm in *D.scalaroides* is drawn out into only one appendage.

Key to the species of *Diplocladiella*

1. Conidia obpyramidal, measuring 20-23 µm across, with an appendage at each corner cell .... *D.tricladioides*.

1. Conidia triangular or Y-shaped 2

    2. Conidia triangular, measuring 30-35 µm across with an appendage at the apex of each arm. *D.scalaroides*

    2. Conidia Y-shaped, measuring 48-60 µm across, with two appendages at the apex of each arm.. *D.appendiculata*

A characteristic feature common to all three described species is that their conidia are 8-celled, distoseptate with the basal and apical cells lighter in colour. Whilst the extension of the apical cell in *D.scalaroides* is seldom referred to as an appendage but merely as horns (Ellis,1976) or hair-like cell (Ingold,1975), observations on numerous conidia and illustrations given by previous workers show that these unpigmented extensions can be regarded as appendages which all 3 species posses. Another feature they all have in common is holoblastic sympodial conidiogenesis from remarkably similar conidiogenous cells. Tubaki(1958) described the growth of *D.scalaroides* on 2% MA as very slow growing, restricted, compact, olive-green to dark in colour, which is quite similar to the growth of *D.appendiculata*. *D.tricladioides* has also similar growth characteristics.

I thank Professor J. Webster for reviewing the manuscript and for helpful comments. The technical assistance of Mrs. Eugenie Yoon is gratefully acknowledged.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 303-311 April-June 1987

DESIGNATION OF TYPE COLLECTIONS FOR LACCARIA PROXIMA, L. TORTILIS, AND L. TRULLISSATA.[1]

GREGORY M. MUELLER

Field Museum of Natural History
Chicago, IL 60605-2496, U.S.A.

Neotypes for Laccaria proxima (Boud.) Pat. and L. tortilis (Bolt.) Cooke and a lectotype for L. trullissata (Ellis) Peck are designated.

Key words: Agaricales, Laccaria, lectotype, neotype, nomenclature, type specimen

INTRODUCTION

Several commonly used Laccaria names lack type specimens. To stabilize the nomenclature of Laccaria, it was necessary to designate type specimens for names that lacked types, that are generally accepted, and whose identity could be determined by common usage (Korf, 1982a, 1982b). This is done here for Laccaria proxima (Boud.) Pat., L. tortilis (Bolt.) Cooke, and L. trullissata (Ellis) Peck. Neotypes for L. amethystea (Bull.) Murrill and L. pumila Fayod (= L. altaica Sing.) were designated by Mueller and Vellinga (1986). Names that lack type specimens, have not generally been used, and are based only on inadequate descriptions have been treated as nom. dubium and no attempt at typifying them has been made.

Macromorphological descriptions are based on the original protologue. Micromorphological descriptions are based on my observations of the type specimen following standard techniques (e.g., Largent et al., 1977).

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[1] Based on a portion of a dissertation submitted to the Graduate School of the Universtiy of Tennessee, Knoxville, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Basidiospore size data are always given without ornamentation and hilar appendage and were obtained with the hilar appendage in profile. Width and diameter measurements for other elements were taken at the widest point. At least 30 basidiospores, 15 basidia, and 10 terminal cells of cuticular hyphae were measured for each collection. The following abbreviations are used: $\bar{x}$ = mean, Q = length/width ratio, and $\bar{Q}$ = mean length/width ratio.

TYPIFICATIONS AND DESCRIPTIONS

1. **Laccaria proxima** (Boudier) Patouillard, Hymeno. Eur. p. 97. 1887. [Fig. 1]

Basionym: Clitocybe proxima Boudier, Bull. Soc. Bot. France 28: 91-92. 1881.

Neotype nov.: France, Montemorency, November 1904, Boudier s.n. (as C. proxima) (PC!).

MACROMORPHOLOGY (Teste Boudier, 1881): BASIDIOMA: **Pileus** convex becoming plane, depressed, covered with appressed fibrils, hygrophanous, orange rust ("fauve orange," Boudier); disc becoming squamulose with age; margin striate when moist. **Lamellae** distant, rather thick, pinkish flesh-colored ("rose carne," Boudier), paler toward margin becoming subconcolorous with pileus, often covered with a white powder (?spores). **Stipe** externally fibrillose, equal or slightly thickened at base, subconcolorous with pileus.

MICROMORPHOLOGY: PILEUS: **Pileipellis** interwoven with scattered fascicles of ±perpendicular hyphae; fascicles usually composed of 10-20 hyphae; terminal cells of fascicular hyphae 38-64 x 4.6-9.2 µm, undifferentiated to swollen, subclavate to clavate, occasionally subcapitate, light yellowish brown in mass; walls up to 0.5 µm thick, pale yellowish brown; contents hyaline. **Trama** tightly interwoven, undifferentiated, hyaline, light yellowish brown toward cuticle. LAMELLA: **Trama** parallel; hyphae 4-12 µm diam, mostly 5.5-9.5 µm diam, thin-walled, hyaline to light yellowish brown; cells long, barrel-shaped. **Subhymenium** undifferentiated. **Basidia** 30.5-43 x 8.7-11.5 µm, Q = 2.88-4.25, clavate, elongate, hyaline; sterigmata 4, up to 5.2 µm long. **Pleurocystidia** lacking.

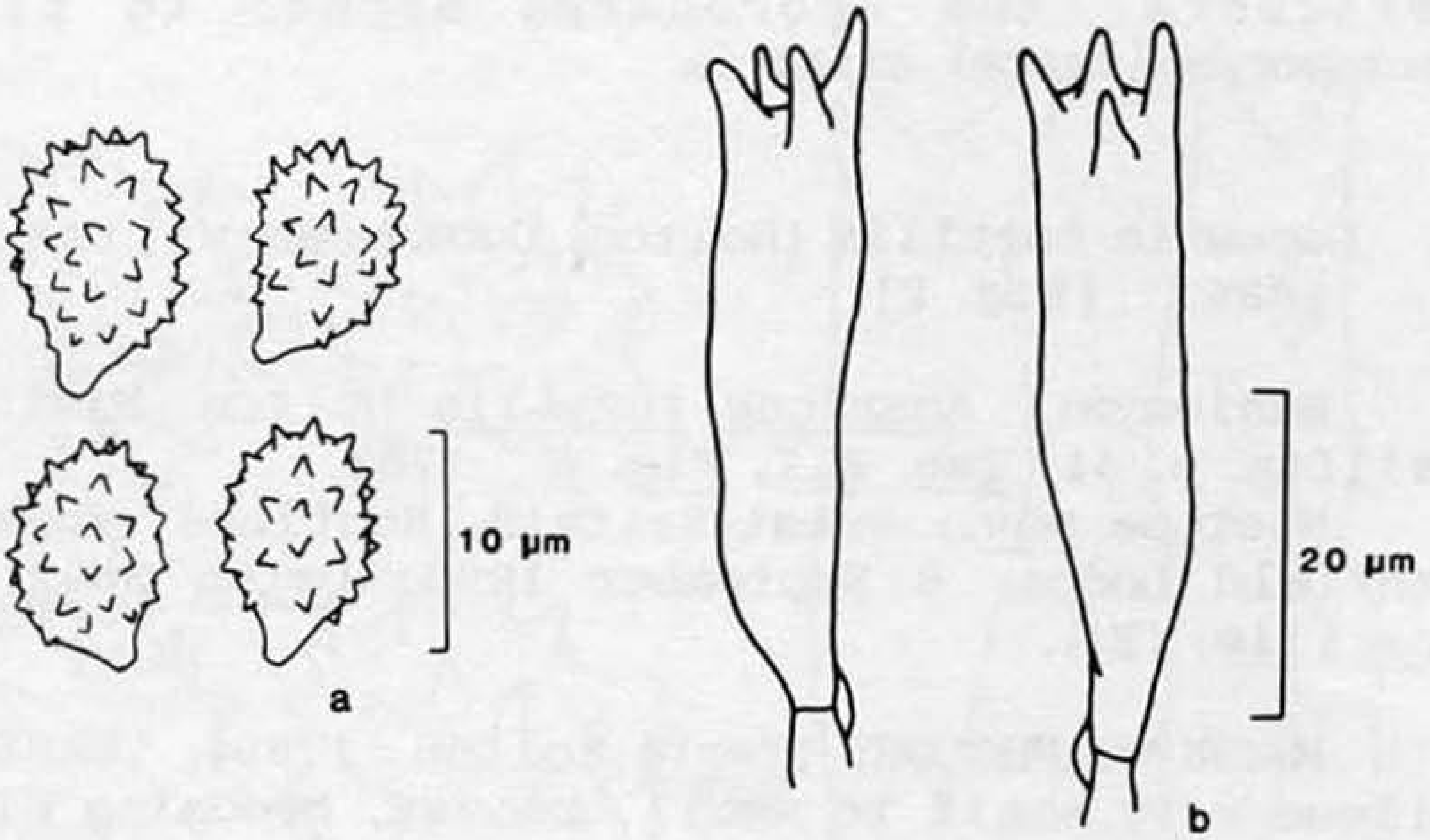

Fig. 1. Laccaria proxima (Neotype, Boudier s.n., Nov. 1904). A. Typical ellipsoid, finely ornamented basidiospores. B. Four-sterigmate basidia.

Cheilocystidia not observed. **Basidiospores** (excluding ornamentation) 7.8-11 x (6.4-)6.9-8.3(-8.7) µm ($\bar{x}$ = 9.6 ± 1 x 7.6 ± 0.6 µm), Q = (1.05-)1.12-1.49 ($\bar{Q}$ = 1.3 ± 0.1), usually ellipsoid to amygdaliform, occasionally subglobose, hyaline, echinulate; spines 0.5-0.9 (-2.3) µm long, sometimes with one or two long spines at apex; hilar appendage 1.4-1.8 µm long, prominent, truncate; plage present; contents occasionally uniguttulate. BASAL MYCELIUM: **Hyphae** mostly 2.5-4 µm diam, tightly interwoven, undifferentiated, hyaline.

OBSERVATIONS: There has been much controversy in the literature as to the correct name of this species (Mueller and Sundberg, 1981). Typification of the name L. proxima should stabilize application of the name and the taxonomy of the species.

Although collected 23 years after the original publication date, this is the only Boudier collection labelled C. proxima that could be found at PC, and thus, it is the only authentic material from which to designate the type specimen. Spore data of this collection closely fit those in the original description ("spores ovales, finement echinulees"). Additionally, although difficult to discern with certainty due to possible preservation artifacts, the sporocarps appear to fit the macromorphological criteria.

2. **Laccaria tortilis** (Bolton) Cooke, Grevillea 12: 70. 1884. [Fig. 2]

Basionym: *Agaricus tortilis* Bolton, Hist. Fung. Halifax. p. 41, *Tab. XII, Fig. A.* 1788.

Neotype *nov.*: Great Britain, Scotland, Yorkshire, Tanfield Lodge, 6 September 1969, *Orton 3642* (as *L. tortilis*) (E!).

MACROMORPHOLOGY (*Teste* Bolton, 1788): BASIDIOMA: **Pileus** very small to small, convex, becoming plane to uplifted, striate, dark reddish brown; margin lobed, crumpled and distorted. **Lamellae** dusky color. **Stipe** 6 mm long, dusky flesh color.

MICROMORPHOLOGY: PILEUS: **Pileipellis** interwoven with widely scattered fascicles of ±perpendicular hyphae; terminal cells of fascicular hyphae (n=5) 32–55 x 6.5–12.5 µm, undifferentiated to subclavate, occasionally clavate; walls up to 0.5 µm thick, pale yellowish brown; contents hyaline to light yellowish brown. **Trama** tightly interwoven, undifferentiated, hyaline, light yellowish brown toward cuticle. LAMELLA: **Trama** parallel; hyphae 3.2–13 µm diam, thin-walled, hyaline to light yellowish brown; cells long, barrel-shaped. **Subhymenium** undifferentiated. **Basidia** 40–60 x 9–13 µm, Q = 3.35–5.64, clavate, elongate, hyaline; sterigmata 2, up to 11 µm long. **Pleurocystidia** lacking. **Cheilocystidia** not observed. **Basidiospores** (excluding ornamentation) 11.5–14.7(–17) x 11.5–14.7(–17) µm ($\bar{x}$ = 13.4 ± 1.3 x 13.4 ± 1.3 µm), Q = 1(–1.04) ($\bar{Q}$ = 1 ± 0.01), globose, hyaline, strongly echinulate; spines 2.3–4 µm long, 1.3–1.8 µm wide at base, crowded to very crowded; hilar appendage 1.3–2.3 µm long, prominent, truncate; plage present; contents occasionally uniguttulate. BASAL MYCELIUM: **Hyphae** mostly 2.8–5.5 µm diam, tightly interwoven, undifferentiated, hyaline.

OBSERVATIONS: *Agaricus tortilis* (Bolton, 1788) is the earliest name used for the very small, often distorted *Laccaria* with large, globose, strongly ornamented

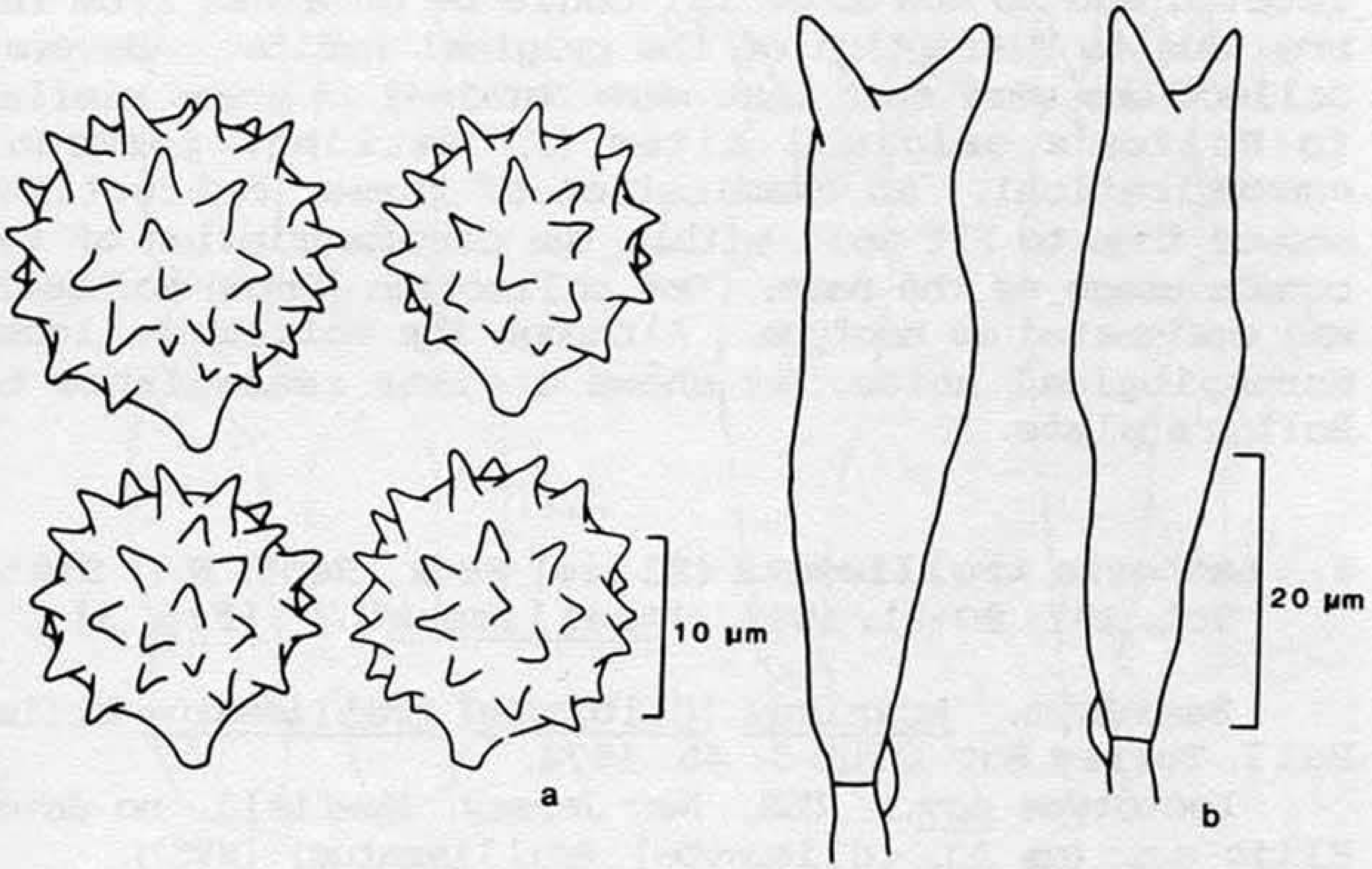

Fig. 2. Laccaria tortilis (Neotype, Orton 3642).
A. Typical large, globose, strongly ornamented basidiospores. B. Two-sterigmate basidia.

basidiospores born on 2-sterigmate basidia. Although no holotype exists and Bolton's description did not give any micromorphological data, his color plate clearly illustrated the macromorphological traits of this taxon. An examination of representative material from the environs of the type locality shows that Bolton probably had access to specimens that fit into this micromorphological form. I agree with the majority of modern workers (e.g., Dennis et al., 1960; Orton, 1960; Phillips, 1981; Bon, 1983; Moser, 1983) who use L. tortilis for this species based on common usage (Korf, 1982a, 1982b). Rea (1922), Singer (1950, 1952) and Clémençon (1984) consider L. tortilis to be a smaller spored species and Singer and Clémençon have used L. echinospora (Speg.) Sing. for the taxon that I call L. tortilis.

To stabilize the application of the name and the taxonomy of the species, a loan of representative material of the taxon from the Halifax area was requested from E and K. No specimens of L. tortilis from Halifax were located and no new material could be obtained from the area due to disruption of the original habitat. Several collections were sent that were obtained in areas similar to Bolton's original sites (R. Watling, personal communication). An examination of these collections showed them to fit well within the circumscription of the common usage of the name. One collection (Orton No. 3642) was designated as neotype. Although the collection lacks morphological notes, it shows a clear resemblance to Bolton's plate.

3. **Laccaria trullissata** (Ellis) Peck, Rept. N.Y. State Bot. 157: 90-91. 1912. ("trullisata"). [Fig. 3]

Basionym: Agaricus (Clitocybe) trullissatus Ellis, Bull. Torrey Bot. Club 5: 45. 1874.

Lectotype nov.: USA, New Jersey, Newfield, no date, Ellis s.n. (as Ag. [Clitocybe] trullissatus) (NYS!).

MACROMORPHOLOGY (Teste Ellis, 1874): BASIDIOMA: **Pileus** plano-convex, becoming depressed, fibrose-squamose, smoother at disk, fleshy; margin thin. **Lamellae** coarse and thick, unequal, distant, arcuate-decurrent, purple-violet, becoming dark brick red, white pulverulent. **Stipe** club-shaped, radicating, fibrillose, stuffed; flesh violet-purple; stipe base tomentose, covered with sand.

MICROMORPHOLOGY: PILEUS: **Pileipellis** interwoven with widely scattered fascicles of ±perpendicular hyphae, fascicles usually composed of 10-25 hyphae; terminal cells of fascicular hyphae 33-64.5 x 8.3-13.8(-16) µm, subclavate to clavate, occasionally broadly clavate, light yellowish brown in mass; walls up to 0.5 µm thick, light yellowish brown; contents hyaline. **Trama** tightly interwoven, undifferentiated, hyaline, light yellowish brown toward cuticle. LAMELLA: **Trama** parallel; hyphae mostly 6.4-14.7 µm diam, thin-walled, hyaline to light yellowish brown; cells long, barrel-shaped. **Subhymenium** undifferentiated. **Basidia** 30-53 x 9.2-12.4 µm, Q = 3.08-4.65, clavate, elongate, hyaline; sterigmata 4, up to 8.2 µm long. **Pleurocystidia** lacking. **Cheilocystidia** not observed. **Basidiospores** (13.8-)14.7-21.6(-36.3) x (5.5-)6-7.8(-8.3) µm ($\bar{x}$ = 18.9 ± 4.0 x 6.8 ± 0.7 µm), Q = 1.99-3.31(-6.05) ($\bar{Q}$ = 2.68 ± 0.7), subfusiform to fusiform-

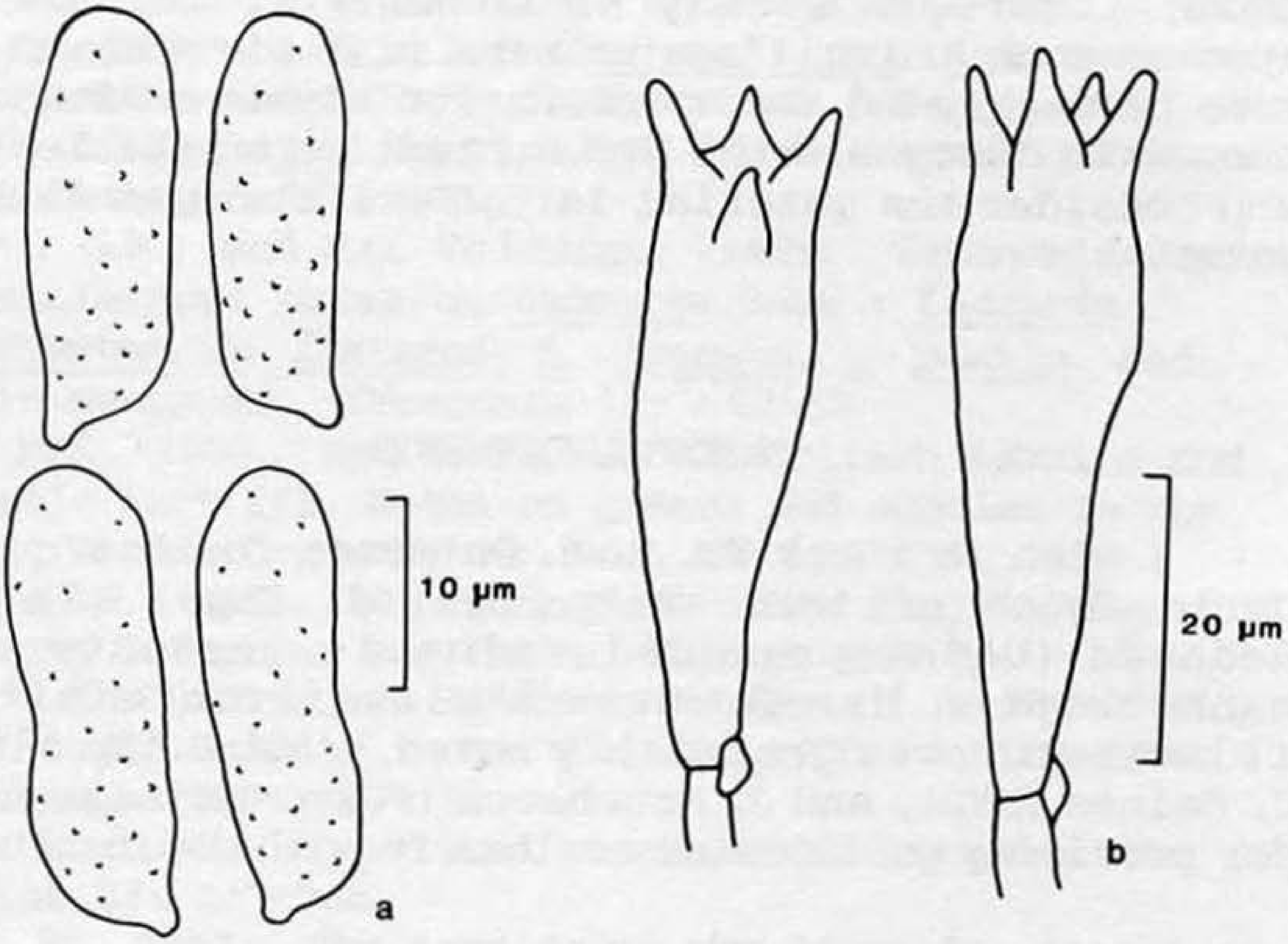

Fig. 3. Laccaria trullissata (Lectotype, Ellis s.n., no date, Newfield, New Jersey). A. Typical subfusiform to fusiform-ellipsoid basidiospores. B. Four-sterigmate basidia.

ellipsoid, hyaline, very finely roughened; hilar appendage 1.3-1.8 µm long, prominent, truncate; contents occasionally uniguttulate, rarely biguttulate. BASAL MYCELIUM: **Hyphae** mostly 2.8-14.7 µm diam, tightly interwoven, hyaline; cells long, undifferentiated to barrel-shaped.

OBSERVATIONS: There is little confusion over the correct name for this species. Ellis (1874) did not designate a type specimen, however, so it was necessary to designate one. Note that the correct spelling for the epithet is "trullissata" not "trullisata."

Two possible sources for a type exist: 1) the collection at NYS labelled COTYPE which included a note in Ellis's handwriting giving collection data and stating that it is a new species and 2) the specimens in Ellis's exsiccata "Fungi of North America." Since the exsiccata was not distributed until 1875-1885 (Stafleu and Cowan, 1976), there is no way of knowing if the included specimens of A. trullissatus were in Ellis's hands at the time he designated the species. For these reasons, I have chosen to designate the NYS collection as the lectotype and consider the material in the exsiccata as authentic material.

ACKNOWLEDGEMENTS

I wish to thank Dr. R. H. Petersen for his quidance during much of this study. Drs. J. Engel (F) and S. Redhead (DAOM) provided valuable comments on the manuscript. Ms. B. Strack's assistance with the illustrations is gratefully noted. Drs. R. Watling (E), J. Haines (NYS), and J. Mouchacca (PC) are kindly thanked for providing collections on loan from their institutions.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 313-326 April-June 1987

A RECLASSIFICATION OF ENTOMOPHTHORA TURBINATA IN THAXTEROSPORIUM GEN. NOV., NEOZYGITACEAE FAM. NOV. (ZYGOMYCETES: ENTOMOPHTHORALES)

ISRAEL S. BEN-ZE'EV, ROBERT G. KENNETH, and AVIVA UZIEL

Department of Plant Pathology and Microbiology, Faculty of Agriculture, The Hebrew University of Jerusalem, P.O.Box 12, Rehovot 76 100, Israel

ABSTRACT

The description of *Entomophthora turbinata* is emended with regard to the number of nuclei in its conidia, conidiophores and hyphal bodies. Its resting spores were found to be binucleate zygospores produced by conjugation of hyphal body pairs. *E. turbinata* nuclei stain with acetoorcein, acetocarmine and bismark brown Y like those of *Neozygites* spp., but differently from entomophthoroid nuclei.

A new family of Entomophthorales is proposed: Neozygitaceae, to include *Neozygites* and a newly proposed genus, *Thaxterosporium*. The family Neozygitaceae is distinguished from the other families of Entomophthorales by its different nuclear structure and behavior of components of its mitotic apparatus during mitosis.

Thaxterosporium, having *T. turbinatum* comb. nov.(=*E.turbinata*) as generic type, is distinguished from the tetranucleate *Neozygites* by having a basic nuclear number (in hyphal bodies, conidiophores and conidia) twice as large or larger, and by lacking the ability to resporulate.

The description of the genus *Neozygites* is emended and a new combination is proposed for one species: *Neozygites lecanii* (=*Triplosporium lecanii*).

KEY WORDS: Entomophthorales families; Neozygitaceae fam. nov.; *Thaxterosporium* gen. nov.; *Thaxterosporium turbinatum* comb. nov. *Neozygites lecanii* comb. nov.

Entomophthora turbinata Kenneth (1977) was first described from infected peach-trunk aphids, *Pterochloroides persicae* Cholodkowski (Lachnidae) in Israel. Its possible identity with a number of unidentified aphidicolous fungal pathogens mentioned in the literature as attacking species of Lachnidae was discussed and its morphology was compared with that of some known entomophthoralean species (Kenneth, 1977).

Remaudière and Keller (1980) transferred *E. turbinata* to the genus *Neozygites* Witlaczil, without giving any taxonomic explanations for their transfer, but apparently on the grounds of close morphological similarity between the resting spores of *E. turbinata* and those of the type species of *Neozygites*, *N. fresenii* (Nowakowski) Remaudière & Keller. However, Ben-Ze'ev and Kenneth (1982 a) argued that the transfer of *E. turbinata* to *Neozygites* was not justified by the extant knowledge of this fungus. They kept *E. turbinata* in a list of *Entomophthora nomina provisoria* (*non Entomophthora sensu stricto*) which was proposed as a repository for entomophthoralean taxa for which characters important at the generic level were lacking or doubtful.

The generic name *Neozygites* was given by Witlaczil (1885) to what he mistakenly considered to be a microsporidian organism. In the Entomophthorales, species belonging to this taxon were first recognized as a subgeneric group: *Empusa* subg. *Triplosporium* Thaxter 1888. Giard (1889) compared Witlaczil's (1885) figures with those of Thaxter (1888) and concluded that at the subgeneric level *Triplosporium* and *Neozygites* are synonymous. Giard's comments remained rather unnoticed by students of the Entomophthorales, and eventually Batko (1964 b) elevated Thaxter's subgenus to generic rank, as *Triplosporium* (Thaxter) Batko. Batko's generic description is the core of the emended descriptions published by Remaudière and Keller (1980) and by Ben-Ze'ev and Kenneth (1982a). A proposal to conserve the generic name *Triplosporium* against *Neozygites* (Humber *et al.*,1981) was voted against and rejected by the Committee for Fungi and Lichens, of the International Committee of Botanical Nomenclature (Korf, 1986).

The diagnosis of *Neozygites* given by Remaudière and Keller (1980) was based mainly on the morphology of primary and secondary conidia, and even as such it did not fit the conidial shapes of two species included by them in this genus: *N. fumosa* (Speare) Remaudière & Keller and *N. turbinata*, both with elongate conidia and non-truncate bases. The emended description of *Neozygites* (as *Triplosporium*) given by Ben-Ze'ev and Kenneth (1982 a) was based on the morphology and nuclear numbers of hyphal bodies, conidiophores, primary and secondary conidia. Characters related to resting spores and their mode of production, as well as to the absence of rhizoids and cystidia were enumerated in both of the abovementioned descriptions. The nuclei of *Neozygites* were mentioned as entomophthoroid by Ben-Ze'ev and Kenneth (1982 a) due to their stainability with acetocarmine and acetoorcein, and the genus was therefore classified in the family Entomophthoraceae.

The aims of this article are to emend the description of *E.turbinata* by adding some recently found characters and to reclassify it, together with the genus *Neozygites*, in a new family of Entomophthorales.

ENTOMOPHTHORA TURBINATA: EMENDED DESCRIPTION

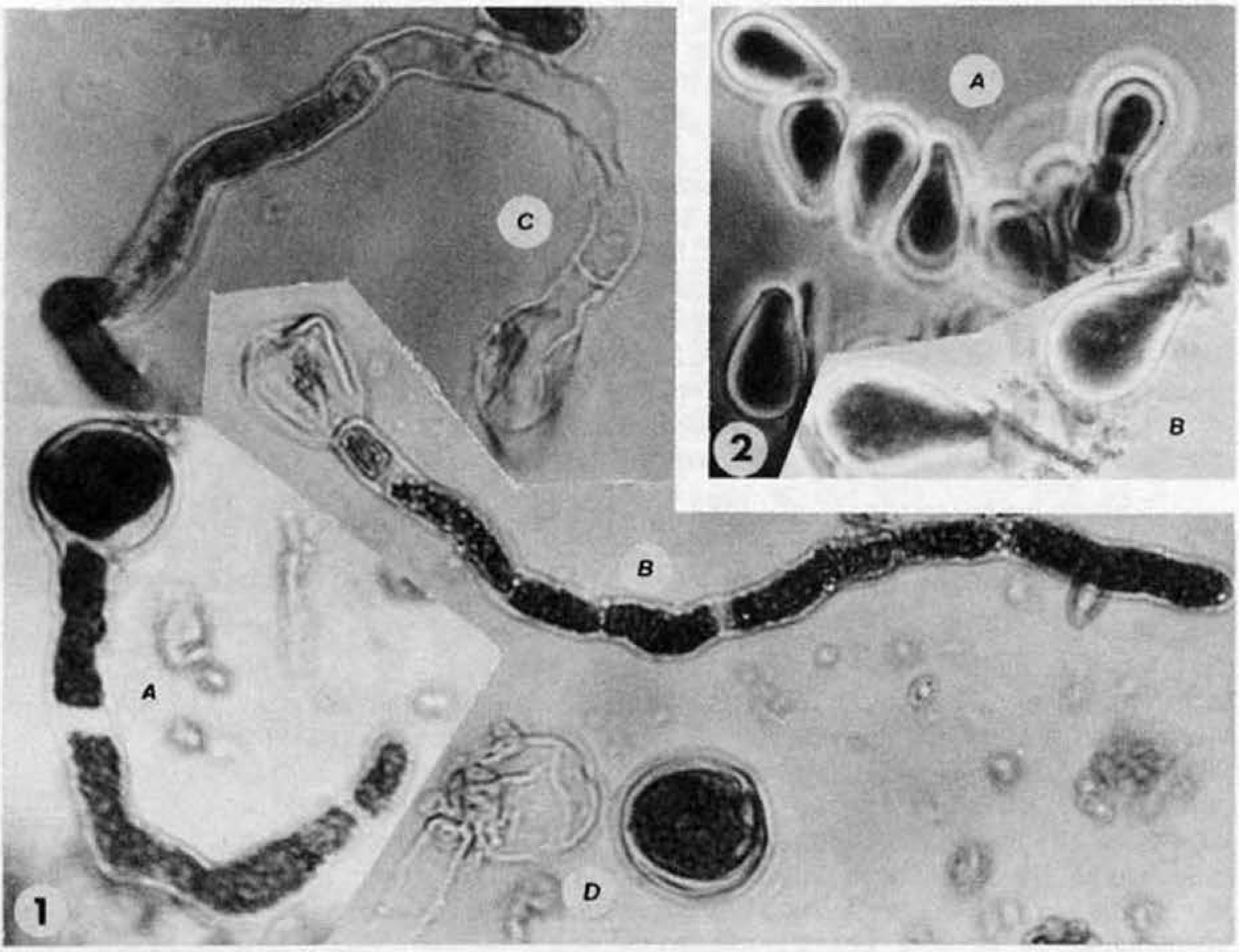
A Japanese-plum tree was found infested with the aphid *Pterochloroides persicae* in late May 1985, in Rehovot, Israel. A few dead, mummified aphids with their rostra still inserted into the bark clung from branches. Aphids freshly killed by mycosis were not found later on, and the population declined rapidly, apparently due to a prolonged period of hot, dry weather. Some of the cadavers contained subspherical and spherical hyphal bodies, along with conidia and conidiophores of *Entomophthora turbinata*, while others contained similar hyphal bodies, some of which were conjugating in pairs, producing zygospores. Within the same aphid the zygospores were at various stages, from very small to almost mature ones, with no conidiophores or conidia present. Several cadavers were filled with black, mature resting spores similar to those described by Kenneth (1977) along with apparently immature, hyaline ones, similar to the largest immature zygospores found in aphids which contained conjugating hyphal bodies. Dead aphids with liquefied abdomens, containing resting spores in a liquid matrix were not found. This symptom, described by Kenneth (1977), is probably a result of high humidity, lacking during May 1985.

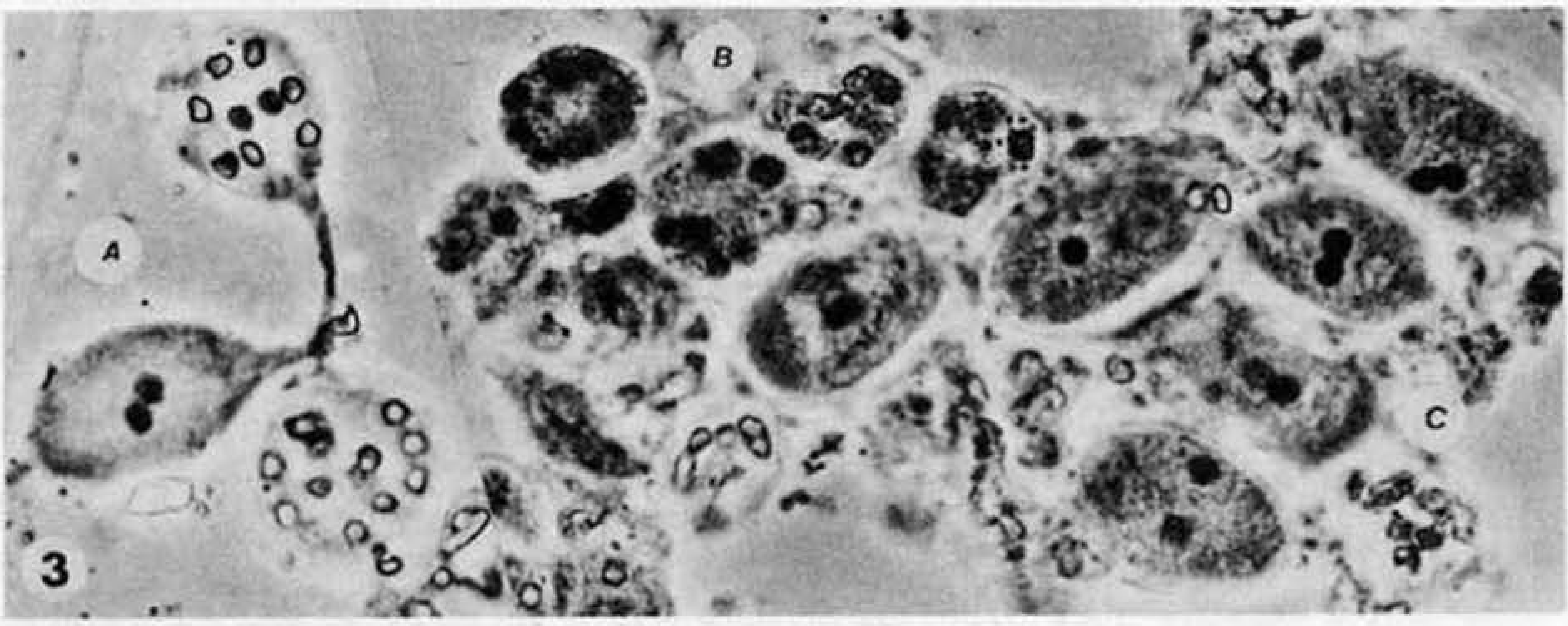
Squash preparations of dead aphids were stained with lactophenol-cotton blue (LPCB), acetocarmine, acetoorcein or bismark brown Y, and the various fungal structures were measured and their nuclei counted.

NUCLEI did not stain with LPCB and stained very faintly or not at all with bismark brown. They stained immediately with acetoorcein, somewhat less well with acetocarmine, and in general less strongly than nuclei of Entomophthoraceae. *E. turbinata* nuclei stained with the abovementioned dyes appeared uniformly red — unlike entomophthoroid nuclei, in which granules and vermiform bands stain red against a translucent, unstained background. In this respect the nuclei of *E. turbinata* had the same appearance as those of *Neozygites fresenii* and *N. floridana* (Weiser & Muma) Remaudière & Keller stained with the same dyes (Ben-Ze'ev and Zelig, unpublished).

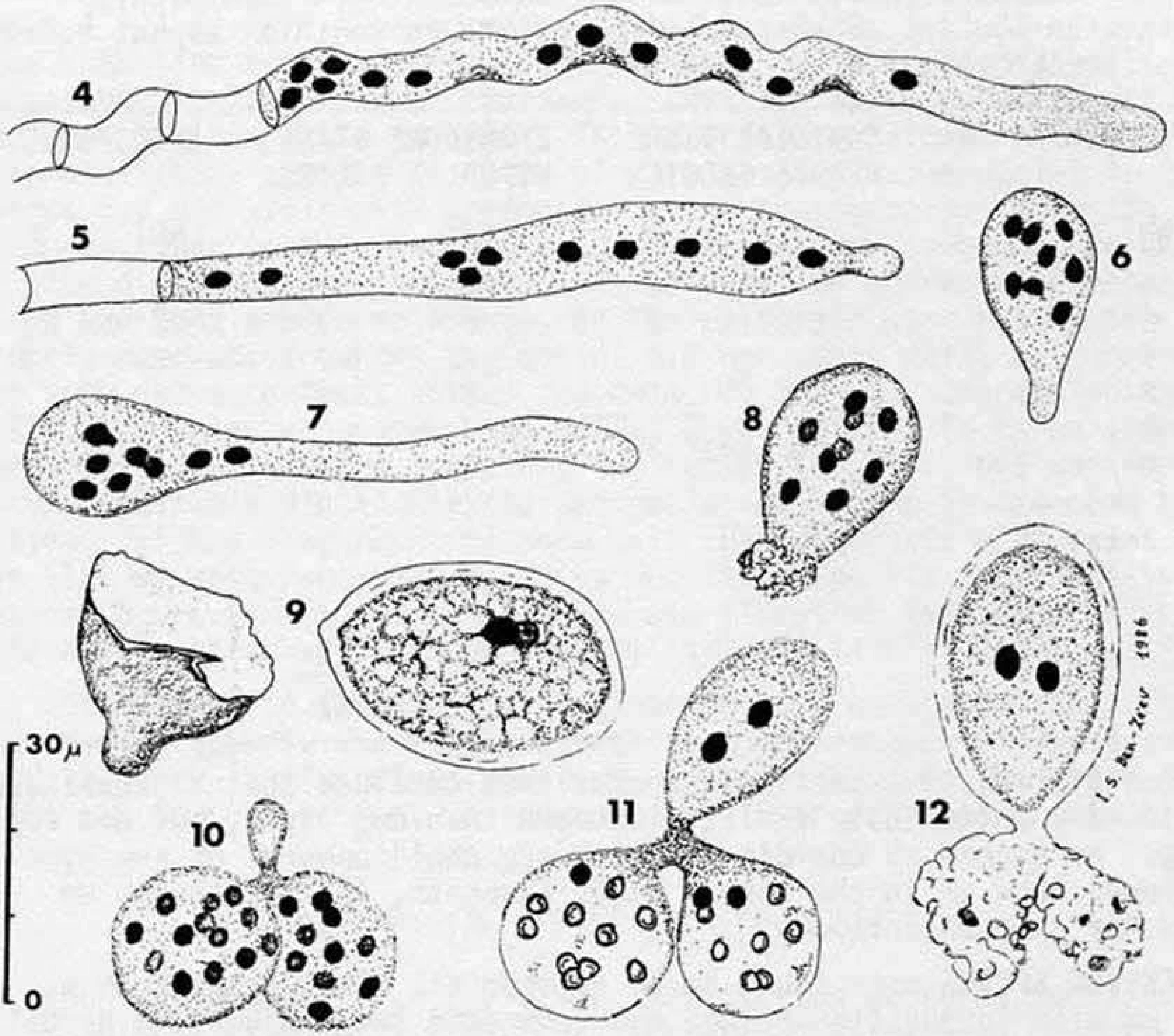
HYPHAL BODIES were subspherical or less frequently spherical in both the conidial (Fig 1) and the resting spore stages (Figs 3b, 10), with reddish cytoplasm when viewed unstained, in lactophenol. They appeared to differ in size, being somewhat larger in the conidial stage, but this was not immediately apparent without measuring, and the difference might prove to be statistically insignificant. Measurement of a statistically adequate sample was impossible due to the scarcity of material and to the large quantities of opaque debris found in aphids stricken by this disease, as already noted by Kenneth (1977). The length x width dimensions of hyphal bodies of the conidial stage were 16.6 - 27.7 x 13.4 - 20.5 µm ($\bar{x}$= 21.1 x 16.7 µm; s= 2.6 x 2.5 µm, n=17). Hyphal bodies in the resting spore stage were 12.6 - 22.1 x 11.9 - 15.8 µm ($\bar{x}$= 16.3 x 13.9 µm; s= 2.8 x 1.7 µm, n= 20). Hyphal bodies in the conidial stage were found with 7 - 9 nuclei while those in the resting spore stage contained (4-)6 - 15 nuclei, most frequently 9 - 11 (Table 1).

CONIDIOPHORES originated each as a hyphal outgrowth from a hyphal body. As the conidiophore elongated, the parent hyphal body became evacuated of cytoplasm and was cut off by a septum from the former. Conidiophores elongated apparently with little increase in their cytoplasmic content, and additional septa were laid down to cut off empty compartments toward the base, while the cytoplasm moved forward (Fig 1). Immature conidiophores, after emerging through the host's integument, comprised an apical cylindrical conidiogenous cell, 6 - 10 µm wide, containing ca. 10 linearly arranged nuclei (Fig 4). A mature conidiophore with an apical conidial bud is a clavate conidiogenous cell at the tip of an empty, multiseptate, unbranched hypha (Fig 5). The





Figs 1-3. *Thaxterosporium turbinatum* (=*Entomophthora turbinata*). 1a, b, and c: Successive stages of conidiophores arising from hyphal bodies (h.b.) — h.b. in 1b and c are already empty of cytoplasm — the basal part of the conidiophore in 1c is already an empty compartment; 1d: conidial-stage h.b. — one full, the other evacuated. 2a: Conidia stained with lactophenol cotton blue; 2b: conidia (at a magnification of ca. x 1000) showing debris attached to their papillae. 3a: Conjugating hyphal bodies and resulting zygospore — the h.b. are almost empty of cytoplasm, and their nuclei (which have not been retouched!) appear different from those in zygospores or in non-conjugating h.b.; 3b: group of h.b. together with group of young zygospores (3c), some with h.b. rem-



Figs 4-12. *Thaxterosporium turbinatum* (=*Entomophthora turbinata*) 4: Young conidiophore with 12-nucleate conidiogenous cell and empty compartments at the base. 5: Mature conidiophore with conidial bud at the apex. 6-7: Conidia with germ tubes growing through their papillae. 8: Conidium of a fungus close to *T. turbinatum*, attacking *Tuberolachnus salignus* in England. 9: Resting spore of the English fungus, beside its broken episporium. 10-12: Successive stages in *T. turbinatum* zygosporogenesis. All figures drawn and brought to the same scale.

hyphal bodies described by Kenneth (1977) were, in fact, immature conidiophores in various stages of development.

CONIDIA were as described by Kenneth (1977), but with 5 - 10 nuclei, usually 7 - 8 nuclei in each (Table 1 and Figs 2, 6, 7). Nuclei in hyphal bodies, conidiophores and conidia measured 2.0 - 2.4 µm in diameter. Many of the conidia observed had germinated, invariably through their papillae, one germ-tube per conidium, and some germ tubes were more than twice as long as the conidia and contained as many as half of the nuclei of their parent conidia (Figs 6, 7). Kenneth (1977) mentioned that "The outer wall of the conidium sometimes was seen to separate from the inner wall along the sides." During the present examination we did not reencounter such wall separation. The "separation" in the former study (Kenneth, 1977) was very likely an obscure optical artifact which appeared when the concave profile of the lower half of

nants still attached.(acetoorcein). All figs except 2b ca. x 650.

Table 1. *Thaxterosporium turbinatum* (=*Entomophthora turbinata*): distribution (n) of nuclear numbers (NN) in conidia, hyphal bodies, and zygospores.

CONIDIA		CONIDIAL STAGE HYPHAL BODIES		ZYGOSPORE STAGE HYPHAL BODIES		ZYGOSPORES	
(NN)	n	(NN)	n	(NN)	n	(NN)	n
5	2	7	2	4	1	1	2
6	6	8	3	6	1	2	64
7	16	9	2	7	7	3	3
8	10			8	4		
9	4	total	7	9	8	total	69
10	2			10	11		
total	40			11	9		
				12	3		
				13	3		
				14	3		
				15	2		
				total	52		

some conidia was in a particular focus. We conclude that *E. turbinata* conidia have unitunicate walls: with more than one layer, but not separating. No secondary conidia or secondary conidiophores of any type were found here or in the former study (Kenneth, 1977) although we looked for them extensively.

RESTING SPORES were found to be zygospores. Each grows from a 1 - 2 µm wide conjugation bridge that connects two conjugating hyphal bodies (Figs 3a, 10, 11). Conjugation bridges were usually very short and were often obscured by the two hyphal bodies and zygospore. Very young zygospores had no nuclei; usually two nuclei were observed in each zygospore that attained at least the size of a hyphal body (Figs 3 a,c,10, 11, 12). Zygospores appeared to have a very thin wall or no wall at all until they reached full size (compare Figs 3a with 3c, and 11 with 12). Parent hyphal bodies evacuated all their cytoplasm, but only one nucleus passed from each into the growing zygospore. After conjugation and zygospore formation the parent hyphal bodies are but empty sacs with degenerating nuclei which appear as empty vesicles with dark membranes (Fig 3a). In fully grown zygospores with thick hyaline walls, there were usually 2 nuclei and rarely 1 or 3 (Table 1); although of apparently recent hyphal body origin, they were slightly larger than in hyphal bodies, 2.4 - 3.2 µm in diameter, and although they appeared to be stained red in lower magnifications, at 40 x 25 (objective x ocular), they appeared blue, while nuclei in hyphal bodies were red at the same magnification (in acetoorcein or acetocarmine) (compare nuclei in Figs 3a, 10 and 11 for size). Mature resting spores with black episporia were exactly as described by Kenneth (1977). Karyogamy within zygospores was not observed.

N. Wilding found in England, in 1976, a fungus attacking aphids, *Tuberolachnus salignus* (Lachnidae), as being very similar to *Entomophthora turbinata* (pers. commun. to R.G.K., 1978) and sent us microscope slides and herbarium material. Conidia measured 17.7 - 24.1 µm in length ($\bar{x}$= 20.9 µm; s= 1.8 µm; n= 30), matching well that of *E. turbinata* conidia. Their width, however, was 12.8 - 19.3 µm ($\bar{x}$= 16.0 µm; s= 1.4 µm; n= 30) which is more than 20% larger than that of *E. turbi-*

nata conidia, and thus the length/width ratio of the English isolate was 1.1 - 1.5; x̄= 1.3 as compared with 1.2 - 1.86; x̄= 1.52 of *E. turbinata*. Resting spores examined and measured in 1978 matched well, in shape and size, those of *E. turbinata*. Resting spore material was stained and examined again in 1985. The material contained resting spores morphologically similar to those of *E. turbinata*. The nuclei in those spores did not stain with acetocarmine and acetoorcein. When the spores were squashed between slide and coverslip they seemed to be empty or with disintegrated contents. Several resting spores were observed which had less opaque episporia, or the episporia were partly or completely removed, in which the nuclei did not stain well, but were visible with phase contrast optics and measured 3.6 µm. One nucleus/spore was observed in two spores, two nuclei were observed in three spores, one spore contained one, possibly two nuclei (Fig 9). One conidium with 7 (possibly 9) faintly stained nuclei was found in the same preparation. It had the brownish-smoky wall characteristic of *E. turbinata* but also of most *Neozygites* species and its shape was intermediate between *E. turbinata* and *N. lageniformis* (Thaxter) Remaudière & Keller, with debris attached to and obscuring its papilla (Fig 8).

With regard to its conidial nuclear number, nuclear stain affinity, and resting spores, the fungus attacking *Tuberolachnus salignus* in England is, very likely, closely allied with *E. turbinata*; however, they might not be conspecific, as indicated by their different conidial widths.

THE FAMILIAL AFFILIATION OF NEOZYGITES

The most prominent criteria for delimitation of three families of Entomophthorales, namely the ultrastructure of interphase nuclei, their stain reactions and mitotic mechanisms and performance, have been stressed, but only sketchily in recent literature (Humber, 1981; 1982; 1984; Ben-Ze'ev and Kenneth, 1982 a). A compilation of ultrastructural studies dealing with Ancylistaceae, Basidiobolaceae, and very recently with Entomophthoraceae reveals the following nuclear characteristics of each familial group:

1. ANCYLISTACEAE: nuclei without condensed chromatin*; nucleoli, 1-2/ nucleus, are persistent and substantially more electron dense than nucleoplasm and stain more deeply during mitosis; there is a pair of spindle-polar-bodies (SPB), each composed of a short cylindrical (or shaped as a shallow cup or saucepan-like) extranuclear component (ENC)** and a saucer-shaped intranuclear component (INC) in which the ends of spindle microtubules seem to be anchored; during mitosis the nuclear membrane remains intact; the metaphase spindle is eccentrically located and occupies only a small part of the total nuclear volume (Moorman, 1976; T.M. Butt and A. Beckett, pers. commun.+ TEM micrographs. Details of nuclear ultrastructure of several members of Ancylistaceae are corroborated by TEM micro-

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* Also referred to as heterochromatin, observable as electron-dense, intermingled bands (in TEM micrographs) or as deeply stained in acetocarmine, acetoorcein, bismark brown Y, and sometimes in lactophenol-cotton blue. Lack of condensed chromatin does not mean that these nuclei are devoid of chromatin.

** Term used in Butt and Beckett (1984 a; 1984 b), also referred to as nucleus associated organelle (NAO) e.g. in Murrin *et al.*(1984).

graphs published in the following articles: *Conidiobolus coronatus* — Garrison *et al.*,1975; *C. apiculatus* — Lambiase and Yendol, 1976; *C. thromboides* — Ohkawa and Aoki, 1980; *C. obscurus* — Latgé *et al.*, 1982; 1986; Brey *et al.*, 1986).

2. BASIDIOBOLACEAE: nuclei without condensed chromatin; nucleolus single, very large, substantially more electron dense than nucleoplasm; the nucleolus disperses during prophase; there is a pair of short, cylindrical, extranuclear SPB; chromosomes become condensed and visible as condensed chromatin at late prometaphase (in both TEM micrographs and in acetocarmine preparations) and disperse again in late anaphase; during metaphase the dispersed nucleolar material becomes again very electron-dense, as two large polar caps in which the spindle microtubules seem to be anchored (as in the INC of Ancylistaceae); each polar cap becomes a daughter nucleolus in telophase; during prometaphase the nuclear membrane breaks down to form vesicles and cisternae around the nucleoplasm — it is fully restored in telophase; the metaphase spindle is barrel-like and occupies the entire nuclear volume (Robinow, 1963; Sun and Bowen, 1972; Gull and Trinci, 1974; McKerracher and Heath, 1985).
3. ENTOMOPHTHORACEAE: nuclei characterized by thick, vermiform bands or aggregates of extensively condensed chromatin during interphase (with certain exceptions) and during all stages of mitosis; nucleoli, 1-2/nucleus, staining less and appearing less electron-dense than those of the other two families, persistent during mitosis; SPBs, where observed, are composed of ENC and INC, of similar type, but larger than in Ancylistaceae, possibly differing in shape among the different genera; the nuclear membrane remains intact during mitosis; the metaphase spindle is eccentrically located and occupies a small part of the nuclear volume (Humber, 1981; 1984; Butt and Beckett, 1984 a; 1984 b; Murrin *et al.*,1984; 1986. Details of nuclear ultrastructure of members of Entomophthoraceae are corroborated by TEM micrographs published or pending publication, e.g. *Erynia neoaphidis* — Kobayashi *et al.*,1984).

Other characters important at the familial level in this order, such as the mode of zygosporogenesis, have been discussed by Humber (1984).

During 1982-1984 it became gradually apparent that the ultrastructure and mitotic behavior of *Neozygites fresenii* nuclear components differs substantially from those of other Entomophthoraceae, and from those of the other two families as well. One important difference claimed was the lack of condensed chromatin in *N. fresenii* nuclei (T.M. Butt, IIIrd Intl. Colloq. Invert. Pathol., Sept. 1982, Brighton, U.K., and study of his electron micrographs; Butt and Beckett, pers. commun. + TEM micrographs, 1983), or as quoted in Murrin *et al.*(1984): [The nucleus of *N. fresenii*] "...does not show features of chromatin or spindle organization typical of other members of the Entomophthoraceae (Butt and Beckett, personal communication)."; and "...condensed chromatin in 'interphase nuclei' absent (Murrin *et al.*,1984, Table 1, quoting Butt and Beckett, pers. comm.).

Careful scrutiny of TEM micrographs of *N. fresenii* nuclei (Fig 13) (and Butt and Beckett's TEM micrographs examined by us) reveals a network of heterochromatic aggregations, substantially less electron-dense and smaller than those in entomophthoroid nuclei, but in contrast to the absence of such aggregations in ancylistoid nuclei. Similar heterochromatic material was demonstrated in *Neozygites acaridis* (Petch) Milner (Milner, 1985, Fig 3). Butt (cited above) regarded his own

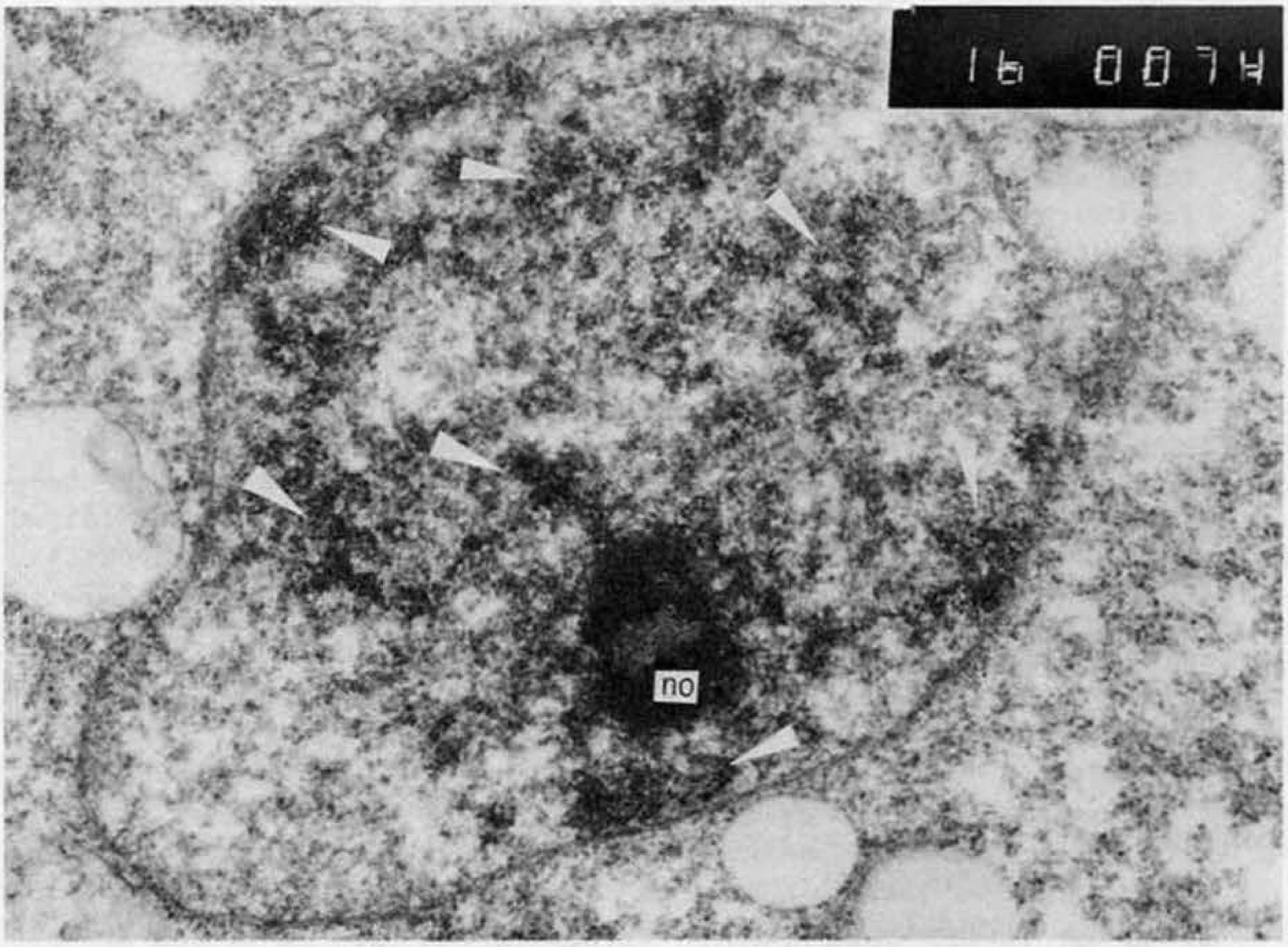

Fig 13. *Neozygites fresenii*: Interphase conidial nucleus with electron-dense nucleolus (no) and aggregations of semi-condensed heterochromatin (arrows). Reproduced from Uziel (1987). x 16000.

findings as lack of condensed chromatin – we hold the view that the moderately electron-dense aggregates in *N. fresenii* and *N. acaridis* nuclei are better defined as semi-condensed chromatin. This is consistent with the somewhat fainter, but nonetheless visible staining of *N. fresenii* and *N. floridana* (Ben-Ze'ev and Zelig, unpublished) and *N. acaridis* (Milner, 1985) nuclei with acetoorcein, acetocarmine, and bismark brown Y. The staining of *E. turbinata* nuclei with those stains, reported here, is similar to that of *Neozygites* species.

Murrin *et al.*(1984) concluded that "...characteristics of chromatin organization and mitotic division at the ultrastructural level in *E.[ntomophaga] aulicae* support the proposal of the Entomophthoraceae being distinct from the Basidiobolaceae and Ancylistaceae". With regard to the recent findings of nuclear characters of *Neozygites fresenii*, they correctly questioned its placement in the Entomophthoraceae. An analysis of the nuclear ultrastructural features of the three families listed above shows that each group differs from the other two in at least two characters, and all groups are interrelated by shared characters. Since these three groups are recognized as families mostly because of their nuclear characters (although other characters are also useful at this level), we conclude that *Neozygites* should be removed from the Entomophthoraceae and deserves its own familial status in the Entomophthorales:

NEOZYGITACEAE Ben-Ze'ev, Kenneth & Uziel, fam. nov. (Zygomycetes)

Familia Entomophthoralium, differens ab Ancylistaceis, Basidiobolaceis, et Entomophthoraceis in nucleorum structura et *functione in mitosi. Nuclei neozygitoidei per "aceto-carmin" et "aceto-orcein" moderate colorantur, sed dilute vel nullo modo per "bismark brown Y". Nucleoplasma observatum per microscopium opticum aequaliter coloratum et sine filamentis crassis heterochromatinis esse videtur. In picturis per microscopium electronicum reticulum subtile chromatini hemicondensati manifestum est. Fusus mitoticus centraliter locatus maximam partem nuclei voluminis occupat.*

TYPUS FAMILIARIS: Neozygites *Witlaczil 1885* [=Triplosporium *(Thaxter 1888) Batko 1964*]

Family of Entomophthorales, differing from Ancylistaceae, Basidiobolaceae, and Entomophthoraceae in nuclear structure and behavior of nuclear components during mitosis. Neozygitoid nuclei stain moderately with acetocarmine and acetoorcein, but faintly or not at all with bismark brown Y. The nucleus viewed with the optical microscope appears to be uniformly stained and devoid of thick heterochromatic threads. In electron microscope photographs a fine network of semi-condensed chromatin is revealed (Fig 13). The mitotic spindle is centrally located and occupies most of the nuclear volume. The nucleolus is single, more or less centrally located, very electron-dense relative to the nucleoplasm; its fate during mitosis is unknown. No SPBs have been observed yet. The nuclear membrane stays intact during mitosis.*

FAMILIAL TYPE: *Neozygites* Witlaczil 1885 [=*Triplosporium* (Thaxter 1888) Batko 1964].

Since our former emendation of *Triplosporium* (Ben-Ze'ev and Kenneth 1982 a), new characters have been discovered, along with some flaws in the older description. Therefore a new emendation is required:

Neozygites Witlaczil 1885, *emend.*, Ben-Ze'ev & Kenneth, *emend. nov.*

MYCELIUM coenocytic, generally composed of tetranucleate, rarely trinucleate or up to hexa-nucleate hyphal bodies: spherical, oval, cylindrical or irregularly shaped.

NUCLEI neozygitoid (as defined in the familial description).

CONIDIOPHORES unicellular, simple, each arising from one hyphal body, and generally with the same number of nuclei.

PRIMARY CONIDIA unitunicate, generally tetranucleate, rarely tri- to penta-nucleate, spherical-truncate or oval-truncate [Truncata-lageniformis, acc. to Lakon's (1919) classification] or elongate: ellipsoid with or without a slight constriction above the papilla.

SECONDARY CONIDIA, if present, are of types Ia or II (capilliconidia), with the same nuclear number as primary ones.

CAPILLICONIDIA are the more usual secondary conidia, almond-shaped, with an adhesive haptor at the apex, through which germination occurs; they are passively detached from a capillary conidiophore.

ACTIVE EJECTION of primary and type I secondary conidia is by some degree of rounding-off (papillar eversion). All types of conidia are usually smoky-colored.

RESTING SPORES, usually covered by a dark-colored episporium, arise either by isogamous conjugation of two hyphal bodies and are binucleate, or by budding from one hyphal body without apparent conjugation (zygospores and azygospores, respectively).

RESTING SPORE GERMINATION, where observed, has been by a capillary

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* Ultrastructural details have been provided by T.M. Butt (pers. commun.) and have been studied by us in TEM micrographs kindly provided by Dr. Butt in 1982 and 1983.

germ-conidiophore upon which a germ-capilliconidium was produced.
PSEUDOCYSTIDIA absent.
RHIZOIDS, absent in all but one species, are simple, without specialized holdfast at the apex, produced singly from hyphal bodies.
OBLIGATE PATHOGENS of arthropods.

A NEW GENUS OF NEOZYGITACEAE: THAXTEROSPORIUM BEN-ZE'EV & KENNETH, GEN. NOV.(ENTOMOPHTHORALES)

Species entomopathogenica. CORPORA HYPHALIA sphaerica vel subsphaerica vel ovoidea, 4-15 nucleata, vulgo 7-11 nucleata. NUCLEI neozygitoidei, comparate mediocres, nucleoplasmate sine filamentis crassis heterochromatinis, cito sed moderate colorati per "acetocarmin" vel "aceto-orcein" sed dilute vel nullo modo per "bismark brown Y". CONIDIOPHORA simplicia, plus minusve cylindrica et apice clavata, unicellularia, plus minusve deca-nucleata. CONIDIA PRIMARIA unitunicata, violenter emissa eversione papillarum basalium, plus minusve 7-8 nucleata, per papillas basales germinantia, sed nullis conidiis secundariis formatis. SPORAE PERDURANTES binucleatae, a ponte coniugali duorum corporum hyphalium coniugatorum portae. Modus germinationis zygosporarum — ignotus. RHIZOIDEA et PSEUDOCYSTIDIA — ignota.

TYPUS GENERIS: Thaxterosporium turbinatum *(Kenneth) Kenneth & Ben-Ze'ev, comb. nov. BASIONYM:* Entomophthora turbinata *Kenneth, Mycotaxon 6:388, figs 1-8, 1977. SYNONYM:* Neozygites turbinata *(Kenneth) Remaudière & Keller, Mycotaxon 11:332, 1980.*

Entomopathogenic species. HYPHAL BODIES spherical, subspherical or ovoid, 4-15 nucleate, usually 7-11 nucleate. NUCLEI neozygitoid, medium-sized (when compared with the usually smaller ancylistoid ones, or with the larger entomophthoroid ones), with nucleoplasm devoid of thick heterochromatic filaments, staining quickly but moderately with acetocarmine and acetoorcein but faintly or not at all with bismark brown. CONIDIOPHORES simple, more or less cylindrical and clavate at the apex, unicellular, ca. ten-nucleate. PRIMARY CONIDIA unitunicate, violently discharged by eversion of basal papillae, more or less 7-8 nucleate, germinating only through the basal papillae but not producing secondary conidia. RESTING SPORES are binucleate zygospores arising from the conjugation bridge of two conjugating hyphal bodies. The mode of zygospore germination is unknown. RHIZOIDS and PSEUDOCYSTIDIA unknown. This genus is named in honor of Professor Roland Thaxter (1858 - 1932) and his contribution to the knowledge of Entomophthorales.

From a strictly phenetic point of view, the resting spores of *Neozygites fresenii* and those of *Thaxterosporium turbinatum* are very much alike, and that was probably what prompted Remaudière and Keller (1980) to transfer *E. turbinata* to *Neozygites*. At that time this was the only character available that could justify such a transfer. The similarity, revealed here, in the mode of zygospore ontogeny, appears to strengthen even more the placement of *E. turbinata* near *N. fresenii* in *Neozygites*. No doubt, these characters, and the similar stain affinity of their nuclei, place them together in the same familial group. One of the strongest generic-level criteria advocated in Batko's (1964 a,b,c) classification, and in neobatkoan classifications of Entomophthorales (Humber, 1981, 1984; Humber and Ben-Ze'ev, 1981; Ben-Ze'ev and Kenneth, 1981; 1982 a,b) and partly in that of Remaudière and Keller (1980) is the number of nuclei in conidia, conidiophores and hyphal bodies.

Every single species of *Neozygites* (=*Triplosporium*) of the eight listed in Ben-Ze'ev and Kenneth (1982 a) is known to have conidia and hyphal bodies containing 4 ± 1 nuclei. The same is true for seven of the eight species listed in *Neozygites* by Remaudière and Keller (1980) — *N. turbinata* is the exception in their list; *Triplosporium lecanii**, also tetranucleate, is missing in their list. The recently discovered *Neozygites acaridis* (Milner, 1985) is also tetranucleate.

Our decision to erect a new genus, *Thaxterosporium*, for *T. turbinatum*, is based on two major characters in which this genus diverges from *Neozygites*:

1. The basic nuclear number of *Thaxterosporium* (in conidia, conidiophores, and hyphal bodies) is, on the average, double or more than that of *Neozygites*. *Neozygites* appears to be, unlike other plurinucleate entomophthoralean genera such as *Entomophthora* Fresenius 1856 *sensu stricto* Batko (1964 a), *sensu stricto, emend.* Remaudière & Keller (1980), *Entomophaga* Batko 1964, and *Massospora* Peck 1879, a genus in which individual species did not diverge from their common ancestor with regard to the basic nuclear number. A strict control over this basic nuclear number seems to have been inherited from that common ancestor and preserved — somewhat like the uninucleate condition in the conidiogenous cells and conidia of *Erynia* Nowakowski 1881 and *Strongwellsea* Batko & Weiser 1965, or even in the mycelial cells of *Basidiobolus* Eidam 1886.
2. *Thaxterosporium* further differs from *Neozygites* in its lack of resporulation. While the presence vs. absence of certain types of secondary conidia is advocated by us (Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1981; 1982 a, b) as a criterion of sub-generic importance — the situation here is different: a total lack of resporulation in *Thaxterosporium*, against two types (I and II, see Ben-Ze'ev and Kenneth, 1982 a), exceptionally one (Milner, 1985), of resporulation in *Neozygites*.

A third character which might be of some importance, although it is difficult to decide at which level, is the germination of *T. turbinatum* conidia exclusively through their papillae, a character which has as yet not been shown to occur in primary conidia of *Neozygites* spp.

With the description of the new genus *Thaxterosporium* and the more comprehensive description of *T. turbinatum*, the way is open to reexamine species that might belong to this genus, such as the one attacking *Tuberolachnus* aphids in England, and isolates reported on Lachnidae elsewhere.

ACNOWLEDGMENTS

We sincerely thank R.P. Korf, R.J. Milner, and F. Murrin for their reviews of the manuscript. We acknowledge the valuable correspondence and personal communications of T.M. Butt and associates, I.B. Heath, R.A. Humber, and F. Murrin. We also thank N. Wilding for personal communications and herbarium material, E.D. Kolman for the preparation of Latin descriptions, and Naomi Bahat for technical help with TEM preparation.

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* *Neozygites lecanii* (Zimmermann) Ben-Ze'ev & Kenneth, comb. nov. Basionym: *Empusa lecanii* Zimmermann, Meded. Lands. Plantent. 44:25-27, 1901. Synonym: *Triplosporium lecanii* (Zimmermann) Ben-Ze'ev & Kenneth, Mycotaxon 14:436, 1982.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 327-360 April-June 1987

Studies on Ectomycorrhizae IX*

Mycorrhizae Formed by Tricholoma sulfureum and T. vaccinum on Spruce

R. AGERER

Institute for Systematic Botany University of Munich
D-8000 Munich
Menzingerstraße 67
FRG

Summary: The mycorrhizae of Tricholoma sulfureum and T. vaccinum on spruce are comprehensively described. These species differ in many anatomical, morphological and chemical features and in autofluorescence. There seem to be more mycorrhizal similarities of T. sulfureum with Dermocybe cinnamomea than with T. vaccinum. The literature on anatomical and morphological features of Tricholoma mycorrhizae is reviewed. A key is also given for all ectomycorrhizae characterized up to now in this series.

Zusammenfassung: Die Mykorrhizen von Tricholoma sulfureum und Tricholoma vaccinum werden ausführlich beschrieben. Diese beiden Arten unterscheiden sich hinsichtlich anatomischer, morphologischer und chemischer Merkmale und in ihrer Autofluoreszenz. Zwischen den Mykorrhizen von T. sulfureum und Dermocybe cinnamomea scheinen mehr Ähnlichkeiten zu bestehen als zwischen jenen von T. sulfureum und T. vaccinum.

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*) Studies on Ectomycorrhizae VIII: BRAND & AGERER (1986)

Alle in der Literatur besprochenen Mykorrhizen von *Tricholoma* Arten sind vergleichend zusammengestellt. Für alle bisher in dieser Serie beschriebenen Mykorrhizen wird ein Bestimmungschlüssel angeführt.

Key Words:
ectomycorrhizae-characterization, -identification, -anatomy, -morphology, -surface view, -longitudinal section, -cross-section, inner surface of mantle, chemical reaction, autofluorescence, nucleus, siderophilous granulation, emanating hyphae, rhizomorph, *Picea abies, Tricholoma sulfureum, T. vaccinum,* key.

In this series on anatomical and morphological studies of ectomycorrhizae, we construct and expand a key in which all mycorrhizae described in this series are included. In the future it should be possible to determine increasing numbers of the ectomycorrhizae found in natural soil from the most recent key of this series, which will include identified ectomycorrhizae as well as those formed with unknown fungi. Most of these mycorrhizae will be pictured in the COLOUR ATLAS OF ECTOMYCORRHIZAE (Einhorn-Verlag, Schwäbisch Gmünd, FRG).

I. MATERIAL AND METHODS

The methods for studying ectomycorrhizae anatomically and morphologically in this series are discussed extensively in AGERER (1986) with additional remarks in BRAND & AGERER (1986) and AGERER (1987). The value of the features used is discussed in detail in AGERER (1986a) and AGERER et al.(1986).

Some additional characters are introduced in this paper: first, the average tangential length of tannin and cortical cells, and secondly, the ratio between their tangential length and radial width. This is done for cross-sections as well as for longitudinal sections. The values are based upon 20 up to 50 and more measurements. Average length and ratio between length and width have been already successfully used for characterizing spores of fungi (e. g. AGERER 1983). These values are probably more appropriate for characterizing the cells than is their range of dimensions. GODBOUT & FORTIN (1985) used such ratios, too, for characterizing the proportions of the outer cortical cells (the so-called elongation-ratio) of synthesized aspen mycorrhizae. The average tangential length of tannin cells will be abbreviated in this study by TC t (CC t: average tangential length of cortical cells), the average ratio between tangential length and radial width by TC q (CC q: average ratio between tangential length and radial width of cortical cells); only cortical cells surrounded by the Hartig net on three or more sides have been measured.

II. KEY FOR THE MYCORRHIZAE DESCRIBED SO FAR IN THIS SERIES

1 Mycorrhizae of Fagus sylvatica
  2 Mycorrhizal mantle plectenchymatous throughout, laticiferous hyphae lacking; young mycorrhizae with bright blue-violet tips
    Laccaria amethystina (s. BRAND & AGERER 1986)
  2 Mycorrhizal mantle with distinct layers: outer layer pseudoparenchymatous, inner layers plectenchymatous; with laticiferous hyphae; young mycorrhizae without bright blue-violet tips
    3 Mycorrhizal mantle in surface view with epidermis-like cells; cell walls very thick and colourless
      Lactarius vellereus (s. BRAND & AGERER 1986)
    3 Mycorrhizal mantle in surface view with angular cells; cell walls only slightly thick, orange-brown
      Lactarius subdulcis (s. BRAND & AGERER 1986)

1 Mycorrhizae of Picea abies
  4 Mycorrhizae smooth, somewhat hairy only as seen under a dissecting microscope; rhizomorphs lacking or with rhizomorphs possessing distinct margins
    5 Mycorrhizae lacking rhizomorphs; mantle hyphae strongly gelatinous; hyphae of Hartig net in several rows; outer cortical cells with conspicuous intracellular hyphae "Piceirhiza gelatinosa"** (s. GRONBACH & AGERER 1986)
    5 Mycorrhizae with rhizomorphs; mantle hyphae not strongly gelatinous; hyphae of Hartig net more or less in one row; outer cortical cells conspicuous intracellular hyphae lacking
      6 Mantle of mycorrhizae with laticiferous hyphae
        7 Surface of mantle with normal hyphae running more or less parallel to the surface of the mycorrhizae Lactarius deterrimus (s. AGERER 1986a)
        7 Surface of mantle with short, obtuse hyphal ends protruding more or less perpendicularly to the surface of mantle Lactarius picinus (s. AGERER 1986a)

**) With such binomials we try to name yet unidentified mycorrhizae unequivocally and thus intend to avoid confusing designations by letters, numbers or other symbols. The names are always accompanied with detailed descriptions and citations of reference specimens. But we do not have the intention to designate mycorrhizae in the sense of the "Botanical Code of Nomenclature", as it is usual for species of fungi, lichens or plants. Such names for ectomycorrhizae should only help to facilitate the international communication, and they should make it possible to speak about one and the same mycorrhiza. We do this with full agreement by Dr. Jim Trappe, Corvallis.

6 Mantle of mycorrhizae lacking laticiferous hyphae

8 Surface of mantle pseudoparenchymatous, the cells angular

Russula ochroleuca (s. AGERER 1986a)

8 Surface of mantle a network of hyphae

Russula xerampelina (s. AGERER 1986a)

4 Mycorrhizae conspicuously hairy, furnished with many hyphae; hyphae partly densely interconnected to hyphal strands (rhizomorphs)

9 Rhizomorphs of mycorrhizae lacking epimembranaceous pigment

10 Mycorrhizae greenish yellow; some hyphae of mantle surface with brown contents that turn distinctly dark brown in Melzer's reagent

Dermocybe cinnamomea (s. AGERER 1987)

10 Mycorrhizae slightly red or brownish-red; mantle lacking hyphae with brown contents that turn distinctly dark brown in Melzer's reagent

Dermocybe sanguinea (s. AGERER 1987)

9 Rhizomorphs of mycorrhizae with epimembranaceous pigment

11 Emanating hyphae and hyphae of rhizomorphs with abundant "contact-septae"; lacking "contact-clamps"; rhizomorph hyphae of uniform diameter

Tricholoma sulfureum

11 Emanating hyphae mostly lacking "contact-septae", and lacking "contact-clamps"; rhizomorph hyphae varying markedly in diameter.

Tricholoma vaccinum

III. DESCRIPTION OF THE MYCORRHIZAE

1. Tricholoma sulfureum (Bull.: Fr.) Kummer

Fig. 1,2, Pl. 1, 2.

MORPHOLOGICAL CHARACTERS

Mode of ramification: monopodial, sometimes infrequently ramified; length of unramified ends: up to 0.2 mm; diameter of unramified ends: up to 0.3 (0.33) mm; shape of unramified ends: straight; structure of surface: matted and stringy, with fan-like rhizomorphs, rhizomorphs sometimes yellow. Colour of unramified ends: white; colour of tips: white; colour of older parts: brownish to shiny dark brown.

ANATOMICAL CHARACTERS OF SURFACE

OUTER SURFACE OF MANTLE
Structure: plectenchymatous, intermingled with short, cylindrical, sometimes distorted end-cells; diameter of hyphal cells: 3 - 4 (5) µm; thickness of cell walls: up to 0.5 µm; surface at the very tip: plectenchymatous, hyphae often slightly and rapidly collapsing, 2 - 3.5 µm in diam.
RHIZOMORPHS
Shape in cross-section: more or less flat; arrangement and diameter of hyphae: loosely woven, all of nearly the same diameter, without thicker central hyphae, (2.5) 3 - 4 (5.5) µm; thickness of cell walls: up to 0.5 µm; colour of hyphae: pigment epimembranaceous and hyphae slightly

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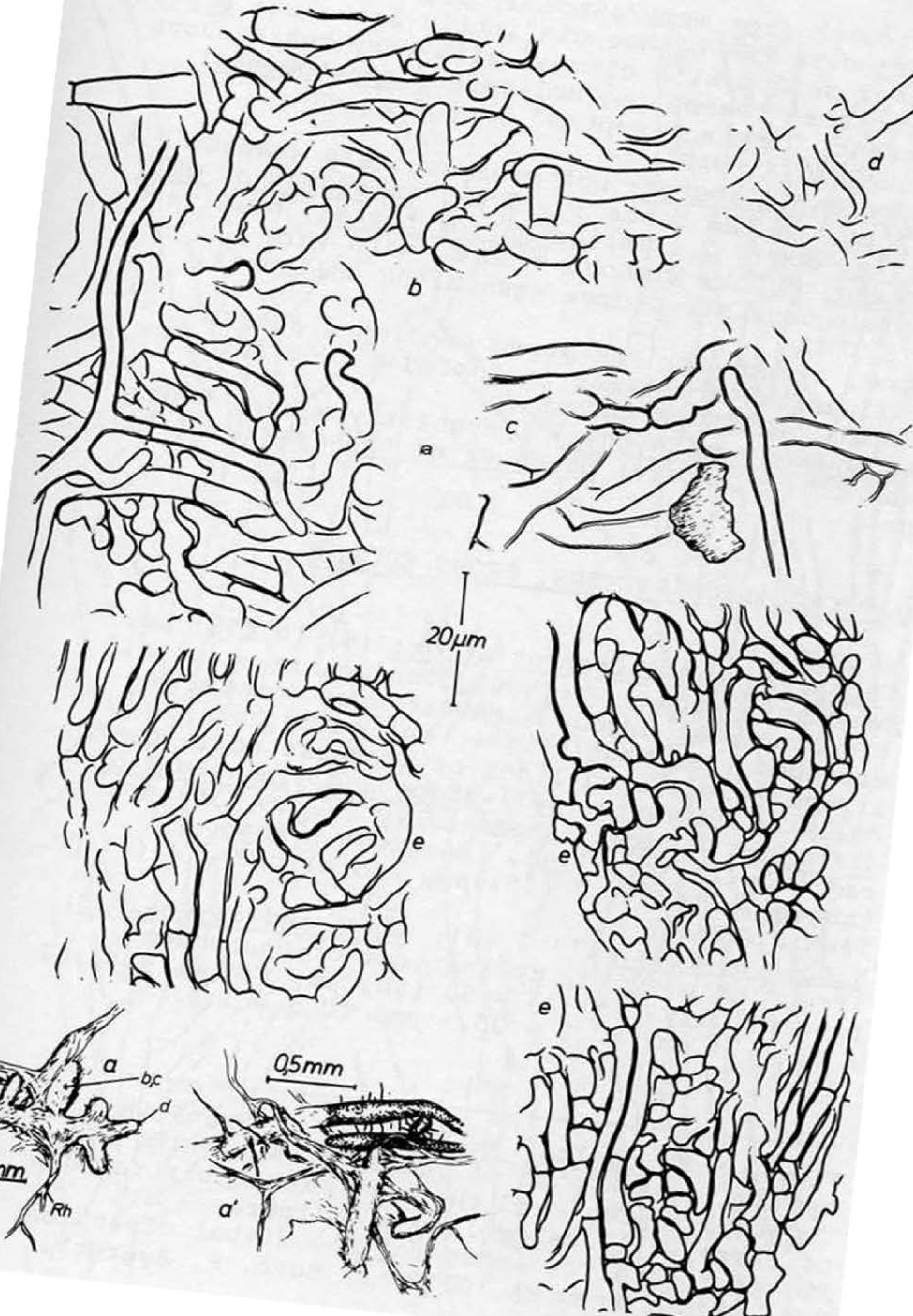
Fig. 1 - Tricholoma sulfureum - a, a': Habit of mycorrhizae. - b: Surface view of mantle. - c: Some short emanating hyphae. - d: Surface view of very tip. - e: Different views of inner surface of mantle. (All figs. from RA 10712, in Herb. R. Agerer).


b
d
c
a
20µm
e
e
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a
b,c
d
mm
Rh
0,5mm
a'

yellowish from membranaceous pigment; after storage in FAA hyphae distinctly brownish; septae: rather seldom with clamps, with very conspicuous structures resembling dolipores; anastomoses: present, "contact-septae" very frequent.

EMANATING HYPHAE

Shape and diameter: not conspicuously shaped, 3.5 - 5 µm, on the basis 5 - 7 µm; thickness of cell walls: about 0.3 µm; colour of hyphae: hyaline; septae: mostly without clamps, with very conspicuous structures resembling dolipores.

CYSTIDIA

None, except for the above mentioned short, cylindrical sometimes distorted end-cells.

INNER SURFACE OF MANTLE

Arrangement of hyphae: irregularly woven, hyphae short to elongate; diameter of hyphae: 2 - 3 (4) µm.

ANATOMICAL CHARACTERS, CROSS-SECTION

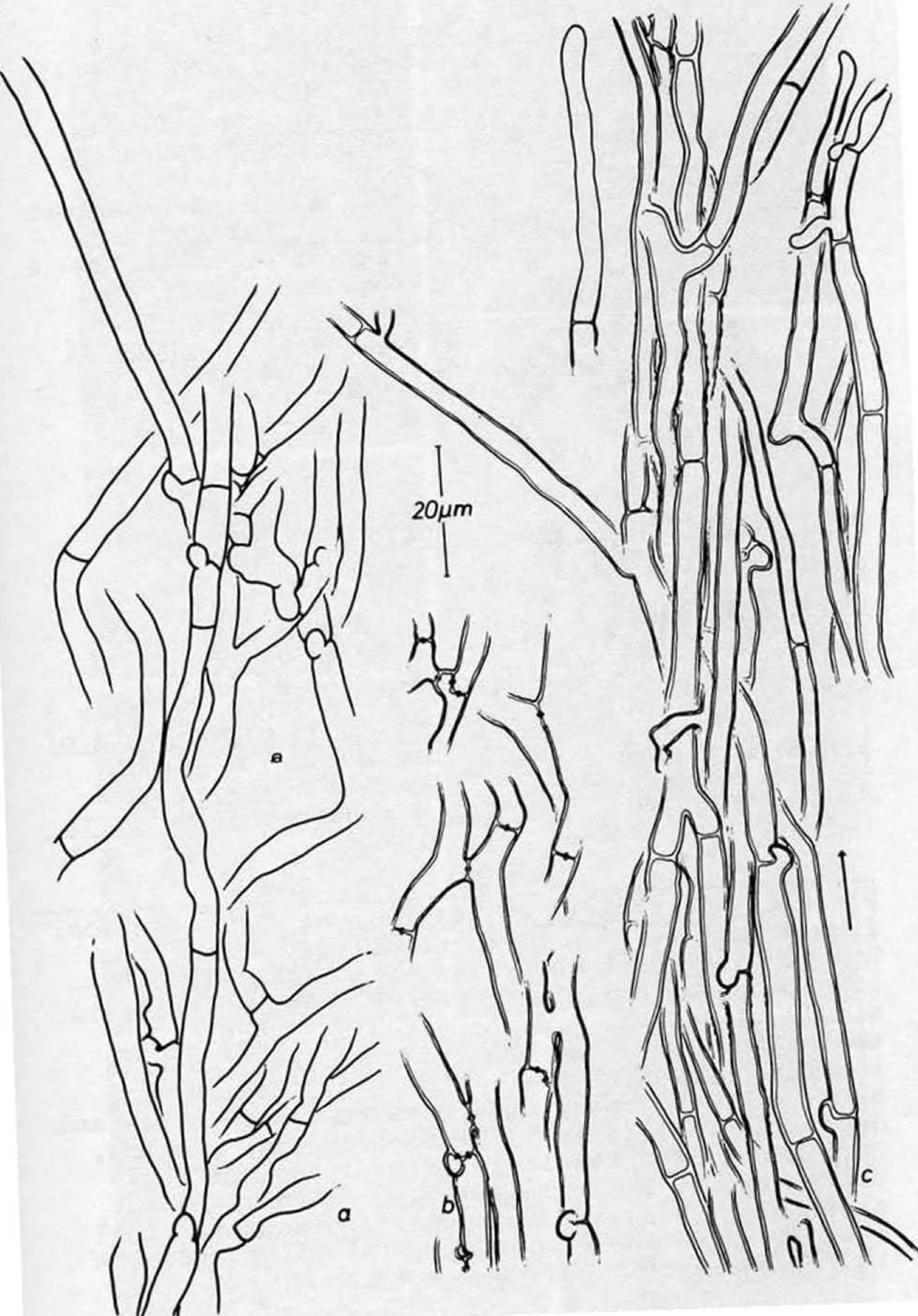
MANTLE

Thickness and differentiation: (5) 10 (15) µm, plectenchymatous, without distinct layers, only the innermost hyphae somewhat more compactly arranged, the mantle often enclosing thin, irregularly shaped lines of probably collapsed cells of calyptra; cell-shape and dimensions of different layers: tangentially 3 - 15 (30) µm, radially 2 - 4 (5) µm, innermost hyphae tangentially 3 - 7 (15) µm, radially 2 - 4 (5) µm.

TANNIN CELLS

Number of rows: (1) 2 (3); shape and dimensions: irregularly ovoid, cylindrical or clupshaped, tangentially (15) 25 - 50 (60) µm, radially (4) 7 - 15 (17) µm, TC t = 35.4 µm, TC q = 3.8.

Fig. 2 - Tricholoma sulfureum - a: Emanating hyphae. - b: Hyphae of rhizomorphs showing the "contact-septae" and the very distinct structure of cross wall, resembling a dolipore. - c: Rhizomorph; arrow indicates the distal direction. (All. figs. from RA 10712, in Herb. R. Agerer).


20µm
a
a
b
c

HARTIG NET

Shape and dimensions of cortical cells: more or less tangentially oval, tangentially (15) 20 - 35 (45) µm, radially (10) 15 - 25 (30) µm, CC t = 29.4 um, CC q = 1.5; depth of H'net: 4 - 5 cell rows, inclusive of tannin cells, often including outer cell walls of endodermis, but always including radial (= anticlinal) walls of innermost cortical cells; thickness of H'net: around and between tannin cells 4 - 6 (8) µm, otherwise 2 - 4 um, remaining walls of cortical cells very conspicuous, number of hyphal rows of H'net: around tannin cells 2 - 3, otherwise 1; shape of H'net cells in section: around tannin cells irregularly thickset and oval or elongate, otherwise round or elongate, in surface view: lobes relatively broad.

ANATOMICAL CHARACTERS, LONGITUDINAL SECTION

MANTLE

Shape and dimensions of the hyphae at the very tip: mantle lacking distinct layers, relatively densely plectenchymatous, up to 25 µm thick, hyphae tangentially (3) 5 - 12 (20) µm, radially 3 - 4 (7) µm; differentiation through older parts of the mantle: plectenchymatous, without distinct layers, hyphae next to root cells somewhat more densly arranged; shape and dimensions of cells in

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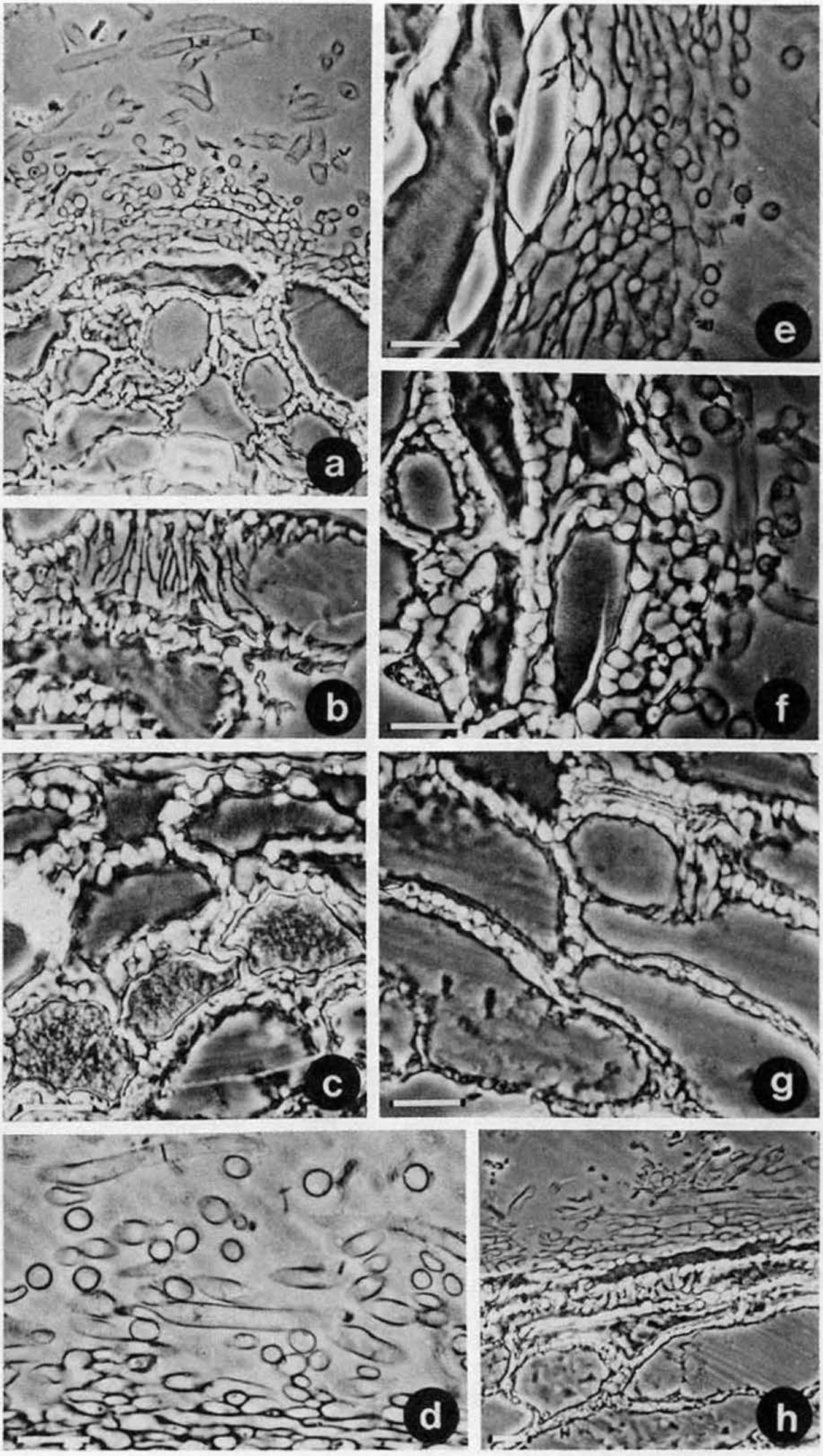
Plate 1 - Tricholoma sulfureum - a: Cross-section, from emanating hyphae to endodermis. - b: Longitudinal section, plain view of Hartig net. - c: Cross-section, Hartig net from tannin cells to middle of cortex. - d: Longitudinal section, emanating hyphae and mantle. - e: Longitudinal section through the very tip. - f. Longitudinal section, from emanating hyphae to tannin cells and outer cortical cells. - g: Longitudinal section, Hartig net from tannin cells to inner cortical cells next to the endodermis. - h: Longitudinal section, from emanating hyphae to inner cortical cells next to the endodermis. (All figs. from RA 10712, phase contrast, bar = 12.5 µm).


a
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different layers: tangentially (3) 10 - 30 (50) µm, radially 3 - 4 µm, innermost hyphae tangentially (5) 10 - 20 (30) µm, radially (2.5) 3 - 4 (5) µm.

TANNIN CELLS

Shape and dimensions: irregularly oval or cylindrical, oriented in an oblique way, sometimes almost parallel, tangentially (18) 30 - 80 (105) µm, radially (4) 6 - 14 (17) µm, TC t = 56.5 µm, TC q = 6.7.

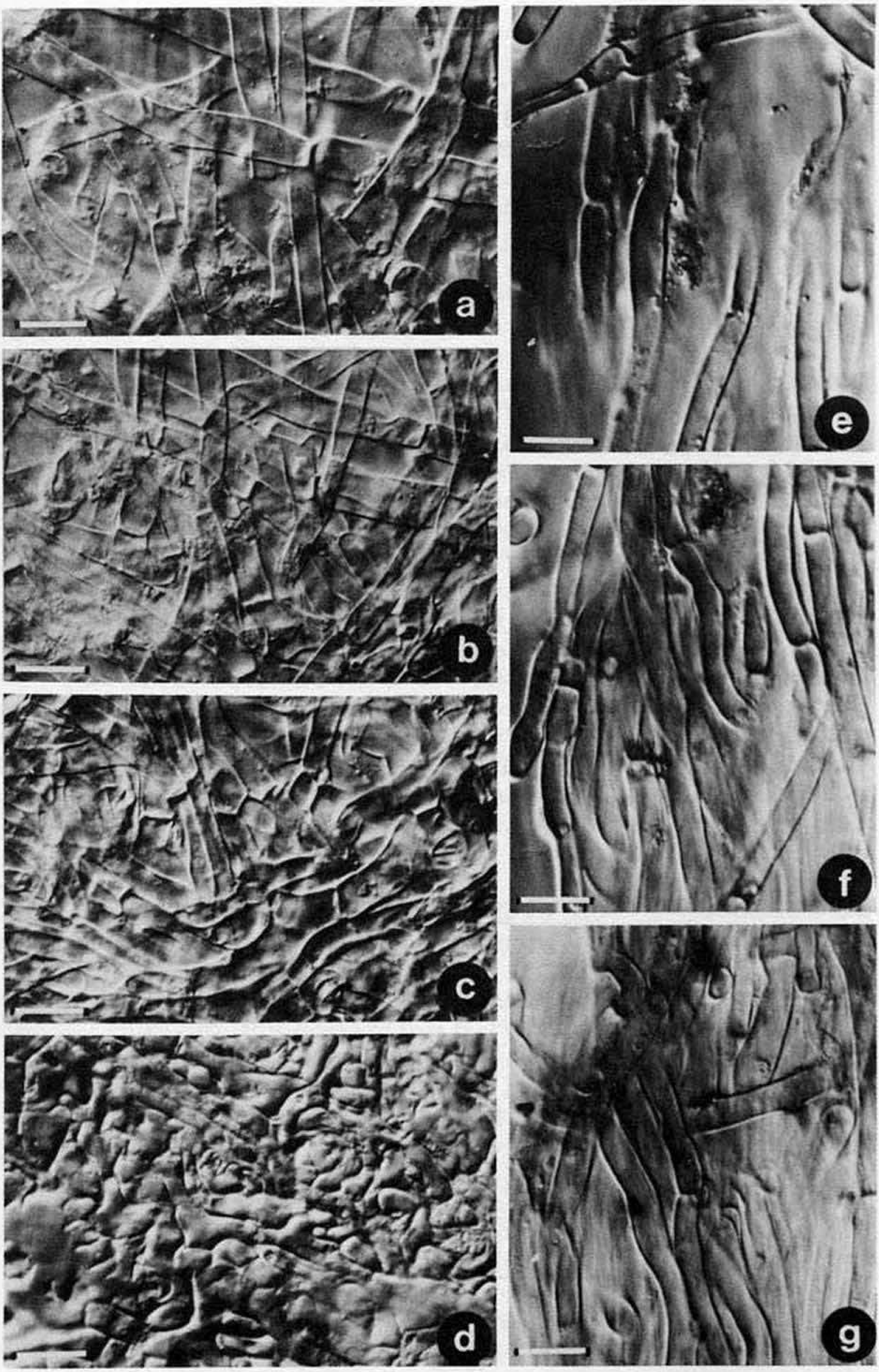
HARTIG NET

Shape and dimensions of cortical cells: irregularly oval, cylindical or rhombic, oriented in a slightly oblique way, tangentially (20) 35 - 90 (102) µm, radially (8) 12 - 25 (32) µm, CC t = 62.2 µm, CC q = 3.1

COLOUR REACTION IN DIFFERENT REAGENTS

Acetic-Fuchsin: --- ; a-Naphtol: --- ; Ammonium-Hydroxide: --- ; Brilliant-Kresyl-Blue: bright-blue, after treatment with water partially violet-blue; Chlorazol-Black E: greyish blue; Cotton-Blue: hyphal walls slightly blue; Erythrosin: slightly pinkish; Fast-Green: green; Formol: ? ; Guaiac: --- ; Iron-Sulfate: --- ; KOH 15%: --- ; Kongo-Red: salmon-red; Magnesium-Acetate: --- ; Malachit-Green: green; Martius-Yellow: --- ; Melzer's Reagent: --- ; Phenol: --- ; Phenol-Anilin: --- ; Phloxin B: slightly pinkish; Stahl's EP-Reagent: --- ; Sulfo-Vanillin: --- ; Toluidin-Blue: violet-blue.

Plate 2 - Tricholoma sulfureum - a - d: Different plain views of mycorrhizal mantle, always from the same position. - a: Surface view of mantle, b: plain view ca. 5 µm deeper, c: plain view ca. 5 µm deeper again, d: plain view of the innermost layer of hyphal mantle, again ca. 5 µm deeper. - e - g: Different plain views of rhizomorph, always from the same position. - e: Surface view of rhizomorph, f: plain view ca. 10 µm deeper, g: plain view of the middle of the rhizomorph, again ca. 10 µm deeper. (All. figs. from RA 10712, Normarski Interference Contrast, bar = 10 µm).


a
b
c
d
e
f
g

AUTOFLUORESCENCE

WHOLE MYKORRHIZA
UV 254 nm: --- ; UV 366 nm: --- .
MANTLE AND RHIZOMORPHS
UV-filter 340 - 380 nm: distinctly greenish yellow (in lactic acid); Blue-filter 450 - 490 nm: distinctly yellow (in lactic acid).

STAINING OF NUCLEI

Mostly one nuclear pair per cell, regardless whether cells possess clamps or simple septae. Paired nuclei lying mostly close together. Proliferation of number of nuclei not seen (method: aceto-carmine). Occasionally hyphae possess dense siderophilous granulations.

MATERIAL STUDIED AND METHOD OF IDENTIFICATION

Deutschland, Bayern, München-Allach, Allacher Forst bei Karlsfeld (MTU), 23. 9. 1984; with Picea abies; reference specimen of mycorrhiza and fruitbody RA 10712 in herb. R. Agerer, M. Some rhizomorphic connections occurred between base of the fruitbody and mycorrhizae.

COMPARISON OF THE MYCORRHIZAE OF TRICHOLOMA SULFUREUM WITH THOSE OF T. VACCINUM.

(1) Morphological characteristics

The only morpholgical difference between these two species seems to be the greater diameter of the mycorrhizae in T. vaccinum. While the diameter of the mycorrhizae of T. sulfureum reaches up to 0.3 (0.33) mm, the mycorrhizae of T. vaccinum, in contrast bear tips up to 0.46 (0.59) mm. The colour of rhizomorphs is also different: white and sometimes yellow in T. sulfureum, white and sometimes brownish in T.vaccinum.

(2) Anatomical characteristics

The surface of the mycorrhizae of T. sulfureum in contrast to that of T. vaccinum , bears intermingled short, cylindrical cells. All fungal cells of the mycorrhizae of T. sulfureum - except those of the very tip of the mycorrhizae - possess somewhat thicker cell walls than is the case in T. vaccinum. On the other hand, the hyphae of the mycorrhizal surface as well as the emanating hyphae and the hyphae of the rhizomorphs are thicker in T. vaccinum than in T. sulfureum. One highly diagnostic difference between these two mycorrhizae relates to the rhizomorphs. While the rhizomorphs of T. sulfureum are composed of similarly shaped hyphae, those of T. vaccinum are well differentiated, outer hyphae being thinner and centrally arranged ones thicker. Regarding the types of connections between the hyphae and the hyphal cells, additional differences are obvious. A high percentage of the rhizomorphic hyphae of T. sulfureum are interconnected by "contact-septae"(which are fully developed simple septae, presumably possessing dolipores), which seem to have only the function of connecting the hyphae without making true anastomoses. Therefore it is evident that no efficient pathways across the different hyphae are formed. Such connections, however, have the advantage that in case of cells being ruptured, little cell plasma is lost. The septum may act then as a barrier. And at least in one of the connected hyphae the plasmatic continuity for the transport of water and nutrients is retained. Similar structures occur on the already characterized mycorrhizae of Dermocybe cinnamomea and D. sanguinea (AGERER 1987, see also below). The cells of the hyphae of T. vaccinum are more frequently connected by clamps, whereas in T. sulfureum clampless septae occur more often.

The main direction of mantle hyphae seems to differ between the two species. This is evidenced by the different length of hyphal cells in longitudinal sections: In T. sulfureum mainly 10 - 30 µm, whereas in T. vaccinum only 3 - 7 µm.

The tannin cells also show some differences between these two species. T. vaccinum mycorrhizae have only 1 or sometimes 2 rows , T. sulfureum has mostly two but sometimes 3 rows. The "TC q" is also different: the tannin cells seem to be more thickset at least in cross-sections in T.

sulfureum (3.8) than in T. vaccinum (5.7). And in T. sulfureum the Hartig net grows deeper towards the endodermis than it does in T. vaccinum. Some additional differences regard the Hartig net: it is composed of 2 - 3 neighbouring hyphal cells in T. sulfureum - at least around the tannin cells - whereas in T. vaccinum it mostly has only one; the cortical cells in T. sulfureum have in cross-section a ratio of 1.5 (3.1 in longitudinal section), but in T. vaccinum 1.1 (8 in longitudinal section).

One of the more interesting features of T. vaccinum is the special appearance of the Hartig net, tannin cells and cortical cells where the rhizomorphs are connected with the mantle. There, the Hartig net grows more deeply towards the endodermis, is composed of more hyphal rows, and has more tannin cells, which lie more closely to the endodermis. Consequently, fewer cortical cells are present in this position. At these junctions the rootlets and the rhizomorphs are apparently in closer contact than elsewhere.

(3) Chemical characteristics

The only striking difference is caused by Guaiac. The mycorrhizal mantle and the rhizomorphs of Tricholoma vaccinum turn slightly greyish blue and after treatment with water green. Testing Guaiac on the fruitbodies of T. sulfureum and T. vaccinum MEIXNER (1975) did not produce any colour changes, whereas other species of Tricholoma subg. Tricholoma sect. Genuina (in which T. vaccinum belongs) turned blue or greenish, viz.: Tricholoma focale and T. aurantium. The same is the case with some species of Tricholoma subg. Tricholoma sect. Tricholoma and Tricholoma subg. Pardinicutis and subg. Contextocutis. No such colour changes, however, could be found by MEIXNER (1975) with Guaiac in Tricholoma subg. Sericeicutis (in which T. sulfureum belongs).

The mycorrhizal mantle of T. sulfureum and T. vaccinum differs slightly in the tints of their reddish colour, if erythrosin and kongo-red are used.

(4) Autofluorescence

Fragments of mantle and rhizomorphs observed through UV filter are distinctly greenish yellow in T. sulfureum and greenish blue in T. vaccinum. Use of a blue filter produced a similar picture but not equally distinct reaction.

(5) Nuclei

These two species are similar in arrangement and occurrence of nuclei and in siderophilous granulation.

T. sulfureum and T. vaccinum mycorrhizae differ in many ways, but at present the two are compared on the basis of a single specimen of each only. Further studies are urgently needed to verify the differences. The highly diagnostic features such as the anatomy of mantle and rhizomorphs, however, will distinguish these two species with certainty.

MYCORRHIZAE OF TRICHOLOMA SULFUREUM AS TREATED IN THE LITERATURE

No anatomical and morphological studies of the mycorrhizae of T. sulfureum or other members of Tricholoma subg. Sericeicutis have been published.

2. Tricholoma vaccinum (Pers.: Fr.) Kummer

Fig. 3,4, Pl. 3, 4.

MORPHOLOGICAL CHARACTERS

Mode of ramification: monopodial; length of unramified ends: up to 3.3 (3.9) mm; diameter of unramified ends: 0.39 - 0.46 (0.59) mm; shape of unramified ends: straight or occasionally slightly twisted; structure of surface: matted and stringy with fan-like rhizomorphs, some rhizomorphs brownish. Colour of unramified ends: white; colour of tips: white; colour of older parts: more or less umbre brown.

layers: hyphal walls slightly gelatinous, tangentially 4 - 20 (70) µm, radially 2.5 - 4.5 (6) µm.

TANNIN CELLS

Number of rows: 1 (2); shape and dimensions: irregularly oval or cylindrical, near basis of rhizomorphs up to 3 or 4 rows, only with 1 - 2 rows of cortical cells present there, tangentially (15) 25 - 50 (60) µm, radially 5 - 11 (15) µm, TC t = 40.9 µm, TC q = 5.7.

HARTIG NET

Shape and dimensions of cortical cells: more or less roundish, or tangentially or radially oval, tangentially (10) 15 - 30 (48) µm, radially (6) 11 - 30 (35) µm, CC t = 21.8 µm, CC q = 1.1; depth of H'net: 3 - 4 (5) inclusive of tannin cells, the cell row next to the endodermis radially (= anticlinal) to a half or completely free of Hartig net; thickness of H'net: around tannin cells and nearby 3 - 5 µm, otherwise 2 - 3.5 µm, near basis of rhizomorph especially voluminous, remaining walls of cortical cells not very conspicuous, number of hyphal rows of H'net: 1; shape of H'net cells in section: short irregularly oval or cylindrical, cells 3 - 5 (12) µm long, sometimes longer, sometimes beaded, in surface view: relatively infrequently ramified and lobes comparatively broad.

ANATOMICAL CHARACTERS, LONGITUDINAL SECTION

MANTLE

Shape and dimensions of the hyphae at the very tip: plectenchymatous, lacking distinct layers, hyphae somewhat collapsing, tangentially 3 - 10 (15) µm, radially 2 - 3.5 (4) µm; differentiation through older parts of the mantle: plectenchymatous, lacking distinct layers, hyphae next to root cells somewhat denser arranged; shape

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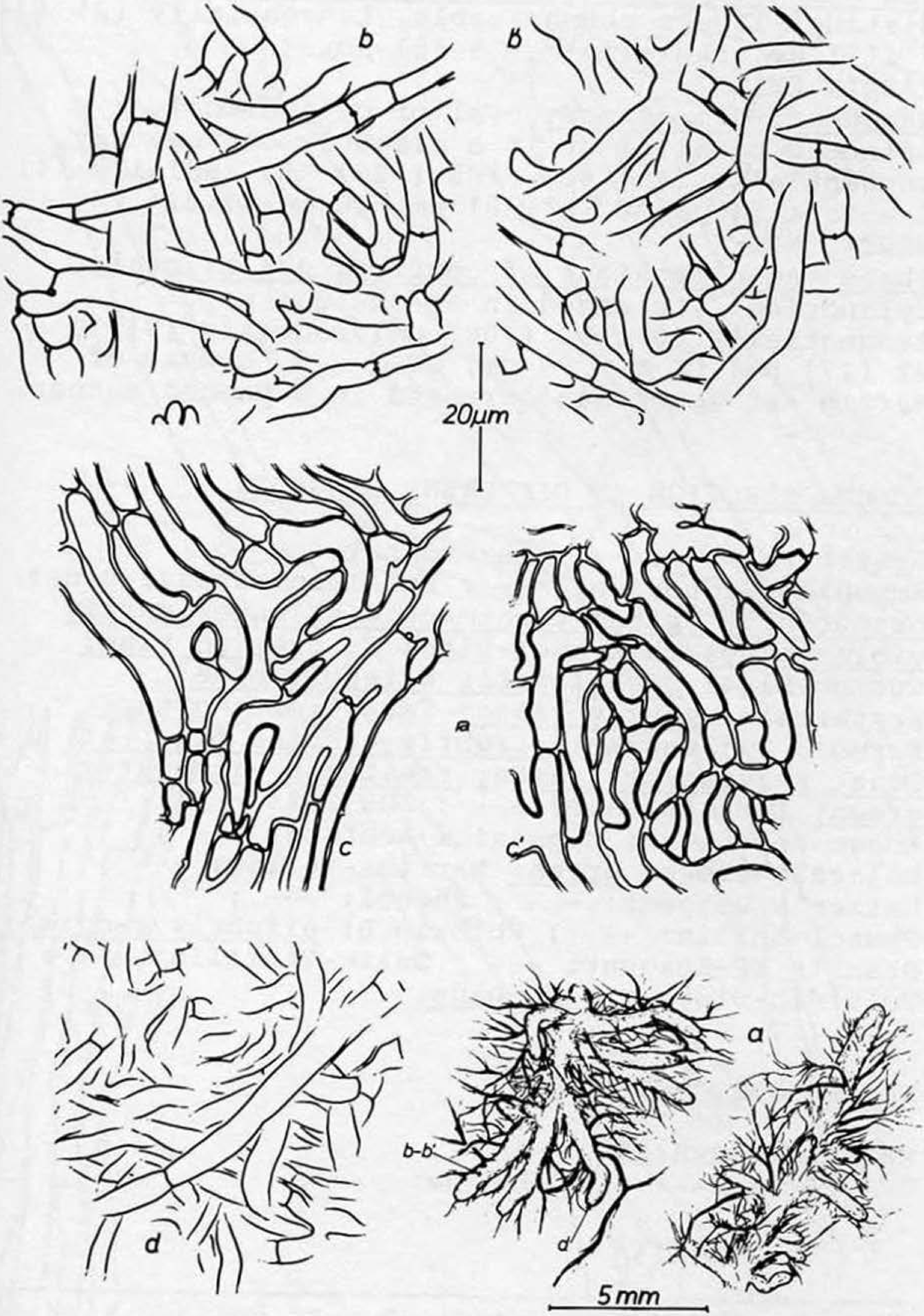
Fig. 3 - Tricholoma vaccinum - a: Habit of mycorrhizae. - b, b': Different surface views. - c, c': Different views of inner surface of mantle. - d: Surface view of very tip. (All figs. from RA 10742, in Herb. R. Agerer).


b
b'
20µm
a
c
c'
d
b-b'
d
a
5 mm

and dimensions of cells in different layers: no distinct layers recognizable, tangentially (2) 3 - 7 (15) µm, radially 2 - 4 (6) µm.

TANNIN CELLS

Shape and dimensions: oval or cylindrical, oriented parallel or in a slightly oblique way, tangentially (45) 60 - 105 (120) µm, radially (4) 8 - 15 (19) µm, TC t = 81 µm, TC q = 7.4.

HARTIG NET

Shape and dimensions of cortical cells: oval, cylindrical, oriented in an oblique way, tangentially 40 - 90 (100) µm, radially (8) 10 - 22 (27) µm, CC t = 73 µm, CC q = 8, hyphae of Hartig net sometimes arranged in a beaded manner.

COLOUR REACTION IN DIFFERENT REAGENTS

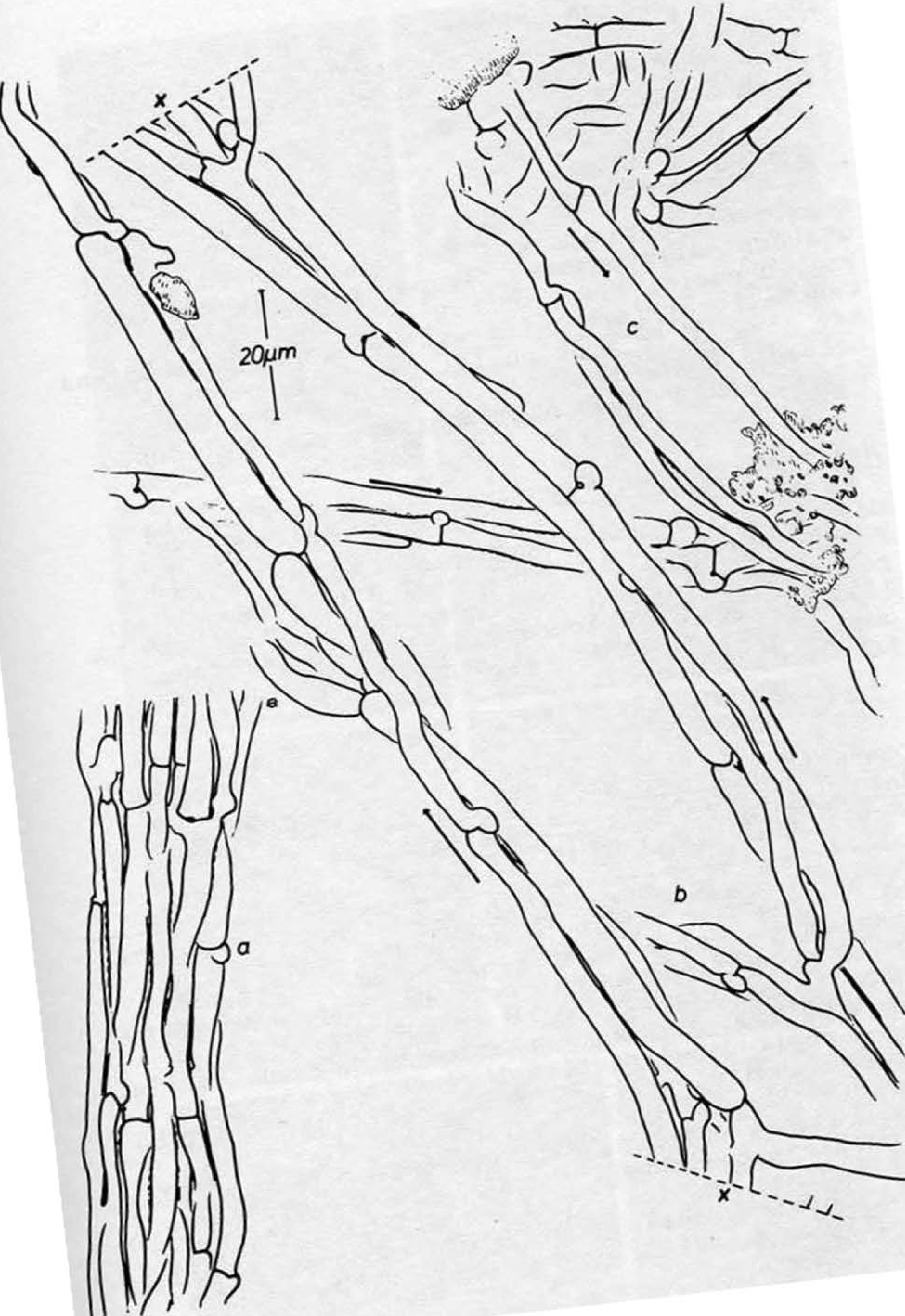
Acetic-Fuchsin: --- ; a-Naphtol: --- ; Ammonium-Hydroxide: --- ; Brilliant-Kresyl-Blue: bright-blue, after treatment with water partly violet-blue; Chlorazol-Black E: greyish blue; Cotton-Blue: hyphal walls slightly blue; Erythrosin: weakly lilac; Fast-Green: green; Formol: ? ; Guaiac: slightly greyish blue, at least rhizomorphs, after treatment with water green; Iron-Sulfate: --- ; KOH 15%: --- ; Kongo-Red: --- ; Magnesium-Acetate: --- ; Malachit-Green: green; Martius-Yellow: --- ; Melzer's Reagent: --- ; Phenol: --- ; Phenol-Anilin: --- ; Phloxin B: slightly reddish; Stahl's EP-Reagent: --- ; Sulfo-Vanillin: --- ; Toluidin-Blue: violet-blue.

AUTOFLUORESCENCE

WHOLE MYKORRHIZA

UV 254 nm: --- ; UV 366 nm: --- .

Fig. 4 - Tricholoma vaccinum - a: Surface view of averagely thick rhizomorph. - b: Narrow end of a rhizomorph. - c: Emanating hyphae. Arrows indicate the distal direction. (All figs. from RA 10742, in Herb. R. Agerer).


x
20μm
c
e
a
b
x

MANTLE AND RHIZOMORPHS
UV-filter 340 - 380 nm: greenish-blue (in lactic acid); Blue-filter 450 - 490 nm: yellowish-green (in lactic acid).

STAINING OF NUCLEI

Mostly one nuclear pair per cell, regardless whether cells possess clamps or simple septae. Paired nuclei lying mostly closely together. Centrally arranged, thicker hyphae of rhizomorphs may have up to four nuclei per cell (or more?, method: aceto-carmine). Some hyphae possess occasionally dense siderophilous granulations.

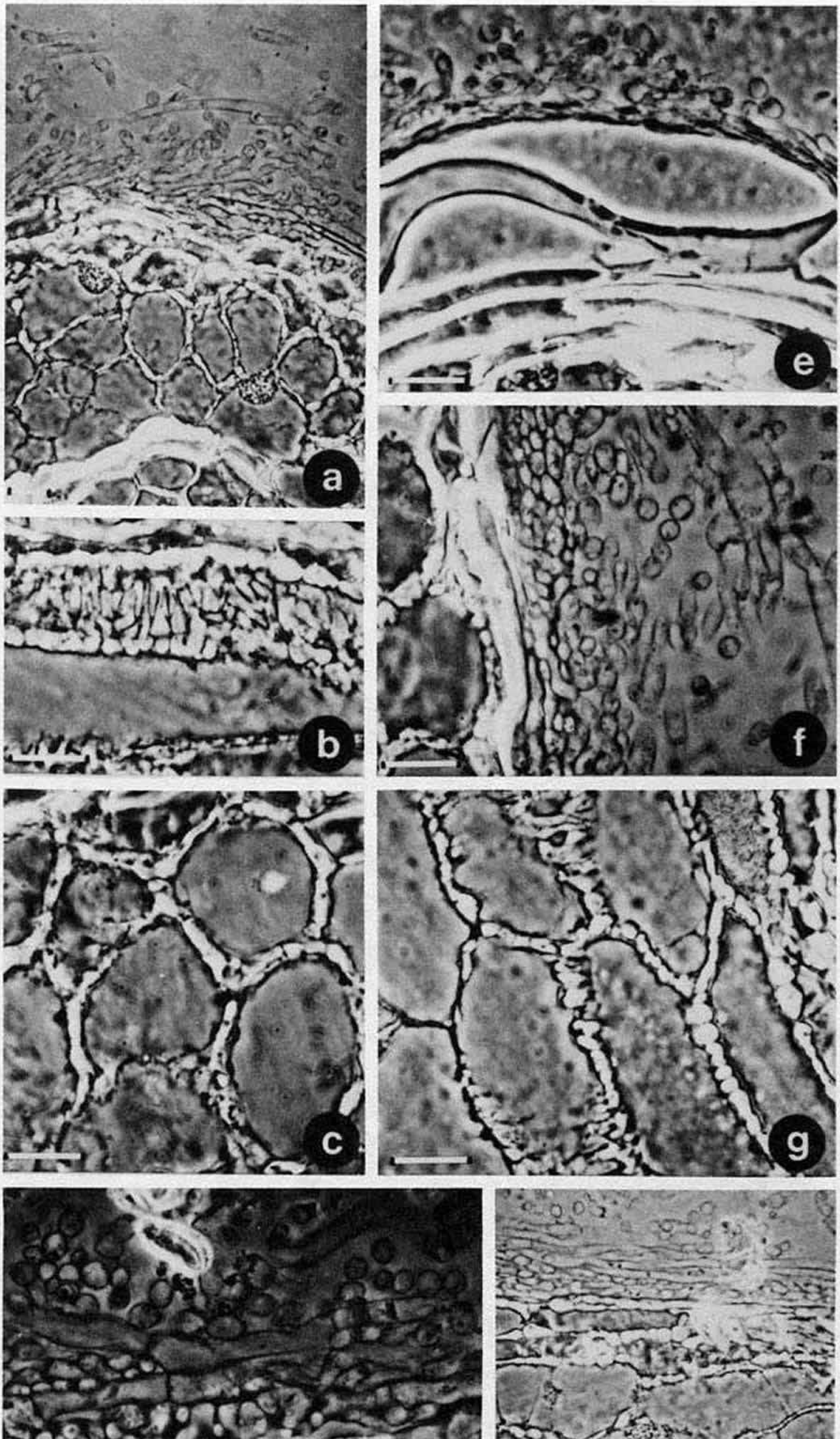
MATERIAL STUDIED AND METHOD OF IDENTIFICATION

Deutschland, Bayern, Buchenau, Lkr. Fürstenfeldbruck, 2. 10. 1984; with Picea abies; reference specimen of mycorrhiza and fruitbody RA 10742 in Herb. R. Agerer, M. Some rhizomorphic connections occurred between the base of the fruitbody and mycorrhizae.

COMPARISON OF THE MYCORRHIZA OF TRICHOLOMA VACCINUM WITH THOSE OF T. SULFUREUM.

(See T. sulfureum).

Plate 3 - Tricholoma vaccinum - a: Cross-section, from emanating hyphae to pericycle. - b: Longitudinal section, plain view of Hartig net. - c: Cross-section, Hartig net from tannin cells to cortical cells next to the endodermis. - d: Longitudinal section, emanating hyphae and mantle. - e: Longitudinal section through the very tip. - f: Longitudinal section, from emanating hyphae to tannin cells and outer cortical cells. - g: Longitudinal section, Hartig net from tannin cells to çortical cells next to the endodermis. - h: Longitudinal section, from emanating hyphae to inner cortical cells next to the endodermis. (All. figs. from RA 10743, phase contrast, bar = 12.5 µm).


a
e
b
f
c
g
d
h

MYCORRHIZAE OF TRICHOLOMA VACCINUM IN THE LITERATURE

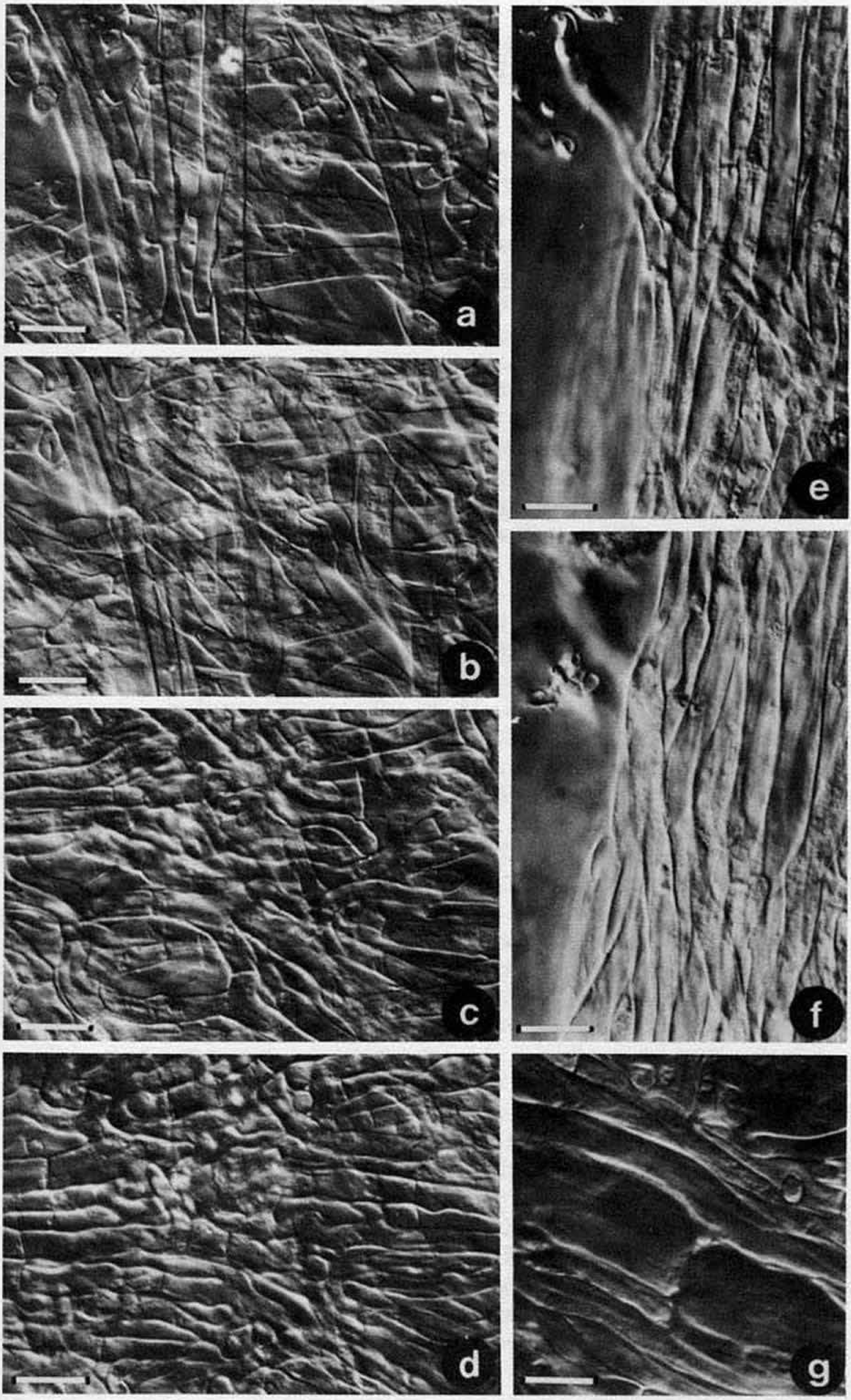
Anatomical and morphological studies of the mycorrhizae of this species could not be found. This species belongs to Tricholoma subg. Tricholoma sect. Genuina. Some mycorrhizae of this section are described in the literature (see below).

MYCORRHIZAE OF THE GENUS TRICHOLOMA IN LITERATURE

Mycorrhizae of two subgenera (arrangement after SINGER 1975) of the genus Tricholoma have been described earlier. Only the more detailed descriptions will be mentioned below.

(1) Tricholoma subg. Contextocutis:
T. saponaceum and T. sudum.
(2) Tricholoma subg. Tricholoma
    (a) sect. Tricholoma:
    T. cingulatum, T. flavovirens, T. portentosum, T. sejunctum, T. terreum and T. virgatum.
    (b) sect. Genuina:
    T. albobrunneum, T. caligatum, T. flavobrunneum, T. focale, T. fulvocastaneum (this section ?), T. fulvum, (this sect-

Plate 4 - Tricholoma vaccinum - a - d: Different plain views of mycorrhizal mantle, always from the same position. - a: Surface view of mantle, b: plain view ca. 5 µm deeper, c: plain view ca. 5 µm deeper again, d: plain view of the innermost layer of hyphal mantle, again ca. 5 µm deeper. - e - f: Different plain views of an averagely thick rhizomorph, always from the same position. - e: Plain view near surface of rhizomorph, b: plain view ca. 10 µm deeper, near the middle of the rhizomorph; notice the somewhat thicker central hyphae. g: Plain view of the middle of a rather thick rhizomorph; notice the thick hypha with incomplete cross wall. (All figs. from RA 10742, Normarski Interference Contrast, bar = 10 µm).


a
b
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ion ?), T. imbricatum, T. matsutake, T. pessundatum, T. ponderosum, T. robustum and T. zelleri.

(1) Mycorrhizae of species of Tricholoma subg. Contextocutis.

NORKRANS (1949) synthesized the mycorrhizae of Tricholoma saponaceum with Pinus silvestris and Betula verrucosa. She emphasized that the pine mycorrhizae had a parenchyma-like mantle, whereas the Betula mycorrhizae generally possessed a looser sheath. In both cases the mantle was rather thick (up to 55 µm), the mycorrhizae had a very conspicuous Hartig net between the outer cortical cells (in each case probably due to the high concentration of sugar in the medium, compare DUDDRIDGE & READ 1984, 1984a) and the individual hyphae of the sheath were about 3 µm in diameter. NORKRANS (l.c.) noticed intracellular hyphae only in the Betula mycorrhizae.

PACHLEWSKI & PACHLEWSKA (1974) synthesized the mycorrhizae of Tricholoma sudum with Pinus silvestris in agar medium. They showed a two-layered, hyaline, 20 - 35 µm thick mantle. The inner part of the mantle was pseudoparenchymatous whereas the outer region was composed of individually recognizable hyphae (= prosenchymatous as termed by the authors). The well developed Hartig net was restricted to a single outer row of cortical cells. The photos of the synthesized mycorrhizae show a very untypical habit of a pine mycorrhiza. This is probably due to the agar-medium, in which the mycorrhizae are submerged completely and deprived of adequate oxygen.

(2) Mycorrhizae of species of Tricholoma subg. Tricholoma

GODBOUT & FORTIN (1985) synthesized several mycorrhizae of different fungi with Populus tremuloides. They concluded that the special structures of rhizomorphs and sections of mantle may indicate a relationship between different fungal species, provided these structures are similar. PACHLEWSKI & PACHLEWSKA (1974) came to the same conclusion as they compared cross-sections of synthesized mycorrhizae. For species of *Tricholoma* GODBOUT & FORTIN (1985) emphasized a white, conspicuous extramatrical mycelium with smooth hyphal strands composed of centrally arranged thicker hyphae and of an outer rim of hyphae of smaller diameter. In addition they stressed the existence of a more or less double hyphal mantle. The species which they investigated were *T. flavobrunneum, T. cingulatum* and *T. populinum.* The overall similarity of the mycorrhizae of these species may indicate that related species form similar mycorrhizae, but the host species may introduce its own root features. This, for instance was pointed out by GODBOUT & FORTIN (1985) for the genus *Populus* as far as Hartig net formation is concerned. They investigated only three species of *Tricholoma subg. Tricholoma,* however.

MELIN (1923) synthesized mycorrhizae between *Tricholoma flavobrunneum* and *Betula pendula.* The white mycorrhizae formed hyphal strands and pseudoparenchymatous mantles (about 40 µm thick) with rather small cells and with a Hartig net only between the outer half of the outermost cortical cells. MELIN (1923) regarded the mycorrhizae as an ectendotrophic type. NORKRANS (1949) characterized the synthesized mycorrhizae of *T. flavobrunneum* with *Pinus silvestris* as having no sheath but a great Hartig net work.

As shown in the present description of the mycorrhizae of *T. sulfureum (T. subg. Sericeicutis)* , the various *Tricholoma* species can produce strongly differing mycorrhizae. It remains to be determined, however, if this applies at the species level or at the subgenus level. *Tricholoma sulfureum,* stands apart from many other species of this genus if other taxonomic features are considered. KüHNER (1980) emphasized some similarities between *T. sulfureum* and *Dermocybe cinnamomea.* Similarties can also be found in the features of the mycorrhizae of these two species (comp. AGERER 1987). The rhizomorphs belong to the same type in both species: densely interconnected hyphae, without centrally arranged broader hyphae.

The hyphae of the rhizomorphs of *T. sulfureum* are connected by "contact-septae", those of *Dermocybe cinnamomea* by "contact-clamps". These structures seem to be identical from a functional point of view (AGERER 1987 and above). On the other hand HØILAND (1983) judged the similarities between some species of the genera *Tricholoma* and *Dermocybe* as convergences.

PACHLEWSKI & PACHLEWSKA (1974) synthesized some species of *Tricholoma subg. Tricholoma* with *Pinus silvestris.* As remarked above, the conditions of synthesis of mycorrhizae in an agar medium are very unnatural. The mycorrhizal habit thus seems to deviate strongly from the natural one. This becomes obvious by the rare occurrence of dichotomously forked mycorrhizae in this medium, whereas the naturally grown mycorrhizae of *Pinus* species are almost exclusively of a dichotomous habit. The synthesized mycorrhizae of all *Tricholoma* species *(T. albobrunneum, T. flavovirens, T. focale, T. imbricatum, T. pessundatum, T. portentosum, T. sejunctum* and *T. terreum)* show a white extramatrical, mostly conspicuous mycelium. The cross-sections nearly always indicate a plectenchymatous mantle with an internal pseudoparenchymatous layer and a strongly developed Hartig net. Such a Hartig net has already been mentioned above for the mycorrhizae of *Tricholoma subg. Contextocutis* and was also reported for syntheses by PACHLEWSKI & PACHLEWSKA (1974) and by NORKRANS (1949).

It was pointed out by NORKRANS (1949) that the mycorrhizae of *T. flavovirens (= T. equestre)* on *Pinus silvestris* appear very similar to those of *T. saponaceum* (s. above). Apart from a very thick mantle (80 µm) she noticed the absence of a Hartig net; on *Betula verrucosa,* however, there was a discontinuous intercellular mycelium. The mycorrhizae of *T. sejunctum (subg. Tricholoma)* on *Betula verrucosa* resembled those of *T. flavovirens* on the same host (NORKRANS 1949).

LUPPI & GAUTERO (1967) characterized the mycorrhizae of *Tricholoma albobrunneum* found on *Quercus petraea* and *Q. pubescens*. The mycorrhizae were characterized as whitish when young, becoming hazel-brown when older, surrounded by hyphae to give a velvety appearance. Under the microscope the superficial hyphae were hyaline, in the inner part of the mantle slightly orange-brown. The mantle was about 30 µm thick with a prosenchymatous (= plectenchymatous in our nomenclature) surface and a pseudoparenchymatous inner layer. The emanating hyphae were almost hyaline and occasionally connected to cords. The hyphae were swollen near the septae, which mostly were simple. The rhizomorphs of the fruitbodies showed uniform hyphae resembling those of the mantle. No centrally arranged thicker hyphae were noticed.

MASUI (1927) described the mycorrhizae of Pinus densiflora, found beneath and connected with the fruitbodies of T. caligatum. He characterized them as being small, clavate and enveloped in a white mycelium becoming darker with age. MASUI, too, mentioned a thin mantle composed of loosely woven hyphae. According to his descriptions the inner layers, however, show more densely arranged hyphae, resembling a pseudoparenchymatous structure. The Hartig net - apart from the tannin cells - comprised only the outer row of cortical cells. Intrusions into the cortical cells occurred occasionally. Another description of these mycorrhizae, but on Cedrus libanotica ssp. atlanica, originates from OHARA & OGAWA (1982). The Japanese decription does not allow to get a distinct impression of these mycorrhizae. The cross-sections shown, however, indicate that a mantle is either absent or at the most very scanty and that there some cortical cells have intracellular infections. As mentioned by the authors, the mycorrhizae of this species are morphologically identical with the mycorrhizae of T. matsutake on Pinus densiflora.

The mycorrhizae of Tricholoma matsutake were described by MASUI (1927) and by OGAWA in various papers (OGAWA 1975, 1976, 1977, 1981, OGAWA & HAMADA 1965). A summary of OGAWA's papers shows the mycorrhizae of T. matsutake on Pinus spp. and other conifers are somewhat twisted, not dichotomously forked but pinnate or witches-broom like, white but turning to brown or nearly black with age, and covered with mycelial wefts and even at full growth lacking a hyphal mantle. There is no Hartig net but the hyphae grow intercellularly and invade cortical cells. MASUI (1927) too, mentions only a very thin, rather loose hyphal mantle (7 - 16 µm thick) and intracellular infections of cortical cells.

OGAWA described mycorrhizae of some additional Tricholoma species. The mycorrhizae of T. fulvocastaneum (OGAWA 1977a) on Quercus serrata and P. densiflora, and of T. ponderosum (OGAWA 1979) on Pinus contorta and Pseudotsuga menziesii closely resembled those mycorrhizae of T. matsutake in morphology and anatomy. On the other hand the mycorrhizae of T. robustum (OGAWA 1981, 1981a) on Pinus densiflora and T. zelleri (OGAWA 1981a) on Pinus contorta resemble each other in having a thin mantle and possessing a Hartig net, and differ from the species previously characterized by OGAWA, in having a mantle but lacking intracellular hyphae.

MELIN (1924) tried to synthesize the mycorrhizae of Tricholoma virgatum with Pinus montana. But he did not succeed in getting a well developed mycorrhiza.

GILTRAP (1979) synthesized the mycorrhizae of Tricholoma fulvum with Betula pendula and B. pubescens. The mycorrhizae were 0.1 - 10 mm long and 0.25 - 0.5 mm in diameter. Depending on their position regarding inoculum and roots, the mycorrhizae were long, tortuous and highly ramiformly branched or shorter, straight and mostly simple. The mycorrhizae were white to light orange and with glistening to frosty mantle surface texture. The rhizomorphs and emanating hyphae showed an orange colour, were directly attached to the surface of the mycorrhizal mantle, were highly branched, fine threadlike and reached 0.08 mm in diameter. The mantle varied from 20 - 70 µm thickness and was irregularly developed. It possessed a prosenchymal structure and the inner mantle was tightly woven without any gaps, whereas the outer mantle was composed of loosely woven hyphae. The Hartig net included only the epidermal cell layer and was composed of single chains of cells 2 - 5 µm in diam. It is striking that the colour of the mycorrhizae including that of the rhizomorphs is seemingly similar to the colour of the fruitbodies (T. fulvum) . The characteristics of the mantle fit well with the

features shown for the mycorrhizae of T. vaccinum. The restricted Hartig net is a special feature of the mycorrhizae of Betula and of other deciduous trees (GODBOUT & FORTIN 1985).
GILTRAP unfortunately did not describe the anatomy of the rhizomorphs.

If one summarizes all these descriptions of mycorrhizae of the genus Tricholoma in context with our own results, the following may be emphasized:

Three different groups of mycorrhizae occur in the genus Tricholoma concerning the contact between the hyphae and the rootlets.

First, a group consisting of Tricholoma sulfureum, with rhizomorphs not differentiated into centrally arranged thicker hyphae and surrounding thinner ones; second a group including most of the other species studied with differentiated rhizomorphs; and a third group with frequent intracellular hyphae, lacking a Hartig net, and with a scanty or absent mantle as in T. matsutake, T. fulvocastaneum and T. ponderosum. Whether synthesized mycorrhizae can be compared with naturally grown mycorrhizae is dubious, however. Furthermore, most past descriptions are very scanty, so that more detailed work must still be done.

IV. Acknowledgements

I am much obliged to Mr. P. Altheide for having skillfully prepared the sections and to Mr. K. Liedl who made the prints of the drawings. I thank all members of my staff who contributed to this study by discussing several questions. I am very much indebted to Dr. Jim Trappe (Corvallis) for critical comments on the manuscript. The researches were supported by "DFG, Deutsche Forschungsgemeinschaft, grant Ag 7/5-2". Agfa AG (Leverkusen), Audi AG (Ingolstadt), Dachser-Spedition (Munich), Daimler-Benz AG (Stuttgart), Dralle GmbH (Hamburg), Leitz AG (Munich), and Carl Zeiss AG (Oberkochen) subsidized the investigations by a "fund for researching the tree die-back".

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 361-363 April-June 1987

A NEW RUST ON LEGUMINOSAE

ANNETTE W. RAMALEY

Department of Plant Pathology and Weed Science
Colorado State University
Fort Collins, Colorado 80523

There have been no reports of any rust on Thermopsis rhombifolia Nutt. ex Rich. (2) although other species of the genus in the eastern hemisphere are known to have rusts (5). Poliomopsis thermopsidis Ramaley nov. gen. nov. spec. is a rust with 2-celled teliospores found on Thermopsis rhombifolia in Larimer County, Colorado.

Poliomopsis Ramaley nov. gen. Spermogonia, aecia et uredinia ignota. Telia hypophylla, subepidermalia, erumpentia, aggregata. Teliosporae bicellulares, generatae in cellulis sporogenis elongatis, non pedicellatae; cellulae paene aequales vel inferiorae aliquantum minores; parietes tenues, colorati pallidi fusci, verrucosi; pori non visi.

Poliomopsis Ramaley nov. gen. Spermogonia, aecia and uredinia unknown. Telia hypophyllous, subepidermal, erumpent, clustered. Teliospores 2-celled, born on elongate sporogenous cells, not pedicellate; cells almost equal or the lower somewhat smaller; wall thin, lightly brown pigmented, verrucose; pores not distinguished.

Poliomopsis thermopsidis Ramaley nov. spec. Spermogonia, aecia et uredinia ignota. Telia hypophylla, subepidermalia, erumpentia, aggregata; raro pauca telia epiphylla super teliis in foliae pagina inferiore insidentibus; nigra, aperientia et monstrantia sporas pallidas fuscas. Teliosporae non pedicellatae, generatae in cellulis sporogenis fuscis elongatis maxime pigmentiferis prope paginam fecundam, bicellulares, 9-(11-13)-15 x 15-(18-22)-27 µm; parietes tenues, pallidi fusci colorati, verrucosi, saepe constricti in septo; pori non visi; cellulae rotundae vel leviter angustatae in extremo, inferiorae interdum truncatae in base, aequales vel inferiorae aliquantum minores. Paraphyses nullae. Hab. in foliis Thermopsis rhombifolia Nutt. ex Rich.

Poliomopsis thermopsidis Ramaley nov. spec. Spermogonia, aecia, and uredinia unknown. Telia hypophyllous, subepidermal, erumpent, clustered; rarely a few epiphyllous telia above those on the lower leaf surface; black, opening to expose the light brown spores. Teliospores not pedicellate, born on brown elongated sporogenous cells most intensely pigmented near the fertile surface, 2-celled, 9-(11-13)-15 x 15-(18-22)-27 µm; wall thin, slightly brown pigmented, verrucose, often constricted at the septum; pores not distinguished; cells rounded or slightly narrowed terminally, the lower sometimes truncate at the base, equal or the lower somewhat smaller. Paraphyses absent. On leaves of Thermopsis rhombifolia Nutt. ex Rich.

Holotype: On Thermopsis rhombifolia Nutt. ex Rich., 0.2 mile from Boy Scout Camp Road, 3.3 miles from the Red Feather Lakes Road, Larimer County, Colorado, Annette W. Ramaley, September 1, 1986, BPI. Isotype PUR.

The telia are compact, sharply delimited subepidermal masses of tissue in which elongate pigmented sporogenous cells appear at the surface as maturation progresses. The sporogenous cells are difficult to separate from one another, but appear to be unbranched and bear only one 2-celled spore (Fig. 1) at the apex (Fig. 2). Telia measure up to 200 µm in diameter and are clusterd to form spots from less than 1 mm in diameter to covering nearly all the lower leaf surface. Telia in an area bounded by minor leaf veins mature evenly; in adjacent areas telia may be younger or older. Rarely a few epiphyllous telia appear above those on the lower leaf surface. Stipules or young leaves may have equal numbers of telia on both surfaces. Telia are occasionally found on very young petioles or stems.

Existing rust genera are distinct from Poliomopsis. Puccinia Persoon has pedicellate spores which usually have pores. Sorataea Sydow, a rust of the Leguminosae (4, 6), has 2-celled pedicellate teliospores which germinate without dormancy. Germination has not been seen in fresh Poliomopsis teliospores. Polioma Arthur (1), a genus not reported on legumes, has 2-celled teliospores lacking pedicels. However, Polioma teliospores are smooth, hyaline, have pores, germinate with no dormancy, and are much larger than the spores of Poliomopsis. Sorataea

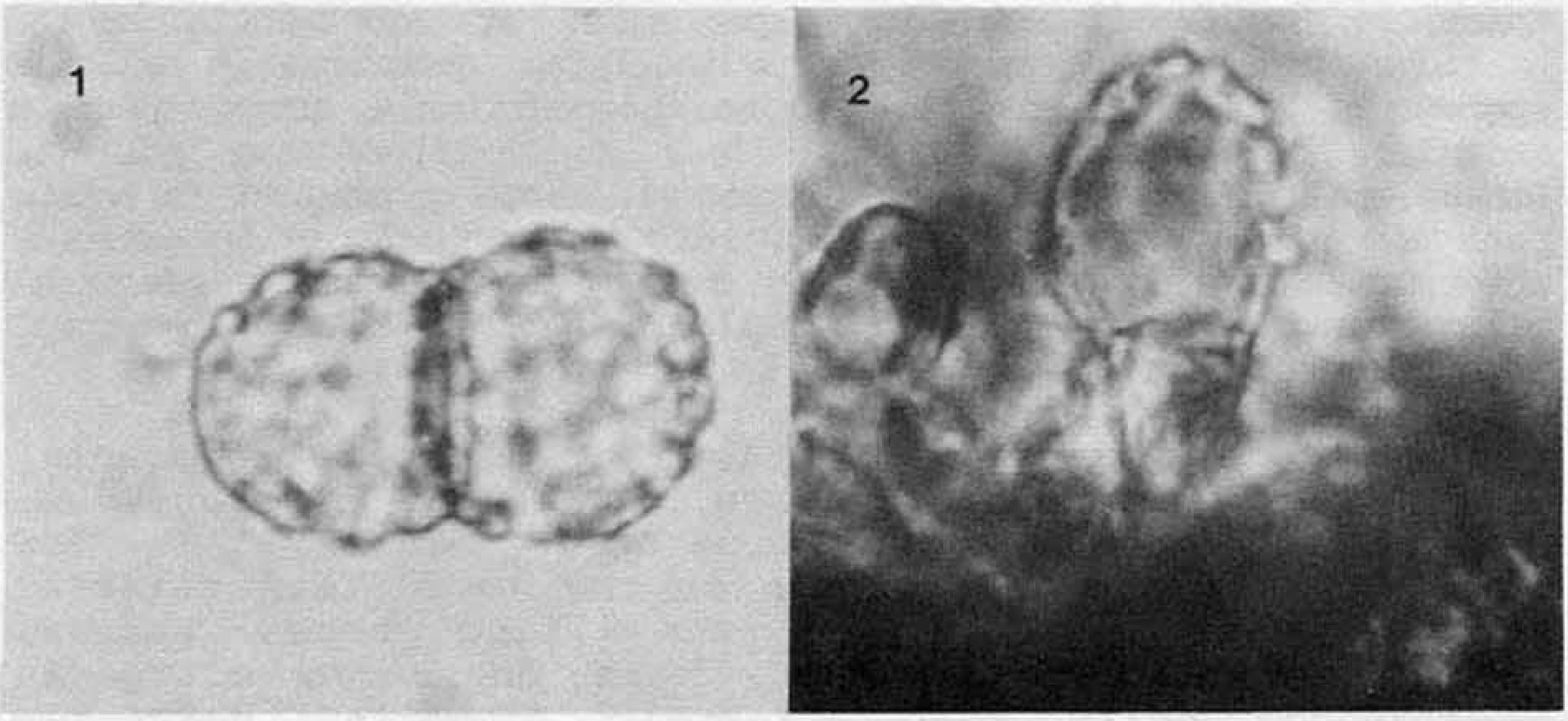

Fig. 1. Verrucose epedicellate teliospore of Poliomopsis thermopsidis, 1460x. Fig. 2. Sporogenous cell bearing a single developing terminal teliospore, 1460x.

differs from Polioma and Puccinia in spermogonial structure (3) which is not known for Poliomopsis.

When the life cycle of Poliomopsis thermopsidis is completely known, its relationships may be clarified. Whatever its affinities prove to be, the species is the first rust of United States legumes with 2-celled, sessile teliospores.

Acknowledgements: My thanks to Dr. George Cummins for his review of the manuscript and for his helpful suggestions. I also thank Dr. Edouard Thai for his help in the preparation of the Latin diagnoses.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 365-368 April-June 1987

A NEW SPECIES OF TARZETTA (PEZIZALES) FROM NEW ZEALAND

WEN-YING ZHUANG AND RICHARD P. KORF

Plant Pathology Herbarium, Cornell University
Ithaca, New York 14853 USA

During our studies of the genus *Aleurina* (Zhuang and Korf, **1986**), more than twenty specimens under the generic name *Jafneadelphus* were sent to us from PDD for examination. When we studied them we found that some specimens cannot be accommodated in *Aleurina (= Jafneadelphus)* or in *Jafnea*. They represent a new species of the genus *Tarzetta*, which we describe and discuss here.

Tarzetta jafneospora Zhuang & Korf, *sp. nov.* (FIG. 1)

Ab Tarzetta *speciebus aliis ascosporis fusoideis cum ornamentatione cyanophilica differens.*

Apothecium cupulate, subsessile to substipitate, 4-12 mm in diam when dry, margin crenate, hymenium yellow to orange, receptacle yellowish beige when dry, surface strongly pustulate. *Ectal excipulum* of textura angularis to textura globulosa, 75-120 µm thick, cells ovoid to isodiametric, hyaline; cells at margin arranged in long, parallel hyphae which extend beyond the hymenium; cells of pustules hyaline, ovoid or subspherical, loosely interconnected, arranged irregularly in chains; a few cylindrical hyphae growing from outermost cells, septate, hyaline and thin-walled, ca. 5.5-7.5 µm wide. *Medullary excipulum* of textura intricata, 185-220 µm thick, hyphae hyaline, ca. 5.5 µm wide. *Subhymenium* not clear. *Asci* 8-spored, cylindrical, J- in Melzer's Reagent, ca. 325-340 X 13.2-18.3 µm, croziers not seen. *Ascospores* uniseriate, subfusoid, biguttulate, uninucleate, nucleus staining in acetocarmine, 20.5-25.2 X 9.0-10.8 µm, with numerous small warts, warts less than 0.5 µm in diam, often irregularly interconnected. *Paraphyses* filiform, slender, 2.0-2.8 µm wide, not exceeding asci.

HABITAT: On sandy soil, rarely on rotten wood.

HOLOTYPE: On sandy soil, Waikareiti Tr., L. Waikaremoana, Urewera Nat. Park, Gisborne, G.J. Samuels, A.P. Hawthorne, P.R. Johnston, E. Horak, and R.H. Petersen, 2. V. 1981, PDD 49572; CUP 61778 *(isotype).*

PARATYPES: On sandy soil, Lake Waikaremoana, Urewera Nat. Park, Gisborne, G.J. Samuels et al., 22. V. 1981, PDD 46049; on sandy soil under *Nothofagus* sp., Black Beech Tr., L. Waikaremoana, vic. motorcamp, Urewera Nat. Park, Gisborne, G.J. Samuels, A.P. Hawthorne, R.H. Petersen, and P. R. Johnston, 22. V. 1981, PDD 49445; on sandy soil, Waikareiti Tr., L. Waikaremoana, Urewera Nat Park, Gisborne, G.J. Samuels, E. Horak, A.P. Hawthorne, P.R. Johnston, and R.H. Petersen, 24. V. 1981, PDD 42042; on sandy soil, Aniwaniwa Falls, Lake Waikaremoana, Urewera Nat. Park, Gisborne, G.J. Samuels, 26. V. 1981, PDD 49494; on sandy soil, Nelson Lakes National Park, Nelson, G.J. Samuels et al., 13. V. 1982, PDD 45645; on wood, L. Waikare-iti, L. Waikaremoana, Urewera Nat. Park, Gisborne, G.J. Samuels and C.E. Samuels, 23. V. 1982, PDD 49800; on *Nothofagus* sp., L. Waikare-iti, Urewera Nat. Park, Gisborne, G.J. Samuels, and C.E. Samuels, 23. V. 1982, PDD 49801; on sandy soil, Taupeupe Saddle, 15 km SE Ruatahuna, Urewera Nat. Park, Gisborne, G.J. Samuels, P.K. Buchanan, and P. R. Johnston, 3. XI. 1982, PDD 49720; on sandy soil, Aniwaniwa, Tr. to Ruapani, L. Waikaremoana, Urewera Nat. Park, Gisborne, G.J. Samuels, P.K. Buchanan, and P.R. Johnston, 4. XI. 1982, PDD 49721; on soil, NW Nelson State Forest Park, vic. Whisky Cr., Nelson, G.J. Samuels, R.E. Beeber, P.R. Johnston, and R.H. Petersen, 18. IV. 1983, PDD 50183; on soil, Robinsons Cr., Haast Pass, Mt. Aspiring Nat. Park, Westland, G.J. Samuels, R.E. Beeber, P.R. Johnston, and R.H. Petersen, 18. IV. 1983, PDD 50184.

NOTES: The genus *Tarzetta* has been placed in the tribe Jafneeae by Korf (**1972**) and in Otideeae by Dennis (**1978**). Three genera, *Geopyxis, Jafnea,* and *Otidea,* have been thought to be similar to *Tarzetta* in different aspects by many authors (Dennis, **1978**; Eckblad, **1968**; Harmaja, **1974**; Korf, **1972**, **1973**; Rifai, **1968**). These genera can be distinguished on the basis of the shape and structure of apothecium, the presence of brown hairs or hyaline hyphae on the receptacle surface, the shape and guttulation of ascospores, the stainability of nuclei in acetocarmine, and the presence of spore ornamentations. The species from New Zealand, to a certain extent, shares the characters of both *Jafnea* and *Tarzetta*. It has the pustulate, substipitate apothecium, crenate margin, a few hyaline hyphae on the receptacle, angular to globose cells in the ectal excipulum, and the interwoven hyphae in the medullary excipulum, which are characters of *Tarzetta,* but the fusoid, marked ascospores recall species of *Jafnea*. This reminds us of the situation in *Trichophaea geoporoides,* which we treated as a *Trichophaea* species though it is similar to *Geopora* in some ways (Korf &

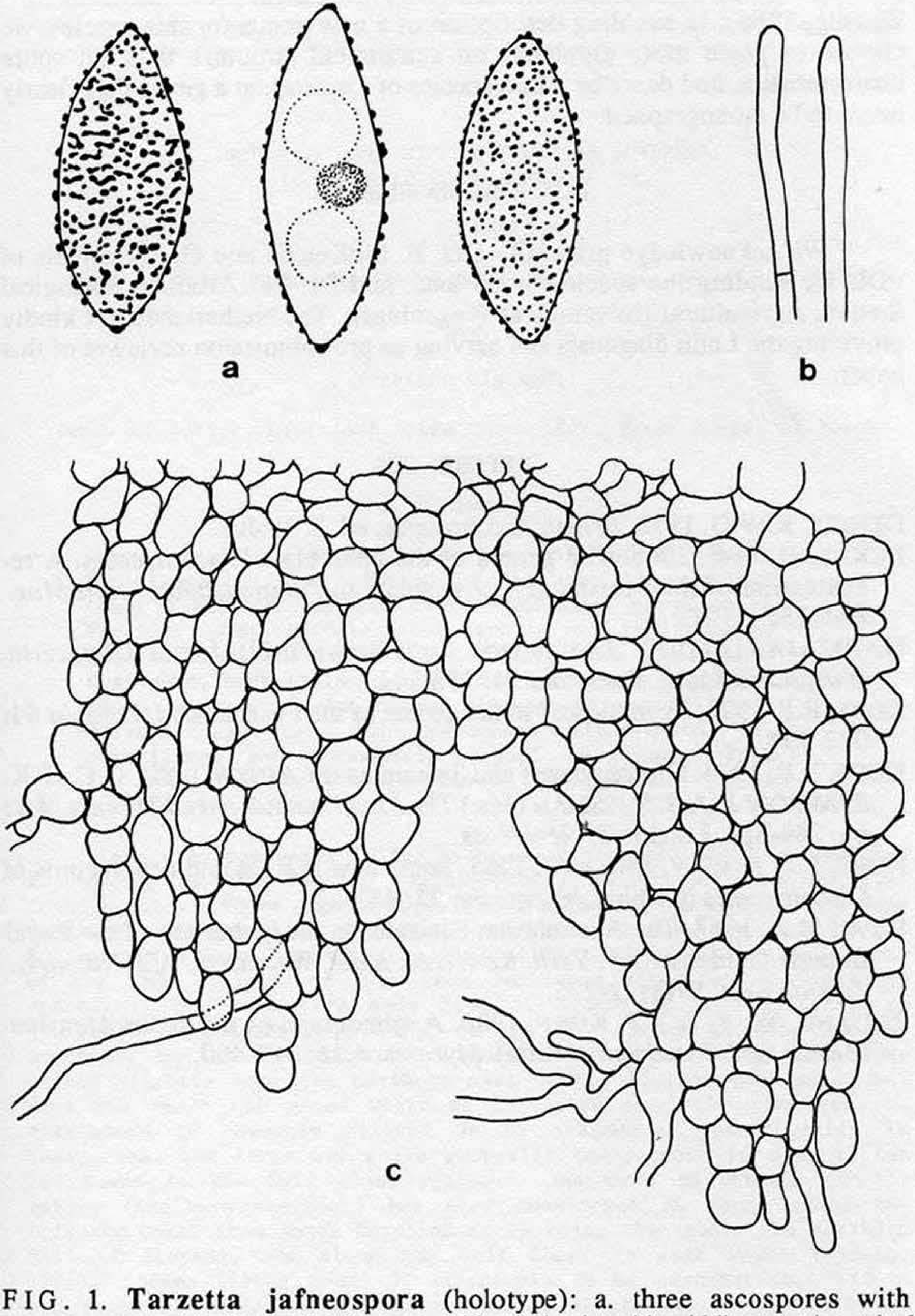

FIG. 1. **Tarzetta jafneospora** (holotype): a. three ascospores with ornamentations stained in cotton blue in lactic acid, middle spore in optical section showing guttules and the single, central nucleus staining in acetocarmine, x1580; b. two paraphysis apices, x1000; c. outer portion of the ectal excipulum with pustules and hyaline hyphae, x500.

Zhuang, **1985**). In avoiding description of a new genus for this species, we choose to place more emphasis on anatomical structure than on spore characteristics, and describe it as a species of *Tarzetta,* in a genus that clearly needs to be monographed.

ACKNOWLEDGEMENTS

We acknowledge gratefully Drs. E. McKenzie and G. J. Samuels of PDD for sending the specimens on loan, and Dr. Eef Arnolds, Biological Station, Agricultural University at Wageningen, The Netherlands, for kindly providing the Latin diagnosis and serving as pre-submission reviewer of this paper.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 369-402 April-June 1987

NOTES ON WOOD-ROTTING FUNGI ON JUNIPERS IN THE GULF COAST REGION. II.

R.L. Gilbertson

Dept. of Plant Pathology, University of Arizona, Tucson, AZ 85721

and

Meredith Blackwell

Dept. of Botany, Louisiana State University, Baton Rouge, LA 70803

SUMMARY

Twenty-six additional species of wood-rotting basidiomycetes are reported on junipers in the Gulf Coast region in an area from Louisiana to northern Florida. Most of these decay bark or wood on living or dead branches on living trees. Only three (**Coniophora fusispora, Dacryobolus sudans**, and **Fomitopsis feei**) are known to cause brown rots. **Xenosperma murrillii** is described as new and **Hyphoderma albocremeum, H. obtusiforme**, and **Hyphodontia nespori** are reported from the United States for the first time. A key to 51 species is provided.

In a previous paper (Gilbertson and Blackwell, 1985) we reported 25 species of wood-rotting basidiomycetes on junipers in the Gulf Coast region. These reports were based primarily on collections from Louisiana, Mississippi, and Texas. Further collecting in 1985 in Louisiana, Alabama, and Florida yielded 26 additional species. Most of the 1985 collections were from **Juniperus virginiana** L. (eastern redcedar), but some were made from **J. phoenicea** L. (Mediterranean juniper), an ornamental planted on the LSU campus in Baton Rouge. According to Little (1971) the natural range of **J. virginiana** does extend slightly into the northern part of the Florida panhandle, but does not reach the areas where we collected in 1985. However, **J. virginiana** is commonly planted as an ornamental, particularly in cemeteries, and large trees are generally conspicuous in most cities and towns in the Gulf Coast region. **Juniperus silicicola** (Small) Bailey (southern redcedar) has been considered to range along the Atlantic Coast from North Carolina to Florida, throughout the northern half of Florida, and along the Gulf Coast to east Texas (Little, 1971). Adams (1986) found **J. silicicola** to be circumscribed within the range of variation encountered in **J. virginiana** on the basis of morphological characters and volatile leaf terpenoids. He therefore recognized the varietas **J. virginiana** var. **silicicola** (Small) Silba for the populations from North Carolina along the coast to Northern Florida and possibly west to Mississippi. Adams considers the disjunct populations in southern Louisiana and eastern Texas to be **J. virginiana.**

Three of the species included here are brown rot fungi. Of these, **Dacryobolus sudans** decays dead, decorticated branches, **Fomitopsis feei** causes a trunk and butt rot in living trees, and **Coniophora fusispora** was generally collected at the base of living trees near the groundline. A brown heartrot is rather common in living trees and the most likely cause in the Gulf Coast region is **Fomitopsis feei.** In other parts of North America **Antrodia juniperina** (Murr.) Niem. et Ryv. is a major cause of brown trunkrot (Gilbertson and Ryvarden, 1986), but we did not collect it in the Gulf Coast region.

Of the 26 species reported in this paper, five (**Dacryobolus sudans, Dendrothele incrustans, Exidiopsis calcea, Hyphodontia spathulata**, and **Trechispora farinacea**) were also found on Arizona junipers by Gilbertson and Lindsey (1975, 1978).

In addition to the 26 species reported here, new distribution and host records are given for fungi included in the first paper in this series, and an expanded key to all 51 species is provided.

Microscopic characters were determined from freehand sections or squash mounts in phloxine and 2% KOH and in Melzer's reagent. Drawings were made with the aid of a camera lucida on a Leitz Labolux microscope.

NEW DISTRIBUTION AND HOST RECORDS FOR FUNGI REPORTED IN THE FIRST PAPER IN THIS SERIES

The 25 fungi reported in the first paper in this series (Gilbertson and Blackwell, 1985) were mostly from Louisiana and Texas. Our collecting over a larger area of the Gulf Coast region has shown many of these to have a wide distribution. Also, a number of new host records were obtained from Mediterranean juniper, **Juniperus phoenicea** L., on the LSU campus in Baton Rouge. These additional records are included here. Numbers in the 2000 series are MB collections and those in the 15000 series are RLG collections.

Ceriporia xylostromatoides (Berk.) Ryv. et Johan. 15652, on **J. virginiana**, Ft. Gaines, Dauphin Island, AL; 15735, on **J. virginiana**, Gainesville, FL; 15796, on **J. phoenicea** L., LSU campus, Baton Rouge.

Dendrothele itihummensis Gilbn. et M. Blackwell. This species is evidently one of the main decomposers on juniper branches throughout the Gulf Coast region. 15645A, Elberta, AL; 15661, Santa Rosa Beach, FL; 15766, 15768, 15771 and 2291, 2299, Milton, FL; 2279, 2282, DeFuniak Springs, FL, all the above on **J. virginiana**; 15789, on **J. phoenicea**, LSU campus, Baton Rouge.

Dendrothele nivosa (Berk. et Curt.) Lemke. Definitely the most common wood-rotting fungus on bark on living trunks and branches of junipers throughout the Gulf Coast region. Trees without **D. nivosa** are the exception. 2247, Houston, TX; 15644, Foley, AL; 15645, Elberta, AL; 15648, Pass Christian, MS; 15652, 15654, Pensacola, FL; 15659, Santa

Rosa Beach, FL; 15666, Apalachicola, FL; 15673, Sopchoppy, FL; 15682, 15683, Cedar Key, FL; 15685, Hollister, FL; 15692, Palatka, FL; 15694, 15754, Gainesville, FL; 2288, 2289, 15767, Milton, FL; all of the preceeding on **J. virginiana**; 15787, 15794, LSU campus, Baton Rouge, on **J. phoenicea.**

Henningsomyces candidus (Pers.) O. Kuntze 15684, Cedar Key, FL; 2287, 15762, Milton, FL; all on **J. virginiana.**

Hyphoderma praetermissum (Karst.) John Erikss. 2292, Milton, FL; on dead branches of **J. virginiana.**

Marasmiellus juniperinus Murr. Although the report by us of this fungus on the LSU campus was the first from the United States, it is evidently widely distributed and rather easy to find throughout the Gulf Coast Region. 15660, Santa Rosa Beach, FL; 15665, Panama City, FL; 15707 Gainesville, FL; 2298, 15760, Milton, FL; all of the preceeding on **J. virginiana**; 2302, LSU campus, Baton Rouge, on **J. phoenicea.**

Pachykytospora alabamae (Berk. et Curt.) Ryv. 15649, Elberta, AL; 15658, Santa Rosa Beach, FL; 15765, Milton, FL; all on **J. virginiana.**

Peniophora junipericola John Erikss. 15667, 15670, Apalachicola, FL; 15686, Hollister, FL; 15742, Gainesville, FL; 15777, Milton, FL; all on **J. virginiana.**

Schizopora paradoxa (Shrad.:Fr.) Donk 15693, St. Augustine, Fl; 2285, DeFuniak Springs, FL; the preceeding on **J. virginiana**; 2305, LSU campus, Baton Rouge, on **J. phoenicea.**

Sebacina epigaea (Berk. et Br.) Rea. 2310, LSU campus, Baton Rouge, on base of living **J. virginiana.**

Tubulicrinis medius (Bourd. et Galz.) Oberw. 2297, Milton, FL, on **J. virginiana**; 2304, LSU campus, Baton Rouge, on **J. phoenicea.**

Vararia gomezii Boid. et Lanq. This was also reported by us from the United States for the first time from Baton Rouge, but it is widely distributed throughout the Gulf Coast region. 15660, Santa Rosa Beach, FL; 15665, Panama City, FL; 15707, Gainesville, FL; 2298, 15760, Milton, FL, all on **J. virginiana**; 2302, 15800, LSU campus, Baton Rouge, on **J. phoenicea.**

EXPANDED KEY TO FUNGI ON JUNIPERS IN THE GULF COAST REGION

1. Hymenophore tubular to cupulate 2

1. Hymenophore smooth, hydnaceous or lamellate 8

    2. Basidiocarps consisting of free, single tubes or cupules . 3

    2. Basidiocarps with hymenophore consisting of united tubes . 4

3. Basidiocarps cupulate, pale vinaceous gray ... **Stigmatolemma taxi**

3. Basidiocarps tubular, white .... **Henningsomyces candidus**

4. Basidiocarps stipitate; upper surface and stipe laccate; basidiospores pigmented, with a double wall .. **Ganoderma sp.**

4. Basidiocarps sessile or resupinate; basidiospores hyaline, wall not double 5

5. Basidiocarps sessile, perennial; context and tubes rose colored .... **Fomitopsis feei**

5. Basidiocarps resupinate, annual; context not rose colored 6

6. Basidiospores cylindric, with minute echinulae in rows, appearing longitudinally striate ... **Pachykytospora alabamae**

6. Basidiospores subglobose to broadly ellipsoid 7

7. Basidiospores subglobose; hyphae simple-septate .... **Ceriporia xylostromatoides**

7. Basidiospores broadly ellipsoid; generative hyphae with clamps .... **Schizopora paradoxa**

8. Hymenophore lamellate 9

8. Hymenophore smooth or hydnaceous 14

9. Tissue turning green in KOH .... **Anthracophyllum lateritium**

9. Tissue not turning green in KOH 10

10. Basidiocarps large, commonly over 5 cm in diam, stipitate 11

10. Basidiocarps small, mostly less than 1 cm wide, sessile or stipitate 12

11. Fruiting in clusters at the base of trees and stumps .... **Naematoloma fasciculare**

11. Fruiting singly .... **Phylloporus rhodoxanthus**

12. Basidiocarps centrally stipitate .... **Hemimycena albida**

12. Basidiocarps sessile or laterally stipitate 13

13. Pleurocystidia thick-walled, heavily incrusted .... **Hohenbuehelia approximans**

13. Pleurocystidia thin-walled, not incrusted .... **Marasmiellus juniperinus**

14. Basidia vertically septate 15

14. Basidia nonseptate 18

15. Hymenial surface with minute aculei .... **Heterochaete shearii**

15. Hymenial surface smooth 16

16. Basidiospores thick-walled, ellipsoid ..... **Sebacina epigaea**

16. Basidiospores thin-walled 17

17. Basidiospores allantoid; basidiocarps chalky white, on branches .... **Exidiopsis calcea**

17. Basidiospores ellipsoid; basidiocarps pale buff, at base of trunks .... **Sebacina incrustans**

18. Hymenophore hydnaceous 19

18. Hymenophore smooth or nearly so 25

19. Basidiocarps resupinate, hymenial surface white to cream colored or pale buff 20

19. Basidiocarps often reflexed or pileate; hymenial surface pinkish-buff .... **Steccherinum ochraceum**

20. Basidiospores echinulate; some hyphae ampullate .... **Trechispora farinacea**

20. Basidiospores smooth; hyphae not ampullate 21

21. Teeth with an apical amber droplet; basidiospores allantoid, .75-1 µm in diam .... **Dacryobolus sudans**

21. Teeth not with an apical amber droplet, basidiospores cylindric to subglobose 22

22. Basidiospores subglobose; teeth flattened .... **Hyphodontia spathulata**

22. Basidiospores cylindric to ellipsoid 23

23. Basidiospores cylindric, 6-7.5 x 2.5-3 µm 24

23. Basidiospores ellipsoid, 5-6.5 x 3.5-4 µm .... **Hyphodontia juniperi**

24. Basidiocarps firm and compact; hymenial surface grandinioid .... **Hyphodontia crustosa**

24. Basidiocarps soft and loosely constructed; hymenial surface odontioid .... **Hyphodontia nespori**

25. Dextrinoid asterohyphidia, dichohyphidia, or dendrohyphidia present 26

25. Dextrinoid hyphidia not present 28

26. Subiculum composed mainly of asterohyphidia .... **Asterostroma muscicola**

26. Subiculum and/or hymenium with dichohyphidia or dendrohyphidia 27

27. Dichohyphidia present; basidiospores fusiform ... **Vararia gomezii**

27. Dendrohyphidia present; basidiospores globose .... **Scytinostroma portentosum**

28. Amyloid lyocystidia present .... **Tubulicrinis medius**

28. Amyloid lyocystidia absent 29

29. Conical, heavily incrusted cystidia present 30

29. Conical, heavily incrusted cystidia absent 33

30. Basidiocarps very thin and inconspicuous; basidiospores globose .... **Litschauerella clematidis**

30. Basidiocarps thick and conspicuous; basidiospores ellipsoid to allantoid 31

31. Hymenial surface purplish gray to purplish brown; basidiospores allantoid; clamps present 32

31. Hymenial surface cream colored to pale buff; basidiospores ellipsoid; clamps absent .... **Phanerochaete flavido-alba**

32. Hymenial surface dark to pale purplish brown; margin white .... **Peniophora albobadia**

32. Hymenial surface dark purplish gray; margin concolorous .... **Peniophora junipericola**

33. Gloeocystidia abundant and conspicuous 34

33. Gloeocystidia absent or inconspicuous 36

34. Hymenial leptocystidia present; basidiospores broadly allantoid; stephanocysts usually present .... **Hyphoderma praetermissum**

34. Hymenial leptocystidia absent; basidiospores broadly ellipsoid; stephanocysts absent 35

35. Basidiospores slightly rough .... **Hypochnicium eichleri**

35. Basidiospores smooth .... **Hyphoderma baculorubrense**

36. Basidiospores amyloid; dendrohyphidia with amyloid incrustation .... **Aleurodiscus botryosus**

36. Basidiospores not amyloid; dendrohyphidia, if present, without amyloid incrustation 37

37. Basidiospores fusiform, dextrinoid; basidia up to 110 µm long .... **Coniophora fusispora**

37. Basidiospores not fusiform or dextrinoid; basidia not over 60 µm long 38

38. Basidiospores pigmented, asperulate to echinulate 39

38. Basidiospores hyaline, smooth or minutely verrucose 40

39. Basidiocarps pileate; hyphae simple-septate .... **Thelephora cuticularis**

39. Basidiocarps resupinate; hyphae with clamps .... **Tomentella asperula**

40. Catahymenium with finely branched dendrohyphidia present 41

40. Euhymenium present; dendrohyphidia absent 45

41. Basidiospores up to 27 µm long and 21 µm wide, echinulate .... **Dendrothele nivosa**

41. Basidiospores up to 15 µm long and 8 µm wide, smooth 42

42. Basidiospores biapiculate .... **Dendrothele itihummensis**

42. Basidiospores ellipsoid to globose 43

43. Basidiospores narrowly ellipsoid to cylindric-ellipsoid, 9.5-12 x 5-6 µm .... **Dendrothele pachysterigmata**

43. Basidiospores broadly ellipsoid to globose 44

44. Basidiospores globose .... **Dendrothele incrustans**

44. Basidiospores broadly ellipsoid to subglobose .... **Dendrothele griseocana**

45. Basidiospores triangular to stellate ...... **Xenosperma murrillii**

45. Basidiospores not triangular to stellate 46

46. Basidiospores with thickened walls 47

46. Basidiospores thin-walled 49

47. Basidiospores subglobose, finely verrucose .... **Hypochnicium punctulatum**

47\. Basidiospores ellipsoid, smooth 48

48\. Basidiospores 8.5-11 x 6-8 um ...... **Hypochnicium bombycinum**

48\. Basidiospores 6-7 x 5-5.5 um .... **Hypochnicium lundellii**

49\. Basidiospores 4.5-5.5 x 3.5-4.5 um; capitate cystidioles present .... **Hyphoderma sambuci**

49\. Basidiospores over 8 um long and 5 um wide 50

50\. Basidiospores 8-9.5 x 5-6 um; cystidia absent .... **Hyphoderma albocremeum**

50\. Basidiospores 11-14 x 5.5-7 um; cylindric cystidia present .... **Hyphoderma obtusiforme**

ASTEROSTROMA MUSCICOLA (Berk. et Curt.) Massee, J. Linn. Soc. Bot. 25:154. 1889.

Basidiocarps resupinate, effused up to 15 cm, soft and spongy or felt-like; hymenial surface smooth, light pinkish brown to ochraceous, with a thin whitish pruina visible at 50 X; margin fimbriate with coarse whitish hyphal strands and thicker pinkish buff rhizomorphs, hyphal strands and rhizomorphs also conspicuous in the lower subiculum and in the bark below the basidiocarp; subiculum soft and spongy or floccose under a more compact surface layer, pinkish-buff, up to .5 mm thick; hyphal system consisting of generative hyphae and asterohyphidia; generative hyphae hyaline, thin-walled, simple-septate, with occasional branching, 1.5-5 um in diam; asterohyphidia of lower subiculum with 4-7 main rays up to 5.5 um in diam at the base and tapering to a pointed apex, up to 60 um long, frequently dichotomously branched, rarely with three or more branches; asterohyphidia of surface region smaller, with short main rays up to 5-20 um long, these mostly with 1-2 dichotomous branchings; cystidia frequent, thin-walled, clavate to bluntly fusiform, 40-60 x 8-11 um; basidia clavate or with a swollen base, mostly 2-sterigmate, rarely 4-sterigmate, simple-septate at the base, 25-32 x 6-8.5 um; basidiospores globose, strongly ornamented with rounded tubercules up to 2 um long,. hyaline, amyloid in Melzer's reagent, 6.5-9 um in diam, with a prominent blunt hilar appendix. Associated with a white rot. 2276, DeFuniak Springs, Walton County, FL, on bark of living **J. virginiana**. **Asterostroma muscicola** occurs on other substrates in the Gulf Coast region, commonly on dead standing hardwoods, especially oaks.

CONIOPHORA FUSISPORA (Cke. et Ell.) Sacc., Syll. Fung. 6:650. 1888.

Basidiocarps annual, resupinate, effused up to 5 cm, usually developing in small patches of mycelium, soft and fragile, easily separated from substrate; hymenial surface dingy cream at first, becoming brownish with maturation of spores, smooth; margin white to cream colored, with coarse hyphal strands; subiculum composed of loosely interwoven hyphal strands, soft; hyphal system monomitic; hyphae of strands thin-walled, hyaline, mostly simple-septate, but some with single, double, or multiple clamps, the larger hyphae with multiple clamps up to 18 um in diam, the others 4-7 um in diam;

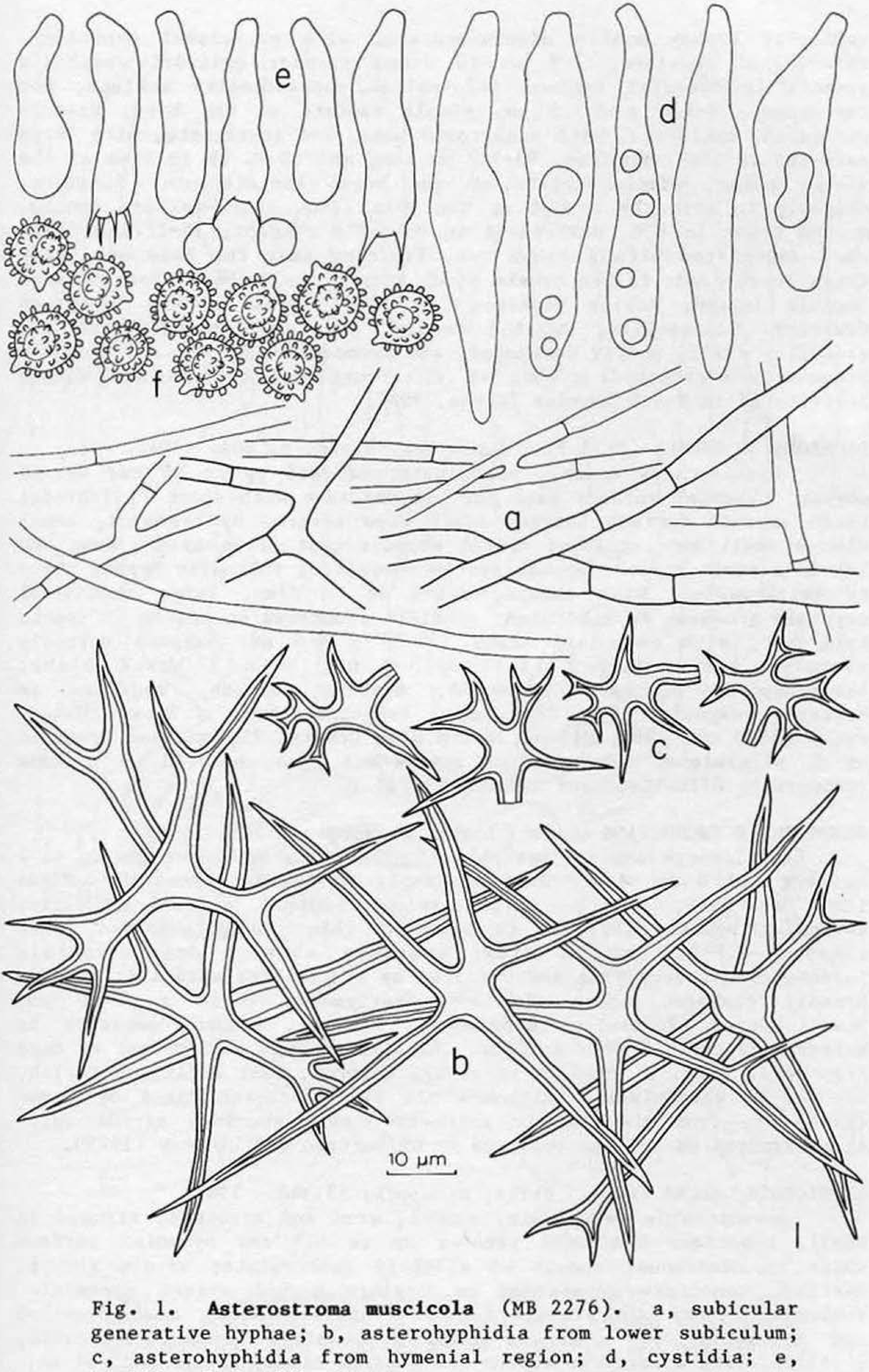


Fig. 1. **Asterostroma muscicola** (MB 2276). a, subicular generative hyphae; b, asterohyphidia from lower subiculum; c, asterohyphidia from hymenial region; d, cystidia; e, basidia; f, basidiospores.

subicular hyphae mostly simple-septate, with occasional branching, thin-walled, hyaline, 3-9 µm in diam; slender cylindric hyphidia present in hymenial region, thin-walled, occasionally septate, not incrusted, 90-110 x 3-5.5 µm, simple septate at the base; basidia elongated, cylindric, with a narrowed base, 2-4 sterigmate, with large guttules in the cytoplasm, 90-110 µm long and 10-12 µm in diam at the widest point, simple-septate at the base; basidiospores fusiform, slightly to strongly curved at the basal end, thick-walled, smooth, golden brown in KOH, dextrinoid in Melzer's reagent, 15-17.5 x 5.5-7 µm. Associated with a brown rot, fruiting near the base of living trees or on dead, fallen trunks of **J. virginiana.** 15643, Fort Gaines, Dauphin Island, Mobile County, AL; 15740, 15741, 15749, Evergreen Cemetery, Gainesville, Alachua County, FL. The basidiocarps are generally small, poorly developed, and inconspicuous, and are probably frequently overlooked. This is a circumglobal species and widely distributed in North America (Ginns, 1982).

DACRYOBOLUS SUDANS (Fr.) Fr., Summa Veg. Scand. p. 404. 1849.

Basidiocarps annual, resupinate, effused up to 10 cm; margin abrupt; hymenial surface pale buff, hydnaceous with short cylindrical teeth, smooth surface between teeth also covered by hymenium, teeth with a small amber-colored apical droplet that often breaks away and leaves a small crater; hyphal system monomitic; subicular hyphae thin- to thick-walled, with clamps, 2.5-4 µm in diam; large rhomboidal crystals abundant in subiculum; cystidia clustered at apices of teeth, cylindric, with secondary septa, 50-70 x 4-6 µm; basidia narrowly clavate, 4-sterigmate, 13-17 x 3-4 µm, with a basal clamp; basidiospores narrowly allantoid, hyaline, smooth, negative in Melzer's reagent, 5-7 x .75-1 µm. Associated with a brown cubical rot. 15775 and 2296, Milton, Santa Rosa County, FL, on dead branches of **J. virginiana. Dacryobolus sudans** was also reported on Arizona junipers by Gilbertson and Lindsey (1975).

DENDROTHELE INCRUSTANS (Lemke) Lemke, Persoonia 3:366. 1965.

Basidiocarps annual, resupinate, effused in small patches up to 2 cm long and 8 mm wide, cracking deeply on drying; hymenial surface ivory to buff, smooth, margin abrupt; hyphal system monomitic; subicular hyphae difficult to discern, thin- to firm-walled, with clamps, 1.5-3.5 µm in diam; cystidia absent; dendrohyphidia inconspicuous, very fine and obscured by crystalline material; basidia broadly clavate, apparently 2-4 sterigmate, 20-38 x 9-12 µm; basidiospores globose to subglobose, hyaline, smooth, negative in Melzer's reagent, 8-11 x 8-10 µm. Associated with a white rot of dead branches. 2318, F. Roberts property, Clinton, East Feliciana Parish, LA, on **J. virginiana.** Although all the specimens cited by Lemke (1964) are from the Pacific Northwest, this specimen agrees well. Also reported on Arizona junipers by Gilbertson and Lindsey (1975).

EXIDIOPSIS CALCEA (Pers.) Wells, Mycologia 53:348. 1961.

Basidiocarps resupinate, annual, arid and crustose, effused in small, sometimes confluent patches up to 1.5 cm; hymenial surface white to cinereous, smooth to slightly tuberculate; margin abrupt, fertile, sometimes separating on drying; hyphal system monomitic, subicular hyphae with clamps; dendrohyphidia present, much branched and contorted, 1.5-4 µm in diam, hypobasidia globose to ovoid, 2-celled, with a vertical septum and a basal clamp, 15-20 x 10-12 µm,

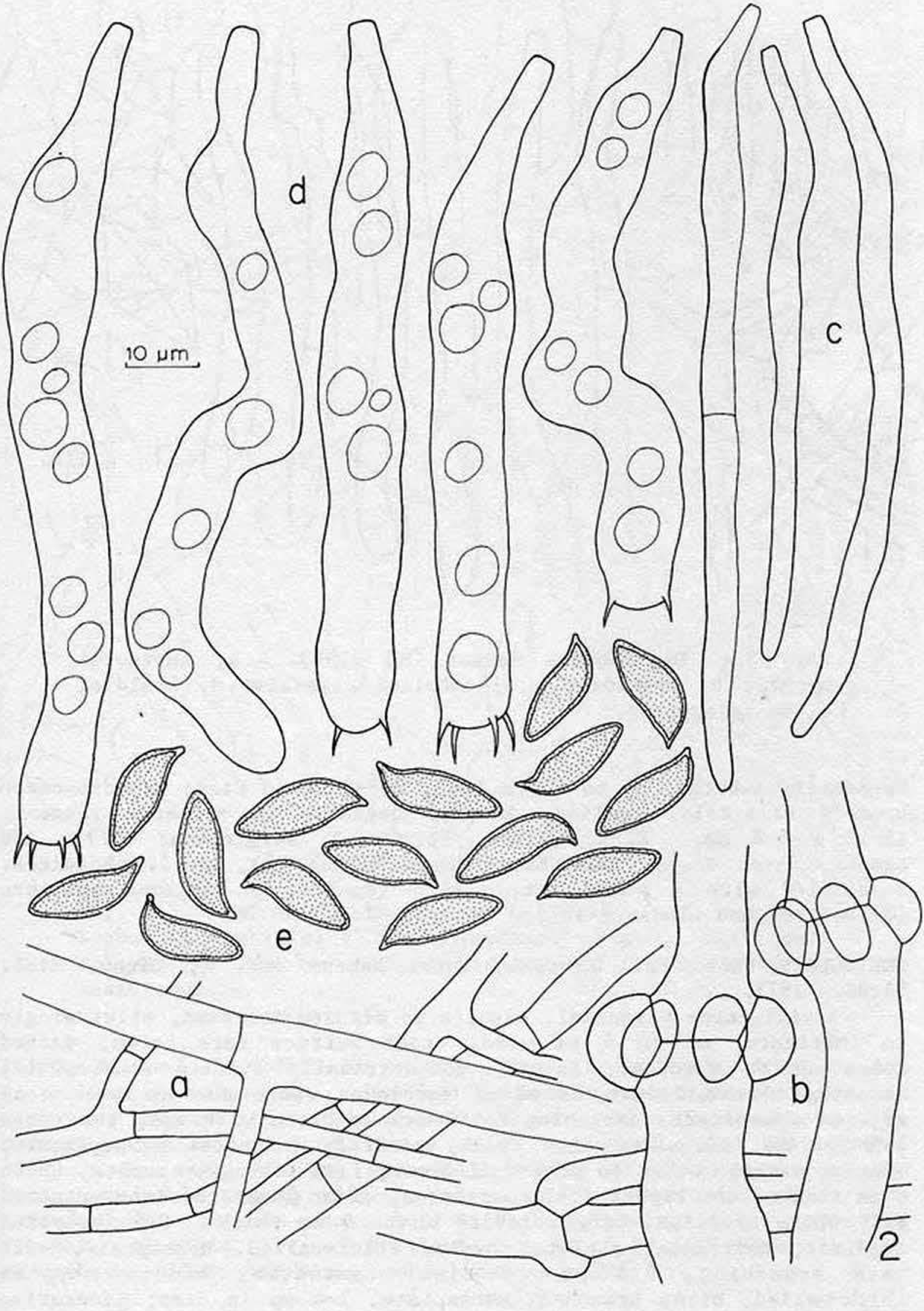


Fig. 2. **Coniophora fusispora** (RLG 15740). a, simple-septate subicular hyphae; b, subicular hyphae with double or multiple clamps; c, hymenial hyphidia; d, basidia; e, basidiospores.

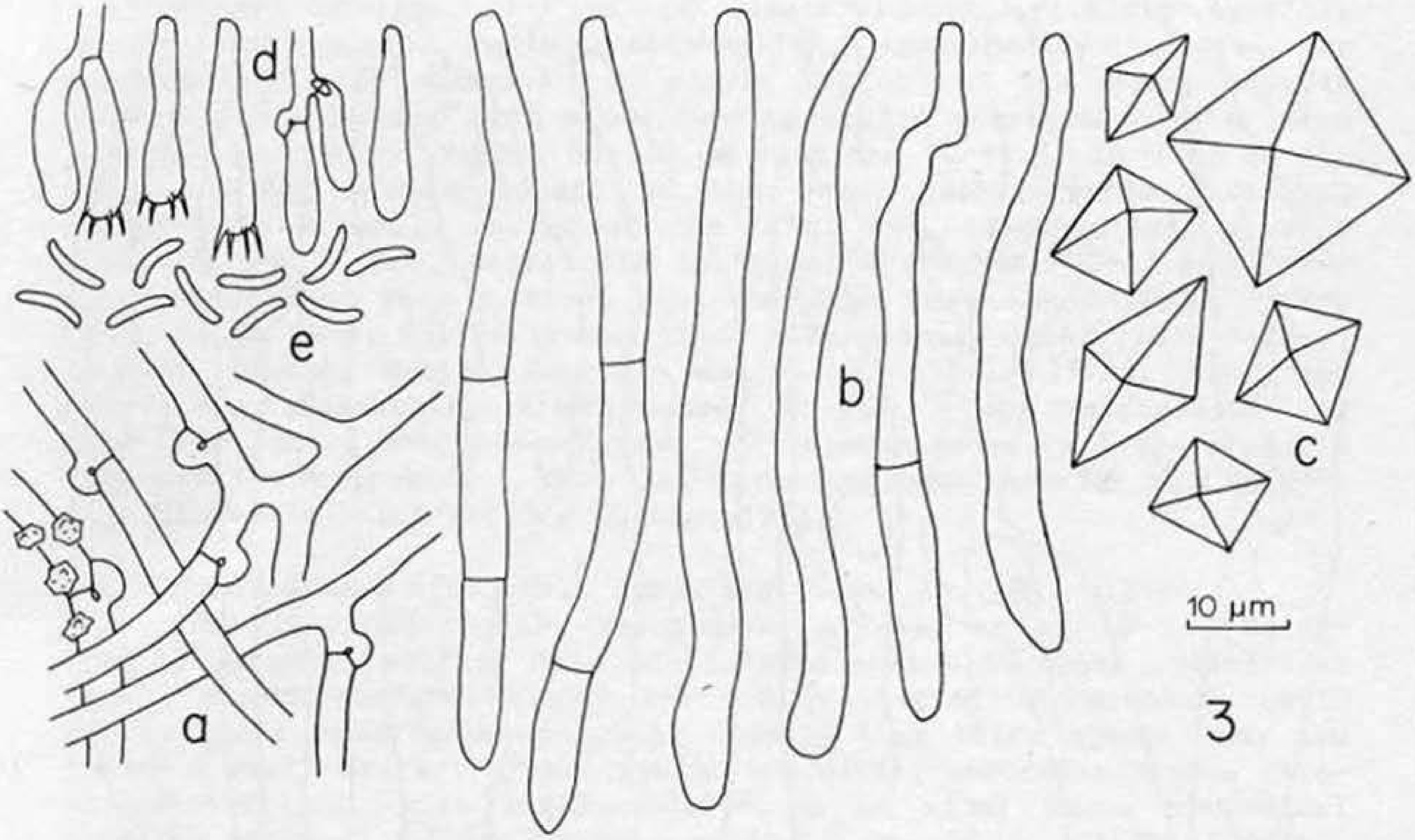
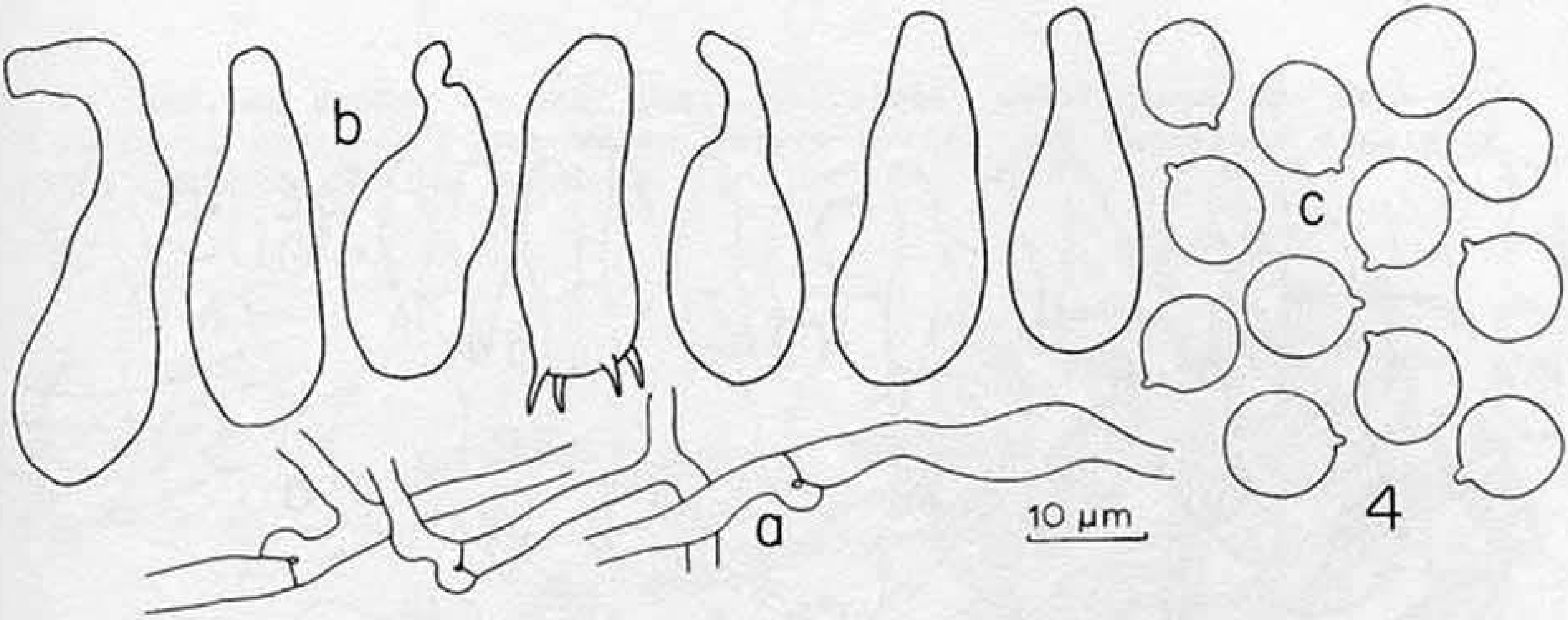


Fig. 3. **Dacryobolus sudans** (MB 2296). a, subicular hyphae; b, cystidia; c, rhomboidal crystals; d, basidia; e, basidiospores.

epibasidia tubular, up to 40 µm long, 2.5-4 µm in diam; basidiospores broadly allantoid, hyaline, smooth, negative in Melzer's reagent, 15-19 x 6-8 µm. 2295, Milton, FL, on **J. virginiana**; 15791, LSU campus, Baton Rouge, East Baton Rouge Parish, LA, on **J. phoenicea.** Associated with a white rot. Also reported on Arizona junipers (Gilbertson and Lindsey, 1975).

FOMITOPSIS FEEI (Fr.) Kreisel, Univ. Habana Ser. 4, Cienc. Biol. 16:83. 1971.

Basidiocarps perennial, sessile to effused-reflexed, pilei single to imbricate, up to 4 cm wide; upper surface dark brown, matted tomentose to scrupose, faintly concentrically sulcate and zonate, becoming blackish-brown in older specimens; pore surface pale rose colored when fresh, darkening to vinaceous brown with age, the pores 5-8 per mm, circular, with thick, minutely tomentose dissepiments; context pinkish brown to dark dull brown, firm-fibrous, azonate, up to 4 mm thick; tube layers dull rose brown, older layers of tubes stuffed with white mycelium, single layers up to 4 mm thick. Hyphal system trimitic; contextual skeletal hyphae thick-walled, nonseptate, with rare branching, 3-5 µm in diam; contextual binding hyphae thick-walled, often branched, nonseptate, 2-4 µm in diam; generative hyphae thin-walled, with clamps, 2-3.5 µm in diam; fusoid cystidioles present, 15-20 x 4-5 µm; basidia clavate, 4-sterigmate, 14-17 x 4.5-6 µm, with a basal clamp; basidiospores oblong, hyaline, smooth, negative in Melzer's reagent, 4.5-6 x 2-2.5 µm. 2237, Avery Island, Iberia Parish, LA; 2278, DeFuniak Springs, FL; 15752, Gainesville, FL;



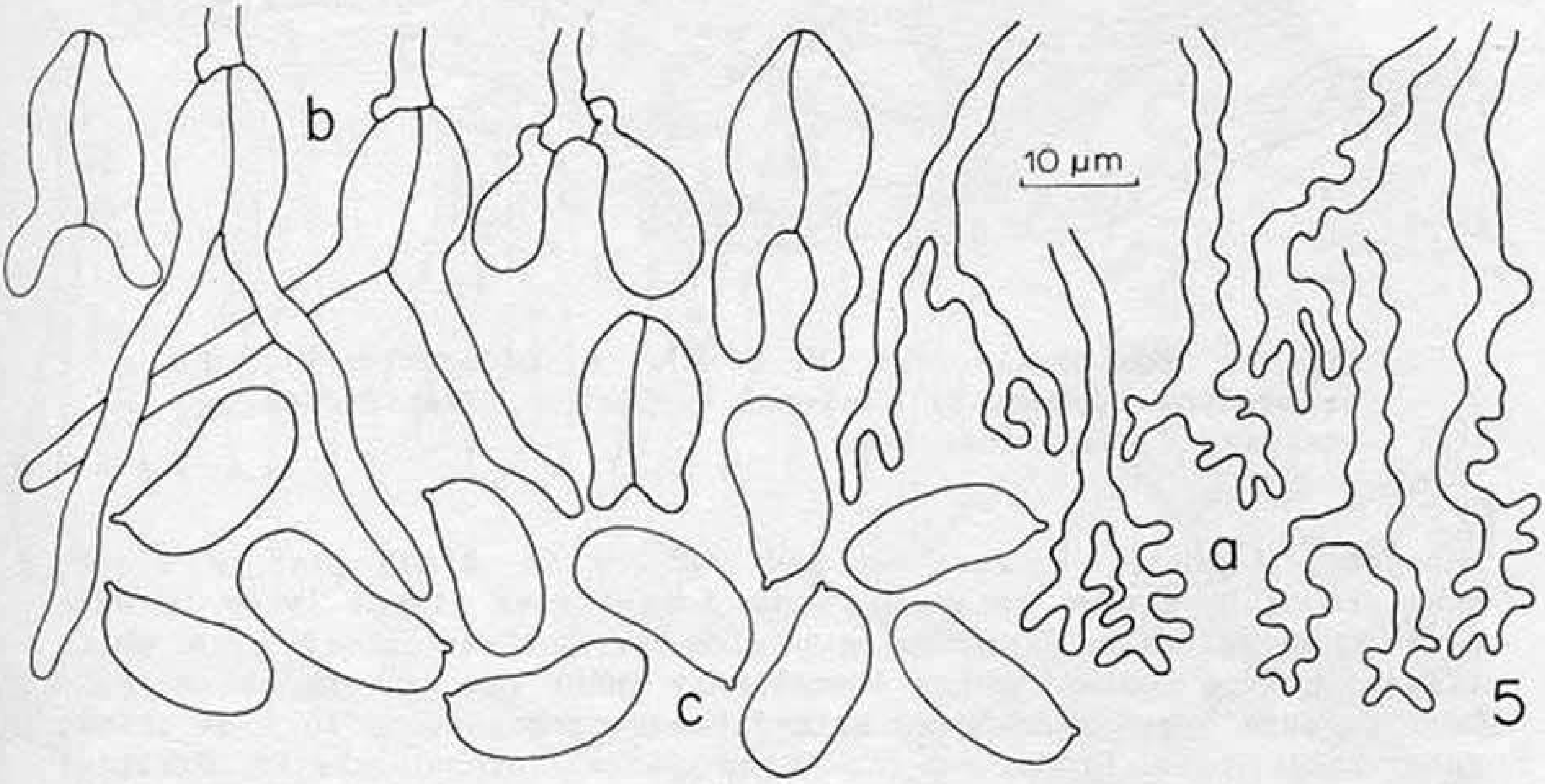


Fig. 4. **Dendrothele incrustans** (MB 2318). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 5. **Exidiopsis calcea** (MB 2295). a, dendrohyphidia; b, basidia; c, basidiospores.

15780, Milton, FL; 2345, St. Joseph Catholic Cemetery, Baton Rouge, LA; all on **J. virginiana.** Previous collections of **Fomitopsis** species with rose colored tissue on **J. virginiana** in the Southeastern U.S. have been identified as **F. rosea** or **F. cajanderi** (USDA Host Index, 1960). Our specimens are certainly neither of those species. **F. rosea** has straight, cylindric spores and is a boreal fungus. **F. cajanderi** has a wide range but differs morphologically in having slender, allantoid spores. Previous records of **F. feei** have all been on hardwoods (Carranza-Morse and Gilbertson, 1986).

GANODERMA SP. RLG 15764

Basidiocarp annual, laterally stipitate; pileus dimidiate, 1.8 x 2 x 1 cm; upper surface of pileus pale buff to light reddish brown, laccate and shiny, shallowly sulcate at the base and near the margin; margin rounded, fertile below; stipe lateral, cylindric, dark

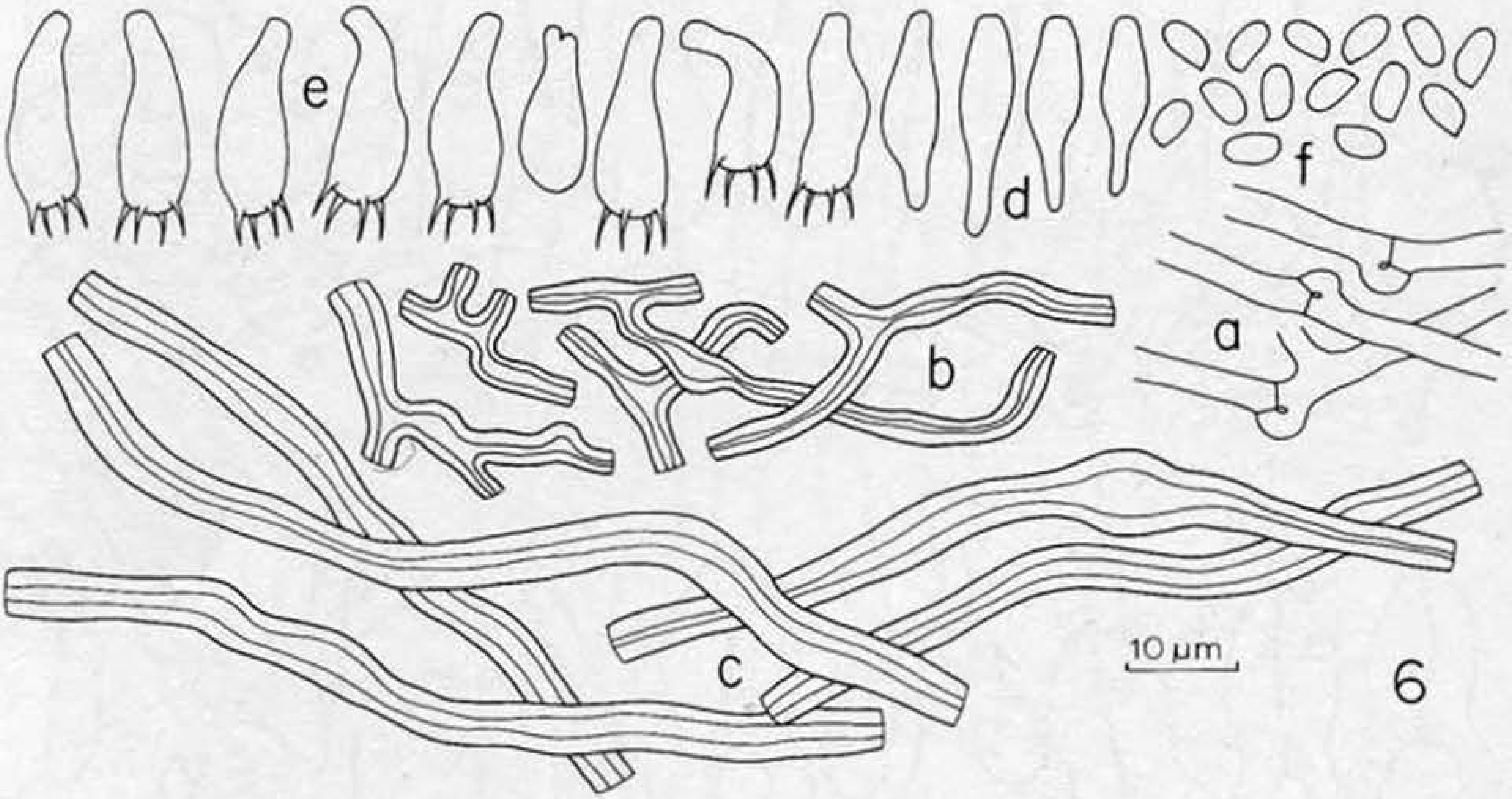


Fig. 6. **Fomitopsis feei** (MB 2237). a, generative hyphae; b, binding hyphae; c, skeletal hyphae; d, cystidioles; e, basidia; f, basidiospores.

mahogany, laccate, 2 cm long and 0.8 cm in diam, with a rough, non-laccate hypogeous extension 3 cm long, inner tissue ivory to pale buff with scattered longitudinal pits or pockets lined with white tissue; pileus context white immediately under the laccate cutis, pale buff to pale brown elsewhere, soft-fibrous, azonate, up to 4 mm thick; tube layer pale brown, up to 6 mm thick; hyphal system dimitic; contextual generative hyphae difficult to discern, thin-walled, with clamps, 2-3.5 µm in diam; contextual skeletal hyphae hyaline, thick-walled, nonseptate, becoming dendritically branched with long tapering apices, often sinuous or wavy, main branches 2.5-4 µm in diam, tapering down to apices less than 1 um in diam; tramal hyphae similar; cutis of pileus and stipe composed of a palisade of pilocystidia covered by the varnish layer, on the pale pileus surface pilocystidia are thin-walled, clavate, weakly amyloid, on the dark stipe surface pilocystidia are closely packed, clavate, rarely branched or lobed, thick-walled, moderately amyloid, 30-77 x 7.5-14 µm; hymenial cystidia none; basidia broadly clavate to sub-globose, 4-sterigmate, 17-21 x 9-12 µm; basidiospores cylindric to narrowly ellipsoid, pale brown in KOH, negative in Melzer's reagent, with a double wall, walls separated by indistinct interwall pillars, apex truncate with a germ pore, 9.5-14 x 4-6 µm. 15764, Milton, FL, on roots of **J. virginiana.** This small **Ganoderma** basidiocarp has a combination of characters unlike that of any member of the **Ganoderma lucidum** complex recognized in North America. The narrow, often cylindric spores are highly unusual in the group. **Ganoderma zonatum** Murr., a southern species restricted to palms, has relatively narrow spores, but its pilocystidia are quite different from our unidentified specimen (Gilbertson et Ryvarden, 1986). As we were unable to get a culture, we prefer to wait until additional collections are made and cultural characters are known before making any decisions regarding the taxonomy of this specimen.

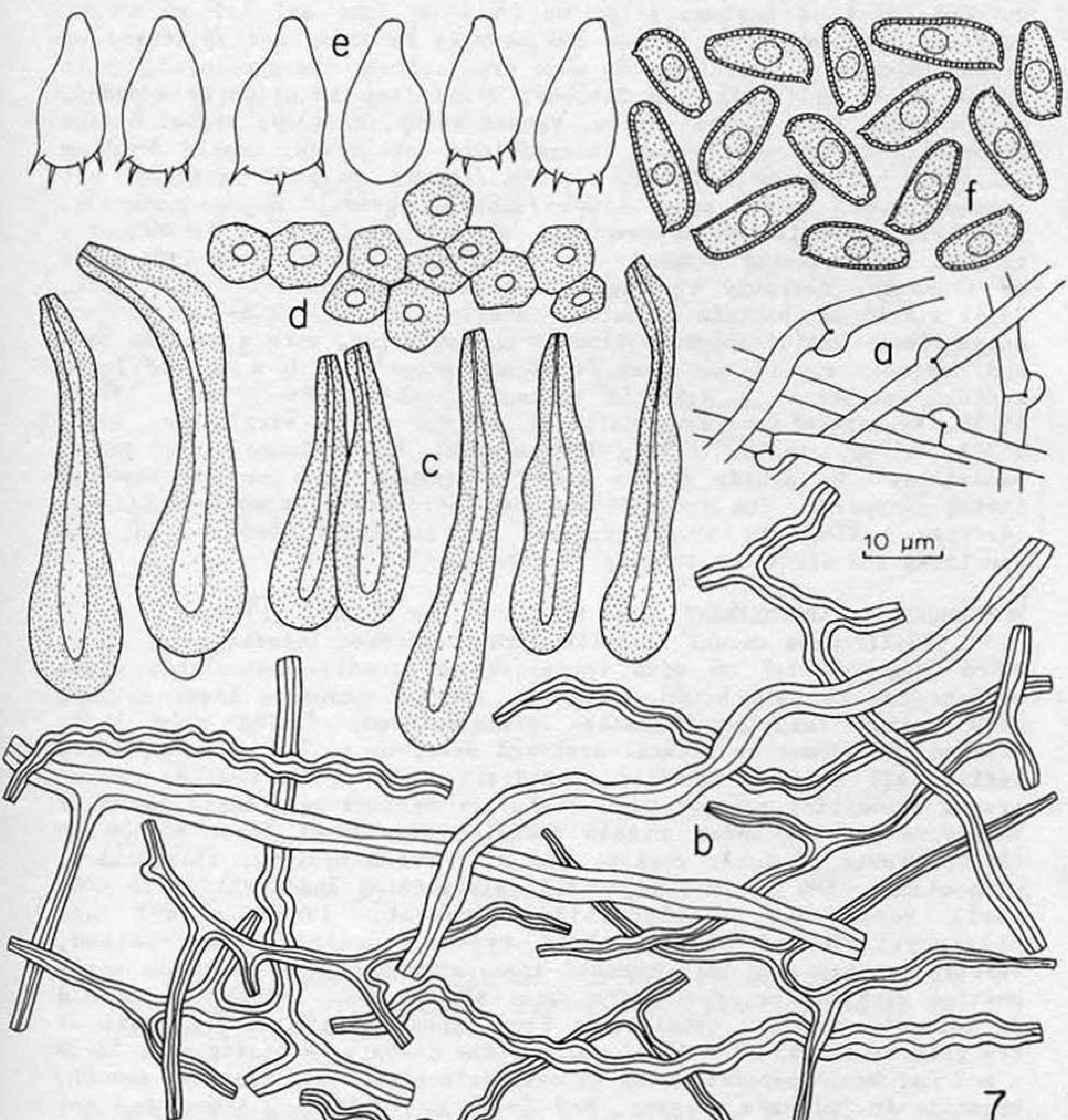


Fig. 7. **Ganoderma** sp. (RLG 15764). a, tramal generative hyphae; b, contextual skeletal hyphae; c, pilocystidia; d, cross section through pilocystidia; e, basidia; f, basidiospores.

HEMIMYCENA ALBIDA (Murr.) Singer, Sydowia 15:61. 1962.

Basidiocarps annual, centrally stipitate, single or in small clusters; pileus circular, up to 1.5 cm wide, flat or with a shallow central depression, cream colored to pale buff, dry, glabrous, azonate, becoming wrinkled on drying; margin concolorous, acute, curving under on drying; stipe up to 4 cm long and 2.5 mm thick, glabrous, pinkish buff, hollow and usually twisting and splitting on drying, appearing cartilaginous when dry; context cream-colored, up to .5 mm thick, uniformly soft-fibrous; gills free to slightly adnexed, pale pinkish buff, edges entire, rather thick, crowded; hyphal system monomitic; contextual hyphae thin-walled, interwoven, mostly 4-10 µm in diam but some inflated up to 16 µm, clamps present but inconspicuous, also some simple septa; tramal hyphae similar, parallel; gloeoplerous hyphae also present, refractive in Melzer's reagent and staining brightly in phloxine; pleurocystidia infrequent to abundant, narrowly to broadly clavate, thin-walled, mammillate, 28-45 x 7-14 µm; basidia clavate, 4-sterigmate, 25-30 x 6-8 µm, with a basal clamp; basidiospores cylindric to navicular, with a pointed base and narrower toward the apex, hyaline, smooth, with a single large guttule, negative in Melzer's reagent, 9-12 x 3.5-4.5 µm. 15745, 15755, Evergreen Cemetery, Gainesville, FL, on **J. virginiana**; 2311, 15788, 15790, 15795, 15797, LSU campus, Baton Rouge, LA, on **J. phoenicea. H. albida** fruits near the ground line at the base of living junipers. The variation in the incidence of pleurocystidia is striking. They are always present but extremely abundant in some specimens and difficult to find in others.

HOHENBUEHELIA APPROXIMANS (Pk.) Sing., Lilloa 22:255. 1951.

Basidiocarps annual, sessile with a narrowed lateral base, up to 2 cm long and 1.5 cm wide, petaloid to broadly spathulate; upper surface tan to pale brown, glabrous, smooth, azonate; lower surface with radial lamellae; lamellae cream-colored, drying pale buff, crowded, decurrent on lateral narrowed base, up to 0.7 mm deep, edges entire, all surfaces clearly cystidiate under a 30 X lens; hyphal system monomitic; context with a sharply defined gelatinous layer of interwoven hyphae under a thin cuticle, gelatinous layer 65-100 µm thick; hyphae of lower context and gill trama hyaline, thin-walled, with clamps, 3-6 µm in diam, walls gelatinizing and swelling in KOH; small ventricose cheilocystidia present, 15-24 x 4-5 µm; pleurocystidia of the metuloid type, abundant, thick-walled, ventricose, tapering to a rounded apex, most incrusted over the upper portion with coarse crystalline material, hyaline, faintly dextrinoid in Melzer's reagent, originating from hyphae in the central part of the gill trama, 55-70 x 12-18 µm; basidia clavate, 4-sterigmate, 22-26 x 6-7 µm; basidiospores ovoid to cylindric-ellipsoid, hyaline, smooth, negative in Melzer's reagent, 6-9 (-11) x 3.5-5 µm. Associated rot unknown. 15733, 15738, 15743, Evergreen Cemetery, Gainesville, FL, on **J. virginiana.** Previous reports of **H. approximans** by Coker (1944) from North Carolina and Thorn and Barron (1986) from Ontario and New York were on hardwoods. Coker (1944) described two new species on "cedar" in North Carolina, **Pleurotus elegans** and **P. crustosus**, but both differ in numerous respects from our specimens. Both of these Coker names are illegitimate because no Latin diagnosis was given.

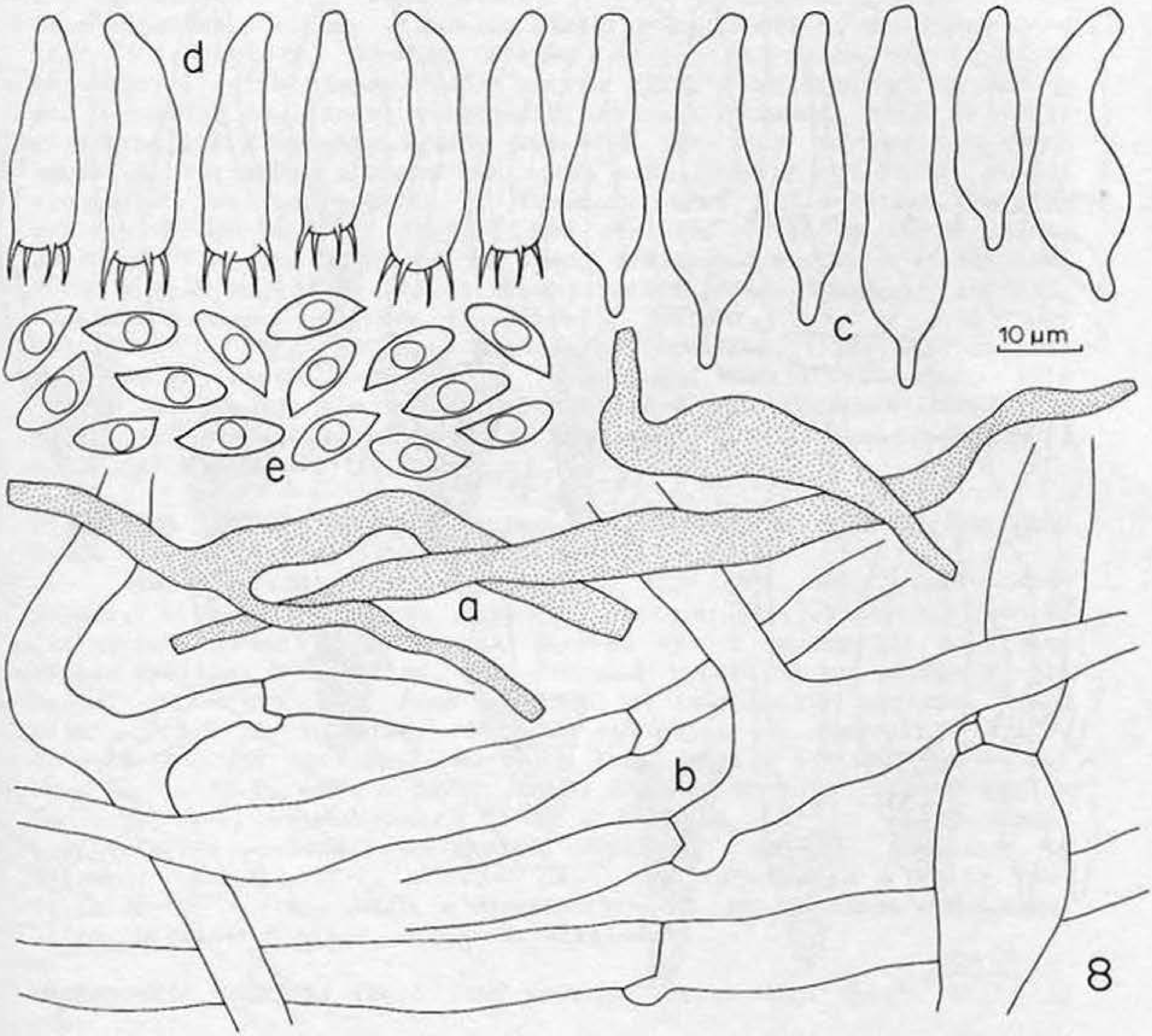


Fig. 8. **Hemimycena albida** (RLG 15797). a, gloeoplerous hyphae; b, contextual hyphae; c, pleurocystidia; d, basidia; e, basidiospores.

HYPHODERMA ALBOCREMEUM (Hoehn. et Litsch.) John Erikss. et Strid, in John Erikss. and Ryv., Cort. N. Europe 3:453. 1975.

Basidiocarps annual, resupinate, effused in small patches up to 1.5 cm, membranous, easily separated from substrate; hymenial surface white, smooth, cracking to expose a white, arachnoid subiculum; hyphal system monomitic; subicular and subhymenial hyphae thin- to firm-walled, closely septate with clamps at all septa, profusely branched, commonly with ampullate or swollen cells that branch into two hyphae, 5-10 µm in diam; cystidia absent; basidia in large, complex candelabra, narrowly clavate or almost cylindric, 4-sterigmate, 21-28 x 5-7 µm, evidently repetitive and arising from a mass of disorganized and collapsed hyphal walls that are apparently

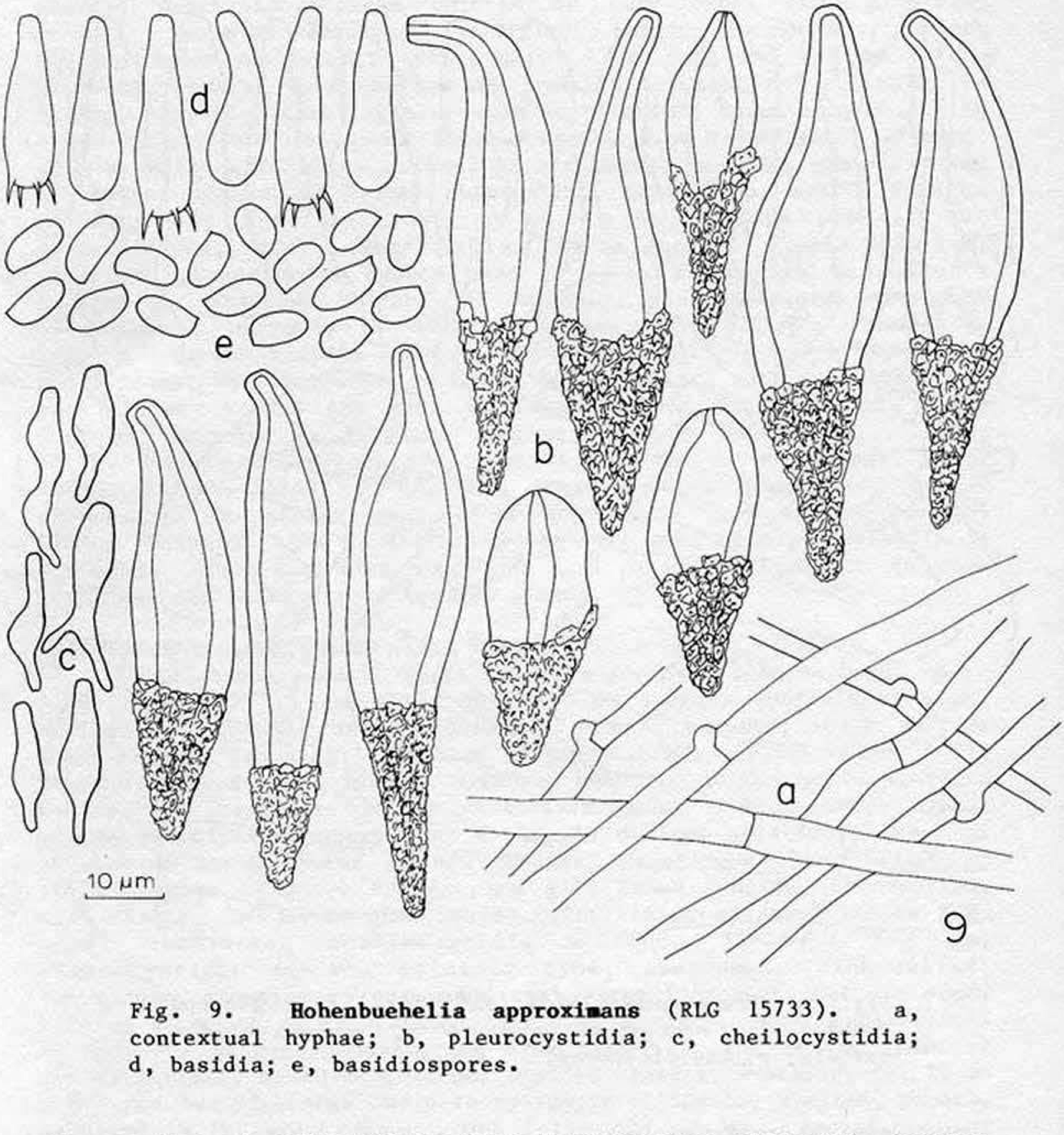


Fig. 9. **Hohenbuehelia approximans** (RLG 15733). a, contextual hyphae; b, pleurocystidia; c, cheilocystidia; d, basidia; e, basidiospores.

the remains of collapsed basidia; basidiospores ellipsoid, hyaline, smooth, negative in Melzer's reagent, 8-9.5 x 5-6 µm. 2301, LSU campus, Baton Rouge, LA, on **J. phoenicea.** This fungus apparently has not been reported from North America. It deviates somewhat from the description of **H. albocremeum** in Eriksson and Ryvarden (1975) in having hyphae with a more irregular branching pattern, spores without a prominent apiculus, and a disorganized sub-basidial layer. However it differs from the only other similar North American species, **Hyphoderma terricola** (Burt), in lacking cystidia and having larger spores. Jülich (1975) proposed a new genus, **Conohypha**, for these two species and perhaps our fungus represents a third.

HYPHODERMA BACULORUBRENSE Gilbn. et M. Blackwell, Mycotaxon 20:89. 1984.

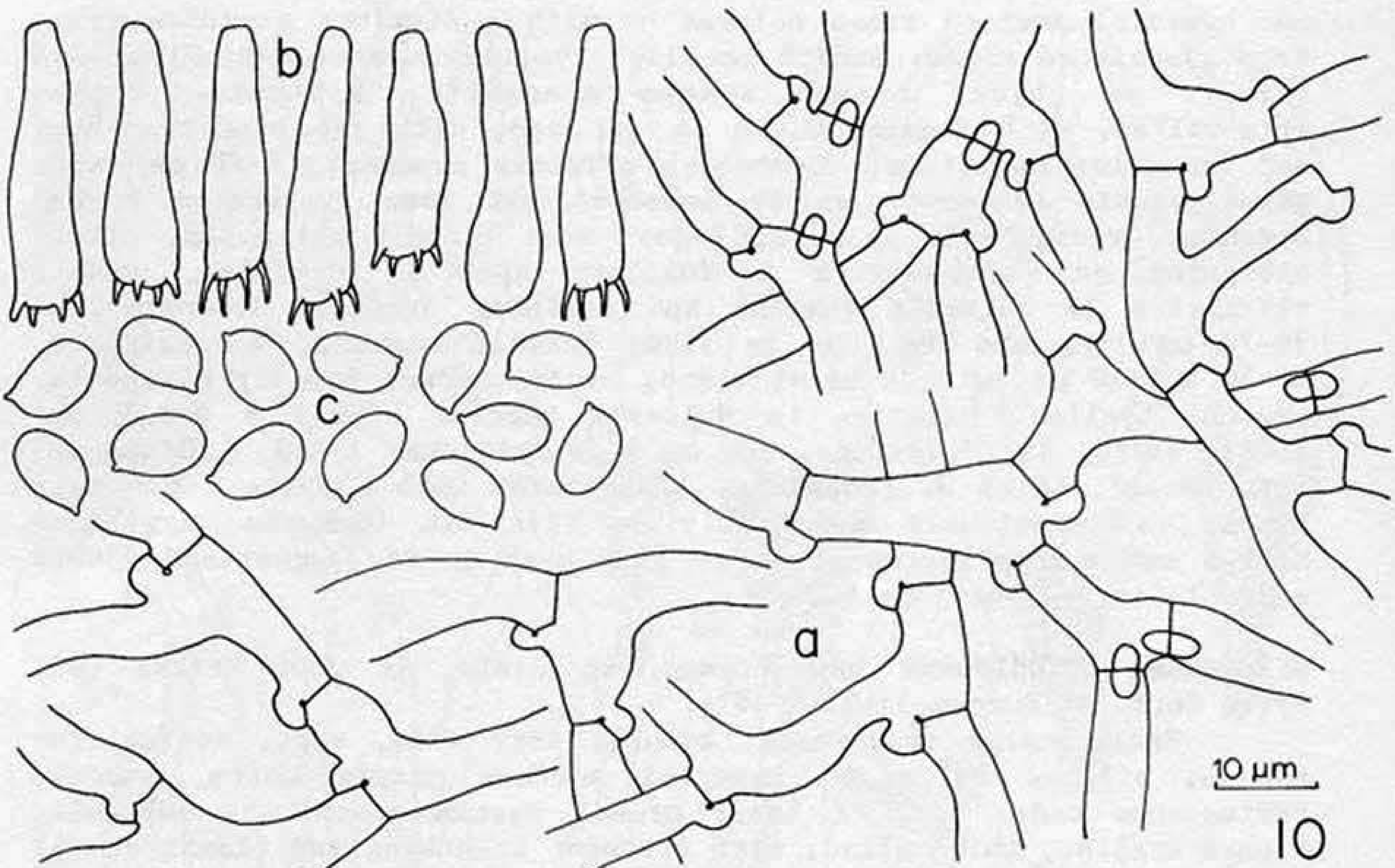
Basidiocarps resupinate, annual or persisting, effused up to 5 cm; hymenial surface cream colored or with a distinct greenish tinge from associated algae, smooth to slightly tuberculate; subiculum less than 1 cm thick; hyphal system monomitic; subicular hyphae thin-walled, with clamps, 2.5-6 µm in diam, with frequent branching and irregular swellings; rhomboidal crystals abundant, 6-20 µm wide; gloeocystidia frequent, mostly imbedded but some projecting beyond hymenium, variable in shape and size, some broadly ellipsoid, others elongated and often with a fusiform apex, thin-walled, highly refractive in Melzer's reagent and staining brightly in phloxine, 38-70 µm long and 8-13 µm in diam; basidia clavate, 4-sterigmate, 25-30 x 9-10 µm, with a basal clamp; basidiospores broadly ellipsoid, smooth, hyaline, negative in Melzer's reagent, 8-9.5 x 5-6.5 µm. 15761, 15770, 15778, Milton, FL, on **J. virginiana**; 15793, LSU campus, Baton Rouge, LA on **J. phoenicia.** Associated with a white rot. This fungus was previously known only on live oak (**Quercus virginiana** Mill.) and was collected by us on that host in St. Augustine (15697) and Chiefland (15679) in FL.

HYPHODERMA OBTUSIFORME John Erikss. et Strid, in John Erikss. and Ryv., Cort. N. Europe 3:493. 1975.

Basidiocarps resupinate, annual, very thin, soft, reticulate-porose, effused to 1 cm; hymenial surface grayish-white, smooth, farinaceous under a 30 X lens; hyphal system monomitic; subicular hyphae hyaline, thin-walled, with frequent branching and clamps at all septa, often branching from a clamp or immediately adjacent to a clamp, 3.5-5 µm in diam; cystidia cylindric to narrowly clavate, thin-walled, not incrusted, 40-50 µm long, mostly 6-8 µm in diam but some up to 12.5, with a basal clamp; basidia broadly clavate with a narrowed base, 4-sterigmate, 23-36 x 8-14 µm, with a basal clamp; basidiospores cylindric-ellipsoid, hyaline, smooth, negative in Melzer's reagent, 11-14 x 5.5-7 µm. Associated with a white rot, fruiting in contact with a basidiocarp of **Steccherinum ochraceum.** 2281A, DeFuniak Springs, FL, on **J. virginiana.**

HYPHODONTIA CRUSTOSA (Fr.) John Erikss., Symb. Bot. Upsal. 16:1, p. 104. 1958.

Basidiocarps annual, resupinate, effused up to 5 cm, tough, compact and adherent; hymenial surface odontoid with small, scattered aculei less than 1 mm long, some specimens nearly smooth, cream colored; margin white, abrupt to finely fimbriate; subiculum white, compact, less than 1 mm thick, often with greenish spots due to associated algae; hyphal system monomitic; subicular hyphae thin- to firm-walled, with clamps, often brached, 2.5-4 µm in diam; cystidia absent, fusoid hyphal ends present in hymenium and clustered at apices of aculei, 30-55 x 3-5 µm some lightly incrusted; basidia clavate, often with a median constriction, 4-sterigmate, 24-28 x 4-5.5 µm, with a basal clamp; basidiospores cylindric, hyaline, smooth, negative in Melzer's reagent, 5-7.5 x 2.5-3 µm. 15664, Panama City, Bay County, FL; 15668, 15671, Apalachicola, Franklin County, FL; 15694, 15696, St. Augustine, St. Johns County, FL; 2294, Milton, FL. All on bark or wood of dead branches of **J. virginiana.** Associated with a white rot. There is some variation in length of spores in the group of specimens



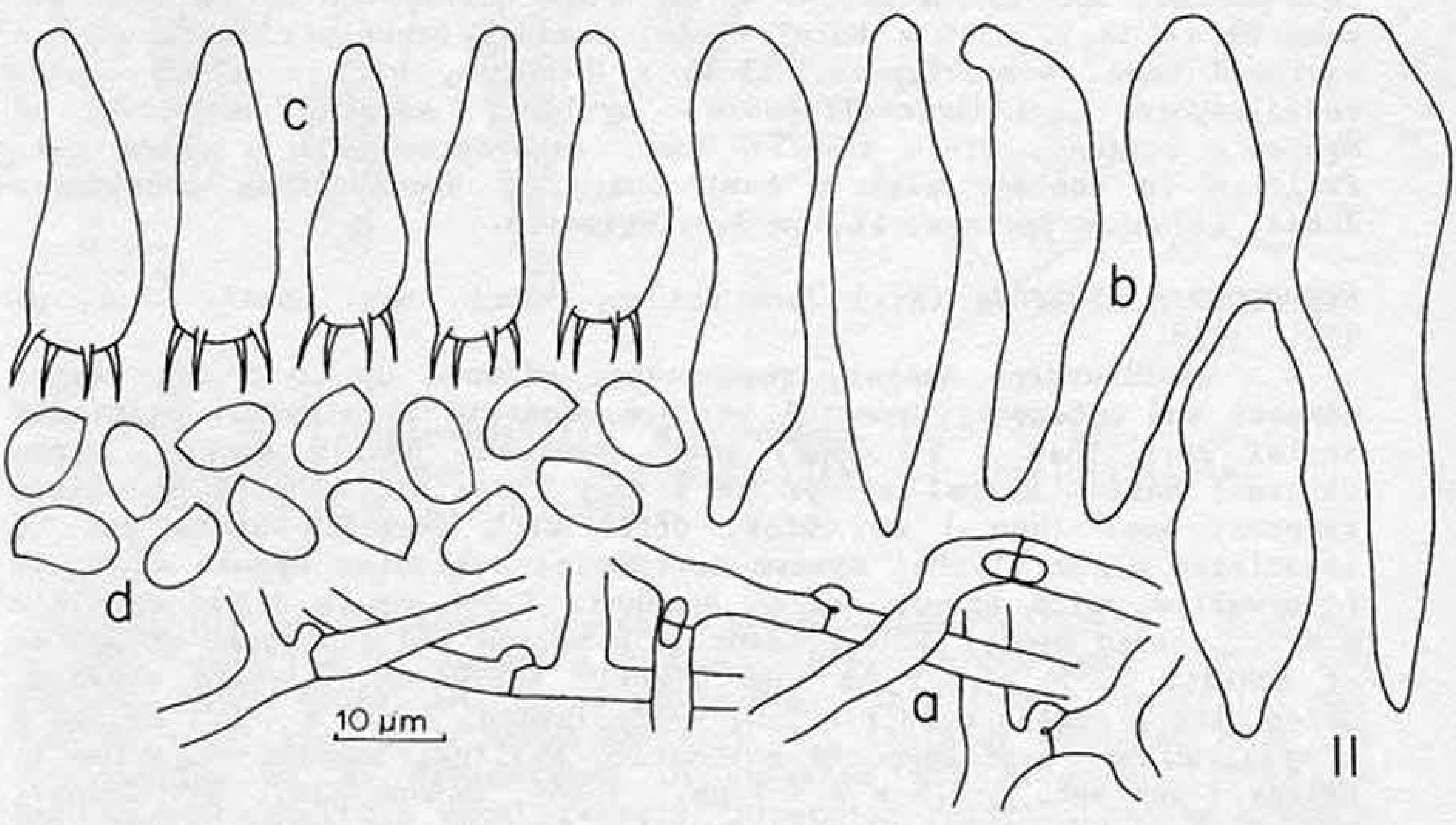
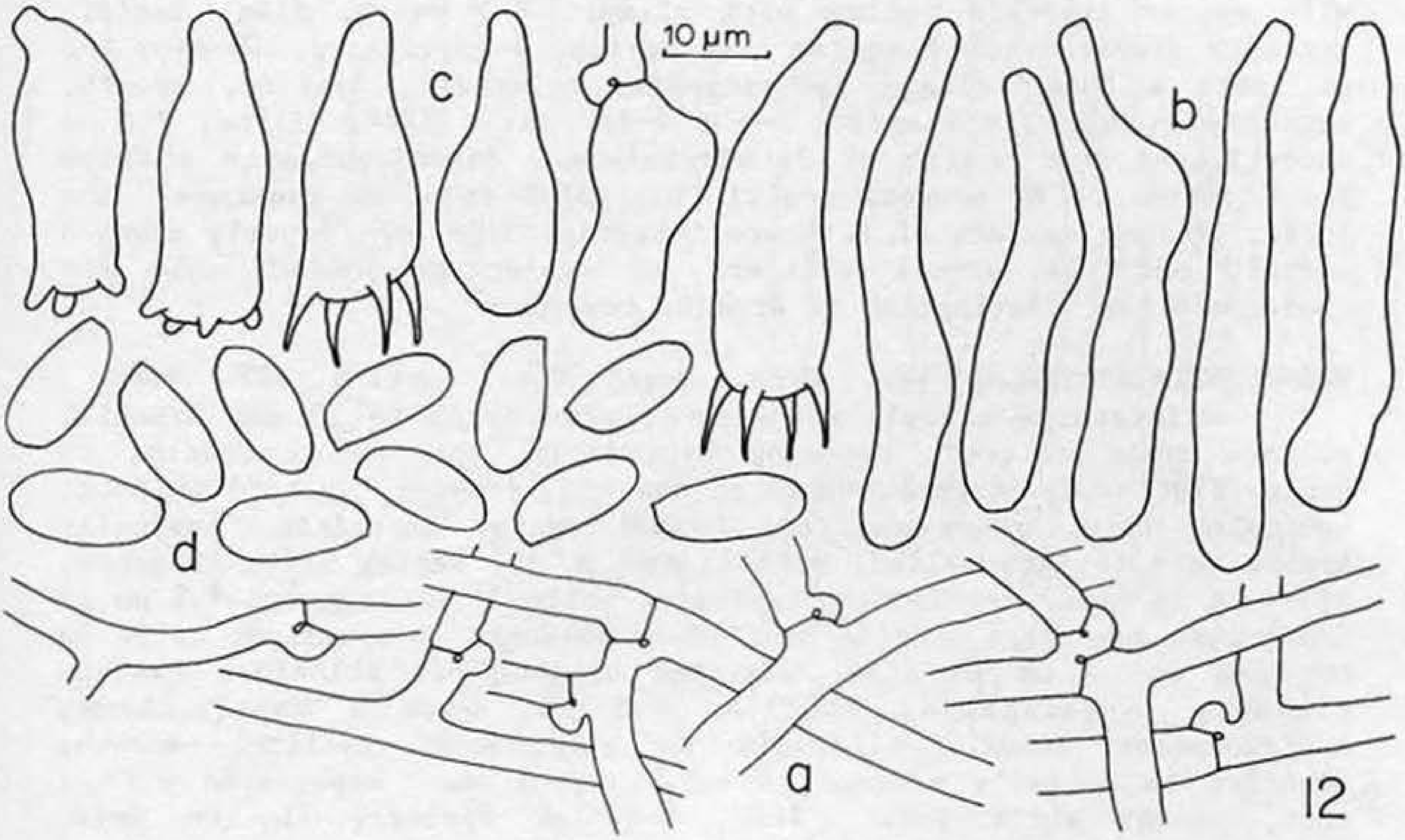


Fig. 10. **Hyphoderma albocremeum** (MB 2301). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 11. **Hyphoderma baculorubrense** (RLG 15778). a, subicular hyphae; b, gloeocystidia; c, basidia; d, basidiospores.

but they are macroscopically similar with very short scattered aculei and their other microscopic structures are similar.



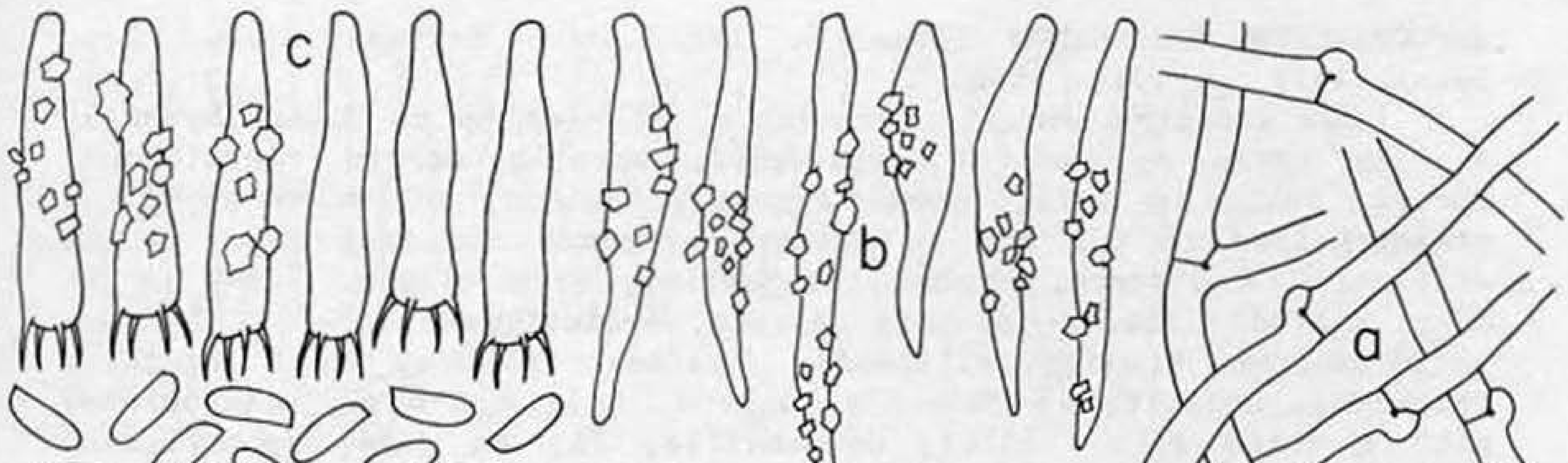


Fig. 12. **Hyphoderma obtusiforme** (MB 2281A). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores. Fig. 13. **Hyphodontia crustosa** (RLG 15671). a, subicular hyphae; b, fusoid hyphal ends from hymenium; c, basidia; d, basidiospores.

HYPHODONTIA NESPORI (Bres.) John Eriks. et Hjortst., in John Erikss. and Ryv., Cort. North Eur. 4:655. 1976.

Basidiocarps annual, resupinate, effused up to 10 cm, soft, with a loosely tomentose texture; hymenial surface white to cream colored, odontioid, with crowded, short aculei; margin white, thinning out, floccose to arachnoid; subiculum white, soft, less than 1 mm thick;

hyphal system monomitic; subicular hyphae loosely arranged, with clamps at all septa, frequently branched, thin-walled, 2.5-4 µm in diam; cystidia absent, capitate cystidioles present; hyphoid elements projecting in clusters from the apices of aculei, lightly incrusted, with coarse crystals, often with clamps, 3-5 µm in diam; basidia narrowly clavate with a median constiction, 4-sterigmate, 18-20 x 4-5 µm, with a basal clamp; basidiospores cylindric, hyaline, smooth, negative in Melzer's reagent, 5-6 x 2-2.5 µm. 15784, Milton, FL, on decorticated dead branch of **J. virginiana.** Associated with a white rot. Spores of **H. nespori** are similar to those of **H. crustosa.** The loose, cottony texture of **H. nespori** basidiocarps, the densely crowded aculei, and the apical clusters of projecting hyphal ends are characters that distinguish it from **H. crustosa.**

HYPHODONTIA SPATHULATA (Fr.) Parm., Consp. Syst. Cort. p. 123. 1968.

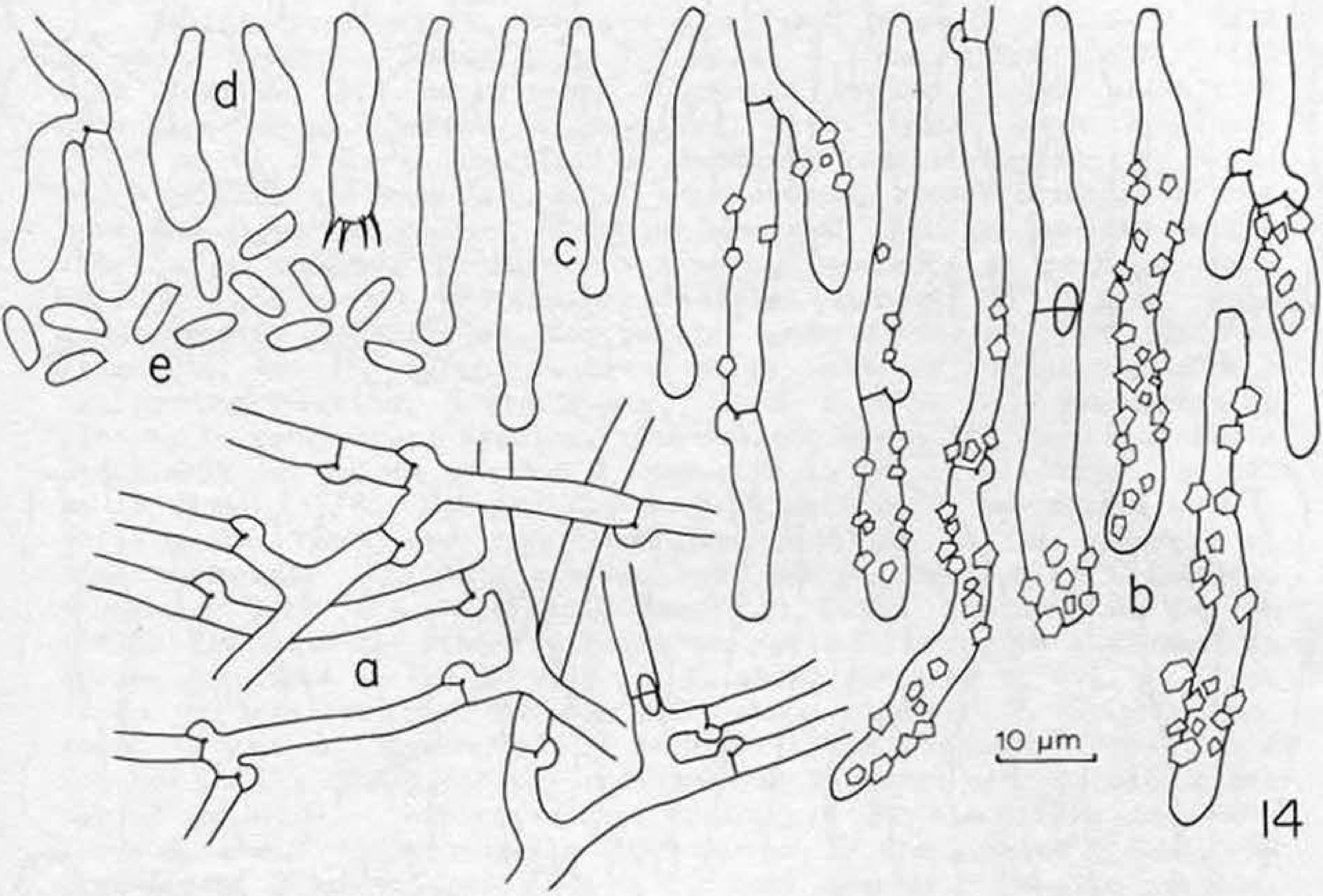
Basidiocarps annual, resupinate, effused up to 15 cm; hymenial surface cream colored, becoming hydnaceous, the aculei tending to become flattened, often branched at the tip, crowded, up to 1 mm long; subiculum thin, cream colored; hyphal system monomitic; subicular hyphae thin to firm-walled, with clamps at all septa, often branched, 2.5-4 µm in diam; cystidioles capitate, up to 34 µm long and 4.5 µm in diam, also some rare sterile moniliform elements in hymenium, up to 30 µm long and 5 µm in diam, staining brightly in phloxine; basidia clavate, 4-sterigmate, 15-17 x 4-5 µm, with a basal clamp; basidiospores broadly ellipsoid to subglobose, hyaline, smooth, negative in Melzer's reagent, 4.5-5.5 x 4-5 µm. Associated with a soft, spongy white rot. 2280, DeFuniak Springs, FL, on dead, decorticated branches of **J. virginiana.**

HYPOCHNICIUM BOMBYCINUM (Sommerf. :Fr.) John Erikss., Symb. Bot. Upsal. 16:1, p. 101. 1958.

Basidiocarps annual, resupinate, effused up to 3 cm; hymenial surface cream colored to pale buff, smooth; margin concolorous, abrupt; subiculum thin; hyphal system monomitic; subiculum appearing disentegrated in KOH and in Melzer's reagent and individual hyphae difficult to discern, hyphae thin-walled, with clamps, 3.5-7 µm in diam; cystidia absent; basidia clavate, 4-sterigmate, 30-38 x 7-9 µm; basidiospores broadly ellipsoid, hyaline, smooth, wall slightly thickened, negative in Melzer's reagent, 8-11 x 6-8 µm. Associated with a white rot. 15701, Gainesville, FL, on dead, decorticated branch of **J. virginiana.** This species differs from **H. lundellii,** which also occurs on dead juniper branches, in having larger spores.

HYPOCHNICIUM PUNCTULATUM (Cke.) John Erikss., Symb. Bot. Upsal. 16:1, p. 101. 1958.

Basidiocarps resupinate, effused up to 8 cm, soft-fibrous and easily peeled from substratum; hymenial surface ivory white, smooth, cystidiate under a 30 X lens; subiculum ivory-white, floccose or felty, up to 200 µm thick; hyphal system monomitic; subicular hyphae hyaline, with clamps at all septa, frequently branched, firm to moderately thick-walled, 3-6 µm in diam; cystidia abundant, subcylindric, tapering to the tip, thin-walled, not incrusted, 80-120 x 6-9 µm, completely to partially imbedded but some projecting to 50 µm; basidia clavate, often with a median constriction, 29-40 x 7-8 µm, with a basal clamp; basidiospores subglobose to broadly ellipsoid,



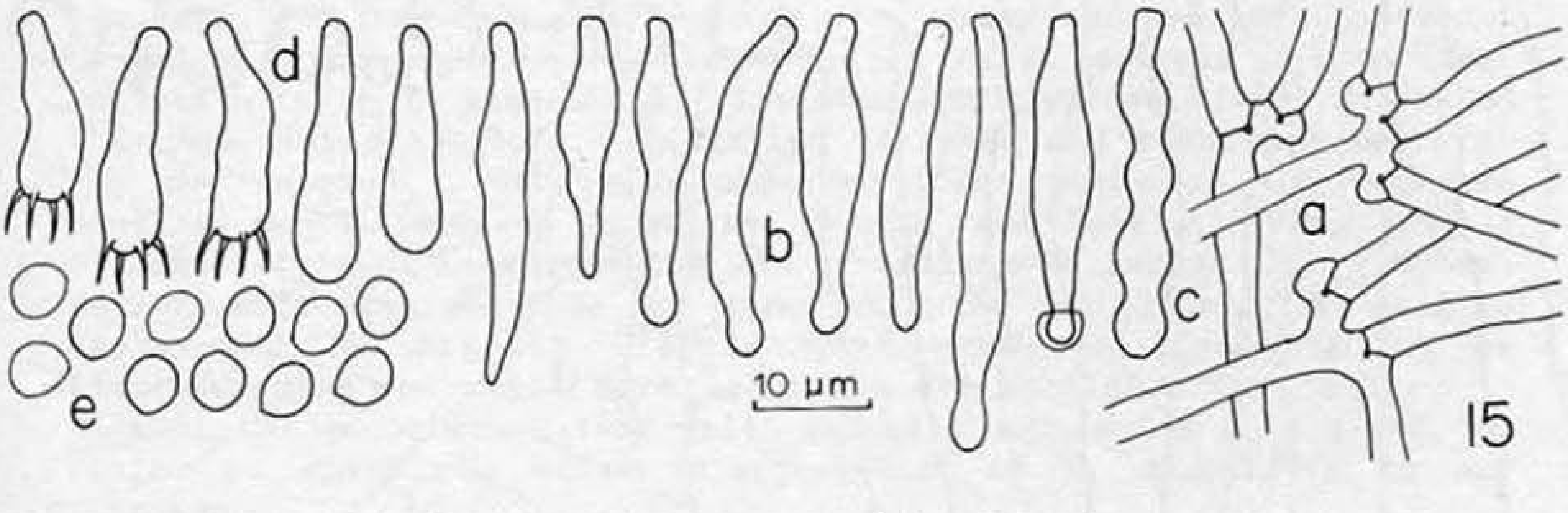
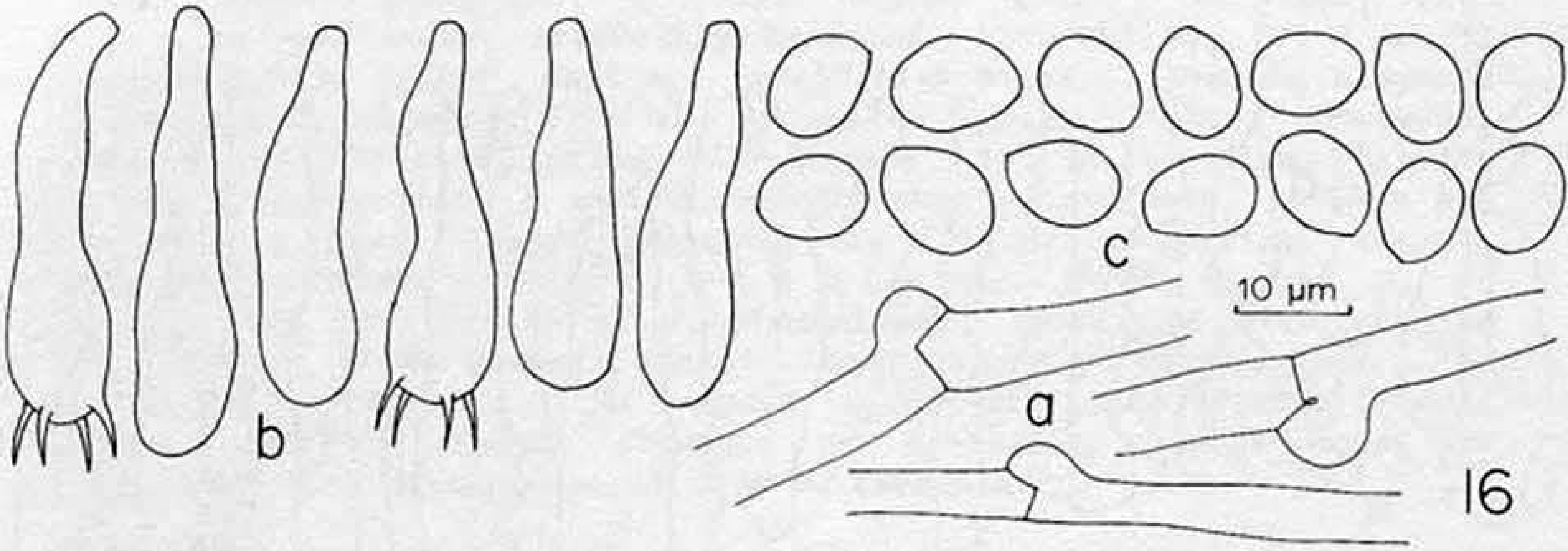


Fig. 14. **Hyphodontia nespori** (RLG 15784). a, subicular hyphae; b, hyphoid elements from apices; c, capitate cystidioles; d, basidia; e, basidiospores. Fig. 15. **Hyphodontia spathulata** (MB 2280). a, subicular hyphae; b, cystidioles; c, moniliform element; d, basidia; e, basidiospores.

hyaline, finely verrucose, thick-walled, 6-7 x 5-5.5 (-6) µm. Associated with a white rot. 15781, Milton, FL, on **J. virginiana.** Some of the subicular hyphae of this specimen have distinctly thickened walls like those described by Parmasto (1967) and Eriksson and Ryvarden (1976) for **Hypochnicium caucasicum** Parm. However as most hyphae are relatively thin-walled it is best to assign this collection to **H. punctulatum.**



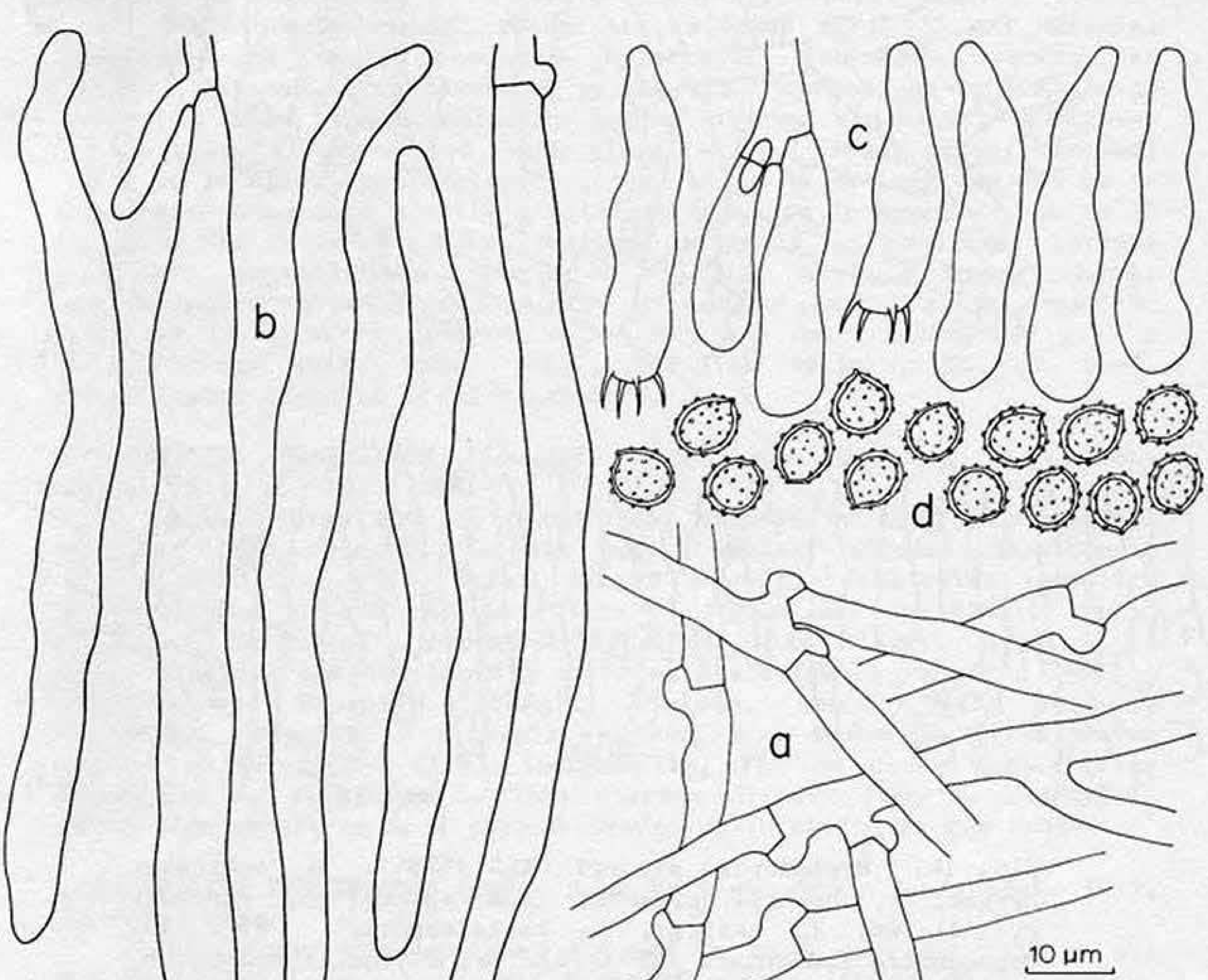


Fig. 16. **Hypochnicium bombycinum** (RLG 15701). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 17. **Hypochnicium punctulatum** (RLG 15781). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

LITSCHAUERELLA CLEMATIDIS (Bourd. et Galz.) Erikss. et Ryv., Cort. N. Europe 4:839. 1976.

Basidiocarps annual, resupinate, effused in small patches up to 4 mm wide, appearing under a 30 X lens as a thin, grayish white film with abundant and conspicuous cystidia; hyphal system monomitic; subicular hyphae hyaline, thin-walled, with clamps, often branched, 2-3.5 µm in diam; lamprocystidia abundant, conical-fusoid, incrusted and appearing thick-walled, often with several hyphal branches at the base and appearing rooted, 60-85 µm long and 10-16 µm in diam at the base, wall negative in Melzer's reagent, contents or perhaps inner wall surface weakly dextrinoid; basidia terminal or lateral, some pleurobasidia appearing as if a lateral hypha developed after basidial formation, broadly cylindric or slightly urniform, sometimes with a median constriction, 4-sterigmate, 17-32 x 9-13 µm; basidiospores globose to subglobose, hyaline, thin-walled, appearing smooth at 600 X and finely asperulate at 1500 X, negative in Melzer's reagent, 8.5-11 µm in diam. 15763, Milton, FL, on **J. virginiana.** Associated with a white rot. There are some unresolved problems in the taxonomy of **Litschauerella.** The main species involved are **Peniophora clematidis** Bourd. et Galz. and **P. abietis** Bourd. et Galz. Bourdot and Galzin (1928) distinguished these species on spore size, with **P.clematidis** spores described as 4-5 µm wide and **P. abietis** spores as 6-11 µm wide. It is of interest that Bourdot and Galzin reported **P. abietis** "sur sapin pectin et genevrier". Boidin (1958), Weresub (1961), and Liberta (1962) considered the two names as synonyms with **P. clematidis** having priority. Liberta also transferred **P. clematidis** into the genus **Xenasma. Litschauerella** was proposed by Oberwinkler (1965), who transferred **P. abietis** into it as the only species. He also proposed the genus **Tubulicium** and the new combination **Tubulicium clematidis.** The basis for Oberwinkler's separation of these species into different genera was the presence of pleurobasidia in **L. abietis** and terminal basidia only in **T. clematidis.** Eriksson and Ryvarden (1976) concluded that basidial morphology was similar in types and other specimens of the two species. They also observed that spores of the Corbiere specimen of **P. abietis** cited by Bourdot and Galzin (1928) have a different type of ornamentation and are ellipsoid rather than globose. Because this specimen does not agree with the lectotype of **P. abietis** designated by Weresub (1961), they chose to describe it as **Litschauerella** sp. until more specimens are available for study. In view of the uncertainty that still prevails concerning this genus, we prefer to apply the broad interpretation of **L. clematidis** to our specimen.

PHYLLOPORUS RHODOXANTHUS (Schw.) Bres., Fung. Trid. 2:95. 1900.

Basidiocarps centrally stipitate, fleshy, pileus 3.5 cm wide, upper surface convex, dry, minutely squamulose, pale yellowish brown; hymenophore radially lamellate, lamellae decurrent, crowded, pale yellowish brown, appearing finely cystidiate under a 30 X lens, edges entire; context yellowish buff, staining bluish; stipe pale buff to yellowish brown, 4 cm long and .5-.7 cm in diam, base connected to masses of pale buff mycelium between flakes of outer bark; contextual hyphae thin-walled, simple-septate, 6-11 µm in diam; pleurocystidia and cheilocystidia abundant, cylindric to clavate, thin-walled, hyaline, 55-80 x 9-16 µm; basidia clavate, 4-sterigmate, 35-43 x 7-9.5 µm, simple-septate at the base; basidiospores cylindric to subnaviculate, smooth, pale brownish in KOH, negative in Melzer's

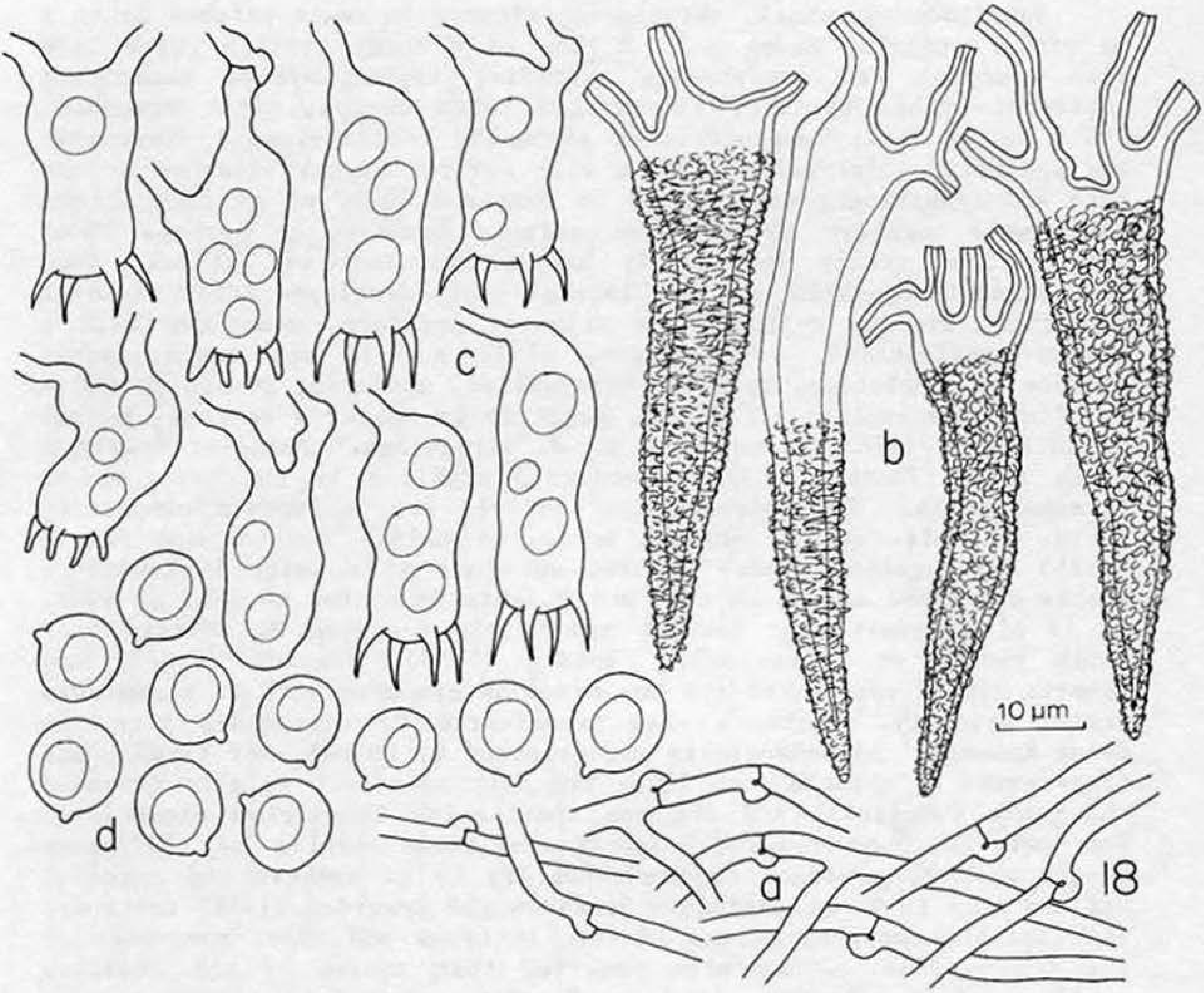


Fig. 18. **Litschauerella clematidis** (RLG 15763). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

reagent, 10.5-14.5 x 4-5.5 µm. 15677, Sopchoppy, Wakulla County, FL, on base of living **J. virginiana**. This is probably not a wood rotting fungus, and was fruiting from mycelium between the layers of rather thick, dead outer bark. It is placed in the Paxillaceae, a family that contains some wood-rotting species, by current authors (Smith et al. 1979; Miller 1972). We also collected **P. rhodoxanthus** fruiting on the base of a living palm tree in Gainesville, FL.

SEBACINA INCRUSTANS (Fr.) Tul., J. Linn. Soc. Bot. 13:36. 1871.

Basidiocarps annual, resupinate, effused up to 8 cm, tough and adherent; hymenial surface cream colored to cream-buff, smooth; margin abrupt to thinning out; subiculum white, up to .8 mm thick; hyphal system monomitic; subicular hyphae thin-walled, simple-septate, with frequent branching, 2.5-4 µm in diam; much branched dendrohyphidia present, hyaline, not incrusted, 1.5-3 µm in diam; hypobasidia subglobose to ellipsoid, becoming vertically septate and 2-4 celled,

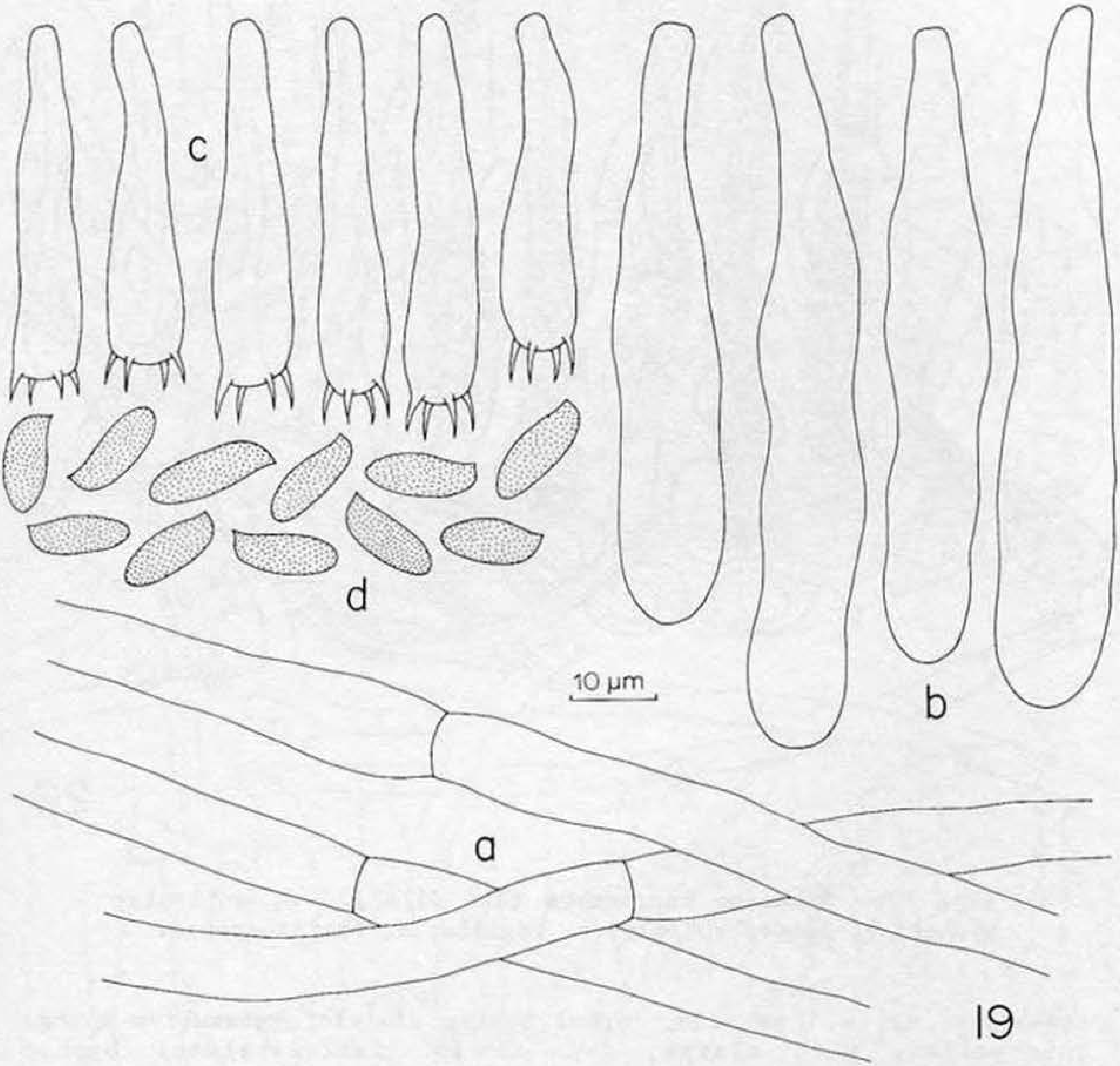


Fig. 19. **Phylloporus rhodoxanthus** (RLG 15677). a, contextual hyphae; b, cystidia; c, basidia; d, basidiospores.

15-20 x 11-15 µm, epibasidia 2-4, elongated, cylindric, up to 35 µm long; basidiospores ellipsoid to ovoid, hyaline, smooth, negative in Melzer's reagent, 11-12 x 6.5-8.5 µm. 15747, Gainesville, FL, at base of living **J. virginiana.** **Sebacina incrustans** is similar to **S. epigaea,** which also occurs on junipers in the Gulf Coast region. The latter species differs in its more fragile, membranous basidiocarp.

STECCHERINUM OCHRACEUM (Pers.:Fr.) S.F. Gray, Nat. Arr. Brit. Pl. 1:651. 1821.

Basidiocarps annual, resupinate to slightly reflexed, effused up to 3 cm; upper surface tomentose, pinkish-buff, azonate; hymenial surface pinkish-buff, hydnaceous, the teeth crowded, cylindric, up to 1 mm long; margin fertile and concolorous or sterile, white,

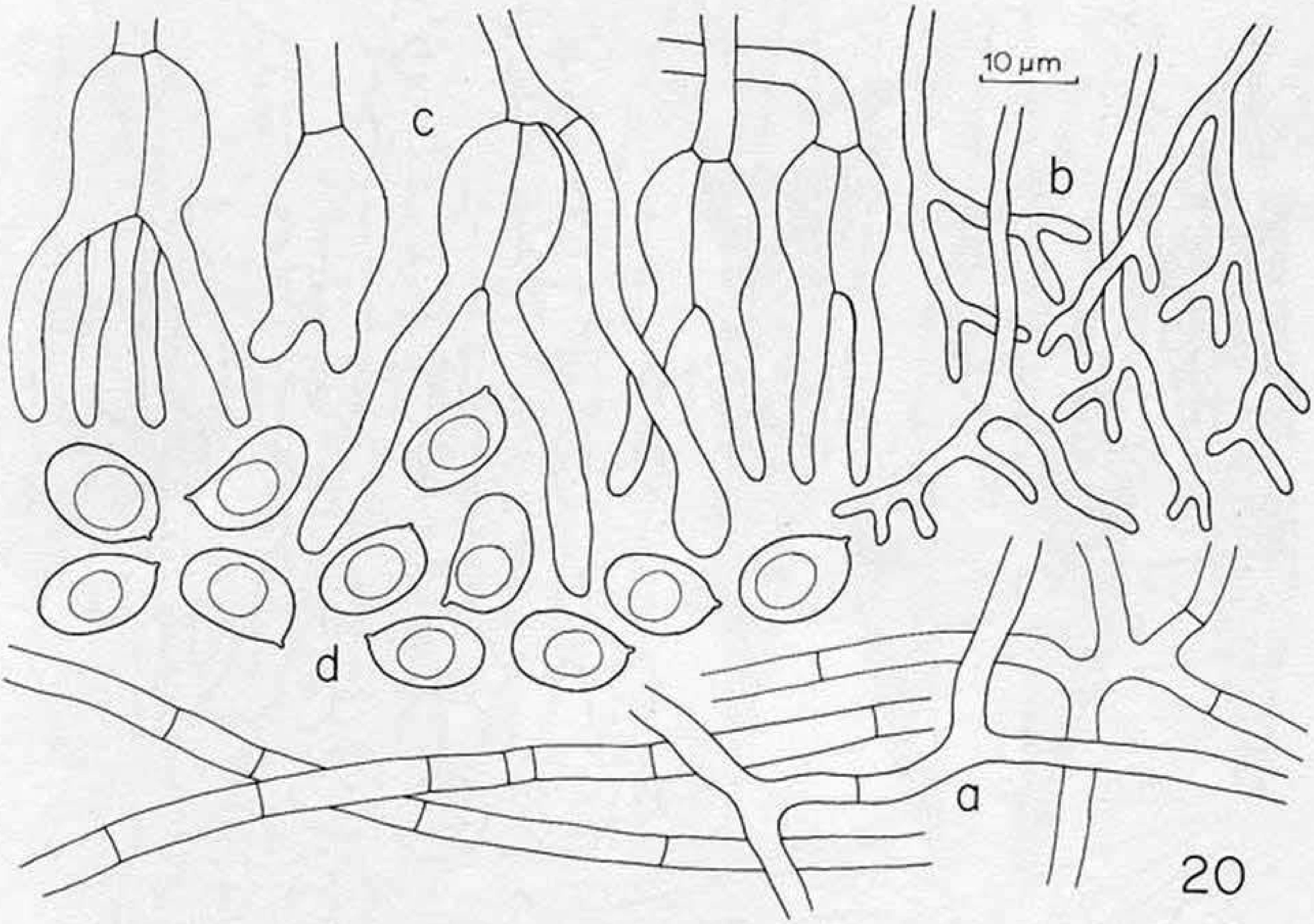
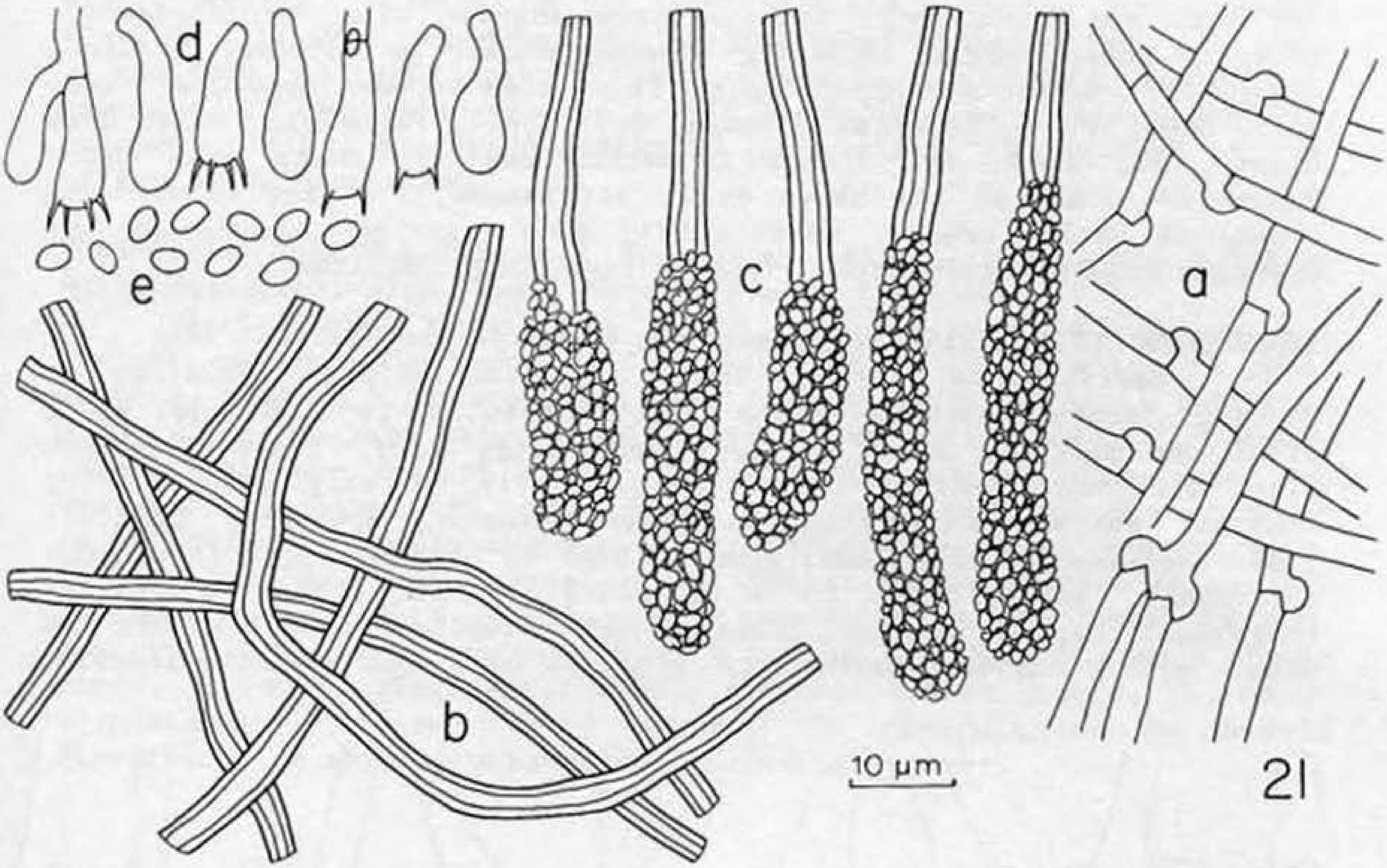


Fig. 20. **Sebacina incrustans** (RLG 15747). a, subicular hyphae; b, dendrohyphidia; c, basidia; d, basidiospores.

tomentose, up to 1 mm wide; hyphal system dimitic; generative hyphae thin-walled, with clamps, 2-3 µm in diam; skeletal hyphae thick-walled, nonseptate, with rare branching, 2-4 µm in diam; skeletocystidia imbedded in trama or projecting from the hymenium, thick-walled, heavily incrusted, incrusted portion up to 10 µm in diam; basidia clavate, 4-sterigmate, 15-20 x 4-4.5 µm; basidiospores ovoid to oblong, hyaline, smooth, negative in Melzer's reagent, 3.5-4 x 1.5-2 µm. 2281, DeFuniak Springs, FL, on **J. virginiana**.

STIGMATOLEMMA TAXI (Lév.) Donk, Persoonia 2:342. 1962.

Basidiocarps annual, sessile or substipitate with a narrowed base, cupulate, dorsally or laterally attached, individual fruiting bodies up to 1.5 mm wide and 1 mm deep, shrinking on drying, usually fruiting in large numbers on areas up to 1 meter long; outer surface pale vinaceous gray, farinaceous under a 30 X lens, inner surface dark brownish; hyphal system monomitic; tramal hyphae thin-walled, hyaline, with clamps at all septa, occasionally branched, 2-4 µm in diam; hyphae on outer surface giving rise to much branched and contorted dendrohyphidia with slender, pointed ultimate branches, loosely incrusted with small crystals, up to 75 µm long, main branches 3-7 µm in diam; cystidia or other sterile hymenial elements absent; basidia clavate with a distinctly narrowed base, 4-sterigmate, 24-36 x 7-8.5



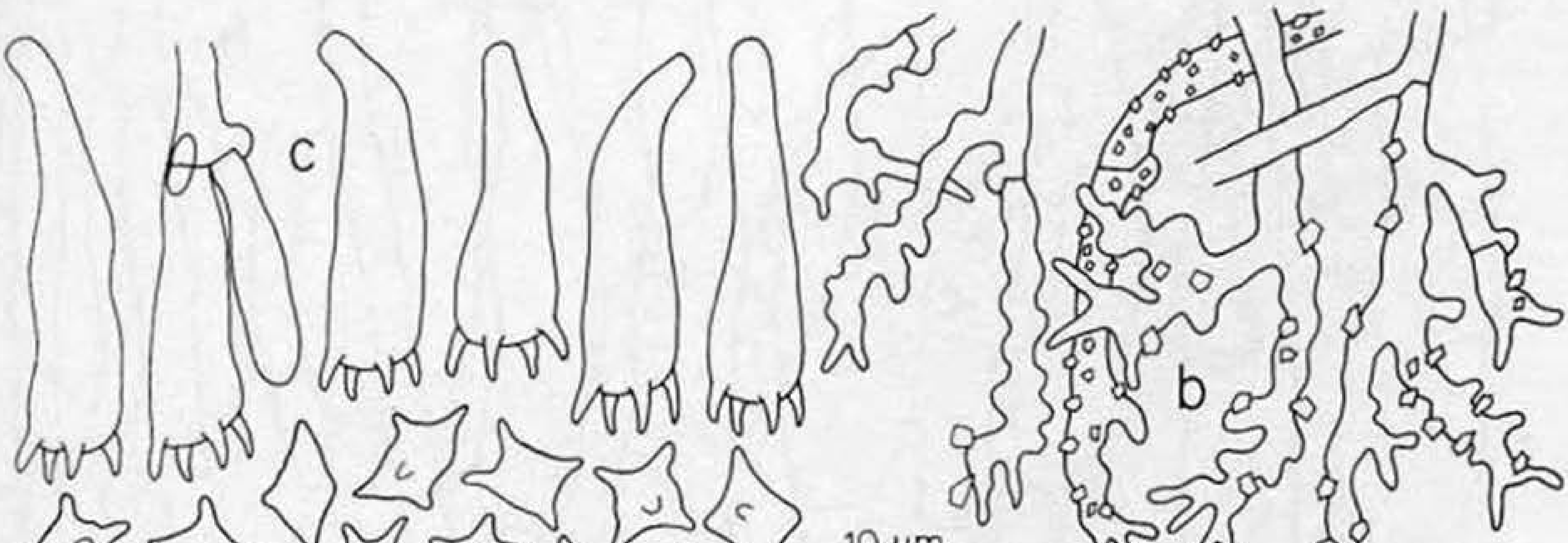


Fig. 21. **Steccherinum ochraceum** (MB 2281). a, generative hyphae; b, skeletal hyphae; c, cystidia; d, basidia; e, basidiospores. Fig. 22. **Stigmatolemma taxi** (MB 2274 and 2283). a, contextual hyphae; b, dendrohyphidia; c, basidia; d, basidiospores.

µm, with a basal clamp, the sterigmata stout, up to 2 µm in diam at the base and 5 µm long; basidiospores angular with 4-6 elongated, tapering lobes, often appearing diamond-shaped in outline, hyaline, negative in Melzer's reagent, up to 11 µm wide between opposite lobes. 2274, 2283, 15776, DeFuniak Springs, FL; 15651, Pensacola, Santa Rosa County, FL; 2344, St. Joseph Catholic Cemetery, North St., Baton Rouge, LA. All of the above on **J. virginiana**, fruiting on bark on trunks of living trees. Coker (1921) also reported this fungus (as **Cyphella cupulaeformis** Berk. et Rav.) from North Carolina.

THELEPHORA CUTICULARIS Berk., Hooker's Lond. J. Bot. 6:324. 1847.

Basidiocarps annual, sessile to substipitate, dimidiate or forming circular rosettes with a narrowed base, up to 4 cm wide; young pilei and marginal zone of older ones dingy gray, becoming almost black with age, radially fibrillose, faintly concentrically zonate; hymenial surface dark purplish brown, smooth, appearing minutely tomentose under a 30 X lens; context Drab to Hair Brown, soft-fibrous to spongy, azonate, up to 3 cm thick; hyphal system monomitic; contextual hyphae hyaline, thin-walled, simple-septate, 3-6 µm in diam, with occasional branching; cystidia none but hyphoid sterile

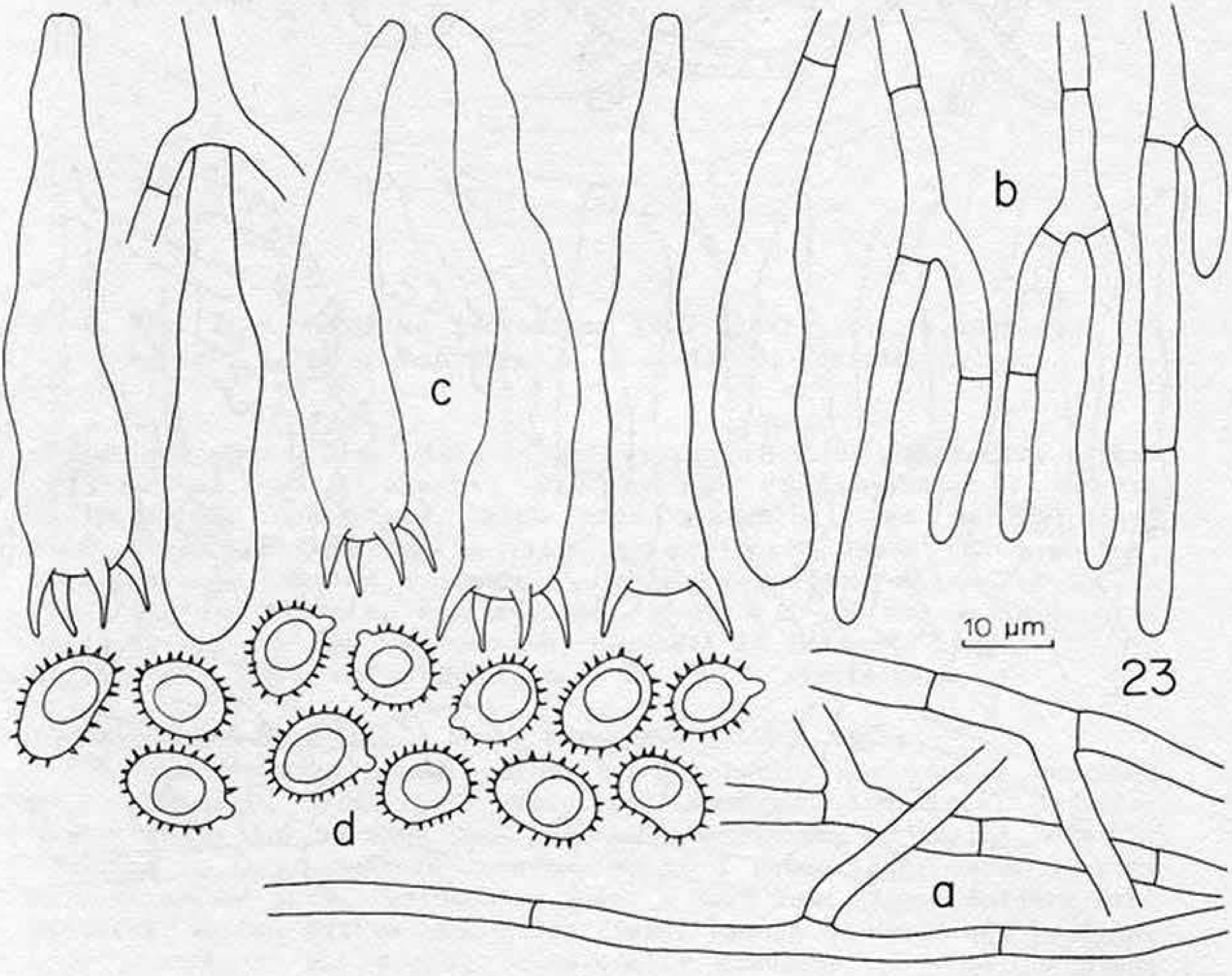


Fig. 23. **Thelephora cuticularis** (RLG 15751). a, contextual hyphae; b, hyphoid sterile elements; c, basidia; d, basidiospores.

elements present between basidia in hymenium, these thin-walled, simple-septate, 3.5-4.5 µm in diam; basidia clavate, 4-sterigmate, 45-62 x 9-12 µm, simple-septate at the base; basidiospores ellipsoid or reniform to subglobose, pale brownish, strongly echinulate, negative in Melzer's reagent, 9-13 x 6.5-8 µm. Associated rot unknown. 15751, Evergreen Cemetery, Gainesville, FL, on bark at base of living **J. virginiana.**

TOMENTELLA ASPERULA (Karst.) Hoehn. et Litsch., Sitzungs. Kaiserl. Akad. Wissensch. Wien, Math.-Naturw. Klasse 115:1570. 1906.

Basidiocarps resupinate, annual, effused up to 4 cm; hymenial surface smooth, pale brown to dark dull brown, margin white to cream colored, fimbriate to arachnoid with fine mycelial strands; subiculum thin, white to pale brown; hyphal system monomitic; subicular hyphae pale brownish to hyaline in KOH, thin- to firm-walled, with clamps and frequent branching, 4-8 µm in diam; cordons present but not abundant in subiculum; cystidia absent; basidia broadly clavate, 4-sterigmate, 37-45 x 9-11 µm, with a basal clamp; basidiospores globose to broadly ellipsoid or reniform, echinulate to aculeate, pale brownish in KOH, negative in Melzer's reagent, 7.5-9 x 6-7 µm. 2314, LSU campus, Baton Rouge, LA, on **J. virginiana**; 15691, Palatka, Putnam County, FL, on **J. virginiana.** Larsen (1974) reports **T. asperula** to be widely distributed on several substrates, including juniper.

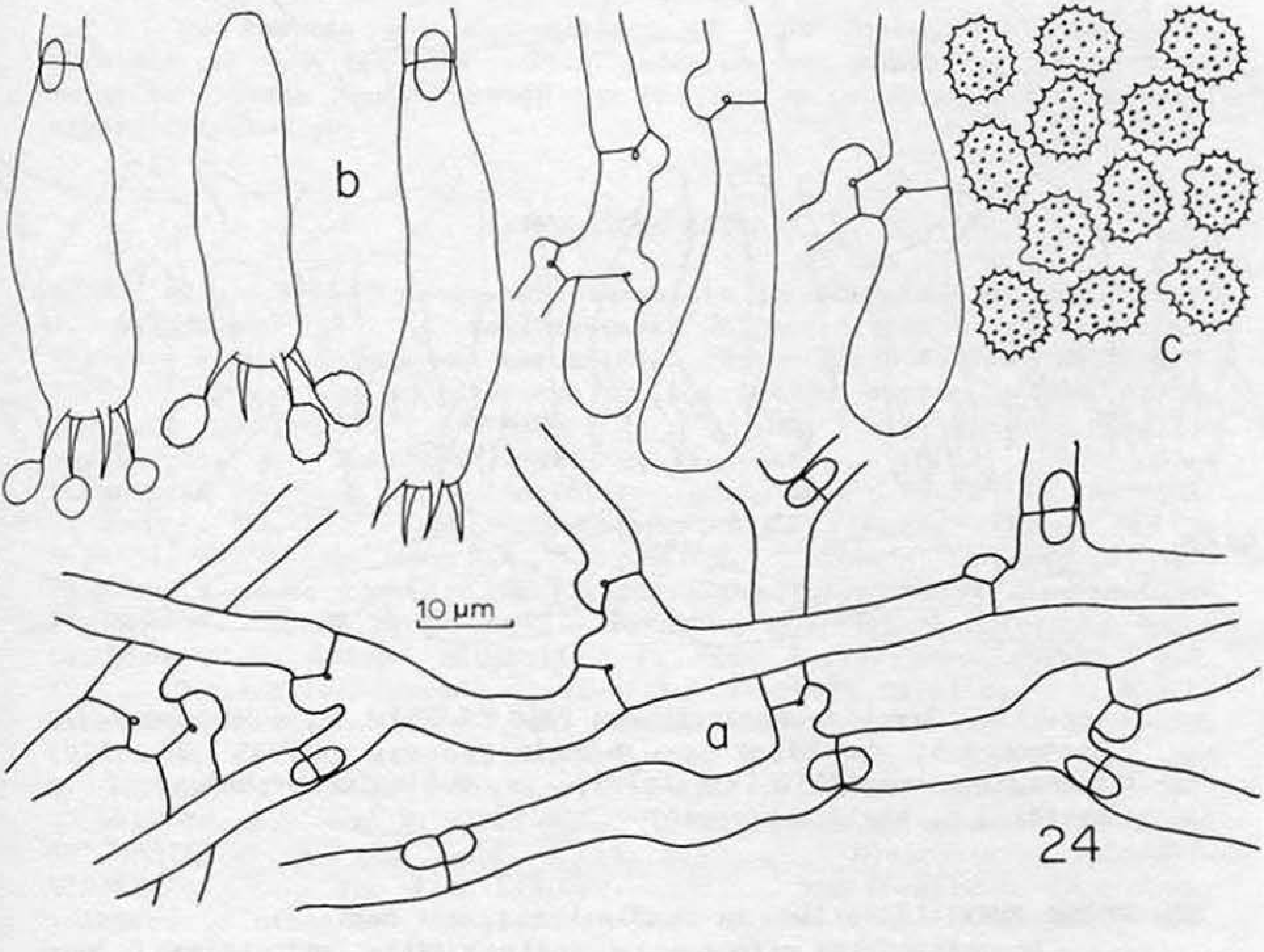
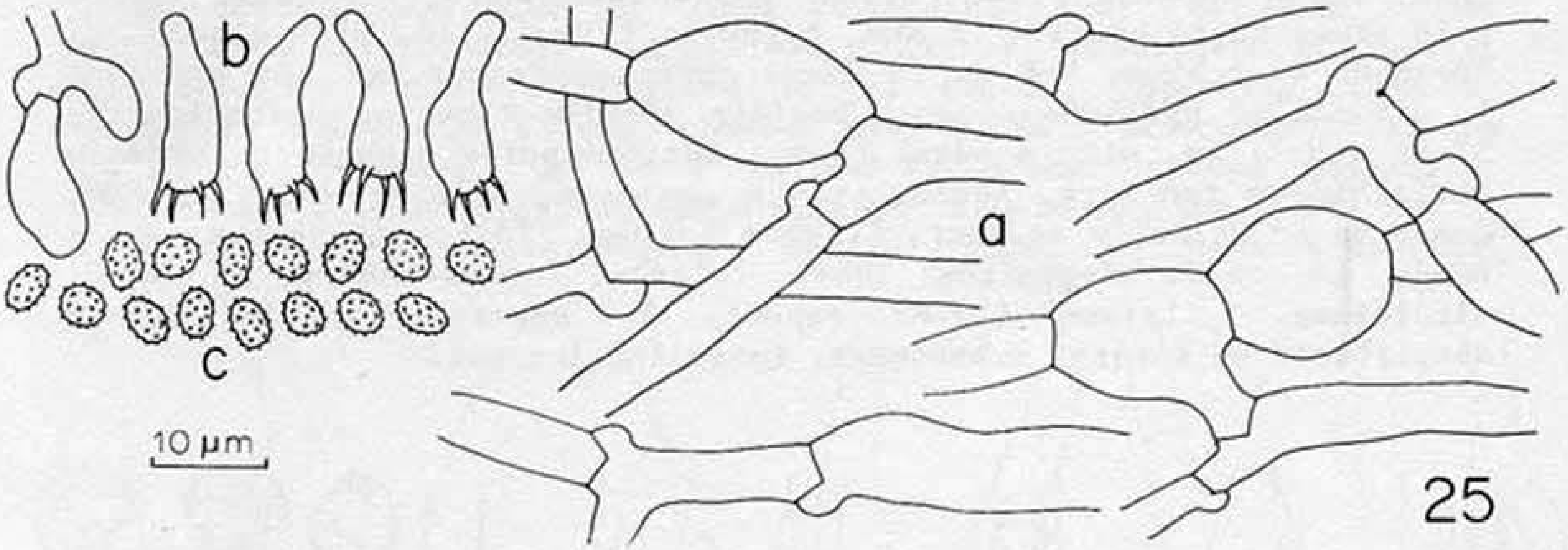


Fig. 24. **Tomentella asperula** (RLG 15691). a, subicular hyphae; b, basidia; c, basidiospores.

TRECHISPORA FARINACEA (Pers.:Fr.) Liberta, Taxon 15:318. 1966.

Basidiocarps annual, resupinate, effused up to 3 cm, soft and fragile, easily separated; margin cream colored, thinning out, arachnoid; hymenial surface pale buff, hydnaceous with crowded cylindric teeth up to .8 mm long; hyphal system monomitic; subicular hyphae thin-walled, with abundant clamps, with frequent branching, often ampullate, mostly 2-5 µm in diam with ampullations up to 13 µm, some ampullations nearly spherical; cystidia absent; basidia clavate, often with a median constriction, 4-sterigmate, 11-13 x 4-5 µm, with a basal clamp; basidiospores ovoid to subglobose, hyaline, strongly echinulate, negative in Melzer's reagent, 3-4.5 x 2.5-3 µm. RLG 15773, Milton, FL, on brown-rotted wood on dead branch of **J. virginiana.**



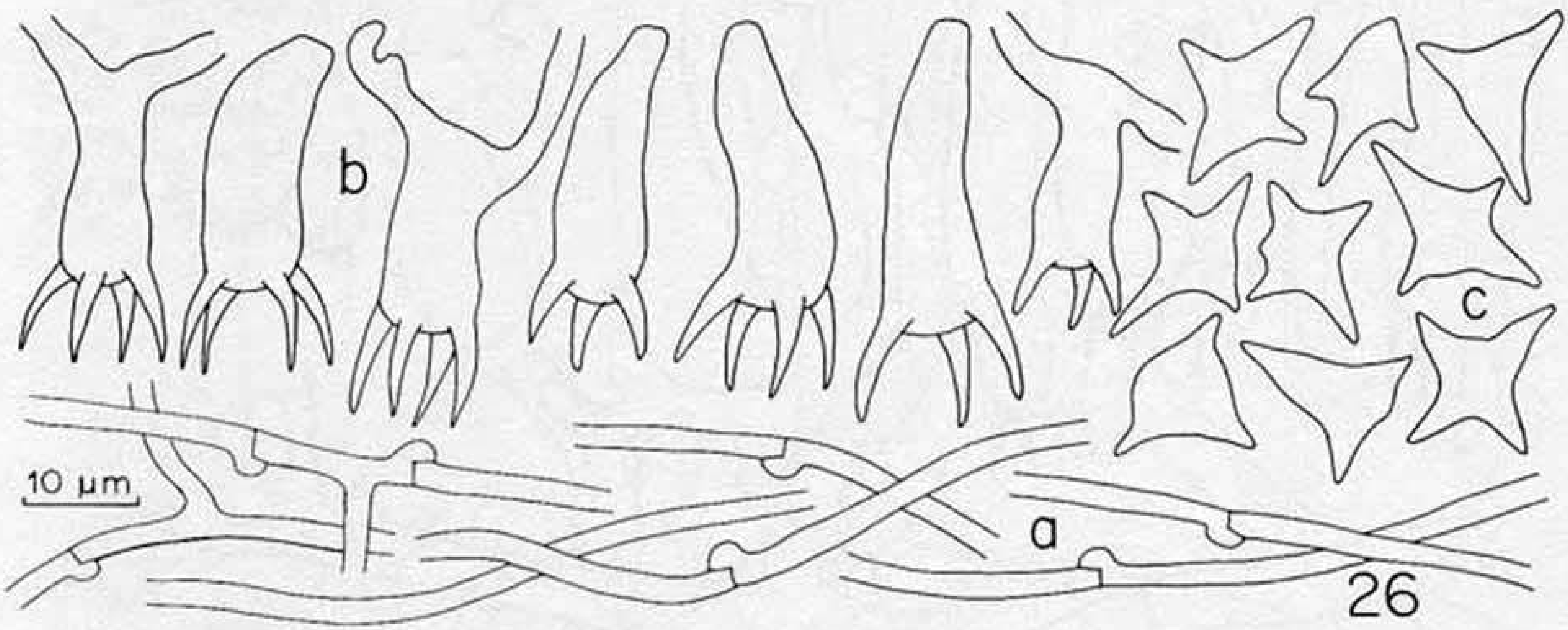


Fig. 25. **Trechispora farinacea** (RLG 15773). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 26. **Xenosperma murrillii** (RLG 15748). a, subicular hyphae; b, basidia; c, basidiospores.

XENOSPERMA MURRILLII Gilbn. et M. Blackwell, sp. nov.

Fructificatio effusa, tenuissima, alba vel cremea, haud conspicua; hyphae fibulatae, 1.5-2.5 µm in diam; cystidia nulla; basidia clavata vel cylindracea, interdum biradicosa, 25-28 x 8-10 µm, sterigmata 2-4, crassa, usque ad 9 x 3 µm; basidiosporae hyalinae, tenuitunicatae, triangulatae vel stellatae, usque ad 18 um inter apices. Holotypus: leg. R.L. Gilbertson, No. 15748, ad ramos **Juniperus virginiana**, Gainesville, FL, Aug. 10, 1985; in herb National Fungus Collections, Beltsville, MD (BPI).

Basidiocarp annual, resupinate, thin and inconspicuous, effused up to 1.5 cm; hymenial surface white to cream colored, smooth; margin thinning out, with some fine white hyphal strands; hyphal system monomitic; subicular hyphae with clamps, thin-walled, with frequent branching, 1.5-2.5 µm in diam; cystidia absent; basidia clavate to subcylindric, some of the pleurobasidium type, biradicate at the base, 2-4 sterigmate, 25-28 x 8-10 µm; sterigmata stout, up to 3 µm wide at the base and 9 um long; basidiospores angular with 3-4 pointed lobes, shark tooth shaped to stellate, hyaline, thin-walled, negative in Melzer's reagent, up to 18 µm wide from tips of opposite lobes. Associated rot unknown. 15748, near the grave of W.A. Murrill, Evergreen Cemetery, Gainesville, FL, on **J. virginiana**. This is an extremely distinctive fungus microscopically. The only other species of **Xenosperma** is **X. ludibundum** (D.P. Rogers et Liberta) Oberw. It differs in having smaller, 2-sterigmate basidia and smaller spores (Liberta, 1962; Oberwinkler, 1965).

ACKNOWLEDGMENTS

We express our appreciation to R.G. Thorn, who examined a specimen at our request. This research was supported in part by McIntire-Stennis funds through the University of Arizona Agricultural Experiment Station.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 403-412 April-June 1987

NOTES ON ENTOMOPHTHORALES (ZYGOMYCOTINA) COLLECTED BY T. PETCH:
III. ERYNIA SUTURALIS SP. NOV. AND OTHER ERYNIA SPECIES RECORDED ON COLEOPTERA

ISRAEL S. BEN-ZE'EV*

Agriculture Canada, Research Branch, Research Station
Harrow, Ontario NOR 1GO Canada

ABSTRACT

T. Petch's collection of *Entomophthora anglica* was found to contain two different *Erynia* species, on different Coleopteran hosts. *Erynia anglica* (Petch) Ben-Ze'ev, on *Agriotes sputator* (Elateridae) and on an unidentified beetle was discussed in part I. The second species, *Erynia suturalis* sp. nov., described here, was found on *Lochmaea suturalis* (Chrysomelidae) and possibly on another, unidentified beetle, but not on *A. sputator*. While *E. anglica* belongs in the subgenus *Zoophthora*, *E. suturalis* belongs in subgen. *Neopandora* and is characterized by uninucleate, bitunicate, subpapillate, obovoid to ellipsoid primary conidia averaging 17.5 x 10.6 µm, with a length/width ratio of ca. 1.7 and narrow papillae. It has wide, monohyphal rhizoids, some of which are fasciculate at the base and have dichotomously lobed holdfasts. Pseudocystidia are long, narrow and tapering toward sharp apices.

The ten species of *Erynia* recorded on Coleoptera are compared. It is concluded that each deserves its own specific status. Although species in several families of Coleoptera have mycoses caused by *Erynia* species, the host range of each fungal species is, according to presently available data, restricted to a single coleopteran family, and within that, to species belonging to one or two genera.

KEY WORDS: Entomophthorales; *Erynia suturalis* sp. nov.; *E. anglica*; Coleoptera; *Lochmaea suturalis*; *Agriotes* sp.; Entomopathogenic fungi.

Two different species of *Erynia* Nowakowski, emend. Humber & Ben-Ze'ev (1981) were found during a reexamination of T. Petch's material annotated *Entomophthora anglica* Petch. The first part of this study (Ben-Ze'ev, 1986) dealt with one of them: *Erynia anglica*, subgen.

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* Visiting fellow, National Science and Engineering Research Council, Canada.
Present address: Department of Plant Pathology and Microbiology, Faculty of Agriculture, The Hebrew University of Jerusalem, P.O.Box 12, Rehovot 76 100, Israel.

Zoophthora Batko 1966*. The second species, described here, *Erynia suturalis*, belongs in another subgenus, *Neopandora* Ben-Ze'ev & Kenneth 1982, and attacks hosts different from those of *E. anglica*.

The methods and the material examined are essentially the same as in part I (Ben-Ze'ev, 1986). *E. suturalis* was found in Petch's specimen R-1228 (*Entomophthora anglica* Petch, on *Lochmaea*** *suturalis*, Edinburgh, R.W.G. Dennis, 3 June, 1939). A fungus very similar, possibly identical with *E. suturalis* was found in specimen R-775 (*Entomophthora anglica* Petch, on a beetle, Hornsea, 14 July, 1931). The host in this second specimen was annotated in Petch's article (1944) as "beetle (? *Plateumeris*)" and later (Petch, 1948) as "*Cantharis*". The specimens were kindly lent by The Herbarium, Royal Botanical Gardens, Kew.

With the description of *E. suturalis*, the number of coleopterous species of *Erynia* rises to ten. The second purpose of this report is to provide a comprehensive comparison of these ten species, as suggested by Bałazy (1981).

RESULTS AND DISCUSSION

Specimen R-775, from which two microscope slides were prepared (R-775a, b) was apparently at the beginning of sporulation when collected, judging by the small number of conidia found in the slides, and by the lack of secondary (or tertiary) conidia (Table 1). This specimen was less well preserved than specimen R-1228 which justified preparation of several microscope slides (R-1228a-d). It contained many conidia, some of which were resporulating – producing secondary conidia (or tertiary ones if the parent conidia were secondary), still attached to the empty, parent spores. These cecondary or tertiary conidia differed in shape from most conidia found in both specimens. Therefore, other detached conidia that were similar in shape to the attached secondary or tertiary conidia, were listed separately, in the third column of Table 1. The conidia in specimen R-775 were obovoid to ellipsoid, resembling *Erynia nouryi* Remaudière & Hennebert (1980), with a marked constriction between the papilla and the rest of the conidium. Similarly shaped conidia in specimen R-1228 had a less marked constriction or lacked it, and had larger diameters and thus, smaller l/d ratios (Table 1). These dissimilarities between the two specimens can be explained in several possible ways: a) The conidia in both specimens belong to the same species, but those in R-775, being less well preserved, shrank irreversibly in diameter and therefore gained in l/d – such shrinking of conidia was observed by the author in preparations of *Erynia phytonomi*, affecting the diameter of conidia but not their length, and emphasizing their papillae. Similarly, in *E. anglica*, the most pronounced papillae were associated with the less well preserved conidia (Ben-Ze'ev, 1986). b) The ovoid to ellipsoid conidia in both specimens belong to the same species and are mixtures of primary and secondary conidia, with more primary conidia in R-775 than in R-1228. c) If the host in specimen R-775, annotated as "a beetle (? *Plateumeris*)" in the collection and as (*Cantharis*) in Petch (1948), is different from the host in R-1228 (*Lochmaea suturalis*), it is not impossible that each specimen contains a different fungal species. It should be mentioned, however, that although both specimens were annotated by Petch "*Entomophthora anglica*", the

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* For author citations of coleopterous *Erynia* species see Table 2.
** Erroneously spelled "*Lochnoea*" in Petch's collection and followed in the literature (Petch, 1944; Ben-Ze'ev, 1986).

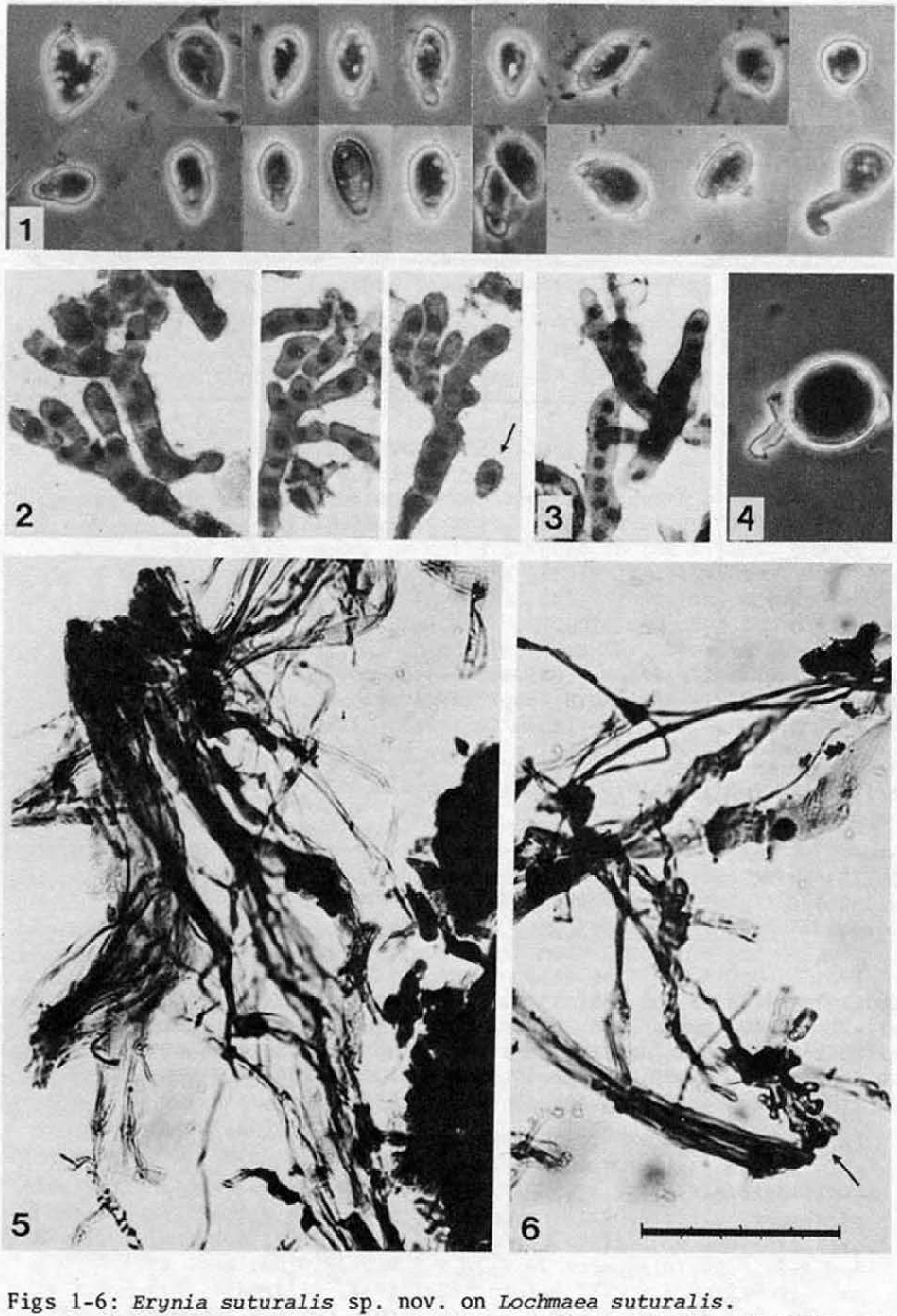
Table 1. Comparison of conidial dimensions of *Erynia suturalis* sp. nov. on *Lochmaea suturalis* from specimen R-1228, and a similar fungus on an unidentified beetle, tentatively annotated "a beetle (? *Plateumeris*) from specimen R-775, both from T. Petch's collection annotated "*Entomophthora anglica*".

DIMENSIONS MEASURED	OBOVOID CONIDIA (primary & secondary ?) prep. R-775a; n= 37	OBOVOID CONIDIA (primary & secondary ?) prep. R-1228d; n= 93	PYRIFORM CONIDIA (secondary & tertiary ?) prep. R-1228d; n= 8
LENGTH (µm)			
min. - max.	13.74 - 21.76	14.31 - 24.62	13.17 - 15.46
$\bar{x}$	18.1	17.54	14.31
s	1.9	1.77	
most frequent		14.9-18.9 (88%)	
DIAMETER (µm)			
min. - max.	6.78 - 13.74	8.02 - 16.6	9.73 - 11.45
$\bar{x}$	8.87	10.59	11.01
s	1.37	1.46	
m.f.		9.2-12.0(ca.88%)	
L/D RATIO			
min. - max.	1.5 - 2.7	1.33 - 2.28	1.2 - 1.37
$\bar{x}$	2.06	1.67	1.3
s	0.3	0.21	
m.f.		1.4-1.9 (ca.80%)	
PAPILLAR PROPORTIONAL LENGTH (papillar length as % of conidial length)			
min. - max.	5.6 - 11.8%	5.3 - 20.0%	8.3 - 12.0%
$\bar{x}$	7.15%	9.2%	9.5%
PAPILLAR PROPORTIONAL WIDTH (papillar width as % of conidial diameter)			
min. - max.		24 - 63%	35 - 45%
$\bar{x}$		44%	40%
NUCLEAR SIZE (µm)			
ellipsoidal	4.6-5.7×5.7-6.9	3.4-5.7×4.6-6.9	3.4 x 4.6
spheroidal	4.6-6.3	4.6-6.9	4.6

fungus in R-775 is not that species, but is much more similar to *E. suturalis*. The following description of *E. suturalis* is based on specimen R-1228 alone, to exclude the possibility of mixed species and, if the two specimens contain one species, to exclude conidial dimensions which might have been distorted by poor preservation.

ERYNIA SUTURALIS *BEN-ZE'EV, SP. NOV., SUBGENUS* NEOPANDORA,
ENTOMOPHTHORALES: ZYGOMYCOTINA

CONIDIA PRIMARIA (ET SECUNDARIA ?) hyalina, uninucleata, bitunicata, plerumque multivacuolata, obovoidea, plerumque subpapillata, raro papillata aut epapillata [secundum Lakoni (1919) systema], 14.3-24.6 X 8.0-16.6 µm (plerumque 14.9-18.9 X 9.2-12.0 µm, med. 17.5 X 10.6 µm). CONIDIORUM NUCLEI entomophthoroidei, elliptici, 3.4-5.7 X 4.6-6.9 µm, vel globosi 4.6-6.9 µm diametro. CONIDIA SECUNDARIA (ET TERTIARIA ?) pyriformia vel ovoideo-pyriformia, 13.2-15.5 X 9.7-11.5 µm (med. 14.3 X 11.0 µm) conidiophoris brevibus ex conidiis primariis (et secundariis ?) lateraliter orientibus portata.



Figs 1-6: *Erynia suturalis* sp. nov. on *Lochmaea suturalis*.
1. Primary, secondary and possibly tertiary conidia. Conidia nos. 5,6 in the upper row, left to right, and 2,3 in the lower row are from specimen R-775 – their belonging to *E. suturalis* is possible but doubtful (see text). The last two conidia in the upper row

> *CAPILLICONIDIA non observata. CONIDIOPHORA PRIMARIA ramosa, digitata, determinata, ad 15 µm lata. SPORAE PERDURANTES non observatae praeter una, hyalina, subglobosa, 24.0 X 25.2 µm, pariete leni, 2.3 µm crasso. PSEUDOCYSTIDIA 2-3 septata, simplicia, 150-200 µm longa, basibus 15-20 µm lata, ad acutos apices gradatim angustata. RHIZOIDEA numerosa, filiformia, unihyphalia, interdum in parte media ad 30 µm lata et infrequenter ramosa, apice dichotomico-ramosa. In adultis mortuis* Lochmaeae suturalis *(Thunberg) (Coleoptera; Chrysomelidae) in Britannia.*
>
> *TYPUS: Exsiccati no.R-1228, et lamina per microscopium* Erynia suturalis *R-1228 (a - d) designata, Reg. Bot. Herb., Kew, Britannia.*

PRIMARY (AND SECONDARY ?) CONIDIA hyaline, uninucleate, bitunicate, obovoid or ellipsoid, most of them subpapillata type, with some epapillate and some papillate ones [acc. to Lakon's (1919) classification], 14.3-24.6 x 8.0-16.6 µm ($\bar{x}$= 17.5 x 10.6 µm), with a length/diameter ratio of 1.3-2.3 ($\bar{x}$= 1.67). Most conidia are multivacuolate, about 1/3 have 2-3 vacuoles and 6% are univacuolate. Conidial papillae are narrow, mostly less than half of the conidial width (Table 1 and Fig 1). CONIDIAL NUCLEI are entomophthoroid, stain well with acetocarmine, and are mostly ellipsoidal (58%), the rest are spheroidal (Table 1 and Fig 2 arrow). SECONDARY OR TERTIARY CONIDIA are of type I (Ben-Ze'ev and Kenneth, 1982 a), produced by resporulation on short secondary conidiophores arising laterally from primary or secondary conidia, and ejected by papillar eversion. They are pyriform or ovoid-pyriform, 13.2-15.5 x 9.7-11.5 µm ($\bar{x}$= 14.3 x 11.0 µm) with a l/d ratio of 1.2-1.4 ($\bar{x}$= 1.3) (Table 1 and Fig 1 extreme right). CAPILLICONIDIA were not observed. CONIDIOPHORES are digitately branched but not profusely so, with 3-7 uninucleate conidiogenous cells up to 15 µm wide, and with plurinucleate subtending cells (Fig 2). HYPHAL BODIES are short hyphal segments, up to ca. 120 µm long, with rounded ends, usually not branched, plurinucleate, with nuclei closely and unilinearly arranged (Fig 3). RESTING SPORES were not observed except for one, hyaline, subglobose, 24.0 x 25.2 µm, with a smooth wall 2.3 µm thick (Fig 4). Structures that resemble very much PSEUDOCYSTIDIA of other *Erynia* (subgen. *Neopandora*) species were observed in slide R-1228 d, among conidiophores, but their position relative to the host's cuticle was not observed. They were ca. 15-20 µm wide at the base and ca. 150-200 µm long, tapering gradually toward sharp apices. They were 2-3 septate, with empty compartments, sometimes with cytoplasm in the apical cell. Petch (1944) did not mention pseudocystidia in his description of *Entomophthora anglica*. However, Waterhouse (1975) and Waterhouse and Brady (1982) described for the same species "...cystidia ? long, narrow". As such pseudocystidia are very probably absent in *E. anglica* (Ben-Ze'ev, 1986), those observed by Waterhouse were probably those of *E. suturalis* in Petch's material on *Lochmaea suturalis*. RHIZOIDS were many, emerging in fascicles that appeared as pseudorhizomorphs, but diverged into

and last one in the lower row are secondary or tertiary (lactophenol-cotton blue). 2. Conidiophores showing septa and nuclei, and a conidium with stained nucleus at the lower right corner (acetocarmine). 4. Resting spore (lactophenol-cotton blue). 5. Fascicles of rhizoids diverging into monohyphal ones. 6. Single, flattened rhizoidal threads and dichotomously lobbed holdfast (arrow). Bar (in Fig 6) represents 50 um in Figs 1 and 4; 100 um in Figs 2 and 3; and 200 um in Figs 5 and 6.

Table 2. A comparison of ten species of the genus *Erynia* recorded on coleop-

ERYNIA species, subgenus	PRIMARY CONIDIA Length × Width (µm) min. - max. $\bar{x}$	L/W ratio min.-max. $\bar{x}$	Papillar type, proportional width	SECONDARY CONIDIA: Type	RHIZOIDS
E. phytonomi (Arthur) Humber *et al.* 1981, subgen. *Zoophthora*	19.7-32.4 × 5.5-7.9 23.7-27.4 × 6.2-6.8	3.0-5.0 3.5-4.2	papillate av. 65%	Ia and II	monohyphal and pseudorhizomorphs
Erynia sp. (unnamed yet) -"- *Zoophthora ?*	17.5-27.5 × 7.5-12.0 21.1 × 9.2	av. 2.3-2.6	papillate est. 50 - 65%	Ia (and II ?)	monohyphal (and pseudorhizomorphs ?)
E. anglica (Petch) Ben-Ze'ev 1986, -"- *Zoophthora*	24-36 × 7-13 27.6-32.0 × 8.7-10.0	2.4-4.4 2.9-3.6	papillate av. 65%	Ia and II	monohyphal and pseudorhizomorphs
E. crassitunicata Keller 1980, -"- *Zoophthora*	25-36 × 8.5-12 31.8 × 9.8	? 3.2-3.3	papillate est. 65%	Ia and II	present but undescribed
E. coleopterorum (Petch) Humber & Ben-Ze'ev 1981, *Erynia s.lato*	27.6-44.0 × 8.0-15.0 ?	est. 2.5-4.5 av. est. 3.5	papillate to subpapillate ca. 50%	Ia, others unknown	"hyphal fascicles" (pseudorhizomorphs ?)
E. nebriae (Raunkiaer) Humber & Ben-Ze'ev 1981, *Erynia s.l.*	28-37 × 10-13 ?	est. 2.5-3.5 ?	undescribed	unknown	present but undescribed
Erynia sp. (unnamed yet) *Erynia s.l.*	18.6-23.7 × 9.3-12.0 19.5-22.8 × 9.6-11.6	av. est. 2.0-2.4	papillate to subpapillate 3.8-4.8 µm wide, 25-30%	Ia, others unknown	numerous fasciculate (pseudorhizomorphs ?
E. brahminae (Bose & Mehta) Remaud. & Henneb. 1980, *Neopandora*	18-22 × 11-15 ?	est. 1.2-2.0 ?	subpapillate to papillate est. 30-50%	Ia	monohyphal, 14-24 µm wide, with discoidal holdfast, 100-160 µm diameter
E. zabrii Rozsypal *ex* Ben-Ze'ev & Kenneth 1982, *Neopandora*	?-29.0 × ? -18.0 25.0 × 14.0	av. est. 1.8	papillate ?	unknown	present but undescribed
E. suturalis Ben-Ze'ev this report, -"- *Neopandora*	14.3-24.6 × 8.0-16.6 17.5 × 10.6	1.3-2.3 1.6-1.7	subpapillate (some epapillate, some papillate) (24-)44(-63%)	Ia	fascicles diverging into monohyphal rhizoids with dichotomous ends (holdfasts)

teran hosts.

CONIDIOPHORES PSEUDOCYSTIDIA	RESTING SPORES Description Diameter: (µm) min. - max. $\bar{x}$	HOSTS / REFERENCES
digitate, terminally clavate absent	subhyaline-yellowish, smooth episporium, zygo- or azygospores, globose, 24.5 - 44.2 33.4 µm	*Hypera postica, H. punctata* larvae (Curculionidae)/(Ben-Ze'ev & Kenneth, 1980, and references within; Humber and Ben-Ze'ev, 1981)
digitate, terminally clavate absent	light greyish to yellowish-brown, verrucose episporium, zygo- or azygospores, globose, 27.5 - 44.0 34.0 µm	*H. postica* larvae (Curculionidae)/(Harcourt *et al.*,1974; 1981; Ben-Ze'ev & Kenneth, 1980; Tyrrell *et al.*, 1981, and pers. commun.)
digitate unknown or absent	subhyaline, smooth episporium, ? azygospores, globose, 27.0 - 34.5 29.4 - 32.3 µm	*Agriotes sputator, A.obscurus* adults (Elateridae)/(Petch, 1944; Ben-Ze'ev, 1986, and refs. within)
unbranched or very sparsely branched unmentioned, ? absent ?	brown, smooth, globose, 35 - 56 43.5 µm	*? Malthodes* sp.(Cantharidae)/ (Keller, 1980)
digitate 10 µm at base, tapering upwards	dark brown, densely verrucose, thick-walled (up to 6 um), globose, 35 - 50 µm or broadly oval, 48 - 52 x 44 - 46 µm, or pyriform, 56 x 44 µm	*Sitona flavescens* & other coleopteran larvae (Curculionidae)/(Petch, 1932; 1944; Ben-Ze'ev, 1986)
branched, septate, with claviform tips, 11-15 µm wide unmentioned	hyaline to brownish, smooth episporium, globose, produced as azygospores outside host's body 30 - 50 µm	*Nebria brevicollis* adults (Nebriidae)/(Petch, 1944; Ben-Ze'ev, 1986)
richly branched, long 6 µm wide, as long ac c-phores , obtuse ends	in culture: delicately rough, hazel-brown episporium, globose azygospores, 20 - 33 µm	*Rhagonycha lignosa* adult (Cantharidae)/ (Balazy, 1981)
septate, digitate, 8-9 µm wide unmentioned	hyaline to pale yellowish, spiny episporium, globose zygospores, 22 - 39 29 µm	*Brahmina* sp., *Anomala rufiventris* adults (Scarabeidae: Rutelinae)/ (Bose & Mehta, 1953)
bifurcately branched 14-18 µm wide, 300 µm long, bulbous base, tapering upwards	dark brown, smooth or verrucose episporium, globose with thick walls, produced outside & inside host's body, 33 - 44 µm	*Zabrus tenebrioides* larvae (Pterostichidae)/ (Rozsipal, 1951; Ben-Ze'ev & Kenneth, 1982 b)
digitate, 3-7 branches 150-200 µm long, 15-20 µm at base, tapering, 2-3 septate	only one, immature observed: hyaline, smooth, globose, 24.0 x 25.2 µm	*Lochmaea suturalis* adults (Chrysomelidae)/ (Petch, 1944; This study)

individual, monohyphal threads, up to 35 µm wide when flattened, sometimes branching at the middle, with dichotomically lobed holdfasts (Figs 5, 6). Pathogen of heather beetles (adults), *Lochmaea suturalis* (Thunberg)(Coleoptera: Chrysomelidae).
TYPE: exsiccatum no. R-1228 and slides nos. R-1228a-d. Other material possibly containing the same species is exsiccatum R-775 and slides R-775a, b – all deposited at The Herbarium, Royal Botanical Gardens, Kew.

The distribution of conidial length, diameter, and L/D ratios in unmixed spore populations of *Erynia* species is a normal, bell-shaped curve (Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1982 a). This is not the case with the conidial sample of *E. suturalis* examined here. There are indications that the conidial population examined is a mixture of primary, secondary and possibly tertiary conidia. Even when the small, pyriform conidia are listed separately (Table 1), the rest of the population gives a skewed curve. As a result, conidia were described above as "primary and secondary" and as "secondary and tertiary".

Of 52 species of *Erynia* published to this day, only nine have been recorded from coleopteran hosts; of these nine, host ranges appear so far to be restricted to a number of families of Coleoptera, but each pathogen has been recorded only in a single family. *E. suturalis* was compared with those nine *Erynia* species (Table 2) and found to be different enough from each of them to justify its description as a new species. Furthermore, all the species listed in Table 2 differ in at least two characters from each other and thus all of them deserve independent status. Confusion about the possible conspecificity of *E. coleopterorum* and *Tarichium punctata* Garbowski with *Erynia phytonomi*, as assummed by Batko (1966), was dealt with recently (Ben-Ze'ev and Kenneth, 1980; Ben-Ze'ev, 1986); Table 2 reveals that the two *Erynia* species clearly differ from each other. *Erynia elateridiphaga* (Turian) Humber *et al.*, considered by some to be very close to the two abovementioned species (Balazy, 1981) is now a synonym of *E. anglica*. A debate about the true identity of *E. phytonomi* (Harcourt *et al.*,1974; Ben-Ze'ev & Kenneth,1980) revealed the existence of two different *Erynia* species: *E. phytonomi* and a species yet to be named (possibly related to *E. phytonomi* at the subgeneric level – no. 2 in Table 2)(Harcourt *et al.*, 1981; D. Perry, D. Tyrrell and D.M. MacLeod, pers. commun. and examination of their unpublished data). Another yet unnamed *Erynia* sp. (Balazy, 1981), attacking *Rhagonycha lignosa* in Poland (no.7 in Table 2), appears to be different enough from the other nine species to warrant its validation as a new species.

Balazy (1981) doubted the broad host range of *Entomophthora anglica*, as listed by Petch (1944; 1948): *Agriotes sputator*, *Lochmaea suturalis*, (? *Plateumeris*), *Cantharis* sp. and *Galerucella tenella* larvae, and an unidentified Staphylinid beetle. Table 2 reveals that each coleopterous *Erynia* species seems to be restricted to one or two host species, belonging in one or two genera in a single family of Coleoptera. This is true as well for the two *Erynia* species found in Petch's "*Entomophthora anglica*" collection; the broad host range of the latter is split between the two. The specimens of "*E. anglica*" recorded on *Cantharis* sp., on *Galerucella*, and on the Staphylinid beetle were not received from the Herbarium and are assumed to be missing – it is impossible to determine which fungal species attacked these hosts, but one should not exclude the possibility, especially in the light of other mixtures of fungal species in Petch's collection (Ben-Ze'ev, 1982; 1986), that *Cantharis* sp. was infected by a different fungus, possibly Balazy's unnamed *Erynia* sp. or *Erynia crassitunicata* (see Table 2). One of the two specimens annotated "? *Plateumeris*" contained *E. anglica* while the second contained a fungus resembling *E. suturalis*, however, Petch himself (1944) regarded these host identifications as doubtful and in his later list (1948) he changed the host identification to *Cantharis*, while in his collection the same specimens are annotated simply as "beetle".

There are still several unsolved nomenclatural problems concerning coleopterous *Erynia* species. One, concerning the naming of *Erynia* sp. on *Hypera postica* larvae, was discussed in detail elsewhere (pp.:463-464 in Ben-Ze'ev and Kenneth, 1982 b). A solution to this problem is currently being studied with the help of the Type of *Tarichium punctata* (R. Humber, pers. commun.). *Erynia* sp.on *Rhagonycha lignosa* remains unnamed, awaiting a clarification of its possible conspecificity with *Tarichium rhagonycharum* Balazy (Balazy, 1981; and pers. commun.). The doubtful association between the *Erynia* and *Tarichium* states of *E. coleopterorum* was discussed in detail by Ben-Ze'ev (1986). One way to deal with such doubtful associations between *Erynia* and *Tarichium* states was demonstrated with *E. zabrii* (pp.: 463-465 in Ben-Ze'ev and Kenneth, 1982 b) where its speculative association with *T. jaczewski* Zapr. in Jacz. & Jacz., as proposed by Batko (1964) was rejected.

ACKNOWLEDGMENTS

The author was supported during this study by a Visiting Fellowship generously provided by the National Science and Engineering Research Council, Canada. The courtesy of the Curator of The Royal Botanical Herbarium, Kew, U.K. in lending me specimens for study is gratefully acnowledged. I thank Prof. R.G. Kenneth for the constructive review of the manuscript, and Prof. E.D. Kollman and Dr. Irene Gruenberg-Fertig for their help with the Latin description. I also thank Drs. S. Balazy, R.A. Humber, D.M. MacLeod, D. Perry, and D. Tyrrell for valuable personal communications and for showing me their unpublished data relevant to this study.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 413-414 April-June 1987

SPHAEROBOLUS: RECORD OF A NEW GENUS OF GASTEROMYCETES FOR MEXICO

TEOFILO HERRERA
AND
EVANGELINA PEREZ - SILVA

Laboratorio de Micología, Departamento de
Botánica, Instituto de Biología, UNAM
Apartado Postal 70-233, 04510 México, D.F.

ABSTRACT

The first report of *Sphaerobolus stellatus* Tode: Pers. (Sclerodermatales: Sphaerobolaceae) in México is discussed as well as the habitat, distribution and biological importance.

INTRODUCTION

The Gasteromycetes are well represented in México; notwithstanding, in this country the taxonomic studies on genera of the group started only a few decades ago by Herrera (1950, 1964), Guzmán and Herrera (1969) and Guzmán (1970). Until now no record on *Sphaerobolus* has been reported.

The continous recent changes in taxonomy permit us, in accord with modern authors, to place the family Sphaerobolaceae in the Sclerodermatales (Demoulin, 1968; Demoulin and Marriot, 1981; Ing, 1984) instead of the Nidulariales where it was classified before (Coker and Couch, 1928).

DESCRIPTION OF THE SPECIES

Sphaerobolus stellatus Tode: Pers.

Peridium globose, fleshy, scarcely 2 mm. in diameter; after the dehiscence the peridium remains divided in six triangular lobules. Gleba shining and viscid, white, later yellow or chestnut brown, with many gemmae sprouting to form hyphae densely filled with granules. Spores hyaline, smooth, elliptical, 5.1-6.8 x 3.4 um borne on the basidia irregulary disposed in sectors of the gleba.

Habitat: On rotten wood, litter, and fallen branches of *Abies religiosa* (H.B.K.) Cha. & Schl., solitary or gregarious.

Studied material. State of MEXICO, Km 25.5 of the road Toluca to Temascaltepec, PEREZ-SILVA, SANCHEZ and CASTRO, September 23, 1984 (MEXU 18266). HIDALGO: Municipio de Omitlán, Vicente Guerrero; C. LEON, July 5, 1986 (MEXU 20108). MORELOS: road Lagunas de Zempoala to Chalma, PEREZ-SILVA, CHINCHILLA, SAMANIEGO and LEON, August 14, 1984 (MEXU 19613).

Discussion: This fungus is often rare and difficult to collect because of the small size of the species, but it has a wide distribution. It is well know from the United States, Europe, South America, and the Antilles but not from Mexico (Coker and Couch, 1928; Pilat, 1958, Courtecuisse, 1985; Martínez, 1956, Reid, 1977; Demoulin and Mariot, 1981; Brodie, 1972). It is important because the mycelium of its species grows easily in the laboratory and can be used to show phototropism in the fungi, and for the study of the interesting

mechanism of throwing the gleba as a cannon ball to a distance up to 6 m (Buller, 1933; Ingold, 1971, 1972; Ingold and Peach, 1970).
The accumulation of polysaccharide has been determined as very important in this mechanism for the ejection of the glebal mass (Walker and Anderson, 1925; Flegler, 1982).

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AKNOWLEDGMENTS

We wish to thank Dr. V. Demoulin, Dr. G. Guzmán and Dr. M. Ulloa for reviewing the manuscript.

MYCOTAXON

Vol. XXVIII, No. 2, pp. 415-417 April-June 1987

CAMAROPS BIPOROSA SP. NOV. FROM FRENCH GUIANA

Jack D. Rogers
Department of Plant Pathology
Washington State University
Pullman, WA 99164-6430
and
Gary J. Samuels
The New York Botanical Garden
Bronx, NY 10458

Camarops biporosa sp. nov. is described from a French Guiana collection. It differs from all other *Camarops* species in having a germination pore at each end of the ascospore.

A collection of a *Camarops* superficially resembling *C. ustulinoides* (P. Henn.) Nannf. proved, on closer examination, to be an undescribed species. It is described here.

Camarops biporosa J.D. Rogers & Samuels, sp. nov. Fig. 1-6.

Stromata pulvinata, connectivis latis vel attenuatis, in totis ad 1.7 cm lata X 5 mm crassa, extus atra, intus nigra. Stratum extimum 0.5 mm crassum, durum; contextus ligneus. Superficies praeter ostiola levis. Perithecia ca. 0.5 mm diam X 1-2 mm alta. Ostiola leviter elevata, inconspicua. Asci saepe biseriate octospori, cylindrici vel clavati, stipitati, 74-85 µm longitudine tota X 7-8 µm crassi, partibus sporiferis 63-70 µm, apparatu apicali in liquore iodino Melzeri haud caerulescente, minutus. Ascosporae brunneae, unicellulares, ellipsoideo-inaequilaterales, leves, 8.8-10.3 X 4.4-5(-5.9) µm, poro germinativo in quoque extremo. Status anamorphosis ignotus.

Stromata pulvinate on broad or narrowed connectives, up to 1.7 cm diam X 5 mm thick, externally dull black, internally satin black. Outermost layer ca. 0.5 mm thick, carbonaceous, interior woody. Surface smooth except for ostioles. *Perithecia* ca. 0.5 mm diam X 1-2 mm high. Ostioles barely raised, inconspicuous. *Asci* 8-spored, the spores somtimes arranged in biseriate manner, cylindrical to clavate, stipitate, 74-85 µm total length X 7-8 µm broad, spore-bearing part 63-70 µm, with apical ring not staining in Melzer's iodine reagent, minute. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 8.8-10.3 X 4.4-5(-5.9) µm, with germ pore in each end. Anamorph unknown.

COLLECTION EXAMINED: FRENCH GUIANA: Vicinity of Saul, elev. ca. 200, on well-rotted log in primary forest, G. J. Samuels 3407, 3-16 Feb 1986 (NY, HOLOTYPE; CAY, ISOTYPE).

The taxon described here differs from all other Camarops species in having a germ pore at each end of the ascospores. It differs from most other Camarops species in having ascospores that are not more or less flattened and in the relatively large size of the ascospores (see 1 and 2). In other respects it seems a typical Camarops and not worthy of forming the type of a new genus. We were unfortunately unable to obtain cultures from our material.

ACKNOWLEDGMENTS

Scientific Paper No. 7619, Washington State University, College of Agriculture and Home Economics Research Center, Project 1767. This project was supported in part by National Science Foundation Grants BSR 84-07359 to JDR and BSR 85-00236 to GJS.

We thank Michael J. Adams and Ruby Latham (Washington State University) for aid with photography and typing the manuscript, respectively. We thank Brenda Callan (Washington State University) and Clark T. Rogerson (New York Botanical Garden) for reading the manuscript.

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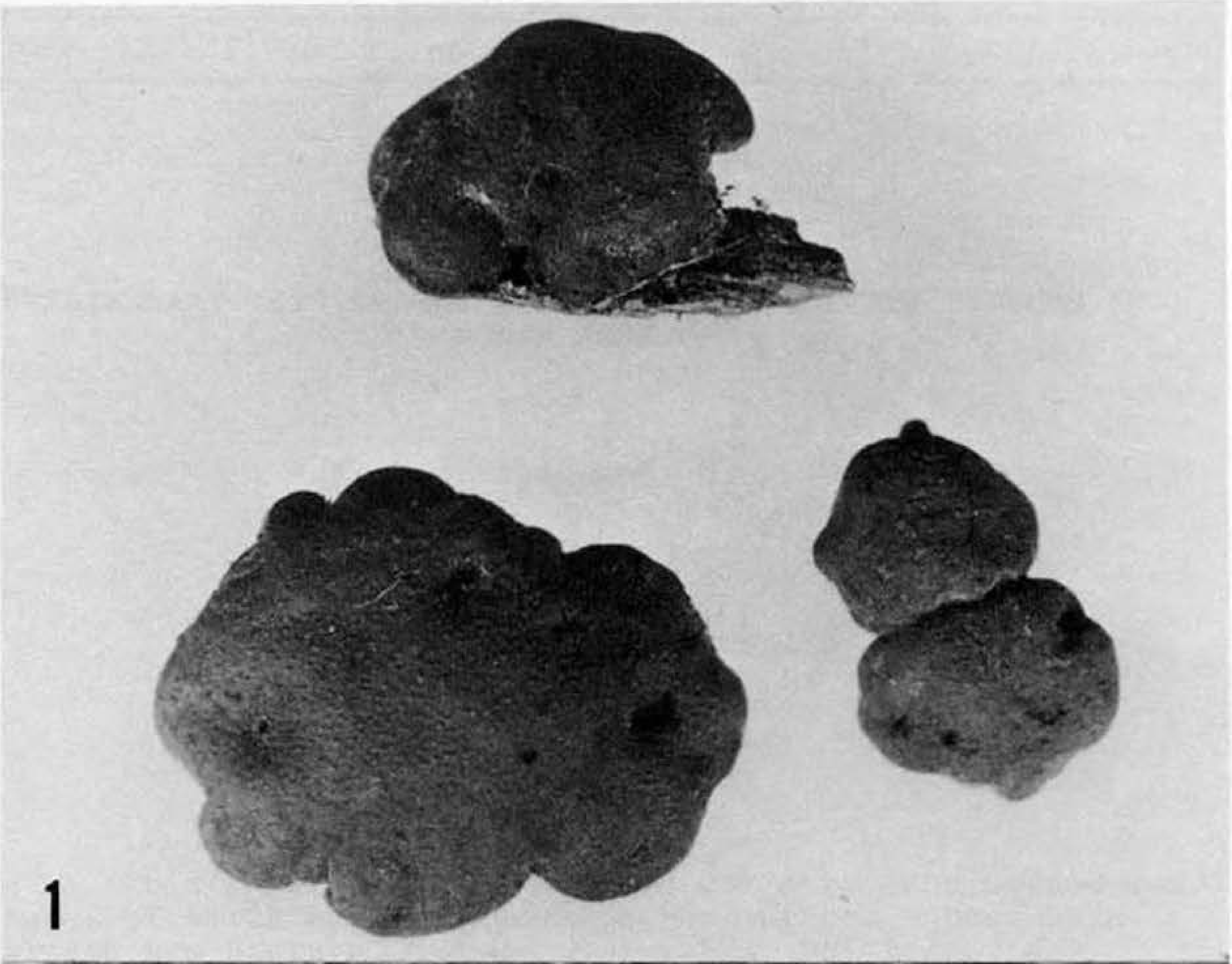
Figs. 1-6. Camarops biporosa. 1. Stromata, ca. X 3. 2. Stromatal surface showing ostiolar papillae, ca. X 24. 3 and 4. Ascal apices (arrows), X 1600. 5 and 6. Ascospores. Germ pores (arrows), X 1600. Figs. 1 and 2 by photomacrography. Figs. 3 and 4 by darkfield phase microscopy. Figs. 5 and 6 by brightfield microscopy.



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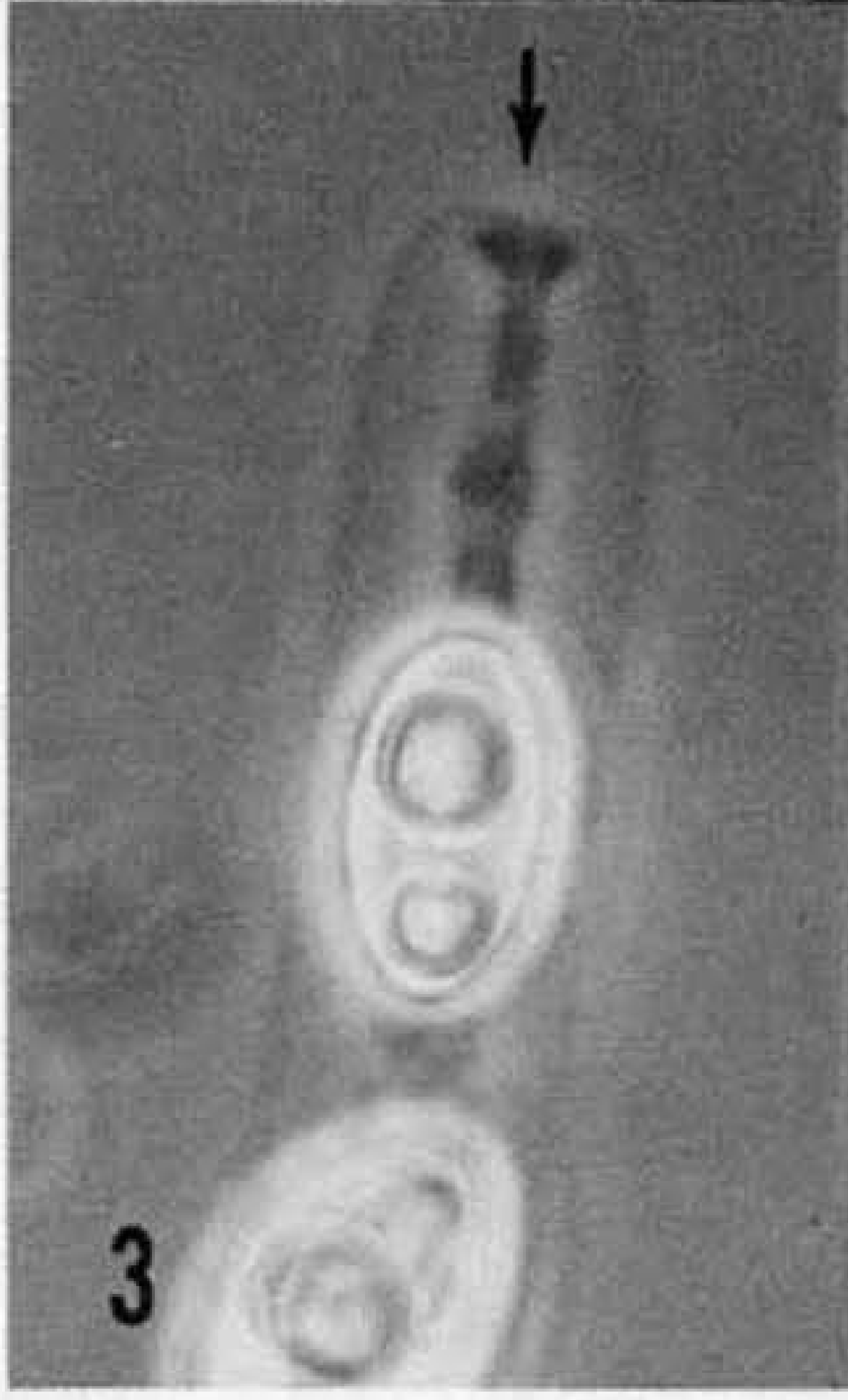

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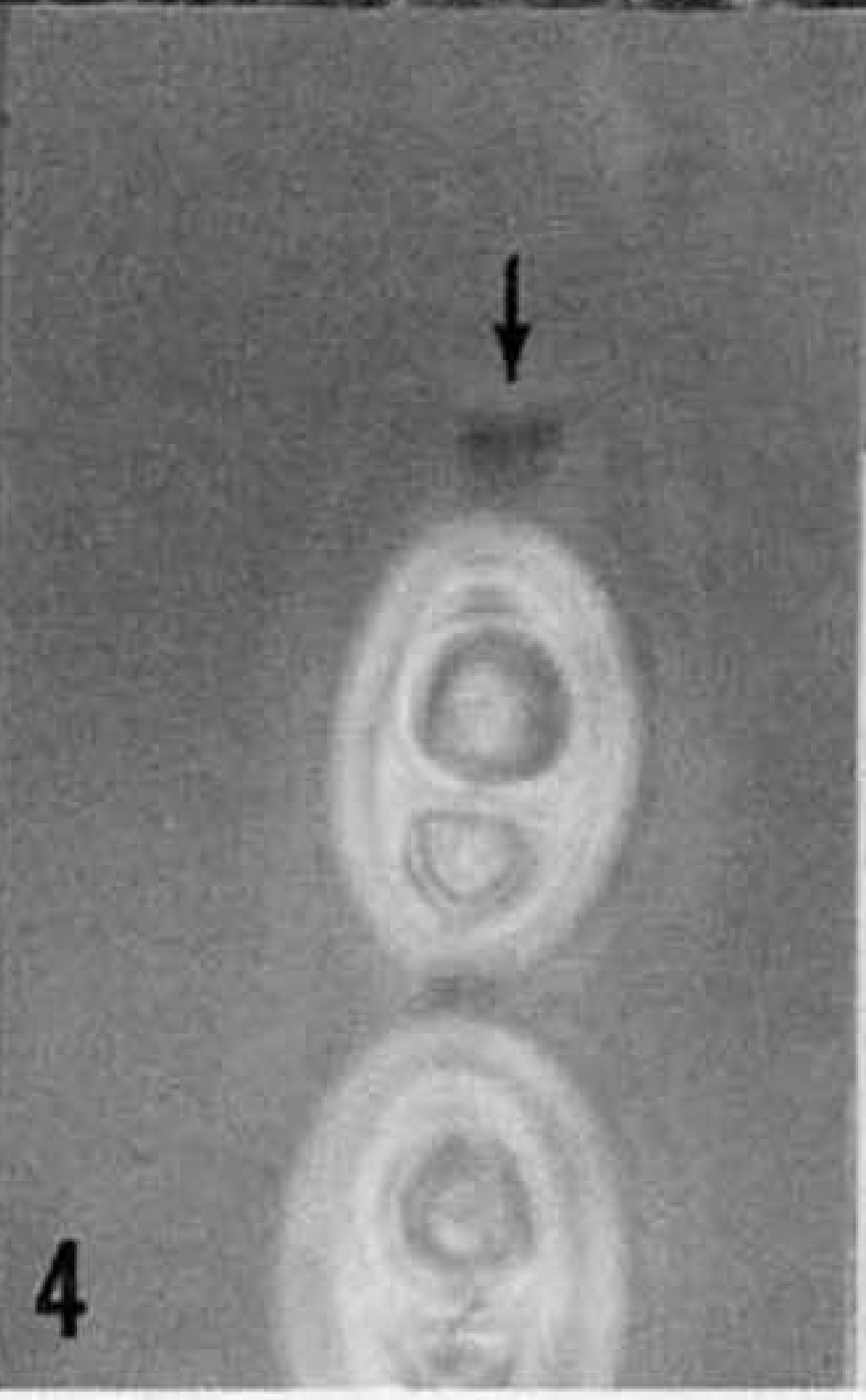

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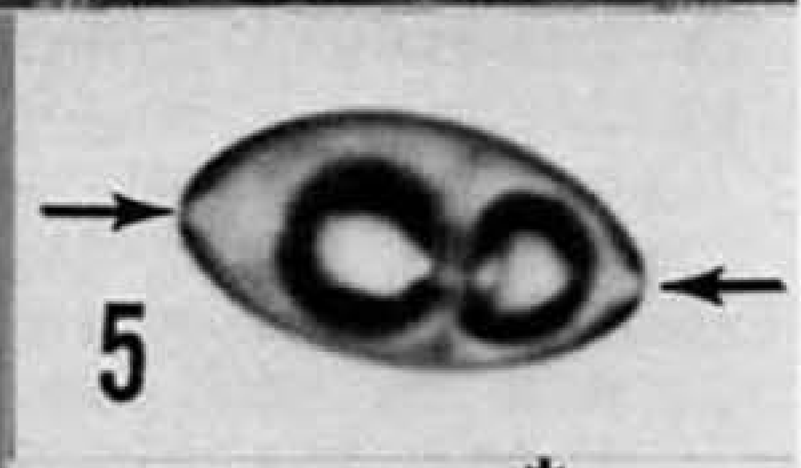

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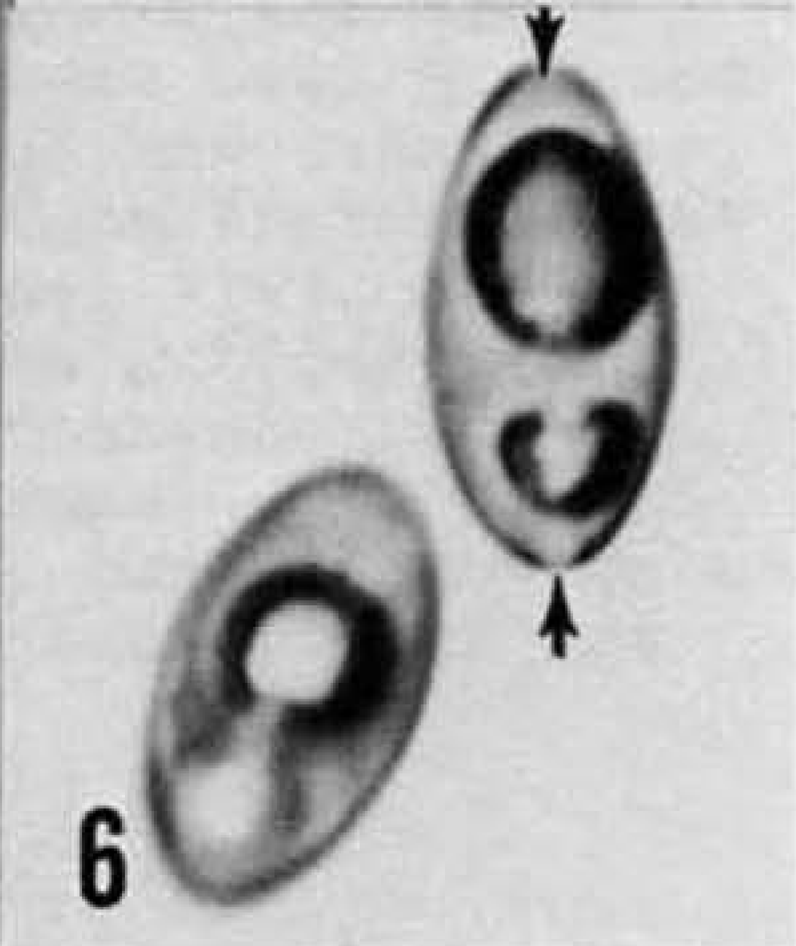

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 419-426 April-June 1987

PRELIMINARY KEYS TO THE TERRESTRIAL STIPITATE HYDNUMS OF NORTH AMERICA

K.A. Harrison and D. W. Grund

Department of Biology
Acadia University
Wolfville, N.S. BOP 1XO

ABSTRACT

This paper presents keys to the stipitate hydnaceous fungi of North America known to the authors. Genera included are Bankera, Hydnum, Hydnellum, Phellodon, and Sarcodon with sixty nine species and varieties.

INTRODUCTION

The following are keys to the terrestrial stipitate hydnums of North America known to us. These are being made available ahead of the detailed descriptions of species which are now in preparation for a monographic treatment of the family. The hydnums are a fascinating group, sensitive to the microclimate of their surroundings. Many are long lived and mature specimens usually are strikingly different in appearance from when they were actively expanding. Many species appear to be endemic to different regions of the continent and these keys will only be explicit for the regions where it has been possible to collect over a period of several weeks when the common species of the area were present. In the keys, an (E) or (W) indicate East and West respectively. Plate numbers designated thus: ***(Pl. 3)**, refer to the plate numbers with discussions published in the companion article with this paper (Differences in European and North American Stipitate Hydnums). We do not cite references in the text of this paper, but do provide a list of "selected references" that offer descriptions for the taxa presented in the keys.

Key to the Genera

Basidiocarp supporting positively geotropic spines bearing the hymenium.

1. Spores brown, tuberculate..............................2
1. Spores white; smooth or echinulate....................3

    2. Context of basidiocarp tough; scissile ....*Hydnellum*
    2. Context of basidiocarp fleshy, brittle....*Sarcodon*

3. Spores smooth; context fleshy...................*Hydnum*
3. Spores tuberculate to echinulate.......................4

    4. Context fleshy.................................*Bankera*
    4. Context tough...............................*Phellodon*

Key to the species of BANKERA (Coker & Beers.) Pouz.

1. Pileus glabrous, surface layer soft with debris adhering to it conspicuously....*B. fuligineo-alba* (Schmidt: Fr.) Pouz. *(Pl.1)
1. Pileus glabrous to scaly, surface not holding debris conspicuously......*B. violascens* (Alb.& Schw. : Fr.) Pouz. * (Pls. 2,30)

Key to the species of PHELLODON Karst.

1. Context without clamps...................................2
1. Context with clamps (E)..........*P. fibulatus* K. Harr.

    2. Pileus strongly zonate............*P. tomentosus* (L.: Fr.) Banker *(Pl. 6)
    2. Pileus not strongly zonate..........................3

3. Stipe slender, usually under 4 mm in dia..............4
3. Stipe stout, usually over 4 mm in dia.................5

    4. Pileus brownish-black, amyloid-like inclusions in cutis hairs, spines stain brownish upon brusing *P. melaleucus* (Sw. apud Fr.: Fr.) Karst. *(Pl. 5)
    4. Pileus bluish-black, no amyloid-like inclusions in cutis hairs, spines stain blackish upon bruising (W). ....*P. atratus* K.Harr.

5. Spores not over 2 mm long, pileus tomentose, tan, becoming gray, finally brown; flesh not black, hyphae not dark in Melzer's reagent (E.) ....*P. confluens* (Pers.) Pouz. *(Pl.4)
5. Spines up to 4 mm long 6

    6. Pileus deep purplish-black when young, black to brownish in age; flesh and surface hyphae dark in

Melzer's reagent (E.) ....P. niger (Fr.: Fr.) Karst. ***(Pl.6)**

6. Pileus whitish when young to dark brown in age; flesh dark, cutis hyphae not dark in Melzer's Reagent (E)..P. niger var. **albonige**r (Pk.) K. Harr.

Key to species of HYDNUM L. : Fr.

1. Pileus tan, pinkish-cinnamon, or dull orange..........2
1. Pileus white to creamy with tints of tan..............5

2. Pileus convex, color pinkish cinnamon to apricot-buff; spores 6-7 x 7-8.5µm..H. repandum L:Fr. *(Pl. 6,8)
2. Pileus usually under 7cm; rusty-orange...............3

3. Spores 6-7 x 7-8.5µm.....H. rufescens Fr. ***(Pl. 9)**
3. Spores larger, pileus variably colored................4

4. Pileus tan to rusty-orange; umbilicate; spores 6-7.5 x 8-9.5 µm.........................H. umbilicatum Pk.
4. Pileus color similar to H. repandum; spores 6-9.5 x 7-10(11) µm ....H. washingtonianum E & E.

5. Pileus usually over 6 cm; surface viscid; late fall species; spores 3.5-5 x 6-7 µm ....H. albomagnum Banker
5. Pileus smaller; surface dry; summer species..........6

6. Pileus rarely up to 7 cm dia.; spores 3-4 x 4-6 µm ....H. albidum Pk.
6. Pileus 3-9 cm or smaller; spores 6-7 x 7-8.5 µm ....H. repandum var. album (Quél.) Rea

Key to the genus SARCODON Karst.

1. Pileus glabrous to slightly scaly, may crack deeply in age...2
1. Pileus soon distinctly scaly 17

2. Pileus or spines fawn, yellowish to orange-cinnamon; fused stipes common 3
2. Pileus or spines not as above 5

3. Pileus fawn, spines with a trace of yellow; taste sharply acrid; resembles a hydnellum (E)...S. piperatus (Coker) Maas G.
3. Pileus cinnamon to grayish; spines orange-cinnamon....4

4. Pileus cinnamon, young spines orange-cinnamon, becoming darker; odor unpleasant, taste farinaceous ....S. versipellis (Fr.) Quél. ***(Pls. 29,30)**
4. Pileus grayish to brown, spines apricot; taste and odor strongly farinaceous ....S. martioflavus

5. Pileus or context or both shaded with indigo, violet, or lilac 6
5. Pileus gray or brown or tinted olivaceous; context not as above 9

6. Pileus with shades of indigo; context shaded lilac. 7
6. Pileus drab to brownish; context lilac to vinaceous 8

7. Context indigo to vinaceous violet; no clamps (W). ....**S. fuscoindicus** (K. Harr.) K. Harr.
7. Context indigo to violet; clamps present (W) ....**S. cyanellus** (K. Harr.) K. Harr.

8. Pileus brownish; context vinaceous; blue-green in KOH 24
8. Pileus with ecru-drab spots; context not blue-green in KOH, but cuticular layer blue-green (W) ....**S. rimosus** (K. Harr.) K. Harr. *(Pl. 32)

9. Pileus shades of dull or dark brown; odor farinaceous or medicinal..10
9. Pileus grayish to olivaceous or fawn-drab; odor not farinaceous..12

10 Taste bitter; stipe and pileus usually irregular, cespitose (E).**S. subfelleus** (K. Harr.) K. Harr.
10. Taste mild, resembling a smooth S. imbricatus; gregarious or in arcs of fairy rings (E).......... .....**S. ustalis** (K. Harr.) K. Harr. *(Pl. 28)

11. Pileus fleshy, spores 5-6 x 4.5-5 µm, coarsely tuberculate; resembles a hydnellum.................... .... **S. stereosarcinon** Wehm.
11. Pileus subfleshy, indeterminate growth; spores 4.5-5.5 x 4-5 µm,coarsely tuberculate (E).................. ....**S. piperatus** (Coker) Maas G.

12. Pileus drab, smoky-buff or grayish with olive tints..13
12. Pileus various shades of gray to fawn..........14

13. Pileus drab to smoky-buff, darkening in age, taste bitter.....**S. atroviridis** (Morgan) Banker *(Pl. 40)
13. Pileus drab-gray to flesh color; stipe often eccentric; context turns slowly olive-green in herbarium (E)...... ....**S. scabripes** (Pk.) Banker *(Pl. 40)

14. Spores small, 4-5 x 3.5-4.5 µm; odor pungent (W) when fresh.........**S. calvatus** (K. Harr.) K. Harr.
14. Spores as above; odor fragrant W) ....**S. calvatus** var.**odoratus** (K. Harr.) K. Harr.

15. Taste strongly bitter after drying...................... ...*S. leucopus* (Pers.) Maas G. & Nannf. ***(Pl. 28)**
15. Taste mild, slightly salty............................. .... *S. excentricus* (Coker & Beers) Baird

16. Pileus strigose to woolly, scaly 17
16. Pileus moderately scaly to imbricate scaly...........18

17. Pileus grayish; taste and odor farinaceous, then slowly acrid ....*S. lanuginosus* K. Harr.

17. Pileus yellowish; taste acrid, southeastern ....*S. cristatus* (Pers.) Banker

18. Taste mild or slightly bitter in age; clamps present 19
18. Taste bitter or intensely nauseous; clamps absent in context 20

19. Pileus brown, imbricate- scaly; under conifers .. ...*S. imbricatus* (L. : Fr.) Karst. ***(Pl. 26)**
19 Pileus pallid-brown; fibrillose; under pines ....*S. ustalis* (K. Harr.) K.Harr.

20. Base of stipe olive-black 21
20. Base of stipe not olive-black 22

21. Pileus brown, sometimes with vinaceous shades; spines coarser than following; taste bitter; in coniferous woods. .*S. scabrosus* (Fr.) Karst. ***(Pl.34)**
21. Pileus light brown; spines fine, close;taste extremely bitter; in deciduous woods ....*S. underwoodii* Banker ***(Pl. 36)**

22. Pileus brown with purplish tint, surface black, subcutis blue-green in KOH (W) ....*S. subincarnatus* (K. Harr.) K. Harr.
22. Surface blue-green in KOH (W) ....*S. fennicus* (Karst.) Karst. ***(Pl. 31)**

23. In coniferous wood .... *S. fuligineo-violaceus* (Kalchbr.) Pat. ***(Pls. 38,39)**
23. In deciduous wood (E) ....*S. joeides* (Pass.) Bat. ***(Pls. 3k7,40)**

Key to the Genus HYDNELLUM Karst.

1. Pileus, context or spines orange or with shades of orange 5
1. Pileus some other color 2

2. Pileus and spines sulphur yellow when young, dull in age ...*H. geogenium* (Fr.) Banker ***(Pl. 24)**
2. Pileus or spines not as above.....................3

3. Context of stipe with bluish or mauve shades or zones (if red juice present see 16) 4
3. Context of stipe ferruginous to buff...................5

4. Context not with blue shades until dried (E).[also see key lead 13] ....*H. ferrugipes* Coker
4. Context and margin of pileus bluish (E) ....*H. alachuanum* Murr.

5. Pileus bright salmon, spines a lighter shade on tips, context of stipe buff to ferruginous................6

5. Pileus as above, but may have orange or yellowish tints in spines or on base of stipe 10

6. Pileus infundibuliform, rarely over 6 cm, context thin (W) ..*H. conigenum* (Pk.) Banker *(Pl. 12)
6. Pileus colliculose, complicate, often thick 7

7. Pileus in age often spreading and brown with uneven surface or remaining solid and compact, spores 6-7 x 5-6 um, margin and tips of spines white ....*H. aurantiacum* (Batsch. : Fr.) Karst. *(Pls. 11,12)
7. Spores smaller 8

8. Pileus surface markedly scrobiculate, spines persistently orange, brownish when very old, growing under Pinus resinosa ....*H. chrysinum* K. Harr.
8. Similar to above, in deciduous or mixed woods ..9

9. Pileus usually scrobiculate, rarely smooth, spines when young with bright yellowish tips becoming brown, dried flesh brittle (E) ....*H. earlianum* Banker
9. Pileus usually imbricate, clusters from a single stipe, dried flesh rather tough (E) .....*H. complicatum* Banker

10. Growing margin of pileus and spines pale yellowish; traces of yellow mycelium on base of stipe (Michigan) ....*H. septentrionale* K. Harr.
10. Very similar in stature and dried appearance but without traces of yellow (Nova Scotia) ....*H. frondosum* K. Harr.

11. Pileus or stipe or context blue or with some bluish tint 12
11. Pileus or stipe or context some other color 18

12. Pileus white when young, stipe violet, odor fragrat.......*H. suaveolens* (Scop. : Fr.) Karst. *(Pls. 15,16)
12. Pileus some other color, young spines bluish, can be faint 13

13. Pileus bluish when very young becoming tan, context zoned with blue ....H. caeruleum (Hornem. ex Pers.) Karst. *(Pls. 13,14)
13. Not as above 14

14. Pileus usually greyish, generally irregular, stipe rooting, context and surface brownish, spines bluish ....H. cyanodon K. Harr.
14. Stipe color not as above, pileus margin with red droplets 15

15. Stipe thick (sclerotoid), white mycelioid over a bluish surface (E) ....H. scleropodium K. Harr.
15. Stipe slender, rooting 16

16. Pileus tan to greyish, fibrous and pitted by depressions where red droplets exuded (E) ....H. cruentum K. Harr.
16. Pileus not as above 17

17. Pileus tinted with bluish .....H. cyanopodium K. Harr.
17. Pileus connate, brownish with hoary appearance, small, stipe not rooting (E) ....H. subzonatum K. Harr.

18. Pileus and stipe brown to reddish brown, KOH gives violet flash before turning context black 25
18. Pileus variably colored, KOH reactions not associated with violet flash 19

19. Pileus white with red droplets when young, darkening and scrobiculate in age, dark matted cuticular mycelium 'apparent amyloid' (W) ...H. peckii Banker *(Pl. 10)
19. Not as above 20

20. Pileus velutinous, with red droplets, cuticular hyphal mycelium not 'apparent amyloid'........... ....H. diabolus Banker *(Pl. 10)
20. Pileus blackish 21

21. Pileus large, velutinous young, purplish black, stipe brownish (W) ....H. regium K. Harr.
21. Pileus fibrillose 22

22. Pileus small, greyish black with hoary appearance ....H. nigellum K. Harr.
22. Pileus variously colored 23

23. Pileus low and squat, surface strigose exuding coffee colored droplets .H. mirabile (Fr.) Karst.*(Pls. 17,18)
23. Not as above 24

24. Pileus brown, complexly imbricate, occasional single sporocarps (E) ....H. multiceps K. Harr.
24. Pileus drab, fleshy context, acrid (E) ....

24. Pileus drab, fleshy context, acrid (E) .... **Sarcodon piperatus** (Coker) Maas G.

25. Pileus connate, context and stipe thick, deeply scrobiculate ..**H. scrobiculatum** (Fr.) Karst. ***(Pls. 18,19)**
25 Pileus usually thinner with surface not or rarely scrobiculate 26

26. Pileus usually convex, rarely complexly imbricate ....**H. cumulatum** K. Harr. ***(Pl. 20)**
26. Pileus individually developed or concrescent ...27

27. Pileus with bulbous stipe from thick layer of tomentum, under oaks (E) ..**H. spongiosipes** (Pk.) Pouz. ***(Pl. 22)**
27. Pileus without bulbous stipe 28

28. Pileus as individual sporocarps, usually under Pinus spp.(E) ...**H. pineticola** K.Harr. ***(Pl. 21)**
28. Pileus often concrescent, zonate 29
29. Pileus thin, strongly zonate, context dry................**H. scrobiculatum** var. **zonatum** (Batsch : Fr.) K. Harr. ***(Pl. 19)**
29. Pileus similar but context with yellowish juice (W) ....**H. subsuccosum** K. Harr.

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The following selected references may be used for detailed descriptions for taxa presented in this key.

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MYCOTAXON

Vo. XXVIII, No. 2, pp. 427-435 April-June 1987

DIFFERENCES IN EUROPEAN AND NORTH AMERICAN STIPITATE HYDNUMS

K.A. HARRISON and D.W. GRUND

Department of Biology, Acadia University,
Wolfville, N.S. BOP 1XO

ABSTRACT

This paper evaluates the plates in Die Terrestrischen Stachelpilze Europas published in 1975 by R. A. Maas Geesteranus, for use when identifying North American species of stipitate hydnaceous fungi. The figures in the plates are compared with Harrison's collection of Kodachrome slides of hydnums found in North America. Some of the illustrations of European species in this book are not recognizable as the taxa known under the same name in North America, while others are typical.

INTRODUCTION

The stipitate hydnums are a conspicuous part of the North American fleshy fungus flora and are widely collected by mycologists. At present there is not a comprehensive treatment of the group; thus, most identifications are based on the European literature. Dr. R. A. Maas Geesteranus (1975) published a monograph for Europe that includes keys, descriptions in German, and abstracts in English, as well as forty colored plates taken from paintings by van Os and the author. This monograph, Die Terrestrischen Stachelpilze Europas (The Terrestrial Hydnums of Europe) is today a standard reference for North American mycologists examining the hydnums.

One problem with this approach is that some of the illustrations of European species in the book are not recognizable as the taxa known under the same name in North America. Unfortunately, neither Maas Geesteranus nor we have been able to study the hydnums fresh, in the other's country. It is certain that there are many additional taxa in North America remaining to be studied and described before there can be an agreement on the species present in the two regions.

There is always a problem with the color reproduction of plates, and it is possible that this happened in this publication. In any event, if the illustration is misleading, this must be known if accurate identifications are to be made.

The following analysis of each plate is based upon Harrison's extensive Kodachrome collection of North American stipitate hydnums, and his field records based upon over 50 years of collecting these fungi across North America.

DISCUSSION

PLATE 1 Bankera fuligineo-alba (Schmidt : Fr.) Pouz. Fig. a is a typical illustration of this species as known in North America, while b and c illustrate peculiar variations. The malformation of c is undoubtedly the result of insect feeding. The taxon recognized as this species in North America usually has the regular outline of a mushroom. In Nova Scotia it has been collected in stands of Pinus resinosa from under the layers of pine needles.

PLATE 2 and 3. Bankera violascens (Alb. & Schw.:Fr.) Pouz. Figs. b and c are similar to fresh and dried specimens of a taxon in North America that is known as B. carnosa (Banker) Pouz. Plate 2, figs. a and Plate 3 are unlike it. The taxon named Phellodon carnosus by Banker is common on this continent but is usually much darker in color. However, it has been possible to examine a collection of B. violascens from Sweden which contained sporocarps that are as dark as North American material, and it is accepted that we are dealing with a species that is more variable in Europe that in North America.

PLATE 4. Phellodon confluens (Pers.) Pouz. Figs. a, b, and c bear little resemblance to fresh North American specimens of this species. The dried material shown in fig. d can be recognized as such, but is too light colored to be typical. The upright sporocarp (fig. a) does not illustrate the normal habit for this species in North America, where the spined surface is normally parallel to the surface of the soil. Fig. e, Phellodon melaleucus (Sw.: Fr.) Karst. occurring in North America does not have a deeply infundibuliform pileus and is much darker on the disc than illustrated. Our material is so different that it would appear that we have another species. Our taxon is relatively common in north- eastern North America and is abundant in the pine forest of northern Michigan along the shores of Lake Superior. After one season's experience with the Phellodon species growing in the southern Appalachian mountains, it was felt that this genus will be understood in North America only after intensive work for several seasons in that region.

PLATE 5. Not one of the figures in this plate resembles

North American taxa included under the names given for these illustrations. P. melaleucus is illustrated by figs. a, b, and c. Fig. a has a slight resemblance to P.tomentosus (L.: Fr.) Banker, but does not have the characteristic stipe of P. tomentosus ; fig. b appears to be an overgrown form of fig. a; fig. c is dark on the disc but the margin is unusually light colored to be Phellodon niger (Fr.) Karst. The three sporocarps marked d do not illustrate the species recognized under this name in North America. They do not show the characteristic thick, tomentose-felty stipe and do not have the normal gray-black pileus. The violet shade of the youngest pileus has not been found on the hundreds of sporocarps seen in Nova Scotia. Fig. e of dried material is a beautiful painting, but illustrates something different from the species considered to be P. niger in Nova Scotia or North Carolina. Possibly it comes closer to representing P. niger var. alboniger, but Canadian sporocarps of that taxon are larger with longer, thickly felted stems, also the colors of the pileus are not typical. P. niger var. niger and var. alboniger (Pk.)K. Harrison are closely related taxa which can be separated by the differences in color of growing basidiocarps. In age, after weathering, they are similar.

PLATE 6. P. niger. Fig. b slightly resembles the North American taxa labelled with this species name, but the pileus is thin and split in the European species, a condition unknown here, because the context of our taxon is thick and the sporocarp stout. Fig. a resembles one of the larger forms of P. tomentosus found in the Pacific Northwest. P. tomentosus fig. c is recognized as a beautiful picture of this common species. Fig. d is not an illustration of this taxon as it grows in North America. It is not known here as an imbricate species.

PLATE 7. Hydnum repandum L.: Fr. Figs. a, b, and c are all recognizable. Fig. a appears to represent a normal sporocarp, but the red spines are unknown here. The spines on fig. b are most unusual as they seem to be arranged in windrows. In fig c, the specimen shown, if collected in North America, would be suspected as being infested with nematodes. The colors of this plate are too light a shade to represent typical North American material.

PLATE 8 Hydnum repandum. The illustrations in this plate are very light colored, but there is a distinctive late fall form with light colors in Michigan that partially matches them, but is a much larger fungus.

PLATE 9. Hydnum rufescens Fr. It is interesting to see such light colored illustrations of this, one of the most controversial species. This species can be much darker in Europe. The colors and appearance as presented are similar but too light colored to be the American Hydnum umbilicatum Pk., which has larger spores. The darker

reddish brown form considered to be H. rufescens in this continent has only been collected two or three times, but Dr. A.H. Smith informs us that it was found many times under oaks in southern Michigan in 1980.

PLATE 10. Hydnellum peckii Banker, (H. diabolus Banker has been considered a synonym in Europe). Fig. f resembles H. peckii as found in the Pacific Northwest but H. diabolus in the east is quite different. Figs a, b, and c of young material are too whitish to be typical for H. peckii. The red drops are the character in common with H. diabolus, which is a strigose, brownish species in North America. In fig. d the context of the stipe and pileus is too light colored. The outline of fig. a with the long spongy stipe, is so sharp and clear that there is no doubt all details are shown, yet it does not look like any of the hundreds of specimens seen over the years on this continent. This plate supports our concept of two distinct North American species.

PLATE 11. Hydnellum aurantiacum (Batsch : Fr.) Karst. This is a beautiful plate of variations found in this species. Larger sporocarps are the rule in North America but often take up too much space to be used for illustrations. The figs. e, f, and g show a deeply infundibuliform species that is unknown in most of this country but has been found several times in Alaska. Hydnellum conigenum Pk., a western species, is similar but the fruit bodies are smaller and the spores distinctly smaller.

PLATE 12. Hydnellum aurantiacum. Figs. a and b illustrate further easily recognized forms of this variable species, Hydnellum auratile (Britz.) Maas G., figs. c, d and e. There has been some question whether H. conigenum is a synonym of this taxon. These figures are sharp and detailed, showing red streaks on the pileus. These are not present on North American material either dried or fresh. The two appear similar otherwise but distribution patterns and microscopic differences indicate two species are involved.

PLATE 13. Hydnellum caeruleum (Hornem. : Pers.) Karst. This is a long-lived and extremely variable taxon in North America that sometimes must be cut open to examine the characteristic zoned flesh before one is certain of the species. Fig. a is typical of young Canadian material except that the mycelial subiculum at the base is too brightly colored. Fig. c is too rough on top. North American material usually has a smooth surface even when the sporocarps reach the size shown in figs. b and c.

PLATE 14. H. caeruleum, fig. a (upper left) shows the typically colored subiculum around the base of the stipe of the North American form; in fig. a (upper center) the subiculum is too white. These two are obviously of young material but the color of the caps is not like any

North American forms that we have seen. Fig. b illustrates an old specimen that has almost reached the condition found in the type of Hydnellum humidum (Banker) Banker. Fig. c illustrates the zonate bands in the context of the pileus and stipe of H. caeruleum when young.

PLATE 15. Figs. **a** represent Hydnellum suaveolens (Scop. : Fr.)Karst., but fig. **b** must be something else. No collection of this species to our knowledge in North America has the appearance of this figure. Older material in Canada has a dull dirty gray shade and a water-soaked appearance. Fig. **a** on the right, is a somewhat closer representation of typical specimens found in Nova Scotia. Our young fruit bodies are white except for the blue stipe. Some variations, such as violet tints on the spines occur in age on some collections.

PLATE 16. H. suaveolens. Fig. **a** is a section that shows the typical zonations found in the context of pileus and stipe. H. compactum (Pers.: Fr.) Karst. Figs. **b** and **c** and plate 17, fig. **a** represent a species unknown to us.

PLATE 17. Hydnellum mirabile (Fr.) Karst., figs. **b**. These could never be recognized as the species known by this name in North America. The colors are too white, even for extremely young material. In North America, the coffee colored droplets of exuded juice soon discolor the strigose hairs and the pileus is only white when slugs have eaten the outer layer and secondary growth has occurred.

PLATE 18. H. mirabile. Fig. **a** is a large, tan, imbricate form with white spines. A most unusual specimen, and too light colored to be given this name in North America. Hydnellum coalitum Maas G., fig. **b**. These are two beautiful illustrations of an interesting form that might be confused with H. mirabile in North America. Our H. mirabile is not acrid and has abundant sweetish juice in the stipe. Hydnellum concrescens (Pers.) Banker. Figs. **c** illustrate young material, snow white on the margin with a deeply depressed scrobiculate center. In our H. scrobiculatum-zonatum complex, there are no sporocarps this white in the youngest pedicellate stages.

PLATE 19. H. concrescens. Fig. **a** illustrates a strange zonate-imbricate species with a white margin unknown in North America but slightly resembling Hydnum humidipes K. Harrison = Sarcodon piperatus (Coker ex Maas G.) K. Harrison (1984). Figs. **b** and **d** are easily recognized as similar to variations collected in North America that can only be separated into H. scrobiculatum (Fr.) Karst. or its var. zonatum (Batsch: Fr.) K. Harrison after careful study of the spores. Fig. **b** with minute crystalline granules on the pileus is a familiar form. Coker made the combination H. zonatum forma vespertilo stressing this character. Fig.**c** is the form found under bracken in coniferous woods;

d is another form, with a depressed scrobiculate center, that is common in northeastern North America.

PLATE 20. Hydnellum cumulatum K. Harrison. Figs. a illustrate a small, brown imbricate species. It is suggested that the fungus illustrated by Maas Geesteranus be given another name since its habit of growth and appearance is not typical of any of the forms found in Nova Scotia (the type locality). In 1979 during a rainy season, H. cumulatum was found as a thick solid sporocarp with context 4 cm thick, but the surface still had the broad convex lumps typical of the cumulus effect seen on clouds. Hydnellum ferrugineum (Fr.) Karst. Figs. b, c, and d has not been recognized in North America, but figs c and d appear similar to Hydnellum pineticola K. Harrison, except that the latter does not have the white young stage shown in fig. b, nor is it found in concrescent clumps as illustrated in Plate 21., fig. a.

PLATE 21. H. ferrugineum. Figs. b and c show a distinctive European species. The colors and surfaces are different from anything found in North America. It is maintained that H. pineticola, which has been considered a synonym, is a distinct species because it does not exude red droplets. It does have red juice at times and is distinctly reddish brown in the youngest stages. The dead sporocarps of this species persist over winter in Nova Scotia and finally disappear during the following summer. It is the most rot-resistant Hydnellum known in North America and is closely followed in this character by H. spongiosipes (Pk.) Pouz.

PLATE 22. Hydnellum gracilipes (Karst.) Karst. Fig. a shows little about the surface of the pileus, the stipe, and the spines and stipe base are lacking. (What is it?) H. scrobiculatum figs. b, c and d. These nice illustrations are instantly recognized as the taxon with the same name in North America, except the figs. d have unusually long stipes to be this species. H. spongiosipes, figs. e and f, nicely represent the young growth forms of the species; f is especially accurate for this North American taxon but has a bewildering resemblance to the forms illustrated in the figs. d on this page.

PLATE 23. Hydnellum spongiosipes (Pk.) Pouz. Fig. a represents a common form of this species found in North America; fig. b is unusual as obviously it is a regrowth over an earlier sporocarp that persisted over winter or whose development was checked by dry weather; fig. c is not a typical picture of H. spongiosipes, but does resemble H. pineticola rather closely. The two can be rather difficult to tell apart. Hydnellum tardum Maas G. figs. d. These could illustrate young actively growing basidiocarps of H. scrobiculatum. The section key (p. 94) contains "immature spines pale purplish" and the discussion (p. 99) compares

the species with H. cyanodon K. Harrison. The illustration has no resemblance to H. cyanodon. The color of the spines might lead to H. subzonatum K. Harrison, another species that is distinctly different. H. tardum, as illustrated and described, is unknown in North America.

PLATE 24. Hydnellum geogenium (Fr.) Banker. Figs. **a**, **b**, and **c** are recognizable but rather pale colored. The older parts are distinctly darker in Nova Scotian specimens and the margin and spines can be a much brighter yellow. Sarcodon imbricatus (L. : Fr.) Karst. Figs. **d**, **e**, and **f** are not helpful for the identification of this magnificent species. The young are too pale and the dried specimen is only a dried specimen (of what?).

PLATE 25. S. imbricatus. Fig. **a**, is a most unusual lacerated form that is unknown in North America; fig. **b** (lower one), the scales illustrated on this specimen show why early North American mycologists misnamed so much S. scabrosus as S. imbricatus; fig. **b** of the sectioned sporocarp shows the characteristic center that develops in mature specimens, especially when maggots are present. The pileus in age can be smooth and infundibuliform after heavy rains have removed the scales. This has never been seen by most collectors in this continent. Harrison first saw it in 1971 in North Carolina and again in Nova Scotia 1978.

PLATE 26. S. imbricatus. Fig. **a** is easily recognized as the North American form of the species, although the truncated central scales indicate a very young sporocarp. Fig. **b** matches dried material nicely.

PLATE 27. Sarcodon leucopus (Pers.) Maas G. & Nannf., is a sporocarp from Switzerland. This is much too brown to be typical of North American material and our sporocarps are not usually as thick in stipe and context.

PLATE 28. S. leucopus. Fig. **a** is very light colored for this variable species; **b** and **c** are of dried specimens, but North American material is not as dark as fig. **c**, and also has a grey-violet cast not shown here. The easiest test for this species is a bitter taste of the dried flesh. The typical spores separate it from several other large fleshy hydnums of the Pacific Northwest.

PLATE 29. Sarcodon versipellis (Fr.) Quel. Fig. **a** is of dried material and is too light in color to be typical of North American material; also there are no traces of the greyish violet color that is found on dried specimens of this taxon and S. leucopus (syn. H. laevigatum Fr.). Fig. **b** is quite typical of the taxon that Harrison named H. crassum = H. versipellis in Nova Scotia.

PLATE 30. S. versipellis fig. **a**. Typical dried material should show traces of the greyish violet color that devel-

ops after standing in herbaria for a year or more. Fig. **b**, typical form, but tan color is a bit off shade. The color should be identical with that of Albatrellus confluens (Alb. & Schw. : Fr.) Kotl. & Pouz., often found in the same habitats in North America.

PLATE 31. Sarcodon fennicus (Karst.) Karst. Figs. **a**, **b**, and **c**, illustrating dried specimens, appear to be of three different species. Fig. **a** does not show innate scales while **b** and **c** do not have dark stipe bases. These have not been recognized in North America amongst the numerous forms that exist here. S. glaucopus Maas G. & Nannf. fig. **d** is not duplicated by North American material known to us.

PLATE 32. Sarcodon lepidus Maas G., fig. **a**, fresh, is not in North America if the colors are correct. S. regalis, figs. **b** and **c**, fresh, is a distinct species. The description is similar to that of S. rimosus (K. Harrison) K. Harrison especially in the color of the stipe, but cap color as illustrated is too light a shade for S. rimosus, which on this continent is darker, especially in wet weather.

PLATE 33. Sarcodon regalis fig. **a**. S. rimosus has a cap fissured as in this painting. Sarcodon scabrosus (Fr.) Karst. figs. **b**, **c**, and **d**. It is doubtful if any North American mycologist familiar with the species would guess that these represented S. scabrosus. They might suspect because of the blackish base on the stipe of fig. **b**.

PLATE 34. S. scabrosus. Fig. **a** is not typical for the species as it lacks a blackish base; fig. **b** is a good illustration of old material occuring in sandy pine forests of Nova Scotia and Michigan, but the spines are usually darker when they reach this stage of maturity.

PLATE 35. H. scabrosus. Fig. **a** (top of plate). Why is this not S. fennicus (Karst.) Karst.? Fig. **a**, lower figure on the plate, is a beautiful picture of typical material as found in North America. Fig. **b** is a strange sporocarp to picture as S. scabrosus. The scales are abnormally far apart.

PLATE 36. Sarcodon cyrneus Maas G., fig. **a**, S. lundellii Maas G. & Nannf., fig. **b**, and S. underwoodii Banker, fig. **c** are all dried and all could be paintings of variations found in S. underwoodii in North America. S. underwoodii fig. **d**. This form was common in North Carolina in 1971.

PLATE 37. Sarcodon martioflavus (Snell, Harrison, & Jackson) Maas G. figs. **b** and **c**. The pileus color is nicely illustrated, but in North America, spines and margins are orange brown. Figs. **b** were made from Dr. Snell's holotype and are authentic for dried material. Figs. **c** are of fresh European material and do not illustrate the species as

known here. Figs. a show an interesting taxon resembling some conditions of S. joeides (Pass.) Bat.

PLATE 38. Sarcodon fuligineo-violaceus (Kalchbr.) Pat. North American material is not as stout, but colors are accurate. Very rare here.

PLATE 39. S. fuligineo-violaceus figs. a. Only two collections from North America are known that match the colors shown here. Sarcodon joeides (Pass.) Bat., figs. b and c, the flesh is the correct color but the cap in North America is the color of last season's beech leaves. Common in northeastern North America but difficult to find.

PLATE 40. S. joeides. It is a problem recognizing fig. a as this species, but the color of the dried flesh might give it away. Sarcodon atroviridis (Morgan) Banker. A nice illustration of a dried specimen, with the typical, slowly developing, dark olive-green flesh color of Section Virescentes Maas G. In North America S. fumosus Banker and S. scabripes (Pk.) Banker are look-alikes after storage in the herbarium. It is unfortunate that the species was not illustrated in its distinctive fresh color.

ACKNOWLEDGMENTS

This investigation was supported by a research grant (A-2826) from the Natural Sciences and Engineering Research Council of Canada, Ottawa. We are indebted to Dr. R.L. Shaffer, Director, University of Michigan Herbarium for providing space and facilities when preparing this paper and to Dr. A.H. Smith who read and made suggestions during its preparation. Also our sincere thanks to Mr. K.J. Harrison for proofreading early copies of the manuscript.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 437-445 April-June 1987

STUDIES IN THE GENUS *PHOMA*. VII. CONCERNING *PHOMA GLOMERATA*.

James F. White, Jr.,

Department of Botany, University of Texas,
Austin, Texas 78713-7640

and

Gareth Morgan-Jones

Department of Plant Pathology, College of Agriculture,
Auburn University, Auburn, Alabama 36849-4210

ABSTRACT

Phoma glomerata (Corda) Wollenweber and Hochapfel, is described and illustrated from collections made in Europe, North America, and Turkey. Details of its cultural characteristics *in vitro*, pycnidial wall anatomy, micropycnidial development, and dictyochlamydospore ontogeny are documented.

INTRODUCTION

Nine species of *Phoma* Sacc., are known to produce chlamydospores (Dorenbosch, 1970; Boerema *et al.*, 1977; Sutton, 1980; Morgan-Jones and White, 1983). As mentioned in previously published papers in this series (White and Morgan-Jones, 1983; 1986), seven of these bear dictyochlamydospores, namely; *P. americana* Morgan-Jones and White, *P. chrysanthemicola* Hollós, *P. epicoccina* Punithalingam, Tulloch and Leach, *P. glomerata* (Corda) Wollenw. and Hochapf., *P. jolyana* Pirozynski and Morgan-Jones, *P. pomorum* Thümen and *P. sorghina* (Sacc.) Boerema, Dorenbosch and van Kesteren. To date we have provided comprehensive, modern descriptions of three; *P. americana, P. pomorum* and *P. sorghina* (Morgan-Jones and White, 1983; White and Morgan-Jones, 1983; 1986). In recent years we have also had opportunity to study a number of isolates of *P. glomerata* from diverse geographical origins and these form the subject of this paper.

Phoma glomerata, together with *P. jolyana* and *P. pomorum*, comprise a group of taxa classified at one time or other in the genus *Peyronellaea* Goidànich, because of possession of so-called "alternaroid" chlamydospores. These are dictyochlamydospores [a term first applied to them by Luedemann (1959)] borne in chains that superficially resemble the conidia of *Alternaria* Nees, especially those of *Alternaria alternata* (Fr.) Keissler, its type species. Boerema *et al.* (1965) provided arguments in favor of incorporation of taxa classified in *Peyronellaea* into *Phoma*, particularly the close similarity of the pycnidia of the type species of

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Alabama Agricultural Experiment Station Journal Series No. 18-861153

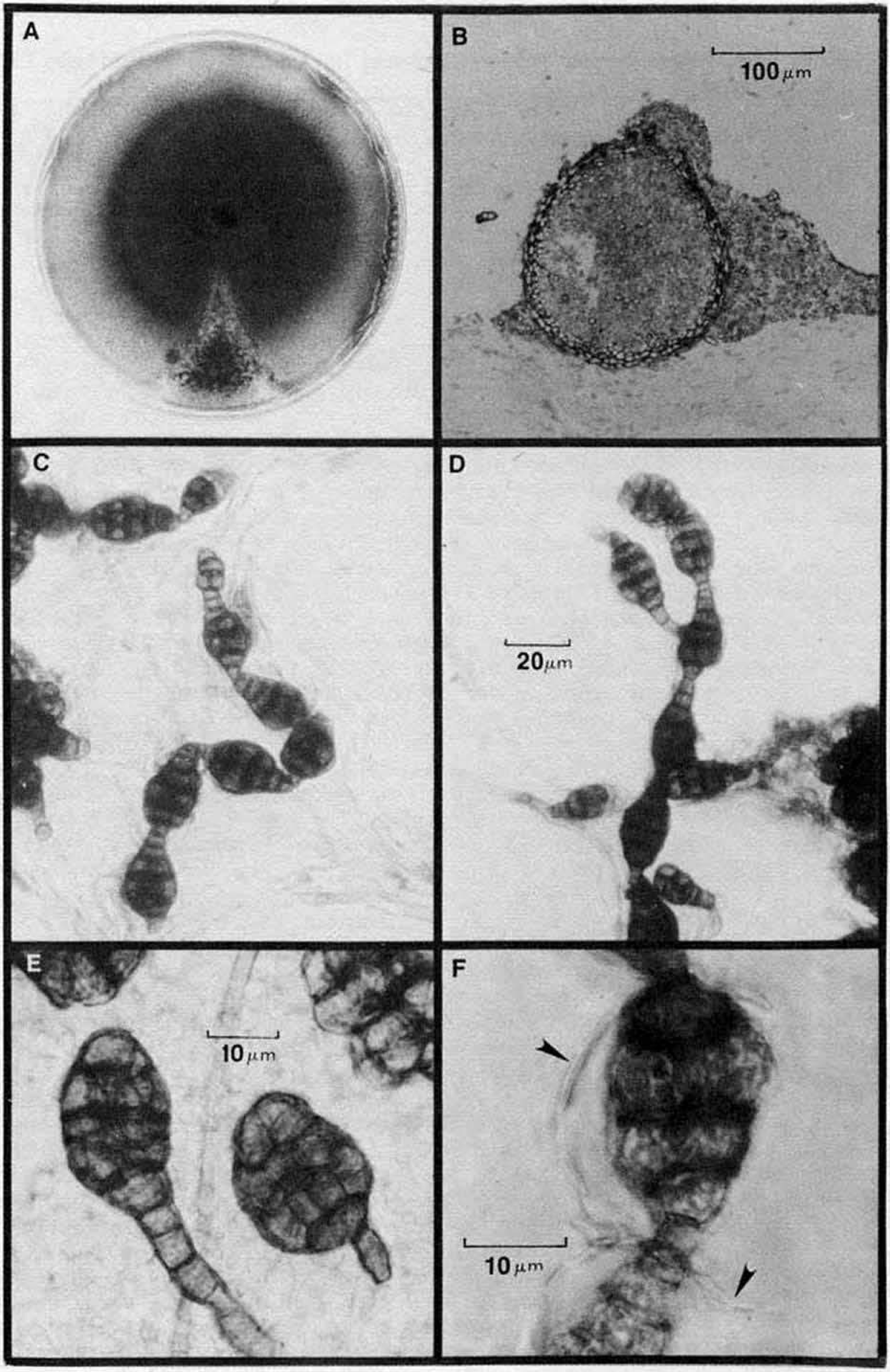
two genera, *Peyronellaea glomerata* (Corda) Goidànich and *Phoma herbarum* West., respectively. The presence of dictyochlamydospores was not considered to be a sufficiently significant and stable criterion to warrant segregation of those species possessing them in a separate genus. This view of generic concepts in the complex has been upheld by Morgan-Jones (1967), Sutton (1980) and White and Morgan-Jones (1983, 1986).

Considerable confusion has arisen over the years in the matter of application of binomials to *Phoma*-like pycnidial fungi which produce dictyochlamydospores. Even separate binomials have been proposed, largely as a result of a misunderstanding of their true nature, for the chlamydospores alone. Names such as *Alternaria fumaginoides* Peyronel, *A. hominis* Agostini and Tredici, and *A. polymorpha* Planchon, were erected on the false assumption that the chlamydospore state on which these are based is essentially identical to the dictyoconidia of *Alternaria*. Goidànich (1946) transferred twenty epithets into *Peyronellaea*, from such genera as *Aposphaeria* Sacc., *Coniothyrium* Corda, as well as *Phoma*, even though only seven of these were known, from their published descriptions, to have dictyochlamydospores. Further species, such as *Peyronellaea musae* Joly [now *Phoma jolyana*], *P. nainensis* Tandon and Bilgrami [a synonym of *P. jolyana*], *P. nicotiae* Leduc [a synonym of *P. pomorum*], and *P. stipae* Lacoste [a synonym of *P. glomerata*], were subsequently added to the genus. Following a thorough review of the literature, including consideration of the pioneering work of Wollenweber and Hochapfel (1936), and examination of a large number of original cultures, Boerema *et al.* (1965) concluded that the plethora of names extant for *Phoma*-like pycnidial fungi producing "alternaroid" dictyochlamydospores were based on only three distinguishable entities. They pointed out that a narrow species concept, based primarily on recognition of minor discontinuities in morphology and cultural expression, or on host differences, was untenable, impractical in its application, and resulted in chaos. Chodat (1926) had earlier demonstrated single spore isolates of strains of these fungi to vary considerably in their cultural characteristics. Boerema *et al.* (1965) adopted the names *Phoma glomerata, Phoma prunicola* (Opiz) Wollenw. and Hochapf. [now *P. pomorum*], and *P. musae*, for the taxa alluded to above.

Phoma glomerata is a commonly encountered species that is ubiquitous on a wide range of substrates and cosmopolitan in distribution (Boerema *et al.*, 1965; Morgan-Jones, 1967; Sutton, 1980). It is known to occur on close to a hundred host plant genera and has been associated with a number of disease symptoms in man and animals (Benham, 1931; Agostini and Tredici, 1937; Sutton, 1980). As a plant pathogen its role appears to be predominantly as a secondary invader (Boerema *et al.*, 1965).

This fungus, as is the case with the related *Phoma pomorum* (Boerema *et al.*, 1977; White and Morgan-Jones, 1986), has an extensive nomenclature. As can be expected from its widespread occurrence on a variety of hosts a large number of different names have been applied to it. Added to this the fact that it is quite variable *in vitro* and it is easy to understand the reasons for the species concept being, historically, illdefined and confused.

PLATE 1. *Phoma glomerata*. A, two-week-old colony on PDA at 25C; B, vertical section of pycnidium; C-D, chains of dictyochlamydospores; E, solitary, terminal dictyochlamydospores; F, dictyochlamydospores mounted in water showing detachment of outer wall (indicated by arrow-heads).


A
B
100 μm
C
D
20μm
E
10 μm
F
10 μm

TAXONOMIC PART

Phoma glomerata (Corda) Wollenweber and Hochapfel, Z. Parasitkde 8: 592, 1936 (Plates 1, 2 & 3).

≡ *Coniothyrium glomeratum* Corda, Ic. Fung. 4: 39, 1884.

≡ *Peyronellaea glomerata* (Corda) Goidànich, Rc. Accad. Lincei 1: 455, 1946.

[For full synonymy see Boerema *et al.*, 1965, 1968, 1971, 1977 and Boerema and Dorenbosch, 1973]

Colonies on malt extract agar [Difco] variable in appearance, generally with rather sparse aerial mycelium but sometimes becoming dense and woolly in places, olivaceous-gray or gray, attaining a diameter of 50mm at 20C after 6 days, 55mm at 25, and 10mm at 30C; those with abundant aerial mycelium frequently sectoring to produce areas with sparse growth bearing numerous pycnidia and chlamydospores, those predominantly sparse producing pycnidia abundantly and sometimes with denser, woolly sectors. Conidial masses at first pale-buff to salmony, later darkening and becoming olivaceous to olivaceous-brown. Reverse dark olivaceous to blackish beneath sectors with dense aerial mycelium, paler eleswhere. Colonies on potato dextrose agar [Difco] (Plate 1, A) generally similar in appearance to those on MEA, occasionally with a single sector bearing numerous chlamydospores, attaining a diameter of 60mm at 20C after 6 days, 67mm at 25C and 11mm at 30C. Colonies on oatmeal agar usually woolly, frequently becoming sooty-black due to production of masses of chlamydospores. Aerial mycelium composed of septate, branched, subhyaline to pale brown, smooth, 2-6µm wide hyphae; hyphae sometimes aggregated into closely appressed strands. Pycnidia usually solitary, very occasionally coalescing, partly immersed or superficial on agar, subglobose to obpyriform, with necks of various lengths, brown to black, with one ostiole or, sometimes, with two, 100-300µm in diameter. Pycnidial wall three to five layers thick, 8-12µm wide, frequently up to 18µm wide, six cells thick, in the vicinity of the ostiole: when young (Plate 2, B) composed of two easily discernible cell types [a single layer of large, pale brown, cylindrical to narrowly ellipsoid, 5-10 X 2.5µm cells on the outside and an inner layer of smaller, thinner-walled, flattened, somewhat rectangular, hyaline cells]; when old (Plate 2, A) cells of each layer inflated, ellipsoid in shape, and with irregular accumulations of dark brown, granular material occurring between them (indicated by arrow-heads). Conidiogenous cells (Plate 2, B: indicated by arrow-heads) monophialidic, hyaline, smooth, simple, ampulliform to doliiform, with a short, narrow neck, mostly discrete, borne on the inner cells of the pycnidial wall. Micropycnidia (Plate 2, C: indiacted by arrow-head) fertile, formed from the aerial mycelium or, frequently, arising from a single dictyochlamydospore cell, 20-50µm in diameter, more or less globose or flask-shaped, uniostiolate, with a wall composed of one or two layers of subglobose to ellipsoid cells. Conidia (Plate 2, D) enteroblastic, hyaline, smooth, ellipsoid or oblong to short cylindrical or narrowly obovate, sometimes very slightly curved, usually biguttulate, occasionally tri- or tetraguttulate, obtuse at each end, continuous or, very rarely, one-septate, 4.5-9 X 1.5-3µm; swelling and becoming pale olive-brown with age (Plate 2, D: indicated by arrow-head) and appearing to be minutely roughened [probably due to deposition of dark-brown material on the conidial wall (Plate 2, A: indicated by arrows)]. Conidia with such wall deposits tend to adhere to one another, forming densely aggregated masses.

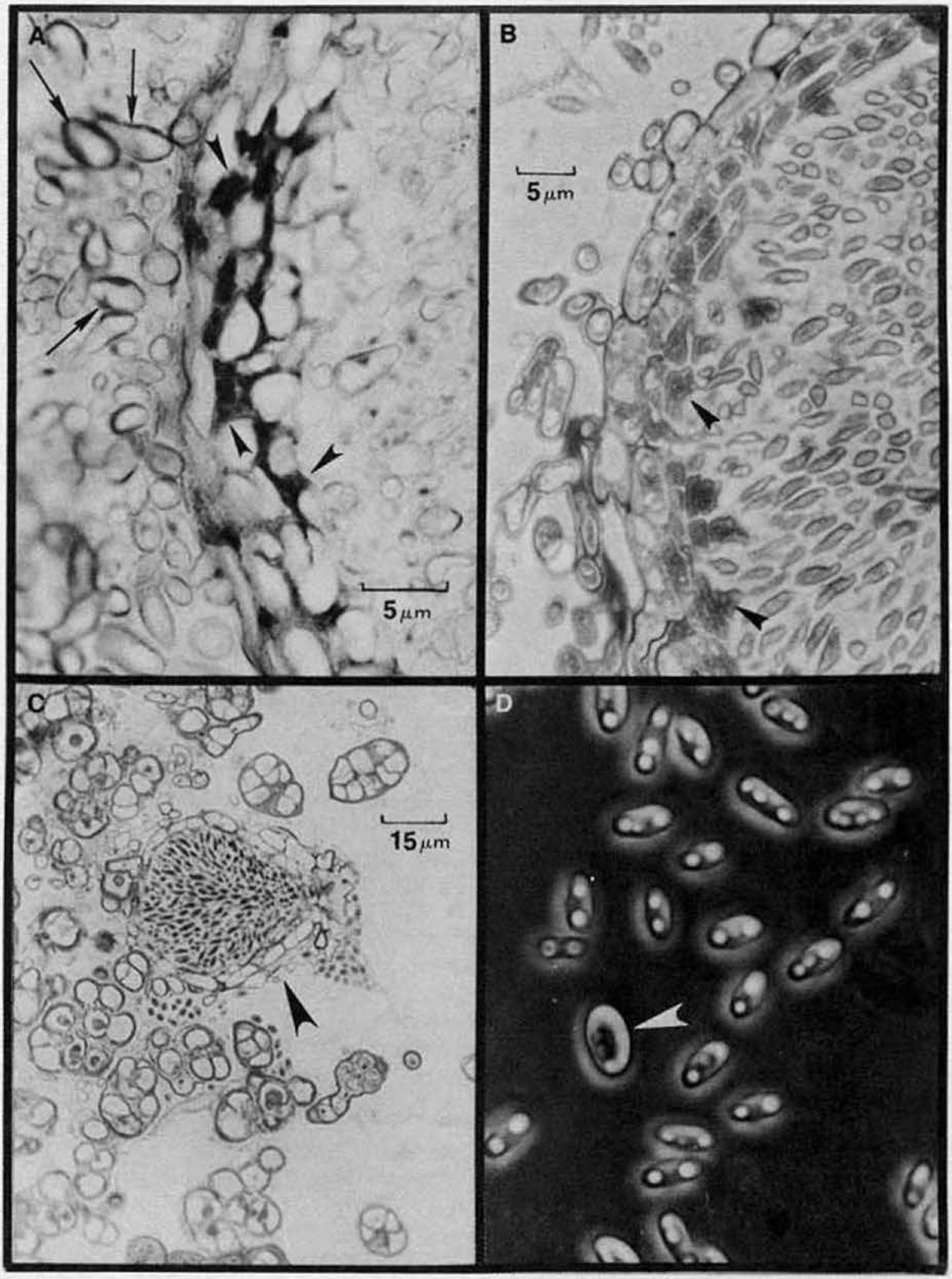


PLATE 2. *Phoma glomerata*. A, anatomy of pycnidial wall of mature pycnidium showing dark, granular, extra-cellular deposits; B, anatomy of pycnidial wall of young pycnidium showing conidiogenous cells; C, vertical section of dictyochlamydospores and micropycnidium; D, conidia.

Dictyochlamydospores (Plate 1, C-F; Plate 3, A-H) single, or, more frequently, in branched or unbranched chains, where solitary, usually terminal and somewhat *Stemphylium*-like in appearance, mid to dark-brown, at first pale-brown and smooth-walled, later appearing irregularly roughened due to part detachment and ruffling of outer wall layer, borne intercalarily or, more often, terminally on aerial or, sometimes, immersed hyphae, or originating from hyphal cells proximal to the walls of older pycnidia, where single becoming botryose with age, otherwise ovoid to obclavate, or obpyriform, dictyosporous, with up to eight transverse septa and several oblique or longitudinal septa, with some peripheral cells becoming markedly inflated when mature, individual cells having discrete walls within an outer, all encompasing wall layer, 30-65 X 15-20µm, with individual cells 4-10µm or, with age (Plate 3, G-H), 7-15µm in diameter.

Plurivorous; cosmopolitan.

Collections examined: isolated from stem of *Solanum melongena* L., Bornova-Izmir, Turkey, 1970, CBS, AUA; isolated from roots of *Picea mariana* (Miller) Britton, Sterns and Poggenburg, northern Ontario, Canada, June 1982, R. Summerbell, TEX, AUA; isolated from twig of *Olea europaea* L., Madrid, Spain, May 1984, P. Melgarejo, TEX, AUA; isolated from stem canker of *Elaeagnus angustifolia* L., Mandan, North Dakota, U.S.A., July 1984, J. Krupinsky, TEX, AUA.

The anatomy of the pycnidial wall of *Phoma glomerata* (Plate 2, A & B), is noticeably different from that of other dictyochlamydosporic species of *Phoma* with which it can sometimes be confused. The presence of an outer layer, composed of a single row of comparatively large, cylindrical to ellipsoid cells, is partticularly distinctive, as is the irregular deposition of granular, pigmented material between wall cells in mature pycnidia. The pycnidial wall of *Phoma pomorum* (see White and Morgan-Jones, 1986) is much narrower and its outer cells are cylindrical but appreciably more slender than those of *P. glomerata*. The wall of *Phoma americana*, in vertical section of pycnidia (see Morgan-Jones and White, 1983), also has an unique appearance, as does that of *Phoma sorghina* (see White and Morgan-Jones, 1983). The outer part of the pycnidial wall of *P. americana* is composed of two or three rows of more or less identical, flattened, angulated cells, giving the tissue a more even appearance. In *P. sorghina* the presence of highly inflated, ellipsoid cells, scattered randomly throughout the outer layer of the pycnidial wall is a hallmark characteristic. The distinctions in pycnidial wall anatomy between taxa in the complex underlines the importance of documentation of this characteristic and its usefulness as a criterion in defining species. Had more attention been paid to this in the past much of the confusion surrounding species concepts in the genus *Phoma* could, perhaps, have been to some degree avoided.

The dictyochlamydospores of *P. glomerata*, in common with those of *P. pomorum* and *P. sorghina*, are complex in structure and can be considered to be distoseptate, *sensu* Luttrell (1963). Constituent cells are surrounded by individual, separate, discrete walls, distinct from the outer wall, and true septa, such as those occurring in the euseptate dictyochlamydospores of *P. americana*, are lacking (Plate 3, H). The internal organization of the dictyochlamydospores is not dissimilar to that of the conidia of the pycnidial fungus *Camarosporium obiones* Jaap (Dickinson and Morgan-Jones, 1966) and the ascospores of the pyrenocarpous lichen genera *Anthracothecium* Hampe, *Pyrenula* Ach., and *Trypethelium* Spreng. (Morgan-Jones, 1973). In the latter, discrete endoascosporic cells are formed within individual ascospores which

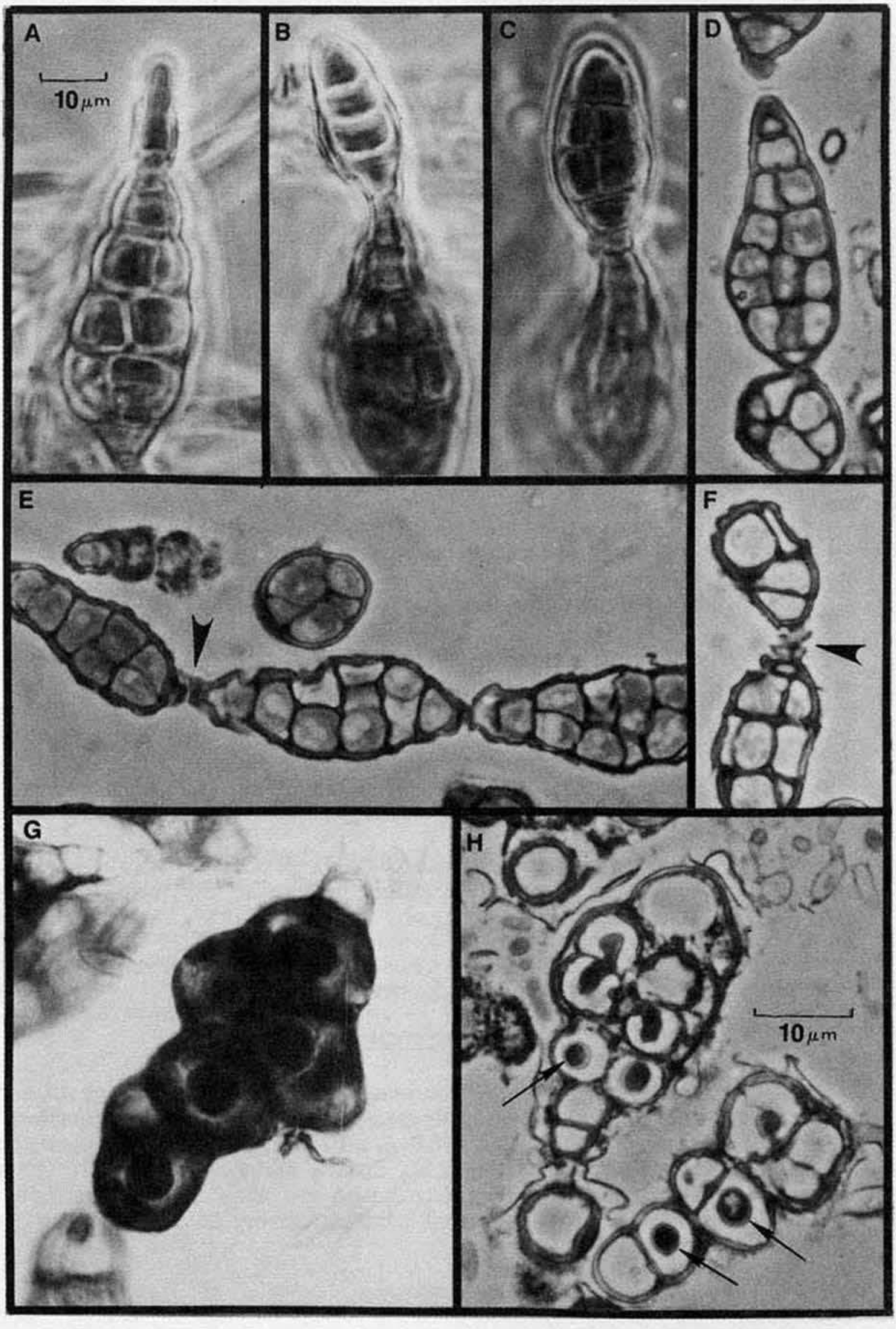


PLATE 3. *Phoma glomerata*. A-D, ontogeny of dictyochlamydospore chain; E-F, detachment of dictyochlamydospores; G, mature dictyochlamydospore showing dark inclusions; H, section of mature dictyochlamydospores.

can be released following fracture of an encompasing wall or epispore. The occurrence of similar cells in the conidia of *Drechslera sorokiniana* (Sacc.) Subram. and Jain [as *Helminthosporium sorokinianum* Sacc.] was documented by Luttrell (1963), who also showed that all cells of the conidia of *Drechslera avenacea* (Curt.) Shoemaker [as *Helminthosporium avenaceum* Curt.] were capable of producing germ tubes. Morgan-Jones (1973) speculated that each of the endoascosporic cells within the ascospores of the above mentioned lichen genera might also be capable of germination and that, in nature, these could be released following breakdown of the epispore, thus increasing the number of propagules. It seems possible that the individual cells within the dictyochlamydospores of *Phoma glomerata* might function in the same manner.

When mature dictyochlamydospores of *P. glomerata* are mounted in water for microscopic examination, the outer wall inflates and frequently tears away from the cells within (Plate 1, F: indicated by arrowheads). It can be seen similarly detached in sections of the dictyochlamydospores (Plate 3, H). Luedemann (1959) noted that the endogenous component cells of mature dictyochlamydospores are loosely associated and may separate from each other following application of pressure when mounted under a coverslip. He also noted that, prior to germination, these cells swell and rupture the outer wall. Sections of dictyochlamydospores prepared during the course of the present study also reveal the presence of what appears to be a tertiary wall surrounding protoplasts within component cells (Plate 3, H: indicated by arrows). These inclusions frequently appear as dark, globose bodies, considerably smaller than the lumen of the cells containing them (Plate 3, G).

In the process of formation of chains of dictyochlamydospores the apical cell of a parent entity elongates and ruptures the enveloping outer wall distally (Plate 3, A). Transverse septa are first laid down, followed by longitudinal septa in the median cells. Individual dictyochlamydospores in a chain become detached from one another by a circuscissile break in the outer wall (Plate 3, E), leaving behind frills at the truncated ends (Plate 3, F).

Pycnidia of *P. glomerata* are occasionally produced directly from a dictyochlamydospore. A single endogenous cell inflates, rupturing the outer wall, and, following a number of subsequent cell divisions, a pycnidial primodium is elaborated. Such pycnidia are generally much smaller (Plate 2, C) than those normally produced directly from hyphae and are therefore referred to in the above description as micropycnidia.

ACKNOWLEDGMENTS

We are grateful to Drs. G.H. Boerema, Plantenziektenkundige Dienst, Wageningen, The Netherlands; J. Krupinsky, United States Department of Agriculture, Mandan, North Dakota, U.S.A.; P. Melgarejo, Escuela Tecnica Superior de Engenieros Agronomos, Madrid, Spain; and R. Summerbell, University of Toronto, Ontario, Canada, who contributed isolates for use in this study. Dr. J. Leland Crane, State Natural History Survey Division, Illinois, U.S.A., reviewed the manuscript.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 447-451 April-June 1987

NOTES ON HYPHOMYCETES. LII.
STELLOMYCES, A NEW DENTICULATE GENUS FROM THE TRANSVAAL, SOUTH AFRICA

Gareth Morgan-Jones

Department of Plant Pathology, College of Agriculture,
Auburn University, Auburn, Alabama 36849-4210

and

Robert C. Sinclair and Albert Eicker

Department of Botany,
University of Pretoria, Pretoria 0002, South Africa

ABSTRACT

Stellomyces suidafrikanus Morgan-Jones, Sinclair and Eicker, a new genus and species, is described and illustrated from a collection made on decorticated wood in the Transvaal, South Africa.

INTRODUCTION

During the course of collecting and describing hyphomycetes from decorticated wood in South Africa we have encountered a number of novel taxa, some of unique morphology (Morgan-Jones, 1982; Morgan-Jones and Sinclair, 1980a, 1980b, 1983; Morgan-Jones *et al.*, 1983, Sinclair *et al.*, 1983; Sinclair and Eicker, 1985). Among those not yet named or documented in the literature is a striking denticulate anamorph bearing conidiophores whose apices have a stellate morphology.

TAXONOMIC PART

Stellomyces gen. nov.

Deuteromycotina; Hyphomycetes.

[Etym. L *stella*, star, et Gr. *mykes*, fungus]

Coloniae effusae, sparsae, incoloratae. Mycelium plerumque immersum ex hyphis hyalinis, laevis, ramosis, septatis compositum. Conidiophora macronemata, mononemata, ex hyphis mycelialibus lateraliter et terminaliter producta, simplicia vel ramosa, cylindrica, erecta, recta vel saepe curvata, continua vel septata, hyalina, apicem versus denticulis numerosis praedita. Cellae conidiogenae polyblasticae, in conidiophoris et in ramis incorporatae, ad instar stellae, apicibus inflatis, denticulatis. Conidia holoblastica, ex denticulis successivis singulatim producta, unicellularia, ellipsoidea vel navicularia, tenuitunicata, hyalina.

Alabama Agricultural Experiment Station Journal Series No. 18-861157.

Species typica: *Stellomyces suidafrikanus* Morgan-Jones, Sinclair et Eicker.

Colonies effuse, sparse, colorless. Mycelium predominantly immersed in the substratum, composed of hyaline, smooth, branched, septate hyphae. Conidiophores macronematous, mononematous, produced as lateral branches of and terminally on the mycelial hyphae, simple or branched, cylindrical, erect, straight or slightly curved, continuous or septate, smooth, hyaline, with numerous long denticles situated distally. Conidiogenous cells polyblastic, integrated in the main axis or discrete as a lateral branch, denticulate, in the form of a star at the apex. Conidia holoblastic, produced singly from a succession of denticles, unicellular, ellipsoid or boat-shaped, thin-walled, hyaline.

Stellomyces suidafrikanus sp. nov. (Plate 1, figure 1)

Coloniae effusae, sparsae, incoloratae. Mycelium partim superficiale, plerumque immersum, ex hyphis hyalinis, laevis, ramosis, septatis, flexuosis, tenuitunicatis, 1-1.5µm crassis compositum. Conidiophora macronemata, mononemata, dispersa, ex hyphis superficialibus singulatim oriunda vel gregaria, simplicia vel interdum ramosa, cylindrica, attenuata, erecta, recta vel saepe curvata, continua vel septata, laevia, hyalina, apicem versus denticulis numerosis praedita, usque ad 35µm longa, 1-2µm crassa, basi saepe ad 3µm inflata. Cellae conidiogenae polyblasticae, in conidiophoris et ramis incorporatae, indeterminatae, ad instar stellae, apicem versus latiores, cum denticulis cylindricis longibus incrassis. Conidia holoblastica, ex denticulis successivis, singulatim producta, unicellularia, ellipsoidea vel navicularia, tenuitunicata, laevia, hyalina, 8-10 X 3-5µm.

In ligno emortuo, Dullstroom District, Transvaal, South Africa, April 18, 1983, H.M. Smith, AUA, holotypus.

Colonies effuse, sparse, colorless. Mycelium partly superficial but predominantly immersed in the substratum, composed of hyaline, smooth, branched, septate, flexuous, thin-walled, 1-1.5µm hyphae. Conidiophores macronematous, mononematous, scattered, arising singly from superficial mycelium or gregarious, somewhat thicker-walled than the vegetative hyphae, simple or sometimes branched, cylindrical, attenuating gradually towards the distal end, erect, straight or slightly curved, continuous or, more frequently, septate, smooth, hyaline, bearing numerous denticles towards the apex, up to 35µm long, 1-2µm wide, usually slightly swollen to 3µm wide at the base. Conidiogenous cells polyblastic, integrated, terminal, or discrete as a lateral branch which is sometimes not delimited by a septum, indeterminate, broader towards the apex and swollen to 5.5µm in diameter, with the distal inflated portion assuming a more or less globose shape and bearing numerous, radiating, narrowly cylindrical, attenuated, thin-walled, straight or slightly curved, horn-like, non-cicatrized denticles, 4-7µm in length, giving a star-like appearance; sometimes continuing growth to produce additional inflated extensions which assume a somewhat lateral posture and also become denticulate. Occasionally the inflated terminal portion of a conidiogenous cell gives rise to a secondary cylindrical extension which itself becomes swollen distally and is eventually fertile. Conidia holoblastic, produced singly from a succession of denticles, unicellular, ellipsoid or boat-shaped, slightly asymmetrical, frequently guttulate, thin-walled, smooth, hyaline, with no discernible basal scar, 8-10 X 3-5µm.

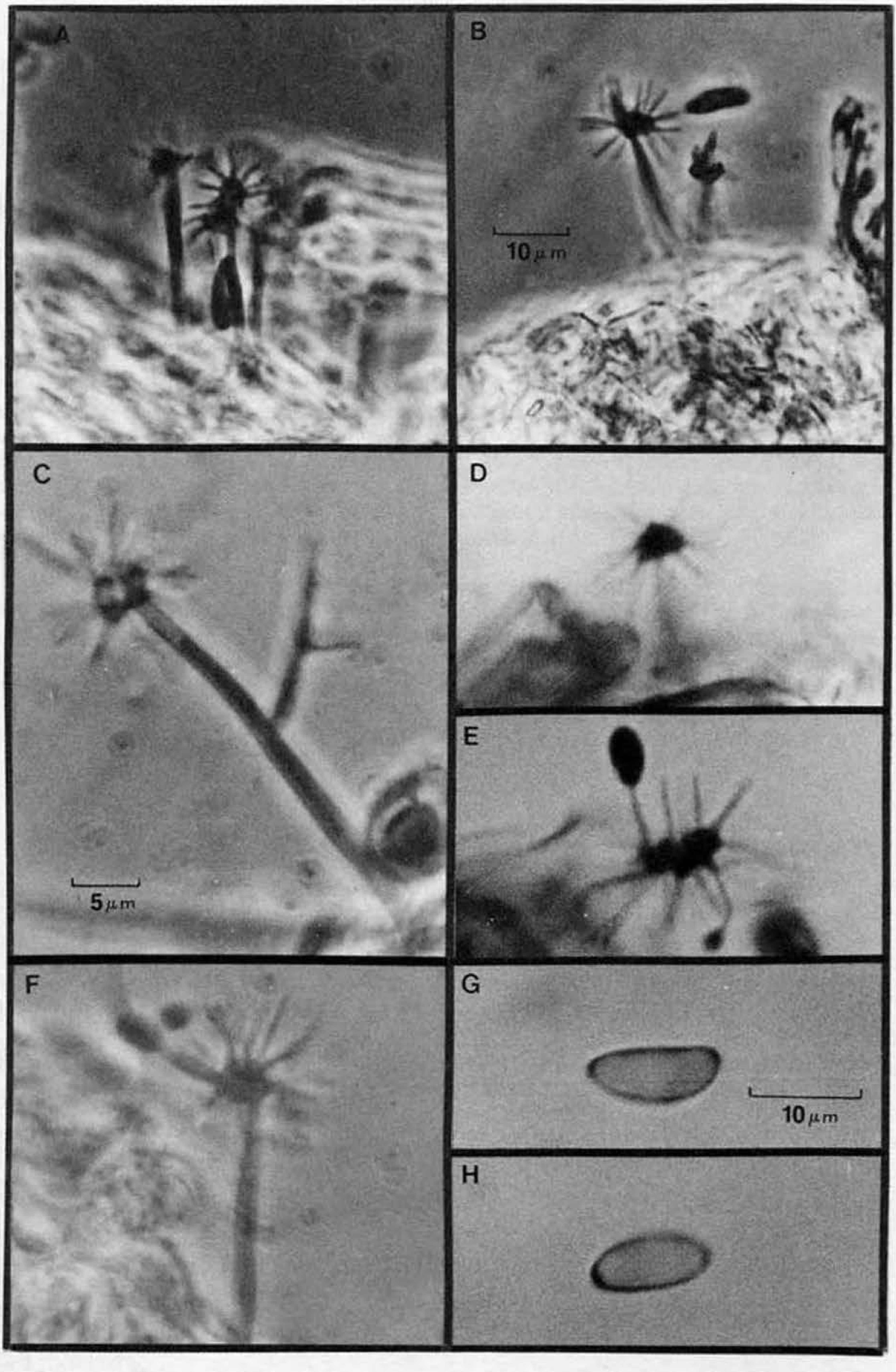

PLATE 1. *Stellomyces suidafrikanus*. A-F, conidiophores; G-H, conidia.

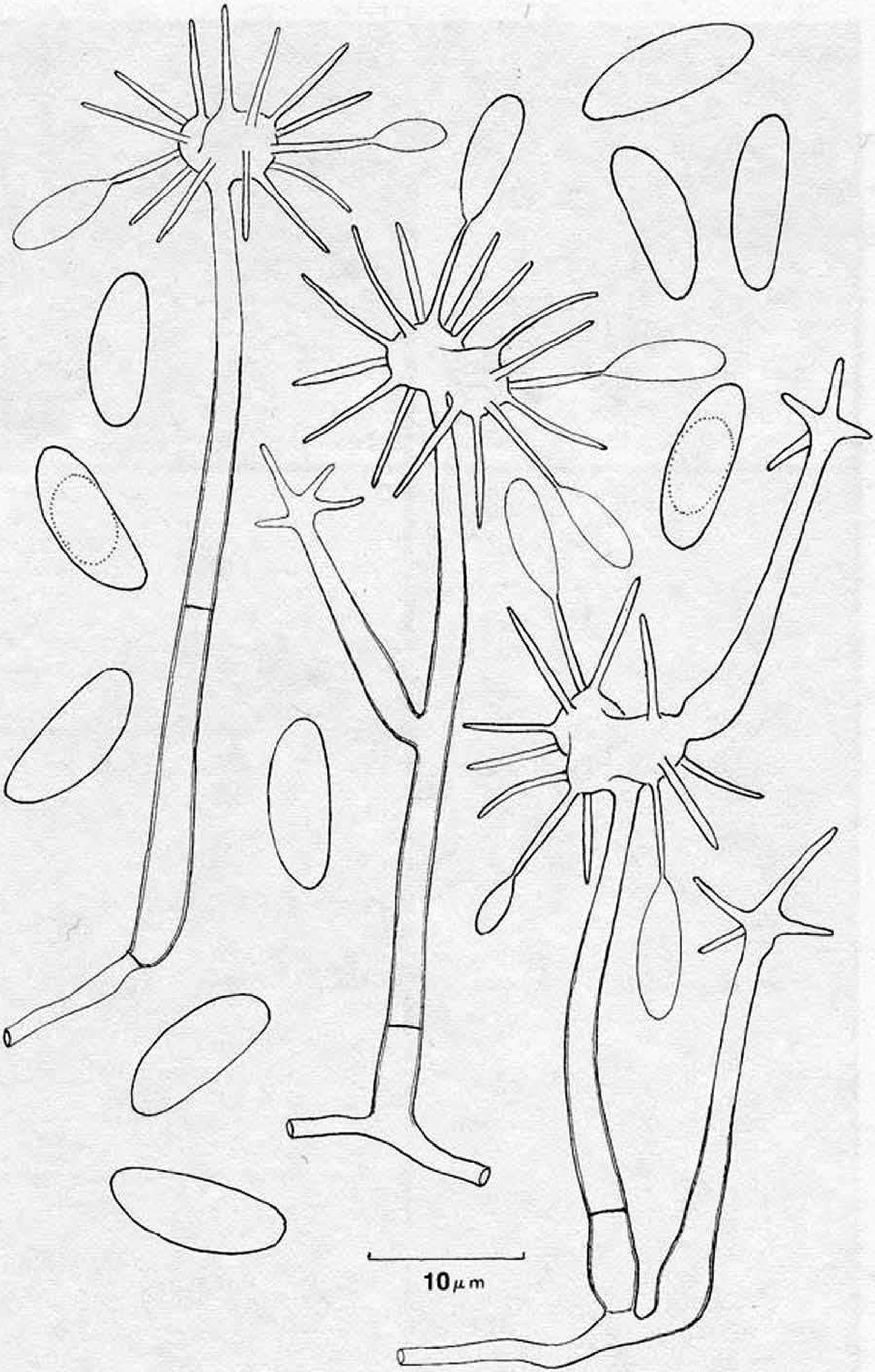

FIGURE 1. *Stellomyces suidafrikanus*; conidiophores and conidia.

On decorticated wood; South Africa.

Collection examined: Dullstroom District, Transvaal, Republic of South Africa, April 18, 1983, H.M. Smith, AUA, PREM, type.

Several genera have been considered as possible options for accommodating this fungus. *Stellomyces* is essentially similar to *Dactylaria* Sacc., in overall morphology and method of conidiogenesis from distinct, cylindrical denticles. It approximates such species as *Dactylaria uniseptata* Matsushima and *D. quadriguttata* Matsushima in pattern of growth of the fertile portion although in *Stellomyces* this is much more restricted and less obviously sympodial. The denticles of *Stellomyces* are, however, much longer than those of *Dactylaria.* The stellate morphology, resulting from the substantial swelling of the conidiogenous cell apex and the length and radial arrangement of the denticles, gives *Stellomyces* an unique appearance and, in addition, the possession of nonseptate, navicular conidia separates it readily from *Dactylaria. Calcarisporiella* de Hood and *Calcarisporium* Preuss are other genera having apical clusters of long, conidium-bearing denticles on their conidiogenous cells. Again, however, the strikingly different appearance of *Stellomyces* precludes classification in either of these genera. *Olpitrichum* Atkinson produces spiniform or fusiform denticles from slightly inflated conidiophore apices but it also differs from *Stellomyces* in detailed morphology.

The shape and size of the conidia and the resemblance of the denticles to sterigmata led us to also consider the possibility of basidiomycete affinity. The genus *Spiniger* Stalpers, an anamorph of the Aphyllophorales with oedocephaloid conidiophores, has some resemblance to *Stellomyces* but it has blastic-synchronous conidia which originate simultaneously from shorter, sharply-attenuated denticles on determinate conidiogenous vesicles. It seems very doubtful that *Stellomyces* is related to this genus.

ACKNOWLEDGMENTS

We thank Ms. Hester M. Smith for allowing us to study her collection. The manuscript has been reviewed by Dr. W. Bryce Kendrick, University of Waterloo, Ontario, Canada.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 453-459 April-June 1987

STUDIES IN THE AMPHISPHAERIACEAE (SENSU LATO) 1. COLLODISCULA JAPONICA AND ITS ANAMORPH, ACANTHODOCHIUM COLLODISCULAE

GARY J. SAMUELS[1]
Plant Diseases Division, DSIR, Private Bag,
Auckland, New Zealand

JACK D. ROGERS
Plant Pathology Department, Washington State
University,
Pullman, Washington 99164, U.S.A.

and

EIJI NAGASAWA
Tottori Mycological Institute, Tottori, Japan

SUMMARY

Collodiscula japonica Hino & Katumoto is grown in pure culture. The anamorph represents a new species in a new genus, **Acanthodochium collodisculae** Samuels, Rogers & Nagasawa. The relationships of **Collodiscula** with other taxa are discussed.

INTRODUCTION

Collodiscula japonica Hino & Katumoto (Hino & Katumoto 1955), the only known species of this peculiar genus of pyrenomycetous Ascomycetes, has so far been reported only from bamboo culms in Japan. When **C. japonica** was described and subsequently redescribed (Nagasawa 1973) no anamorph was linked to it. We have examined several specimens that were associated with a conidiomatal fungus that is morphologically similar to initial stages of ascomata of **C. japonica.** The morphological similarity of the two fructifications suggested that they were part of the same anamorph. This was confirmed when we isolated ascospores of **C. japonica** and conidia of the anamorph and found that cultures and culturally formed conidiomata were identical.

The conidioma of **C. japonica** is morphologically and anatomically unusual. Superficially, it looks like a small black tooth situated in the middle of a flat, carbonous disc; a pale grey tuft of conidium-bearing cells protrudes from its tip. It is easily removed from the

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[1] Present address: The New York Botanical Garden, Bronx, N.Y. 10458

surface of the bamboo and apparently does not penetrate the cells of the culms. The conidioma consists of a central core of colorless thin-walled hyphal cells that terminate apically in denticulate, sympodially proliferating conidiogenous cells. Conidia are formed singly at the tips of conspicuous teeth and these teeth give the conidiogenous cells the aspect of a basidiomycetous acanthophysis. The conidiogenous cells extend beyond the level of carbonized cells and are arranged in a compact, light-colored palisade. We are unable to place this unusual anamorph in any of the known genera of anamorph fungi and therefore propose **Acanthodochium collodisculae** gen. et sp. nov.

The sympodially proliferating, denticulate conidiogenous cells broadly suggest anamorphs of the Xylariaceae (Rogers 1979), but we do not know of any xylariaceous anamorphs that have such conspicuous denticles. Likewise, the relatively large, flame-shaped conidia of **Acanthodochium colodisculae** are unlike those usually encountered in the Xylariaceae. Conidiphores of the Xylariaceae are either mononematous (e.g. **Geniculosporium** Chesters & Greenhalgh and **Nodulisporium** Preuss) or are exposed on synnemata of greater or lesser complexity (**Dematophora** Hartig). None of the known anamorphs of the Xylariaceae have conidiomata that are anatomically similar to those of **A. collodisculae.**

The ascoma of **Collodiscula japonica** is three-layered. The innermost wall is very thin and noncarbonized. The two outer layers that enclose the inner layer are heavily carbonized; they can be chipped away to reveal the inner layer. The inner carbonized layer develops within and progressively protrudes through the outer layer through development. The outer layer remains, giving the entire fructification a coronate appearance.

The taxonomic position of **Collodiscula japonica** is not clear. The species has obvious affinities with the Xylariaceae and the Amphisphaeriaceae, families of the Sphaeriales. The superficial and heavily carbonized, stromatic, ascomata resemble ascomata of some species of **Rosellinia.** The ascus tip, with its large, wedge-shaped, amyloid ring is of the **Xylaria**-type (Rogers 1979). Other characters argue in favor of the Amphisphaeriaceae. These include the sessile or short-stipitate asci; the light brown, septate ascospores that lack a germ slit; and the relatively broad and short paraphyses.

Anamorphs tend to be predictive as to the relationships of their holomorphs but we are unable to distinguish between the Xylariaceae and the Amphisphaeriaceae on this basis. Anamorphs of the Xylariaceae have ellipsoidal to oblong unicellular conidia produced holoblastically from denticles on sympodially proliferating, dematiaceous conidiophores. Relatively few members of the

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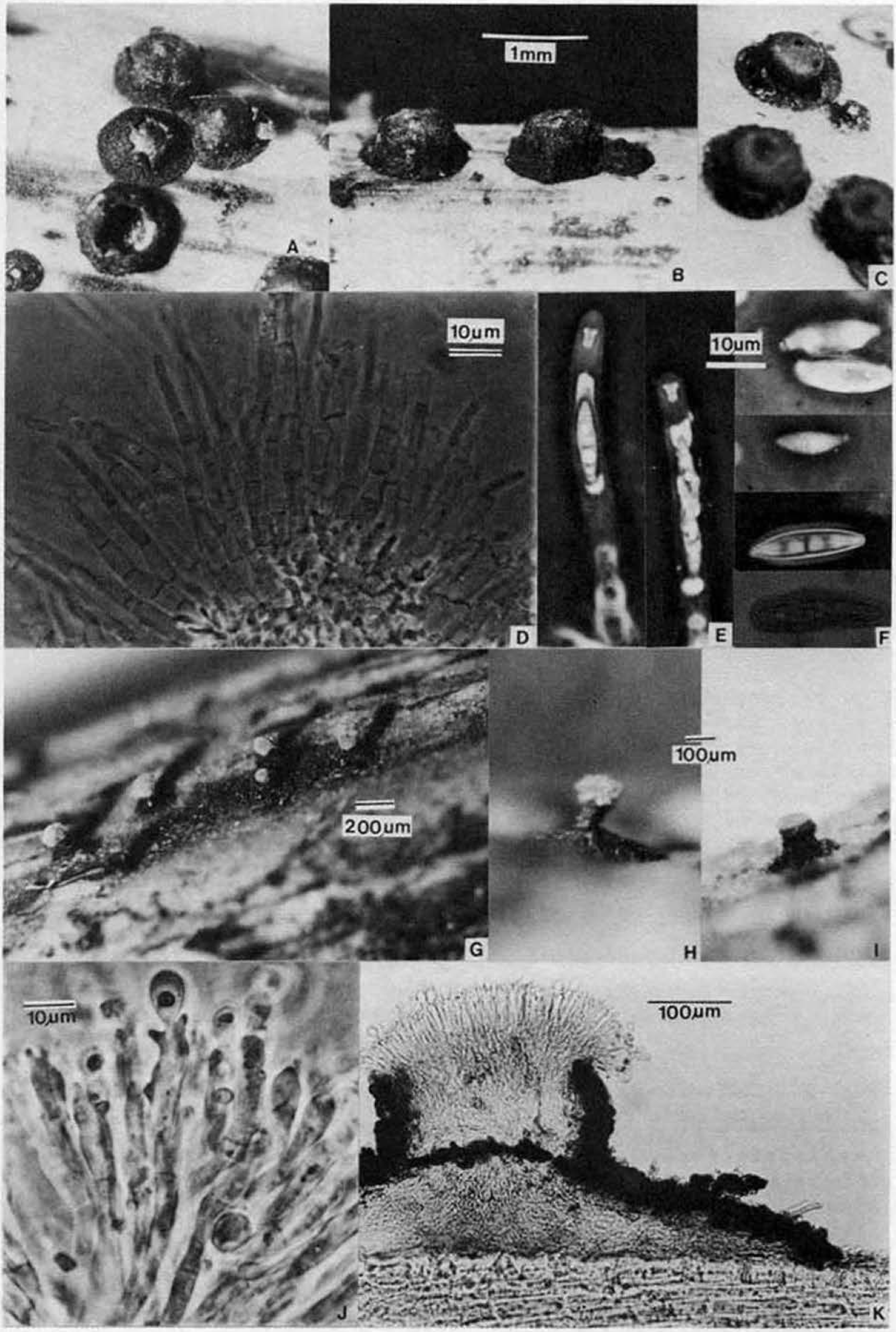
Fig. 1 A-F **Collodiscula japonica.** A Developing ascomata with inner wall protruding through the outer wall. B Mature ascomata with coronate aspect of the outer wall. C One mature ascoma with the stromatic wall layers chipped away to reveal the thin, perithecial wall. D Apices of two asci (Melzer's reagent, dark field phase contrast microscopy). E Ascospores, the two spores at the top showing the basal appendage; the ascospore at the bottom appearing striate. F Paraphyses. G-I **Acanthodochium collodisculae.** G Three views of conidiomata. H Section of a mature conidioma. I Conidiogenous cells.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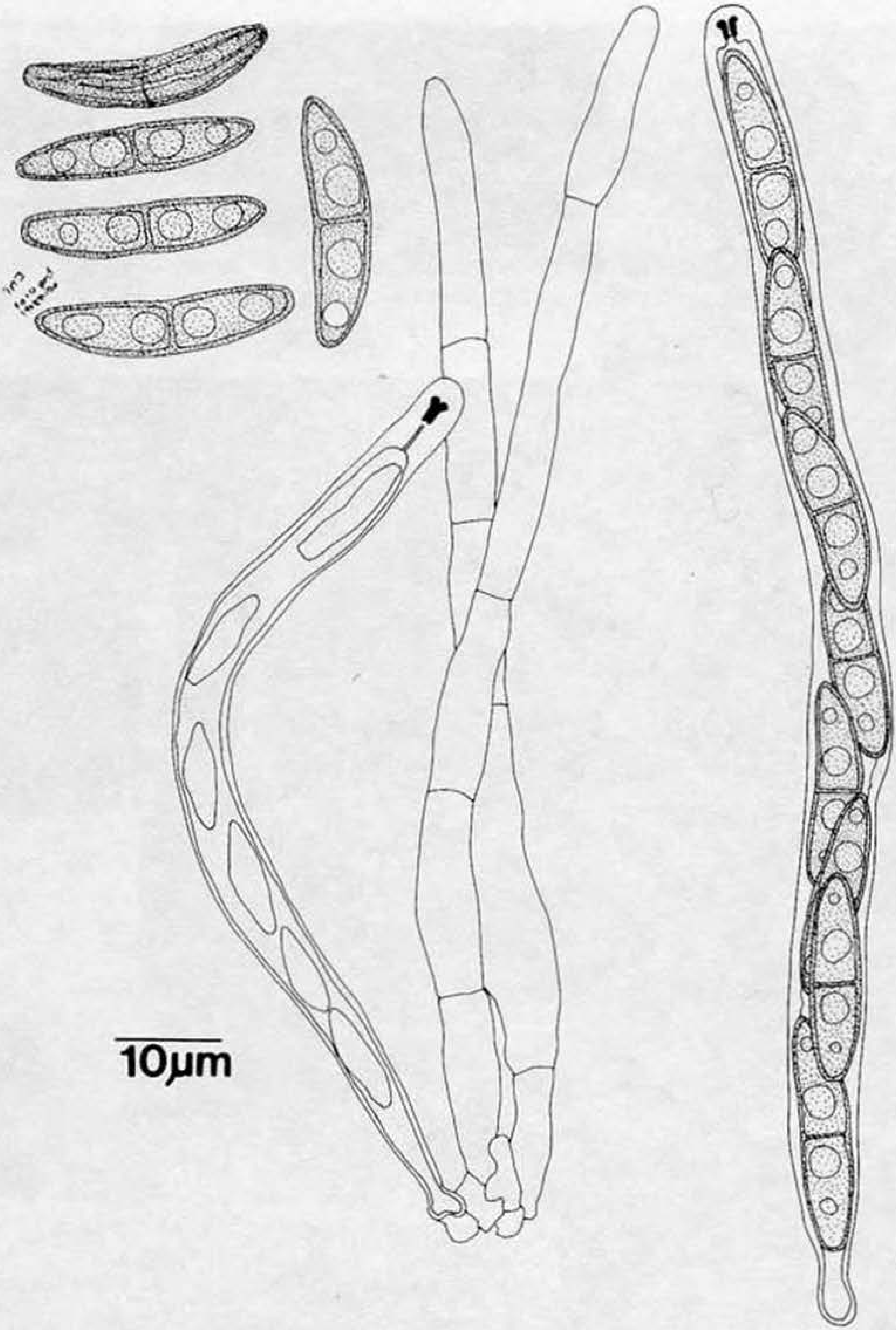

Fig. 2. **Collodiscula japonica.** Asci, ascospores and paraphyses (asci stained in Melzer's reagent).

Amphisphaeriaceae (sens. lat.) have been linked to anamorphs. Interestingly, several have been linked to anamorphs with conidia produced holoblastically on denticulate conidiogenous cells in the style of Xylariaceae [e.g. the **Beltraniella** anamorph of **Pseudomassaria** Jacz., Hodges & Barr 1971). However, additional anamorph-teleomorph correlations must be made in the broadly circumscribed Amphisphaeriaceae before a family pattern of anamorph expectations can be established. The family is certainly unnatural and in need of rearrangement (unlike the Xylariaceae which we view as a largely natural assemblage).

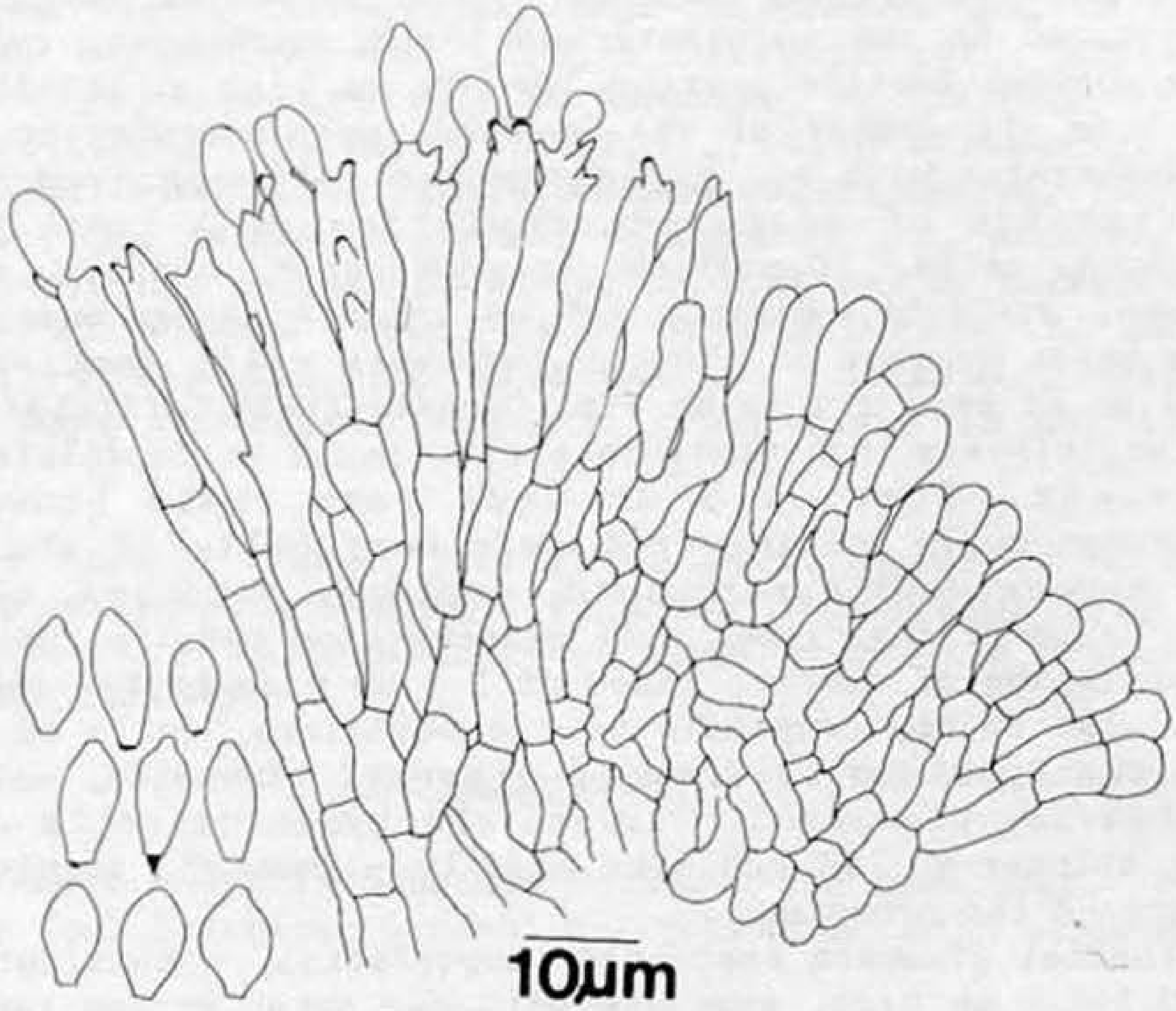

Fig. 3. **Acanthodochium collodisculae.** Conidia and portion of the hymenium showing conidiogenous cells, and marginal hyphae on the right.

In the absence of definitive evidence from the anamorph, we must rely on characters of the teleomorph to indicate the taxonomic position of **Collodiscula.** Features of the ascospores, asci and paraphyses seem to indicate the Amphisphaeriaceae, as mentioned earlier. Furthermore, a seemingly large proportion of the species of the Amphisphaeriaceae are found on monocotyledonous hosts. Within that family, **Collodiscula** is peculiar in having a heavily carbonized and superficial, stromatic perithecium.

REDESCRIPTION OF COLLODISCULA JAPONICA AND ITS ANAMORPH

Acanthodochium Samuels, Rogers & Nagasawa, gen. nov.

Sporodochia dentiformia, textura externa carbonacea, nigra; textura interna hyalina. Cellulae fertiles hymenium penicillatum formans, sympodiales, dentatae, hyalinae. Conidia hyalina.
Species typica: **Acanthodochium collodisculae** Samuels, Rogers & Nagasawa

Acanthodochium collodisculae Samuels, Rogers & Nagasawa, sp. nov. Figs. 1 G-I, 3.

Sporodochia basi disciformi 300 um usque diam. et parte fertili cylindrica, penicillata, 200-300 um alta x 125-150 um diam e basi exorienti constantia. Cellulae fertiles dentatae, dentes magnae. Conidia (7-)8.5-1(-13) x (1.5-) 5-6(-6.5) um, clavata vel limoniformia. Holotypus. TMI 7952, isotypus NY.
Status teleomorphosis. **Collodiscula japonica** Hino & Katumoto

Collodiscula japonica Hino & Katumoto, Bull. Fac. Agric. Yamaguti Univ. 6: 55. Dec 1955. Figs. 1-3.

Conidiomata consisting of a carbonous, discoidal base up to 300 um diam appressed to the substrate and black, carbonous, cylindrical to truncate conical fertile portion 200-300 um high x 125-150 um diam, arising from the center of the base and perpendicular to the surface of the substrate; with tan conidiogenous cells protruding from the tip. Hymenium of anamorph consisting of a loose palisade of conidiogenous cells. Conidiophores unbranched, septate, cylindrical, pale brown, straight, smooth, 4-5 um wide; conidogenous loci forming over the upper quarter of the conidiogenous cell, denticulate, 2 um long x 2 um at base x 1 um at tip. Conidia (7-)8.5-11(-13) x (1.5-) 5-6(-6.5) um, clavate to limoniform with a round to papillate apex and a protuberant, flat, 1.5 um wide base, pale brown, smooth. Conidiogenous cells arising from medullary cells of the conidioma. Medulla composed of intertwined, septate, branched, ca. 3 um wide hyphae. Cells of conidiomal wall arising from medulla, wall ca. 30 um wide, consisting of compact files of 3-5 um wide hyphal cells arranged perpendicular to the long axis of the conidioma, cells of the surface pseudoparenchymatous, 5-7 um in greatest dimension, walls ca. 2 um thick, heavily pigmented. Toward the hymenium cells of the wall becoming thinner-walled and less heavily pigmented, forming a sterile margin around the hymenium.

Perithecial stromata scattered, superficial, ± pulvinate, 0.8-1 mm diam x 0.3-0.5 mm high, coronate with the outer stroma remaining as a ragged 'crown' around the inner stroma, black, carbonous, the combined outer and inner stromal layers fused to form a single layer ca. 100 um thick, esily chipped away to reveal the thin, brown perithecial wall within. Perithecia ca. 400 um diam, opening through an apical pore; periphyses not seen. Paraphyses persisting among mature asci, slightly longer than asci, apically free, septate, unbranched, 7 um wide basally x 4.5 um apically. Asci (103-)109-135(-155) x (5-) 5.5-6.5(-7) um, cylindrical, unitunicate, ascal apex with a wedge-shaped J+ (Melzer's) ring 2-3 um long x 2.0-2.5 um wide; asci 8-spored, ascospores uniseriate or partially biseriate, eventually filling each ascus or up to 30 um of the ascal base empty. Ascospores (14-)18-24(-26.5) x 4-5.5(-7) um, bicellular, with a median septum, narrowly fusiform, brown, smooth but wall often wrinkled and appearing striate; with an inconspicuous fugaceous basal cell when young, base often truncate.

CHARACTERISTICS IN CULTURE. Colonies derived from single ascospores and from conidia slow-growing, 2 cm diam within 3 weeks on oatmeal agar (Difco) at 15-18°C diffuse daylight, white, aerial hyphae short. Conidiomata scattered, hemisphaerical, 0.5-1 mm diam x 0.5 mm high, nonstromatic, dark olivaceous with conidia forming over all the surface. Conidiophores and conidia as found in nature.

HABITAT. On dead bamboo culms (**Phyllostachys, Pleioblastus, Sasa**).

KNOWN DISTRIBUTION. JAPAN: Kyushu, central to western Honshu and Hokkaido.

HOLOTYPE. JAPAN: Honshu, Yamaguchi Pref., Shimonoseki-shi, Chofu, Takahata, on **Phyllostachys bambusoides** Sieb. & Zucc., K. Katumoto, 25 Oct 1953 (YAM 20169 !).

ADDITIONAL SPECIMENS EXAMINED. JAPAN: Honshu, Kyoto Pref., Takeno-gun, Yasaka-cho, Taikoyama, on **Sasa** sp., E. Nagasawa, 26 Aug 1978 (TMI

9746); Okayama Pref., Mt. Nagisen, Nagi-cho, Takata-gun, on **Sasa** sp., E. Nagasawa, 2 Sep 1976 (TMI 7945); Tottori Pref., Tottori-shi, Kokoge, on **Phyllostachys** sp., E. Nagasawa, 19 Apr 1975 (TMI 7943), second collection, 17 Apr 1984 (TMI 7951), third collection, 21 May 1984 (TMI 7952: HOLOTYPE of **Acanthodochium collodisculae**, ISOTYPE NY); Tottori Pref., Mt. Daisen, Masumizu, on **Sasa** sp., E. Nagasawa, 25 May 1976 (TMI 7944), Mt. Daisen, Kawadoko, on **Sasa** sp, E. Nagasawa, 19 May 1979 (TMI 7948); Gumma Pref., Nikko National Park, on **Sasa** sp., Samuels (83-314), Aug 1983 (PDD 44501). Hokkaido, Ebetsu-shi, Napporo, on **Sasa senanensis** Rehder, E. Nagasawa, 13 May 1972 (TMI 1010).

NOTES. The colony description given above is based on cultures derived from ascospores isolated from one collection (PDD 44501). Those cultures are unfortunately no longer viable; a dry culture is preserved with PDD 44501.

ACKNOWLEDGEMENTS

Drs M.E. Barr and C.T. Rogerson reviewed the manucript. Dr Rupert Barneby (New York Botanical Garden) corrected the Latin diagnosis.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 461-471 April-June 1987

STUDIES IN THE AMPHISPHAERIACEAE (SENSU LATO) 2. LEIOSPHAERELLA COCOES AND TWO NEW SPECIES OF OXYDOTHIS ON PALMS

GARY J. SAMUELS[1]

Plant Diseases Division, DSIR, Auckland, New Zealand

and

AMY Y. ROSSMAN

SBMNL, B 011A, BARC-West,
Beltsville, Maryland 20705, U.S.A.

SUMMARY

Metasphaeria cocoes Petch is an older name for **Leiosphaerella longispora** Sivanesan, Shaw & Brown. The species is now known to have a pantropical distribution in coconut palm (**Cocos nucifera** L.). Perithecia of this fungus occur on fronds and within coconuts but they were not associated with any obvious disorder. The species was grown in agar culture; perithecia formed but there was no anamorph. Two species of **Oxydothis** Penzig & Saccardo, **O. selenosporellae** Samuels & Rossman and **O. rhopalostylidis** Samuels & Rossman, were found on the palm **Rhopalostylis sapida** Wendl. & Drude in New Zealand. **Oxydothis selenosporellae** was grown in agar culture and a **Selenosporella** Arnaud ex McGarvie anamorph formed. The genera **Leiosphaerella** Hohnel and **Oxydothis** are discussed. Species of **Leiosphaerella** and **Oxydothis** were found to have semifissitunicate ascal dehiscence.

INTRODUCTION

Leiosphaerella Penzig & Sacc. and **Oxydothis** Hohnel are closely related genera of the broadly defined Amphisphaeriaceae (**sensu** Muller & Arx 1962). Although several species have been described for each genus, there has been no critical review of either. In this work we present new information about ascal structure and dehiscence, and we report the first anamorph to be linked to a species of **Oxydothis**.

Leiosphaerella and **Oxydothis** are characterized in part by their immersed perithecia, unitunicate asci that have an amyloid apical ring, paraphysate centrum and long, narrow bicellular ascospores. The genera are usually distinguished (Muller & Arx 1962) by the orientation of their perithecia and by the form of the ascospores. The long axis of perithecia and asci of **Leiosphaerella** are oriented

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[1] Present address: The New York Botanical Garden, Bronx, New York 10458

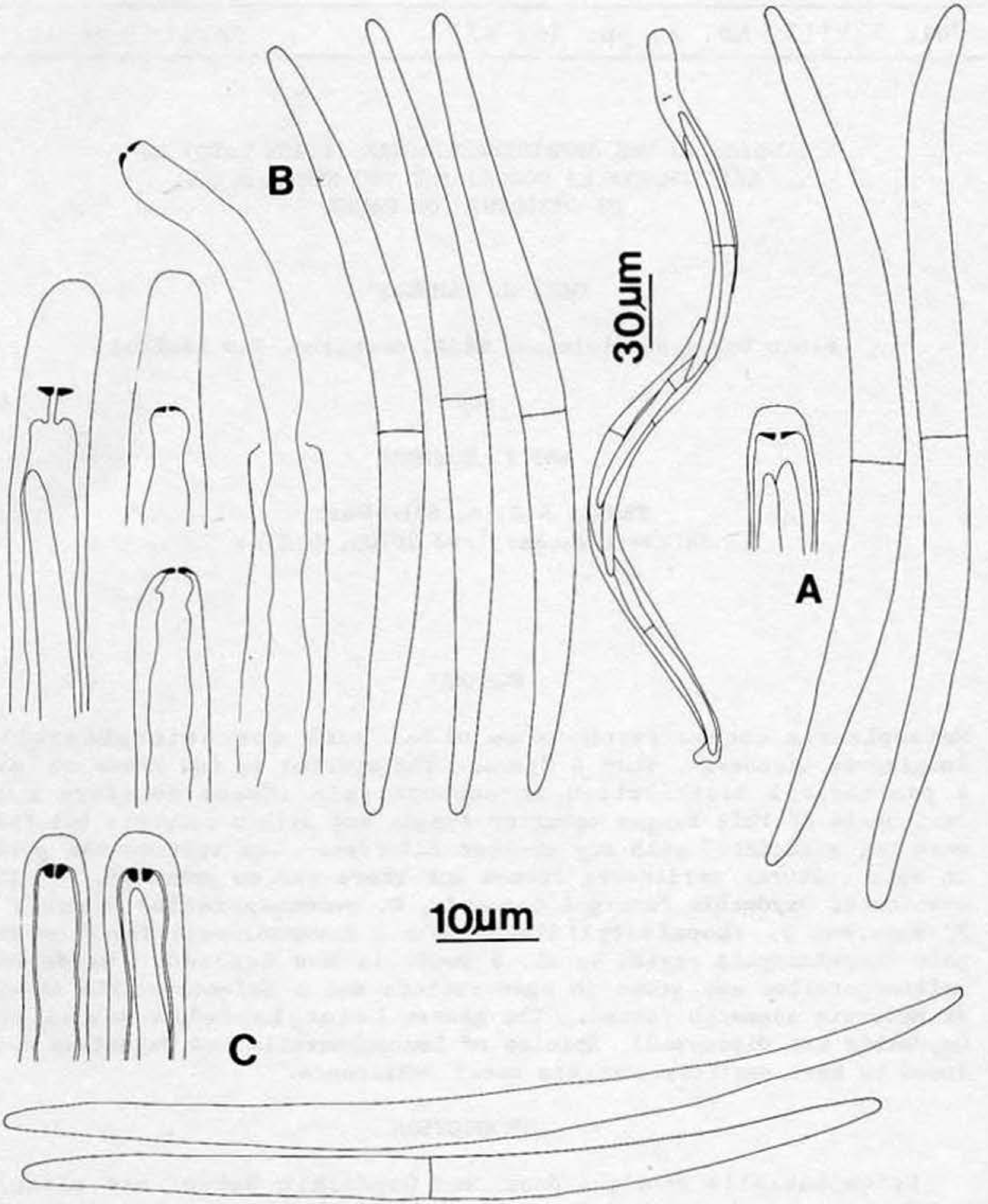


Fig. 1 A, B **Leiosphaerella cocoes.** A Ascal apex and ascospores from the type collection of **Metasphaeria cocoes.** B Ascal apices and ascospores. The ascal apices, discharging ascus and the whole ascus from PDD 40223. Ascospores in the middle from IMI 44957 b, paratype of **Leiosphaerella longispora.** All asci mounted in Melzer`s reagent. C **Oxydothis poliothea.** Ascal apices and ascospores (Type).

perpendicular to the surface of the host. The long axis of perithecia and asci of **Oxydothis** are parallel to the surface of the host and at right angles to the ostiolar canal. The extremities of ascospores of **Leiosphaerella** are considered to be rounded whereas ascospores of **Oxydothis** have finely drawn, sometimes ciliate, tips. Species of both genera are common on monocotyledonous plants and a high proportion of the species of each genus is found on palms. The correlation of perithecial orientation and ascospore form is generally consistent. A further correlation can be seen in the shape of the amyloid ascal ring. In asci of the species that we have studied the ascal ring of **Oxydothis** is wedge-shaped, longer than it is broad [e.g. **O. sabalensis** (Cooke) Petrak, Fig. 4 D], while in **Leiosphaerella** the ring is more discoid, broader than it is long. The correlation of these three characters is, unfortunately, not absolute. Perithecia of the type collection of **O. poliothea** Sydow (BPI, Fig. 1 B) are 'horizontal,' the ascal ring is wedge-shaped and the ascospores have rounded ends. Because of this combination of characters in **O. poliothea**, the only distinction between **Oxydothis** and **Leiosphaerella** may be in perithecial orientation. We are unable to judge whether this single character is sufficient for generic distinction; at the very least, the genera are closely related.

Barr (1976) included **Oxydothis** in the family Physosporellaceae (Phyllachorales). This family is characterized in part by paraphyses that, at an early stage are attached to the apex and base of the centrum; the family is also characterized in part by a pseudoparenchymatous perithecial wall. Although we did not follow development of the centrum of any of the species of **Leiosphaerella** or **Oxydothis** that we studied, the paraphyses in these species are branched and anastomosed. They extend beyond the tips of the maturing asci; at their extremities we saw many slightly swollen, free ends. The free, swollen ends suggest that the paraphyses were never attached at the top of the locule. The perithecial wall of all the species we studied is thin, 20 um or less, and is formed of compressed, flat cells.

Asci of **Oxydothis** and **Leiosphaerella** species that we have studied, when viewed by brightfield microscopy, have the same anatomical aspect. The amyloid ring is discoid or wedge-shaped and, depending upon the state of maturity of the ascus, is situated at a greater or lesser distance from the tip of the ascus. Before the spores have formed, or while they are forming, the ring is at its furthest distance from the apex. A canal joins the ring to the interior of the ascus. As the time of ascal dehiscence approaches, the ring shifts to the tip of the ascus. The ascal wall is multilayered. It consists of a thicker outer layer and a thin inner layer. This inner layer is best seen by darkfield phase contrast microscopy. Prior to ascospore discharge, the inner layer and the amyloid ring extend through the outer layer, thus appearing to be semifissitunicate (Eriksson 1981). We have not actually seen spores being discharged and cannot comment on the involvement of the amyloid ring in that process.

The asci are anatomically similar to those of some other amphisphaeriaceous fungi (e.g. **Lepteutypa** Petrak) that have amyloid ascal rings. The apparent mobility of the ring and the semifissitunicate dehiscence is not seen in the Xylariaceae or Diatrypaceae, two families that are characterized in part by having amyloid ascal rings.

No species of **Leiosphaerella** or **Oxydothis** have previously been linked to anamorphs. The two species of **Leiosphaerella** that we know have been cultured [**L. phoenicis** (Chona & Munjal) Muller & Ahmad, Muller & Ahmad 1963; **L. cocoes** (Petch) Samuels & Rossman] produced

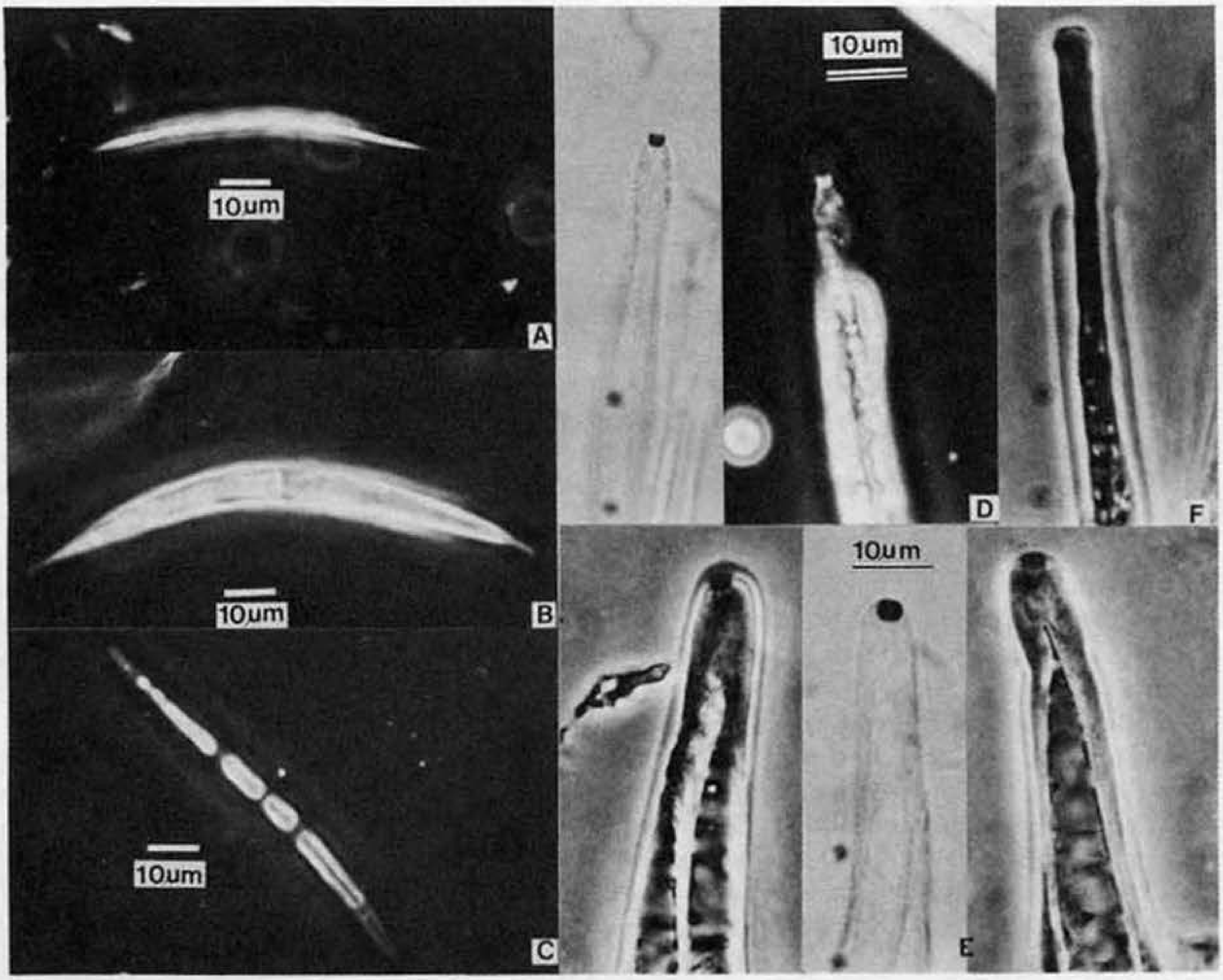


Fig. 2 A, D **Oxydothis selenosporellae.** A Ascospore (PDD 45799). D Two ascal apices, the ascus on the right dehiscing (PDD 45783; ascus on the right mounted in water, ascus on the left mounted in Melzer's reagent). B, E **Oxydothis rhopalostylidis.** B Ascospore. E Three ascal apices, the ascus on the right dehiscing (PDD 45799, mounted in Melzer's reagent). C, F **Leiosphaerella cocoes.** C Ascospore (IMI 14957 b, paratype of **Leiosphaerella longispora**). F Dehiscing ascus (PDD 40223, Melzer's reagent).

perithecia in culture but no anamorph. In our experience, ascospores of species of these genera are inconsistent in their ability to germinate. We have tried unsuccessfully to germinate ascospores of several collections of **L. cocoes, O. selenosporellae** sp. nov., and **O. rhopalostylidis** sp. nov. but ascospores of only one collection of each of **L. cocoes** and **O. selenosporellae** germinated. Conidia of the **Selenosporella** anamorph that is formed by **O. selenosporellae** are formed holoblastically on denticles on sympodially proliferating conidiogenous cells. Thus, conidial development of this anamorph is consistent with most of the known anamorphs of ascomycetes that have amyloid ascal rings (e.g. Xylariaceae, Diatrypaceae; see Rogers 1979, Glawe & Rogers 1986).

MATERIALS AND METHODS

Solitary ascospores were isolated with the aid of a micromanipulator. Cultures were grown on cornmeal dextrose agar (CMD, Difco), potato dextrose agar (PDA, Difco), oatmeal agar (OA, Difco) and coconut milk agar (coconut milk + 2 % agar).

DESCRIPTIONS OF THE DISCUSSED SPECIES

1. **Leiosphaerella cocoes** (Petch) Samuels & Rossman, comb. nov. Figs. 1 A; 2 C, F
≡ **Metasphaeria cocoes** Petch, Ann. Roy. Bot. Gard. Peradeniya 4: 304. Mar 1909.
= **Leiosphaerella longispora** Sivanesan, Shaw & Brown, Trans. Brit. Mycol. Soc. 67: 531. 1976.

Anamorph. None known.

Perithecia immersed in tissue of palm frond below raised, blister-like areas with only minute black dots of the perithecial openings evident, or occurring within fruit between the woody shell (endocarp) and fleshy endosperm in vascular channels, solitary or clustered in groups of a few and then appearing as black spheres. Perithecial body ca. 375 um high x 310-450 um wide, globose to subglobose; papillate and ostiolate and periphysate; or nonpapillate and lacking a preformed ostiolum and periphyses when immersed within fruit. Perithecial wall 15-20 um wide, composed of several layers of flat, brown pigmented cells. Paraphyses persisting among mature asci or deliquescing, indistinct, filamentous, 1-2 um wide, branching and anastomosing with many apically free and slightly swollen, 3-3.5 um wide ends. Asci (160-)205-275(-307) x (7-)9-12(-13) um, cylindrical, apical ring J+ Melzers, ± discoidal, 3-4 um wide x 1 um long; 8-spored, ascospores biseriate to multiseriate, completely filling each ascus or up to 50 of the ascal base devoid of ascospores. Ascospores (56-)77-92(-108) x (3-)4.2-5.2(-6) um, fusiform with subacute ends; with a single, median septum; hyaline, smooth.
CHARACTERISTICS IN CULTURE. Colonies grown two weeks at 20°C in darkness. CMD: 5 cm diam; PDA: 3 cm diam; coconut milk agar: 3 cm diam. Maximum colony diameter at 30°C (7.5, 6.5, 9 cm respectively). No growth at 15°C or 35°C and growth not resumed when colonies removed to 20°C. Colonies grown on CMD and PDA identical, flat, opaque, submerged hyphae dark green, aerial hyphae scant, granular, light green. Colonies grown on coconut milk agar translucent, more olivaceous; aerial hyphae more abundant and cottony. Conidia not observed. Perithecia with oozing ascospores forming within 2 weeks on CMD at 30°C, developing more slowly at lower temperatures.

HABITAT. On fronds and fruit of **Cocos nucifera** L.

KNOWN DISTRIBUTION. Cook Islands, Dominican Republic, Guam, Indonesia (North Sulawesi), Jamaica, Mexico, Papua New Guinea, Sri Lanka, Tahiti, Tonga, U.S.A. (Hawaii).

HOLOTYPE. Ceylon (Sri Lanka): Kurunegala, on coconut palm, Petch 2360, Jan 1907 (K!).

ADDITIONAL SPECIMENS EXAMINED. DOMINICAN REPUBLIC: Santo Domingo, intercepted at New York 47081, on fruit husk of **Cocos nucifera**, Lennox, 23 Sep 1935 (BPI). GUAM: on fibrous calyx of **Cocos nucifera**, intercepted at San Francisco 22859, Bryant, 28 Feb 1947 (BPI). INDONESIA: North Sulawesi, vic. Komangaan limestone caves, 0°49' N, 124°12' E, 400 m, on frond of **Cocos nucifera**, Samuels 2370, 24 Oct 1985 (NY, BO). JAMAICA: on diseased midrib of coconut developed in moist chamber, Nr. 5301, collector & date unknown (NY). MEXICO:

Tuxpan, intercepted at Brownsville, Texas 010568, on fruit husk of **Cocos nucifera**, van Valkenburgh, 21 Jan 1981 (BPI). UNITED STATES: Hawaii, Hilo, intercepted at Hilo 1250, on fibrous calyx of **Cocos nucifera**, Rader, 15 Feb 1970 (BPI). TONGA: on coconuts imported from Tonga and purchased in Auckland, Samuels, 31 May 1980 (PDD 41200), second collection, Samuels, Apr 1981 (PDD 42054). COOK ISLANDS: Rarotonga, on coconuts, Fullerton, Sep 1979 (PDD 40223, NY); second collection, May 1980 (PDD 41199). PAPUA NEW GUINEA: Creek Plantation, on leaves of **Cocos nucifera**, Charles (TPNG 4659), 6 Aug 1965 (IMI 114957 b); Aroa Plantation, Hisiu Beach, on leaf midrib of **Cocos nucifera**, Charles (TPNG 8369), 19 Oct 1972 (IMI 171688 c, Holotype of **Leiosphaerella longispora**); Panapau Plantation, New Ireland, Alcorn (TPNG 8336), 12 Oct 1972 (IMI 171687).

NOTES. **Leiosphaerella cocoes** was recently reported from Western Samoa, where it was circumstantially linked to a blast disease of coconut (as **L. longispora**, see summary in Raju & Reddy 1984) and Raju & Reddy (1984) found the species on the outside (epicarp) of coconuts imported into India from Tahiti. We have seen several specimens of **L. cocoes** from the New World as well as from Oceania and Indonesia and can confirm that it is a pantropical species. In all the coconuts purchased in Auckland markets and imported from various nations of the southwest Pacific basin, **L. cocoes** was found within the fruit between the woody shell (endocarp) and the fleshy endosperm. Apparently the ascomatal wall is firmly attached to the surrounding tissue of the fruit as it is impossible to expose ascomata, through separating the endocarp from the endosperm, without tearing them apart. Perithecia were not seen on the outer wall of the endocarp nor were they formed anywhere on the fibrous pericarp. Even though the fungus was in direct contact with the endosperm, the endosperm was apparently unaffected.

The specimens that we have seen from fruit agree overall with the species as was described by Sivanesan et al. (1976, as **L. longispora**) although we did note minor differences. Those authors gave the measurements of the ascospores as 69-90 x 3.5-4.5 um whereas we found ascospores (28) of their material (IMI 171688 c, 114957 b, 171687) to be (77-)80-88(-100) x 5-5.5 um. The combined measurements of the ascospores (200) of all the collections that we studied are given above in the redescription of the species.

Perithecia of the Indonesian specimen cited above were intimately associated with perithecia of **Oxydothis** cf. **poliothea** Sydow in fronds of coconut palm.

Ascospores of one of our collections from the Cook Islands (PDD 40223) germinated on CMD by producing a germ tube. The spores darkened and became 3-5-septate prior to germination. Perithecia that formed in culture were globose but adjacent perithecia were confluent and tended to be variable in shape. Most of the culturally produced perithecia had a fine, short and acute papilla that was either apical or lateral. Perithecia often did not appear to have a papilla and ascospores were discharged through a hole in the top or side. No anamorph was found after one month.

2. **Oxydothis selenosporellae** Samuels & Rossman, sp. nov.
Figs. 2 A, D; 3 A, B-D; 4 A, B.

Oxydothis sabalensis (Cooke) Petrak similis sed ascosporae differt, (49-)55.2-64.7(-77) x (2.5-)3.5-4 (-4.5) um.
Holotypus. PDD 46266.
Status anamorphosis. **Selenosporella** sp.

Anamorph. **Selenosporella** sp.

Perithecia immersed in host tissue below slightly raised and blister-like, blackened lesions with only minute black dots indicating the perithecial openings, aggregated in groups of several in a common stroma within the hypodermis, 1 cell layer below the epidermis and with two layers of hypodermal cells below each perithecium; with brown hyphal cells growing into underlying vascular tissues. Stroma compact, 80-100 um thick between perithecia, cells pseudoparenchymatous, 10-25 um long x 4-5 um wide, walls ca. 1.5 um thick, brown, arranged in distinct files that are perpendicular to the surface of the host. Perithecial body 350-400 um long x 150-170 um high, with long axis parallel to the surface of the host and perpendicular to the ostiolar canal; ostiolar canal 35-80 um long; adjacent perithecia discharging through a common ostiolar canal. Perithecial wall 5-6 um wide, composed of a few layers of very narrow and flattened cells with light brown walls; perithecial papilla composed of 5 um wide hyphal elements arranged in a palisade; ostiolar canal periphyste, periphyses 20-25 um long, apparently arising from a tissue distinct from the paraphyses. Paraphyses persisting among mature asci or deliquescing, much branched and anastomosed, 1.5-4 um wide, cells 10-15 um long. Asci (125-)150-180(-200) x (6-) 6.5-7.5(-8) um, cylindrical, apical ring J+ Melzer's, wedge-shaped, 2-2.5 um wide x 1-1.5 um long; 8-spored, ascospores biseriate to multiseriate, completely filling each ascus or up to 50 um of the ascal base devoid of ascospores. Ascospores (49-)55.2-64.7(-77) x (2.5-)3.5-4(-4.5)um, narrowly fusiform with ends apiculate but not ciliate, with a single, median septum, hyaline, smooth.

CHARACTERISTICS IN CULTURE. Colonies grown one month at 20°C, diffuse daylight. CMD: 2-3.5 cm diam, scant aerial mycelium, with a few, hemispherical stromatic masses; center of colony dark olivaceous, margin colorless to pale olivaceous grey. OA: no aerial mycelium formed, black stromatic masses with developing perithecia forming throughout the colony. Conidia forming abundantly on CMD on stromatic masses or in aerial mycelium; none forming on OA. Conidiophores macronematous, mononematous, 30-45 x 4-6 um wide at base, with (1-)2-3 septa, unbranched or once branched; brown olivaceous and thick-walled below; thin walled and nearly colorless above. Conidiogenous cells 10-15 um long, finely denticulate, with a minute, refractive scar remaining after conidial dehiscence. Conidia (17-)23-27(-29) x 1-1.5(-2) um, arcuate, without obviously differentiated apex or base, unicellular, colorless.

HABITAT. On leaf midrib of **Rhopalostylis sapida** Wendl. & Drude.

KNOWN DISTRIBUTION. New Zealand (North Island: Northland, Auckland).

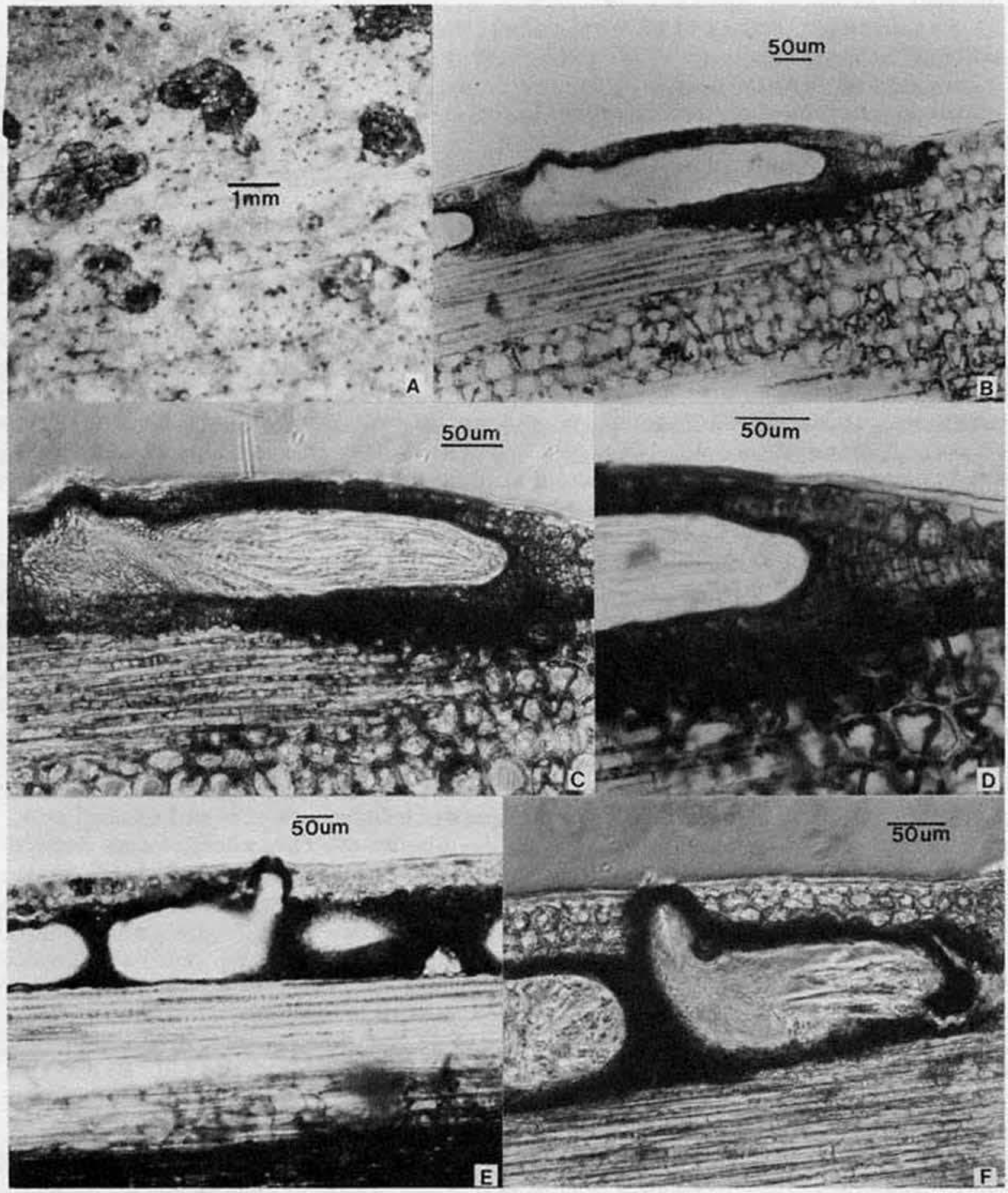


Fig. 3 **Oxydothis selenosporellae** and **O. rhopalostylidis.** A Surface of frond of **Rhopalostylis sapida** with **O. selenosporellae** appearing as large blackened areas, and **O. rhopalostylidis** appearing as minute black dots (PDD 45799). B–D **O. selenosporellae.** B Section through a mature perithecium (PDD 45799). C Section through a mature perithecium showing orientation of asci and the eccentric ostiolar area (PDD 45799). D Section through stroma (PDD 45799). E, F **O. rhopalostylidis.** E Section through a mature perithecium showing habit and relationship to the palm epidermis (PDD 45799). F Section through a mature perithecium showing orientation of asci and the eccentric ostiolar area (PDD 45799).

HOLOTYPE. NEW ZEALAND: Auckland, Waitakere Ranges, Waitemata City, Huia, Mill Bay, on **Rhopalostylis sapida**, Samuels (83-60), Matsushima & Petersen, 3 May 1983 (PDD 46266, Isotype NY).

ADDITIONAL SPECIMENS EXAMINED (all on **Rhopalostylis sapida**). NEW ZEALAND: Northland, Waipoua State Forest, 4 collections [PDD 44394, 45777, 45783, 45786 (NY)]; Omahuta State Forest, Samuels, 8 May 1983 (PDD 45798). Auckland, Waitemata City, Waitakere Ranges, Cascades, Samuels, Horak & Johnston, 6 May 1981 (PDD 42057); Manukau City, vic. Clevedon, Morehu Reserve, Johnston, Samuels & Petersen, 5 May 1983 (PDD 44744).

NOTES. **Oxydothis selenosporellae** has much narrower and shorter ascospores and a smaller ring than **O. rhopalostylidis.** Paraphyses of **O. selenosporellae** tend to be broader and to have longer cells than the paraphyses of **O. rhopalostylidis.** Both species have larger ascospores than **O. sabalensis** (Fig. 4 D).

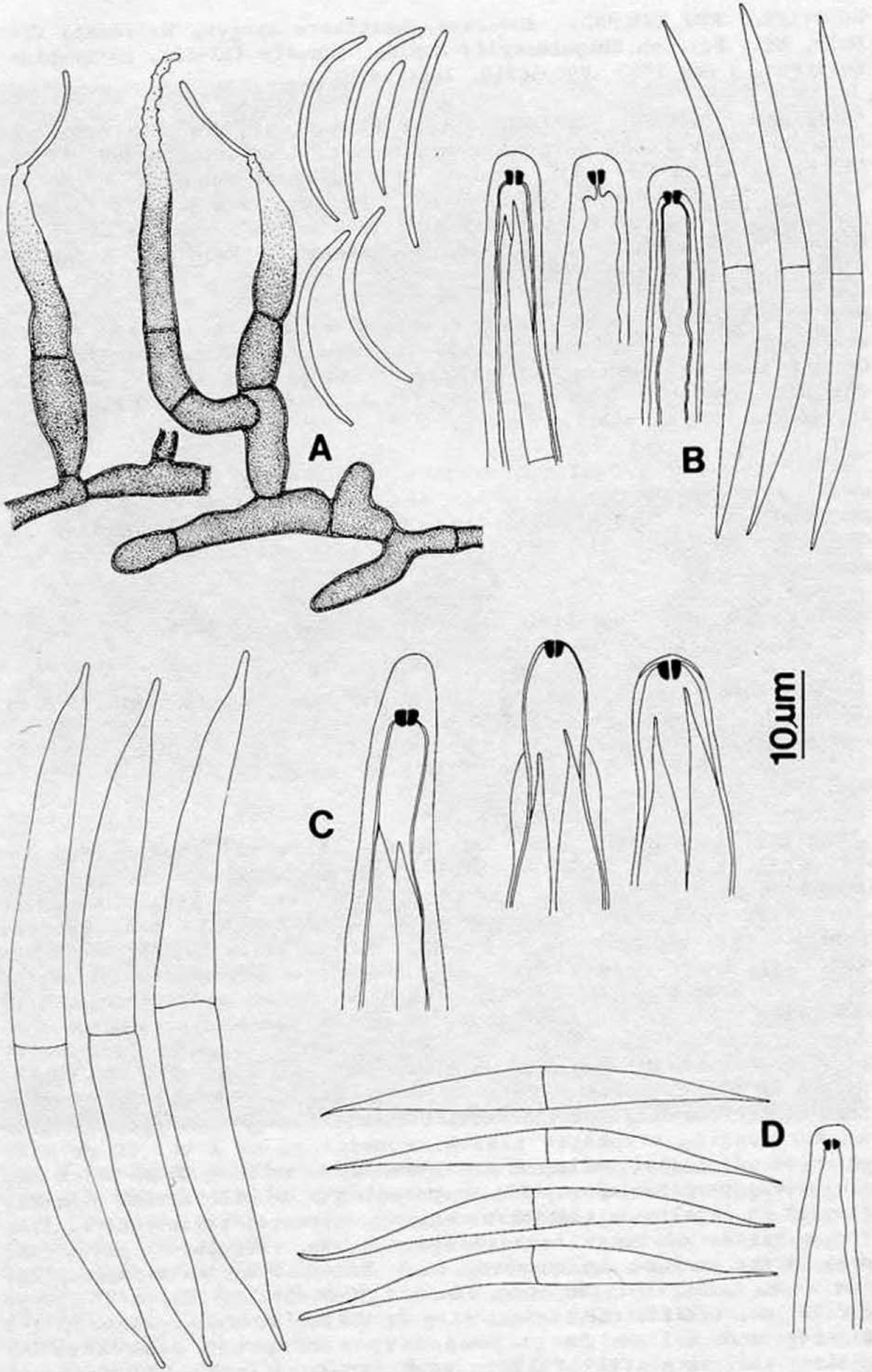
Perithecia of **O. selenosporellae** consistently form only a single cell layer below the epidermis and in a compact stroma whereas perithecia of **O. rhopalostylidis** form more deeply and lack a well developed stroma. The two species are intermingled on palm leaf midribs.

3. **Oxydothis rhopalostylidis** Samuels & Rossman, sp. nov.
Figs. 2 B, E; 3 A, E, F; 4 C.

Oxydothis sabalensis (Cooke) Petrak similis sed ascosporae differt, (65-)74-88(-95) x (5.5-)6-7.2(-8) um.
Holotypus. PDD 45779.

Anamorph. None known.

Perithecia immersed in host tissue below slightly raised and blister-like, non-blackened lesions with only minute black dots indicating the perithecial openings, solitary or gregarious; each surrounded by stromatic tissue that lacks definite orientation; forming within the hypodermis, 3-4 cell layers below the epidermis and with 1 cell layer of hypodermal cells below each perithecium or seated directly on the vascular tissue; with brown hyphal cells growing into underlying vascular tissues. Cells of stroma pseudoparenchymatous, 8-12 um in greatest dimension, walls < 1 um thick, brown. Perithecial body 220-280 um long x ca. 125 um high, with long axis parallel to the surface of the host and perpendicular to the ostiolar canal; ostiolar canal 110-175 um long. Perithecial wall not easily distinguished from the surrounding stromatic tissue, consisting of a ca. 10 um wide region of elliptical cells 12 x 4.5 um, with walls < 1 um thick and dark brown; perithecial papilla composed of 5 um wide hyphal elements arranged in a palisade; ostiolar canal periphysate; periphyses arising from a tissue distinct from the paraphyses. Paraphyses persisting among mature asci or deliquescing, much branched and anastomosed, ca. 2 um wide, cells 10-15 um long. Asci (130-)165-235(-285) x (7-)13.5-19.7(22) um, cylindrical, apical ring J+ Melzer's, wedge-shaped, 2-3 um wide x 2-2.5 um long; 8-spored, ascospores biseriate to multiseriate, completely filling each ascus or up to 50 um of the ascal base devoid of ascospores. Ascospores (65)74-88(-95) x (5.5-)6-7.2(-8) um, narrowly fusiform with ends apiculate but not ciliate, with a single, median septum, hyaline, smooth.


A
B
C
D
10µm

HABITAT. On leaf midrib of **Rhopalostylis sapida.**

KNOWN DISTRIBUTION. New Zealand (North Island: Northland, Coromandel).

HOLOTYPE. NEW ZEALAND: Northland, Hokianga County, vic. Mangamuka Bridge, Omahuta State Forest, at forest headquarters, on **Rhopalostylis sapida**, Samuels (83-507), 11 May 1983 (PDD 45779, Isotype NY).

ADDITIONAL SPECIMENS EXAMINED (all on **Rhopalostylis sapida**). NEW ZEALAND: Northland, Hokianga County, Omahuta State Forest, Samuels, 8 May 1983 (PDD 45798), second collection, Samuels, Matsushima & Petersen, 9 May 1983 (PDD 45799); Hokianga County, Waipoua State Forest, 30 May 1982 (PDD 44394), second collection, Samuels, Matsushima & Petersen, 12 May 1983 (PDD 45786, NY), third collection, Samuels 13 May 1983 (PDD 45777). Coromandel, Thames, Kauaeranga Valley, Samuels & Petersen, 1 May 1983 (PDD 46262, 46263).

ACKNOWLEDGEMENTS

This research was supported in part by a grant from the U.S. National Geographic Society to the senior author. We appreciate the loan of specimens from IMI and K.

Drs. Margaret Barr, Jack Rogers and Clark Rogerson reviewed the manuscript.

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Fig. 4 A, B **Oxydothis selenosporellae.** A **Selenosporella** anamorph drawn from culture (PDD 46266). B Ascal apices (Melzer's reagent, PDD 46266) and ascospores (PDD 44744). C **Oxydothis rhopalostylidis.** Ascospores and ascal apices, the ascus in the middle dehiscing (asci mounted in Melzer's reagent, PDD 45799). D **Oxydothis sabalensis.** Ascospores and ascal apex (the ascus mounted in Melzer's reagent; Reliquiae petrakianae 252, PDD).

MYCOTAXON

Vol. XXVIII, No. 2, pp. 473-499 April-June 1987

STUDIES IN THE AMPHISPHAERIACEAE (SENSU LATO) 3. NEW SPECIES OF MONOGRAPHELLA AND PESTALOSPHAERIA, AND TWO NEW GENERA

Gary J. Samuels[1]
Plant Diseases Division, DSIR, Auckland, New Zealand

Emil Müller
Mikrobiologisches Institute, Eidg. Technische Hochschule,
Universitätstr. 2, CH-8006, Zürich, Switzerland

and

Orlando Petrini
Bodenacherstrasse 86, CH-8121 Benglen, Switzerland

SUMMARY

Monographella passiflorae and its anamorph **Microdochium passiflorae**, **Pestalosphaeria leucospermi** (anamorph = **Pestalotiopsis** sp.) are described as new. **Induratia apiospora** (anamorph = **Nodulisporium** sp.) is described in the monotypic new genus **Induratia**. **Lasiosphaeria phyllophila** is referred to the new genus **Iodosphaeria** as is the new species **Iodosphaeria ripogoni**. The synanamorphs of **I. phyllophila** and **I. ripogoni** are **Selenosporella** and **Ceratosporium** species. The significance of anamorphs to taxonomy of the Amphisphaeriaceae is discussed.

In this, the third and final article in this series on the Amphisphaeriaceae (<u>sens. lat.</u>, Samuels et al. 1987, Samuels & Rossman 1987) several miscellaneous ascomycetes and their anamorphs are described. These include **Monographella passiflorae** sp. nov. and **Pestalosphaeria leucospermi** sp. nov. **Lasiosphaeria phyllophila** Mouton is placed in a new genus, **Iodosphaeria**, with **I. ripogoni** sp. nov. **Induratia apiospora** sp. nov. is described in the new genus **Induratia**. A discussion of the Amphisphaeriaceae and the anamorphs that have been linked to it conclude this paper.

MATERIALS AND METHODS

Ascospores of **Monographella passiflorae**, **Pestalosphaeria leucospermi**, **Induratia apiospora** and **Iodosphaeria phyllophila** were isolated with the aid of a micromanipulator on cornmeal dextrose agar (CMD, Difco). Colony characteristics were taken from CMD, potato dextrose agar (PDA, Difco) and oatmeal agar (OA, Difco).

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[1] Present address: The New York Botanical Garden, Bronx, New York 10458

DESCRIPTIONS OF THE SPECIES

1. **Monographella passiflorae** Samuels, Müller & O. Petrini, sp. nov. Figs. 1 A-D, 2.

Ascomata 200-250 µm diametro, globosa, papilla cumque in cultura orta ostiolo nonpraedita, maturitate peridium secessione rumpentia, pallida sed nonnulla saepe fuscescentia. Paries ascomatis 20-25 µm crassa, ex hyphis non laxe intricatis composita, cellulis hypharum conspectu frontali ellipticis vel fusiformibus, texturae epidermoideae visu.

Asci (57-)60-80(-120) x (9-)10-11 µm, clavati, apice annulo discoideo iodi ope coerulescenti praedito, in hymenio dispositi. Ascosporae biseriatae, totum ascum implentes, ellipticae vel elongatae fusiformes vel naviculatae, 1-3-septatae, non coloratae, laeves, (15-)17-23(-25) x 4-5 µm. Paraphyses ex ascis maturitate provecta exsertae, ascis vix longiores apicaliterque liberae, eramosae, septatae, ad 4 µm crassae crassioresque ad basim quam ad apicem.
Status anamorphosis **Microdochium passiflorae** Samuels & Müller.
Habitat in caulibus emortuis **Passiflorae edulis** Sims.
Holotypus: PDD 47874.

Microdochium passiflorae Samuels, Müller & O. Petrini, sp. nov. Figs. 1 C-D, 2.

Cellulae conidiogenae in pionnotibus aurantiacis orientes, non coloratae, cylindricae, 3-4 µm crassae, sympodiales vel percurrentes proliferationes in una atque eadem cellula ferentes. Conidia holoblastice orta, falcata apice saepe curvo basique truncata, 3-4(-6) septata, 28-50 x 3-4 µm.
Holotypus idem stato teleomorphosis **Monographellae passiflorae** atque in eodem loco inventum.

Perithecia known only from culture, 200-250 µm diam, globose, nonpapillate and apparently nonostiolate and opening by splitting; pallid but many becoming dark with age. Perithecial wall 20-25 µm wide, composed of tightly interwoven hyphae, cells appearing elliptic to fusoid in section, 5-8 x 2-3 µm, walls < 0.5 µm thick; tissue at surface of perithecial wall textura epidermoidea. Asci (57-)60-80 (-120) x (9-)10-11 µm, clavate, apex with a disc-shaped, J+ (Melzer's) ring, 8-spored; ascospores biseriate, completely filling each ascus; asci forming in a hymenium. Ascospores ellipsoidal to narrowly fusiform to naviculate, (15-)17-23(-25) x 4-5 µm, 1-3-septate, hyaline, smooth. Paraphyses persisting among mature asci, somewhat longer than asci and apically free, unbranched, septate, ca. 4 µm wide but narrower at tip than at base.

CHARACTERISTICS IN CULTURE (Table 1).

Conidiogenous cells formed in orange pionnotes, colorless, cylindrical, 3-4 µm wide, with sympodial and percurrent proliferations on the same conidiogenous cell. Conidia formed holoblastically, falcate and **Fusarium**-like, tip often curved and base truncate, 3-4 (6)-septate:

3-septate: 28-40 x 3-3.5 µm
4-septate: (30-)35-40 x 3-3.5 µm
5-septate: 34-42 x 3-3.5(-4) µm
6-septate: 35-50 x 3-3.5 µm

HABITAT. Isolated from dead stems of **Passiflora edulis** (Passionfruit). Known only in culture and from the original isolation.

Table 1. Colony diameter and characteristics of **Monographella passiflorae**.

	TEMPERATURE (°C)					
	10	15	20 (darkness)	20 (light[1])	25	30
CMD	5-6[2]	<----------- greater than 9 ------------->				
	Scant aerial mycelium, colony salmon-colored, sterile					
PDA	5-6	<----------- greater than 9 ------------->				
	Colonies as on CMD but more intensely salmon-colored at 20°C					
OA	5-6	7	<------ greater than 9 ------->			
	as above	felty, salmon, sterile	aerial mycelium tufted, most at 25°C, colonies sterile at 20°C light, conidia forming in darkness at all temperatures			

[1] 12 h darkness/12 h near ultraviolet + cool white fluorescent light.

[2] Colony diameter (cm) including a 5 mm plug of inoculum.

HOLOTYPE. NEW ZEALAND: North Island, Auckland, Mt. Albert, Mt. Albert Research Centre, on **Passiflora edulis**, G.I. Robertson, 1980 (PDD 47874).

NOTES. Dr. Robertson (pers. comm.) originally isolated this species from dying stems of declining passionfruit plants. He reinoculated the fungus back onto 3 month old seedlings but no disease symptoms resulted.

In spite of an examination of many crush mounts and freezing microtome sections, we did not observe an ostiolar canal or periphyses in perithecia of this species. This is consistent with our observation that perithecia split at maturity. We would not be surprised if naturally formed perithecia are ostiolate. Other pyrenomycetes are known to vary in their ability to produce a perithecial ostiolum (Arx 1973).

Monographella passiflorae can be distinguished from all other species of this genus on the basis of the combined attributes of ascosporal and conidial measurements (see summary in Müller & Samuels 1984).

2. **Pestalosphaeria leucospermi** Samuels, Müller & O. Petrini, sp. nov. Figs. 3,4.

Ascomata in brunneis, diffusis laesionibus orientia, amphigena, gregaria, conidiomatibus intermixta, plane immersa, subcuticularia, intraepidermalia, globosa, fusca, ad 250 µm diametro. Ascomatis paries 15-20 µm crassa, e nonullis stratis compressarum planarum cellularum 15 µm longitudine, parietibus tenuioribus quam 0.5 µm

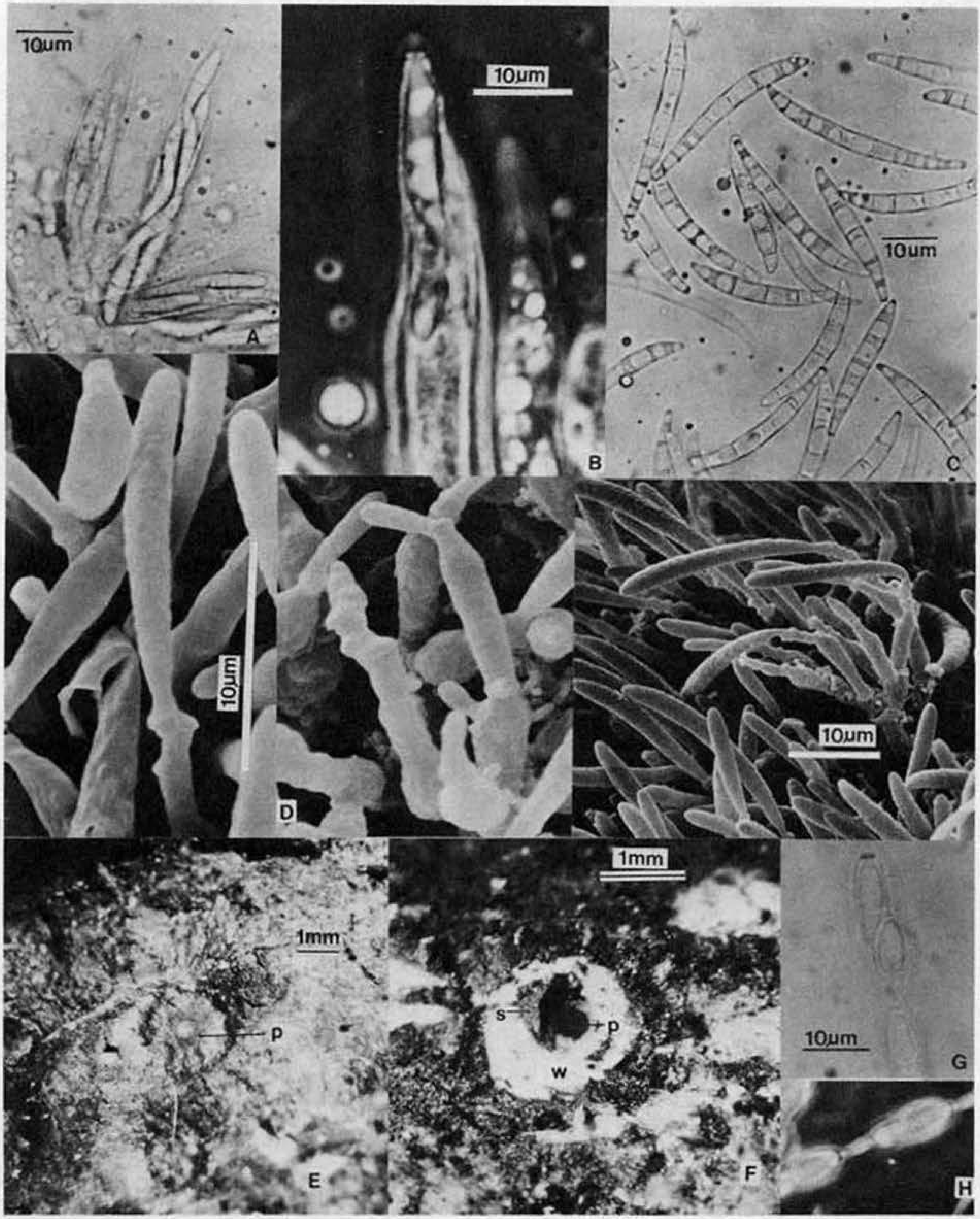


Fig. 1 A-D **Monographella passiflorae.** A Two asci (Melzer's reagent, brightfield microscopy). B Ascal apex (Melzer's reagent, darkfield phase contrast microscopy). C **Microdochium** conidia. D Three views of sympodially proliferating conidiogenous cells. E-H **Induratia apiospora.** E Stromal surface with a single immersed perithecium (p). F One immersed perithecium with most of the overlying stroma (s) chipped away to reveal bare wood (w) below the stroma and the perithecial opening (p). G Ascospores and ascal apex (Melzer's regent). H Two ascospores with terminal appendages. All illustrations from the type collections.

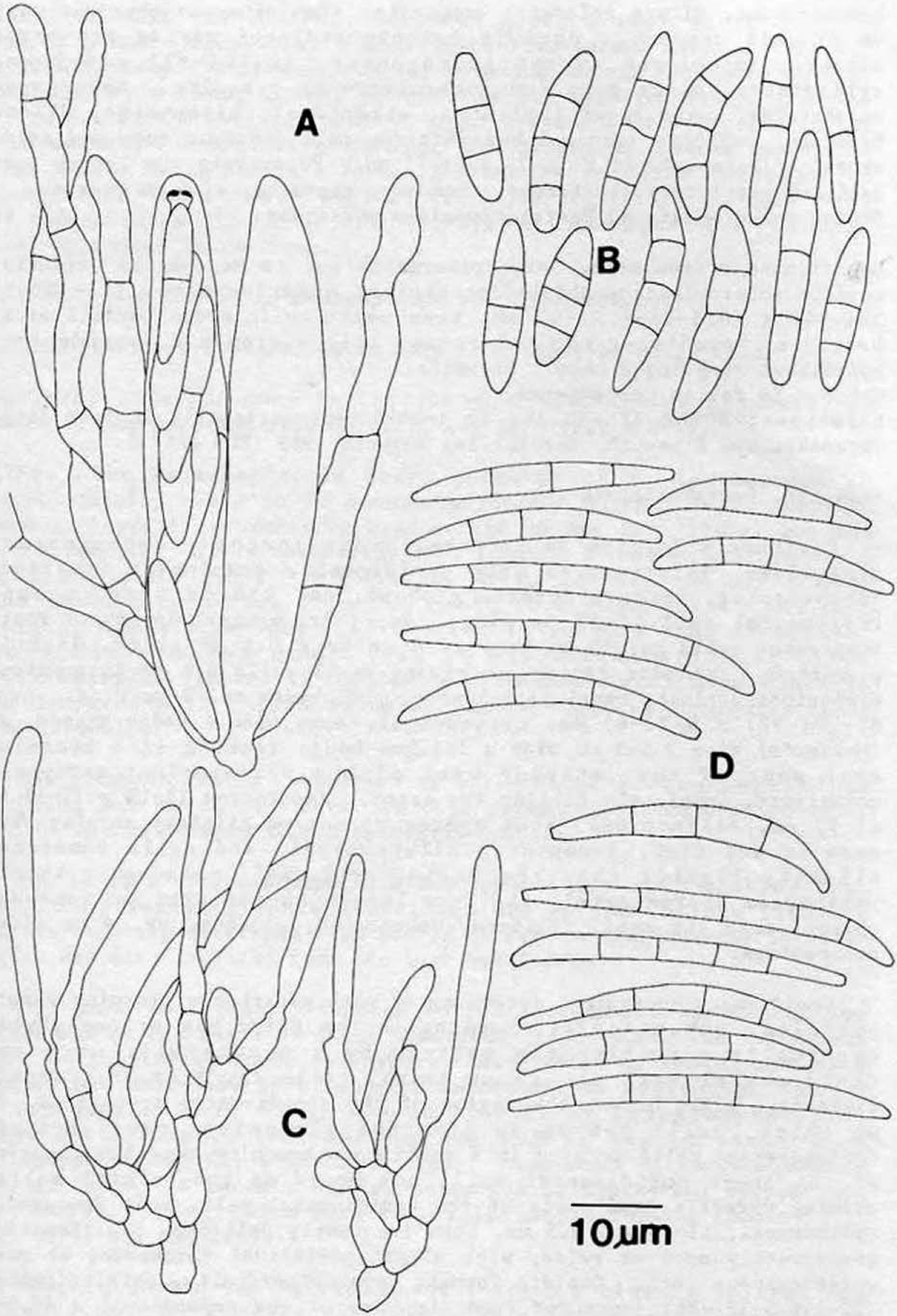


Fig. 2 **Monographella passiflorae.** A Two asci with paraphyses (Melzer's reagent). B Ascospores. C Conidiogenous cells with developing conidia. D Conidia. All drawn from the type collection.

crassitudine, dilute coloratis composita. Ostiolum periphysibus ad 3 µm crassis ornatum. Asci in hymenio ordinati maxima pro parte parietem interiorem ascomatis tegentes, 80-90(-97) x 6-7 µm, cylindracei, apice poro iodo coerulescenti praedito. Ascosporae uniseriatae, totum ascum implentes, ellipticae, biseptatae, dilute brunneae, cellulis terminalibus interdum pallidioribus quam medianis, crassitunicatae, 12-15 x (5-)5.5-6(-7) µm. Paraphyses tum longae quam asci tum breviores, filiformes, eramosae, septatae, ad 4 µm crassae. Status anamorphosis ad **Pestalotiopsidem** pertinens.

Conidiomata acervularia, intraepidermalia aut in mesophyllo orientia; conidia enteroblastice phialidice genita, quadriseptata, (22-)26.5-32(-34) x (6.5-)7-8.5(-9) µm; tres cellulae in medio conidii sitae brunneae, terminales non coloratae, tribus eramosis appendicibus apicalibus singuloque basali praedita.
Habitat in foliis **Leucospermi.**
Holotypus: NOVAE ZELANDIAE, in insula septentrionali, in loco dicto Taranaki, New Plymouth, Hartill leg augusto 1985 (PDD 47671).

Anamorph. **Pestalotiopsis** sp.

Perithecia forming in diffused brown lesions, amphigenous, gregarious, intermingled with conidiomata, completely immersed, subcuticular, intraepidermal, globose, ca. 250 µm diam, brown. Perithecial wall 15-20 µm wide, comprising several layers of flat, compressed cells ca. 15 µm long with walls < 0.5 µm thick, lightly pigmented. Ostiolar region comprising small cells 4-6 µm in greatest dimension; ostiolar canal periphysate, periphyses ca. 3 µm wide. Asci 80-90(-97) x 6-7(-8) µm, cylindrical, apex with a wedge-shaped, J+ (Melzer's) ring 2.5-3 µm wide x 1-1.5µm long; forming in a hymenium over most of the interior wall of the perithecium; ascopores uniseriate, completely filling the ascus. Ascospores 12-15 x (5-)5.5-6(-7) µm, ellipsoidal, some spores appearing slightly angular when seen in end view, 2-septate, dilute brown, end cells sometimes slightly lighter than the median cell, wall noticeably thick. Paraphyses approximately the same length as the asci or somewhat shorter than the asci, filiform, unbranched, septate, ca. 4 µm wide, not copious.

Conidiomata acervular, intermingled with perithecia, forming minute pustules, subcuticular, forming in the epidermis or mesophyll, eventually rupturing the cuticle by a minute slit or pore. Conidiomatal wall ca. 15 µm thick, cells ca. 3 µm in greatest dimension, light brown; the region of the conidiomatal opening ca. 25 µm thick, cells 5-6 µm in greatest dimension, nonpigmented. Conidiogenous cells forming in a continuous hymenium over the interior of the lower conidiomatal wall, not noted on the lateral walls, arising directly from cells of the conidiomatal wall, most frequently cylindrical, 11-18 x 2-2.5 µm, less frequently doliform, proliferating percurrently once or twice, with slight periclinal thickening at many conidiogenous loci. Conidia forming enteroblastically, phialidically, (22-)26.5-32(-34) [measured from the base of the appendages] x (6.5-)7-8.5 (-9) µm, median cells (16-)18.5-21.2(-23) µm, fusiform to ellipsoidal, widest in the middle, 4-septate, middle 3 cells brown, concolorous, terminal cells colorless; with 3 apical appendages 15-23 x 0.5-1 µm, unbranched; and 1 basal appendage, 6-10 x 0.5-1 µm.

CHARACTERISTICS IN CULTURE. Colonies grown 1 week at 20°C, 12 h dark/12 h near ultraviolet + cool white fluorescent light. CMD: 6.5 cm diam, colony transparent, aerial mycelium scant, very pale salmon. PDA, OA: 8 cm diam, colony opaque, aerial mycelium felty, greenish yellow but with a marginal band of white hyphae; colony reverse on PDA pale salmon. Conidiomata forming abundantly in obvious concentric rings on all media within 5 days. Conidiogenous cells identical to those found in nature. Conidia (20-)22.5-30.5(-34) x (6-)6.7-8(-9) um; median cells (13-)15-17(-18) um; apical appendages 10-17 um long, basal appendage 3-4 um long.

HABITAT. Live leaves of **Leucospermum** sp. (Proteaceae).

DISTRIBUTION. New Zealand, known only from the type collection.

HOLOTYPE. NEW ZEALAND: North Island, Taranaki, New Plymouth, on leaves of **Leucospermum** sp., Hartill, Aug 1985 (PDD 47671).

NOTES. The **Pestalotiopsis** Stey. anamorph of **P. leucospermi** is morphologically close to **P. macularis** (Corda) Nag Raj [= **P. guepinii** (Desm.) Steyaert] as recently redescribed by Nag Raj (1985a) but has larger conidia. It is noteworthy that conidia formed in cultures (n = 34; mean: 23.5 ± 2.3 x 7.0 ± 0.4 um) of **P. leucospermi** are smaller than those from nature (n = 50; mean: 26.4 ± 4.0 x 7.4 ± 0.7 um); conidial appendages were also shorter in culture than in nature. These differences could lead to misdetermination of other **Pestalotiopsis** species if conidial measurements taken from isolates are compared with published measurements that are apparently taken from nature.

The greenish yellow coloration of cultures of **P. leucospermi** is striking but we do not know how this pigmentation compares to other species in the **Pestalotiopsis macularis**-complex.

The conidia of **Pestalosphaeria leucospermi** are much smaller than conidia of **Pestalotiopsis montellicoides** Mordue (Mordue 1986), a species recently described from leaves of **Protea** (Proteaceae) in South Africa and also isolated from air over New Zealand.

The genus most closely related to **Pestalosphaeria** is **Lepteutypa** Fuckel and on the basis of their described differences, the two genera might be considered to be synonymous. Ascospores of **Pestalosphaeria** species are described as biseptate, ascospores of **Lepteutypa** species as triseptate (Barr 1975; key to species of **Pestalospheria** in Shoemaker & Simpson 1981 and Nag Rag 1985b; key to species of **Lepteutypa** in Nag Raj & Kendrick 1985). Anamorphs of **Pestalosphaeria** species belong to **Pestalotiopsis**; anamorphs of **Lepteutypa** species are attributed to **Seiridium** Nees and **Hyalotiopsis** Punith. (Swart 1973, Barr 1975, Nag Raj 1985b).

Pestalotiopsis and **Seiridium** are certainly closely related and variants on one, readily distinguishable theme (see Sutton 1980). **Hyalotiopsis** is likely to fit into the series even though its conidiomata are described as pycnidial and conidiogenous cells as holoblstic with sympodial proliferation (Sutton 1980) or blastic-annellidic (Nag Raj & Kendrick 1985). Nag Raj & Kendrick (1985) recently removed **Lepteutypa indica** (Punith.) Arx to the monotypic

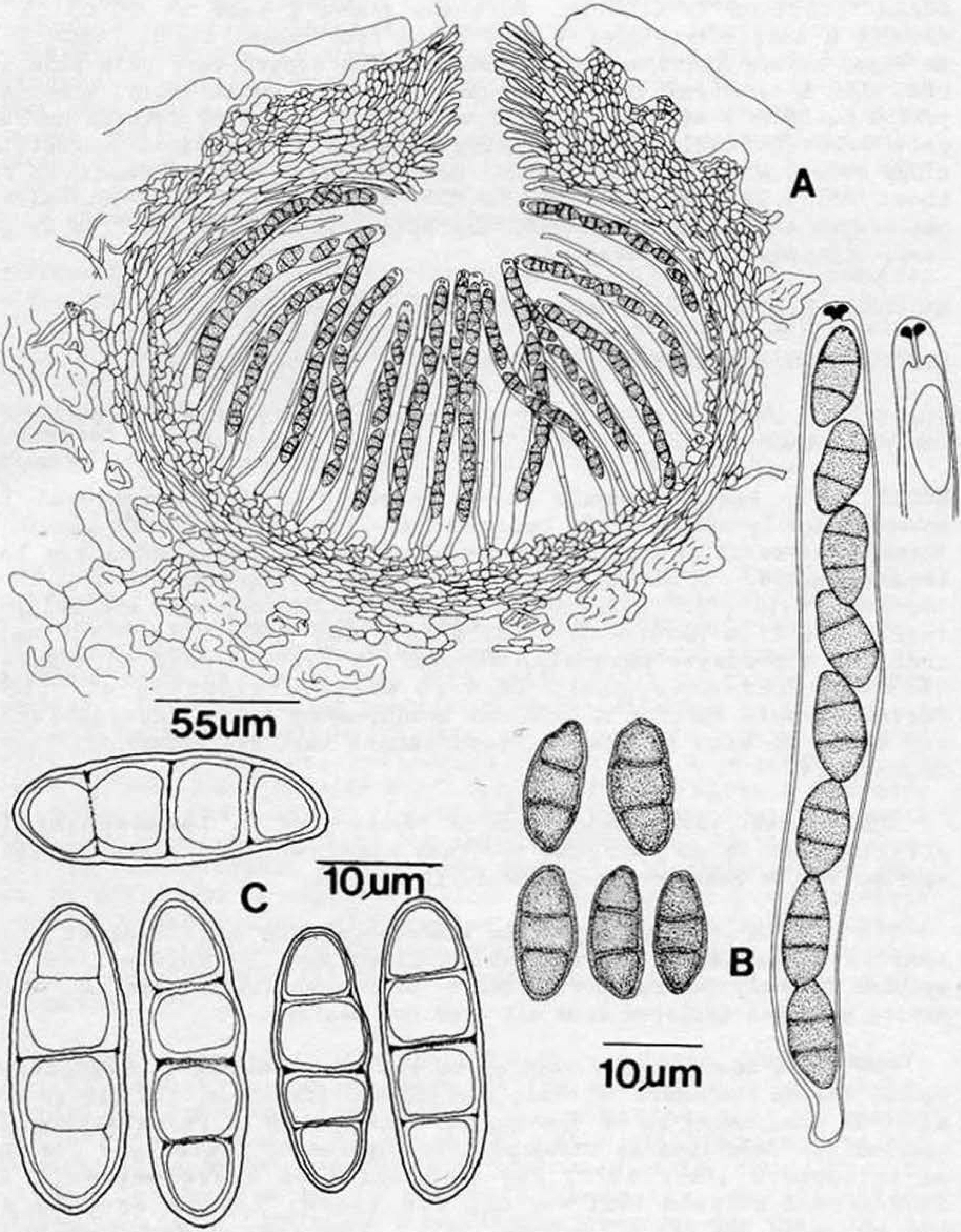


Fig. 3 A,B **Pestalosphaeria leucospermi.** A Section through a mature perithecium immersed in host tissue. B Asci and ascospores (Melzer's reagent). C **Lepteutypa fuckelii.** Ascospores. Ascospores on right mounted in water, ascospores on left mounted in 3% KOH. A,B drawn from the type collection. C drawn from Petrak, Jasinka-Tal (NY).

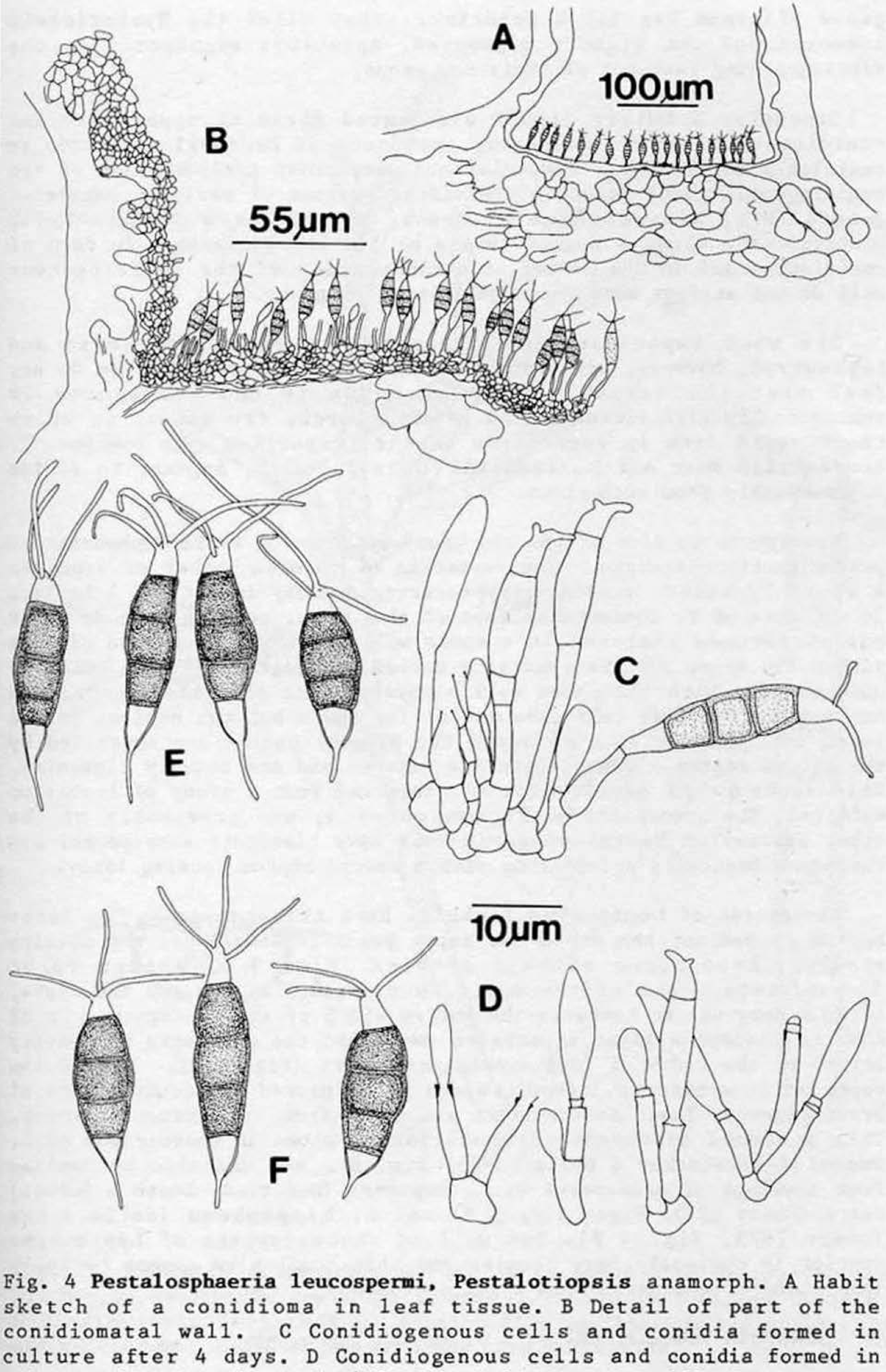


Fig. 4 **Pestalosphaeria leucospermi, Pestalotiopsis** anamorph. A Habit sketch of a conidioma in leaf tissue. B Detail of part of the conidiomatal wall. C Conidiogenous cells and conidia formed in culture after 4 days. D Conidiogenous cells and conidia formed in culture after 1 week. E Conidia from culture. F Conidia from nature. All drawn from the type collection.

genus **Ellurema** Nag Raj & Kendrick. They cited the **Hyalotiopsis** anamorph and the lightly pigmented, spinulose ascospores as the distinguishing features of their new genus.

Shoemaker & Müller (1963) discounted conidial appendages and conidiomatal form in assigning anamorphs of **Broomella** Saccardo to **Pestalotia** de Notaris. Sympodial and percurrent proliferation of the conidiogenous locus occur in individual species of various, unrelated genera (e.g. **Microdochium** H. Sydow, see Müller & Samuels 1984; Diatrypaceae, Glawe & Rogers 1982 a,b; 1986). Variations in form of conidiomata and in the manner of proliferation of the conidiogenous cell do not support more than one teleomorph genus.

The most important differences between **Pestalosphaeria** and **Lepteutypa**, however, are seen in the ascospores. Although we do not feel that the actual number of septa in the ascospores is taxonomically significant at the generic level, the manner in which those septa form in ascospores of the respective type species, **P. concentrica** Barr and **L. fuckelii** (Nits.) Petrak, appears to differ fundamentally from each other.

Ascospores in five of the six known spescies of **Pestalosphaeria** are predominantly biseptate. The formation of an even number of septa in a spore implies a consistently occuring anomaly in nuclear behavior. In the case of **P. concentrica** each of the eight, post meiotic daughter nuclei becomes enclosed in a spore wall. Each nucleus then divides within the spore but the resulting nuclei are segregated into cells of unequal size with the upper cell always smaller than the lower. The nucleus in the upper cell does not divide again but the nucleus in the lower cell divides once more and the progeny nuclei are separated by the second septum. These septa are eusepta and are heavily pigmented. This sequence of development was inferred from a study of herbarium material. The ascospores of **P. concentrica**, and presumably of the other species of **Pestalosphaeria** that have biseptate ascospores, are therefore basically apiosporous with a second septum forming later.

Ascospores of **Lepteutypa fuckelii** have three septa. The first septum is median; the other two septa begin forming later and develop slowly. Ascospores of this species (Fig. 3 C) appear to be distoseptate. All of the septa, but especially the two end septa, often appear not to traverse the entire width of the ascospore. In 3% KOH the endospore layer appears to swell and the end septa may merely extend to the width of that swollen endospore (Fig. 3 C). All of the septa often appear as incomplete and to be marked by accumulations of brown pigment. These observations are drawn from herbarium material. This presumed distoseptate condition is shown in photographs of **L. fuckelii** (Shoemaker & Müller 1965, Fig. 8), and can also be implied from drawings of ascospores of **L. cupressi** (Nattrass, Booth & Sutton) Swart (Swart 1973, Figs. 2 F, 3 F) and **L. hippophaes** (Sollm.) Arx (Swart 1973, Fig. 4 F). The wall of the ascospore of **Lepteutypa** species is obviously very complex and this complexity cannot be fully understood or evaluated with light microscopy alone.

3. **Induratia** Samuels, Müller & O. Petrini, gen. nov.

Stromata dispersa, solitaria, globosa, papilla minuta praedita, perithecium singulum continentia, ex ectostromate entostromateque

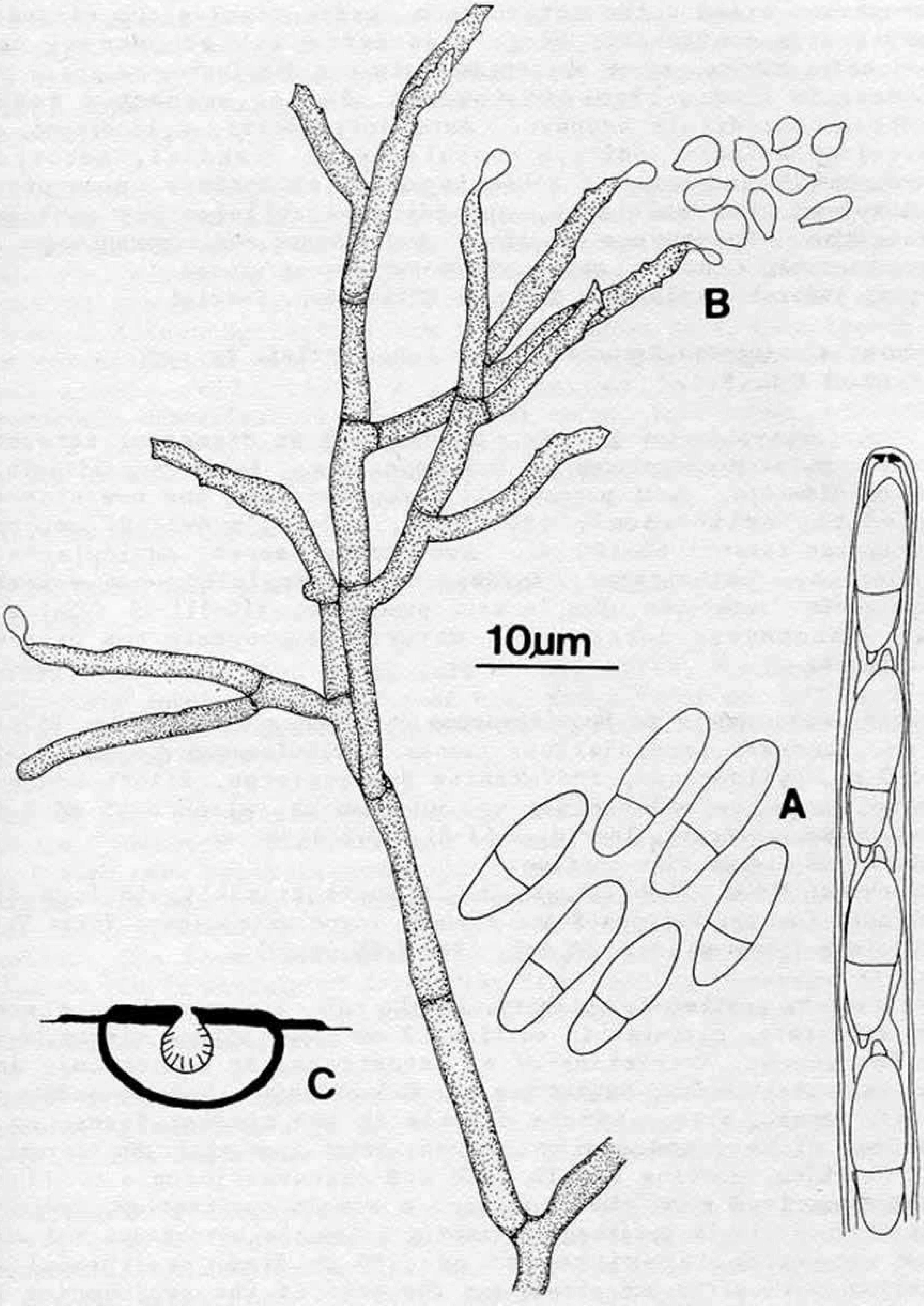


Fig. 5 **Induratia apiospora.** A Part of an ascus with ascospores and discharged ascospores (Melzer's reagent). B Conidiophore and conidia. C Diagrammatic longitudinal section of a perithecium and ectostroma and entostroma. All drawings from the type collection.

composita. Ectostroma valde carbonaceum, nigrum, laeve, superficiale; entostroma etiam valde carbonaceum, parte ligni a quo circumdata perithecium continenti, singulo ascomata sub ectostroma orto. Perithecia minuta, apice ab ectostromate non distincto, relinqua parte libera, in fibris lignosis immersa. Paries ascomatis tenuis, membranacea, dilute brunnea. Asci unitunicati, cylindracei, poro discoideo apicali iodi ope coerulescenti praediti, octospori. Ascosporae uniseriatae, naviculares ad ellipticae, uniseptatae, apiosporae, non coloratae, appendicibus cellularibus amphigenis praeditae. Paraphyses dimorphae, tum ramosae anastomosantesque, tum rare ramosae, septatae, quam anastomosantes crassiores.
Typus: **Induratia apiospora** Samuels, Müller & O. Petrini

Induratia apiospora Samuels, Müller & O. Petrini, sp. nov.
Figs. 1 E-H, 5.

Species typica sui generis. Stromata 2 mm diametro; ectostroma atque cupulatum entostroma ad 0.5 mm crassa. Ascomata solitaria, ad 200 µm diametro. Asci poroapicali discoideo iodi ope coerulescenti praediti, cylindracei, octospori, 120-160 x 4-5(-6) µm, parte ascosporae ferenti 60-100 µm. Ascosporae laeves, naviculares vel ellipticae, uniseptatae, apiosporae, appendicibus non coloratis amphigenis immaturae dum in asci praeditae, (10-)11-13 (-14) x 4-5 µm. Paraphyses inter ascos maturitate provecta tum exsertae, dimorphae.

Status anamorphosis ad **Nodulisporium** pertinens. Conidiophora 95-145 x 3 µm, brunnea, irregulariter ramosa. Cellulae conidiogenae 11-25 x 2.5-3 µm, cylindricae, indistincte denticulatae, dilute brunneae. Conidia anguste ellipsoidea vel subglobosa, plana basi ad 0.5 µm crassa, non colorata, laevia, 4-5(-6) x 2.5-3(-4) µm.
Habitat ad lignum sine cortice.
Holotypus: NOVAE ZELANDIAE, in Insula Septentrionali, in loco dicto Hokianga County, Waipoua State Forest, circa viam dictam Yakas Track, Samuels & Johnston leg., 30 majo 1982 (PDD 44399).

Stromata scattered, solitary, barely raised above the surface of the substrate, circular in outline, 2 mm diam, with a minute papilla in the center, consisting of an ectostroma, an entostroma, and a solitary perithecium. Ectostroma ca. 0.5 mm thick, heavily carbonized, black, smooth, with a minute papilla in the middle; formed on the surface of wood and easily removed intact from wood. Entostroma ca. 0.5 mm thick, growing within wood and circumscribing a portion of nonstromatized wood that contains a single perithecium. Perithecia solitary, a single perithecium forming below the ectostroma and within the entostroma; perithecium ca. 200 µm diam, perithecial apex continuous with the ectostroma but the rest of the perithecium free and embedded within wood fibers; perithecial wall very thin, membranous, light brown; the presence or absence of periphyses in the ostiolar canal could not be confirmed. Asci 120-160 µm total length x 4-5(-6) µm, sporiferous part 60-100 µm, cylindrical, apical ring J+ (Melzer's), discoidal, 2 µm wide x 1 um high; 8-spored, ascospores 1-seriate. Ascospores (10-)11-13(-14) x 4-5 µm, naviculate to ellipsoidal, 1-septate, septum submedian, many spores with a hyaline cellular appendage at each end while still in the ascus, appendage not apparent on discharged ascospores; hyaline, smooth. Paraphyses of two types persisting among mature asci. Paraphyses of Type 1 ca. 1 µm wide, frequently branched and anastomosed through short, lateral bridges, appearing aseptate. Paraphyses of Type 2 ca. 2 µm wide, infrequently branched, septate.

CHARACTERISTICS IN CULTURE. Colonies grown 2 weeks at 20°C diffuse daylight on CMD, PDA and OA 1-1.5 cm diam, flat, white but with brown coloration in the center of some colonies, scant aerial mycelium on CMD and PDA, colony on OA felty. Conidiophores forming abundantly on CMD and OA; PDA colonies remaining sterile. Conidiophores 95-145 x 3 µm, brown, branching irregularly from the upper half, each branch a conidiogenous cell or many branches bearing two conidiogenous cells. Conidiogenous cells 11-25 x 2.5-3 µm, cylindrical, bearing inconspicuous denticles over the terminal third, pale brown. Conidia 4-5(-6) x 2.5-3(-4) µm, narrowly ellipsoidal to subglobose, with a flat, 0.5 µm wide basal abscission scar, hyaline, smooth.

HABITAT. On decorticated wood.

KNOWN DISTRIBUTION. New Zealand (Northland), known only from the type collection.

HOLOTYPE. NEW ZEALAND: North Island, Northland, Hokianga County, Waipoua State Forest, between forest H.Q. and a point ca. 1/2 hr walk N of H.Q. along Yakas Track, on decorticated wood, Samuels & Johnston, 30 May 1982 (PDD 44399).

NOTES. We have not previously encountered such fine paraphyses as are found in **Induratia apiospora** and we were surprised to find them mingled with more typical, wider paraphyses. We were not able to determine whether the two types of paraphyses were connected to the top of the perithecial locule; they were definitely attached to the hymenium. The fine, anastomosing, paraphyses are morphologically similar to the "trabeculate" paraphyses described by Chesters (1938) and Barr (1979) for **Melanomma** Nitschke ex Fuckel and the Melanommatales respectively.

Ascal dehiscence, observed in only few asci, occurred when the endotunica extruded through the ectotunica. Samuels & Rossman (1987) have noted such dehiscence in two species of **Oxydothis** Penz. & Sacc.

Induratia is morphologically somewhat similar to **Exarmidium** Karsten, a genus that Barr & Boise (1985) recently included in the Physosporellaceae (Phyllachorales) and that included some species that have amyloid ascal rings and other species, the asci of which have no apparent reaction to iodine. According to Barr & Boise (1985), ascal dehiscence is accomplished without the extrusion of an endotunica. The clypeus of **Exarmidium** species is soft, and there is no ventral entostroma while in **Induratia** the clypeus is extremely hard and the entostroma is conspicuous. As far as we are aware no species of **Exarmidium** have been cultured and no anamorphs have been linked to the genus. We doubt that there is a close relationship between **Induratia** and **Exarmidium**.

Induratia shares characters of the Xylariaceae and the Amphisphaeriaceae (sensu lat.). Its amyloid ascal ring and holoblastically produced conidia are common to both families. The **Nodulisporium** anamorph and heavily carbonized stroma are features of the Xylariaceae. The immersed perithecia, the presence of an ectostroma and an entostroma, and the colorless, bicellular ascospores are features of the Amphisphaeriaceae. **Induratia** is atypical in either family, but it has more in common with the genera of the Amphisphaeriaceae than with the much more homogeneous Xylariaceae. Pending a more thorough review of the Amphisphaeriaceae, we refer **Induratia** to that family.

The anamorph of **Induratia apiospora** is very similar to the **Nodulisporium** Preuss anamorphs formed by members of the Xylariaceae. There is an anamorph abundantly formed on the type specimen of **I. apiospora**. Conidiophores and conidiogenous cells are identical to those formed in cultures of **I. apiospora** but the conidia are lunate and short. The similarity of the conidiophores and the physical relationship of this anamorph to ascomata of **I. apiospora** suggest a genetic relationship that cannot be excluded in spite of the differences in the conidia. The formation of lunate conidia of **I. apiospora** would be consistent with what Samuels & Rossman (1987) have already described for **Oxydothis selenosporellae** Samuels & Rossman, and with what we have described below for species of **Iodosphaeria.**

4. **Iodosphaeria** Samuels, Müller & O. Petrini, gen. nov.

Ascomata solitaria vel gregaria, nonstromatica, superficialia, in reptanti diffusa rete crassitunicatarum brunnearum hypharum insita, nigra, apice plano radiatis nonnullis brunneis, eramosis flexuosisque filamentis e cellulis superficialibus perithecii orientibus ornato. Paries ascomatis crassa, e duobus stratis composita, ostiolum e cellulis valde coloratis in parte exteriori compositum, periphysatum. Asci clindracei vel anguste clavati, unitunicati, apice simplice vel poro discoideo iodi ope coerulescenti praediti, octospori. Ascosporae uniseriatae vel biseriatae, allantoideae, unicellulares, laeves, non coloratae. Paraphyses longiores ascis, cellula basali inflata, aetate provecta dirumpentes.
Typus: **Iodosphaeria phyllophila** (Mouton) Samuels, Müller & O. Petrini.

Iodosphaeria phyllophila (Mouton) Samuels, Müller & O. Petrini, comb. nov. Figs. 6-8.
$\equiv$ **Lasiosphaeria phyllophila** Mouton, Bull. Soc. Roy. Bot. Belg. 34: 48. 1900.

Synanamorphs. **Selenosporella** sp. and **Ceratosporium** sp.

Perithecia solitary to gregarious, nonstromatic, superficial and easily removed from the substrate, associated with a repent, spreading network of coarse brown hyphae; consisting of a 400-500 µm diam, nonpapillate black body with a flat top from which radiate numerous long, flexuous, brown, unbranched hairs. Perithecial wall 55-60 µm wide, comprising two regions. Outer region 40-50 µm wide, cells angular, 10-15 µm in greatest dimension, walls 0.5-1 µm thick, pigmented, exposed walls of cells at the exterior heavily pigmented. Inner region 10-15 µm wide, cells flattened, ca. 15 µm long x 2-3 µm wide, walls 1.5 µm thick, nonpigmented. Cells of the perithecial apex

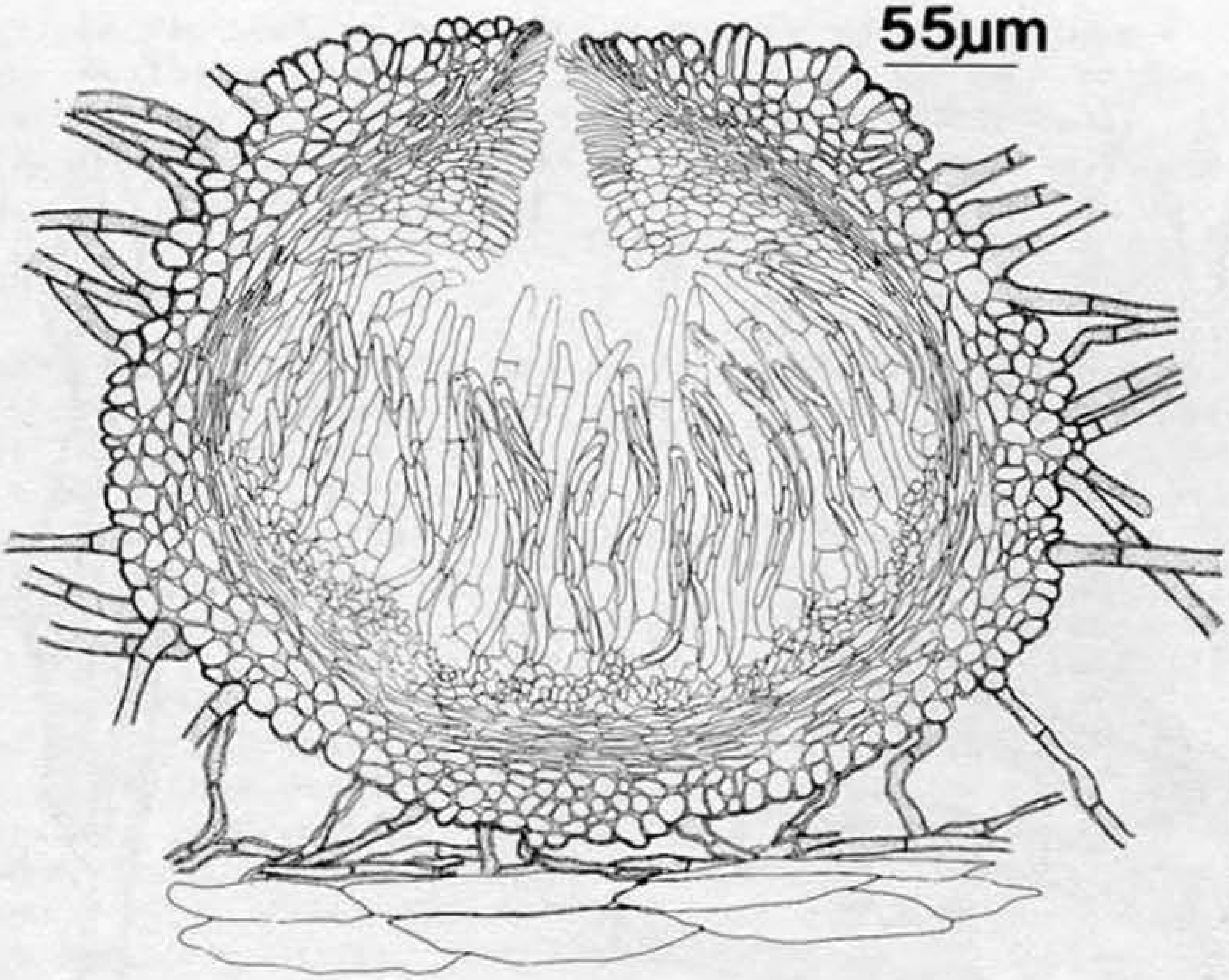
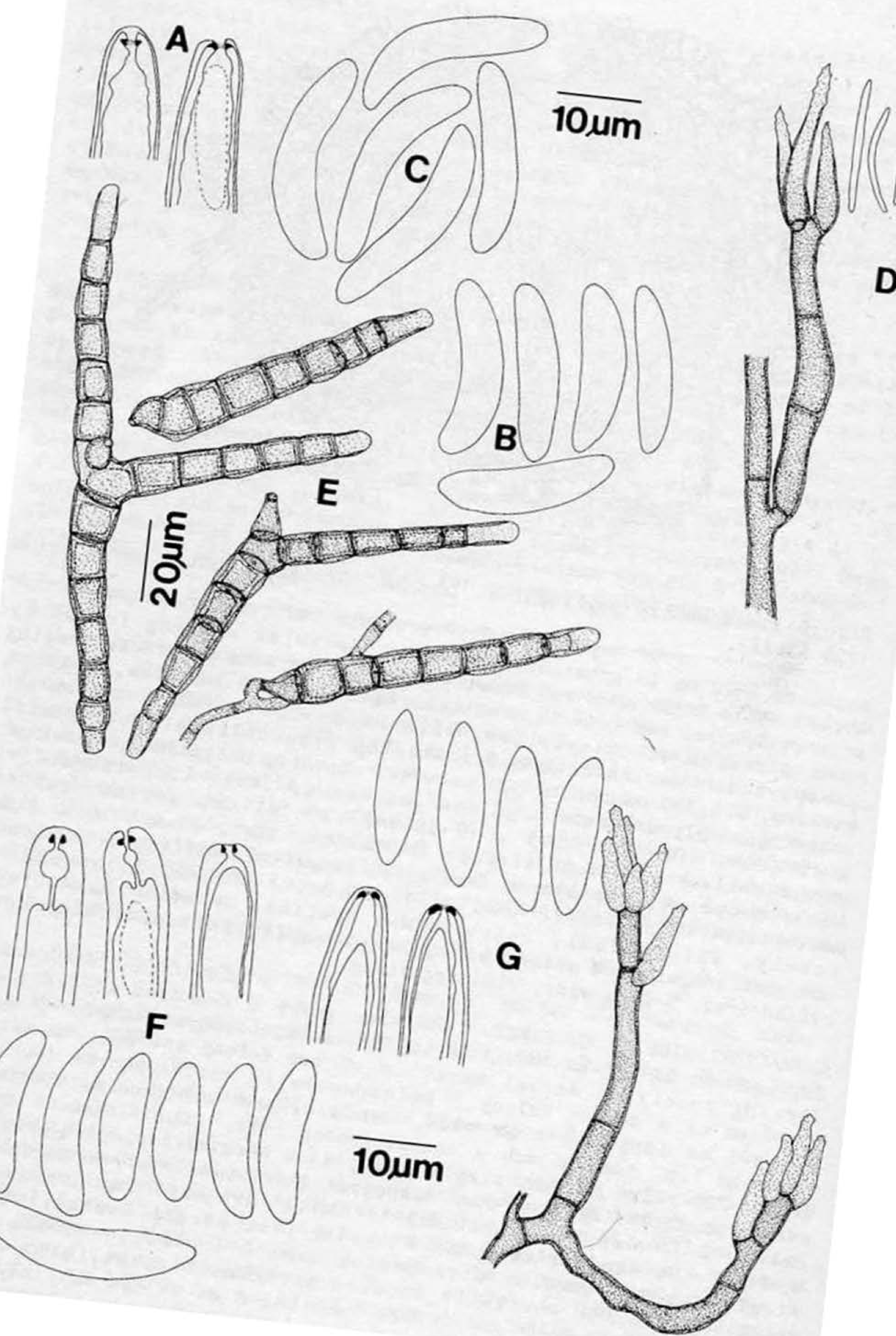


Fig. 6 **Iodosphaeria phyllophila.** Section through a mature perithecium (PDD 32622).

angular, 8-10 µm in greatest dimension. Ostiolar opening formed by hyphal cells 3 µm wide and heavily pigmented at the exterior, merging with periphyses and colorless within; periphyses 3 µm wide, arising from a tissue of thin-walled, colorless cells and distinct fom the paraphyses. Perithecial hairs arising from cells at perithecial surface, 500-700 µm long x 5-7 µm wide, septate, unbranched, flexuous, standing singly or loosely joined into long, tooth-like fascicles. Asci (90-) 105-138(-152) x (9-)9.8-12.2(-14) µm, cylindrical to narrowly clavate, apical ring J+ (Melzer's), flat, 2 µm wide x 1 µm high; 8-spored, ascospores 2-seriate, completely filling each ascus. Ascospores (16-)21-26.7 (-31) x (4-)4.2-5.3(-6) µm, allantoid or rarely, ellipsoidal, unicellular, hyaline, smooth. Paraphyses somewhat longer than mature asci, basal cells swollen, cells above cylindrical, 5-7 µm wide, disintegrating.

CHARACTERISTICS OF CULTURES. Colonies grown 6 weeks at 20°C diffuse daylight on OA 2-3 mm diam, aerial mycelium cottony, black. Conidia forming poorly in aerial mycelium of one colony and well in aerial mycelium of a second colony. **Selenosporella** conidiophores (40-)60-70(-80) µm long x 5-8 µm wide, septate, brown, branching sparingly from the tip, each branch a conidiogenous cell. Conidiogenous cells 14-20(-30) x 3-4 µm, tapering slightly from base to tip, with obscure, minute denticles arising from the upper quarter of each conidiogenous cell. **Selenosporella** conidia 13-19(-24) x 1 µm, linear, aseptate, hyaline. **Ceratosporium** conidia arising from aerial hyphae, with a single arm and usually attached or with 2-3 arms, then the arms radiating from the centrally located attachment point, arms 70-93 (-175) µm long x 9-14 µm at the base x 5-8 µm at the tip; septate, each septum with a central pore; brown, often with a subglobose to conical cell at the point of attachment, dehiscence scar circular, 3-4 µm diam.


A
C
10µm
D
B
E
20µm
G
F
10µm

HABITAT. In New Zealand commonly found on rachis of the tree fern **Cyathea dealbata** (Forst. f.) Swartz; found once each on **Gahnia** sp. (Cyperaceae) and **Ripogonum scandens** Forst. (Smilacaceae). In South America, Britain and Europe found on herbaceous debris in general.

KNOWN DISTRIBUTION. New Zealand, Brazil, French Guiana, Great Britain, Belgium.

SPECIMENS EXAMINED. BRAZIL: Estado do Amazônas, Pico Rondon, upper vine forest immediately below summit, on rachis of **Cyathea** sp., Samuels 147, 4 Feb 1984 (INPA, NY); second collection, same data, Samuels 132a (NY). FRENCH GUIANA: ca. 7 km SW of Saül, on the trail to Mt. Galbao, "Cambrouze," 200-300 m, on decaying dicot. leaves, Samuels 3704, 11-13 Feb 1986 (NY). NEW ZEALAND: North Island, Northland, Hokianga County, Omahuta State Forest, picnic area along road to kauri reserve, on **Cyathea dealbata**, Samuels (82-231), Hawthorne, Johnston & Petersen, 1 Jun 1982 (PDD 43185, NY); Auckland, Rodney County, Atuanui State Forest, Mt. Auckland, vic. Glorit, on rachis of **Cyathea dealbata**, Samuels 73-260, 17 Nov 1973 (PDD 32622); Auckland, N. of Warkworth, Dome Valley Reserve, on rachis of **Cyathea dealbata**, Samuels, Watt & Deitz, 29 Apr 1975 (PDD 36843); Auckland, Waitemata City, Waitakere Ranges, four collections on rachis of **Cyathea dealbata**, Samuels (PDD 36844, 40222, 41795, 45501); Waitakere Ranges, Piha Rd., Cowan Track, on flowering stalk of **Gahnia** sp., Samuels (83-126) & Rossman, 4 Jun 1983 (PDD 46308); North Island, Waikato, vic. Te Awamutu, Mt. Pirongia, track from O'Shea's Rd to Pirongia Trig, on rachis of **Cyathea dealbata**, Samuels (80-31) & Kendrick, 7 Feb 1980 (PDD 40408).

NOTES. **Iodosphaeria phyllophila**, as it is found in New Zealand, conforms to the redescription of **Lasiosphaeria phyllophila** provided by Dennis (1974, 1978). Spores of two collections made from **Cyathea** sp. in Brazil (Samuels 132a, 147) and one made from **Gahnia** sp. in New Zealand (PDD 46308) were slightly broader than spores in the New Zealand collections from **Cyathea**. One additional collection from New Zealand (PDD 35307, on **Ripogonum scandens**) differed from other collections of the species in having ellipsoidal ascospores that were shorter and broader (19-23 x 5.5-6.5 µm) than ascospores from other collections. This collection on **Ripopgonum** may represent a distinct taxon.

Ellis & Ellis (1985) have illustrated this species (as **Lasiosphaeria phyllophila**) and recorded it from fallen dead twigs and debris of **Acer**, **Populus** and **Salix**.

Fig. 7 **Iodosphaeria phyllophila.** A Two ascal apices from Brazil (Melzer's reagent, Samuels 147). B Ascospores from Brazil (Samuels 147). C Ascospores from New Zealand (PDD 40408). D **Selenosporella** conidiophores and conidia from New Zealand, drawn from culture (PDD 43185). E **Ceratosporium** conidia from New Zealand, drawn from culture (PDD 43185). F Three ascal apices and ascospores from **Gahnia** in New Zealand (Melzer's reagent, PDD 46308). G Two ascal apices, ascospores and **Selenosporella** conidiophores from **Ripogonum** in New Zealand (Melzer's reagent, PDD 35307).

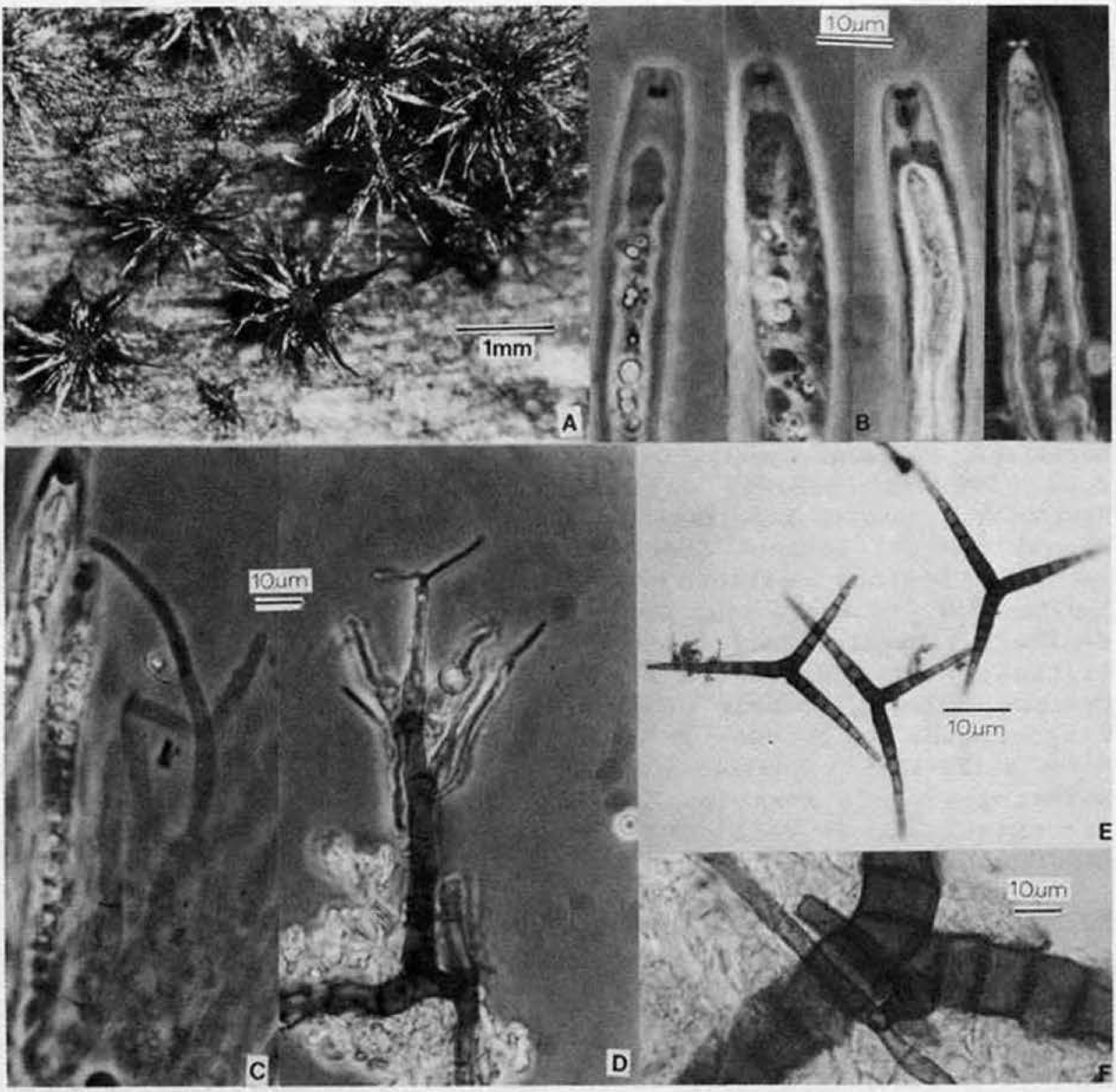


Fig. 8 **Iodosphaeria phyllophila.** A Several perithecia as viewed from above (PDD 32622). B Apices of four asci, the ascus on the right in Melzer's reagent and observed in darkfield phase contrast microscopy (Samuels 147); all others in KOH and observed with brightfield phase contrast microscopy (PDD 40222). C Asci and paraphyses (PDD 40222). D **Selenosporella** conidiophore (PDD 40222). E **Ceratosporium** conidia (PDD 43185). F **Ceratosporium** conidium showing point of attachment to the subtending hypha (Samuels 147).

5. **Iodosphaeria ripogoni** Samuels, Müller & O. Petrini, sp. nov. Figs. 9, 10 A-C.

Constitutione typica sui generis. Ascomata 400-500 µm diametro, paries ascomatis ad 80 µm crassa, e duobus stratis composita; exteriori ad 65 µm crasso, cellulis angularibus 10-15 µm dimensione maxima, pariete 1 µm crassa, colorata; interiori ad 25 µm crasso, cellulis fusoideis in sectione sagittali, 20-25 x 5-6 µm mensis, non coloratis composito. Filamenta ascomatis e cellulis superficialibus orientia, 200-300 x 8 µm, septata, eramosa, flexuosa, singula vel laxe fasciculata. Asci cylindracei, aetate provecta erumpentes, apice iodi ope non coerulescenti ac poro non praediti, octospori, (120-)140-

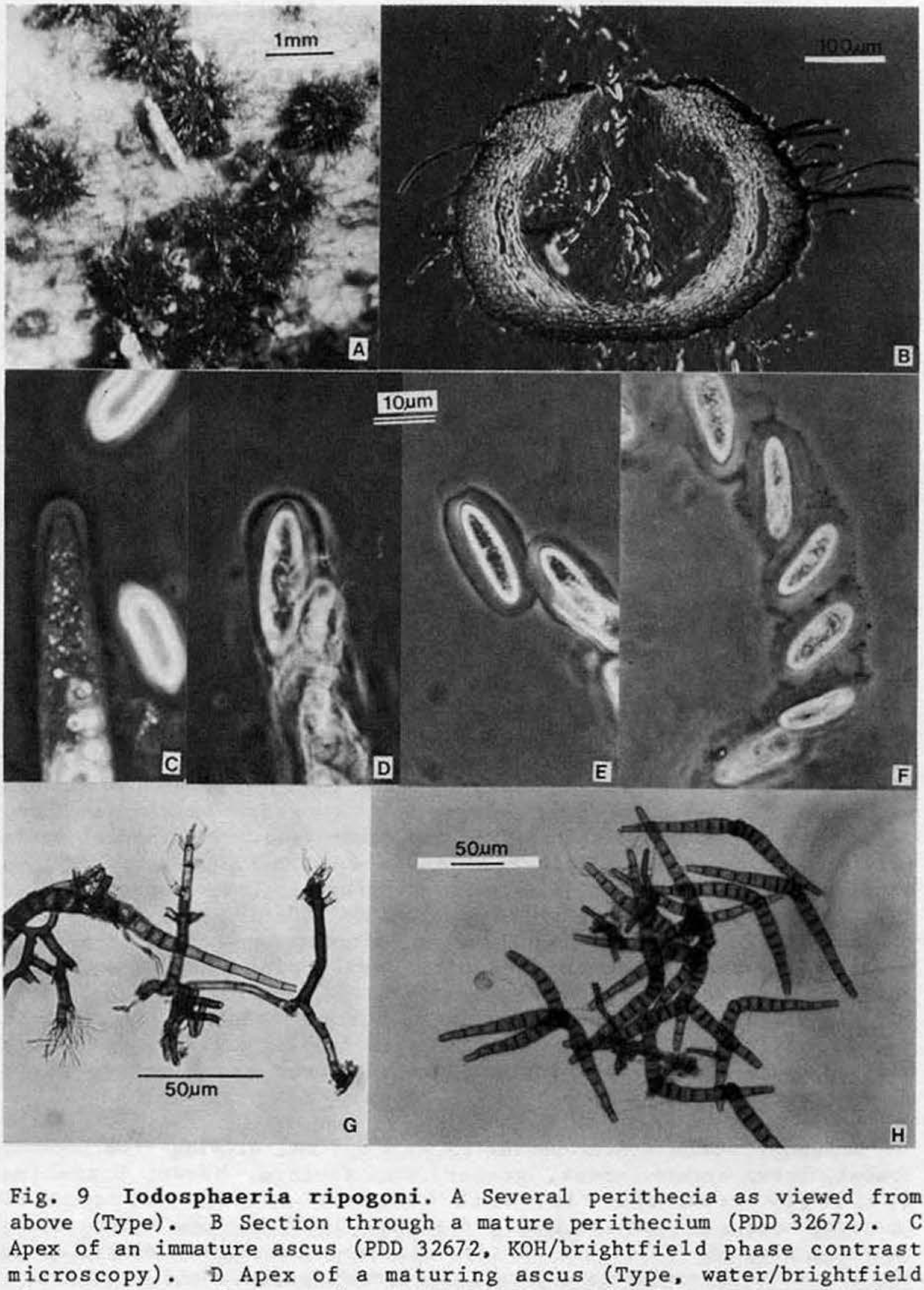


Fig. 9 **Iodosphaeria ripogoni.** A Several perithecia as viewed from above (Type). B Section through a mature perithecium (PDD 32672). C Apex of an immature ascus (PDD 32672, KOH/brightfield phase contrast microscopy). D Apex of a maturing ascus (Type, water/brightfield phase contrast microscopy). E Mature ascus showing ascal apex (PDD 32672, water/brightfield phase contrast microscopy). F Mature ascus with wall disintegrating and each ascospore surrounded by a sheath (PDD 32672, water/brightfield phase contrast microscopy). G **Selenosporella** synanamorph (Type). H **Ceratosporium** synanamorph (Type).

185(-200) x (9-)11-15 µm. Ascosporae uniseriate, totum ascum implentes, elliposoideae, unicellulares, noncoloratae, dum in asco vagina mucosa 5 µm crassa praeditae, laeves, (19-)21.5-26(-29) x (7-)7.2-8.5(-9) µm. Paraphyses anastomosantes, inter maturos ascos subsistentes.

Status anamorphosis **Selenosporellae** conidiophoris brunneis, septatis, erectis, gregariis, minime apicaliter ramosis, 65-95 x 5-7 µm; cellulis conidiogenis minutos denticulos in parte suprema forentes, 10-15 x 4 µm; conidiis linearibus, continuis, non coloratis, 12-20 x 1 µm. Status anamorphosis **Ceratosporii** conidiis biradiatis ramis 95-120 µm longis, 14-16 µm ad basim, 5-8 µm ad apicem crassis, septatis.
Habitat in caulibus lignosis **Ripogoni scandentis.**
Holotypus: NOVAE ZELANDIAE: ad **Ripogonum scandens,** in insulis dictis Chatham, in loco dicto Taiko Camp, McKenzie leg. 8 martio 1983 (PDD 47872).

Synanamorphs. **Selenosporella** sp., **Ceratosporium** sp.

Perithecia solitary to gregarious, nonstromatic, superficial and easily removed from the substrate, associated with a repent, spreading network of coarse brown hyphae; consisting of a 400-500 µm diam, nonpapillate black body with a flat top from which radiate numerous long, flexuous, brown, unbranched hairs. Perithecial wall ca. 80 µm wide, comprising two distinct regions. Outer region ca. 65 µm wide, cells angular, 10-15 µm in greatest dimension, walls 1 µm thick, pigmented, exposed walls at the exterior heavily pigmented. Inner region ca. 25 µm wide, cells fusoid in section, 20-25 µm long x 5-6 µm wide, walls 1 µm thick, nonpigmented. Cells of the perithecial apex angular, 8-15 µm in greatest dimension, walls 1-1.5 µm thick. Ostiolar opening formed by hyphal cells, 4 µm wide and heavily pigmented at the exterior, merging with periphyses and colorless within; periphyses 3 µm wide, arising from a tissue of thin-walled, colorless cells and distinct from the paraphyses. Perithecial hairs arising from cells at perithecial surface, 200-300 µm long x 8 µm wide, septate, unbranched, flexuous, standing singly or loosely joined into long, tooth-like fascicles. Asci (120-)140-185(-200) x (9-)11-15 µm, broadly cylindrical, dissolving at maturity, apex lacking a ring; 8-spored, ascospores uniseriate with overlapping ends, completely filling each ascus. Ascospores (19-)21.5-26(-29) x (7-)7.2-8.5(-9) µm, ellipsoidal, unicellular, with a 5 µm broad sheath while still in the ascus, hyaline, smooth. Paraphyses forming a branching network with synapsis-like areas joining filaments, found among mature asci; disintegrating.

Selenosporella conidiophores 65-95 x 5-7 µm, arising from repent, coarse, brown hyphae, erect, gregarious, septate, brown, branching sparingly from the tip, each branch a conidiogenous cell. Conidiogenous cells penicillately disposed, 10-15 µm long x 4 µm wide, tapering slightly from base to tip, with obscure, minute denticles on the tip of each conidiogenous cell. **Selenosporella** conidia 12-20 x 1 µm, linear, aseptate, hyaline. **Ceratosporium** conidia arising directly from coarse, brown, repent hyphae; conidiophores lacking; primarily biradiate, basal cell integrated and attached to the hypha at the midpoint where the two arms meet, rarely with only a single arm and then basally attached; conidial arms 95-120 x 14-16 µm at the base x 5-8 µm at the tip, multiseptate, brown.

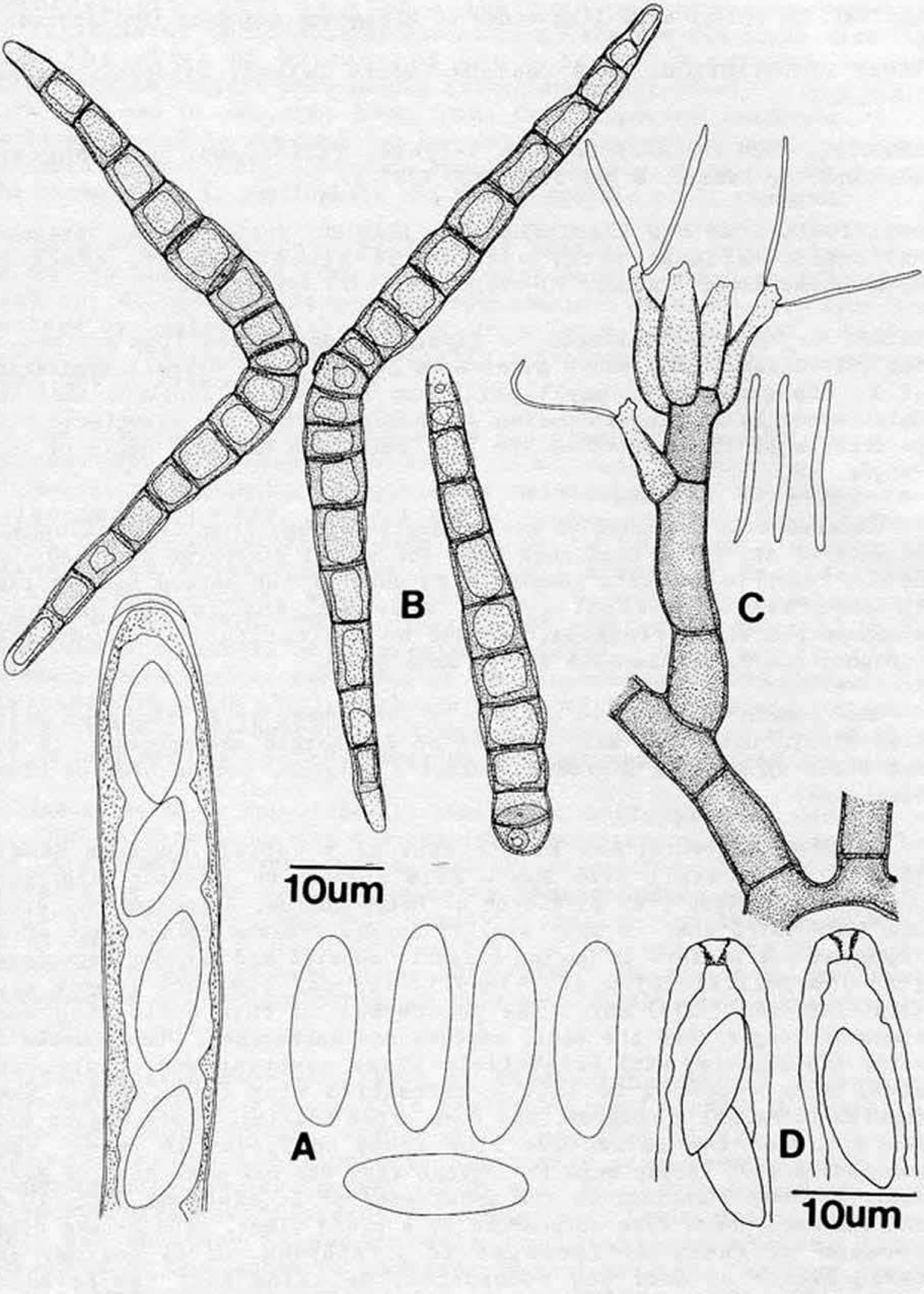


Fig. 10 A-C **Iodosphaeria ripogoni.** A Ascus and ascospores (Melzer's reagent). B Three **Ceratosporium** conidia. C **Selenosporella** conidiophore and conidia. D **Iodosphaeria** sp. from Hawaii. Two ascal apices with refractive, J- rings (water; brightfield phase contrast microscopy). A-C drawn from the type collection of **I. ripogoni**, D from Carpenter No. 4.

HABITAT. On woody, vine-like stems of **Ripogonum scandens** (Smilacaceae).

KNOWN DISTRIBUTION. New Zealand (North Island: Taranaki, Chatham Islands).

HOLOTYPE. NEW ZEALAND: Chatham Islands, Taiko Camp, on **Ripogonum scandens**, Mc Kenzie, 8 Mar 1983 (PDD 47872).

ADDITIONAL SPECIMEN EXAMINED. NEW ZEALAND: North Island, Taranaki, Mt. Egmont National Park, vic. North Egmont Chalet, track to Waiwhakaiho River, Samuels 73-226, 1 Oct 1973 (PDD 32672).

NOTES. We have not cultured **I. ripogoni**; ascospores from neither of the collections cited above germinated on CMD. The overall similarity of **I. ripogoni** to **I. phyllophila** has lead us to conclude that the **Selenosporella** and **Ceratosporium** synanamorphs that are associated with perithecia of **I. ripogoni** on the host belong to the life cycle of that fungus.

Iodosphaeria ripogoni is easily distinguished from **I. phyllophila** because of its broad asci that lack any apical discharge ring and that do not react to Melzer's reagent. Because of the marked similarities in perithecial morphology and anatomy, and in the presumed synanamorphs of **I. ripogoni**, we have no hesitation in including **I. ripogoni** and **I. phyllophila** in the same genus.

The sheath that was so obvious on ascospores of **I. ripogoni** still held within the ascus was not seen on discharged ascospores. It did not stain in aqueous Nigrosin, Melzer's reagent, cotton blue or blue-black ink.

Dr. S.E. Carpenter has kindly sent us a collection from Hawaii [Kauai, Pihea trail from Puu o Kila lookout to junction with Pihea lookout. 4000-4100', on mistletoe on **Metrosideros**, Carpenter No. 4, 20 Nov 1985 (NY)] that is very similar to New Zealand collections of **I. ripogoni** but differs in having slightly shorter and broader ascospores [(18-)18.5-21.2(-26) x (7.2-)8-9.5(-10) μm] and much longer asci [(154-)187-265 (-273) μm]. The paraphyses in this collection were somewhat longer than the asci, septate and unbranched. When mounted in water and observed with brightfield phase contrast microscopy, the ascal apex appeared to have a refractive ring (Fig. 10 D). When mounted in Melzer's reagent, and even after boiling, there was no blue reaction and the refractive ring could no longer be seen. When mounted in 100% lactic acid the apical ring was not seen and the ascal apex appeared identical to the ascal apex of **I. ripogoni** (Fig. 10 A) and the ascospores were surrounded by a broad clear, sheath-like area. Because of these differences in paraphyses, ascal anatomy and measurements of asci and ascospores, we think that the Hawaiian collection represents a distinct taxon. However, it is immature; after several attempts we found only one perithecium with some discharged ascospores. We found neither a **Selenosporella** nor a **Ceratosporium** anamorph on this specimen.

The **Selenosporella** and **Ceratosporium** synanamorphs of **I. phyllophila** found in nature were identical to those found in culture. Naturally formed conidiophores of the **Selenosporella** stand erect from the coarse brown hyphae that radiate over the surface of the substrate.

Ceratosporium conidia also arise from the brown hyphae but differentiated conidiophores are lacking; the conidia arise directly from the sides of hyphae and are repent. Naturally formed **Ceratosporium** conidia were mainly triradiate; only rarely were conidia with only one or two arms seen. The **Ceratosporium** anamorphs of **I. phyllophila** and **I. ripogoni** can be distinguished by the number of arms posessed by the conidia of each species, usually three in conidia of the anamorph of **I. phyllophila** and two in conidia of **I. ripogoni.**

No species of **Ceratosporium** has previously been linked to a teleomorph and the two anamorphs reported herein cannot be identified with any of the **Ceratosporium** species that were reported from New Zealand by Hughes (1964), all of which were lignicolous. Hughes (1964) did describe a **Selenosporella** synanamorph with **C. fuscescens** Schw. and **C. rilstonii** Hughes.

The anamorph genus **Selenosporella** has previously been listed as a synanamorph with anamorph fungi that bear greater or lesser morphological similarity to species of **Ceratosporium. Teratosperma oligocladium** Uecker, Ayers & Adams (Uecker et al., 1980) produces brown, septate stauroconidia with from one to four arms. Conidia of **Laterispora brevirama** Uecker, Ayers & Adams and **Sporidesmium sclerotivorum** Uecker, Ayers & Adams are brown and phragmosporous (Uecker et al., 1978, 1982). These three species are reported to be parasitic on sclerotia of **Sclerotinia** species. What is possibly a **Selenosporella** species was given as the synanamorph of **Endophragmiella africana** Kirk (Kirk 1982), although the denticles on the conidiogenous cells of this **Selenosporella**-like synanamorph are much coarser than any we have seen in the **Ceratosporium** synanamorphs described herewith.

Iodosphaeria is superficially similar to **Lasiosphaeria** Ces. & de Not. but differs in having the combined characters of **Selenosporella** and **Ceratosporium** synanamorphs, and the tendency to form an amyloid apical ring in the ascus. The genus **Lasiosphaeria** is in taxonomic disarray; the anamorphs most commonly ascribed to the genus have phialides (Gams & Holubová-Jechová 1976), and there is a well developed, nonamyloid ring in the ascal apex. We do not believe that **Iodosphaeria** and **Lasiosphaeria,** in this more strict sense, are closely related.

Iodosphaeria may be related to **Phaeotrichosphaeria** Sivanesan (Sivanesan 1983), a genus that has been linked to **Endophragmiella** Sutton (see Hughes 1979). Hughes (1979) and Kirk (1982) have found **Selenosporella** conidiophores associated with conidiophores of **Endophragmiella** species. Hughes (1979) also found **Endophragmiella** and **Selenosporella** conidiophores associated with **Lasiosphaeria punctata** Munk, and he found **Selenosporella** conidiophores arising from ascospores of **Lasiosphaeria canescens** (Pers.) Karsten. We have grown **L.** cf. **canescens** (PDD 44553) and **L.** cf. **punctata** (PDD 44554) from ascospores of New Zealand and Japanese collections respectively. **Endophragmiella** conidia formed in the cultures but we did not note **Selenosporella** synanamorphs. Both of these species of **Lasiosphaeria** are referable to **Phaeotrichosphaeria.** Sivanesan (1983) found **Endophragmiella** anamorphs associated with **Phaeotrichosphaeria indica** Sivanesan, **P. hymenochaeticola** Sivanesan, and **P. brittanica** Sivanesan. **Lasiosphaeria caesariata** (Clinton & Peck in Peck) Sacc. and **L. triseptata** Shoemaker & White, both of which have **Sporidesmium** Link anamorphs (Shoemaker & White 1985) may also belong in this series.

There is no direct evidence linking **Endophragmiella**, **Selenosporella** and **Phaeotrichosphaeria**, but there is strong indirect evidence in the case of **Lasiosphaeria canescens** (see above). Given the interrelationship of these fungi, then the conidia of **Endophragmiella/Phaeotrichosphaeria** species can be equated with the conidia of **Ceratosporium/Iodosphaeria** species. **Phaeotrichosphaeria** and **Iodosphaeria** are also similar in the anatomy of their setose perithecia, and in usually having unicellular ascospores. The asci of the known species of **Phaeotrichosphaeria** lack an apical ring, or when there is a ring, it is inconspicuous and nonamyloid.

ANAMORPHS AND TAXONOMY OF THE AMPHISPHAERIACEAE (SENS. LAT.)

The Amphisphaeriaceae (Sphaeriales), in its broadest sense (Müller & Arx 1962) is usually negatively defined to include all the nonxylariaceous and nondiatrypaceous fungi that have an amyloid apical ring in their asci. The familial concept has been refined by Barr (1975, 1976) and Krug (1977) on perithecial characters.

Unfortunatly very few species of the family, in its broadest sense, have been linked to anamorphs (see reviews in Barr 1975, Brockmann 1975, Nag Raj & Kendrick 1985). **Amphisphaeria umbrina** (Fr.) de Not., the type species of the family, has not been linked to an anamorph and no species of **Amphisphaeria** has been unequivocally linked to an anamorph through pure culture techniques. We have grown two New Zealand collections of **Amphisphaeria multipunctata**[1] (Fuckel) Petrak (PDD 36845, 36846) from ascospores; both isolates produced perithecia on sterilized apple twigs but neither formed an anamorph. This is not surprising as other members of the Amphisphaeriaceae (e.g. **Cainia** Arx & Müller, **Leiosphaerella** Höhnel) have failed to form anamorphs in culture. Nag Raj (1977) found pycnidia of **Bleptosporium pleurochaetum** (Speg.) Sutton intimately associated with perithecia of **A. argentinensis** Nag Raj, a species that he considered to be closely related to **A. umbrinum**.

One consequence of this general lack of information about anamorphs in the Amphisphaeriaceae is that clues manifested by anamorphs and used to clarify the taxonomy of other orders of ascomycetes (e.g. see Hughes 1976, Samuels & Rossman 1979, Samuels & Seifert, In press) are not available for an assessment of amphisphaeriaceous species. In the present series of papers (Samuels et al. 1987, Samuels & Rossman 1987 and herewith) we have documented anamorph-teleomorph connections for several amphispheriaceous ascomycetes. From these observations and from previously published work (Glawe & Rogers 1982a,b; 1986 and summaries in Rogers 1979, Barr 1975, Brockmann 1975, Nag Raj & Kendrick 1985) the anamorphs indicate at least two lines of development among the teleomorphs. Conidia produced holoblastically on sympodially proliferating cells are common to both lines.

The first line is characterized by **Pestalotiopsis** and similar anamorph genera, all anamorphs of a closely-knit group of teleomorph

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[1] **"Amphisphaeria millepunctata"** (Fuckel) Petrak and the so-called basionym, **"Diaporthe millepunctata"** Fuckel, that Petrak published (Ann. Mycol. 21: 329. 1923) were in error and the erroneous spelling has been perpetuated. The original spelling reads: **Diaporthe multipunctata** Fuckel, Jahrb. Nassauischen Ver. Naturk. 27/28: 37. 1873.

genera that includes, among others, **Pestalosphaeria, Lepteutypa, Discostroma** and **Broomella.** If, as surmised by Nag Raj (1977), **Amphisphaeria argentinensis** is closely related to **A. umbrinum** and indeed has **Bleptosporium pleurochaetum** as its anamorph then it fits into this group and this group could be more precisely defined as the Amphisphaeriaceae (sensu str.). These fungi are plant parasites, mostly found within spots on leaves of dicotyledonous plants, less frequently on woody substrates. Conidiomata are formed and are acervular or pycnidial. Conidiogenous cells are phialides that do not proliferate, or that proliferate percurrently giving a conspicuously annellate aspect. Conidia of most of the anamorph genera in this group are pigmented and often versicolorous, transversely septate, and variously appendaged. "Spermatia" produced holoblastically on sympodially proliferating conidiogenous cells are found in conidiomata of the **Seiridium** anamorph of **Lepteutypa cupressi** (Swart 1973). Shoemaker & Müller (1963) found morphologically similar conidia in cultures of **Broomella** species (anamorph = **Pestalotia**) but the method of production was not described.

Perithecia in this first line are immersed, nonstromatic and clypeate or nonclypeate. The perithecial wall is narrow and comprises cells that are elliptical in section. Paraphyses are unbranched and are apparently apically free throughout their development. The ascal apex has a conspicuous amyloid ring (except for species of **Broomella,** where the apical ring is nonamyloid) and the ascospores are usually septate and are often pigmented.

If the Amphisphaeriaceae is thus narrowly defined, there remain several genera that will have to be redisposed in new or existing families. These genera include, among others, **Cainia, Oxydothis** Penz. & Sacc., **Leiosphaeriella** Petrak, **Monographella** Petrak, **Induratia, Iodosphaeria, Collodiscula** and **Pseudomassaria** Jacz. These fungi are loosely united by a tendency to form an amyloid apical ring in the ascus, and to have conidia produced holoblastically on sympodially proliferating conidiogenous cells.

ACKNOWLEDGEMENTS

Research was support in part by grants to the senior author from the National Science Foundation (BSR 8300236) and the National Geographic Society (NGS 2736-83). Samuels' field work in Brazil was also supported by a National Science Foundation grant to the New York Botanical Garden (Projeto Flora Amazonica). Dr Ian Hallett (Plant Diseases Division, DSIR, Auckland) prepared the scanning electron micrographs. We appreciate the comments of Drs Margaret Barr, Jack Rogers and Clark Rogerson. Dr Barr called our attention to the correct spelling of **Amphisphaeria multipunctata.** Dr Steven Carpenter (Oregon State University) collected **Iodosphaeria** cf. **ripogoni** in Hawaii with support from National Science Foundation grant BSR 8500434.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 501-507 April-June 1987

COPROBIA CRASSISTRIATA SPEC. NOV. AND THE RIB-LIKE PERISPORIAL ASCOSPORE STRIATION OF COPROBIA PROVED BY SEM.

JIŘÍ MORAVEC

Sadová 21/5, č.336, 679 04 Adamov u Brna, Czechoslovakia

ABSTRACT

Coprobia crassistriata spec. nov., a new coprophilous discomycete (*Pezizales*, *Pyronemataceae*), collected in Bohemia, Czechoslovakia, is described and illustrated by line drawings and SEM photomicrographs. The SEM photomicrographs have confirmed the rib-like character of the perisporial ascospore striation in *Coprobia*.

The author has revised the type of *Ascophanus flavus* Karst. (= *Coprobia flava* (Karst.) Thind et Kaushal), containing several discomycetes.

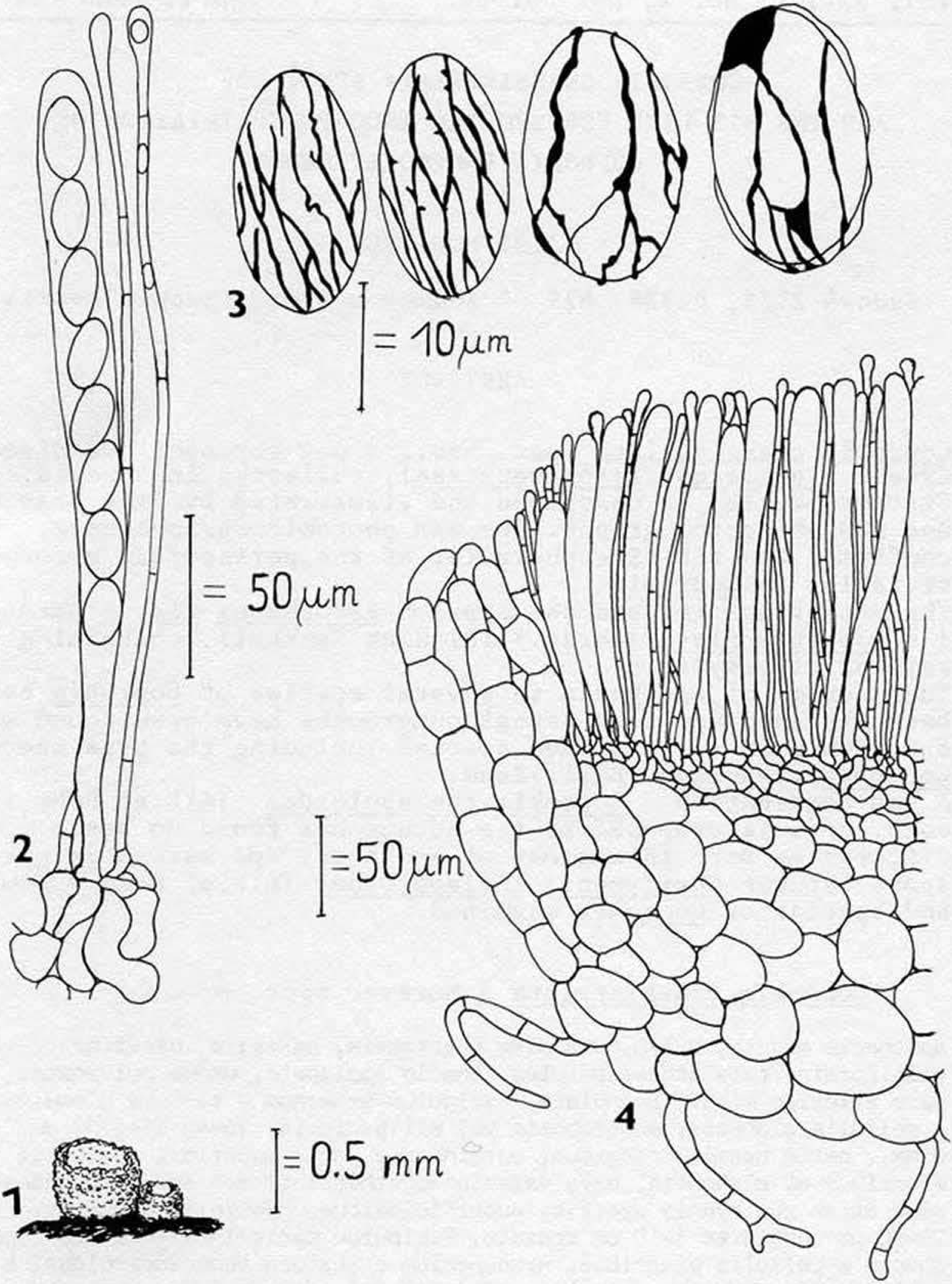
The anatomy of apothecia in several species of *Coprobia* has been examined and rare hyphal outgrowths have been found by the author in all examined species including the type species *Coprobia granulata* (Bull.)Boud.

A new combination - *Coprobia theleboloides* (Alb.et Schw.) comb. nov. is proposed as the author has found no basic differences both in anatomy of apothecia and ascospore perispore between *Cheilymenia theleboloides* (Alb.et Schw.) Boud. and species of *Coprobia* examined.

Coprobia crassistriata J.Moravec spec. nov.

Apothecia minuta, 0.3-0.8 mm diam., gregaria, sessilia, breviter crasse doliiformia, tota ochraceo-lutea, thecio applanato, usque pulvinato, pars exterior minute granulata. Excipulum externum e textura globulosa e cellulis globosis, subglobosis vel ellipsoideis, 16-40-55-(70) µm diam., parte basali maioribus, marginemque parte superiori apothecii minoribus et elongatis, pars exterior apothecii glabra sed parte basali raro etiam cum hyphis sparsis, superficialibus, hyalinis, septatis, 20-90 µm longis et 4-10 µm crassis. Excipulum parte inferiore sub hypothecio e cellulis minoribus. Hypothecium e textura subepidermoidea, e cellulis irregularibus constat. Asci 200-230 x 12-13.6 µm, cylindracei, apice obtusi, octospori. Paraphyses filiformes, 3.2-4.8 µm crassae, apice sensim dilatatae (5.5-8.2 µm), pallide luteolae, saepe cum guttulis donatae. Ascosporae ellipsoideae, 16-19-(20.2) x 8.2-9.5-(10.5) µm, hyalinae, perisporio longitudinaliter striato cum costis 0.2-0.5-0.8 µm crassis, cyanophilis, anastomosantibus.

Habitat: Bohemia, Branžež prope Mnichovo Hradiště, ad extrementa gallinacea in horto, 22. VI: 1969 leg. Jiří Moravec.- Holotypus BRA, isotypus PRM et in herbario privato J.Moravecii asservantur.



Figs. 1-4. *Coprobia crassistriata*. 1. Apothecia. 2. Ascus and paraphyses. 3. Ascospores under oil immersion, x 1600 + CB. 4. Section of the marginal part of the apothecium.

Apothecia very small, 0.3-0.8 mm diam., gregarious, sessile, thickly barell-shaped but rather low, thecium flattened to pulvinate, ochreous-yellow, ectal surface of the same colour, aparently smooth, or very minutely warted. Ectal excipulum of textura globulosa, comprising of globose to ellipsoid cells 16-40-55-(70) µm wide, which are larger near the base and smaller and elongated towards the ectal surface in the marginal part of apothecia, usually without any hyphal outgrowth, but occasionally few hyaline, superficial, septate hyphae occur near the base of apothecia growing from the cells, 40-90 µm long and 4-10 µm thick, with a wall up to 1 µm thick. Inner layer (medulla) of the textura globulosa, the cells are smaller towards the hypothecium. Hypothecium of a textura subepidermoidea consisting of irregularly shaped interlocked small cells. Asci cylindrical, 200-230 x 12-13.6 µm, with a blunt apex, eight-spored. Paraphyses filiform, 3.2-4.5 µm thick, apex slightly enlarged to 5.5-8.5 µm, pale yellow, occasionally with large guttules. Ascospores hyaline, ellipsoidal, 16-19-(20.2) x 8.2-9.5-(10.5) µm, hyaline, with a pealable striate perispore, the striation is formed by cyanophilic longitudinal low ribs, the ribs are 0.2-0.5-0.8 µm thick, usually sparsely anastomosing or the main ribs are sometimes with a very short ramification. (Oil immerssion 1600 x + Cotton blue s. 123 and scanning electron microscope Tesla BS 300, x 5000).
Habitat: Czechoslovakia, Bohemia, Branžež near Mnichovo Hradiště, on excrements of hens and on the surrounding rich soil soaked with the excrements, in a garden of the village, 22.VI. 1969 leg. Jiří Moravec. Holotype BRA, isotype PRM and in the herbarium of J.Moravec (M).

C. crassistriata differs from Coprobia granulata (Bull.) Boud. in several features, especially in its extremely small size, barell-shaped and paller apothecia. The cells of the excipulum are smaller and the paraphyses simply shaped and only slightly enlarged above, and, therefore, different from the capitate and clavate paraphyses of C. granulata. Ascospores of C. crassistriata are slightly larger but the main feature is the conspicuous striation of the perispore which consists of much wider cyanophilic ribs.(See the line drawings fig 3 in this paper and also fig 3b in J.Moravec (1984) where this species was illustrated as a "Coprobia spec.").
This ascospore striation has been also observed by scanning electron microscope and the photomicrographs (SEM fig.5) represent the first evidence of the rib-like nature of the perisporial striation in ascospores of Coprobia.
According to my examination of many collections of C. granulata, its perisporial ascospore striations consists of very fine and inconspicuous longitudinal ribs, 0.1-0.3-(0.4) µm thick (see also the line drawings in J.Moravec (1984) fig.3a).
Humaria granulata var. succinea Velenovský (1934) is according to Svrček (1979) a synonym of C. granulata, having paraphyses of the same shape and width as the paraphyses of C. granulata and also in other features, including the fine ascospore striation, agrees with this common species.
Ascophanus striatus Thind, Cash et Singh (1959) transfered correctly to Coprobia as Coprobia striata (Thind, Cash et Singh) Waraith (1977) is very close to C. granulata having

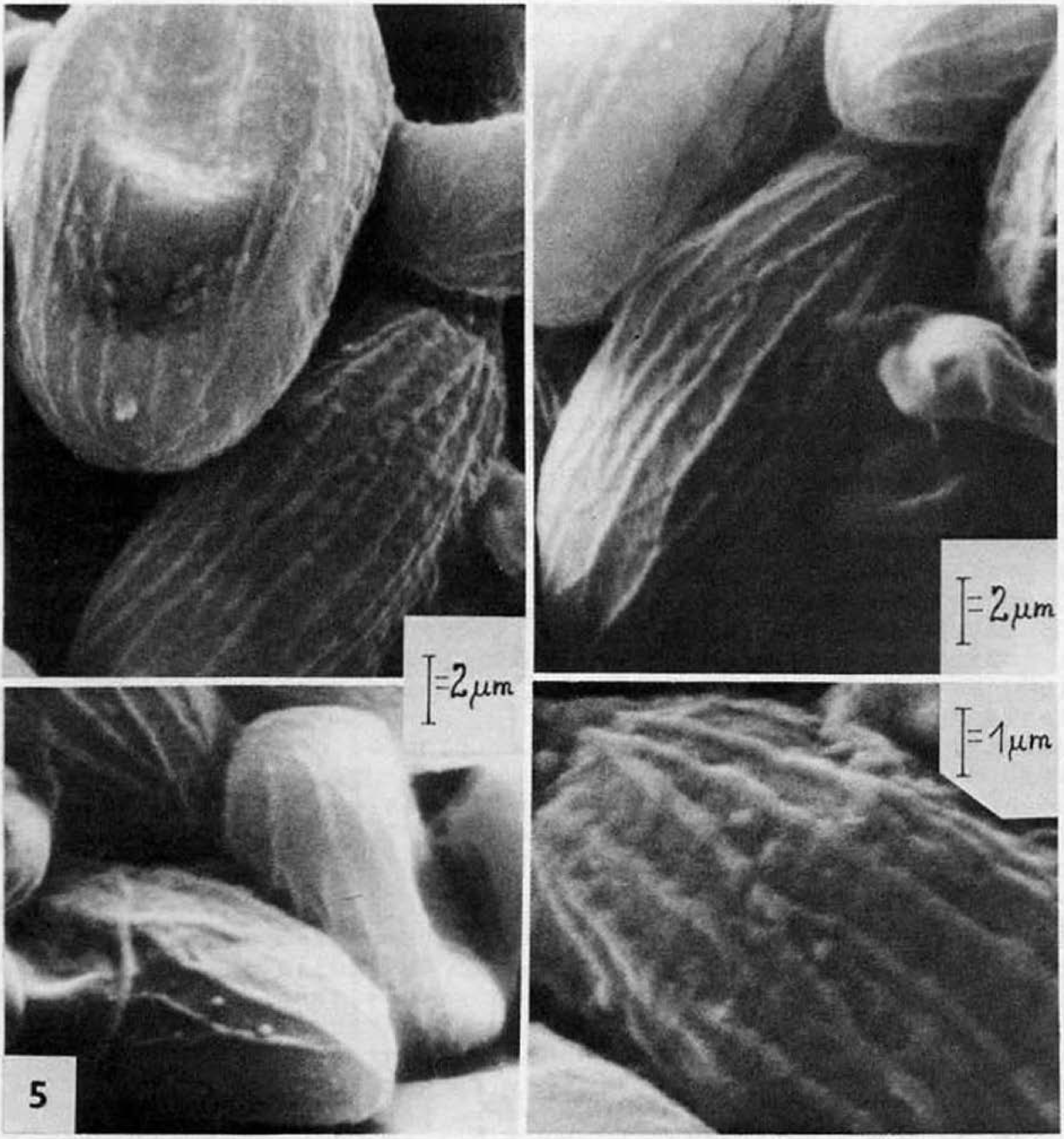


Fig. 5. SEM photomicrographs of the rib-like perisporial ascospore striation of Coprobia crassistriata.

similar large apothecia and thick clavate to capitate paraphyses, but differs by the smaller ascospores, 10.75-14.25-x 5.5-7.25 µm, according to Thind et Kaushal (1978), and by smaller cells of excipulum. Thind et Kaushal (1978) give a great range of its distribution in Himalayas. This species differs clearly from *C. crassistriata* by much smaller ascospores and clavate to capitate paraphyses.

Coprobia humana (Velen.) Svrček (1979) differs from *C. crassistriata* especially by larger orange coloured apothecia and ascospores with a finer striation, and by the presence of much developed hypha-like to pointed hairs, up to 200 µm long, which were found during the reexamination of the type (J.Moravec 1984). This species is closer to *C. theleboloides*.

A very closely related species is *Coprobia flava* (Karst.) Thind et Kaushal (1978). I have examined the type material of *Ascophanus flavus* Karsten (1890) consisting of two collections of the same date and locality:Fennia, Tavastia australis, Tammela, Mustiala, 7.X.1889 leg. et det. P. A. Karsten. (in stercore vaccino). The collection marked as "holotype"(H. 2977) contains rather large fragments of cow excrements, covered with apothecia of several discomycetes. I have found several apothecia of a *Coprobia* species with ochreous,broadly sessile apothecia and a great number of turbinate, yellow-orange (dark when dried) apothecia of a *Coprobia* species which I have selected as *C. flava*. Microscopically, the former species differs merely by the presence of de Bary bubbles, having the same anatomy, similar ascospore size and extremely fine ascospore striation, hardly seen in several ascospores only. It is difficult to decide, if it is a different species, or a stage of its development only, but the macroscopical difference is great. The fungus which I have selected to be *C. flava* has small, (0.2-0.5 mm diam. when dried) apothecia, which are turbinate and higher than their diameter, with a flat thecium; excipulum of textura globulosa, the cells 20-40-95 µm diam., gradding to a hyphal outgrowth near the base of apothecia, the hyphae are up to 250 µm long and 7-12 µm thick, with 1 µm thick wall. Asci 180-200 x 12-15 µm, paraphyses 3-3.5 µm thick, with a slightly enlarged apex (up to 6 µm only). Ascospores ellipsoid, 17-21 x 7.5-9 µm, perispore with a very fine striation consisting of inconspicuous longitudinal ribs 0.1-0.3 µm thick. In my opinion, this material better corresponds with the Karsten's original description. I consider *C. flava* well founded species, which differs from *C. granulata* by the smaller size and turbinate shape of apothecia, and especially, by the simply shaped, only slightly enlarged paraphyses. The Indian collection, described by Thind et Kaushal (1978) (as "flavus" and with quite incorrect citation of the basionym), well agrees with the type I have selected, only the size of apothecia and of cells of the excipulum, described by these authors, is smaller, and the fine striation of ascospores is not mentioned. I have not examined this Indian collection.

C. flava differs from *C. crassistriata* by the much higher turbinate apothecia, and, especially, by the much finer ascospore striation. The correct basionyme is : *Ascophanus flavus* Karsten, Medd. Soc. Fauna Fl. fenn. 16:105, (1889),

Symb. Mycol. Fenn. 29, 1890.
The second Karsten's collection of *A. flavus*, marked as "isotype" (H. 2978), contains the same fungi with a majority of a *Coprobia sp.* mentioned above, and a smaller number of apothecia of *C. flava*. Moreower, I have found two other discomycetes on the substrate of the both type collections of *A. flavus*: a great number of apothecia of a *Lasiobolus* sp. and several apothecia of *Cheilymenia aurantiaco-rubra* Thind et Kaushal (1980). The latter is a well founded species of *Cheilymenia*. I have compared it with the type (PAN 2584) which I have examined. The Karsten's collections well agree with the type material from India.

There is no doubt that the mentioned species of *Coprobia* - *C. crassistriata*, *C. flava*, *C. striata* and *C. humana* are closely related to *C. granulata*, which is the type species of the genus and was separated from *Cheilymenia theleboloides* and other related species by the absence of apothecial hairs. However, as it was already discussed (J.Moravec 1984) the Denison's opinion (Denison 1964) that *Cheilymenia theleboloides*, having superficial hairs different from rooting hairs of *Cheilymenia ciliata* (Bull.)Maas G. and several other species, is close to *Coprobia*, proved to be correct. This is evident not only for the similar anatomy but also for the presence of similar ascospore striation. Moreover, after the examination of the anatomy of many collections of *C. granulata*, I have found that hyphal outgrowths occur, though very rarely, in the ectal cells of the excipulum near the base of apothecia of *C. granulata* too. This fact confirms my opinion (J.Moravec 1984) that there is no basic feature in the anatomy of *Coprobia* and *Cheilymenia theleboloides*, which could be considered an important for the generic separation. I consider now *C. theleboloides* a species congeneric with *Coprobia granulata* and other species of *Coprobia* with similar anatomy and ascospore striation e.g. *Coprobia sordida* J.Mor., *C. hyphopila* J.Mor. (J.Moravec 1984), *C. striata*, *C. crassistriata*, *C. humana* and *C. flava*. Therefore, a new combination is proposed:
Coprobia theleboloides (Alb.et Schw.) J.Moravec comb. nov.
Basionym: *Peziza theleboloides* Albertini et Schweinitz, Consp. Fung. Agr.Nisk. 321, 1805.

Several other species, having ascospore striation, similar anatomy and superficial hairs, related to *C. theleboloides*, e.g. *Cheilymenia fraudans* (Speg.) Gamundi (1960) and *Cheilymenia lemuriensis* Le Gal (1953) must be, in my opinion, transfered to the genus *Coprobia* too. However, I have not yet examined the type material of these species.

ACKNOWLEDGEMENTS

I thank Dr. Harri Harmaja (Helsinki) for the loan of the type of Ascophanus flavus. I am most grateful to Mr. Jiří Lhotecký who kindly performed the SEM photomicrographs of ascospores at the Agriculture University, Brno, and to Dr. Zdeněk Pouzar for the reviewing the manuscript.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 509-523 April-June 1987

TRICHOPHYTON KANEI, SP. NOV., A NEW ANTHROPOPHILIC DERMATOPHYTE

RICHARD C. SUMMERBELL
Mycology Laboratory
Laboratory Services Branch
Box 9000, Terminal A
Toronto, Ontario, M5W 1R5
Canada

A new dermatophyte species from human sources is described. *Trichophyton kanei* sp. nov. shows many similarities to *T. rubrum* and the closely-related *T. raubitschekii*. It differs; however, by failing to produce a typical microconidial synanamorph. Macroconidia are the major means of reproduction *in vitro*.

INTRODUCTION

Traditionally, the name *Trichophyton rubrum* (Cast.) Sab. has been applied to a diverse group of anthropophilic dermatophytes, most of which produce a characteristic non-diffusing, blood-red, quinone-based colony reverse pigmentation in pure culture. The extensive variability found in pigmentation, micromorphology, colonial form, and other characters within *T. rubrum sensu lato* has been documented by many workers (English, 1964; Young, 1972; Mehta et al., 1978; Kane and Smitka, 1980). Only a small number of characters appear to be constant among all traditionally-defined *T. rubrum* isolates: failure to form perforating organs to penetrate hair *in vitro* (Ajello and Georg, 1957); restricted growth on 3 - 5% sodium chloride-amended Sabouraud agar (Kane and Fischer, 1975); restricted, non-ammonifying growth on milk-solids-dextrose agar (Fischer and Kane, 1971; Kane and Smitka, 1980); growth on vitamin-free media; and the stimulation of an incomplete sexual reaction by the (+) strain of *Arthroderma simii* Stockd. (Stockdale, 1965; Young, 1965). In addition, macroconidia, when formed, tend to be thin, cylindrical to undulate, and smooth-walled; microconidia tend to be clavate or clavate-pyriform.

Despite the wide range of variability within *T. rubrum ss. lat.*, workers in recent years have recognized a small number of segregate species which are distinct from *T. rubrum sensu stricto*. Kane (1977) delineated *T. fischeri* Kane on the basis of certain micromorphological features in addition to the inability of the species to form red pigment when grown on casamino acids-erythritol-albumen agar (CEA). Uniquely, this species was typically isolated from non-pathogenic situations: the original isolates were from contaminated agar medium and subsequent isolates were from human body surfaces lacking microscopic evidence of infection. Later, Kane et al. (1981) delineated the pathogenic T. raubitschekii Kane, Salkin, Weitzman, et Smitka on the basis of its copious macroconidial production, variable microconidia, deep red and brown pigments, and positive hydrolysis of urea in Christensen's broth medium (Kane and Fischer, 1971) within seven to nine days.

In recent years, workers in the mycological laboratory of the Ontario Ministry of Health have isolated or received a number of representatives of yet another undescribed species with affinities to T. rubrum. This species, described herein, is primarily characterized by its unusual conidiation: it produces large numbers of macroconidia under most conditions, and also forms arthroconidia in age or on dilute media, but it does not produce the typical microconidia of the T. rubrum species complex.

MATERIAL AND METHODS

Fungal isolates used.

Strains of the new Trichophyton species and related members of the Trichophyton rubrum complex were obtained as routine isolates from skin scrapings, as reference specimens from various clinical laboratories, and as stocks from the collection of the Ontario Ministry of Health (OMH). In comparative studies, the new species was represented by three strains, T. raubitschekii by six, T. fischeri by two, and T. rubrum by twenty-eight, including representatives of the flavous, melanoid, and granular variants. They were purified by single-conidium isolation, exposure to antibacterial antibiotics, and re-isolation from Sabouraud broth amended with chloramphenicol, cycloheximide, gentamicin (collectively termed CCG) and hydrochloric acid (0.1 ml of 0.5 N acid in 14 ml medium). Isolates were maintained on Sabouraud's peptone dextrose agar (SAB).

Media used for description and comparisons.

A standard description of the new Trichophyton species was prepared based on growth on SAB agar. In addition, the new species was compared with representatives of T. rubrum and related species on numerous other media, including SAB + CCG, SAB + 1% sodium chloride (also SAB + 3%, 5%, 7%, 9%, 11%, 13% and 15% sodium chloride) (Kane and Fischer, 1973), diluted Sabouraud agar with added mineral salts (DSS) (Padhye et al., 1973), Leonian's medium (Leonian, 1924), cornmeal agar, malt extract agar, Czapek's agar, Czapek's-yeast extract agar (Raper and Thom, 1949), bromocresol purple-milk solids-dextrose agar (BCP-MS-D) (Fischer and Kane, 1971), casamino acids agar (also casamino acids agar with added thiamine, and with added thiamine and inositol) (Georg and Camp, 1957), casamino acids-erythritol-albumen agar (CEA) (Fischer and Kane, 1974), carbohydrate assimilation test media (23 carbohydrates), blood agar, egg yolk agar, Difco brain-heart infusion agar, polished rice, potato dextrose agar, ammonium nitrate medium with and without added L-histidine (Georg and Camp, 1957), and hydrolysis test media for casein, adenine, xanthine, and tyrosine. The production of macroconidia and microconidia was monitored, and an attempt was made to search for systematic differences in colony pigmentation and morphology, growth rate, and physiological properties.

Growth at 5° C. was tested on SAB, and growth at 37° C was observed on SAB + CCG and on blood agar. Breakdown of urea was investigated on Christensen's urea agar and the corresponding agar-free broth at room temp., 26°, 30°, and 37° C. The *in vitro* hair penetration test was done according to the methods of Ajello and Georg (1957). A *T. mentagrophytes* (Robin) Blanch. strain (zoophilic variety) was used as a control.

In descriptive studies, colony colouration was recorded using the colour chart of Rayner (1970). In preparation for microphotography, isolates were grown in slide cultures on cornmeal agar,casamino acids agar, DSS and SAB.

Stimulation by *Arthroderma simii*.

Strains representing *Trichophyton raubitschekii* and *T. kanei sp. nov*. were crossed with the A (+) mating strain of *Arthroderma simii* on DSS medium. Crosses were examined after 3 weeks at room temperature.

RESULTS

Standard description of *Trichophyton kanei sp. nov*.

Division: Fungi imperfecti
Class: Hyphomycetes
Order: Moniliales
Family: Moniliaceae

Trichophyton kanei Summerbell, sp. nov.

Coloniae in agaro "peptone-dextrose" ad 24.5 mm diametrum in quattuordecim diebus ad 22.5° C crescentes, planae, albidae, in centro dense coactae, versus marginem tenues et velutinae, in pagina inferiore luteae et in centro sanguineae coloratae; in viginti unis diebus coloniae ad 35 mm diametrum crescentes, floccosae, implexae, albidae, in pagina inferiore isabellinae aut sanguineae coloratae. Macroconidia modice vel copiosa producta, clavata vel cylindricea, longa et angusta, 37.5-80.0 x 5.5-10.0 µm magna, laevia,apicibus obtusis, (3-) 5-10 cellulae composita, in apice basi raro segmentum breve hyphae subtendatae exhibentes; in colonia senescentes macroconidia exilia, reducta, (12.5-) 20-67.5 x 1.8-6.3 µm magna, saepe filiformia vel capitata, in cellulae unis rumpentia. Arthroconidia in colonia senescentes producta, saepe catenulata, 4.4-17.8 x 1.2-3.0 µm magna, 1-2 (-3) cellulae composita. Microconidia absunt. Chlamydosporae infrequentes, subglobosae, raro catenulatae, ad 14 µm diametrum crescentes.

HOLOTYPUS: in cute humana lectus est, in oppidum London, in Middlesex comitatu, in Ontario provincia Canadensis regni, June 1985, J. Kane, TRTC 50887. In Torontoensis universitatis Cryptogamarum herbario.

Colony in peptone-dextrose agar attaining a diameter of 24.5 mm after 14 days at 22.5° C, flat or shield-shaped (Fig. 1) with aerial mycelium compactly subfloccose to subtomentose, white, forming a dense felt at centre and thinning towards the margins, Yellow (colour #14 in Rayner, 1970) or becoming Blood Red (#3) on the reverse, paling near the margin; after 21 days reaching 35 mm in diameter, flat, floccose, matted, reverse blood-red throughout or Isabelline (#65) near colony centre, becoming Amber (#47) near margin. Margin regular, slightly diffuse in outline. Exudate, diffusing pigment, and odour absent.

Aerial mycelium well-developed. Hyphae hyaline, tending to branch at right or only slightly acute angles, up to 4.2 µm in diameter.

Macroconidia (Figs. 2-5) moderately or abundantly produced, formed as lateral or terminal aleurioconidia on prostrate mycelial branches; arising directly from the subtending branch or occasionally from the basal cells of previously-formed macroconidia; cylindrical to clavate, long and narrow, with rounded apices, 37.5 - 80.0 x 5.5 - 10.0 µm., containing dense cytoplasm, composed of (3-) 5-10 cells, sometimes breaking down into single cells at maturity. Five unusual features of formation of macroconidia are seen occasionally: 1) incorporation of a single cell of the subtending branch into the macroconidium, resulting in a conidium with a conspicuous T-shaped base (Fig. 3); 2) swelling of one macroconidial cell to produce a vacuolate sphaeroidal cell (not a chlamydospore); if terminal, this cell may possess a papillate apex; 3) retraction of cytoplasm within macroconidial cells, giving the appearance of rectangular inclusions (Fig. 4); in older colonies, the formation of reduced macroconidia (Fig. 5), cylindrical, narrowly clavate or filiform, often capitate, (12.5-) 20.0 - 67.5 x 1.8 - 6.3 µm., with a strong tendency to fragment into individual cells; terminal cells of these

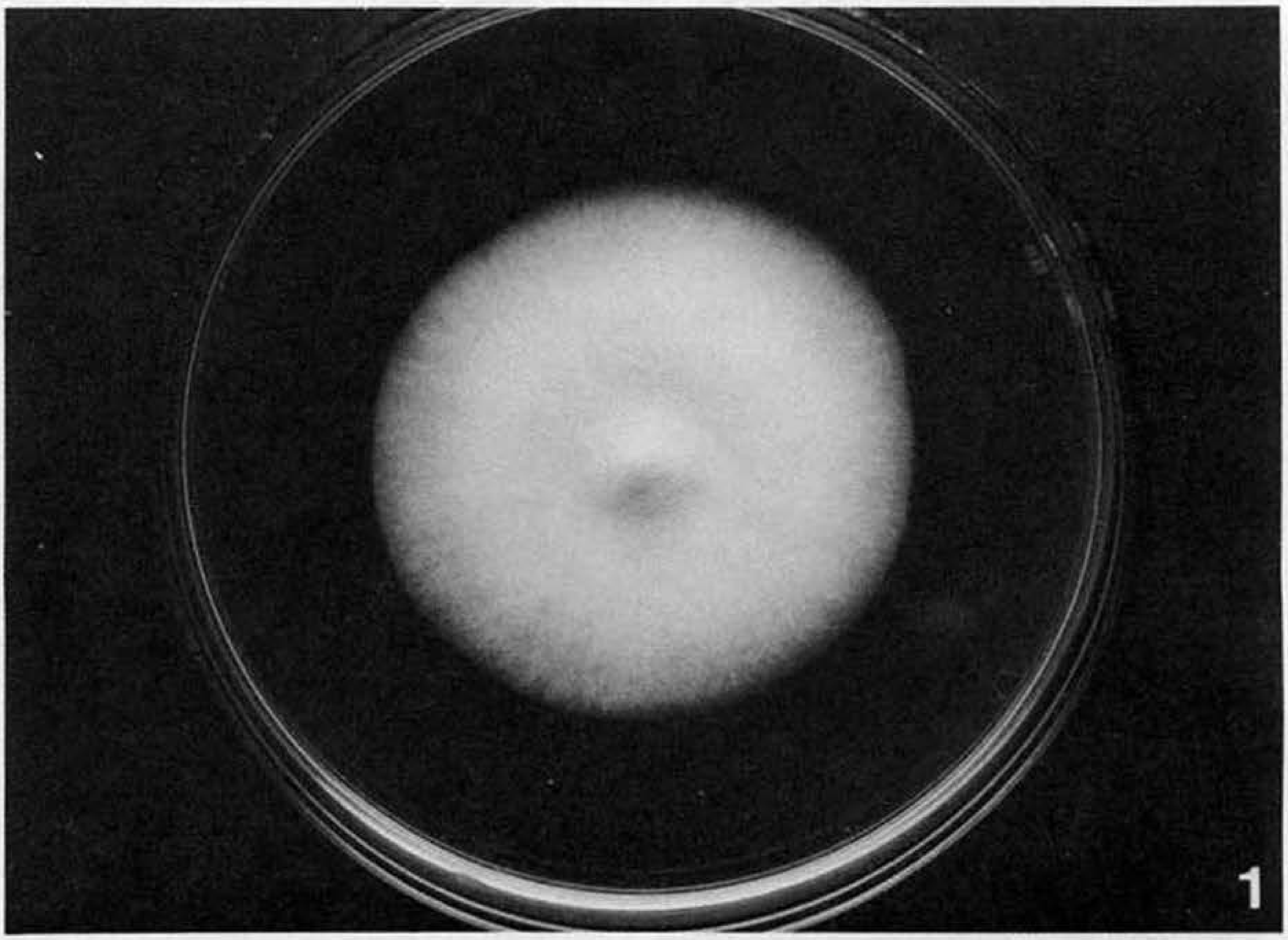
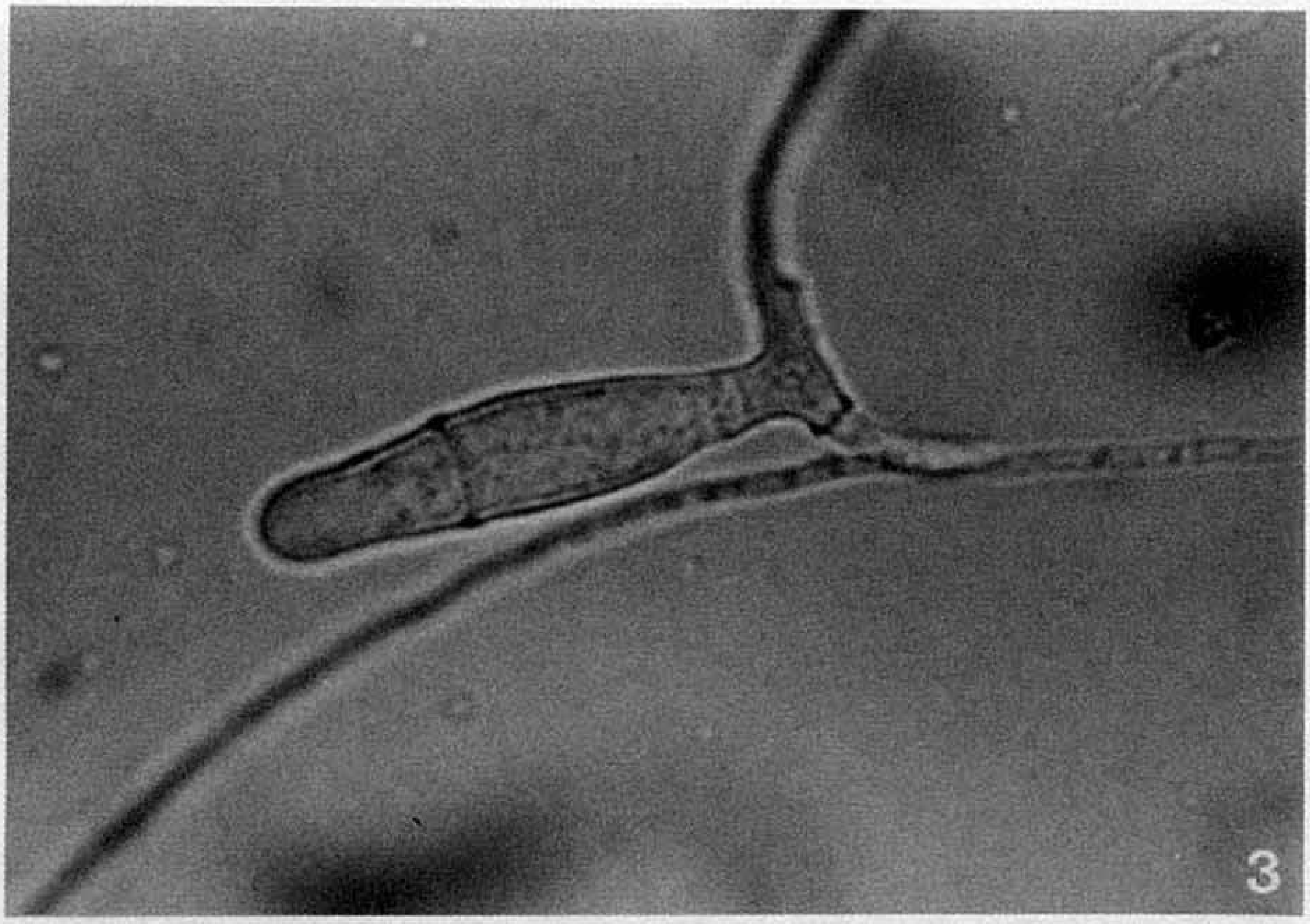
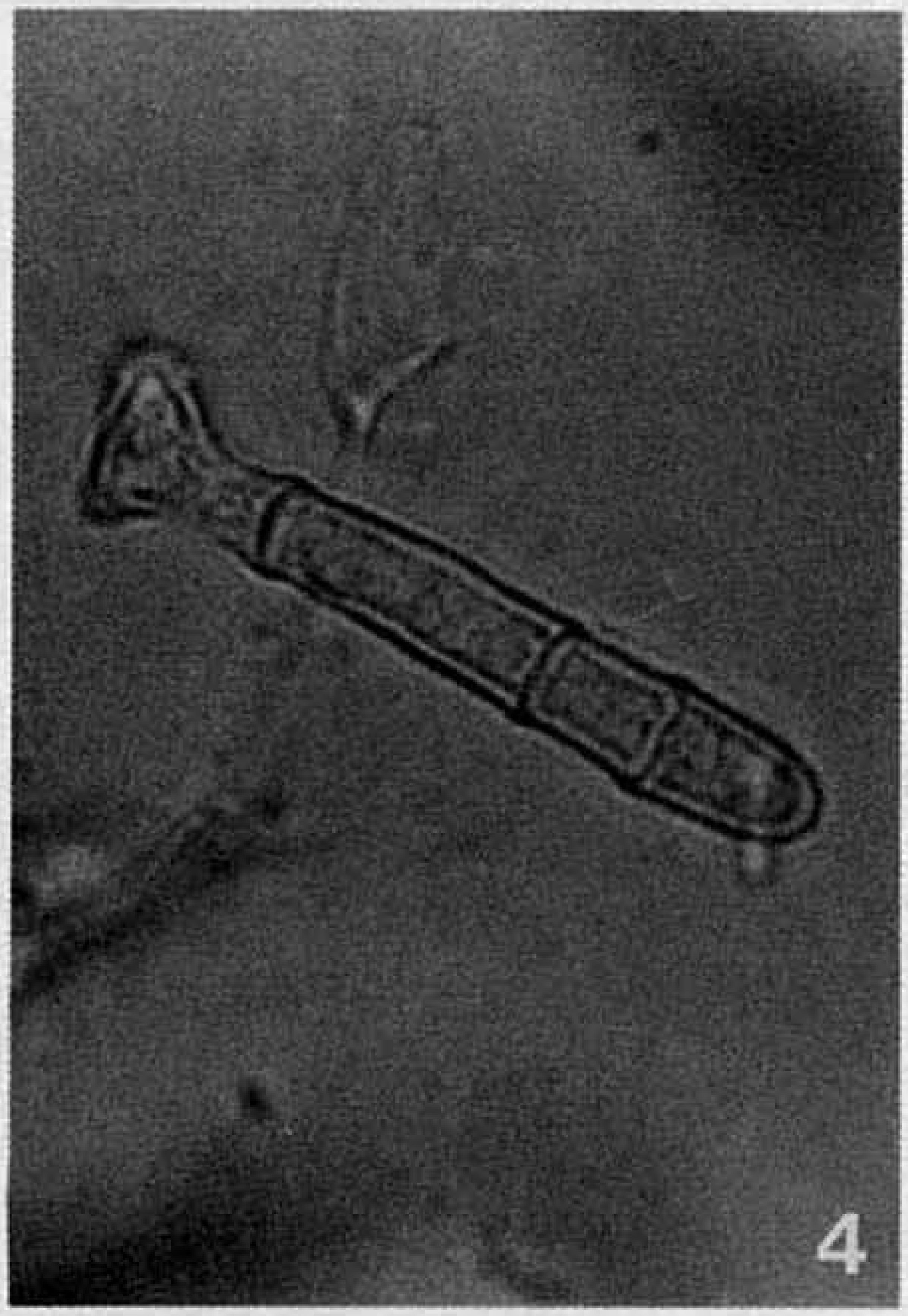


Fig. 1. Culture of T. kanei on SAB after 14 d at 22.5°C.
Fig. 2. Macroconidia on polished rice medium 7 d. x 400.





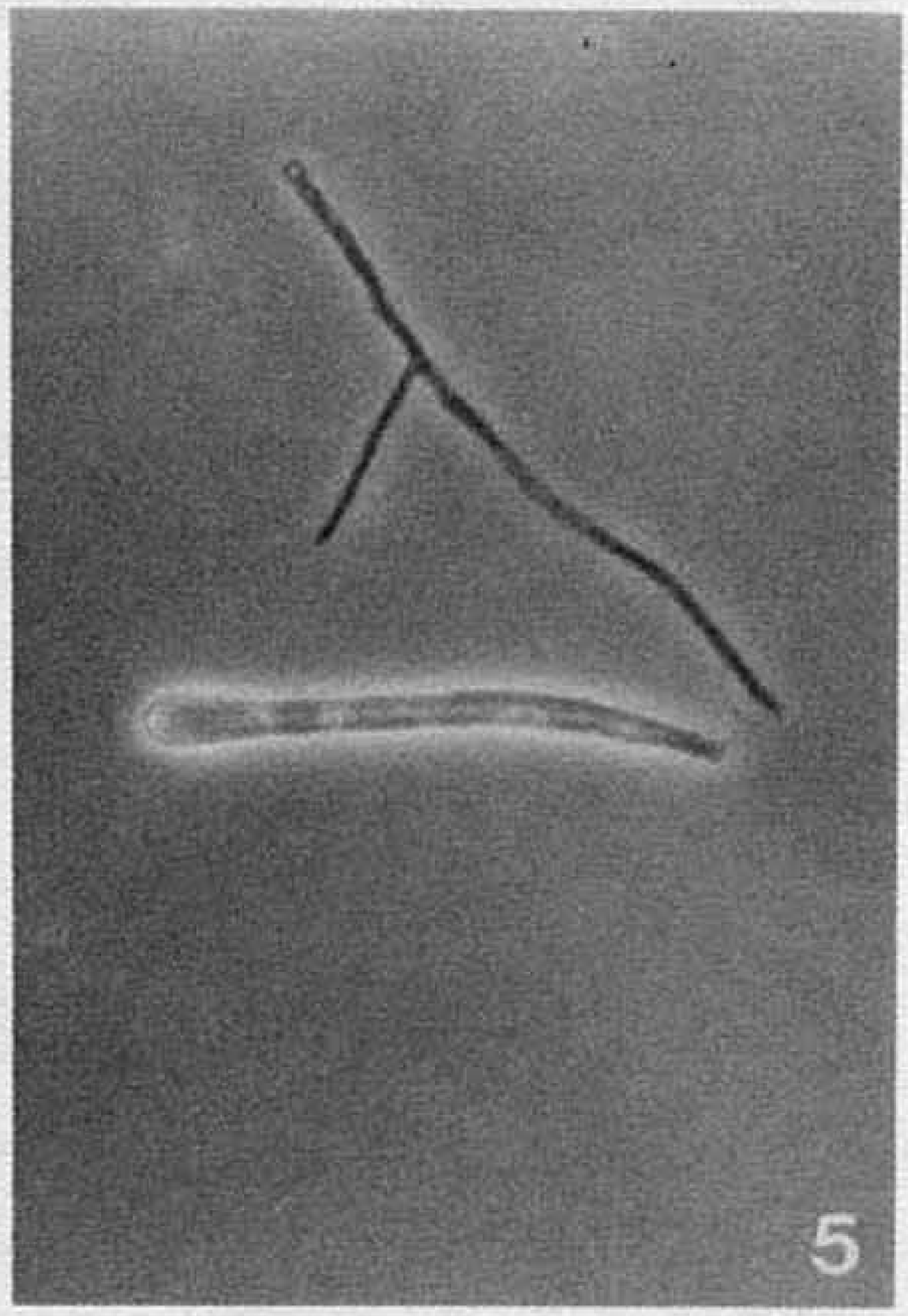


Fig. 3. Macroconidium with T-shaped intercalary base.
Fig. 4. Macroconidium with retracted cytoplasm.
Fig. 5. Reduced macroconidium, casamino acids agar, 7d.
All X1000

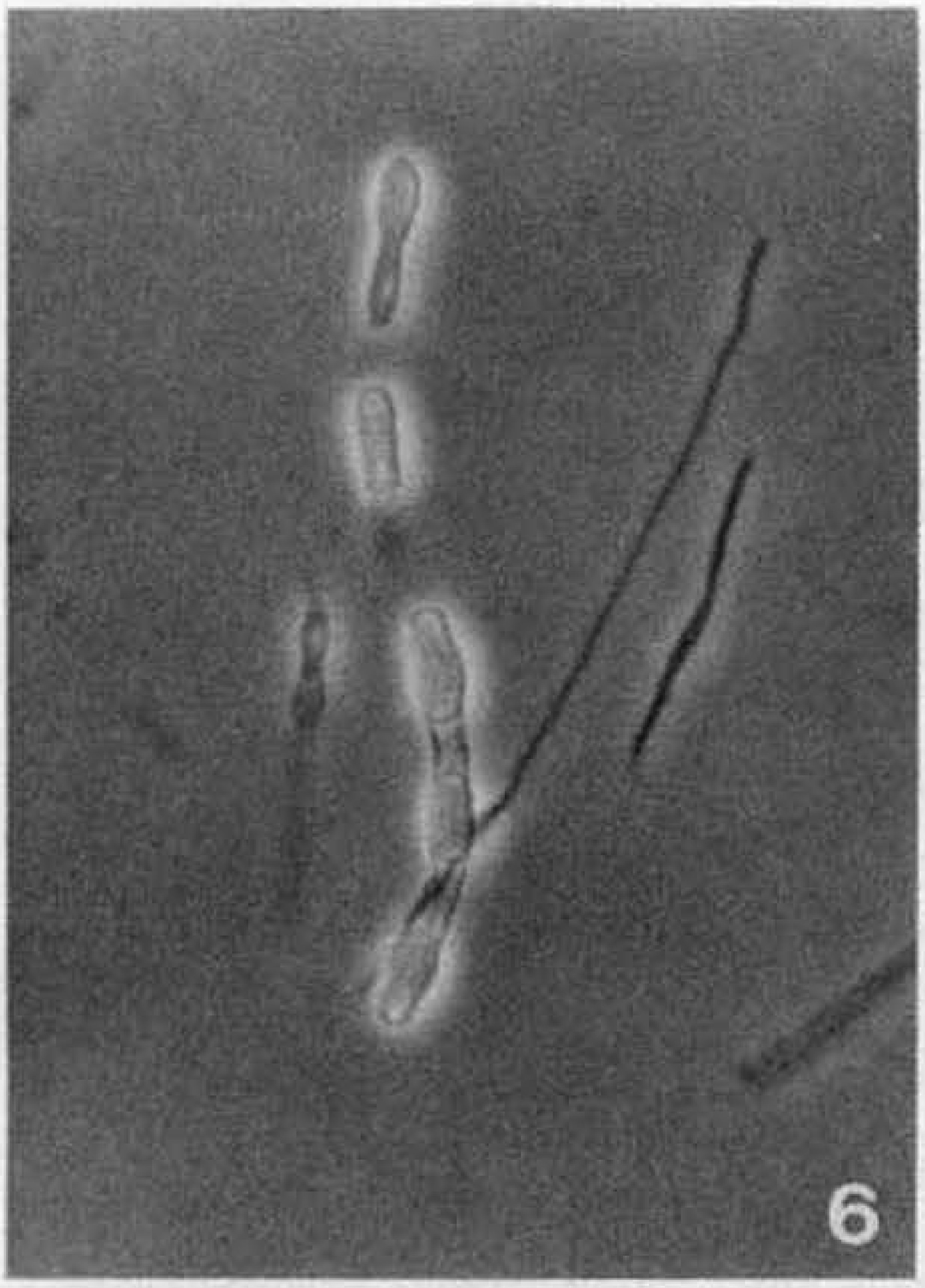
reduced macroconidia are teardrop-shaped, while intercalary cells are cylindrical and thin; and 5) the formation of catenulate macroconidia, in which newly-formed macroconidia proliferate apically to give rise to a linear series of one or two additional macroconidium-like structures.

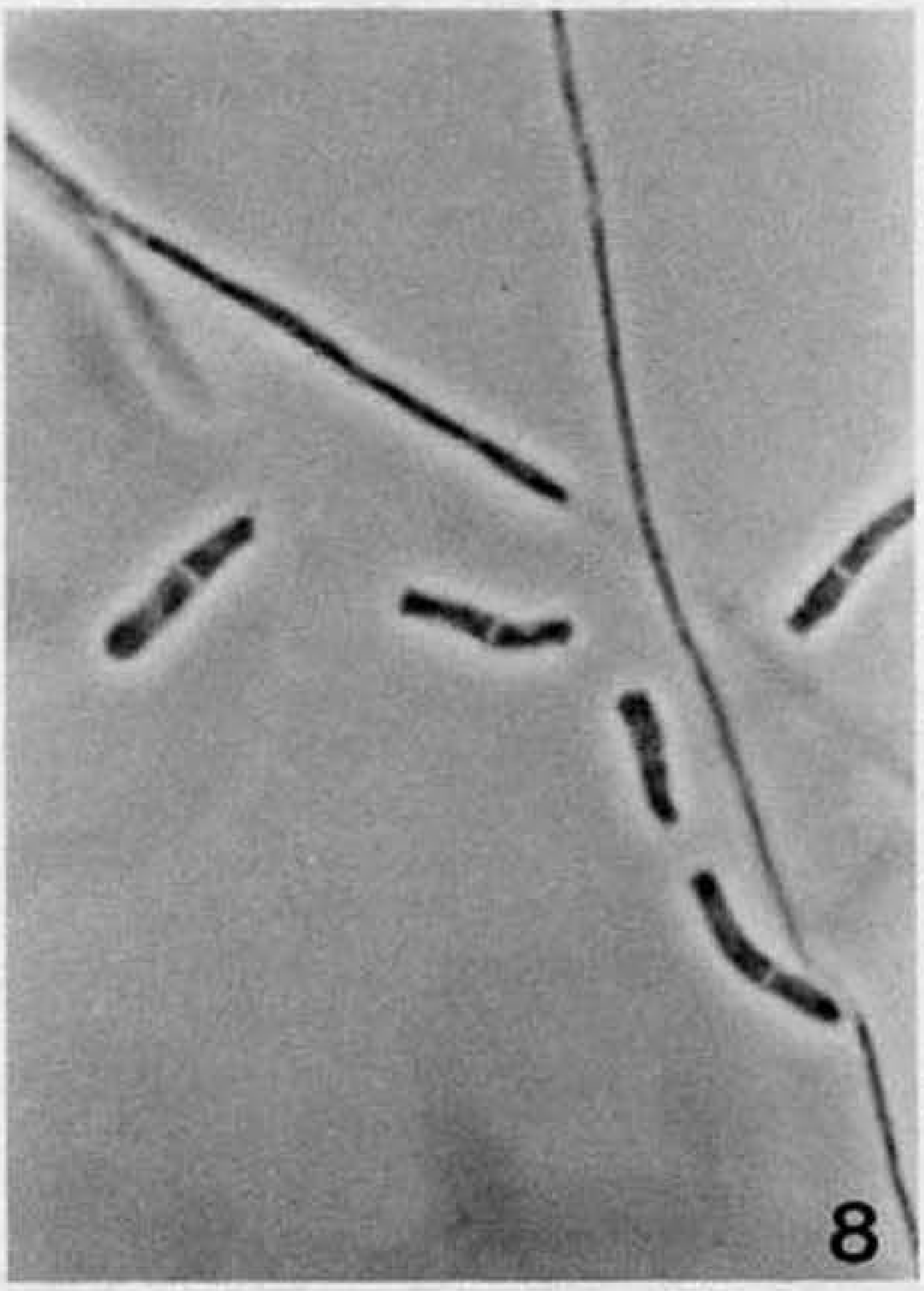
Microconidia absent. Arthroconidia (Fig. 6-8) absent to uncommon on SAB, common on casamino acids agar and DSS, in unbranched or less commonly branched chains, often alternate, in shape narrow-cylindrical, ellipsoidal, clavate, or irregular, 1-2 (-3) celled, 4.4-11.8 x 1.2-3.0 µm (1-celled) or 6.4-17.8 x 1.4-2.6 µm (2-celled), often appearing to intergrade in size and shape with macroconidia. Chlamydospores infrequent, solitary or in chains, subglobose, up to 14 µm. in diameter.

Holotype: TRTC 50887, University of Toronto Cryptogamic Herbarium.
Habitat: human skin and nails.
Telemorph: unknown. Incomplete sexual reaction with _Arthroderma_ _simii_ indicates affiliation with the family Arthrodermataceae.
Etymology: _kanei_, in honour of noted Canadian medical mycologist Dr. Julius Kane, who has made a large number of important contributions to the diagnostics and epidemiology of dermatophytes and other medically-important fungi.

_T_. _kanei_ strains examined: F8546.85 (= CBS 289.86 = ATCC 62345) from skin scrapings associated with dermatophytosis of human buttock, London, Middlesex County, Ontario, Canada, June 1985, J. Kane. FR 634.86, from scrapings associated with onychomycosis, Timmins, Ontario, Canada, May, 1986, J. Kane. FR 1939.86 = C86-178, from skin scrapings, Netherlands, M.C.C. Elders.

_T_. _kanei_ was cultivated on a large number of media in an attempt to induce microconidia to form. It failed to produce these structures, even on media often used to stimulate this faculty in _T_. _rubrum_ isolates (e.g., casamino acids agar, potato dextrose agar, Leonian's agar). However, on some media (esp. casamino acids agar, DSS), it produced a large number of reduced, clavate to filiform-capitate macroconidia (Fig. 5) with a strong tendency to fragment at maturity. The terminal cells of these macroconidia often resembled microconidia in squash mounts, and only cultivation of the fungus in slide cultures enabled the structures to be recognized as macroconidial in origin. Some granular _T_. _rubrum_ strains, e.g., our FR 238.86, also formed small, fragmenting macroconidia under certain conditions, but most representatives of _T_. _rubrum_ did not. All isolates of _T_. _rubrum_ and related species apart from _T_. _kanei_ produced microconidia on most media, although a few media were repressive (e.g., SAB + 3% or greater sodium chloride, egg yolk medium).





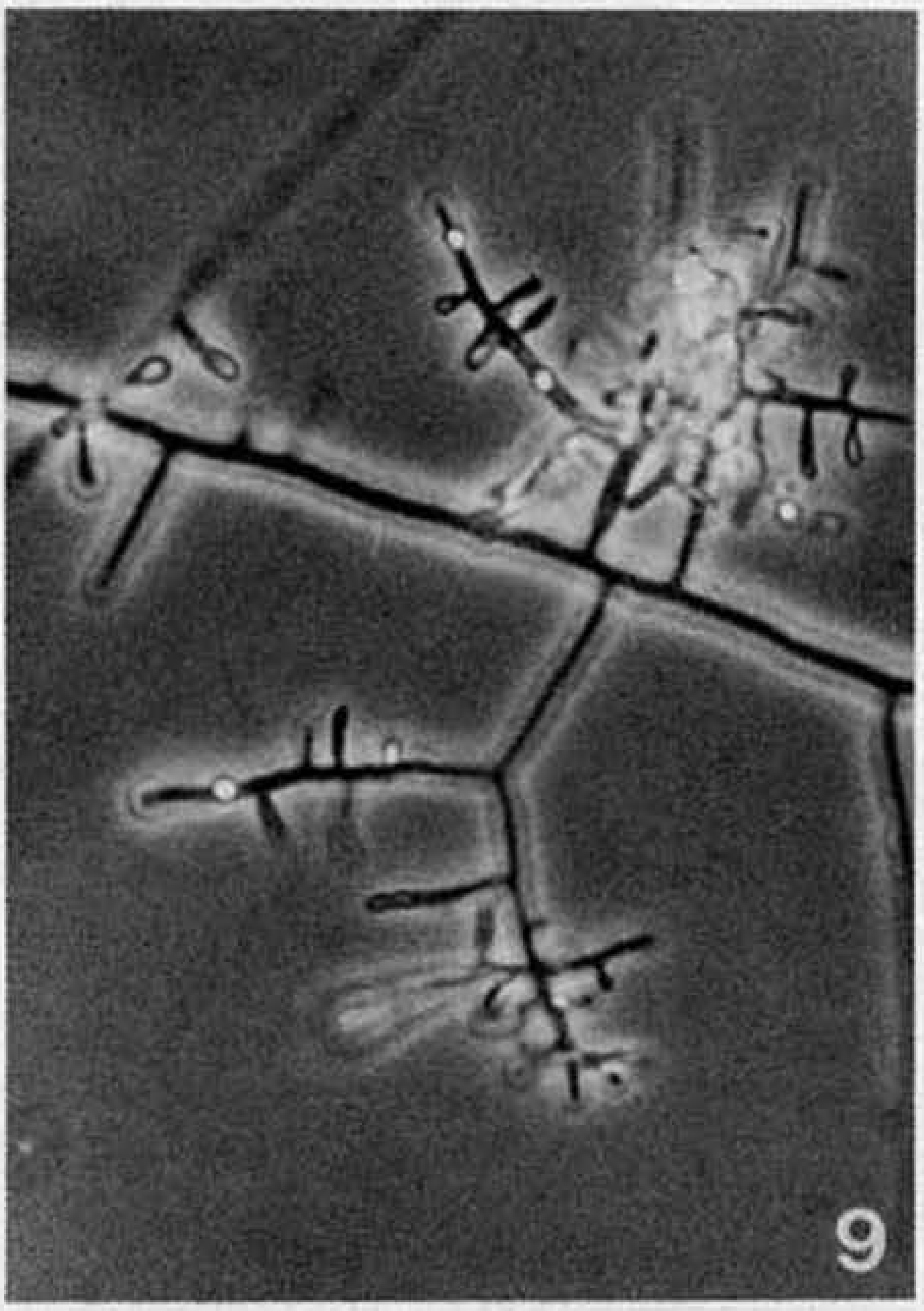


Fig. 6. Arthroconidia, casamino acids agar, 7 d. X1000. Fig. 7. Branching arthroconidial chains. Lateral conidia at arrows are septate. X400. Fig. 8. Arthroconidia. Conidia remain at site of formation, but cells between them have autolysed. X1000. Fig. 9. Typical microconidia of _Trichophyton_ _raubitschekii_. X400.

The media inducing the formation of reduced macroconidia also stimulated the formation of numerous arthroconidia. Detached arthroconidia, and in particular the apical cells of arthroconidial chains, showed a superficial resemblance to microconidia. Unlike typical microconidia of the *T. rubrum* species complex, however, these structures were frequently composed of more than one cell (Fig 8). In slide cultures, arthroconidia could be seen to be formed by the differentiation and disintegration of long sections aerial hyphae distinguished only by the presence of somewhat swollen apical cells. Microconidia in *T. rubrum*, *T. raubitschekii* and *T. fischeri* comparison cultures were clearly formed as regular, determinate, lateral branches (Fig. 9). These branches were sometimes unicellular but often included both a microconidium and a small, evanescent "detaching-cell" (Galgoczy, 1975) at which rhexolytic dehiscence occurred. Some of the comparison cultures formed arthroconidia as well as microconidia.

On some media (e.g., SAB), catenulate macroconidia and structures intermediate between arthroconidia and macroconidia were formed. Many of these structures were similar to macroconidia in dimensions and in the number of cells they incorporated, but were produced in short chains. The terminal conidium in such chains was generally a typical macroconidium, with a diameter of up to 10 µm, and composed of as many as 10 cells. Typical arthroconidia, by contrast, contained no more than three cells and did not exceed 3 µm in diameter.

Physiologically, *T. kanei* was similar to other members of the *T. rubrum* species complex. It failed to perforate hair *in vitro*, formed pale, velutinous to glabrous, restricted colonies on SAB + 3 - 5% salt, and grew restrictedly on BCP-MS-D medium without engendering any pH change after 7 days. It was able to hydrolyze casein solids, but not xanthine, tyrosine, or adenine. Red colony reverse pigment was formed on many media, including CEA, SAB, and malt extract agar. On CEA, *T. kanei* tended to produce large quantities of yellow pigment before beginning to produce red pigment. Only a minority of *T. rubrum* isolates displayed this attribute. In tests of carbohydrate assimilation, *T. kanei* assimilated only mannitol and erythritol rapidly, and utilized glucose and cellobiose much more slowly. Other members of *T. rubrum* and related species were similar in assimilation patterns, although individual strains utilized glucose more readily and also latently used one or more additional sugars. *T. kanei* was independent of external sources of vitamins and L - histidine.

In the urea broth test, *T. kanei* gave a positive reaction at 26° C after 9-12 days. This was slower than the reaction typically found in *T. raubitschekii*, and distinct from the negative reaction found in *T. fischeri* and *T. rubrum*. At

TABLE 1. A comparison of characters: *Trichophyton kanei* and related species.

Character	*T. kanei*	*T. raubitschekii*	*T. rubrum*	*T. fischeri*
Macroconidia	+ (many)	+ (many)	- or +	+ (few)
Microconidia	-	+ (variable shape)	+ (clavate)	+ (clavate)
Arthroconidia	+	+	- or +	+ (few)
Urea catalysis in broth medium	+ in 9-12 d	+ in 7-9 d	-	-
Red reverse pigment on CEA medium, 21 d.	+	+	+ (or - in some variants)	-
Special features	Macroconidia with T-shaped ends, catenulate macroconidia	Deep brown reverse pigments on cornmeal dextrose.	Many colony texture and pigmentation variants	non-pathogenic.

37° C, only *T. raubitschekii* and *T. kanei* isolates gave a (relatively weak) positive urease test at 21 days.

T. kanei did not grow at 5° C. At 37° C on blood agar, it formed a restricted, convoluted colony of pasty texture. Microscopically, this colony was predominantly made up of large, disarticulating, spherical cells. Most *T. rubrum* isolates differed by forming less restricted, tough, velutinous colonies; however, some *T. raubitschekii* and granular *T. rubrum* isolates gave rise to colonies or sectors resembling the *T. kanei* colonies.

T. kanei interacted with the A (+) mating type of *Arthroderma simii* to give rise to sterile pseudogymnothecia **after 21 days at room temperature.**

DISCUSSION

T. kanei is a distinctive species with close affinities to *T. rubrum* and its allies. Primarily, it can be distinguished from other members of this species complex by its copious production of macroconidia and complete lack of typical microconidia. This pattern is particularly evident in the first 7 days of growth on SAB agar, when large macroconidia predominate, and smaller, fragmenting forms are not in evidence. Additional confirming characters for this species include the frequent presence of macroconidia with T-shaped ends, the occurrence of catenulate macroconidia, the distinctive felty or matted-floccose colony morphology, and the positive urea broth test after 9-12 days at 26° C.

Because of its copious macroconidial production and positive urease reaction, *T. kanei* is clearly more closely related to *T. raubitschekii* than to *T. rubrum* or *T. fischeri*. However, *T. raubitschekii* can easily be distinguished by its abundant microconidia, darker colony reverse pigmentation on most media, and more rapid hydrolysis of urea (Kane et al., 1981). *T. kanei* is also distinct from certain unusual granular forms of *T. rubrum*, originating mainly from tropical regions, which produce few or no microconidia in primary isolates (Gentles et al., 1964; Mehta et al., 1978). These isolates generally produce numerous microconidia after one or two transfers, and in general show a morphological similarity to *T. raubitschekii*. The differences between *T. kanei* and related species are summarized in Table 1.

Although *T. kanei* appears to be a rare species, it may have been overlooked in the past because of its resemblance to *T. rubrum*. Besides producing a red pigment similar to that of *T. rubrum* and allies, this species also produces various structures which undergo a rhexolytic, arthroconidial disintegration in age. The conidia produced by this means often show some resemblance to *T. rubrum* microconidia. However, the formation of arthroconidia (called "gemmae" by Galgoczy, 1975, and some other authors) is a common feature of various dermatophyte species in culture, (Rebell and Taplin, 1979) and these conidia are recognized as being distinct from microconidia. T. kanei is unusual in that a large proportion of its arthroconidia are septate.

The differentiation of branched hyphae into arthroconidia in T. kanei occasionally results in the delimitation of short side-branches as small, 1-3-celled lateral conidia. Of the various arthroconidial structures produced by T. kanei, these bear the greatest resemblance to microconidia. It should be stressed that the attribute specifically lacking in T. kanei is not the ability to produce small conidia, but rather the ability to produce the supernumerary, specialized, short, lateral branches which develop into the microconidia of the dermatophytes. This distinction among developmental types of morphologically-similar thalloconidia is easily made in a slide culture, as can be seen by comparing Figs. 6-8 with Fig. 9.

Although T. kanei produces only macroconidia on most media, it cannot be confused with those dermatophyte species reproducing exclusively by means of macroconidia. T. longifusum (Florian and Galgoczy) Ajello forms distinctive, repeatedly proliferating macroconidia on a pulverulent-cottony colony, and does not form the red pigments of T. rubrum and allies. Moreover, it elaborates perforating organs when cultivated on human hair in vitro (Florian and Galgoczy, 1964). Epidermophyton floccosum forms unique, broadly clavate macroconidia in distinctive clusters, and does not produce red reverse pigments. Also, it tends to produce bright yellow or yellow-brown pigments in the presence of 1% or greater sodium choride.

The absence of microconidia in T. kanei might lead some workers to consider placing the species into the genus Epidermophyton, which is partially characterized by the absence of a microconidial synanamorph. This step has not been taken here, since T. kanei shows a high degree of morphological and physiological similarity with other Trichophyton species, particularly T. rubrum and allies. In particular, its macroconidia--the conidial state on which the name Trichophyton must be considered to be based--are highly similar to those of T. raubitschekii and granular T. rubrum isolates, and not at all similar in shape, size, or disposition to those of E. floccosum. Ajello (1968) evidently faced an analogous problem in generic placement when he transferred Keratinomyces longifusus Flor. et Galg., a species not reported to produce microconidia, to Trichophyton. The present author has moved in conformity with his decision. It should also be noted that E. floccosum, unlike T. kanei and other species related to T. rubrum, does not show a partial mating response when challenged with Arthroderma simii mating strains (Stockdale, 1965). This lack of stimulation may indicate that *E. floccosum* is only distantly related to the majority of *Trichophyton* spp. Finally, *E. floccosum*, although it produces intercalary "lateral macroconidia" (Galgoczy, 1975) does not produce small, catenulate arthroconidia.

The little-used generic name *Keratinomyces* cannot be rehabilitated to encompass *T. kanei* or other species lacking microconidia. Although it was long understood to include *Trichophyton*-like dermatophytes lacking microconidia, its type species, *K. ajelloi* (now called *Trichophyton ajelloi* (Vanbr.) Ajello) has been shown to produce a microconidial synanamorph (Ajello, 1968). *T. ajelloi*, moreover, is an unusual organism which bears little morphological or physiological resemblance to *T. kanei* or other *Trichophyton* spp.

The certainty with which *T. kanei* can be associated with the *T. rubrum* species complex is indicative of the high degree of understanding of this complex which has been attained in recent years. Dermatophytic fungi are extremely variable, and the affinities of a red-pigment-producing, non-hair-penetrating, predominantly macroconidial form like *T. kanei* would have been dubious up until only a few years ago. The value of Kane's bromocresol purple-milk solids-dextrose medium in elucidating the affinities of *T. kanei* cannot be overstressed. This medium should not be overlooked by future investigators interested in the biology of *T. kanei* or related species.

ACKNOWLEDGEMENT

The author is particularly grateful to Dr. J. Kane for his encouragement, sponsorship, and sound advice. Dr. David Malloch is thanked for reviewing the manuscript, and Dr.J. Krug is thanked for preparing the Latin diagnosis. Constructive criticism from Dr.M. McGinnis is appreciated. Photographic prints were prepared by the Regional Audio-visual Service, Ontario Ministry of Health. The author was funded by a Medical Research Council of Canada post-doctoral fellowship.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 525-541 April-June 1987

NEW AND NOTEWORTHY POLYPORES FROM TROPICAL AMERICA

by

LEIF RYVARDEN

Botany Div., Dep. of Biology, Univ. of Oslo,
Box 1045 Blindern, N-0316 Oslo 3, Norway.

SUMMARY

Lamelloporus, Nigrohydnum , nov. gen. and **Antrodiella angulatopora, Datronia glabra, Gloeoporus cystidiatus, Inonotus venezuelicus, Lamelloporus americanus, Nigrohydnum nigrum, Nigroporus rigidus, Perenniporia micropora, P. sinuosa, P. stipitata, Phellinus cylindrosporus, Pseudofavolus nigrus, Rigidoporus amazonicus, Trametes ellipsospora, Tyromyces singeri** and **Wrightoporia cremea** are described as new.
The combination **Hapalopilus phlebiaeformis** (Cke.) Ryv. is proposed and **Piptoporus soloniensis** (Fr.) Pil. and **Gloiodon strigosus** (Fr.) Karst. are reported as new to South America.

In August 1984,I had the opportunity to examine a backlog of approximately 1400 polypores in the New York Botanical Garden. Most of the specimens were collected by Kent Dumont during his many expeditions in South America. In addition Gary Samuels had collected rather extensively in Brazil and Venezuela in 1984, and his collection of polypores were also placed to my disposal. New York Botanical Garden covered my financial expenses for which I am very grateful.

Antrodiella angulatopora Ryv. sp. nov. Fig. 1A-D
Fructificatio pileata, pileus velutinus, ochraceus, zonatus,pori facies ochracea ad pallide brunnea, pori angulati vel sinuosi, 1-3 per mm, contextus ochraceus, systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales crassetunicatae, hyalinae, sporae subglobosae, 3.3-5 x 2.5-3 µm hyalinae, non-amyloideae.
Holotype: Venezuela, Edo Sucre, NW of Irapa, trail between Manacal and Los Pocitos. On dead branches. K.P. Dumont-VE 6037.
Holotype in VEN, isotype in O and NY.
Fruitbody pileate, sessile to dimidiate and partly dorsally attached, thin and pliable when fresh, rigid and brittle when dry, pileus 1-3 cm wide, 1-3 mm thick, curled when dry, pileus adpressed velutinate, ochraceous and zonate, pore surface cream to pale brown, pores angular, partly split, 1-3 mm wide, some pores elongated to 1 x 3 mm and tubes in parts split to almost flattened teeth, context paler than tubes, ochraceous, homogeneous and dense, 1-2 mm thick.

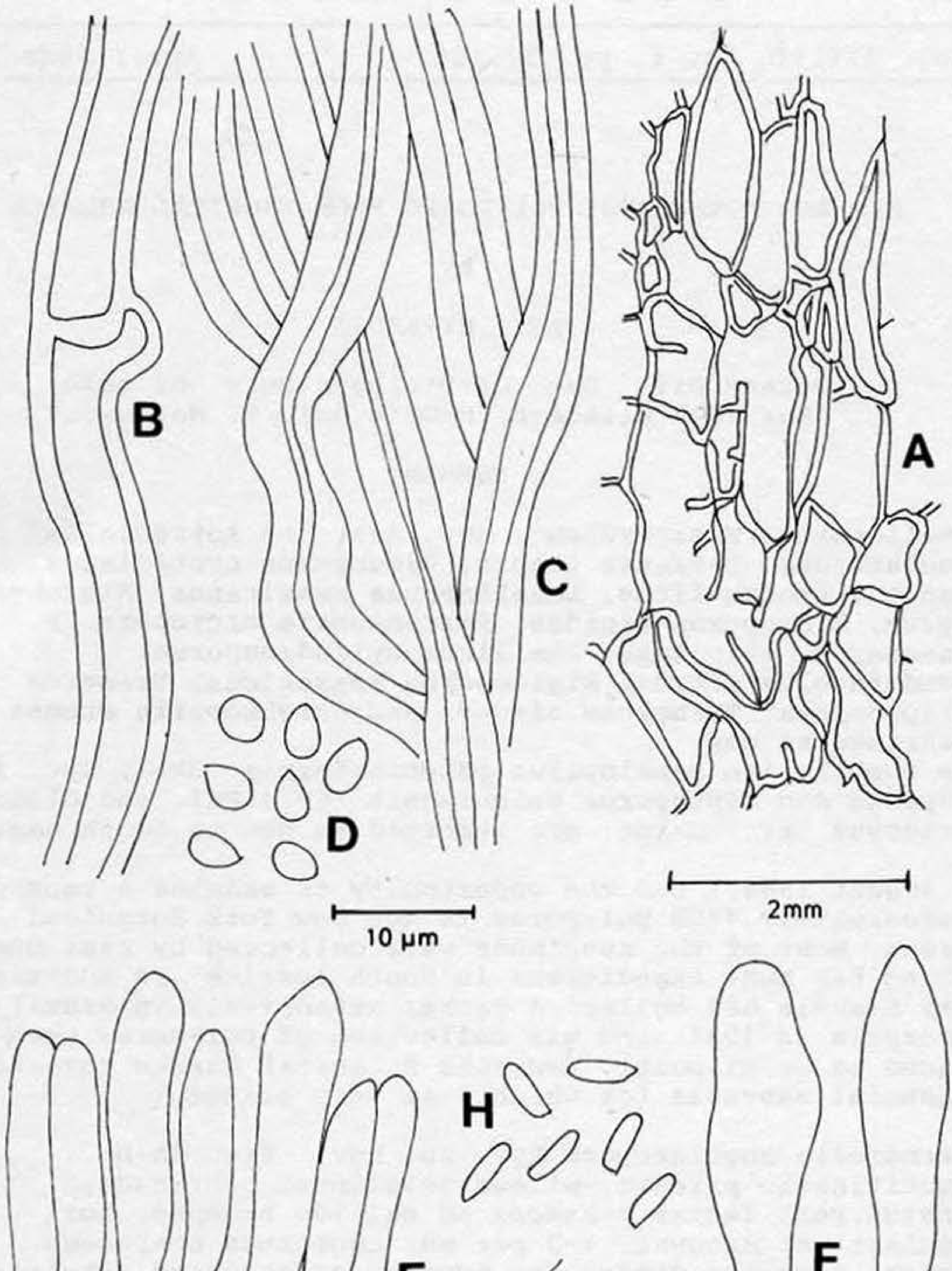

Fig. 1. **Antrodiella angulatopora** A) pore surface showing irregular pores, B) generative hyphae, C) skeletal hyphae, D) spores.
Gloeoporus cystididatus E) hymenium with cystidia, F) cystidia, G) hyphae from subiculum, H) spores. From the holotypes.

Hyphal system dimitic, generative hyphae with clamps, 2-4 µm wide in the subhymenium, in the context there are very thickwalled hyphae 4-12 µm wide with a very few scattered clamps in addition to long segments of hyphae with the same width and without clamps, the latter type of hyphae are interpreted as skeletal hyphae, cystidia not seen, basidia subclavate 10-12 x 5-6 µm with 4 sterigmata, spores subglobose 3-3.5 x 2.5-3 µm, non-amyloid, smooth and hyaline.

Owing to the dimitic hyphal system, the palecoloured fruitbody with a dense and semicartilaginous tube layer and small subglobose spores, **Antrodiella** Ryv. & Johan. seems to be the appropriate genus. The remarkable feature is the fissile, sinuous pores.

Datronia glabra Ryv. sp. nov.

Fructificatio pileatea dimidiata, pileus pallide brunneus, glabrus, pori facies alba inde brunnea, contextus brunneus, systema hypharum trimiticum, hyphae generatoriae fibulatae, hyphae skeletales flavae ad pallide brunneus, hyphae ligativae hyalinae, dextrinoideae, sporae cylindricae, hyalinae, 7-9 x 2-3 µm.

Holotypus: Venezuela, Amazonas Dpto Rio Negro, Rio Mawarinuma, Canon Grande, Neblima base Camp. 22. April 1984. G. Samuels 1499 (VEN), isotype in NY and O.

Fruitbody annual, pileate dimidiate, flabelliform to semicircular, flexible, up to 3 cm wide and 6 cm long, 4 mm thick at the base, pileus glabrous, sulcate and narrowly zoned, pale brown to cork colour, becoming bay in an irregular pattern from the base in the larger specimens, pore surface white when fresh, brown in on drying, pores isodiametric, 7-8 per mm, tubes first white, later pale brown, up to 2 mm thick, context dense and tobacco brown, homogeneous and with a thin cuticle in older specimens, up to 2 mm thick.

Hyphal system trimitic, generative hyphae with clamps, 2-5 µm wide, skeletal hyphae pale brown, thick-walled and slightly dextrinoid, 3-6 µm wide, dominating in the context, binding hyphae mostly confined to the trama, first hyaline, then pale brown, strongly dextrinoid, 2-4 µm wide, cystidia not seen, spores cylindrical hyaline, non-dextrinoid, 7-9 x 2-3 µm.

The species is strongly reminiscent of **D. caperata** (Berk.) Ryv. in its microscopical characters, such as spores and dextrinoid binding hyphae. It is easily separated, however, by its completely glabrous pileus with a bay-coloured base. In fresh specimens the white tubes contrast strongly with the dark brown context. It should be easy to recognize in the field. The literature has been searched in vain to find a suitable name.

Datronia Donk. is typified by **D. mollis** which has a duplex context with a black line separating an upper tomentum and lower denser context. This new species must be regarded as a tropical counterpart adapted to wet conditions where a tomentum is not necessary to overcome desiccation.

The bay to almost black cuticle developing from the base has however been retained.

Gloeoporus cystidiatus Ryv. sp. nov. Fig. 1E-H
Fructificatio resupinata ad pileatea, margo et contextus albus, pileus albus, floccosus, pori facies purpurea, pori angulati 4-6 per mm, systema hypharum monomiticum, hyphae generatoriae afibulatae, 2-4 µm in diametro, cystidia clavata, hyalina, leves, 25-30 x 5-7 µm, sporae cylindricae, hyalinae, non-amyloideae, 4 x 1 µm.
Holotype: Brazil, Amazonas st. Serra Araca, 8 km East of Tio Jauari, 60 m, 12-13 March 1984, Leg. G.J. Samuels no 868. INPA, isotypes in NY and O.
Fruitbody annual, resupinate to effuso-reflexed with a narrow pileus, 1-5 mm wide, pileus white and floccose, margin floccose, wide and white, pore surface purplish, pores angular, 4-6 per mm, tubes up to 500 µm deep, context white and cottony, very thin, tubes probably gelatinous when fresh, cartilaginous when dry. Hyphal system monomitic, generative hyphae with simple septa, moderately branched, 2-4 µm, up to 6 µm wide in the margin and context, thin to slightly thick-walled, cystidia abundant in the hymenium, clavate, hyaline, thin-walled and smooth, 25-30 x 5-7 µm, spores cylindric to suballantoid, hyaline, IKI- 4 x 1 µm.
This is a characteristic species in **Gloeoporus** because of the cystidia in the hymenium. Like all **Gloeoporus** species it has the strong contrast between a white floccose context and upper part of the pileus and a red to purplish hymenophore. The hymenium is continuous over the pore mouths as in other **Gloeoporus** species. Most of the specimens in the collection are resupinate and the pileus was only properly developed in one specimen.

Gloiodon strigosus (Fr.) Karst.
Brazil, Amazonas, Plateau of Serra Araca, North Mountain, 1250 m, 11. Feb. 1984. G.J. Samuels no 345.
This is the first report of this species from South America. It is often placed in Auriscalpiaceae because of its asperulate amyloid spores and dark fruitbody. It has a wide distribution in the Northern hemisphere.

Hapalopilus phlebiaeformis (Cke.) Ryv. comb. nov.
Basionym **Poria phlebiaeformis** Cke. in Grevillea 15:24, 1886.
Brazil, Amazonas: Estrada Manaus-Caracarai km 513, Novo Paraiso. Samuels et al. no 653.
This species belongs in the **Hapalopilus** Karst. by virtue of the reddish colouration in KOH, clamped generative hyphae and ellipsoid spores. The report in Lowe (1966:125) of skeletal hyphae is not correct, as the thick-walled hyphae in the context have scattered clamps and are not true skeletal hyphae. **H. albo-citrinus**, which is also widespread in the tropics (for a description, see Gilbertson & Ryvarden 1986:334), has cylindric spores.

Inonotus venezuelicus Ryv. sp. nov.
Fructificatio resupinata, effusa, poris facies brunnea, pori circulares vel angulati, 3-4 per mm, systema hypharum monomiticum, hyphae generatoriae tenuitunicatae ad crassitunicatae, hyalinae ad brunnae, 3-6 µm in diametro, afibulatae, setae absentes, sporae subglobosae, 5-6 x 4,5-5 µm.
Holotype: Venezuela, Edo Merida, Laguna Negra. East of Laguna Mucubaji, Parc Nac. Sierra Nevada, near Apartaderos. On **Polylepis** sp. leg. K.P. Dumont. Dumont-VE 2300, VEN, isotypes in O and NY.
Fruitbody resupinate, annual, effused, oblique, adnate, hard and brittle, margin distinct, smooth, dark brown, 1-3 mm wide, along upper edge simulating a sloping pileus, pore surface dark brown, glancing in incident light, pores round to angular, 3-4 per mm, tubes up to 10 mm, dark rusty brown, context dense, rusty brown and very thin.

Hyphal system monomitic, generative hyphae hyaline to rusty brown, thin-walled to thick-walled, 2-6 µm in diameter and with simple septa, moderately branched, basidia broadly clavate, 12-15 x 4-6 µm with 4 sterigmata, setae absent, spores sublobose, 5-6 x 4.5-5 µm, smooth, IKI-, rusty brown.
There are rather few resupinate **Inonotus** species and this habitat, the lack of setae and the rusty brown spores characterize this new species. In the synopsis by Pegler (1964), the new species will key out together with **Inonotus pseudoobliquus** from Siberia, which, however, has far larger spores.

Lamelloporus americanus Ryv. gen. et spec.nov. Fig. 2A-E
Fructificatio pileatea, spatulata, 1 x 1.5 cm, pileus glabrus, spadiceus, zonatus, lamellae concentricae, 1 mm distantes, contextus ochraceus ad spadiceus, systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales crassitunicatae, cystidia leves, cylindricae, sporae ellipsoideae 3-4 x 2-2.5 µm, hyalinae, non-amyloideae.
Holotype: Mexico, Vera Cruz, Mpio. Jalacingo, Barranca Cruz Blanca 21. Nov. 1972. 1500, on Ulmus sp. Leg. F. Ventura 7428. Holotype in herb. O, isotype in herb. XAL.
Fruitbody pileate, spathulate, 1 x 1.5 cm with a tapering base, up to 1.5 mm thick at the base, tough when fresh, dense and hard when dry, pileus glabrous, zonate, pale brown to almost bay when old, smooth becoming slightly wrinkled from the base and then finely pruinose (lens), margin thin and sharp, curled in dry specimens, hymenophore of concentric lamellae, ca. 1 mm apart, pale brown to beige, thicker towards the base, up to 1 mm deep, context first ochraceous soon becoming pale brown and cartilaginous with numerous concentric dark zones.
Hyphal system dimitic, generative hyphae with clamps, 3-6 µm wide, difficult to see in the subhymenium and context because of the dense texture, easily observed in the margin, skeletal hyphae thick-walled to solid, hyaline, cystidia

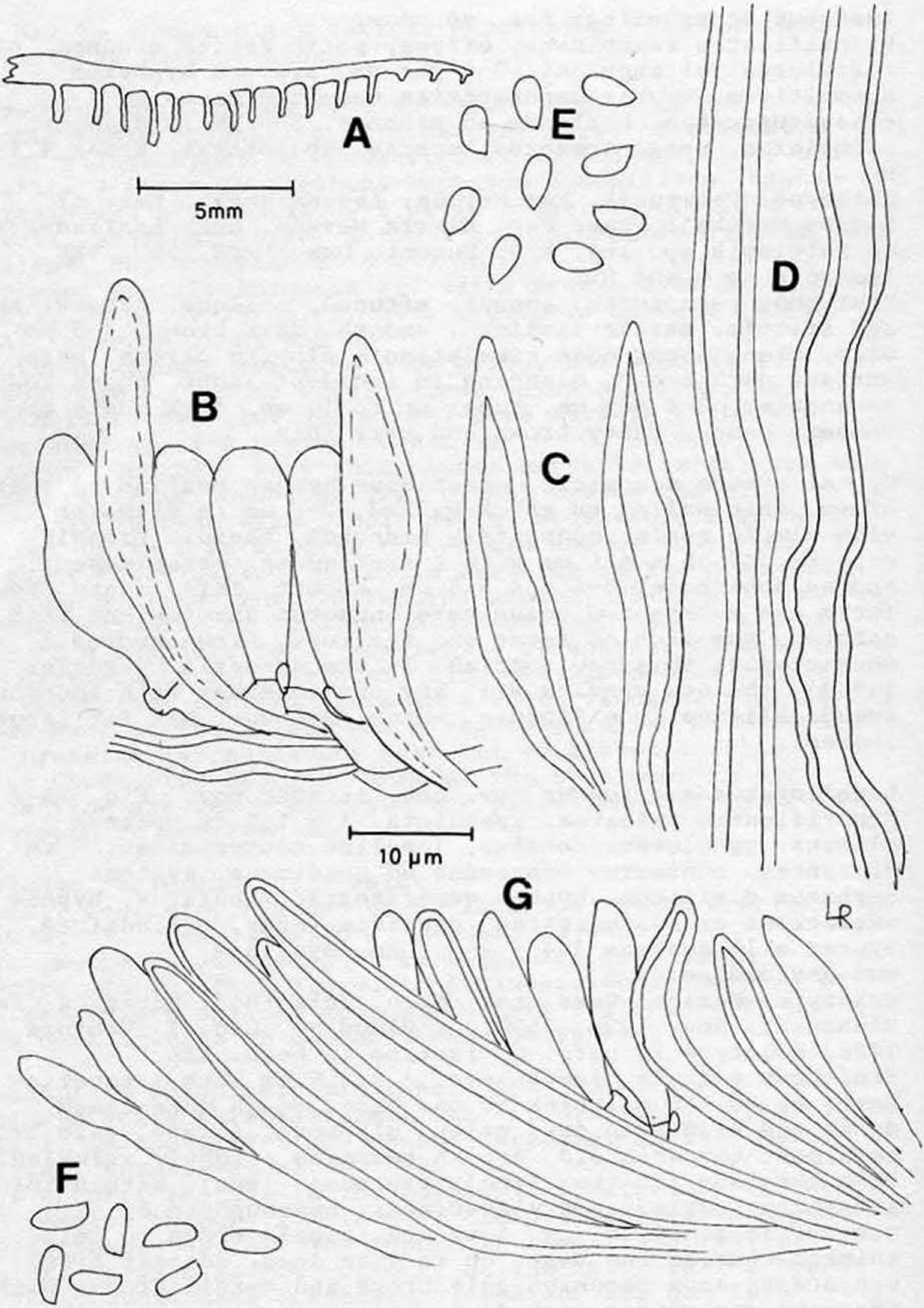

Fig. 2 **Lamelloporus americanus** A) section through fruitbody, B) hymenium with cystidia, C) cystidia, D) skeletal hyphae, E) spores.
Nigrohydnum nigrum F) spores, G) sterile hymenium with projecting skeletal hyphae. From the holotypes.

cylindrical, smooth, apparently thick-walled and rounded, projecting up 20 µm above the hymenium, 20-40 x 5-7 µm, arising in the subhymenium, basidia with 4 sterigmata, 10-14 x 4-5 µm, spores ellipsoid, smooth, thin-walled, hyaline and non-amyloid 3-4 x 2-2.5 µm.

Apart from the type, the following specimen has been examined: Venezuela: Edo. Bolivar, 118 km S of El Dorado, on road between El Dorado and Sta. Elena, N. facing slope of Uei-Tepui, 5. Aug. 1982, on dead wood, Leg. K.P. Dumont-VE 7019 (NY, O).
This is a remarkable species and for a long time the Mexican collection rested in my "problem" box until the second specimen from Venezuela was sent me in a large collection from South America. Among the polypores, concentric lamellae are only known in **Cyclomyces** Fr. a genus in **Hymenochaetaceae**, and grossly different from the species described here in microscopical characters. Except for the cystidia, the species could microscopically resemble a species of **Antrodiella** with its cartilaginous dense structure, dimitic hyphal system and small ellipsoid spores. However, the cystidia are different from the skeletal cystidia which occur in the subhyminum of some **Antrodiella** species. In **Lamelloporus** they arise in the subhymenium and project above the basidia. A lamellate condition has never been observed in **Antrodiella**. **Lamelloporus americanus** should be easy to recognize in the field because of the dense structure, the brown to bay colours and the concentric lamellae.

Nigrohydnum gen. nov.
Fructificatio pileatea, pileus glabrus, zonatus, niger, spinus niger, rotundus vel complanatus, stratosus, contextus purpureus-niger, systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales coloratae, sporae hyalinae, cylindricae, non-amyloideae.
Type species: **Nigrohydnum nigrum** Ryv.
Fruitbody pileate, semicircular, pileus glabrous, purplish black, zonate with age, becoming dark grey, hymenophore hydnoid, teeth round to flattened, along the margin in parts lamellate, context purplish black, hyphal system dimitic, generative hyphae with clamps, skeletal hyphae dark brown, acute, partly curving into the hymenium, basidia 4 sterigmate, spores cylindric. IKI-, hyalinae.
This is a unique genus combining a black to purplish colour with a strongly hydnoid hymenophore. In colour the fruitbodies strongly resemble **Nigrofomes** Murr. The dark colour and the spiny hymenophore also resembles **Gloiodon** Karst. which, however, has strongly warted and amyloid spores and belongs in the Auriscalpiaceae. A search in Harrison (1973) gave no result. **Fuscocerrena** Ryv. is a genus of Polyporaceae which has a dark hydnoid fruitbody of dark colour and cylindric spores (for a description, see Gilbertson & Ryvarden 1985:285), but its colour is distinctly brown and not purplish black. Further it has

dendrohyphidia in the hymenium while in **Nigrohydnum** the skeletal hyphae curve into the hymenium as cystidia.

Nigrohydnum nigrum Ryv. sp. nov. Fig. 2F-G
Fructificatio pileatea, 1-4 cm lata, 0.2-10 mm crassa, pileus glabrus, niger, zonatus, spinus niger, rotundus vel complanatus, 1-3 per mm, stratosus, contextus niger, systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales coloratae, sporae cylindricae, 4.5-5 x 2- µm.

Holotypus: Brazil, State of Amazonas, Serra Araca, 8 km E of Rio Jauari 1. March G.J. Samuels 686. INPA, isotype in O and NY.
Fruitbody pileate, semicircular, up to 3 cm wide, 5 cm broad and 1 cm thick at the base, tough and hard when dry, pileus purplish black, in young specimens with a very thin cover of adpressed tomentum, later glabrous, zonate, margin acute, hymenophore hydnoid, spines round to flattened and in parts, towards the margin, daedaleoid to semilamellate, individual spines up to 3 mm long, 1-3 per mm, hymenophore stratified with up to three layers of spines separated by a thin purplish layer of context, context purplish black and dense. Hyphal system dimitic, generative hyphae with clamps, 2-4 µm wide, trama and context dominated by brown skeletal hyphae, acute and parallel in the trama but from the subhymenium bending into the hymenium as brown pointed cystidia, 70-120 µm long, arising from a clamp, 4-12 µm wide, hymenial cystidia not seen, basidia 10-15 x 4-5 µm with 4 sterigmata, spores cylindric, hyaline, thin-walled and non-amyloid, 4.5-5 x 2 µm.
The species should be very easy to recognize because of the purplish black colour and the hydnoid hymenophore.

Nigroporus rigidus Ryv. sp. nov.
Polyporus scalaris Berk. 1856, non **P. scalaris** Pers. 1825.
Fructificatio sessilia, pileus brunneus, ad badius, tomentosus, pori facies brunnea, systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales pallide brunnea, sporae cylindricae, 3-3.5 x 2 µm, non-amyloideae.
Holotypus: Venezuela, T.F. Amazonas, Cerro de la Neblima, 21. April 1984. G.J. Samuels no 1478. NY (isotype in O).
Fruitbody pileate, biennal to perennial, rigid to woody, semicircular to lobed, broadly attached to dimidiate, up to 7 cm long and 4 cm wide and 1 cm thick at the base, pileus dark brown to deep umber, zonate, finely pubescent becoming blackish and almost glabrous from the base and then often finely scrupose, pore surface dark beige to dark brown, pores isodiametric, 7-9 per mm, tubes dark brown, often stratified, up to 7 mm deep, context slightly duplex, dark brown to umber, the upper part of looser consistency than the lower part, up to 3 mm thick.
Hyphal system dimitic, generative hyphae 2-4 µm wide with clamps,hyaline, skeletal hyphae thick-walled, pale brown, 2-5 µm wide, basidia 5-10 x 3-4 µm with 2 sterigmata (only 4

basidia observed),cystidia not seen, spores broadly cylindric, 3-3.5 x 2 µm, hyaline, thinwalled and non-dextrinoid.

Specimens seen: Brazil, Spruce 199, type of **P. scalaris** Berk., (K), Samuels 1474 and 1558, same locality as holotype.

As indicated above, this species was described already by Berk. in 1856, but under an illegitimate name. The type was sterile and a proper generic assignment was difficult to establish.

Samuels collection 1478 was fertile, and it was more desirable to use it as the type, and a new name had to be found anyway. **Nigroporus** seems to be the natural genus owing to the dark coloured fruitbody with a dimitic hyphal system and cylindrical spores. These characters are also found in **Nigroporus vinosus** (Berk.) Murr, the type of **Nigroporus**, which, however, has almost allantoid spores and a slightly more violet, thinner, and more flexible fruitbody.

N. rigidus is probably widespread in the Amazonian basin but no systematic collection of polypores has seemingly yet been undertaken in the area in recent times.

Perenniporia micropora Ryv. sp. nov. Fig. 3A-B

Fructificatia pileata usque ad 1.5 cm lata, 3 mm crassa, pileus ochraceus ad pallide brunneus, glabrus, zonatus, pori facies ochracea, pori 8-10 per mm, system hypharum dimiticum, hyphae generatoriae fibulatae, 2-3 µm in diametro, hyphae skeletales crassitunicatae 2-3(4) µm in diametro, dextrinoideae, sporae globosae ad subglobosae, 4.5-5 x 4-4.5 µm, crassitunicatae, leviter dextrinoideae.

Holotype: Peru, Depto. Huanuco, Parc National Tingo Maria, ca 5 km from Tingo Maria, on the Tingo Maria-Monzon Rd. 6. July 1976, on indet. log. 2600 ft. K.P. Dumont PE-1039. NY, isotype in O.

Fruitbody effused-pileate, up to 1.5 cm wide and long, 3 mm thick, pileus semicircular and slightly lobed at the margin, pileus ochraceous at the margin becoming dark brown from the base as a thin cuticle develops, glabrous, strongly zonate, slightly sulcate, margin acute, pore surface ochraceous to pale wood-coloured, pore invisible to the naked eye, 8-10 per mm, tubes concolorous, 1 mm deep, context pale cream, dense, 1 mm thick. Hyphal system dimitic, generative hyphae with clamps, 2-3 µm wide, skeletal hyphae straight to sinuous, unbranched or slightly branched, non-dextrinoid, 2-3 (4) µm wide, basidia not seen, spores globose to subglobose, thick-walled and slightly dextrinoid (easily seen in mass), 4.5-5 x 4-4.5 µm.

The species has the same colour of pore surface as **P. stipitata** described in this paper, but the pileus is far darker, the spores smaller, and the growth-habit is grossly different.

Perenniporia tepeitensis (Murr). Ryv. has a similar fruitbody, but larger pores and spores (4-5 per mm and 5-7 µm long respectively).

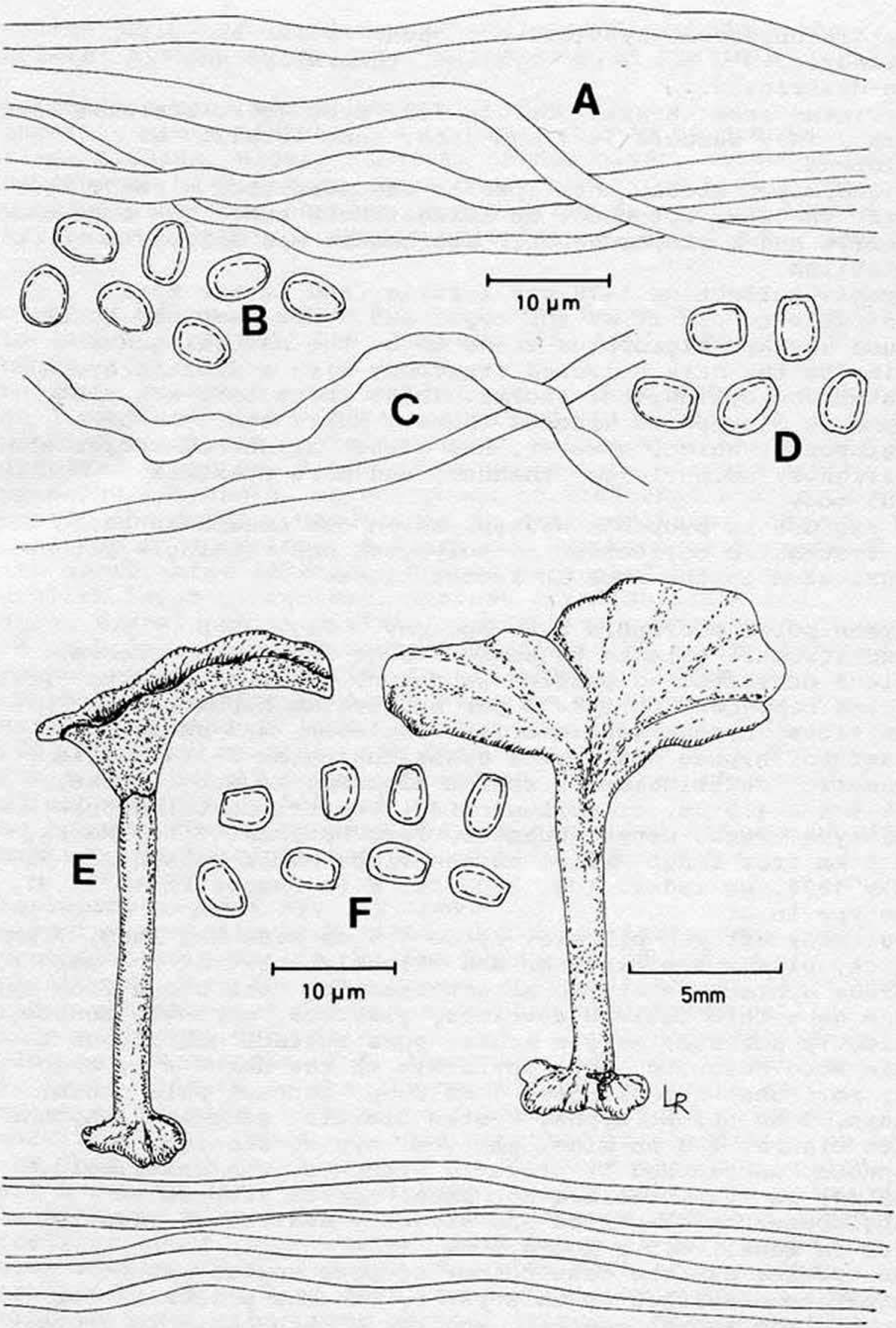

Fig. 3 **Perenniporia micropora** A) skeletal hyphae, B) spores. **Perenniporia sinuosa** C) skeletal hyphae, D) spores. **Perenniporia stipitata** E) fruitbodies seen from below and above, F) spores. From the holotypes.

Perenniporia sinuosa Ryv. sp. nov. Fig. 3 C-D
Fructificatio resupinata, pori facies cremea, pori angulati vel sinuosi, 2-3 per mm, contextus tenuissimus, ochraceus, systema hypharum dimiticum, hyphae generatoriae hyalinae, fibulatae, hyphae skeletales crassitunicatae, 1-3 µm in diam., dextriniodeae, sporae subglobosae, dextrinoideae, 4-5 x 3-4 µm.
Holotype: Brazil, State of Amazonas, Pico Rondon, 3. Feb. 1984. Leg. G.J. Samuels no 117. (NY, isotype in O).
Fruitbody resupinate, annual, separable with a wide margin or nodulose pilei along the upper edge, up to 8 mm thick measured vertically along the tubes, ca. 10 x 6 cm in the holotype, rather light of consistency and friable, margin pale brown, pore surface cream to ochraceous, pores angular 2-3 per mm on horizontal part of the fruitbody, sinuous and deeply split, tubes concolorous, context very thin to almost absent, cream-coloured.
Hyphal system dimitic, generative hyphae hyaline, 2-3 µm wide and with clamps, skeletal hyphae thick-walled, 2-3 µm wide, straight and unbranched, sinuous, rarely dichotomously branched, strongly dextrinoid. Basidia not seen. Spores subglobose to truncate, thick-walled, dextrinoid, 4-5 x 3-4 µm.
The species is undoubtedly related to **P. medulla-panis** (Fr.) Donk, but easily separated by the much larger pores and distinctly smaller spores. Similar spores and pores are seen in **P. variegata** Ryv. & Gilb. which, however, has a very dense translucent tube-layer changing colour from fresh to dry condition. This is not the case with **P. sinuosa** which retains its colour and friable consistency when dry.

Perenniporia stipitata Ryv. sp. nov. Fig. 3 E-F
Fructificatio stipitata, pileus glabrus, pallide brunneus, pori facies ochracea, pori minutus 8-10 per mm, stipes ochraceus, 1-2 mm in diam. 15 mm altus, glabrus, contextus ochraceus ad 200 µm crassus. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales crassitunicatae, dextrinoideae 3-7 µm in diam., sporae subglobosae, crassitunicatae, dextrinoideae, 5-6 x 3-4 µm.
Holotypus: Brazil, Roraima, Estrada Manaus-Caracarai, km 328. G. Samuels & I Araujo 487, herb. INPA no 77.014. 16 Nov. 1977. Isotypes in O, INPA.
Fruitbody laterally stipitate, pileus semicircular to flabelliform, up to 1 mm thick and 15 mm in diam, upper surface glabrous, finely zonate to smooth, ochraceous to pale brown, margin very thin, pore surface ochraceous to pale beige, pores 8-10 per mm, scarcely visible to the naked eye, stipe up to 15 mm high, 1-2 mm in diameter, glabrous concolorous with pore surface, tubes and context pale beige to ochraceous.
Hyphal system dimitic, generative hyphae 2-3 µm wide with clamps, skeletal hyphae 3-7 µm wide, thick-walled, strongly dextrinoid, basidia not seen, spores subglobose to truncate, thick-walled and dextrinoid, 5-6 x 3-4 µm.

The species is unique in **Perenniporia** by virtue of the lateral stipe and the fanshaped pileus. In one specimen from Colombia (see below) the stipe was almost absent and only the base of fruitbody strongly contracted. The type of fruitbody and the extremely small pores characterize the species.
Other specimen seen: Brazil, As in holotype, but km 513 ac. Novo Paraiso, I. Araujo et al. 657, 21. Nov. 1977 (NY, O, INPA), Colombia : Buenaventura, 26. June 1968. Welden no 4430 (O, NO), Trinidad: Waller Field 30. May 1960, H. Fleming 618 (O, NY), Panama: Panama prov. Altos de Pacora 30.6.1975, K.P. Dumont 1522, (NY, O), Panama: san Blas Prov. Puerto Obaldia, 22. Juni 1975, K.P. Dumont 981. (NY, O).

Phellinus cylindrosporus Ryv. sp. nov. Fig. 4 A-B
Fructificatio pileata, pileus brunneus, zonatus, glabrus, pori facies brunnea, pori rotundi, 6-8 per mm, systema hypharum dimiticum, hyphae generatoriae hyalinae, afibulatae, 2-3 µm in diametero, hyphae skeletales pallide brunneus, crassitunicatae, 4-6 µm in diametro, setae subulatae, brunneus, 25-35 x 5-12 µm, sporae hyalinae, cylindrici, 6.5 x 2-2.5 µm.
Holotype: Panama, vicinity Altos de Pacora, 26 km N of Pan American Highway, on old road to Mandinga, Prov. Panama. 2100 feet. Leg. K.P.Dumont 30. June 1975. Dumont PA-1609, on indet log. Holotype in NY, isotype in O.
Fruitbody pileate, flabelliform to semicircular and strongly contracted at the base to a narrow attachment, thin and coriaceous, up to 3 cm wide, 1-3 mm thick, pileus glabrous, subglossy, strongly zonate in rusty brown colours, in dry condition slightly radially wrinkled, margin thin and bent downwards, pore surface dark brown, pores minute, 6-8 per mm, tubes tobacco brown, up to 1 mm deep, context rusty brown, 1-2 mm thick.
Hyphal system dimitic, generative hyphae hyaline, simple septate, 2-3 µm wide, skeletal hyphae dominating, 3-6 µm wide, rusty brown and thickwalled, setae abundant, subulate, dark brown, 25-35 x 5-12 µm, basidia clavate, 12-15 x 6-7 µm, spores cylindrical to subnavicular, hyaline, and IKI negative, 6.5-7 x 2-2.5 µm.
The species is above all characterized by the thin and flexible fanshaped fruitbody with a narrow point of attachment, and the cylindrical spores. **Phellinus chinonensis** (Murr.) Ryv. has slightly wider spores of the same shape, but this is a ungulate to semiapplanate species, normally broadly attached, up to 7 cm thick and very hard. Macroscopically **Phellinus cylindrosporus** resembles **Phellinus discipes** from the paleotropical area, which, however, lacks setae and has shorter spores.

Piptoporus soloniensis (Fr.) Pil.
Venezuela, Amazonia, Estrada Boa Vista- Venezuela, BV 8, mata atras do posto de Funai. 30 Nov. 1977. Leg. G. Samuels et al. 715. This is the first report from South America. It

is a cosmopolitan species. See Schumacher & Ryvarden (1981) for a description with an extensive synonymy.

Pseudofavolus nigrus Ryv. sp. nov. Fig. 4 C
Fructificatio pileatae, dimidiata, cupulata, pileus glabrus, nigrus, azonatus, pori facies nigra, pori 4 per mm, contextus ochraceous, systema hypharum dimiticum, hyphae generatoriae fibulatae, 2-6 µm in diametro, hyphae ligantes leviter dextrinoideae, sporae cylindricae 15-18 x 5-7 µm hyalinae, non-amyloideae.

Holotype: Venezuela: Amazonas, Rio Pacinare, Yatua, Casiquiare, 4. Feb. 1954. Leg. Basset Maguire 37506 NY, isotype in O.
Fruitbody annual, pileate, dimidiate with strongly contracted base, cupulate, 5-15 mm in diameter, hard when dry, pileus black, dull, azonate, pore surface black with greyish black and finely grainy dissepiments, pores angular, 4 per mm, tubes concolorous up to 300 µm deep, context dense, ochraceous and with a very thin black cuticle, hyphal system dimitic, generative hyphae with clamps, 2-6 µm in diameter, binding hyphae moderately branched, solid, gelatinized in 3% KOH, weakly dextrinoid, cystidia not seen, basidia clavate, 30-40 x 10-14 µm with 4 sterigmata, spores cylindrical, 15-18 x 5-7 µm, hyaline, thin-walled and non-amyloid.
P. nigrus is distinguished from the similar **P. orinoccensis** principally by the black colour and the non-gelatinized binding hyphae of the latter. **P. orinoccensis** is ochraceous throughout the fruitbody. **P. nigrus** should be easy to recognize in the field owing to its semistipitate, cupulate and black fruitbodies.

Rigidoporus amazonicus Ryv. sp. nov.
Fructificatio stipitata, pileus ochracues, stipes laterales, ochraceus, pori facies isabellina, pori minuti, 7-8 per mm, contextus albus ad ochraceus, duplex cum zona fusca, systema hypharum monomiticum, hyphae generatoriae afibulatae, cystidioles praesentes, spores ellipsoideae, non-amyloidea, hyalinae, 4-4.5 x 3-3.5 µm.
Holotype: Brazil, State of Amazonas, Serra Araca, 10-13 March 1984, on the ground, G.J. Samuels no 787. Isotype in O and NY.
Fruitbody laterally stipitate, annual, pileus up to 5 cm wide, single or fused to form more compound fruitbodies, dull, azonate, ochraceous with some olivaceous tints, wrinkled in dry condition, smooth when fresh, adpressed tomentose, stipe lateral, concolorous with the pileus, up to 4 cm long and 1 cm in diameter, pore surface isabelline, strongly decurrent but strictly delimited from the sterile parts of the stipe, pores minute, 7-8 per mm, tubes dense and semitranslucent, up to 2 mm deep, context when dry, white to pale ochraceous delimited towards the thin adpressed tomentum by a very thin dark line.

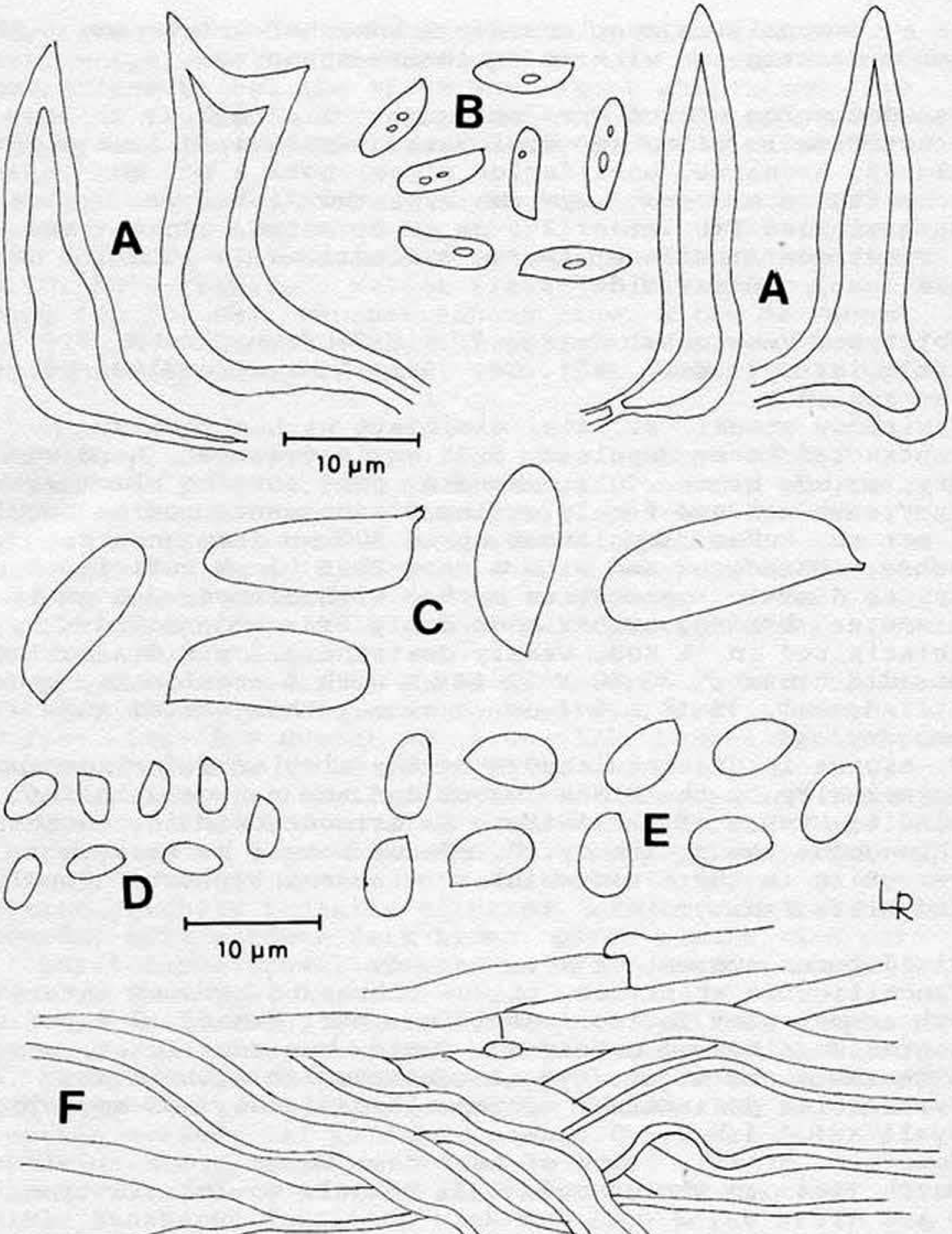

Fig. 4 **Phellinus cylindrosporus** A) setae, B) spores.
Pseudofavolus nigrus C) spores.
Trametes ellipsospora C) spores.
Tyromyces singeri E) spores, F) hyphae from the context.
From the holotypes.

Hyphal system monomitic, generative hyphae with simple septa, in the subhymenium 2-4 µm wide and thin-walled, in the trama and context thick-walled with scattered septa, 3-8 µm wide and slightly branched, basidia 12-15 x 5-6 µm with 4 sterigmata, cystidiols present among basidia, concial, smooth, 12-15 µm long, spores ellipsoid to dropshaped, hyaline, thinwalled and IKI-, 4-4.5 x 3-3.5 µm

Other specimen examined: Same locality, Samuels no. 959 NY (O).
The new species looks like a large specimen of **R. biokensis** (Lloyd) Ryv. which also has a lateral stipe. However, **R. biokenesis** is a small species and besides has a homogeneous context and larger, globose spores.
The holotype is a compound fruitbody, with two specimens fused in their lower part of the stipe and in small lateral part of their pileus. At first sight it may be taken for a centrally stipitate species, but the seam along the joined part of the pileus and the other specimen (Samuels no 959) confirm the lateral attachment which makes the fruitbody partly fanshaped. The spores are distinctly tapering towards the apiculus, which is unusual in the **Rigidoporus**. The cystidioles, the simple septate generative hyphae and the dense fruitbody makes **Rigidiporus** the appropriate genus. It is my guess that the pore surface has a distinct pink hue when fresh. Typically many reddish to pink **Rigidoporus** species fade to isabelline upon drying.

Trametes ellipsospora Ryv. sp. nov. Fig. 4D
Fructificatio pileatea, 1-6 x 2-5 x 0.2-1 cm, pileus glabrus ochraceus, leviter zonatus, pori facies ochracea, pori angulati, 4-5 per mm, contextus albidus, systema hypharum trimiticum, hyphae generatoriae fibulatae, hyalinae, hyphae skeletales hyalinae crassitunicatae, hyphae ligantes praesentes, sporae ellipsoideae, leves, non-amyloideae, 3-4 x 2.5-3 µm.
Holotypus: Venezuela, Dpto. Rio Negro, Cerro de la Neblina, along Rio Mawarinuma, just outside Canon Grande, Neblima Base Camp, 29. April 1984. Leg. G. Samuels 1697. VEN, isotypes in O and NY.

Fruitbody pileate, semicircular to dimidiate with contracted base 1-6 cm wide, 1-5 cm broad and 0.2-1 cm thick, tought when dry, upper surface glabrous, ochraceous, slightly zoned, in part covered with scattered and irregular warts or protuberances, especially towards the base, margin thin and acute, pore surface ochraceous to pale straw-coloured glancing in incident light, pores thin-walled, angular, 4-5 per mm, tubes white to pale cream, up to 3 mm deep, context white and cottony.

Hyphal system trimitic, generative hyphae with clamps, 2-5 µm wide, skeletal hyphae dominating, thick-walled, hyaline 3-10 µm wide, binding hyphae scattered in context, sparingly branched, in parts reminding of the **Bovista** type, solid, 2-5 µm wide, cystidia not seen, basidia clavate, 15-18 x 4-6 µm with 4 sterigmata, spores broadly ellipsoid, smooth hyaline and IKI-, 3-4 x 2.5-3 µm.

In macromorphology, this species resembles **T. marianna** (Pers.) Ryv., a paleotropical species which, however, has cylindric spores. The upper surface may also resemble **T. elegans** (Fr.) Pat., but this species also has cylindric spores and normally elongated to daedaleoid pores. I have searched the literature in vain to find a species with such ellipsoid spores. The trimitic hyphal system and the hyaline spores places the species clearly in **Trametes**.

Tyromyces singeri Ryv. sp. nov. Fig. 4E-F
Fructificatio annua, stipitata, pileus glabrus, rubrus, pori facies rubra, pori angulati 3-4 per mm, contextus rubrus ad aureus. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales paucal, crasse tunicatae, sporae ellipsoideae, leves, non-amyloideae, 6-8 x 3-4 µm.

Holotypus: Brazil, Amazonas, Rio Tarmura in Igapo vegetation,on the ground and very rotten wood, 13. March 1983. Coll.,G. Mill & Singer, no 12409 A, F isotype in O.

Fruitbody laterally stipitate, annual, fleshy, taste mild, without odour, pileus bright red fading to yellowish red, no reaction with KOH in either fresh or dry condition, glabrous with some radial streaks, margin thin and deflexed when dry, stipe slightly expanded towards the pileus, glabrous, bright red when fresh, yellow, up to 8 mm in diameter, rhizomorphs conspicous and red in the substrate, pore surface bright red, yellow when fresh, pores angular 3-4 per mm, more elongated and larger towards the stipe, tubes red to yellow, fragile and slightly cartilaginous when dry, context red to yellow, dense, up to 2 mm thick.

Hyphal system dimitic, generative hyphae with clamps, 2-5 wide, skeletal hyphae few, thick-walled and of same width, basidia not seen, spores ellipsoid, smooth and non-amyloid 6-8 x 3-4 µm.
This is a remarkable species distinguished by its red colour and by growing on wood inundated under the yearly flooding in the Amazon river (Singer pers. comm.). The colour may recall a **Hapalopilus** species, but there is no reaction with KOH. Even if the species is stipitate, **Tyromyces** seems to be the appropriate genus. There are brightly coloured species in the genus like **Tyromyces kmetti** and **T. incarnatus** while species like **T. floriformis** has semistipitate fruitbodies with strongly contracted bases.

Wrightoporia cremea Ryv. sp. nov.
Fructificatio pileata, cremea, pori facies cremea, pori 3-4 per mm, systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales crasse tunicatae, dextrinoideae, sporae subglobosae 3 x 3.5-4 µm, verrucosae, amyloideae.

Holotype: Brazil, Amazonas, Roraima. Eastrada Manaus-Caracarai, do km 335 Toco. 17. Nov. 1977. Leg. I Araujo et al. Herb. INPA (Manaus) no. 77.538. Holotype in INPA, Isotypes in O and NY.

Fruitbody annual (biennial?) pileate, broadly attached, tough, 2 x 3 cm, upper surface cream to pale ochraceous, velutinate to glabrous, azonate, pore surface wood-coloured to cream, pores 3-4 per mm, round to angular, tubes in two distinct layers separated by a thin layer of context, tubes concolorous with pore surface, context pale ochraceous, homogenous, rather dense.

Hyphal system dimitic, generative hyphae with clamps, 1.5-3 µm wide, skeletal hyphae thick-walled, 2-5 µm wide, hyaline, strongly dextrinoid, cystidia and basidia not seen, spores subglobose, 3-3.5-4 µm, asperulate and amyloid.

The species is undoubtedly related to **W. subrutilans** (Murr.) Ryv. which is known from North America. However, this species has smaller pores and spores and gloeocystidia are present in the context, sometimes curving into the hymenium. See Ryvarden 1982.

W. brunnoea-ochracea David. & Rachjenberg was recently described from Guadeloupe (David & Rachjenb. 1985:319). This species has a chestnut-coloured pileus and context with coloured skeletal hyphae. Further the spores are ellipsoid and only 2 µm wide.

Acknowledgements.

Dr. Clark Rogerson at the New York Botanical Garden was very supportive during my stay in New York, and it is a pleasure for me to thank him for his kindness. Dr. David Pegler of the Kew Gardens, London has suggested many improvements in the English text for which I am very grateful.

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 543-552 April-June 1987

NOTES ON STEREOID FUNGI I. THE GENUS DENDROPHORA, STAT. NOV., AND PENIOPHORA MALENCONII SUBSP. AMERICANA, SUBSP. NOV. ("STEREUM HETEROSPORUM")

George P. Chamuris

Systematic Botany, Mycology & Nematology Laboratory
Biosystematics & Beneficial Insects Institute
United States Department of Agriculture
Building 011A, BARC-West
Beltsville, Maryland 20705

Peniophora Cooke subg. *Dendrophora* Parm. is raised to generic rank because of the characteristic dendrohyphidia. Three species are recognized: *D. albobadia* (Schw.:Fr.) comb. nov, *D. erumpens* (Burt) comb. nov., and *D. versiformis* (Berk. & Curt.) comb. nov. Also, the western North American species known previously as *Stereum heterosporum* Burt is named *P. malenconii* subsp. *americana*, subsp. nov.

DENDROPHORA (Parm.) Chamuris, stat. nov. (gen.)

Basionym: *Peniophora* Cooke subg. *Dendrophora* Parm., Conspectus Systematis Corticiacearum, p. 131. 1968.

Type species: *Stereum versiforme* Berk. & Curt.

Basidiomata usually annual; resupinate, effuso-reflexed or sessile-pileate, often umbonate; coriaceous to coriaceous-papery; when thick, corky to somewhat brittle. Upper surface appressed, matted-tomentose to felty; brownish. Hymenial surface even; finely pruinose; brownish to gray.

Hyphal system monomitic; hyphae with clamps, hyaline to brown, thin- to thick-walled, some skeletoid. Dendrohyphidia present in hymenium, apical branches often sinuate, subhyaline to brown, thick-walled; uniform in pigmentation or pale at the base and brownish at branch tips; dark tips demarcate layers (2 - 3) when stratose. Embedded dendrohyphidia present or absent, dark brown, forming a dark abhymenial zone. Cystidia in hymenium acute, thick-walled and heavily encrusted at maturity; when young, thin-walled, smooth, contents weakly sulfo-positive. Embedded, heavily encrusted cystidia present or absent, broader than hymenial cystidia. Basidia narrowly clavate, 4-sterigmate, with a basal clamp. Basidiospores cylindrical to allantoid, hyaline, smooth, thin-walled, negative in Melzer's reagent, uninucleate.

All species are associated with a white rot. *Dendrophora albobadia* and *D. versiformis* are heterothallic, with bifactorial sexual incompatibility (Boidin & Pomeys, 1961; and Boidin, 1958 respectively); *D. erumpens* is presumed to be the same.

Accepted species: **D. albobadia** (Schw.:Fr.) comb. nov. (basionym: *Thelephora albo-badia* Schw., Schriften Naturf. Ges. Leipzig 1:108. 1822; Fr., Elench. fung. 1:189. 1828), lectotype (designated here) in BPI (Michener Herb., Folder XIV, Sheet 13); **D. erumpens** (Burt) comb. nov. (basionym: *Stereum erumpens* Burt, Ann. Missouri Bot. Gard. 7:209. 1920), isotypes in BPI & FH; **D. versiformis** (Berk. & Curt.) comb. nov. (basionym: *Stereum versiforme* Berk. & Curt., Grevillea 1:164. 1873), holotype in K, isotype in FH. Type specimens cited above have been examined by the author. Descriptions and citation of additional specimens will appear in a future publication on the non-stipitate stereoid fungi in the northeastern United States and adjacent Canada.

Discussion: Parmasto (1968) erected the subgenus *Dendrophora* to accommodate those species of *Peniophora* possessing pigmented, thick-walled dendrohyphidia. These species were discussed by Boidin (1961), who later accepted Parmasto's subgenus (Boidin & Lanquetin, 1974). In the present paper they are separated from other *Peniophora* species.

The dendrohyphidia in *Dendrophora* are strikingly different from those formed by species such as *P. lycii* (Pers.) Höhn. & Litsch., *P. polygonia* (Pers.:Fr.) Bourd. & Galz., *Dendrocorticium roseocarneum* (Schw.) M. Larsen & R.L. Gilb. and *Punctularia strigoso-zonata* (Schw.) Talbot (FIG. 1). In the latter species the dendrohyphidia are more or less hyaline, rela-

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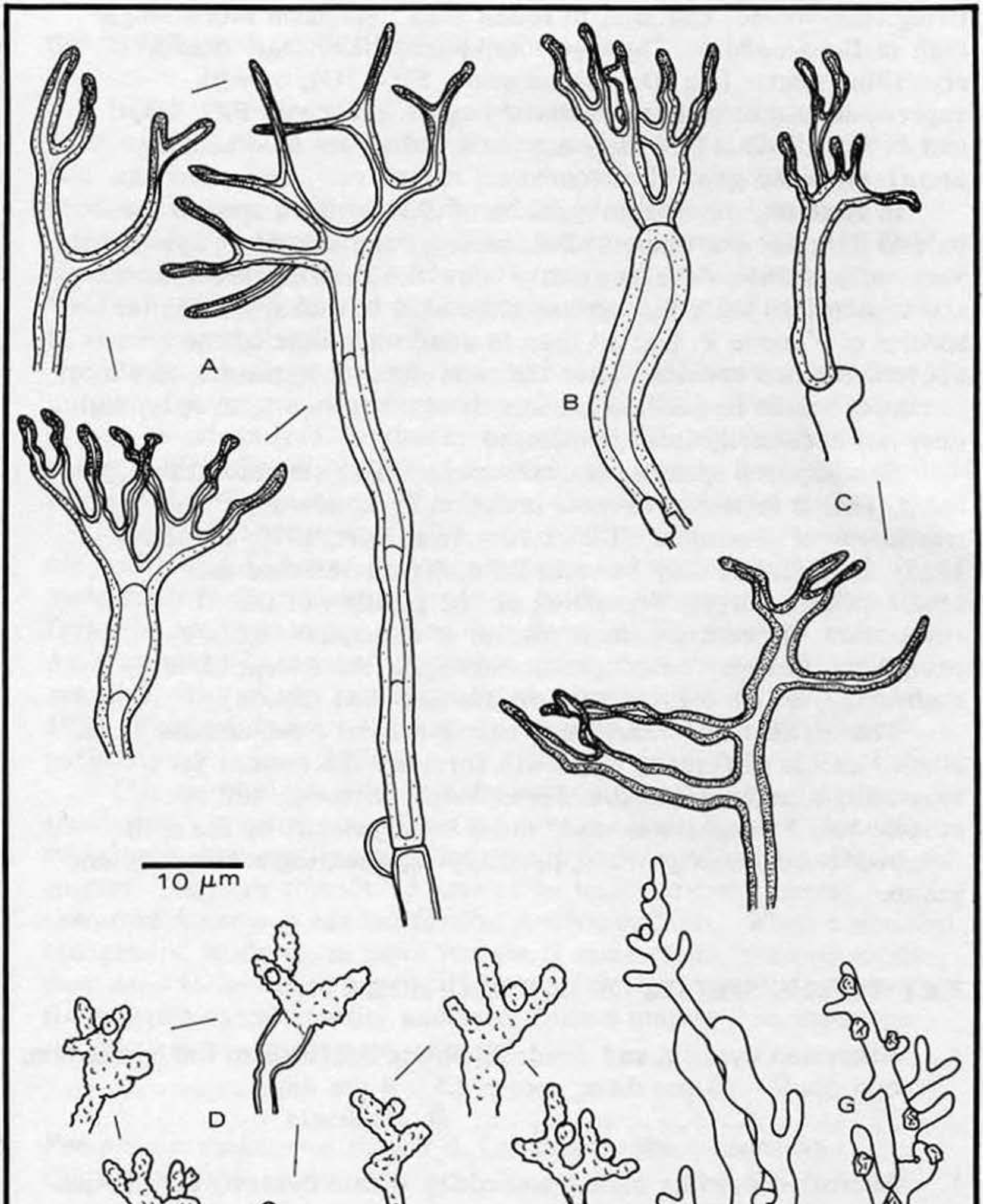
FIG. 1. Comparison of dendrohyphidia. A. Hymenial dendrohyphidia of *Dendrophora albobadia* (GPC 1767 [NYS]). B. Hymenial dendrohyphidium of *D. erumpens* (Bartholomew 4905 [NY]). C. Hymenial (upper) and embedded (lower) dendrohyphidia of *D. versiformis* (Underwood [NY]). D. *Peniophora polygonia* (BPI 228530). E. *P. lycii* (BPI 288264 ex LY 2851). F. *Punctularia strigoso-zonata* (GPC 1499 [NY]). G. *Dendrocorticium roseocarneum* (DP Rogers 2122 [NY]).


A
B
C
10 µm
D
E
F
G
1

tively thin-walled, and tend to retain their cytoplasm much longer than in *Dendrophora.* These structures may be encrusted with crystalline matter (e.g. *D. roseocarneum*, FIG. 1G), or with appressed, brittle, resinous material (e.g. *P. polygonia* FIG. 1D, and *P. lycii*, FIG. 1E). They are branched apices of otherwise undifferentiated generative hyphae.

In contrast, the dendrohyphidia of *Dendrophora* species are pale to dark brown, thick-walled, smooth, and devoid of cytoplasm very early in their development. I view the *Dendrophora*-type as short, modified skeletoid hyphae more akin to dichohyphidia (as in species of *Vararia* P. Karst.) than to dendrohyphidia of the abovementioned species. Thus the term dendrohyphidium, like most terms for sterile hymenial elements, is a descriptive term only, and does not necessarily infer homology.

Dendrophora species are characterized by a stereoid growth habit. This is reflected in their inclusion in conservative treatments of *Stereum* J. Hill ex Pers. (e.g. Burt, 1920; Lentz, 1955). Basidiomata may be resupinate, effuso-reflexed or sessile-pileate, largely depending on the position of the substratum. In contrast, most species of *Peniophora* s.s. are resupinate, but may have upturned margins. An exception is *P. malenconii*, which can be truly pileate (see next section).

The distinct difference in dendrohyphidial type, and the usual albeit flexible difference in growth form are the reasons for separating *Dendrophora* from *Peniophora.* Although still heterogeneous, *Peniophora* is made more homogeneous by the split. *Dendrophora* is homogeneous, probably representing a monophyletic group.

KEY TO THE SPECIES OF DENDROPHORA

1. Encrusted cystidia and dendrohyphidia confined to the hymenium; cystidia 9 - 15 µm diam; spores 2.5 - 4 µm diam . . . . *D. albobadia*

1. Encrusted cystidia mostly embedded within context, 10 - 25 µm diam; dendrohyphidia both in hymenium and embedded in context; spores 1.5 - 2.5 µm diam 2

    2. Basidiomata adnate and spreading when young; hymenial surface rich brown; upper surface brown . . . . *D. versiformis*

    2. Basidiomata erumpent and discrete, with elevated margins when young; hymenial surface gray; upper surface blackish . . . . *D. erumpens*

ON "STEREUM HETEROSPORUM"

Burt (1920) described a new species, *Stereum heterosporum*, from western North America. Unfortunately he based his species on two macroscopically similar but microscopically distinct taxa, choosing as type material specimens of *D. albobadia* (see **Additional Specimens** below). The type specimens in BPI and FH have been critically examined, and are typical *D. albobadia*. Welden (1975) discovered the problem, and reduced *S. heterosporum* to synonymy under *D. albobadia.*

Burt's description was primarily but not exclusively based on the numerous paratype specimens cited (1920, p. 221). These specimens, as well as others (see **Specimens Examined**), belong to the other taxon, which apparently represents the new species Burt had in mind. After Welden's synonymy, this taxon was left without a name.

Boidin & Lanquetin (1977), aware of the synonymy between *D. albobadia* and *S. heterosporum*, proposed the name *Peniophora malenconii* for specimens thought to be *S. heterosporum* known from the Mediterranean region (see Reid, 1968). Matings between American and European population representatives were largely negative, with clamp formation in some crosses (Boidin & Lanquetin, 1977). These data were cited as an example of partial interincompatibility by Boidin (1986).

The morphological identity between European and American specimens, taken together with the mating results suggest that the two forms represent partially interincompatible, allopatric sibling species. They are considered here to be taxonomic subspecies, therefore a name is needed for the American form. When a detailed taxogenetic study using more isolates is undertaken, the subspecies may need to be raised to specific rank. For the present time however, the morphological identity and inconclusive mating data make me reluctant to propose a new species.

Peniophora malenconii Boidin & Lanquetin subsp. **americana** Chamuris, subsp. nov. FIGS. 2 & 3

> *Peniophora malenconii* subsp. *malenconii affinis, sed segregatus geographice et genetice in parte.*
> *Holotypus*: U.S.A.: California, Berkeley, *in lignum corticum*, 14 Feb 1937, E.E. Morse 488, BPI 272468, *ut Stereum heterosporum.*
>
> Type subspecies: *P. malenconii* subsp. *malenconii* Boidin & Lanquetin, Rev. Mycol. (Paris) 41:120. 1977. Holotype in LY. Illustrations: Boidin & Lanquetin, loc. cit., p. 121; Reid, 1968, p. 255.

Basidiomata annual; resupinate, effuso-reflexed or sessile-pileate; confluent; coriaceous to coriaceous-papery. Reflexed parts umbonate when young, becoming laterally extended when confluent; up to 1 cm wide. Upper surface felty when young, becoming matted-tomentose, sometimes glabrous and shiny in age; zonate; *brown (7E5 - 7) to dark brown (8F8), fading to grayish brown, margin white to cream. Hymenial surface even; finely pruinose; cracked when mature; uniformly colored or with 2 - 3 concentric zones of different shades; gray brown (6 - 7E3), brown (6E4, 6E7) to dark brown (7F5 - 8, 8F3 - 4); often with dark violaceous tints.

Hyphal system monomitic; hyphae (2.5 -) 3 - 4 µm diam, with clamps, of two intergrading types: a) hyaline to pale brown, thin-walled, b) pale to dark brown, thick-walled, some ending in hymenium as cystidia. In section 150 - 500 (- 700) µm thick. Context composed of interwoven hyphae with a radial orientation; darker toward tomentum, forming a cutis, also darker in subhymenium. Hymenium thickening, occasionally with 2 strata. Cystidia variable, mostly encrusted, crystals soluble in 3% KOH; thick-walled at maturity, thin-walled with weakly sulfo-positive contents when young; walls uniformly brown, or more commonly darker at apices; embedded in subhymenium and hymenium, or projecting up to 25 µm from the hymenium; acute or cylindrical, often with collapsed or malformed tips; 50 - 100 x 7 - 12 µm. Basidia narrowly clavate, occasionally with slightly thickened walls, 4-sterigmate, with a basal clamp, 30 - 50 x 6 µm. Basidiospores cylindrical to suballantoid, hyaline (may become yellow brown when embedded in thickening hymenium), smooth, negative in Melzer's reagent, uninucleate, 8 - 10 (- 13) x 3 - 3.8 (- 4.2) µm.

Substrata: Dead, usually corticate limbs and trunks of woody dicots; associated with a white rot.

Specimens examined: ARIZONA: on *Acer glabrum* Torr., 272610 [BPI]. CALIFORNIA: on *Acacia* sp., 272611; on *Aesculus californica* (Spach) Nutt., 272612; on *Adenostoma fasciculatum* Hook. & Arn., 272613; on *Baccharis pilularis* DC., 272614; on *Citrus limon* (L.) N.L. Burm., 272615; on *C. grandis* (L.) Osbeck (= *C. maxima* (Burm.) Merr.), 270021; on *C. sinensis* (L.) Osbeck, 272457; on *Crossosona* sp., 272616; on *Encelia californica* Nutt., 272617; on *Eucalyptus globulus* Labill., 272622 & 272623; on *Eucalyptus robusta* J.E. Smith, 272624; on *Eucalyptus* sp., 272618, 272619, 272620 & 272621; on *Laurocerasus lyoni* Britton, 272444; on *Quercus agrifolia* Nee, 272626, 272627 & 272628; on *Umbellularia californica* (Hook. & Arn.) Nutt., 272631 & 272632; on wood, 272607, 272629, 272460 &

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*Colors according to Kornerup & Wanscher (1978)

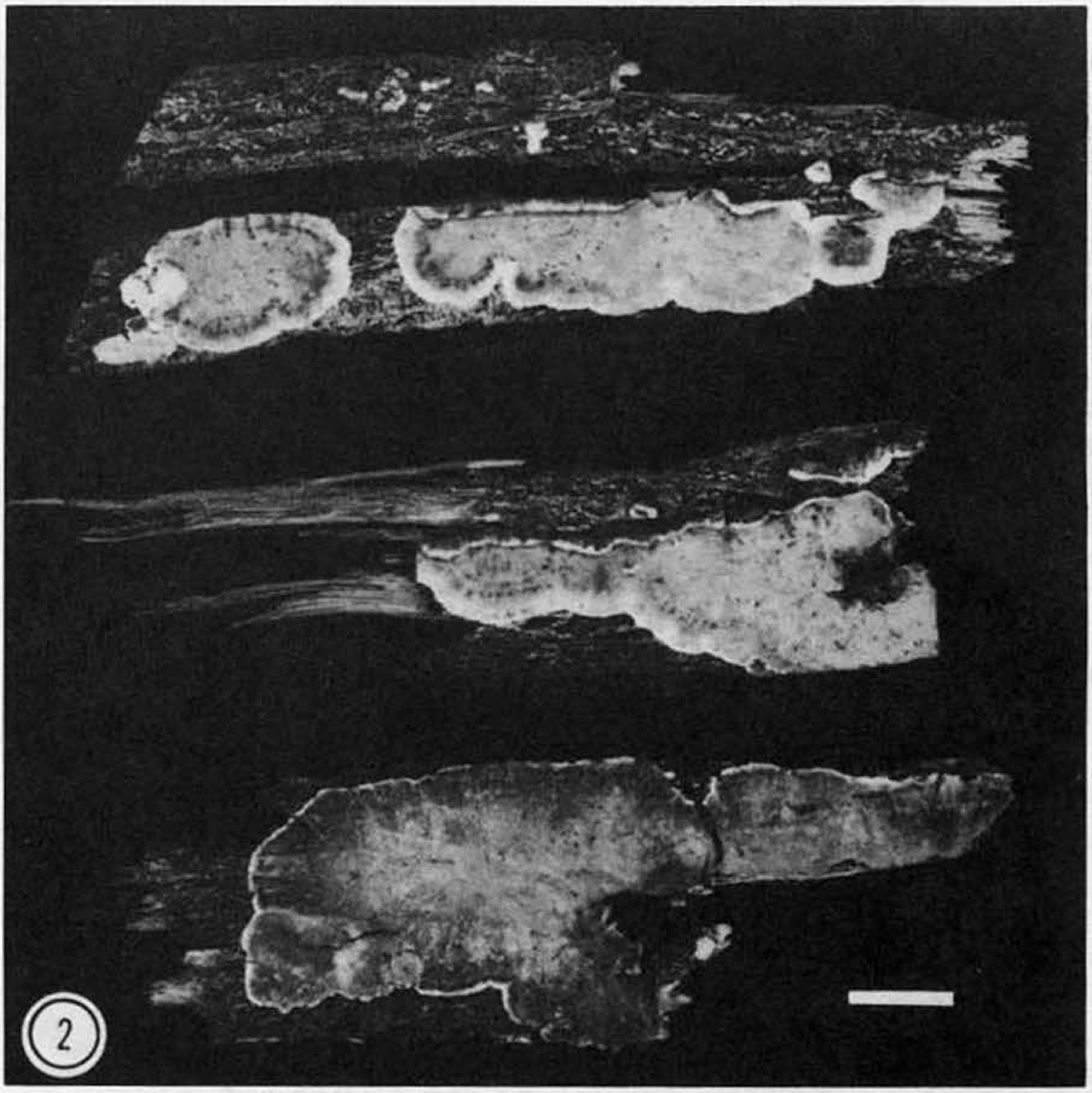

FIG. 2. Basidiomata of *Peniophora malenconii* subsp. *americana*. Holotype. Scale bar = 1cm.

272468; on boards, 269931 [all BPI]; on *Baccharis pilularis*, W.B. Cooke 16554; on *Eucalyptus globulus*, A.J. McClatchie; on *Platanus* sp., M. Doty 2856; on *Umbellularia californica*, California Fungi 573; on wood, A.J. McClatchie 555, M. Doty 3394; on vascular cylinder of cactus, M. Doty 3378 [all NY]. UTAH: on *Rosa* sp. (cultivated), C.T. Rogerson 1.vi.1977 [NY].

Additional specimens: 1) Ellis & Everhart, *Fungi Columbiani* n. 1116, as *Stereum albobadium*, on *Eucalyptus globulus* from California is *P. malenconii* subsp. *americana*; specimens examined in BPI and NY.
2) Type specimens cited by Burt (1920, p. 221), E.O. Matthews 3 and 27, should be called syntypes since it is not clear that he was referring only to one specimen. There are two specimens in BPI labeled EOM 3, one on "inside of oak water barrel" (BPI 272458, Mo. Bot.

FIG. 3. *Peniophora malenconii* subsp. *americana*. A. Origin of specimens examined. B. Radial section through reflexed basidioma. C. Microscopic features of two-tiered hymenium. Holotype.

Gard. 44282), and one on "*Juglans* sp." (BPI 272459, Mo. Bot. Gard. 44420); EOM 27, on *Juglans pecan* Marsh. (= *Carya illinoensis* (Wang.) K. Koch) (BPI 272469, Mo. Bot. Gard. 44106). All were collected in Mexico, and are *D. albobadia*.

3) Another EOM collection from Mexico (BPI 272443) is indeterminable. Burt (1920, p. 221) cited a specimen from Oregon (Humphrey 6125), but this could not be located in BPI.

4) Two additional specimens were filed under *S. heterosporum* in BPI: BPI 272609, on *Abies* sp. from Washington is *Hymenochaete tabacina* (Sow.:Fr.) Lév.; and BPI 272625, on *Fraxinus velutina* Torr. from Arizona is *D. albobadia*.

ACKNOWLEDGMENTS

The curators of the following herbaria are thanked for loans of specimens: BPI, FH, K, LY and NY. Dr. J.H. Ginn's critical review of the manuscript is gratefully acknowledged.

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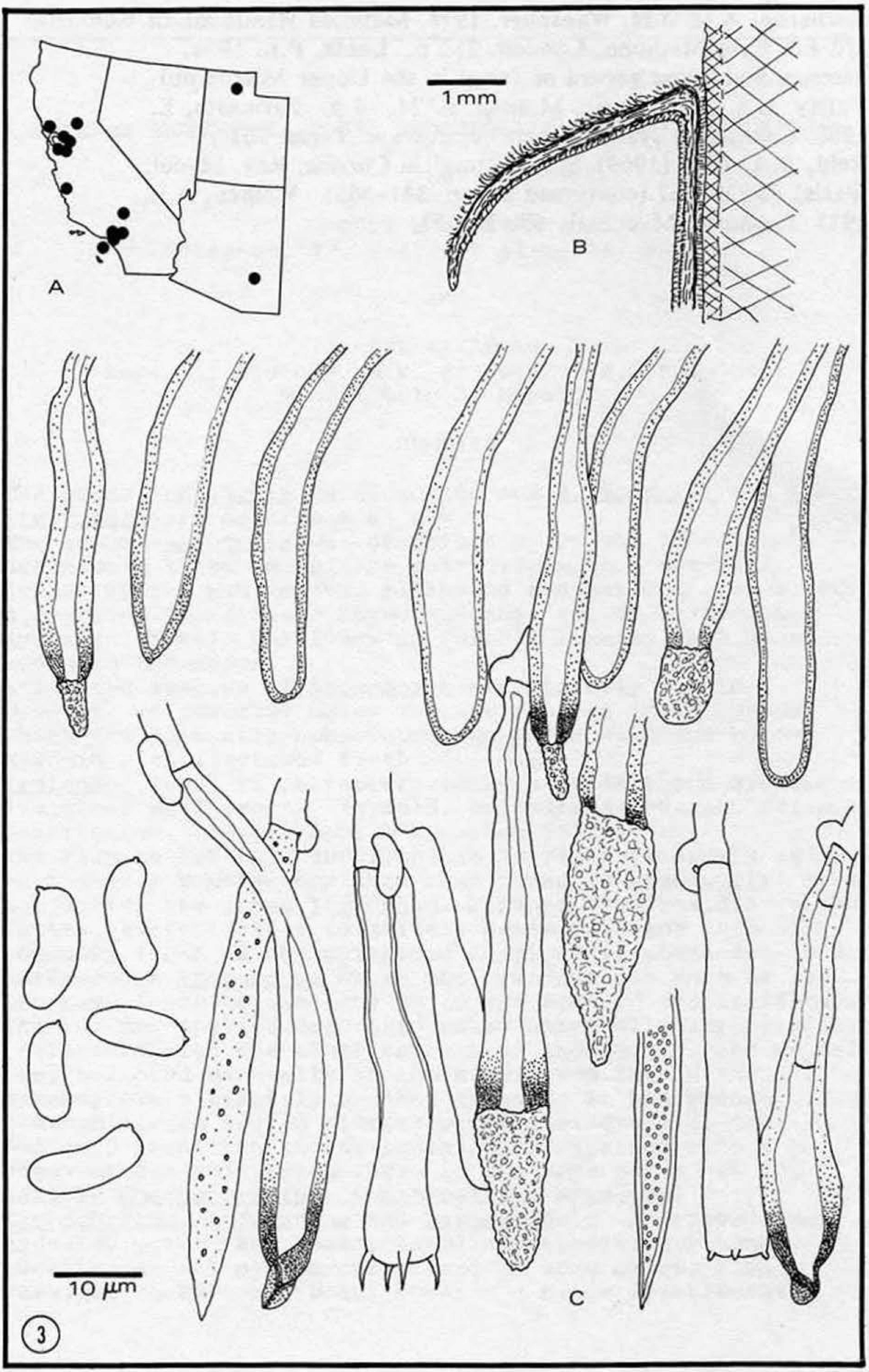

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MYCOTAXON

Vol. XXVIII, No. 2, pp. 553-555 April-June 1987

A NOTE ON ANOMOPORIA POUZ. (POLYPORACEAE, APHYLLOPHORALES).

by

KURT HJORTSTAM
Målaregt. 12, S-44 135 Alingsås, Sweden

and

LEIF RYVARDEN
Dept. of Biology, Div. of Botany, P.O.Box 1045,
N-0316 Oslo 3, Norway.

SUMMARY

The genus Anomoporia is discussed and A. dumontii and A. irpicoides are described as new.

The genus Anomoporia was described by Pouzar (1966) to accomodate three resupinate polypores with a monomitic hyphal system and smooth, ellipsoid and amyloid spores. For a description of these three species, see Gilbertson & Ryvarden (1986). Until now no further species have been added to the genus.

All three species of Anomoporia are strictly poroid. However, we describe below two new species in the genus which are initially subporoid, but which with age become hydnoid with flattened teeth.

Irpicodon Pouz. is characterized by a pileate and hydnoid fruitbody with smooth, amyloid, cylindrical spores. For a description, see Eriksson & Ryvarden (1976).

The pileate habitat, suballantoid to reniform spores and a much denser consistency than that found in Anomoporia, seem to justify the genus Irpicodon. Further, the basidia in the latter develop into a relatively dense palisade such as commonly found in the phlebioid fungi. This character is not observed in Anomoporia where the hymenium has more or less the same loose consistency as in the rest of the fruitbody.

The two new species described below share all microscopical characters with the other species of Anomoporia, and we felt they belonged naturally in the genus even though the hymenophore ultimately becomes hydnoid. It has become commonplace to regard microscopical characters as pre-eminent, resulting in the inclusion of species with a somewhat variable hymenophore in the same genus, as for example Chaetoporellus, Spongipellis, Trametes, Gloeophyllum, Trichaptum and Daedaleopsis. In these genera hydnoid, poroid and partly lamellate species are kept together as all microscopical and in some cases, also chemical characters, point towards a close relationship.

ANOMOPORIA IRPICOIDES Hjortst. & Ryv. spec. nov.
Fructificatio resupinata, initio plus minus subporosa tum distincte hydnoides; aculeis plerumque complanatis, 0.5-2 mm longis. Systema hyphale monomiticum; hyphis fibulatis, hyalinis, 2-5(-7) µm latis. Cystidia nulla vel in aculeo hyphae paraphysoideae praesentes. Basidia clavata, 12-15(-20) x 4-5(-6) µm, 4 sterigmatibus. Sporis subglobosis, tenuitunicatis vel crassiusculis, 4-4.5(-5) x (3-)3.5-4(-4.5) µm, modice amyloidibus et leviter cyanophilis.
Holotypus: Africa. Malawi, Southern Prov., Mulanje Mts., Lichenya Plateau, alt. 1800-2000 m. 9.-10. March, 1973. L. Ryvarden 11293 (O). Isotypus: in Hjm priv. herb.
Basidiocarp annual, resupinate, loosely adnate and easily separable from the substratum, at first subporoid, then split into flattened and irregularly shaped teeth, 0.5-2 mm long, apically penicillate to fimbriate, at least when fully developed, cream-coloured to pale yellow, margin white, cottony, rhizomorphs absent.
Hyphal system monomitic, generative hyphae thin-walled, smooth, forming a loose tissue, in the centre of the aculei irregularly interwoven, in other cases more straight, mostly 2-4 µm wide though some with walls irregular and constricted and up to 7 µm wide, all hyphae hyaline, thin-walled or with slight wall thickening, and with clamps at all septa.
Cystidia lacking, but some protruding hyphoids in the aculeal apex.
Basidia more or less clavate, 12-15(-20) x 4-5(-6) µm, with 4 sterigmata and a basal clamp.
Spores subglobose, thin-walled or with thickened walls, hyaline, smooth, 4-4.5(-5) x (3-)3.5-4 µm, weakly amyloid and slightly cyanophilous.
Type of rot. Associated with a brown rot.
Remarks. Anomoporia was described by Pouzar (1966) to accomodate three resupinate polypores with a monomitic hyphal system and smooth, amyloid and more or less ellipsoid spores. The micromorphology of the new species described here is similar to that of S. myceliosa (Peck) Pouz. Separating characters are the split hymenophore and absence of rhizomorphs in A. irpicoides.

ANOMOPORIA DUMONTII Hjortst. & Ryv. spec. nov.
Species habitu cum Anomoporia irpicoides, sed differt sporis breviter ellipsoidibus, (3.5)3.8-4 x 2.8-3(-3.2) µm, distincte amyloidibus et leviter cyanophilis.
Holotypus: Venezuela. Bolivar Estado, along Rio Apongao, 142 km S. of El Dorado, on road between El Dorado and St. Elena. 4 Aug. 1972, leg. K. Dumont VE 6806 (NY). Isotypi: (O) and in Hjm priv. herb.
The features of this species are essentially the same as described for A. irpicoides excepting the morphology of the spores and the width of the aculeal hyphae, which are comparatively narrower, about 2-5 µm wide, while the spores are short-ellipsoid, mostly 3,8-4 x 3 µm. In the former

species the spores have a pronounced tendency to be more globose and measure 4-4,5 x 3,5-4 µm. Also the amyloid reaction is stronger in A. Dumontii.
Type of rot. Associated with a brown rot.

Acknowledgements.
Dr. D. Reid, Kew Gardens, London has kindly suggested improvements in the text for which we are very grateful.

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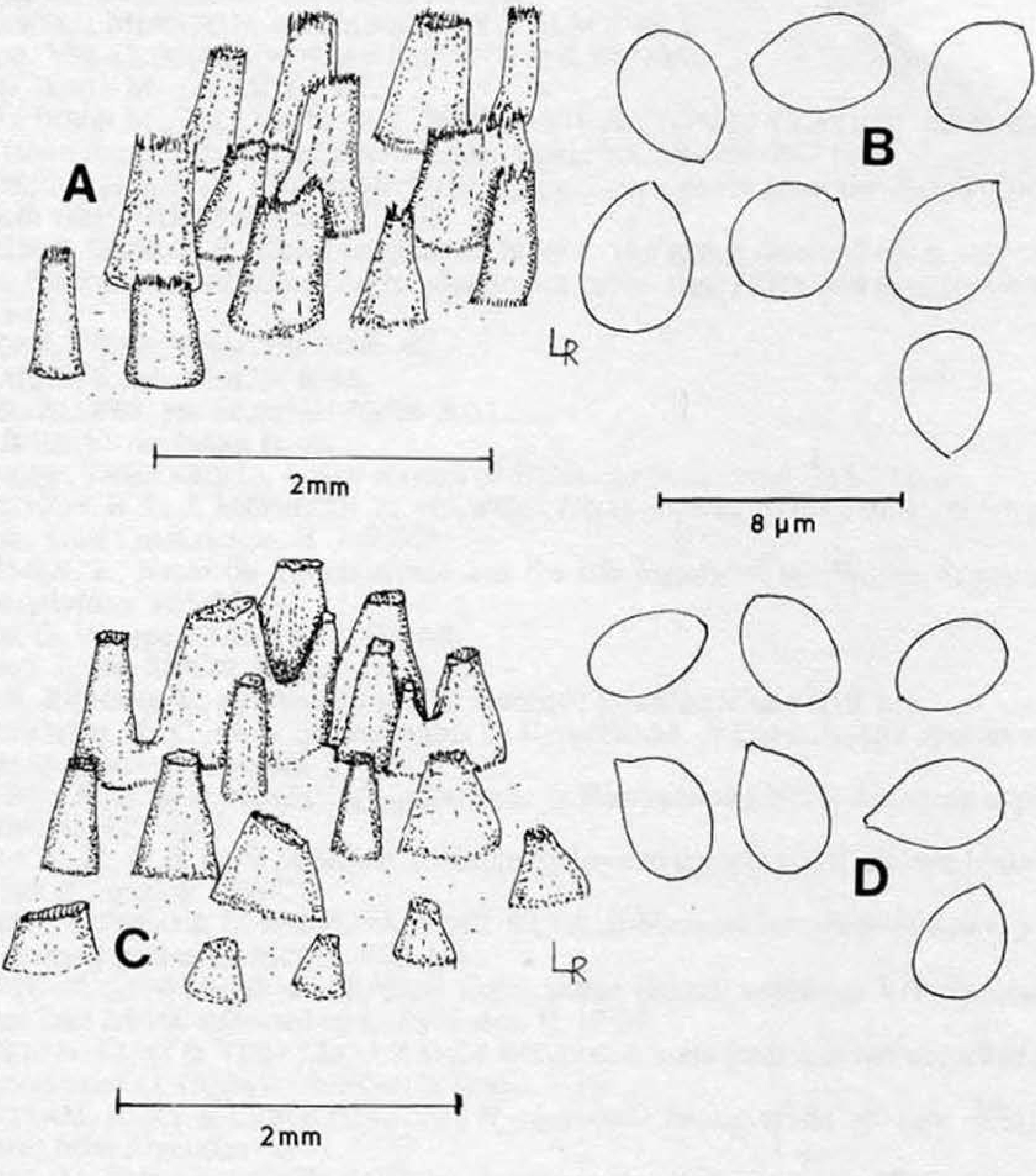

Fig.1. **Anomoporia irpicoides** A) Fruitbody, B) spores. **Anomoporia dumontii** C) fruitbody, D) spores. From the holotypes.

AUTHOR INDEX, VOLUME TWENTY-EIGHT

INDEX TO FUNGOUS AND LICHEN TAXA, VOLUME TWENTY-EIGHT

This index includes the names of genera, infrageneric taxa, species, and infraspecific taxa. New names are *italicized*, as are the page numbers on which such new taxa are proposed. New names of suprageneric taxa appear in *italic CAPITALS*.

REVIEWERS, VOLUME TWENTY-EIGHT

The Co-Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

H. C. ALDRICH
E. ARNOLDS
M. E. BARR BIGELOW
E. A. BROWN
B. CALLAN
L. E. CLAFLIN
J. L. CRANE
G. B. CUMMINS
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MYCOTAXON PUBLICATION DATES

Volume **27**	(October-December 1986)	December 3, 1986
Volume **28**(1)	(January-March 1987)	January 14, 1987

ERRATA, VOLUME TWENTY-SEVEN

Page	558	line	2	*for*	11x	*read*	10x
			3	*for*	18x	*read*	16x
	559		2&3	*for*	11x	*read*	10x
	560		2	*for*	300x	*read*	264x
			4	*for*	600x	*read*	528x
	561		4	*for*	660x	*read*	580x
			5	*for*	1100x	*read*	970x

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Page	22	line	51	for	C. indecorus	read	Crustomyces indecorus
	29		33	for	LUTEO-CYSTIDIATUM	read	LUTEOCYSTIDIATUM
	79		36	*for*	lundelii	*read*	lundellii
	83		19	for	Paulii-	read	Paulli-
	105		14	for	szatalaensis	read	szatalaënsis
			17	for	szatalensis	read	szatalaënsis
	108		5	for	**U. alpina**	read	**Usnea alpina**
	140		1-7	for	(whole legend)	substitute:	

Figure 1. Scanning electron micrographs of odontotremataceous ascocarps. a. Coccomycetella richardsonii. b. Odontotrema inculatum. c, d. Odontotrema majusculum. e. Odontrotrema minus. f. Odontotrema phacidiellum. g. Odontotrema longius (=Durella atrocyanea). h. Phragmiticola rhopalospermum. i. Mycowinteria anodonta. j, k. Xylopezia hemisphaerica. l. Xylopezia inclusa. a-c, e-i, l: approximately x75; d. j: approximately x40. Specimens are those indicated for the species in figs. 1-13.

	141		39	for	megalospora,	read	megalosporum,
	142		31	for	megalospora)	read	megalosporum)
	170		50	for	vermifera	read	vermiformis
	224		14	for	*B. sphaeroidea*	read	*Beniowskia sphaeroidea*

CO-EDITORS OF MYCOTAXON

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B-1348 Louvain-la-Neuve, Belgium

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ENGLISH LANGUAGE EDITOR
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P.O. Box 264
Ithaca, NY 14851, USA

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