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STUDIES ON SOME DISCOMYCETE GENERA WITH AN IONOMIDOTIC REACTION: IONOMIDOTIS, POLONIODISCUS, CORDIERITES, PHYLLOMYCES, AND AMEGHINIELLA

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ABSTRACT

The genera *Ionomidotis*, *Poloniodiscus*, *Cordierites*, *Phyllomyces*, and *Ameghiniella* have been reviewed. Based on type studies, *Ionomidotis*, *Cordierites*, and *Ameghiniella* are accepted as the correct names for three genera of the Leotiaceae, Encoelioideae. The distinctions among them are discussed, and keys to the species are provided. The ionomidotic reaction occurs in some species, only, and also occurs in species referred here to *Encoelia*, and is thus not suitable for use as a generic character in this case. *Cordierites boedijnii* is described as a new species; *Ameghiniella plicata*, *Chlorencoelia indica*, *Encoelia fuscobrunnea*, *Encoelia nicaraguensis*, *Encoelia urceolata*, and *Ionomidotis australis* are recorded as new combinations.

INTRODUCTION

The genus *Cordierites* Mont. has been taken in a very broad sense (Korf, 1973; Rifai, 1977). This paper addresses detailed work on *Cordierites* and on several genera related to it, i.e., *Phyllomyces* Lloyd, *Ionomidotis* Durand, *Poloniodiscus* Svrček & Kubička, and *Ameghiniella* Spegazzini.

During my studies at Cornell University, I have had a chance to examine *Cordierites guianensis* Mont. sensu Boedijn from Java in the herbarium of Richard P. Korf, fresh collections of *Ionomidotis olivascens* Durand from Jamaica and *I. irregularis* from the Ithaca area, and some *Ionomidotis* species in the Durand herbarium in the Plant Pathology Herbarium, Cornell University. My examination of these materials revealed

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significant differences in apothecial anatomy, which enhanced my attempt to clarify the taxonomic problems of this group of fungi. Although type specimens and many additional collections have been studied, this paper does not cover all known material in the world. Traditional methods were used in anatomical studies. An apothecium or a portion of an apothecium was sectioned on a freezing microtome at 15 μm, and the sections were mounted either in cotton blue lactic acid or in Melzer's reagent. The ionomidotic reaction was observed by soaking a small fragment of apothecial tissue in 2% or 10% aqueous KOH solution. The photographs were taken under a Zeiss microscope equipped with a camera. The abbreviations of literature citations are based on *Botanico – Periodicum – Huntianum* (Lawrence, et al., 1968), and those of names of herbaria based on *Index Herbariorum* (Holmgren, et al., 1981).

HISTORICAL REVIEW AND TAXONOMY OF THE GENERA

1. Historical Review

Cordierites Mont. was established to accommodate a single species, *C. guianensis,* which was originally assigned to the Pyrenomycetes (Montagne, 1840). It remained monotypic for more than a decade. Several species have then been added to the genus (Berkeley, 1856, 1867; Cooke, 1875; Möller, 1901; Korf, 1971; Sharma &Thind, 1983; Samuels & Kohn, 1987). Saccardo (1883) correctly removed this genus from the Pyrenomycetes, and later placed it in the family Cordieriteae of the Discomycetes (Saccardo, 1884, 1889). Ciferri (1957) indicated that the genus should belong to the family Helotiaceae. Dennis (1978) placed *Cordierites* in the Encoelioideae of the Helotiaceae; and Korf (1973) and Rifai (1977) treated it in the Encoelioideae of the Leotiaceae, which is accepted in this paper.

Durand (1923) published a paper entitled "The genera *Midotis*, *Ionomidotis* and *Cordierites*" in which he described his genus *Ionomidotis*. Although he did not directly mention his generic concept of *Cordierites* in that paper, he removed *C. irregularis* and *C. sprucei* to *Ionomidotis*. The former is the lectotype species of *Ionomidotis* (Korf, 1958), and the latter is a good species of *Cordierites* according to the results of my study.

In 1936, Boedijn published a paper on the genus *Cordierites* based on two collections from Java. He presented a very detailed description and illustration of these materials, concluded that the genus was monotypic, and listed *C. sprucei*, *C. muscoides*, *C. coralloides*, *C. fasciculata*, and *C. umbilicarioides* as synonyms of the type species of that genus, *C. guianensis.* I disagree with his synonymy, and think that the Javanese collections represent a different taxon in the same genus, and that three species are involved.

In 1957, Ciferri reviewed the species of *Cordierites*. He concluded that the genus contained only a single species, Montagne's *C. guianensis*, and pointed out that Boedijn's concept of this species is quite different from Montagne's original one. He treated Boedijn's "*C. guianensis*" as *Midotis boedijnii*. I agree with him that Boedijn's fungus is not conspecific with *C. guianensis*, but disagree with his placement of that fungus in *Midotis*. Even though he examined the type and specimens of a few other species of *Cordierites* and provided useful, though occasionally incorrect, literature citations for these taxa, I have difficulty comprehending many of his observations, interpretations and taxonomic opinions. I shall take up specific points in the discussion of each taxon.

Ameghiniella Speg. was coined for a single species, *A. australis* Spegazzini (1888). Though his generic and specific descriptions were relatively detailed, the genus is unknown to most mycologists, and has remained monotypic. Clements and Shear (1931) mistakenly synonymized this genus with *Cenangium*. Nannfeldt (1932) in his discussion of the Dermateaceae noted that the genus was known to him only from the description, belonged to the inoperculate Discomycetes, and that he had no position for it. When Gamundí examined the type species of *Ionomidotis chilensis*, she annotated it as "*Ionomidotis chilensis* Durand (1923) = *Ameghiniella australis* Speg., Bol. Ac. Nac. Cs. Cordoba 11: 270. 1887."

The type specimen of *A. australis* was kindly sent to me by Dr. Gamundí. My observation has shown that *A. australis* and *I. chilensis* are not synonyms. *Ameghiniella* and *Ionomidotis* are obviously closely related fungi in the Encoelioideae, but are not congeneric. Although species of both genera exude violet pigmentation in aqueous KOH solution (ionomidotic reaction), they have a different anatomical structure. I distinguish them at the generic level.

Phyllomyces Lloyd (1921) was erected for a single species, *P. multiplex*, which is on dead wood, with ear-shaped and lobed apothecia arising from branched or complex stipes. The genus has remained monotypic. After his examination of the type specimen of this genus, Korf (1973) indicated in his key to the genera of Discomycetes and Tuberales that *Phyllomyces* is a synonym of *Cordierites*. My observations fully agree with his synonymy, and prove that *C. sprucei* Berkeley (1856) is an earlier name for *P. multiplex*.

Ionomidotis Durand (1923) was established to accommodate seven species which exude violet pigmentation from the apothecial tissues when treated with aqueous KOH solution. Durand provided a relatively extensive generic description, but failed to designate the type for the genus. In the following years, the genus was accepted by many mycologists, and quite a few species were added (Seaver, 1925; Cash, 1939; Korf, 1958; Le Gal, 1959; Dennis, 1970). Korf (1958) lectotypified the genus with *I. irregularis*

(Schw.) Durand. The genus was placed in the Helotieae of the Helotiaceae by Seaver (1951), the Dermateaceae by Korf (1958), the Encoelioideae of the Helotiaceae by Le Gal (1959) and by Dennis (1978), and the Encoelioideae of the Leotiaceae by Korf (1973). I accept the placement of this genus in the Encoelioideae of the Leotiaceae.

Seaver (1951) synonymized *Ionomidotis* with *Midotis*, a doubtful generic name, the type species of which remains unknown. *Midotis* has been applied in various senses. Four of Durand's original species of *Ionomidotis* were transferred to *Midotis* by Seaver. In his paper on *Cordierites*, Ciferri (1957) accepted Seaver's opinion, and transferred a fifth Durand species, *I. chilensis*, to *Midotis*. Korf (1973) listed this genus as a synonym of *Cordierites*, which was later accepted by Rifai (1977) and by Dennis (1978). I think that two distinct genera are involved on the basis of anatomical structure, and accept both *Cordierites* and *Ionomidotis*.

Poloniodiscus Svrček & Kubička (1967) was published for a single species, *P. fischeri*, which was later discovered to be a synonym of *Ionomidotis irregularis* (Korf, 1973; Dennis, 1978), and the genus has remained monotypic. *Poloniodiscus* becomes a later synonym of *Ionomidotis*. My observations have confirmed the treatments by Korf and by Dennis.

2. The Ionomidotic Reaction and Taxonomy of the Genera

Before the genus *Ionomidotis* was established (Durand, 1923), the exudation of violet pigmentation in aqueous KOH solutions from the apothecial tissues of certain discomycetes had seldom been used in classification, and perhaps not been paid enough attention to by many mycologists. In later years, this character became diagnostic. Korf (1958) named this phenomenon the ionomidotic reaction. Cash (1939), Korf (1958), Le Gal (1959), and Dennis (1970) transferred a few fungi to *Ionomidotis* based on this and other features. I agree with them that the ionomidotic reaction is a useful tool in taxonomy. On the contrary, Seaver (1951) and Ciferri (1957) ignored this character.

Two of the seven original species of *Ionomidotis* were transferred from *Cordierites* (Durand, 1923), which suggests some connection between these two genera. Stipes branching or arising from a common base, apothecia more or less unequal-sided, and the outer ectal excipulum encoelioid (at maturity the outer cells of the excipulum becoming loose and often the receptacle surface appearing mealy) prove that they are a group of closely related discomycetes. Korf (1973) pointed out that *Ionomidotis*, *Phyllomyces* and *Poloniodiscus* are synonyms of *Cordierites*. This concept has been accepted by Rifai (1977), Dennis (1978), and Sharma & Thind (1983).

My type studies of the species of *Cordierites*, *Phyllomyces*, *Ionomidotis*, *Poloniodiscus*, and *Ameghiniella* have shown that three different anatomical arrangements can be recognized among the five genera. In *Cordierites* and *Phyllomyces*, cells of the ectal excipulum and hyphae of the medullary excipulum are not immersed in a gelatinous matrix, the subhymenium is often distinguishable, asci are subcylindrical, ascospores are uniformly ellipsoid and uniseriate in an ascus. In members of *Ionomidotis* and *Poloniodiscus* cells of the ectal excipulum and hyphae of the medullary excipulum are immersed in a gel matrix and so is the hymenium, the subhymenium is very thin or indistinguishable, the asci are clavate, and the ascospores are allantoid to ellipsoid and biseriate to irregularly biseriate in an ascus. *Ameghiniella* shares with *Ionomidotis* strongly ionomidotic tissues, gregarous apothecia arising from a common base, clavate asci, and allantoid ascospores. But unlike *Ionomidotis*, *Ameghiniella* is characterized by deeply cupulate apothecia when dry, an ectal excipulum of well-developed textura angularis composed of isodiametric, pigmented cells not immersed in gel, a medullary excipulum also lacking gel, and multiguttulate ascospores. I treat the above differences at generic level, and recognize three genera, *Ionomidotis*, *Cordierites*, and *Ameghiniella*. Korf and Dumont (1968) pointed out that the sterile tissues of the apothecium provided valuable taxonomic information. I fully agree with them. In taxonomy of these genera, I put more emphasis on the anatomical structure of apothecia of each species than on the measurements of asci and of ascospores. In regard to the ionomidotic reaction, two species of *Cordierites* react faintly, and one is strongly ionomidotic; all species in *Ionomidotis* and *Ameghiniella* are strongly ionomidotic.

In this paper, I have transferred three species, two weakly ionomidotic and one strongly exuding yellowish brown pigmentation in KOH solution (? xanthochroic), from *Ionomidotis* to the genus *Encoelia* because of their isodiametric, loosely interconnected and pigmented ectal excipular cells, and pustulate receptacle surface. The generic concept of *Encoelia* is taken here in a broad sense.

Most known species of *Ionomidotis*, *Cordierites* and *Ameghiniella* are found in tropical or subtropical areas. *I. australis*, *I. fulvotingens* and *I. irregularis* are distributed in temperate regions. Fungi of these genera usually occur on wood; *I. frondosa*, *I. fulvotingens*, *I. olivascens*, and *C. guianensis* may be associated with other fungi. Studies of these genera in pure culture have not been reported.

3. Key to the Accepted Genera

1. Apothecium discoid to infundibuliform, stipitate, stipes branched or arising from a common base, apothecial tissues not gelatinized at all, ionomidotic or non-ionomidotic, asci subcylindrical, ascospores ellipsoid .... *Cordierites*

1'. Apothecium lobed to ear-shaped, or deeply cupulate, sessile to substipitate, often several arising from a common base, apothecial tissues immersed in gel or slightly gelatinized, strongly ionomidotic, asci clavate, ascospores allantoid, rod-shaped to ellipsoid 2
  2. Apothecium discoid to ear-shaped, ectal excipulum of textura intricata, textura prismatica to textura angularis, cells thin-walled, tissues immersed in gel, or at least ectal excipular cells sheathed by a gel layer .... *Ionomidotis*
  2'. Apothecium deeply cupulate, receptacle strongly pustulate, ectal excipulum of textura angularis, cells thick-walled, tissues not immersed in gel .... *Ameghiniella*

THE GENUS *IONOMIDOTIS*

1. Generic Description

IONOMIDOTIS Durand, Proc. Amer. Acad. Arts 59: 8, 1923.
= *Poloniodiscus* Svrček & Kubička, Česká Mykol. 21: 153, 1967.

Apothecia small to large, very dark when dry, discoid, flat, or ear-shaped, gregarious, sometimes solitary, sessile to short-stipitate, stipes often arising from a common base; margin smooth, undulate, or lobed; receptacle surface smooth, roughened, wrinkled, or pustulate; tissues strongly ionomidotic. Ectal excipulum of loosely arranged textura angularis or textura prismatica to textura intricata, cells elongated, rectangular to more or less hyphoid, loosely interconnected, immersed in gel or at least sheathed by a thin layer of gel, axes of cells nearly perpendicular to the outer surface, walls subhyaline, cells forming pustules sometimes not immersed in gel and with pigmented walls. Medullary excipulum of textura intricata usually immersed in gel, hyphal walls subhyaline. Subhymenium thin or indistinguishable. Asci inoperculate, 8-spored, clavate, J–, pore walls not turning blue in Melzer's reagent with or without KOH pretreatment, sometimes immersed in gel. Ascospores biseriate to irregularly uniseriate, allantoid or rod-shaped to ellipsoid, subhyaline to yellowish, smooth-walled, unicellular, with 2-4 guttules. Paraphyses filiform, straight or curved at apex, in one species with fusoid apices which may become detached, equal to or slightly exceeding asci.

On wood, some species associated with other fungi.

Lectotype: *Ionomidotis irregularis* (Schw.) Durand, selected by Korf (1958).

2. Key to the Accepted Species

1. Apothecium discoid at maturity 2

1'. Apothecium discoid with one side elongated, or ear-shaped at maturity 4
  2. Apothecium turbinate, hyphae immersed in a great amount of gel, ectal excipulum of textura intricata, paraphysis apices with a fan-shaped gelatinous cap .... *I. australis*
  2'. Apothecium discoid, hyphae immersed in gel not as abundant, paraphysis apices without a gelatinous cap 3
3. Apothecium 2-5 mm in diam, ectal excipulum of textura prismatica, axes of cells perpendicular to the outer surface, medullary excipulum thin, outer ectal excipular cells totally immersed in gel .... *I. fulvotingens*
3'. Apothecium 5-8 mm in diam, ectal excipulum of textura angularis mixed with textura intricata, medullary excipulum thick, outer ectal excipular cells loosely arranged, sheathed by a thin layer of gel ... *I. portoricensis*
  4. Paraphyses with an acute, lanceolate head .... *I. irregularis*
  4'. Paraphyses filiform without a lanceolate head 5
5. Ectal excipulum of textura intricata, associated with *Hypoxylon* sp., ascospores 1.5-2.2 μm wide .... *I. olivascens*
5'. Ectal excipulum of textura angularis mixed with textura prismatica or with textura intricata, ascospores often less than 1.5 μm wide 6
  6. Ectal excipulum of textura prismatica to textura angularis, outer cells covered by a thin layer of gel, subhymenium very thin, 0-10 μm thick .... *I. chilensis*
  6'. Ectal excipulum of textura angularis to textura intricata, outer cells immersed in gel, subhymenium well-developed, 30 μm thick .... *I. frondosa*

3. Accepted Species

Ionomidotis australis (Beaton in Beaton & Weste) Zhuang, **comb. nov.** (Figs. 1, 2, 28)

≡ *Claussenomyces australis* Beaton in Beaton & Weste, Trans. Brit. Mycol. Soc. 71: 215, 1978.

Apothecium flat to turbinate when dry, convex, flat or distorted when fresh, sessile, broadly attached to the substrate, 5-7 mm in diam when dry (up to 25 mm in diam when fresh according to the original author), gregarious or solitary; strongly ionomidotic, purple pigmentation exuding from tissues in 2% aqueous KOH solution; hymenium black when dry, ivy green when fresh; receptacle black, surface smooth when fresh, wrinkled and roughened when dry. Ectal excipulum of textura intricata, immersed in a gel matrix, 30-50 μm thick; cells elongated to hyphoid, axes of cells nearly perpendicular to the outer surface, cell walls subhyaline; receptacle slightly pustulate. Medullary excipulum of textura intricata, tissues immersed in a large amount of gel; hyphae loosely interwoven, hyphal walls subhyaline. Subhymenium not clearly distinguishable. Asci 8-spored, clavate, J– in

Melzer's reagent, 29.5-37.5 x 4.2-4.6(-5) µm, immersed in a gel matrix. Ascospores allantoid to rod-shaped, biseriate to irregularly biseriate, biguttulate, 5.0-7.3 x 1.3-1.5 µm (5-7 x 1.5-2.5 according to Beaton). Paraphyses filiform, sometimes branched, ca. 1 µm wide, up to 1.5 µm wide at apex, with a fan-shaped gel cap on the top seen clearly when mounted in Melzer's reagent, equal to or slightly exceeding asci.

On bark of a dead, unidentified eucalypt branch.

Illustrations: Beaton, G. & G. Weste, Trans. Brit. Mycol. Soc. 71: 215, fig. 1, 1978 (as *Claussenomyces australis*). This paper figs. 1, 2, 28.

Specimens examined: AUSTRALIA: on bark of a dead, unidentified eucalypt branch, Kennedy's Ck. Rd., about 3 km from Laver's Hill, Victoria, G. Beaton 53, 6. I. 1962, MELU (holotype), G. Beaton Pers. Herb. (isotype) (filed under *Claussenomyces australis*).

Notes: This species is characterized by a turbinate apothecium, very thick, highly gelatinous medullary excipular tissue, and gel-capped paraphysis apices. That the original author treated this fungus as a species of *Claussenomyces* is probably because of the large amount of gel in the excipular tissues, but all other characters are typical of *Ionomidotis*, especially the small, allantoid ascospores which never produce ascoconidia within the ascus.

IONOMIDOTIS CHILENSIS Durand, Proc. Amer. Acad. Arts 59: 11, 1923. (Figs. 3, 4, 29)
≡ *Midotis chilensis* (Durand) Cifer., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: 269, 1957.

Apothecium ear-shaped, lobed, or discoid with one side elongated, up to 25 mm in length and 30 mm wide, gregarious to solitary, short-stipitate, stipes arising from a common base; tissues strongly ionomidotic in KOH, purple pigmentation exuding from tissues in 2% aqueous KOH solution; hymenium black; receptacle brownish black, surface wrinkled to slightly granulate when dry. Ectal excipulum of textura prismatica to textura angularis, ca. 35 µm thick; cells club-shaped, rectangular, ellipsoid, or ovoid, axes of cells nearly perpendicular to the outer surface, cells in the outermost layer loosely interconnected, cell walls subhyaline to pale yellow, covered by a thin layer of gel; receptacle not pustulate near margin, sometimes slightly pustulate at flanks. Medullary excipulum of textura intricata, mostly immersed in gel except adjacent to the ectal excipulum; hyphae loosely interwoven, walls subhyaline. Subhymenium of textura intricata, 0-10 µm thick. Asci 8-spored, clavate, J– in Melzer's reagent, 33-40 x 3.7-3.9 µm (40-45 µm long according to Durand), arising from croziers. Ascospores allantoid, biseriate, to irregularly biseriate, with 2-4 or rarely more small guttules, 4.7-6.5 x 1.3-1.5 µm. Paraphyses filiform, straight or slightly curved at apex, slightly swollen and branched at apex, 1.0-1.5 µm wide, exceeding asci up to 10 µm.

On rotting log.

Illustrations: Durand, E. J., Proc. Amer. Acad. Arts 59: pl. 1, pl. 2, fig. 7, 1923. Ciferri, R. Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti, Ser. 5, 14: pl., 1, figs. 4, 5, 1957 (as *Midotis chilensis*). This paper figs. 3, 4, 29.

Specimens examined: CHILE: on rotting wood, Corral, R. Thaxter, XII, 1905, FH (holotype); CUP-D 10762 (15-3), NY (isotypes).

Notes: This is one of the original species of *Ionomidotis* Durand. The shape of the ectal excipular cells of this species is somewhat similar to that of *I. portoricensis* Seaver (1925), but the former has larger apothecia (25 x 30 mm *vs.* 5-8 mm in diam or in width) which are ear-shaped instead of discoid to cupulate, with more loosely interconnected cells in outer ectal excipulum and at margin, and with curved paraphyses instead of straight.

On the hymenium surface, many short, branched, irregularly catenulate cells were found. They are either produced by germinated ascospores, or are the reproductive structures of another fungus.

Without examining the type, Ciferri (1957) erroneously determined that *I. chilensis* (as *Midotis chilensis*) is a young specimen of *I. irregularis* (as *Midotis irregularis* Cke.). Actually, *I. chilensis* has never produces ellipsoid ascospores or lanceolate paraphysis tips even when it is fully mature.

IONOMIDOTIS FRONDOSA (Kobayasi) Kobayasi & Korf in Korf, Sci. Rep. Yokohama Natl. Univ., Ser. 2, 7: 19, 1958. (Figs. 5, 6, 30)
≡ *Bulgaria frondosa* Kobayasi, Bot. Mag. (Tokyo) 53: 158, 1939.
≡ *Cordierites frondosa* (Kobayasi) Korf, Phytologia 21: 203, 1971.

Apothecium discoid with one side elongated, or ear-shaped, lobed, 5-8 mm in diam when dry (10-40 mm according to Kobayasi), gregarious, sessile to short-stipitate, stipes arising from a common base; tissues strongly ionomidotic in KOH solution; hymenium black to nearly black; receptacle concolorous, surface minutely pustulate when dry. Ectal excipulum of textura angularis to textura intricata, ca. 30 µm thick, immersed in gel; hyphae more or less parallel, axes of hyphae perpendicular to the outer surface, cell walls subhyaline; receptacle pustulate, cells in pustules angular, ellipsoid, also immersed in gel, walls pale brown, contents brown. Medullary excipulum of textura intricata, immersed in gel; hyphae 2.5-3.0 µm wide, hyphal walls subhyaline, contents pale brown. Subhymenium of textura intricata, ca. 30 µm thick; hyphae densely interwoven. Asci 8-spored, clavate, J– in Melzer's reagent, (31-)34-40 x 3.5-4.5 µm. Ascospores rod-shaped to allantoid, irregularly biseriate, with 2 to several guttules, 4.0-4.5(-5.6) x 1.0-1.4 µm. Paraphyses filiform, curved to slightly circinate and slightly swollen at apex, septate, 1.2-1.4 µm wide, exceeding asci 3-7 µm.

On decorticated wood associated with a ?*Coniochaeta* sp.

Illustrations: Kobayasi, Y., Bot. Mag. (Tokyo) 53: 158-159, figs. 1, 2, 1939 (as *Bulgaria frondosa*). This paper figs. 5, 6, 30.

Specimens examined: JAPAN: on decorticated wood [associated with a ?*Coniochaeta* sp.], Shiratori Mt., near Iinomachi, Kirishima National Park, Miyazaki Pref., Kyushu, S. Imai, et al., 3. XI. 1957, CUP-JA 387, R. P. Korf Pers. Herb.-JA 387; Miharayama Mountain Tokyo, Oshima Island, (no collector), 6. VI. 1956, CUP-JA 1558, R. P. Korf Pers. Herb.-JA 1558.

Notes: The type specimen of this species is lost. But when Kobayasi and Korf transferred this fungus from *Bulgaria* to *Ionomidotis*, JA 387 was confirmed by the original author, and is authentic (Korf, 1958). This fungus can be distinguished from *I. olivascens* by the more or less pustulate receptacle surface, shorter asci, smaller ascospores, and the curved to slightly circinate paraphysis apices. This species is associated with a pyrenomycete, possibly *Coniochaeta* sp.

I designate CUP-JA 387 as the NEOTYPE of this species.

IONOMIDOTIS FULVOTINGENS (Berk. & Curt.) Cash, J. Wash. Acad. Sci. 29: 50, 1939. (Figs. 7, 8, 31)

≡ *Cenangium fulvo-tingens* Berk. & Curt., Grevillea 4: 4, 1875.

Apothecium discoid, margin somewhat folded inward, 1.5-2.3 mm in diam when dry (2-5 mm in diam when fresh according to Luthi, 1969), gregarious or solitary, sessile to very shortly stipitate; tissues ionomidotic in KOH solution; hymenium black; receptacle concolorous, surface wrinkled when dry. Ectal excipulum of textura primatica, 25-34 µm thick, immersed in a gelatinous matrix; cells elongated to rectangular, axes of cells perpendicular to the outer surface, cell walls subhyaline. Medullary excipulum of textura intricata, tissues immersed in gel, 11-44 µm thick; hyphae somewhat parallel to the outer surface, hyphal walls subhyaline. Subhymenium not well-developed, of textura intricata, 0-5 µm thick. Asci 8-spored, clavate, J– in Melzer's reagent, ca. 45-48 x 3.7-4.0 µm (40 x 5 µm according to Luthi), immersed in gel. Ascospores allantoid to rod-shaped, irregularly biseriate, biguttulate, 5.1-6.0 x 1.4-1.5 µm (5-8 x 1.5-2 µm according to Luthi, 1969). Paraphyses filiform, straight, immersed in a gel matrix, 1.0-1.8 µm wide, exceeding asci 4-7 µm.

On wood associated with other fungi.

Illustrations: Luthi, R., Schweiz. Zeit. Pilzk. Bull. Suisse Mycol. 47: 121, figs. a-f, 1969. This paper figs. 7, 8, 31.

Specimens examined: UNITED STATES: on wood [associated with other fungi], Penn., Michener 2537, (no date), CUP-D 3598 (33-243) (ex 5172, isotype), FH-Curtis Herb. 5172 (isotype) (filed under *Cenangium fulvo-tingens*).

Notes: This species has smallest apothecia in the genus, which are discoid, folded inward when dry. The ectal excipulum is immersed in a gel which stains in cotton blue, and the axes of the elongate ectal excipular cells are perpendicular to the outer surface. The arrangement of the medullary hyphae is somewhat parallel to the outer surface, which is unusual in this genus. The substrate which has been indicated as decorticated wood is covered by other fungi. The species might be fungicolous. Cash (1939) has made some comments on the ionomidotic reaction of this fungus and of some other species of *Ionomidotis*. Luthi (1969) provided very good illustrations of both gross morphology and anatomy of this fungus.

IONOMIDOTIS IRREGULARIS (Schw.) Durand, Proc. Amer. Acad. Arts 59: 9, 1923. (Figs. 9, 10, 32)
≡ *Peziza irregularis* Schw., Trans. Amer. Philos. Soc. 4: 171, 1832.
≡ *Cordierites irregularis* (Schw.) Cooke, Bull. Buffalo Soc. Nat. Sci. 3: 26, 1875.
≡ *Midotis irregularis* (Schw.) Cooke in Sacc., Syll. Fung. 11: 42, 1895.
= *Peziza doratophora* Ellis & Ev., J. Mycol. 1: 90, 1885.
≡ *Otidea doratophora* (Ellis & Ev.) Sacc., Syll. Fung. 8: 96, 1889.
= *Poloniodiscus fischeri* Svrček & Kubička, Česká Mykol. 21: 154, 1967.

Apothecium ear- to fan-shaped, irregularly lobed, much elongated on one side, 18-35(-50) x 11-28(-40) mm in size (the clusters 5-7 cm wide according to Durand), gregarious to solitary, short-stipitate, stipes arising from a common base; tissues strongly ionomidotic in KOH; hymenium dark purple to nearly black, receptacle dark purplish brown, surface pustulate, sometimes covered with a buff powder. Ectal excipulum of textura angularis to textura prismatica, immersed in a gel matrix; cells mostly elongated to rectangular, axes of cells nearly perpendicular to the outer surface, cell walls subhyaline, cytoplasm with purplish contents; receptacle pustulate, cells in pustules spherical to subspherical, 7-15 µm in diam, walls thin, pigmented, not immersed in gel. Medullary excipulum of textura intricata, tissues immersed in gel; hyphae densely interwoven, hyphal walls subhyaline, cytoplasm with purplish contents. Subhymenium not clearly distinguishable. Asci 8-spored, clavate, J– in Melzer's reagent, ca. 60-70 x 5.7-6.5 µm (50-70 x 4-5 according to Durand). Ascospores ellipsoid, irregularly uniseriate, biguttulate, 8-10 x 3.4-3.6 µm (3-4 µm wide according to Durand). Paraphyses filiform, with an abrupt, lanceolate, acute apex, 1.5 µm wide below and 2.2-3.7 µm wide at the widest part of the lanceolate apex, septate, exceeding asci 7-11 µm, the apex sometimes becoming detached.

On wood.

Illustrations: Durand, E. J., Proc. Amer. Acad. Arts 59: pl. 1, pl. 2, figs. 5, 6, 1923. Ciferri, R., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: pl., 1, figs. 1, 2, 1957 (as *Midotis irregularis*). Svrček, M. & J. Kubička, Česká Mykol. 21: 152, fig., 1967 (as *Poloniodiscus fischeri*). This paper figs. 9, 10, 32.

Specimens examined: AUSTRIA: [on duff], Exposition Sharnstein, F. Candoussau, 3. IX. 1973, R. P. Korf Pers. Herb. 4161 (filed under

Cordierites irregularis).

CANADA: on *Betula lutea*, old log, Bear Island, L. Temagami, T.F.R., Ont., R. F. Cain, 6. IX. 1933, NY-U. Toronto Crypt. Herb 4775; on much decayed log, Gull Lake Portage, Lake Temagami, T.F.R., Ont., H. S. Jackson, et al., 6. VIII. 1931, NY-Univ. Toronto Crypt. Herb. 2577.

POLAND: in silva virginea ad truncum iacentem arboris frondosae, Bialowieza, W. Fischer, 5. IX. 1966, PRM 668120 (holotype of *Poloniodiscus fischeri*), CUP 49571 (ex PRM 668120, isotype).

SOVIET UNION: on rotten angiosperm wood, regio Primorsk Sudzuhhe reservate, Sapnagon, U.R.S.S., A. Raitviir 42641, 7. IX. 1961, R. P. Korf Pers. Herb. 3356.

UNITED STATES: (no substrate), Bethlehem, Syn. 759, (no collector), (no date), PH (holotype), BPI (isotype) (as *Peziza irregularis*); on rotten wood, White Mts., N. H., Miss S. Minns, IX. 1884, NY (holotype of *Peziza doratophora* Ellis & Ev.), NY (isotype, including 1 specimen and 1 drawing by Massee); on hickory wood, Preston, Ohio, A. P. Morgan, 27. X. 1892, CUP-D 2122 (15-10) (misidentified as *Midotis plicata*); on maple log, North Elba, N. Y., C. H. Peck, 11. IX. 1905, NY (in 2 packets) (as *Midotis irregularis*); on charred wood, Phelps Estate, Hackensack, N. J., B. O. Dodge & C. A. Darling, X. 1910, NY (as *Peziza doratophora*); on dead wood, maple & alder woods, Corvallis, Oregon, H. M. Q., 20. X. 1919, NY (as *Peziza irregularis*); on side of log, in a wood, near Oxford, Ohio, B. T., 25. X. 1926, NY; on damp soil?, Hood River, Ore., J. R. Kienholz, 15. IX. 1932, NY; [on rotten wood], Bass Lake, Oakland Co., Michigan, A. H. Smith 7636, 21. IX. 1937, NY; on log, Warren Woods State Park, Berrien Co., Michigan, C. T. Rogerson 3748, 4. IX. 1955, NY (as *Midotis irregularis*); on mossy area, Saranac Lake, 3 mi W on Forest Home Rd., R. Luck, 11. IX. 1965, NY-KPD 63; on wood, Mianus Gorge Nature Reserve, southeast of Bedford Village, Westchester County, New York, K. P. Dumont, 7. X. 1970, NY ; on wood, SUNY Camp. Ashokan, New York, R. P. Korf, et al., 9. IX. 1972, R. P. Korf Pers. Herb. 4179; on *Acer saccharinum*, Lumberman's Bay, Huron Mtn. Club, Big Bay, Marquette Co., Mich., H. H. Burdsall, Jr. 8257, 9. VIII. 1974, R. P. Korf Pers. Herb. 4283 (filed under *Cordierites irregularis*); on rotten log, Ward Poundridge Reservation, Westchester County, New York, C. T. Rogerson & S. T. Carey, 1. X. 1975, NY (filed under *Cordierites irregularis*); on very rotten log, Audubon Center, Greenwich, Fairfield County, Connecticut, C. T. Rogerson & S. T. Carey, 2. X. 1975, NY (filed under *Cordierites irregularis*); on rotten log, woods, White Memorial Foundation, Litchfield, Connecticut, C. T. Rogerson (3rd COMA foray), 30. IX. 1978, NY (filed under *Cordierites irregularis*); on log, Elyria, Lorain County, Ohio, S. Ristich, 25. IX. 1982, NY; on log, Muscoot Nature Reserve, near Katonah, Westchester County, New York, S. Stein, 7. X. 1984, NY; on log, Woodlawn Park, Darien, Connecticut, S. Sheine, 15. X. 1984, NY; on wood, Ringwood, Ithaca, New York, L. Sachett, 8. X. 1987, CUP 61833.

Notes: This species was designated as the type of *Ionomidotis* by Korf (1958). This fungus is easily distinguished from other species of *Ionomidotis* by the very large (up to 50 x 40 mm), lobed, ear- to fan-shaped apothecia, ellipsoid ascospores, and the paraphyses with a lanceolate, acute tip.

IONOMIDOTIS OLIVASCENS Durand, Proc. Amer. Acad. Arts 59: 13, 1923. (Figs. 11, 12, 33)
≡ *Midotis olivascens* (Durand) Seaver, N. Amer. Cup-fung. (Inop.). p. 94, 1951.

Apothecium discoid with one side elongated to ear-shaped, up to 6 mm in diam when dry, gregarious, shortly stipitate; tissues strongly ionomidotic in KOH; hymenium black when dry (blackish olive with a yellowish tint when fresh according to Durand); receptacle concolorous, surface smooth (granular or nearly smooth according to Durand). Ectal excipulum of textura intricata, gradually running into the medullary excipulum, immersed in a gel matrix; cells elongated to ellipsoid, cells in the outermost layer with a rounded and swollen apex, axes of cells nearly perpendicular to the outer surface, cell walls subhyaline, receptacle non-pustulate. Medullary excipulum of textura intricata, tissues immersed in gel; hyphae loosely interwoven, hyphal walls subhyaline, cytoplasm pigmented. Subhymenium not well-developed. Asci 8-spored, clavate, J– in Melzer's reagent, 39-47 x 4.2-4.8 µm, arising from croziers, immersed in gel. Ascospores allantoid to rod-shaped, irregularly uniseriate to irregularly biseriate, mostly biguttulate, 5.1-6.0(-7.0) x 1.5-2.2 µm (7-8 x 3 µm according to Durand). Paraphyses filiform, curved at apex, immersed in gel matrix, 1.0-1.5 µm wide, exceeding asci 7-8.5 µm.

On rotten wood associated with *Hypoxylon* sp.

Illustrations: Durand, E. J., Proc. Amer. Acad Arts 59: pl.1, pl. 2, fig. 10, 1923. This paper figs. 11, 12, 33.

Specimens examined: JAMAICA: on bark of a fallen, corticated branchlet, associated with *Hypoxylon* sp., North of Hampton School, Mt. Pleasant, Santa Cruz Mountains, St. Elizabeth Parish, elev. 2250 ft., R. P. Korf, T. Iturriaga, & W.-y. Zhuang, 10. XII. 1986, CUP-MJ 1032.

UNITED STATES: on rotting wood, Cocoanut Grove, Florida, R. Thaxter 111, XI. 1897, CUP-D 10571 (15-18) (isotype, marked as "cotype" by Durand); on rotting wood, Cocoanut Grove, Florida, I. 1898, FH (?holotype).

Notes: The non-pustulate receptacle surface of this fungus is very similar to that of *Ionomidotis fulvotingens*, but the latter has small, discoid apothecia, clearly differentiated ectal excipulum and medullary excipulum. *I. olivascens* has larger, ear-shaped apothecia, no sharp delimitation between ectal excipulum and medullary excipulum, and the medullary hyphae extend to give rise to the ectal excipulum. The type specimen is on rotten wood colonized by a *Hypoxylon* species, and so is the collection from Jamaica.

Durand (1923) noted the similarities between this fungus and *Chlorencoelia versiformis* (as *Chlorosplenium versiforme*), but the tissues of the latter are never immersed in gel, and marginal structures of apothecia in these two species are quite different.

The ascospores of the Jamaican collection were shot on to a Petri dish of potato dextrose agar (PDA), but no germination was detected after several months.

In his publication, Durand (1923) indicated that the type was collected in November, 1897, and on deposit in FH; but the collecting date of what appears to be the type specimen in FH is marked January, 1898. The isotype, CUP-D 10571, has the published date on the specimen label.

IONOMIDOTIS PORTORICENSIS Seaver, Mycologia 17: 50, 1925. (Figs. 13, 14, 34)

Apothecium discoid to cupulate when dry, 4 mm in diam when dry (5-8 mm in diam when fresh according to Seaver), gregarious, sessile to subsessile; tissues strongly ionomidotic in KOH; hymenium nearly black; receptacle very dark brown, surface wrinkled when dry. Ectal excipulum of textura angularis to textura intricata, 15-25 µm thick; cells elongated to rectangular, axes of cells nearly perpendicular to or at a small angle to the outer surface, cell walls slightly thickened, pale yellow, outermost cells loosely interconnected, sheathed by a gel layer, inner cells immersed in a gel matrix; receptacle minutely pustulate. Medullary excipulum of textura intricata, tissues immersed in gel; hyphae loosely interwoven, coarse, 3-5 µm wide, becoming finer close to hymenium, hyphal walls subhyaline. Subhymenium not clearly distinguishable. Asci 8-spored, clavate, J– in Melzer's reagent, 37-44(-50) x 3.7-4.2 µm (30 x 5 µm according to Seaver), immersed in gel. Ascospores rod-shaped, allantoid to ellipsoid, biseriate to irregularly biseriate, biguttulate, 5.3-6.5 x 1.5-1.8 µm. Paraphyses filiform, straight, rarely faintly curved, slightly enlarged at apex, immersed in a gel matrix, 1.5-2.0 µm wide, slightly exceeding asci.

On dead wood.

Illustration: This paper figs. 13, 14, 34.

Specimen examined: PUERTO RICO: on wood, F. J. Seaver & C. E. Chardon, 24. I. to 5. IV. 1923, NY-Porto Rico 270 (holotype).

Notes: This species has been inexplicably synonymized with *I. nicaraguensis* by Seaver (1951). My type studies have shown that *I. portoricensis* differs significantly from *I. nicaraguensis* in apothecial size (4 mm *vs.* 10 mm when dry), size of asci and of ascospores (asci 37-47 x 3.7-4.2 µm *vs.* 160-170 x 6.5-8.0 µm, and ascospores 5.3-6.5 x 1.5-1.8 *vs.* 13.4-17.8 x 5.0-6.1 µm), and elongated to rectangular ectal excipular cells which are pale yellow and immersed in gel *vs.* isodiametric excipular cells which are brown and not immersed in gel.

The distinction between *I. portoricensis* and *I. chilensis* has been discussed above. *I. portoricensis* differs from *I. olivascens* in the discoid instead of ear-shaped apothecium, ectal excipulum of textura angularis to textura intricata instead of textura intricata, loosely interwoven and wide medullary hyphae which are distributed among a great amount of gel, and wider, slightly bent paraphysis apices.

4. Excluded Species

Ionomidotis fuscobrunnea (Pat. & Gaill.) Dennis, Kew Bull. Addit. Ser. 3, p. 345, 1970.
≡ *Helotium fuscobrunneum* Pat. & Gaill., Bull. Soc. Mycol. France 4: 101, pl. 18, fig. 8, 1888.
≡ *Rutstroemia fuscobrunnea* (Pat. & Gaill.) Le Gal, Discom. Madag. p. 325, fig. 147, 1953.
≡ **Encoelia fuscobrunnea** (Pat. & Gaill.) Zhuang, **comb. nov.** (Fig. 23)

Specimen examined: sur écorce d'arbre, Rive Gauche de l'Orénoque entre Maipures et San-Fernando, Venezuela, [M. A. Gaillard], 16. VIII. 1887, FH-Herb. Patouillard 240 (holotype, filed under *Helotium fuscobrunneum*).

Notes: The holotype of this species in FH has been examined. The excipular tissues turn strongly purple in KOH solution but the pigmentation only faintly exudes from the tissues. The apothecial anatomy of the type specimen shows that it is a species of *Encoelia*.

Ionomidotis nicaraguensis Durand, Proc. Amer. Acad. Arts 59: 11, pl. 1, pl. 2, fig. 8, 1923.
≡ *Midotis nicaraguensis* (Durand) Seaver, N. Amer. Cup-fung. (Inop.). p. 93, 1951 (as '*Midotia*').
≡ **Encoelia nicaraguensis** (Durand) Zhuang, **comb. nov.** (Fig. 25)

Specimens examined: on rotten logs, Volean Mombacho, Dept. of Grenada, Nicaragua, C. F. Baker 2500, 20. II. 1903, FH (holotype), CUP (isotype) (both filed under *Ionomidotis nicaraguensis*).

Notes: I have looked at the holotype specimen on deposit in FH, and the isotype in the Durand Herbarium of CUP. The appearance of this fungus is somewhat similar to *Encoelia heteromera*, and it was so identified on packet label. The sizes of asci and of ascospores of this fungus are much larger than those of *E. heteromera*. It is not conspecific but is congeneric with *E. heteromera*. The fungus is presumably xanthochroic, since the pigmentation exuded from the tissues is yellowish brown instead of violet, as it would be in the typically ionomidotic species.

Ionomidotis plicata (Phill. & Hark.) Durand, Proc. Amer. Acad. Arts 59: 12, pl. 1, pl. 2, fig. 9, 1923.

Notes: The excipular structure of this species is different from that of *Ionomidotis*, but very similar to *Ameghiniella*. We transfer this fungus to *Ameghiniella*, discussed below on page 287.

Ionomidotis urceolata Durand, Proc. Amer. Acad. Arts 59: 14, pl. 1, pl. 2, fig. 12, 1923.
≡ **Encoelia urceolata** (Durand) Zhuang, **comb. nov.** (Figs. 26, 27)

Specimens examined: (no substrate), Palm Beach, Florida, USA, R. Thaxter 110, XII. 1897, FH (holotype); on rotting wood, Palm Beach Florida, USA, R. Thaxter 110, XII. 1897, CUP-D 10570 (15-22) (isotype) (both filed under *Ionomidotis urceolata*).

Notes: I have studied the holotype of this species in FH and the isotype in the Durand Herbarium of CUP. This fungus is somewhat ionomidotic in KOH solution but the ectal excipular cells are more or less isodiametric, dark, loosely arranged in rows, and not immersed in gel. The excipular structure at the flanks of this fungus resembles *Encoeliopsis rhododendri* (Ces.) Nannf., but the ascospores are 1-celled instead of 2-celled. It is neither a species of *Ionomidotis* nor a species of *Cordierites*. Cells in the outer layers of the excipulum connect to each other very loosely. I treat it as a member of *Encoelia*.

THE GENUS *CORDIERITES*

1. Generic Description

CORDIERITES Mont., Ann. Sci. Nat., Bot. Sér. 2, 14: 330, 1840.
= *Phyllomyces* Lloyd, Mycol. Writings C. G. Lloyd 6: 1057, 1921.

Apothecia discoid, infundibuliform, or ear-shaped, stipitate, usually with branched stipes, receptacle especially at margin covered with light brown to brown, subcylindrical, very short to long hyphal protrusions extending at an acute angle to the outer surface, receptacle surface slightly pustulate, apothecial tissues non-ionomidotic or ionomidotic. Ectal excipulum of textura angularis, tissues not immersed in gel, cells isodiametric to ellipsoid, cell walls brown. Medullary excipulum of textura intricata, hyphae at flanks parallel to the outer surface, hyphal walls light brown to brown. Subhymenium often distinguishable, of textura intricata. Asci inoperculate, 8-spored, subcylindrical, J–, pore walls not turning blue in Melzer's reagent with or without KOH pretreatment. Ascospores uniseriate, ellipsoid, hyaline, smooth-walled, unicellular, biguttulate.

Paraphyses filiform, subcylindrical, usually not exceeding asci.

On wood, sometimes associated with other fungi.

Type: *Cordierites guianensis* Mont.

2. Key to the Accepted Species

1. Apothecium ear-shaped, infundibuliform, or discoid with one side strongly elongate, stipes arising from a common base or branched, tissues strongly ionomidotic .... *C. sprucei*
1'. Apothecium discoid, or discoid with one side somewhat elongate, stipe well-branched, tissues faintly ionomidotic or not 2
    2. Apothecium 1-3 mm in diam, ectal excipulum of well-developed textura angularis, hair-like hyphal protrusions absent, often associated with xylariaceous fungi .... *C. guianensis*
    2'. Apothecium more than 3 mm, up to 20 mm, in diam, ectal excipulum of poorly-developed textura angularis, hair-like hyphal protrusions covering the receptacle surface .... *C. boedijnii*

3. Accepted Species

Cordierites boedijnii Zhuang, **sp. nov.** (Figs. 18, 19)

≡ [*Midotis boedijnii* Cifer., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti, Ser. 5, 14: 269, 1957, nom. nud.]

Misapplication:

Cordierites guianensis Mont. sensu Boedijn, Bull. Jard. Bot. Buitenzorg Ser. 3, 13(4): 527, 1936.

Ab C. guianensi apothecio magno (2-20 mm in diam. vs. 1-3 mm in diam.), prominentibus hyphalibus (usque ad 100 µm longis) quae in receptaculi superficie adsunt, excipulo ectali mediocriter evoluto, atque praesentia in ligno recta vicem societatis cum fungis xylariaceis differens.

Apothecium cupulate, lobed, or discoid with one side elongated, 2-5 mm in diam (apothecium 2-20 mm in diam, and the entire fructifications 20-30 mm high, 10-30 mm broad according to Boedijn, 1936), gregarious, margin enrolled when dry, stipitate, stipes branched, arising from a stroma-like basal trunk, stipes near the base coarse, the final branches ending with an apothecium, tissues not ionomidotic in KOH; hymenium nearly black when dry; receptacle and stipes very dark brown, surface strongly roughened when dry. Ectal excipulum of textura angularis, very thin; cells in the outermost layer giving rise to long, hair-like hyphal protrusions, up to 100 µm long at margin, shorter at flanks and near base, hyphal protrusions septate, cylindrical, with a blunt apex, extending at an acute angle to the receptacle surface, walls pale brown to yellow; tissues not immersed in gel. Medullary excipulum of textura intricata, ca. 125 µm thick at flanks; hyphae parallel to the outer surface, hyphal walls brownish, tissues not immersed in gel. Subhymenium of textura intricata, paler than medullary excipulum, 20-30 µm thick. Asci 8-spored, subcylindrical, J– in Melzer's reagent, ca. 50-60 x 4.4-5.0 µm (47-50 x 4-6 µm according to Boedijn, 1936). Ascospores ellipsoid, uniseriate, biguttulate, 4.9-6.3 x (2.0-)2.2-2.5 µm. Paraphyses filiform, straight, a few slightly bent at apex, 1.0-1.5 µm wide, not exceeding asci.

On wood.

Holotype: on wood, G. Gedeh, Tjibodas, Java, Indonesia, Bruggeman, 1925, BO 9387, R. P. Korf Pers. Herb.-SA 519 (isotype, ex BO 9387) (filed under *Cordierites guianensis*).

Illustrations: Boedijn, K. B., Bull. Jard. Bot. Buitenzorg, Ser. 3, 13: 526-527, figs. 1, 2, 1936 (as *Cordierites guianensis*). This paper figs. 18, 19.

Other specimen examined: INDONESIA: on wood, Krakatau, Z. Oost., Boedijn, 7. IV. 1934, R. P. Korf Pers. Herb.-SA 518 (ex BO 14422) (filed under *Cordierites guianensis*).

Notes: When Boedijn (1936) published a paper referring to the generic concept of *Cordierites,* he described and illustrated his own collections from Java to exhibit the morphology of the type species of this genus, *C. guianensis* Mont. He stated that the Javanese material does not represent a new species, that it is not specifically distinct from the type species, and that the genus consists of one species and all other described species (*C. sprucei*, *C. muscoides*, *C. coralloides*, *C. fasciculata*, and *C. umbilicarioides*) must be reduced to synonyms of *C. guianensis*. Dennis (1955), Ciferri (1957) and Rifai (1977) have thrown doubt on Boedijn's synonymy of *C. guianensis*.

Judging from Boedijn's description of the Javanese "*C. guianensis*," Ciferri concluded that Boedijn's material was different from, and not congeneric with, Montagne's *C. guianensis*, and that it was a species of *Midotis*. A new species (as a new name) was created by him as *Midotis boedijnii* (Ciferri, 1957), but he failed to provide a Latin diagnosis, which makes *M. boedijnii* a nomen nudum.

The type specimen and an authentic collection of *C. guianensis* have been examined and compared with the two collections from Java which had been cited in Boedijn's paper (Boedijn, 1936). Although both fungi share features of gross morphology, such as branched stipes, a discoid apothecium on the tip of each stipe branch, and shape of asci and of ascospores, the ectal excipular structures are different. The true *C. guianensis* has short, slightly elongated cells at the apothecial margin which are not hair-like, and the excipular cells in the outer layers are arranged in rows at an acute angle to the exterior where they form low pustules on the receptacle surface. Boedijn's "*C. guianensis*" has very long marginal hyphae which are hair-like, up to 100 µm long, covering the receptacle surface, and extend toward the outside at an acute angle to the outer surface, and the receptacle surface is not obviously pustulate. The true *C. guianensis* has smaller apothecia and finer stipes than Boedijn's material does. Although I agree with Ciferri that Boedijn's material from Java is not conspecific with Montagne's original one from Guyana, they are congeneric.

CORDIERITES GUIANENSIS Mont., Ann. Sci. Nat. Bot., Sér. 2, 14: 331, 1840. (Fig. 20)
? = *Cordierites coralloides* Berk. & Curt., J. Linn. Soc. Bot. 10: 370, 1868.
≡ *Graphium coralloides* (Berk. & Curt.) Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 118: 894, 1909 (excluding description).

Apothecium cupulate to discoid, gregarious, stipitate, ca. 1 mm in diam when dry (up to 3 mm in diam according to Rifai), stipes well-branched, terete; tissues not ionomidotic in KOH; hymenium dark brown to olivaceous; receptacle dark brown, lighter at margin, surface roughened to furfuraceous when dry. Ectal excipulum of textura angularis, not immersed in a gel matrix; cells isodiametric to elongate, cell walls light brown; receptacle slightly pustulate, cells in pustules more or less isodiametric, walls brown. Medullary excipulum of textura intricata, tissues not immersed in gel; hyphae parallel to the outer surface, walls yellowish brown. Subhymenium of textura intricata, 29-35 µm thick. Asci 8-spored, subcylindrical, J– in Melzer's reagent, asci 4.0-4.5 µm wide, hymenium ca. 70-80 µm thick. Ascospores ellipsoid, uniseriate, biguttulate, walls yellowish, 4.4-6.2 x 2.1-2.2 (-2.5) µm. Paraphyses filiform, straight, 1.5 µm wide, not exceeding asci.

On wood associated with xylariaceous fungi.

Illustrations: Montagne, C., Ann. Sci. Nat. Bot., Sér. 2, 14: pl. 19, fig. 11, 1840. Corda, A. K. J., Anleit. Stud. Mycol., Taf. G, 64, figs. 40-42, 1842. Montagne, C., Ann. Sci. Nat. Bot., Sér. 4, 3: tab. 6, fig. 6, 1855. Payer, J., Bot. Cryptog. p. 64, figs. 273-274; p. 89, figs. 408-409, 1868. Massee, G., J. Linn. Soc. Bot. 31: pl. 18, fig. 3, 1897 (as *Cordierites coralloides*). Dennis R. W. G., Kew Bull. 1955: 366, fig. 3, 1955; Kew Bull. Addit. Ser. 3, fig. 7, H, 1970. Ciferri, R., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: pl. 2, 1957. Rifai, M. A., Kew Bull. 31: 725, fig. 1, 1977 (as *Cordierites coralloides*). This paper fig. 20.

Specimens examined: COLOMBIA: on indet. Xylariaceae on log, ca. 29 miles from Florencia on the Florencia-Altamira Road, Intendencia Caqueta, elev. ca. 4000 ft., K. P. Dumont, P. Buritica, J. L. Luteyn, & L. A. Molina, 18. I. 1976, NY-Dumont-CO 3023.

CUBA: (no substrate), C. Wright 504, K, NY-KPD 2035 (ex K); (no substrate), (no collector), NY-from the Herbarium of George Massee, purchased 1905 (filed under *Cordierites coralloides* B. & C.) (? part of the original material of *C. coralloides*).

GUYANA: ad truncos putridos [?associated with a xylariaceous fungus], Leprieur, XI. 1837, no. 383, PC (holotype of *Cordierites guianensis*), NY-KPD 2017 (isotype, ex PC no. 383); on wood, Rio des Cascades, Leprieur, I. 1843, no. 885 (Crypt. Guyan. no. 578), PC, NY-KPD 2018 (ex PC no. 885).

Notes: This is the type species of *Cordierites*. The specific name was used in a very broad sense by Boedijn (1936) and in a narrower sense by Ciferri (1957), even though both authors claimed the genus to be monotypic. As indicated earlier, Boedijn's concept of *C. guianensis* was based not on a type study but totally on the collections from Java. Ciferri's concept of this species seems to be established on the basis of type examination. But as he mentioned in his paper, what he had really seen was the specimen label, notes, branched stipes, small fragments of stipitate ascocarps, pencil drawings of ascocarps and of ascospores, and black dust in a packet containing two kinds of hyaline spores. In other words, he did not examine the structure of this fungus but only the gross morphology and description.

Through the courtesy of Muséum National d'Histoire Naturelle, Paris (PC), and the New York Botanical Garden (NY), I was able to examine the type specimen (#383) and another authentic specimen (#885), both determined as *Cordierites guianensis* by Montagne (1840, 1855). As indicated by Ciferri (1957) they were in very poor condition. I found, among branched stipes of #383 on deposit in PC, a poorly-preserved and possibly parasitized apothecium, and made microtome sections from it. The sections have been mounted in dilute commercial mucilage, and returned to the packet. The isotype of this species in NY, in slightly better condition, contains a portion of a stipe and a fragment of an apothecium glued on a small piece of paper, as well as sections showing the margin and flank of an apothecium which were made by K. P. Dumont some years ago. #885 in NY (ex PC), which is well-preserved, has sections of a portion of an apothecium, and a small branched stipe bearing an apothecium. These materials gave me much more information than Ciferri's paper. A recent collection of *C. guianensis* from Colombia, associated with a xylariaceous fungus, on deposit in NY (Dumont-CO 3023) was also examined. The gross morphology and anatomical structure of the Colombian collection match those of Montagne's material from Guyana.

When Rifai (1977) restudied *C. coralloides*, which occurs on *Ustulina deusta*, he disagreed with Boedijn's synonymy of this species with *C. guianensis*, and pointed out that it was an independent species. According to Rifai, *C. guianensis* grows on a different type of substrate from *C. coralloides*. My studies have shown that the structure of both type specimens is very similar, and that many xylariaceous spores were also present on the apothecium of the type of *C. guianensis*. I suspect that the type specimen of *C. guianensis* was associated with a fungus which we have not seen, either because the substrate no longer exists in the packet, or because it was never picked up by the original collector. My conclusion is that *C. coralloides* is a later synonym of *C. guianensis*.

In response to my request to the Royal Botanic Gardens, Kew, England for the type of *C. coralloides*, the holotype was not sent, but another specimen in the type folder, "Wright 504." According to Rifai (1977), no fungal material remains in the holotype (Wright 326), only a detailed water color drawing by Phillips labelled "from Wright in Herb. Berk. no. 326," and the illustration clearly depicts linear asci and spores. When Höhnel (1909) examined the holotype of *C. carolloides*, he did not find the discomycete but an imperfect fungus on the substrate, and mistakenly transferred *C. carolloides* to the hyphomycete genus, *Graphium*. The hyphomycete was later described as *Dennisographium episphaeriae* Rifai (1977).

CORDIERITES SPRUCEI Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 280, 1856. (Figs. 21, 22)
≡ *Ionomidotis sprucei* (Berk.) Durand, Proc. Amer. Acad. Arts 59: 13, 1923.
? = *Cordierites fasciculata* Möll., Bot. Mitt. Tropen 9: 278, 1901.
≡ *Midotis fasciculata* (Möll.) Cifer., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: 269, 1957.
= *Cordierites umbilicarioides* Möll., Bot. Mitt. Tropen 9: 279, 1901.
≡ *Ionomidotis umbilicarioides* (Möll.) Le Gal, Bull. Jardin Bot. État. 29(2): 120, 1959, nom. superfl.
= *Phyllomyces multiplex* Lloyd, Mycol. Writings C. G. Lloyd 6: 1057, 1921.

Apothecium discoid with one side elongated, infundibuliform, or ear-shaped, gregarious or solitary, stipitate, 2-12 mm wide and up to 20 mm high, stipes branched, sometimes arising from a common base; tissues strongly ionomidotic in aqueous KOH solution; hymenium very dark purplish brown to nearly black; receptacle concolorous with hymenium, surface furfuraceous and pustulate. Ectal excipulum of textura angularis, very thin; cells isodiametric to ellipsoid, walls pigmented, cells in the outermost layer giving rise to short hyphal protrusions; receptacle pustulate, cells in pustules isodiametric, walls pigmented. Medullary excipulum of textura porrecta to textura intricata, 65-140 µm thick at flanks; hyphae parallel to the outer surface, walls smooth and light brown. Subhymenium clearly distinguishable, of textura intricata, 28-60 µm thick. Asci 8-spored, subcylindrical, J– in Melzer's reagent, ca. 60-75 x 4.0-4.5(-5) µm. Ascospores ellipsoid, uniseriate, biguttulate, 3.7-5.1 x 2.1-3.0 µm. Paraphyses filiform, straight at apex, 1.5-2.0 µm wide, not exceeding asci.

On wood.

Illustrations: Berkeley, M. J., Hooker's J. Bot. Kew Gard. Misc. 8: pl. 10, fig. 5, 1856. Massee, G., J. Linn. Soc. Bot. 31: pl. 18, figs. 4, 5, 1897. Lloyd, C. G., Mycol. Writings C. G. Lloyd 6: fig. 1975, 1921 (as *Phyllomyces multiplex*). Durand, E. J., Proc. Amer. Acad. Arts 59: pl. 2, fig. 11, 1923 (as *Ionomidotis sprucei*). Ciferri, R., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: pl. 1, fig. 10 (as ? *Midotis occidentalis*), figs. 13-15 (as *Midotis fasciculatq*) 1957. Le Gal, M., Bull. Jardin Bot. État. 29(2): 121, 123, figs. 20, 21, 1959; Flore Icon. Champ. Congo fasc. 9, pl. 31, fig. 7, 1960 (color illustration by M. Goossens-Fontana) (as *Ionomidotis umbilicarioides*). This paper figs. 21, 22.

Specimens examined: BRAZIL: in truncis putridis, Panuré, Spruce 85, (no date), K-Herb. Berk. (holotype of *Cordierites sprucei*), CUP-D 4165 (15-20) (? isotype, marked as "cotype"), NY (a drawing by Massee from type), NY-KPD 2034 (isotype, ex K); (no substrate), Spruce, (no date), CUP-D 7514 (15-21); (no substrate), Spruce, (no date), NY-from the Herbarium of George Massee, purchased 1905.

COLOMBIA: on dead wood, Caño Unguya, Rio Apaporris, Vaupes, R. E. D. Baker, 9. IV. 1952, K (filed under *Cordierites guianensis*); on indet. log, ca. 29 miles from Florencia on the Florencia-Altamira Road, Intendencia Caqueta, elev., ca. 4000 ft., K. P. Dumont, P. Buritica, J. L. Luteyn, & L. A. Molina, 18. I. 1976, NY-Dumont-CO 3026.

PHILIPPINES: on dead wood, Mt. Maquiling, Luzon, P.I., B. Corsino, 28. IX. 1920, Lloyd 7283, BPI (holotype of *Phyllomyces multiplex*), R. P. Korf Pers. Herb. 4006 (isotype, ex BPI).

SIERRA LEONE: on dead trunk of *Mangifera indica*, Njala, (no collector), 11. III. 1954, K-M6279 (filed under *Cordierites guianensis*).

SOVIET UNION: on rotten angiosperm wood, regio Primorsk, Sudzukhe reservate, Sandagon, U.R.S.S., A. Raitviir (42650), 7. IX. 1961, R. P. Korf Pers. Herb. 3359.

VENEZUELA: (no substrate), trail from Los Pocitos 1 1/2 hours walking toward Santa Isabel, NW Irapa, Edo Sucre, K. P. Dumont, R. F. Cain, G. J. Samuels, G. Morillo, & J. Farfan, 11. VII. 1972, NY-Dumont- VE 7313.

Notes: This fungus was transferred from *Cordierites* to *Ionomidotis* by Durand (1923) because of the presence of ionomidotic reaction. Structurally it is quite different from the species of *Ionomidotis* but similar to *C. guianensis*, except for the elongated outer cells on the receptacle surface and at the margin which are short, non-septate, hyphal protrusions, never appearing as long as the hyphal protrusions of *C. boedijnii*. Though the ionomidotic reaction is a useful and important tool in classification, fungi other than *Ionomidotis* species have also been reported to be ionomidotic (Korf, 1958; Ouellette & Korf, 1979).

C. umbilicarioides Möll. from Brazil and *Phyllomyces multiplex* Lloyd from the Philippines are later synonyms. Although the apothecia of the types of these two species are larger, they are structurally indistinguishable from *C. sprucei* in Brazil. The Philippine material has higher pustules on the receptacle surface than material from Brazil. I do not treat this as a character at specific level.

The comments made by Ciferri (1957) on *C. sprucei* are very confusing, and probably not based on a careful study. He stated that "in our opinion, may be that *C. sprucei* and *C. lateritia* are the same species, based on imperfect ripeness stage or imperfect description," and later in the same paper that *C. sprucei* "may be doubtfully considered conspecific with *Midotis occidentalis*." The correct name of "*C. lateritia*" is *Encoelia heteromera* (Mont.) Nannf., which is different from *C. sprucei* both in structure and in gross morphology. *M. occidentalis* Durand is an interesting fungus with a J+ ascus iodine reaction and punctate ascospores, and is certainly not congeneric with *C. sprucei*.

The type specimen of *C. fasciculata* on deposit at B is in alcohol and cannot be borrowed, so that I failed to examine it. Le Gal (1959), however, has synonymized this fungus under *C. umbilicarioides*. I accept the synonymy of these two species as proposed by Ciferri (1957) and by Le Gal (1959) Le Gal incorrectly chose *umbilicarioides* as the specific epithet, since Ciferri had previously chosen *fasciculata* when he synonymized the two taxa.

4. Excluded Species

Cordierites acanthophora Samuels & Kohn, Sydowia 39: Figs. 1 A–C, 2 A–D, 1987 (in press).

Specimen examined: on ground, Auckland, Waitemata City, Waitakere Ranges, at junction of Old Coach Road and Fairy Falls Track (from the same site as type collection: G.J.S.), G. J. Samuels & A. Y. Rossman, 4. VI. 1983, NY (ex PDD 46300, filed under *Cordierites acanthophora*).

Notes: A specimen in NY (ex PDD 46300) identified by Dr. Samuels (one of the original authors) has been examined. This is a very special and interesting fungus, its apothecia scattered on a cylindrical stalk bearing thorn-like pycnidia. Samuels and Kohn (1987) have given a very detailed description and illustration. It is obviously a fungus in the Encoelioideae but neither in *Ionomidotis* nor in *Cordierites*. The loosely interconnected, subglobose excipular cells, and J+ ascus iodine reaction remind me of the genus *Encoelia*. The other features, especially the very large, fusoid, ornamented ascospores, and thorn-like pycnidia seated on the stalk, do not fit the genus *Encoelia*. I have no position for it. It might represent a new genus.

Cordierites concrescens (Schw.) Cooke, Bull. Buffalo Soc. Nat. Sci. 3: 26, 1875.
≡ *Peziza concrescens* Schw., Trans. Amer. Philos. Soc. 4: 171, 1832.

Specimen examined: [on rotten wood], Salem, Bethlehem, (no collector), 1829, PH-Schweinitz, Syn. #755 (holotype, in two packets); among rotten wood, Salem, Bethlehem, BPI (isotype, ex Herb. Schw.).

Notes: The holotype and isotype specimens on deposit in PH and BPI have been examined. The fruit bodies of this fungus, firmly attached to a piece of wood, are buff-colored, and highly gelatinous to tremelloid, without any ionomidotic reaction. I cannot find a single ascus in the type material and wonder whether it is an ascomycete. I am convinced by my observations that it is not a *Cordierites*.

Failing to study Cooke's paper, Ciferri (1957) mistakenly thought that the basionym of *Cordierites concrescens* (Schw.) Cooke (1875) was *Sphaeria concrescens* Schw., and gave the wrong literature source. Actually, the epithet that Cooke (1875) transferred was based on *Peziza concrescens* Schw.

Cordierites frondosa (Kobayasi) Korf, Phytologia 21: 203, 1971.
≡ *Bulgaria frondosa* Kobayasi, Bot. Mag. (Tokyo) 53: 158, 1939.
≡ IONOMIDOTIS FRONDOSA (Kobayasi) Kobayasi & Korf in Korf, Sci. Rep. Yokohama Natl. Univ., Ser. 2, Biol. Sci. 7: 19, 1958.

Notes: This species has already been discussed earlier under *Ionomidotis*.

Cordierites indicus (Thind, Cash & Singh) Thind & Sharma, Bibl. Mycol. 91: 188, figs. 1, 2, 1983.
≡ *Midotis indica* Thind, Cash & Singh, Mycologia 51: 833, figs. 1, 4, 7, 10, 1959.
≡ **Chlorencoelia indica** (Thind, Cash & Singh) Zhuang, **comb. nov.** (Fig. 24)

Specimen examined: on *Cedrus deodara* wood, Khadrala, Mahasu, (H.P.), R. K. Singh, 26. VIII. 1971, BPI (ex PAN-Singh 3865, filed under *Midotis indica*).

Notes: Since the holotype of this species was not sent to me, a specimen (Singh 3865), which was identified by one of the original authors and which was cited by Sharma and Thind (1983) when the transfer to *Cordierites* was made, has been examined by me. I have compared very carefully the morphology of Singh 3865 with the original description and illustration of *Midotis indica*, and find that they match each other well. I treat this specimen as authentic.

The discoid to slightly infundibuliform, unequal-sided apothecia, excipular structure, especially the club-shaped cells in the outermost layer of the ectal excipulum, ellipsoid ascospores which have two large guttules, and the J+ ascus iodine reaction recall *Chlorencoelia versiformis*, the type species of *Chlorencoelia*. A transfer to *Chlorencoelia* is thus proposed.

Chlorencoelia indica may be similar to *Chlorociboria* species in the somewhat pustulate receptacle, but it can be distinguished by the clearly delimited subhymenium, ellipsoid ascospores with two large guttules, and failure to produce green stain in the substrate.

Cordierites irregularis (Schw.) Cooke, Bull. Buffalo Soc. Nat. Sci. 3: 26, 1875.
≡ *Peziza irregularis* Schw., Trans. Amer. Philos. Soc. 4: 171, 1832.
≡ IONOMIDOTIS IRREGULARIS (Schw.) Durand, Proc. Amer. Acad. Arts 59: 9, 1923.

Notes: This species has been discussed earlier in this paper under *Ionomidotis*.

"*Cordierites lateritia* Berk. & Curt." in Ciferri, Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: 266, 1957, nom. nud.
≡ ENCOELIA HETEROMERA (Mont.) Nannf., Trans. Brit. Mycol. Soc. 23: 239, 1939.

Specimens examined: (no substrate), Cuba, Wright 580, (no date), CUP-D 3581 (15-25) (marked as type, filed under *Cordierites lateritia* and *Midotis heteromera*); on rotten logs in dense woods, La Perla, C. Wright 580, (no date), NY (filed under *Cordierites lateritia*); on rotten logs, Cuba, Wright, V. 1857, FH-Curtis Herb. (filed under *Cordierites lateritia*).

Notes: The name "*Cordierites lateritia* B. & C." seems to never have been published by Berkeley and Curtis. In the Durand Herbarium of CUP, a specimen numbered CUP-D 3581 (15-25) (ex Wright 580) was marked "type" with a red pen by Durand. *Cordierites lateritia* first appeared in a note by Farlow in the paper by Durand (1923) which indicated "Was the name *Cordierites lateritia* ever published?" I have to ask the same question again. Although Ciferri (1957) used this "name," I could not and perhaps will never find where the name was published. I found that Wright 580 was clearly referred to by Berkeley and Curtis (1867) under the name *Midotis heteromera* (Mont.) Fr. My examinations of "*C. lateritia*" in CUP, FH, K, and NY have shown that it is conspecific with *Encoelia heteromera* (Mont.) Nannf. Ciferri (1957) used this "name" without explanation.

Cordierites muscoides Berk. & Curt. in Berk., Grevillea 4: 2, 1875.

Specimen examined: [on wood], Pennsylvania, Michener 4314, (no date), K (holotype).

Notes: The holotype (No. 4314) of this species at K has been examined. The fungus is on a small piece of wood. Its fruit bodies look like the branched stipes of *Cordierites*, but no apothecia can be found on any ends of these branches. The texture of these branches is corky and spongy, and the fruit bodies consist of brown, thick-walled fibers. By no means it is a discomycete; possibly it is basidiomycetous.

THE GENUS *AMEGHINIELLA*

1. Generic Description

AMEGHINIELLA Speg., Bol. Acad. Nac. Ci. 11(2): 270, 1888. (Fungi Fueg. p. 138, 1888).

Apothecium small to medium in size, gregarious, arising from a common base, deeply cupulate when dry, slightly asymmetrical, sessile; hymenium very dark brown, dark purple or black when dry; receptacle very dark purple to black when dry, surface pustulate; tissues usually ionomidotic. Ectal excipulum of textura angularis, cells pigmented, isodiametric to ellipsoid, very thick-walled, cells in the outer layers encoelioid; cells in the pustules isodiametric, loosely interconnected, thick-walled, walls light brown to brown, cells darker near apothecial base than at flanks and at margin. Medullary excipulum of textura intricata, hyphal walls subhyaline, yellowish to pale brown. Subhymenium not sharply distinguished from medullary excipulum, of textura intricata if present. Asci inoperculate, 8-spored, clavate, J– in Melzer's reagent. Ascospores allantoid to rod-shaped, biseriate to irregularly biseriate, subhyaline to yellowish, with several small guttules. Paraphyses filiform, slightly exceeding asci.

On branches of dead angiosperms.

Type: *Ameghiniella australis* Speg.

2. Key to the Accepted Species

1. Apothecium 4-15 mm in diam at maturity when dry, asci 36-40 x 3.5-3.7 µm, ascospores 5.0-6.5 x 1.0 µm .... *A. australis*

1'. Apothecium often less than 2 mm in diam at maturity when dry, asci 45-52 x 5.0-6.0 µm, ascospores 5.1-8.0(-8.8) x 1.5-2.0 µm ... *A. plicata*

3. Accepted Species

AMEGHINIELLA AUSTRALIS Speg., Bol. Acad. Nac. Ci. 11(2): 271, 1888. (Fungi Fueg. p. 139, 1888). (Fig. 15)

Apothecium deeply cupulate when dry, undulate-plicate, 4-15 mm in diam when dry, gregarious and arising from a common base, sessile; tissues strongly ionomidotic in KOH; hymenium black when dry; receptacle very dark brown to black when dry, surface granulate to pustulate. Ectal excipulum of textura angularis, 32-37 µm thick (excluding pustules), not immersed in gel; cells ellipsoid to subspherical, cell walls light brown, 1.0-1.2 µm thick, axes of cells perpendicular to the outer surface, cell contents brown; receptacle pustulate, cells in pustules subspherical, becoming loose at the tips of pustules, cell walls ca. 1.0-1.8 µm thick, light brown to brown. Medullary excipulum of textura intricata, 124-210 µm thick; hyphae not immersed in gel, slightly gelatinized, densely interwoven, hyphal walls light brown to brown. Subhymenium not clearly distinguishable. Hymenium ca. 50-52 µm thick. Asci 8-spored, clavate, J– in Melzer's reagent after 2% KOH pretreatment, ca. 36-40 x 3.5-3.7 µm (40-50 x 3-4.5 µm according to the original author). Ascospores allantoid, biseriate to irregularly biseriate, yellowish, multiguttulate, 5.0-6.5 x 1.0 µm (4.5-6 x 0.7-1 µm according to Spegazzini). Paraphyses filiform, sometimes curved at apex, slightly exceeding asci.

On dead branches of *Fagus betuloides*.

Illustration: This paper fig. 15.

Specimen examined: (no substrate), (no locality), (no collector), (no date), LPS 15709 (indicated by LPS as Typus) (note in the packet: this material is apparently part of the type).

Notes: This fungus is different from *Ionomidotis chilensis*. The distinctions between *Ameghiniella* and *Ionomidotis* has been discussed earlier in this paper.

The only specimen sent from the Spegazzini Herbarium bears no information on the packet except for "LPS 15709" and "Typus." Two small packets were found in the type. The packets contain different fungi. My description is based on one of them which fits the original description well. The other one is in a young stage, lacking asci in the hymenium. I am not certain whether it is the immature stage of *A. australis*, or more likely a different fungus which has greenish apothecia and which may be close to *Chlorociboria*.

Ameghiniella plicata (Phill. & Hark.) Zhuang & Korf, **comb. nov.** (Figs. 16, 17)

≡ *Midotis plicata* Phill. & Hark., Bull. Calif. Acad. Sci. 1: 24, 1884.

≡ *Ionomidotis plicata* (Phill. & Hark.) Durand, Proc. Amer. Acad. Arts 59: 12, 1923.

Apothecium deeply cupulate when dry (goblet-shaped, resembling a miniature *Urnula craterium* according to Durand, 1923), 1-2 mm in diam when dry, gregarious and arising from a common base, sessile; tissues strongly ionomidotic in KOH; hymenium very dark brown to dark purple when dry; receptacle concolorous with hymenium, surface pustulate. Ectal excipulum of textura angularis, not immersed in gel; cells in outer layers isodiametric, 7.5-15 µm in diam, cell walls thick, slightly roughened, light brown near margin and becoming brown at base, cell contents reddish brown, cells in inner layers ellipsoid, relatively thin-walled, pale brown to light brown; receptacle pustulate, cells in pustules spherical, very loosely interconnected, dark-walled near base. Medullary excipulum of textura intricata, tissues not immersed in gel, slightly gelatinized; hyphae densely interwoven, hyphal walls pale brown to yellowish. Subhymenium not clearly distinguishable from medullary excipulum, of dense textura intricata. Hymenium 75-85 µm thick. Asci 8-spored, clavate, J– in Melzer's reagent, 45-50 x 5.0-6.0 µm (65-70 µm long according to Durand, 1923). Ascospores rod-shaped to allantoid, biseriate to irregularly biseriate, yellowish, multiguttulate, 5.0-8.0(-8.8) x 1.5-2.0 µm. Paraphyses filiform, slightly enlarged at apex, ca. 2-3 µm wide at apex, exceeding asci by ca. 15 µm.

On wood of *Umbellularia californica.*

Illustrations: Durand, E. J., Proc. Amer. Acad. Arts 59: pl. 1, pl. 2, fig. 9, 1923 (as *Ionomidotis plicata*). Ciferri, R., Ist. Bot. Real Univ. Reale Lab. Crittog. Pavia Atti Ser. 5, 14: pl. 1, fig. 6, 1957 (as *Midotis plicata*). This paper figs. 16, 17.

Specimens examined: on *Umbellularia californica*, Sausalito, California, VIII. 1881, Harkness 2734, BPI (holotype), CUP-D 10761 (15-18a, and 15-19) (isotypes) (as *Midotis plicata*).

Notes: The gross morphology and anatomical structures indicate that it is a good species of *Ameghiniella.* It resembles *A. australis* in many aspects.

The isotype specimen on deposit in the Durand Herbarium in CUP is in a much better condition than is the holotype in BPI.

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FIGURES

Fig. 1. Transverse section of excipulum at flank of *Ionomidotis australis*; x 575, from holotype.
Fig. 2. Transverse section of apothecial margin of *Ionomidotis australis*; x 240, from holotype.
Fig. 3. Transverse section of excipulum at flank of *Ionomidotis chilensis*; x 575, from holotype.
Fig. 4. Transverse section of apothecial margin of *Ionomidotis chilensis*; x 240, from holotype.
Fig. 5. Transverse section of excipulum at flank of *Ionomidotis frondosa*; x 575, from neotype.
Fig. 6. Transverse section of apothecial margin of *Ionomidotis frondosa*; x 240, from neotype.
Fig. 7. Transverse section of excipulum at flank of *Ionomidotis fulvotingens*; x 575, from isotype.
Fig. 8. Transverse section of apothecial margin of *Ionomidotis fulvotingens*; x 240, from isotype.
Fig. 9. Transverse section of excipulum at flank of *Ionomidotis irregularis*; x 575, from R. P. Korf Pers. Herb 4283.
Fig. 10. Transverse section of apothecial margin of *Ionomidotis irregularis* (phase contrast); x 240, from R. P. Korf Pers. Herb. 4283.
Fig. 11. Transverse section of excipulum at flank of *Ionomidotis olivascens*; x 575, from holotype.
Fig. 12. Transverse section of apothecial margin of *Ionomidotis olivascens*; x 240, from holotype.
Fig. 13. Transverse section of excipulum at flank of *Ionomidotis portoricensis*; x 575, from holotype.
Fig. 14. Transverse section of apothecial margin of *Ionomidotis portoricensis*; x 240, from holotype.
Fig. 15. Transverse section of excipulum at flank of *Ameghiniella australis*; x 550, from LPS 15709.
Fig. 16. Transverse section of apothecial margin of *Ameghiniella plicata*, x 280, from isotype.
Fig. 17. Transverse section of excipulum at flank of *Ameghiniella plicata*, x 280, from isotype.
Fig. 18. Transverse section of apothecial margin of *Cordierites boedijnii* (phase contrast); x 240, from holotype.
Fig. 19. Transverse section of excipulum at flank of *Cordierites boedijnii* (phase contrast); x 240, from holotype.
Fig. 20. Transverse section of an apothecium at margin and at flank of *Cordierites guianensis* (phase contrast); x 240, from Wright 504.
Fig. 21. Transverse section of excipulum at flank of *Cordierites sprucei* (phase contrast); x 240, from holotype.

Fig. 22. Transverse section of apothecial margin of *Cordierites sprucei* (phase contrast); x 240, from holotype.

Fig. 23. Transverse section of excipulum at flank of *Encoelia fuscobrunnea*; x 280, form holotype.

Fig. 24. Transverse section of excipulum at flank of *Chlorencoelia indica*; x 280, from Singh 3865.

Fig. 25. Transverse section of ectal excipulum of *Encoelia nicaraguensis*; x 280, from holotype.

Fig. 26. Transverse section of apothecial margin of *Encoelia urceolata*; x 280, from holotype.

Fig. 27. Transverse section of excipulum at flank of *Encoelia urceolata*, x 280, from holotype.

Fig. 28. An ascus, an ascospore, and a paraphysis apex of *Ionomidotis australis*, x 1000, from holotype.

Fig. 29. An ascus, an ascospore, and paraphysis apices of *Ionomidotis chilensis*; x 1000, from holotype.

Fig. 30. An ascus, an ascospore, and paraphysis apices of *Ionomidotis frondosa*; x 1000, from neotype.

Fig. 31. An ascus, an ascospore, and a paraphysis apex of *Ionomidotis fulvotingens*; x 1000, from holotype.

Fig. 32. An ascus, an ascospore, and a paraphysis apex of *Ionomidotis irregularis*; x 1000, from holotype.

Fig. 33. An ascus, an ascospore, and paraphysis apices of *Ionomidotis olivascens*; x 1000, from holotype.

Fig. 34. An ascus, an ascospore, and a paraphysis apex of *Ionomidotis portoricensis*; x 1000, from holotype.

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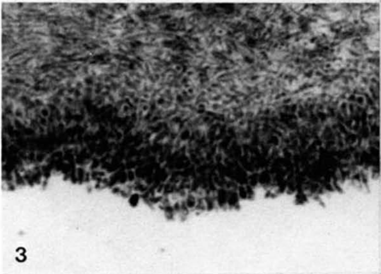

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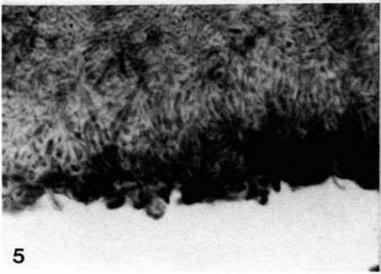

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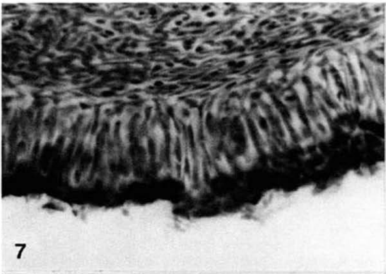

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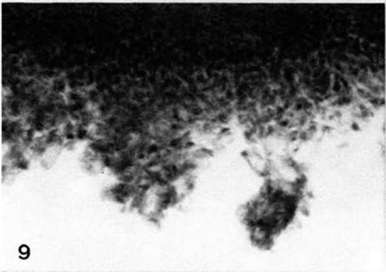

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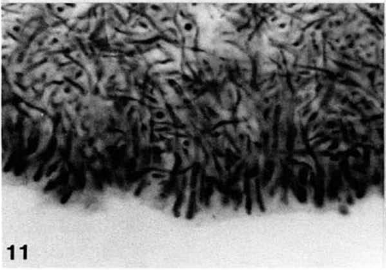

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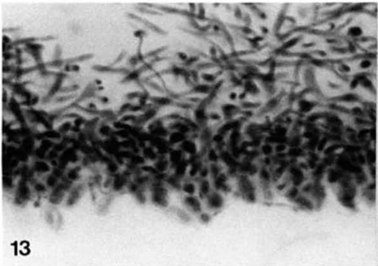
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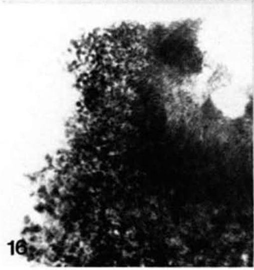
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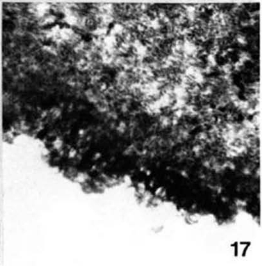
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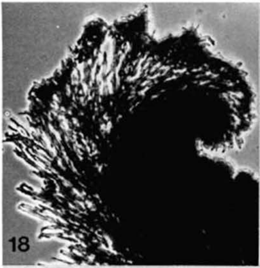
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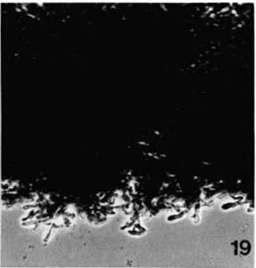
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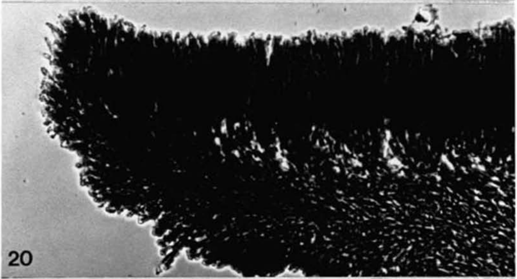
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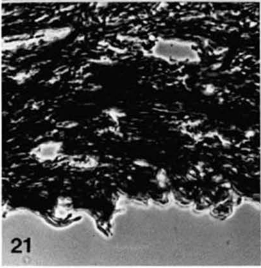
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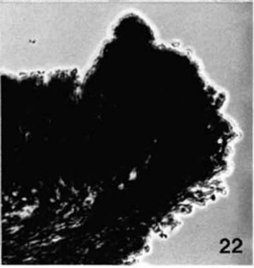
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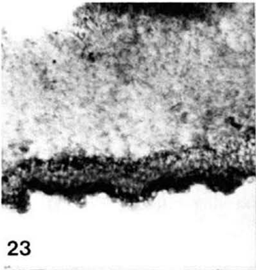

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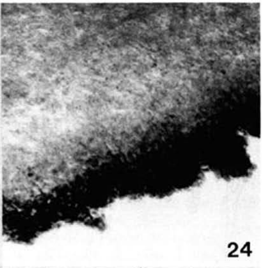

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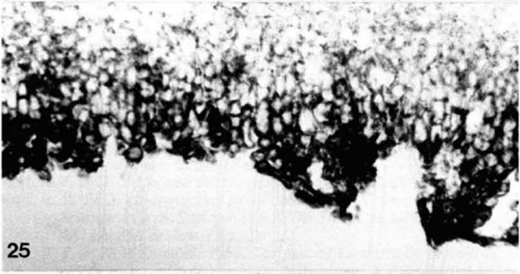

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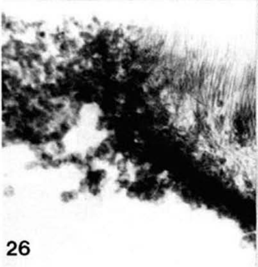

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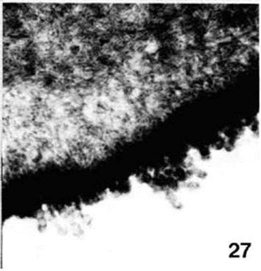

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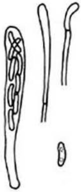

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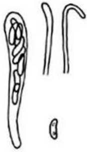

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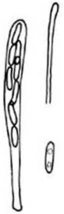

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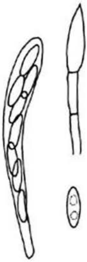

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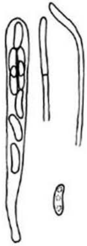

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MYCOTAXON

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TWO NEW SPECIES OF CORTICOLOUS *MYXOMYCETES* FROM SPAIN

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Summary

Two new species of *Myxomycetes* are described from Central Spain which developed on *Juniperus thurifera* L. bark in moist chamber cultures. *Licea nannengae* sp. nov. can be distinguished from other *Licea* species by its double peridium with a membranous, smooth and conspicuous inner layer and smooth, olivaceous spores and *Macbrideola oblonga* sp. nov. which most closely resembles *M. ovoidea* Nann.-Brem. & Y. Yamam., but differs from it in its larger, densely and minutely-warted spores and the shorter stalk.

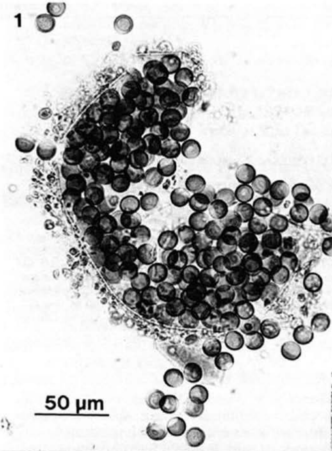
Licea nannengae Pando & Lado sp. nov. subgenus **Licea**

Species *Liceae kelleri* Nann.-Brem. & Y. Yamam. proxima, sed ad ea peridio cristato, substrato peridiali patenti, membranoso, atque sporis maioribus (9.5-13.5 µm diam.) primo ictu discernibilis; a specie autem *Licea denudescenti* Keller & Brooks facile nostra discernetur cum peridium omni ornatu in latere interno careat cumque stratum eius externus tenuis revera et non fugax sit.

Sporangia scattered to gregarious, 0.05-0.20 mm diam., sessile, nearly globose on a somewhat narrowed to broad base, without dehiscent platelets but with little ridges when dry. Hypothallus not observed. Peridium dark brown to yellow-ochraceous, with deposits of granular refuse material, which, when they are scanty allow observation of the membranous inner layer, which is translucent, shiny, somewhat iridescent; in transmitted light, smooth, pale-olive coloured. Dehiscence takes place along the ridges (into platelets and lobes, leaving a cup with a glossy base), although, in transmitted light, such ridges in closed sporangia are not marked. Spores smooth, globose, dark-brown in reflected ligth, in transmitted, olivaceous-brown with a pale area, 9.5-13.5 µm diam., spore wall thick with a thinner area. Plasmodium not observed.

Collections examined. BURGOS: Carazo, 1200 m, 30TVM7047, bark of *Juniperus thurifera* in moist chamber, 21-III-1986, *C. Lado, F. Pando & J. Portela*, 228 Pando, MA-Fungi 16038.

GUADALAJARA: Anchuela del Campo, near 4 km of the road to Labros, 1150 m, 30TWL8343, bark of *Juniperus thurifera* in moist chamber, 17-XII-1984, *J. Checa, C. Lado & F. Pando*, 115 Pando, MA-Fungi 15924. Huertahernando, bridge on Salinas river, 940 m, 30TWL5922, bark of *Juniperus thurifera* in moist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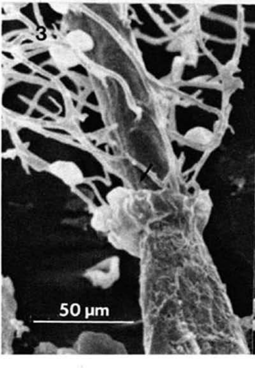
50 µm


2
150 µm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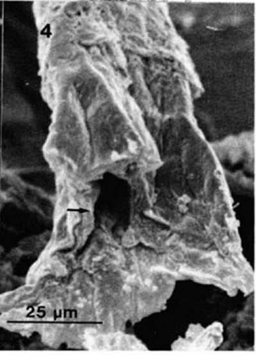
50 µm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25 µm

chamber, 23-X-1984, *C. Lado,* 83 Pando, MA-Fungi 15892; ibidem, 13-XI-1984, 85 Pando, MA-Fungi 15894; ibidem, 21-XI-1984, 86 Pando, MA-Fungi 15895; ibidem, 31-X-1984, 95 Pando, MA-Fungi 15904; ibidem, 21-XI-1984, 96 Pando, MA-Fungi 15905; ibidem, 21-XII-1984, 97 Pando, MA-Fungi 15906; ibidem, 31-X-1984, 99 Pando, MA-Fungi 15908. Santiuste, 1000 m, 30TWL1649, bark of *Juniperus thurifera* in moist chamber, 20-III-1986, *J. Checa, C. Lado & F. Pando,* 224 Pando, MA-Fungi 16034. Tamajón, Virgen del Enebral, 1040 m, 30TVL7941, bark of *Juniperus thurifera* in moist chamber, 28-II-1986, *F. Pando,* 205 Pando, MA-Fungi 16015; ibidem, 17-II-1986, 206 Pando, MA-Fungi 16016. Torremocha del Pinar, 1250 m, 30TWL8027, bark of *Juniperus thurifera* in moist chamber, 30-X-1984, *A. Mendoza & F. Pando,* 111 Pando, MA-Fungi 15920.

SEGOVIA: Prádena, 1200 m, 30TVL4555, bark of *Juniperus thurifera* in moist chamber, 20-II-1986, *J. Checa, C. Lado & F. Pando,* 209 Pando, MA-Fungi 16019; ibidem, 28-II-1986, 211 Pando, MA-Fungi 16021. Siguero, 1080 m, 30TVL4959, bark of *Juniperus thurifera* in moist chamber, 24-II-1986, *J. Checa, C. Lado & F. Pando,* 216 Pando, MA-Fungi 16026.

SORIA: Cubillos, 1080 m, 30TWM0421, bark of *Juniperus thurifera* in moist chamber, 1-IV-1986, *C. Lado, F. Pando & J. Portela,* 236 Pando, MA-Fungi 16046; ibidem, 26-III-1986, 246 Pando, MA-Fungi 16056. Valdenebro, 950 m, 30TWM0403, bark of *Juniperus thurifera* in moist chamber, 13-III-1986, *F. Pando,* 225 Pando, MA-Fungi 16035.

Type locality. SORIA: Cubillos, 1080 m, 30TWM0421.

Type. 246 Pando, MA-Fungi 16056 (Holotype); bark of *Juniperus thurifera* in moist chamber. Paratype in the herbarium of N. E. Nannenga-Bremekamp sub. no. 15244.

Habitat. Bark of living trees *(Juniperus thurifera).*

Distribution. Central Spain.

Etymology. In honor of Mrs. N. E. Nannenga-Bremekamp, a master in the study of the Myxomycetes.

The sporangia often begin to appear soon in moist chamber on suitable substrata, but they may take rather a long time to mature, the incubation time has varied from 9 days to more than a month, with a maximum of gatherings around the 25th day. This species was frequent in our cultures, forming widely-spread fructifications.

This species is rather like *L. kellerii* Nann.-Brem. & Y. Yamam. (NANNENGA-BREMEKAMP & YAMAMOTO, 1983) from which it differs in the ridged sporangia, the conspicuous, membranous inner layer of the peridium and larger spores (fig. 1). It can be readly distinguished from *L. denudescens* Keller & Brooks (KELLER & BROOKS, 1977) which may also resemble it by its smooth inner surface of the peridium without any eroding outer layer.

With respect to other related specimens, Mr. Stephenson collected a *Licea* in the USA which seems to be closely related to *L. nannengae,* but has a wrinkled peridium, and slightly larger spores (13-14 μm diam.) (NANNENGA-BREMEKAMP,

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Fig. 1.—*Licea nannengae.* Single sporangium with spores as seen in transmitted light.

Figs. 2-4.—*Macbrideola oblonga.* 2. Sporangium. 3. SEM showing a sporangium with the peridial collar. 4. SEM showing the base of a stalk with hollow inside and the absence of fibers.

in litt.). There is a taxon from India *(Licea mercurialis* Chopra, unpublished data), which also has spores 13-14 µm diam. and differs from ours in the smooth peridium exterior, and the peridium having a very thin gelatinous outer layer with only a little dirt (NANNENGA-BREMEKAMP, *in litt.).* From *Licea belmontiana* Nann.-Brem. (NANNENGA-BREMEKAMP, 1966) which is very like in the interna smooth inner surface of the peridium and smooth spores, it differs in the double peridium, the outer layer being gelatinous and containing refuse material, and in the colour of the spores which is pinkish brown or brown (not olivaceous) in *L. belmontiana.*

Macbrideola oblonga Pando & Lado sp. nov.

Species *Macbrideolae ovoideae* Nann.-Brem. & Y. Yamam. proxima, sed ab ea sporis maioribus [(9-)10-11 µm diam.] atque densis verruculis ornatis, sporangiis itidem maioribus (0.4-0.9 mm) stipitibusque proportionaliter brevioribus primo icto discernibilis.

Sporangia scattered, sometimes in pairs, stipitate, mostly ellipsoidal (fig. 2), rarely from subglobose to cylindrical, burnt umber (Rainer: 9 Umber) total height 0.4-0.9 mm. Sporangium proper 0.20-0.45 mm in its largest horizontal diam. Hypothallus wide, reddish in reflected light. Stalk conical almost to the apex, short (1/6-1/4 of the total height), reddish, translucent at the base, opaque upwards, indistinctly longitudinally striate, sometimes filled with rather inconspicuous, almost translucent, irregular lumps (fig. 4). Peridium evanescent except for a collar (fig. 3), which is transparent, red-brown, large or small and inconspicuous. Columella a continuation of the stalk almost reaching the apex of the sporangium. Capillitium rising from all parts of the columella, dichotomously branched, ending free of united near the surface, hardly or not anastomosing inside, rather thick, brown, hardly attenuate outwards, free ends blunt, slightly swollen or club shaped. Spores globose, brown in mass, pale brown in transmitted ligth, (9-)10-11 µm in diam. densely regular and minutely warted.

Collections examined. SORIA: Calatañazor, Dehesa de Carrillo, 1050 m, 30TWM1417, bark of *Juniperus thurifera* in moist chamber, 7-III-1986, *C. Lado, F. Pando & J. Portela,* 198 Pando, MA-Fungi 16008; ibidem, 14-III-1986, 199 Pando, MA-Fungi 16009.

Type locality. SORIA: Calatañazor, Dehesa de Carrillo, 1050 m, 30TWM1417.

Type. 198 Pando, MA-Fungi 16008 (Holotype); bark of *Juniperus thurifera* in moist chamber. Isotype in the herbarium of N. E. Nannenga-Bremekamp sub. no. 15208.

Habitat. Bark of living trees *(Juniperus thurifera).*

Distribution. Only known from the type locality.

Etymology. From the Latin oblongus, oblong.

The absence of a capillitial surface net, the hollow stalk and lack of fibers together with the small size and the ovoid shape of the sporangia have led to us to incorporate this taxon in *Macbrideola.* Nevertheless, the prolate shape means a slight approach to *Stemonaria* (NANNENGA-BREMEKAMP, & *al.*, 1984), a very closely related genus for larger species with cylindrical sporangia with a hollow, homogeneous, or indistictly longitudinally fibrous or striate stalk and lacking a capillitial surface net.

M. oblonga resembles *M. ovoidea* Nann.-Brem. & Y. Yamam. (NANNENGA-BREMEKAMP & YAMAMOTO, 1983) in the oval shape of but it differs in its larger, densely and minutely warted spores. Moreover, it is taller (0.4-0.9 mm vs. 0.5 mm), with shorter stalks (circa 1/4 or less of the total height vs. 1/2), wide hypothallus and capillitium frequently anastomosing at the periphery.

ACKNOWLEDGMENTS

We are greatly indebted to Mrs. N. E. Nannenga-Bremekamp for her advice and coments on both species and reading the manuscript. We wish to thank to Dr. M. Laínz, S. J. for his Latin translations and Ms. R. N. Longshaw for kindly checking the English.

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PHYTOPHTHORA FRAGARIAE

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Abstract

Since its first description by Hickman in 1940, the species concept of Phytophthora fragariae has been clouded by controversies in literature concerning its antheridial type, sporangial size and other cultural characteristics. Present study was undertaken to compare 21 isolates of P. fragariae from various parts of the world in order to re-define the species based on morphological, cultural and physiological characteristics.

Introduction

Phytophthora fragariae was erected in 1940 by Hickman (38) for the fungus causing a root disease of strawberries in the United Kingdom, known as the red core due to the characteristic coloration of the stele (1-3,5,6,37). Since its discovery, the disease has been a hazard of commercial strawberry production in many parts of the world, including the USA, Canada, Ireland, New Zealand and Australia (63), Japan (53,67), Egypt (68), Russia (72), Italy (8), Czechoslovakia (9), Sweden (34), Germany (54) and other European countries (63).

Hickman (38) considered P. fragariae distinct from other species of Phytophthora based primarily on its slow growth, inability to grow on malt extract agar medium, preference for low temperature, production of large, obpyriform sporangia in water and fairly large, smooth, globose oogonia with funnel-shaped base and predominantly amphigynous antheridia in single culture as well as pathogenicity limited to cultivated strawberries. However, later researchers claimed that P. fragariae grew on malt (30,50) while Chang (10) reported a high temperature variant of P. fragariae with an optimum temperature of 25-35 C. There was considerable confusion regarding the antheridial type of P. fragariae. Whereas Waterhouse (82) placed it in

Group V with predominantly or entirely paragynous antheridia, Savage et al., (75) reported that the antheridia of P. fragariae were all amphigynous. Besides strawberry, P. fragariae infected loganberry in Canada (59) and by artificial inoculation, members of Rosaceae, e.g., certain species of Potentilla, Geum, Dryas and Rubus (16,66,73) as well as tobacco, tomato and spinach (4). Recently, Wang and Lu (81) reported a new variety of P. fragariae on rice: P. fragariae var. oryzo-bladis, distinguished by its entirely amphigynous antheridia and pathogenicity to rice. It seems that in view of the conflicting reports, the biology of P. fragariae needs to be re-examined to assure proper identification of the species. The purpose of this paper is to compare the characteristics of a wide variety of isolates of P. fragariae under uniform laboratory conditions in order to define the species more precisely.

Materials and Methods

Isolates and media: Specific information on the isolates of P. fragariae used is given in Table 1. All isolates were obtained from the American Type Culture Collection (ATCC), Rockville, Maryland. Unfortunately, Hickman (38) never designated a specific isolate as the type culture but ATCC 58229 which was initially isolated by Hickman (No. 27) from Cambridge seedling in England (39) and brought with him when he moved to the University of Western Ontario, Canada (P18-1-2) can be considered the "type culture". Unless otherwise stated, cleared V-8 agar (74) supplemented with sitosterol (30 mg/l) was used throughout for morphological studies.

Morphology: Colony characteristics on CV8 and Difco corn meal agar (CMA) were compared after incubating in darkness at 20 C for 3 wk. The colony diameters were measured at right angle through the inoculum and the width of primary hyphae measured under light microscope. The minimal and maximal temperatures for growth were tested at 5 C and 30 C. Sporangia were produced by incubating small mycelial agar discs of CV8 in freshly collected running stream water sterilized by filtration through 0.45 µm pore size millipore membrane discs and incubating under light at 20 C. Production of sex organs in single cultures in dark was followed on CV8 by examining them periodically under microscope through the bottom of the petri dish. After the agar dried out and if no oogonia could be observed in the plate, the inoculum was cut out with a scalpel, boiled in distilled water to soften and remove the agar and then stained and mounted on glass slides for further examination for sex organs. Isolates were also paired among themselves and with both mating types of P. nicotianae (ATCC 38606, A2; ATCC 38607, A1 and P. palmivora (ATCC 26200, A2; ATCC 26201, A1).

Ability to grow on malt extract agar: Isolates were grown

Table 1. Isolates of *Phytophthora fragariae* Used

ATCC	Host	Origin	Source
11107	Strawberry	Scotland	Hickman, R-4
11109	Strawberry	Scotland	Hickman, R-13
11110	Strawberry	New Zealand	Hickman, N2
11374	Strawberry	USA	Jeffers, S
13973	Strawberry	USA	Converse, BD C-3, C3,SS-1
13974	Strawberry	USA	Converse, 104a, SS-1
13977	Strawberry	USA	Converse, ATCC 11374, SS-1
16678	Strawberry	USA	Converse, H2FSC
18638	Strawberry	USA	Converse, Calif 6-2
36056	Strawberry	England	Montgomerie, 152
36057	Strawberry	England	Montgomerie, 144
44567	Strawberry	England	Montgomerie, 120
46092	Loganberry	Canada	Montgomerie, 169
46094	Strawberry	Canada	Montgomerie, M2
46095	Strawberry	Canada	Montgomerie, M3
46096	Strawberry	Canada	Montgomerie, M4
46097	Strawberry	Canada	Montgomerie, M7
46447	Strawberry	Canada	Montgomerie, 172
58229"T"	Strawberry	England	Hickman, P18.1.2
62265	Strawberry	Scotland	Duncan, 314
62267	Strawberry	Scotland	Duncan, 452

ATCC - Identified by American Type Culture Collection Accession Number
"T" - Type Culture

on 4.5% Difco malt extract solidified with 1.5% Bacto agar. Colony diameters were measured after 3 wks.

Ability to grow on PDA agar: Isolates were grown on Difco potato agar medium. Colony diameters were measured after 3 wks.

Pigment production: Isolates were grown on Timmer's medium (74) in test tubes. Production of pigment in the medium was determined after 4 wks at 20 C in the dark.

Growth response to malachite green: Malachite green was added to CMA at a concentration of 1:18,000,000. Colony diameters were measured after 3 wks.

Ability to utilize nitrate nitrogen: Isolates were grown on Ribeiro's synthetic agar medium (74) minus asparagine so that nitrate nitrogen was the only nitrogen source. Colony diameter was determined after 3 wks.

Ability to utilize soluble starch: Isolates were grown on starch agar medium (46). At the end of 3 wk, the colony diameters were measured and 3% iodine solution was poured over the colony and the starch hydrolysis index determined as described by Ho and Foster (46).

Pathogenicity to apple: Apple fruit (McIntosh) was inoculated through artificial wound which was then sealed with Scotch tape and enclosed in a plastic bag. Results were determined after incubation at 20 C for 3 wks.

For physiological and pathological tests, not all isolates were used. At least five isolates were selected at random for each test.

Results

Colony morphology: All isolates of P. fragariae were characterized by slow growth rate on CV8 (<1-3 mm/day) with thick and fluffy aerial mycelium. The edge of the colony was slightly irregular and diffuse. The leading hyphae were uniform (5-7 μm wide), long and meandering, with few but elongated branches which intertwined and curved, especially near the bottom or along the side of the dish. While the extent of coiling varied with the isolate, it was most conspicuous in ATCC 13974 and ATCC 62267 which showed hyphal coilings comparable to those usually found in P. porri and P. primulae (44). Isolate ATCC 36057 was exceptional in having irregular, spidery hyphae with short lateral branches while ATCC 11110 showed signs of degeneration with the hyphal tips often bursting. Although the colony displayed no special growth pattern, a characteristic light brown pigmentation often developed near the center on the bottom of the CV8 plate after prolonged incubation. Isolates of P. fragariae grew slightly faster on CMA with appressed web-like colonies and little aerial mycelium and the reverse pigmentation as seen commonly in CV8 never developed. All isolates showed very slight growth at 5 C and no growth at 30 C.

With time, the uniform hyphae occasionally became uneven, developing small swellings (under 25 µm diam), oval, spherical or irregular, randomly spaced along the hyphae or at the junction where branching occurred. They were especially common in isolates ATCC 11109, ATCC 46096 and ATCC 62265.

Sporangia: Sporangia were produced readily in water by all isolates within 24-48 hr except ATCC 11107, ATCC 13973 and ATCC 18638 which did not sporulate until 3-5 days later, whereas, it took ATCC 46097 7 days to produce sporangia sparsely. In general, nonsterile stream water proved to be considerably more stimulatory than sterilized stream water. The sporangia were non-deciduous, nonpapillate and internally proliferation, especially the "nested" type was common. Usually, there was considerable hyphal growth into the water before sporangia were produced singly and terminally on an undifferentiated sporangiophore which sometimes branched sympodially to bear sporangia on short branches. The sporangia were mostly large, regularly obpyriform, ovoid to elongate, with rounded base and sometimes tapering slightly to a blunt beak. The apex of sporangia did not flatten easily on mounting, but the empty sporangia collapsed partially after zoospores were liberated. The measurements of sporangia for all isolates are summarized in Table 2.

After about a week in water, the hyphae sometimes developed small hyphal swellings similar to those found in old agar plates, but chlamydospores were not formed.

Sex organs: Despite numerous attempts to stimulate the production of sex organs in P. fragariae, they were formed only sparsely either in water after sporangial production or in old CV8 cultures which were about to dry out or in desiccated inoculum discs. The oogonia were often aborted and if produced in agar were sometimes so tightly wrapped by hyphae that it was difficult to separate them. Pairing with A1 and A2 mating types of other heterothallic species of Phytophthora failed to improve the production. The oogonium was rather large, globose to subglobose or even ellipsoidal, often with a conspicuous tapered base so that the single spherical oospore appeared to be aplerotic to markedly aplerotic within the flask-shaped oogonial wall. In general, the oogonia developed in agar cultures were deeply pigmented in contrast to the non-pigmented oogonia in water. The antheridium was unicellular, rather large and mostly amphigynous, sometimes subterminal so that the antheridium appeared to bear an appendage or papilla. Distinct paragynous antheridia were found, usually attached singly to the tapered base of the oogonium. In isolate ATCC 13973, the antheridial type was difficult to

Table 2. Sporangial characteristics and morphology of sex organs of *Phytophthora fragariae*

ATCC	Sporangia			Oogonium	Oospore	Antheridia		
	Length(μm)	Breadth(μm)	L/B	diam (μm)	diam (μm)	Type(b)	Length(μm)	Width(μm)
11107	68±12 (a)	32±7	2.1±0.3					
11109	52±8	30±2	1.7±0.2	39±3(c)	30±3(c)	A*/P	18±1(c)	13±1(c)
11110	48±14 (c)	22±7(c)	2.2±0.6 (c)					
11374	87±22	38±5	2.3±0.6	40±3	34±3	A*/P	19±1	17±3
13973	62±11	31±5	2.0±0.3	34±3	28±3	A/P	14±3	14±2
13974	57±11	45±15	1.7±0.1	44±2(c)	37±3(c)	A*/P	17±2(c)	15±2(c)
13977	73±16	33±6	2.2±0.3	45±5	38±6	A*/P	22±4	17±3
16678	50±7	29±4	1.7±0.2	39±3(c)	32±4(c)	A*/P	16±3(c)	15±2(c)
18638	59±7	34±4	1.8±0.2	38±5(c)	29±3(c)	A/P	16±3(c)	12±2(c)
36056	59±8	35±5	1.7±0.2	36±3	29±3	A*/P	15±2	15±2
36057	62±9	37±4	1.7±0.1					
44567	48±8	23±5	2.1±0.2					
46092	72±9	56±17	1.7±0.3					
46094	74±12	40±5	1.8±0.1					
46095	47±6	29±3	1.6±0.2					
46096	43±9	29±6	1.6±0.3	38±2(c)	32±2(c)	A*/P	16±3(c)	16±2(c)
46097	71±8 (c)	31±4(c)	2.1±0.2(c)	40±3	34±3	A*/P	22±4	18±2
46447	48±7	28±4	1.7±0.3					
58229	46±7	28±7	1.9±0.2	41±4	35±4	A*/P	15±1	13±2
62265	44±4	31±3	1.4±0.1					
62267	60±5	32±5	1.9±0.2	34±3(c)	28±3(c)	A/P	13±2(c)	11±2(c)

(a) Mean ± standard error based on 50 measurements

(b) A= Amphigynous, P= Paragynous, *= Dominant type

(c) Less than 50 measurements due to paucity of distinct reproductive structures distinguish due to the abundance of antheridial papillae as in P. richardiae (Ho, unpublished). In ATCC 62267, most of the oogonia were ellipsoidal and the antheridia were sometimes absent. The dimensions of the sex organs and the antheridial types for all isolates are summarized in Table 2.

Although chlamydospore-like structures (20-39 μm diam) were sometimes observed in old cultures, for example in ATCC 11109 and ATCC 13977, they had only a single wall and lacked the reorganization of cell contents characteristic of chlamydospore. With time, these structures become brown like mature oogonia, and so they were interpreted as unfertilized oogonia which aborted due to absence of antheridia.

Physiology: All isolates tested were quite uniform in their response. Thus, they produced very slight pigmentation in Timmer's medium, showed no or very poor growth on malt extract, PDA, nitrate, starch or malachite green agar medium. They caused no or very slight lesions on apple fruit.

Discussion

Since its first discovery, Phytophthora fragariae has been the major factor limiting the production of strawberries in many parts of the world and consequently, most studies centered on its isolation (27,84), inoculum production (11,23,57,70,85), physiological races (12-14,17,29,31,32,39,60,64,65,78), pathogenicity and disease development (26,33,41-43), resistance and disease control (18,51,52,55,69) as well as ecology (20-22,25). Little work was done on taxonomy and morphology of the species except for the zoospore characteristics (47,61). For the sake of discussion, the published data on P. fragariae are summarized in Table 3.

As noted by Hickman (38) and other workers(5,54,56, 68) P. fragariae is characterized by slow growth (1.2 - 6.5 mm per day). We found that P. fragariae isolates grew very slowly on clarified V-8 juice agar medium (<1-3 mm per day) and in addition, produced thick and fluffy aerial mycelia and, with time, light brown coloration of the reverse. Although Maas (56) reported some isolates growing at 30 C, none of the isolates tested here grew at this temperature, thus confirming the experience of previous workers (Table 3) that the maximum temperature for this species should be 30 C or 25-30 C. Krober (54) is the lone exception in listing the maximum temperature for P. fragariae as 25 C. In any case, P. fragariae can be classified as a low-temperature Phytophthora (44). Phytophthora fragariae isolates grew at 5 C, though extremely slowly.

There were conflicting reports on the ability of P. fragariae to grow on malt extract agar medium. Hickman

Table 3. Characteristics of Phytophthora fragariae recorded in literature

Author	Year	Temperature			Sporangium			Oogonium	Oospore	Antheridium		
		Min.	Opt.	Max.	Length (µm)	Breadth (µm)	L/B	diam. (µm)	diam. (µm)	Type (a)	Length (µm)	Width (µm)
Alcock	1929				50	30	1.7	46-47	33-47	A		
Alcock et al.	1930				50			44	33	A/P		
Alcock & Howell	1936									A/P		
Bain & Demaree	1938			30	Large			Large		A*/P		
Hickman	1940	5	20	30	60	38	1.6	39	33	A*/P	134	16
Bain & Demaree	1945	5	22	30	65	38	1.7	39	33.5	A/P*		
Smith	1951				49	31	1.6	32	30	A		
Waterhouse & Blackwell	1954				60	38	1.6	39	33	A*/P	22	16
Gregg	1955							33-83	23-60			
								28-42	20-35			
McKeen	1958	5		30	55	3	1.5	41	33	A*/P		
Schwinn	1959	5	10-15	30								
Cejp	1961				32-90	25-50		25-40	23-35	A*/P	15-30	10-25
Converse & Shiroishi	1962								30	A*/P		
Waterhouse	1963				60	38	1.6		40	A/P*		
Morita	1965		22	30	59.7	32.8	1.8	36	31.6	A*/P	22	16.3
Savage et al.	1968							35	32	A		
								45	34			
Katsura	1971	5	22	30	58.7	32.8	1.8	36	31.6	A*/P	22	16.3
Maas	1972	5		30								
				30								
Novotelnova	1974	4	20	30	60	38	1.6	39	33	A*/P	22	16
Newhook et al.	1978				often 75		1.6	28-50	25-40	A*/P		often 20
Ribeiro	1978	5	20-22	30	32-90	22-52		28-44	22-44	A/P	22	16

Table 3. (continued)

Author	Year	Temperature			Sporangium			Oogonium	Oospore	Antheridium		
		Min.	Opt.	Max.	Length (μm)	Breadth (μm)	L/B	diam. (μm)	diam. (μm)	Type (a)	Length (μm)	Width (μm)
Krober	1985	5		25	60	34	1.8	44	35	A*/P		
Gerrettson-Cornell	1985				57	36	1.6			A*/P		
Moustafa	1986	8	20-24	28								

A = Amphigynous; P = Paragynous; *= Dominant Type

(38) reported that the fungus did not grow on 2% malt extract agar and this was considered an important taxonomic character. This feature was confirmed by Bain and Demaree (6) and Moustafa (68), but challenged by Jarvis (50) who reported good growth on agar medium with 1% Difco malt extract. Gill and Powell (30) found some growth on 0.5% malt extract agar but not on Difco malt extract agar medium which contained 1.275% maltose and 0.275% glucose. In our study, we found none of the isolates of P. fragariae was able to grow on 4.5% malt extract agar medium. It is possible that the discrepancies in results could be attributable to the differences in the concentration of malt extract used. Phytophthora fragariae was completely inhibited in a medium containing 2% reducing sugars like dextrose or maltose which might react with glycine to produce toxins (58). Thus, we found that P. fragariae isolates had no or very poor growth on Difco potato dextrose agar medium which contains 2% glucose. It is likely that in higher concentration of malt extract there is enough toxins produced to inhibit the growth. Ho (unpublished) noted that isolates of P. fragariae which failed to grow on 4.5% malt extract agar, grew well when the malt extract was reduced to 0.5%. The inability of P. fragariae to grow on agar medium containing 2% or more malt extract readily distinguishes it from other species with similar morphological characteristics. Further, it has no or very poor growth on corn meal agar medium incorporated with malachite green. In this respect, it is similar to other Phytophthora species with low maximal growth temperatures, for example P. porri, P. syringae and P. hibernalis which proved to be highly sensitive to malachite green (44).

Unlike most species of Phytophthora, P. fragariae is fastidious in its nutritional requirements (48). Present study has confirmed earlier observations (19, 46) that this species has no or very limited ability to utilize soluble starch, and that it has absolute requirement for organic nitrogen (24,48) which cannot be replaced by inorganic nitrate.

Present study has also clarified various aspects of the morphology of Phytophthora fragariae. As reported by Hickman (38) and McKeen (59), the main hyphae measured about 6 μm wide, smooth to slightly irregular and meandering with frequent coiling, a feature commonly found in P. porri and P. primulae (44). Although Newhook et al., (71) did not list hyphal swellings for P. fragariae, some isolates in our study produced small hyphal swellings under 20 μm in water or in old cultures. They were spherical, oval, elongated or irregular, unevenly spaced along the hyphae or at the junction where branching occurred. Hyphal coiling and swellings of similar size were diagrammed by Hickman in his original description (38).

Most isolates of P. fragariae in our study produced rather large sporangia, some attaining over 100 µm in length. The overall mean sporangial length of all isolates was 59 ± 12 µm comparing well with the published data in literature (49-65 µm). The sporangium of this species has been described as large, up to 90 µm or often over 75 µm long (38,71,82). In shape, the sporangium was regularly obpyriform, mostly with rounded base and often elongated, with the distal portion narrowing slightly to a blunt beak. The nonpapillate apex did not flat out easily on mounting as commonly encountered in *P. cryptogea*, *P. drechsleri* and *P. erythroseptica* (71), and unlike these species, sympodial branching of the sporangiophore was not as common. The overall mean of the length/breadth ratio of sporangia was 1.8 ± 0.2 matching closely the overall mean in literature (1.5 - 1.8). The slightly lower L/B ratio in literature could possibly be due to the fact that sporangia were produced mostly in darkness because light usually stimulates the production of longer sporangia (36). As observed previously by many workers, internal proliferation of sporangia was common in most isolates of *P. fragariae*. It is perplexing that this important character was not listed for this species in the tabular key of Newhook *et al*. (71).

Although *P. fragariae* produced sex organs readily in strawberry roots, it either failed to produce or produced them only sparsely in cultures (6,15,38,75). We have experienced the same difficulty too, in our study. Gregg (35) reported that oospore production of *P. fragariae* was induced by a contact stimulus of artificial membranes, but we were unsuccessful in enhancing the ability of this species to form oospores by means of cellophane or millipore membranes. It is possible that the membrane served as the site for the absorption of active principle(s) and thus in turn, allowed sex organs to be formed in its vicinity. Nevertheless, since there was no indication that mating types existed in *P. fragariae*, we concurred with Savage *et al*. (75) that it should be classified as homothallic until the factors governing sexual reproduction in *P. fragariae* can be worked out in the future.

As often reported in literature (1,6,20,38,67,75,77), the oogonium of *P. fragariae* typically had a tapered base similar to that of *P. cambivora* (44) but differed in having a smooth oogonial wall instead. The overall mean of oogonial diameters of all isolates of *P. fragariae* in present study was 39 ± 3 µm, in close agreement with the published data (35-47 µm). The oospore was aplerotic to markedly aperotic, measuring 32 ± 3 µm, comparing well with the dimensions reported in literature (30-40 µm). However, the antheridial type of *P. fragariae* is highly controversial. Alcock *et al*. (3) and Alcock and Howells (2) reported amphigynous and paragynous antheridia in equal proportion whereas Hickman (38), McKeen (59), Converse and Shiroshi (15), Morita (67), Katsura (53), Krober (54) and Gerrettson-Cornell (28) described the antheridia of *P. fragariae* as predominantly amphigynous. Bain and Demaree (5) initially considered the antheridia to be predominantly amphigynous but later (6) questioned the existence of truly amphigynous type. Waterhouse (82) placed this species in Group 5, characterized by antheridia being completely or predominantly paragynous. Yet, Waterhouse and Blackwell (83) described *P. fragariae* on the British Isles as predominantly amphigynous. Newhook *et al.* (71) designated the antheridia of *P. fragariae* in their tabular key as amphigynous and occasionally paragynous. On the other hand, some researchers found only amphigynous antheridia (1,75,77). The nature of antheridial configuration is especially important because along with the sporangial papillation, it forms the basis for the grouping of *Phytophthora* species (71,82) and is considered as the most important and most reliable taxonomic character (45,79). Thus, Wang and Lu (81) created a new variety of *P. fragariae* partially based on its entirely amphigynous antheridia. Our study showed that of those isolates that produced sexually in culture, the antheridia were mostly amphigynous although paragynous types were also present. Thus *P. fragariae* should not be included in Waterhouse's Group V and to avoid confusion, it is better to merge Group V and Group VI as suggested by Ho (45). In reviewing Waterhouse's key of 1963, Hickman (40) stated that "he would hesitate to place *P. fragariae* in group V with the species in which all or the majority of the antheridia are paragynous". In general, the antheridia of *P. fragariae* are single-celled and long, measuring 17 ± 3 μm. Newhook *et al.* (71) listed the antheridia of *P. fragariae* as large, often more than 20 μm wide. Antheridia of this width was seldom observed in the present study or reported in literature. The overall mean width of antheridia for all the isolates of *P. fragariae* was 15 ± 2 μm. On the other hand, antheridia were often more than 20 μm long.

Chlamydospores have been reported for *P. fragariae* (3, 72). Such chlamydospore-like structures were sometimes observed in the old cultures of isolate ATCC 11109 and ATCC 13977. They were spherical (22-39 μm diam) and thin walled. However, they lacked the secondary wall and the internal re-organization of cell contents of chlamydospores (7,49). Thus, they were interpreted as unfertilized oogonia due to the absence of antheridia. In general, we agree with most other workers that *P. fragariae* does not produce chlamydospores.

In her key, Waterhouse (82) distinguished *P. fragariae* from *P. megasperma* based on the larger sporangia of the former (60 X 38 μm) and the smaller sporangia of the latter (less than 55 x 35 μm). Our study showed that while most isolates of *P. fragariae* produced large sporangia, some formed smaller sporangia. A study of 30 isolates of *P. megasperma* (Ho, unpublished),shows that the overall mean size of sporangia to be 56 (33-80) X 35 (23-45 μm). Thus, sporangial size alone cannot be depended upon to distinguish these two species. On the other hand, *P. fragariae* can be readily distinguished from *P. megasperma* by its conspicuously slower growth rate on cleared V-8 juice agar medium, producing thick and fluffy aerial mycelia and light brown coloration of the reverse, by its meandering and coiling hyphae with sparse but elongated branches, by the absence of large hyphal swellings or chlamydospores, by its slightly more elongated sporangia, by its infrequent production in single cultures of oogonia with tapered base and aplerotic to markedly aplerotic oospore, by its long, predominantly amphigynous antheridia, by its inability to grow at 30 C, no or poor growth on PDA, malt extract (4.5%), starch or inorganic nitrate agar medium and by its sensitivity to malachite green. Further, the mycelium of *P. fragariae* seemed to be more perishable, often losing its viability in stock cultures after 6 months. Tweedy and Powell (80) suggested that the death of *P. fragariae* in stock cultures was caused by an increase in the pH of the medium.

The high temperature variant of "*P. fragariae*" from Taiwan (10) was distinct in having much higher optimum temperature for growth (25-35 vs 20-22 C). It was deposited with the ATCC as *Phytophthora* sp. ATCC 44553. Indeed, we found that this isolate grew well at high temperatures with a maximum around 39 C but its cultural, morphological and physiological characteristics proved to be different from those isolates of *P. fragariae* studied here or reported in literature. It grew well on V8C, 4.5% malt extract agar and Difco PDA media, forming slightly fluffy colonies with distinct floral patterns. The growth rate on CV8 (7-8 mm per day) was faster than any *P. fragariae* isolates known and the characteristic light brown coloration of the reverse as seen commonly in our study was never produced. The hyphae were narrower (4-5 µm wide), free-branching and not coiling or meandering. They produced in water and in agar media many large spherical, oval, to irregular hyphal swellings averaging 33 ± 3 µm in diameter. Sporangia were produced rapidly and abundantly in water in 6-7 hours. No *P. fragariae* isolate in the present study sporulated within such a short period of time. The sporangia were shorter and wider, 54 ± 6 x 34 ± 3 µm with L/B ratio of 1.6 ± 0.2. It was resistant to malachite green, utilized soluble starch and inorganic nitrate well, and infected wounded apple fruit readily. Unfortunately, this isolate never produced sex organs in single cultures, in pairings or on oat grains. Nevertheless, the differences between this isolate and other known isolates of *P. fragariae* are so great that it should not be assigned to this species. In fact, it was very similar to the high temperature variant of *P. megasperma* from alfalfa (ATCC 38831) studied under the same conditions and should be treated as such until the sexual characteristics can be determined.

The new variety of P. fragariae: var. oryzo-bladis, (81), was not available for comparative studies. The "typ culture" deposited at Nanjing Agricultural University was seen by the senior author in 1983 but it proved to be a species of Pythium instead. Although the large oogonia (46.9 μm diam) with tapered base, the long antheridia with hyphal projection and the large obpyriform, internally proliferating sporangia (67x42.8 μm) produced on the rice seedlings suggest its affinity with P. fragariae, the remarkably fast growth rate of the fungus isolated (4-6.5 cm per day) and the rapid production of abundant chlamydospores (81) contrasted sharply with the slow growth and the absence of chlamydospores in P. fragariae. Furthermore, the culture failed to produce sporangia or sex organs in vitro (81) and it is questionable whether it was the same fungus as seen on the host. Thus, the identity of Phytophthora species causing rice seedling disease in China cannot be confirmed until the real causal agent can be isolated and its pathogenicity demonstrated.

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OBSERVATIONS ON HENDERSONIA PINICOLA AND THE NEEDLE BLIGHT OF PINUS CONTORTA

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ABSTRACT

Hendersonia pinicola, causal agent of a needle cast disease of Pinus contorta in the Pacific Northwest, induced initial disease symptoms and presented signs first in the lower parts of crowns and, later, in the upper parts of crowns. Ultimately, only distal parts of branches bore foliage. Diseased needles showed symptoms and signs at the apices, midsections, or both; needle bases remained green. Pycnidia of H. pinicola seated in the mesophyll of lodgepole pine needles extruded cirri of conidia through ostioles that pierced the host epidermis. Hendersonia pinicola and another needle cast fungus, Lophodermella concolor, sometimes coexisted on trees or even single needles. No consistent association was observed between these fungi. Field observations suggested that the capability of H. pinicola as a pathogen is not dependent upon the activities of other organisms. Inoculation studies of P. contorta with H. pinicola were inconclusive. Growth of H. pinicola in culture and histological details of the host-fungus relationship are described. Ultrastructural aspects of conidial wall development and morphology are reported. The verrucose surface of the mature conidium apparently results from the contours of globules of wall material.

Hendersonia pinicola Wehm. from *Pinus contorta* Dougl. ex Loud. var. *murrayana* (Grev. and Balf.) Engelm. (as *P. murrayana* Grev. and Balf.) was described by Wehmeyer (1946) in a study of various needle-inhabiting fungi from northwestern Wyoming. *Hendersonia pinicola* has been reported in British Columbia (Collis, 1972) and Idaho (Robert James, unpubl. information, via personal communication), among other places. The fungus has been observed principally on *Pinus contorta* (Collis, 1972). It causes gray necrotic zones in the center of the needles and causes their distal portions to turn reddish-brown and necrotic. Black masses of conidia are exuded from globose pycnidia that are immersed in host mesophyll (Wehmeyer, 1946).

Associations among *Hendersonia* species and various needle cast fungi of family Hypodermataceae, Discomycetes, have been reported by several researchers. Lagerberg (1910) alleged that *Hendersonia acicola* Tub. is the conidial state of *Lophodermella sulcigena* (Rostr.) Hoehn. [as *Hypodermella sulcigena* (Rostr.) Tub.]. However, Darker (1967) stated that *Hendersonia acicola* is a secondary fungus that attacks needles infected by hypodermataceous fungi and that it is not the anamorph of *L. sulcigena*. Darker (1932) observed a similar association between *Lophodermella montivaga* Petr. [as *Hypodermella montivaga* (Petr.) Dearn.] and *Hendersonia* sp. and believed *Hendersonia* to be a secondary fungus that invades after disease has been induced by other fungi. In addition to his description of *Hendersonia pinicola*, Wehmeyer (1946) noted that *H. pinicola* is associated with *Lophodermella concolor* (Dearn.) Darker in a manner parallel to the *H. acicola* - *L. sulcigena* association, i.e., as a secondary invader. Collis (1972) noted an association between *H. pinicola* and *L. concolor* in British Columbia. Funk (1985) considered *H. pinicola* to be a secondary fungus on *Pinus contorta* foliage, following *Lophodermella concolor* and *L. sulcigena*.

This study was conducted to examine biological, pathological, and cultural characteristics of *H. pinicola*.

MATERIALS AND METHODS

Field collection. Needles of *Pinus contorta* var. *latifolia* Engelm., lodgepole pine (LPP)(the nomenclature of Little, 1979) bearing pycnidia of *H. pinicola* were collected at the following sites: Big Meadow Creek, Latah County, ID (BMC); Laird Park, Latah County, ID (Laird); St. Regis, Mineral County, MT (Mont).

Inoculation studies. One hundred 2-year-old seedlings of LPP grown at the U.S. Forest Service nursery at Coeur d' Alene, ID., from seed obtained from the Elk City Ranger District at 4500 m in Nez Perce National Forest were planted in pressed fiber pots. Eighty trees were placed in a greenhouse and twenty trees in a lath house in Pullman, WA. The greenhouse was unheated and winter temperatures inside at times approached outside temperatures.

Inoculum suspensions were prepared using cultures of *H. pinicola* originating from conidia teased from LPP needles and grown on Difco potato dextrose agar with 5g/L Difco yeast extract (PDYA). After 1 month these cultures were flooded with sterile water to provide a conidial suspension of $8 \times 10^6 - 9 \times 10^7$ spores/ml. Approximately 10 ml of this inoculum suspension was sprayed on each LPP seedling with an atomizer. Some seedlings were covered with clear polyethylene bags, which were removed after 2-21 days. Some of the inoculated seedlings were placed in a lath house, while others remained in the greenhouse. Sterile water was sprayed on control seedlings. Inoculations were made Oct 13, 1983, June 6, 1984, Aug 8, 1984 and May 1, 1985.

Cultural studies. Lodgepole pine needle epidermis was excised with a razor blade and pycnidia were hydrated with drops of sterile water. Conidia were removed directly from pycnidia and streaked onto 2% water agar. After germination, agar blocks with one to several conidia were cut out and transferred to one of the following media: PDYA; Difco oatmeal agar (OMA); or Bonar's modification of Leonian's agar (L)(Booth, 1971). Cultures were placed on laboratory benches at 21 C with 12 hr of fluorescent light.

Histological and ultrastructural studies. Needle tissue and agar-bearing mycelium were processed for eventual paraffin embedment and sectioning. Materials were fixed in formalin-acetic acid-alcohol (FAA) fixative (Berlyn and Miksche, 1976) and dehydrated with a graded ethanol series, followed by infiltration with xylene. The material was subsequently infiltrated with paraffin (Paraplast m.p. 57-58 C) and sectioned with a rotary microtome. Sections 12 μm thick were mounted on glass slides with Haupt's adhesive (Johansen, 1940) and deparaffinized with xylene. The agar material was stained with methylene blue and counterstained with aqueous basic fuchsin. Needle material was stained with safranin O and picro-aniline blue (Bradbury, 1973).

Some materials were processed for embedment in Spurr's resin and subsequent sectioning. A 2-month-old OMA culture of H. pinicola was dissected, 2 mm^3 pieces bearing pycnidia were placed in Karnovsky's fixative (Karnovsky, 1965) for 2 hr, then rinsed in 0.2M cacodylate buffer for ca. 15 min, and fixed in 2% osmium tetroxide (OsO_4) for 1.5 hr. The specimens were again rinsed in 0.2M cacodylate buffer and dehydrated in a graded ethanol series. The material was then infiltrated with propylene oxide-Spurr's resin (Spurr, 1969), and eventually moved into 100% Spurr's resin for three intervals of 4 hr each. After polymerization, 1 µm sections were cut with an ultramicrotome, and stained with brilliant green and safranin O.

Material for scanning electron microscopy (SEM) was fixed in Karnovsky's fixative (Karnovsky, 1965), rinsed twice in 0.2M cacodylate buffer, and post-fixed in 2% OsO_4. Subsequently, the material was rinsed twice in 0.2M cacodylate buffer, once in distilled water, and then dehydrated in a graded ethanol series. The material was critical-point-dried, gold-coated, and viewed with an ETEC Autoscan SEM. Material for transmission electron microscopy (TEM) was prepared in a manner identical to the procedure involving resin embedment. Subsequently, the material was sectioned with a microtome equipped with a diamond knife and placed on nickel grids. Some of the grids were viewed without additional processing; others were post-section-stained with uranyl acetate and Reynold's lead (lead citrate)(UA-RL)(Reynolds, 1963). An alternative post-section-staining procedure involved 5 min in barium permanganate (BAP), destaining 30 sec in 0.5% citric acid, staining 2 min in uranyl acetate and 2 min in Reynold's lead, with water rinses between steps (Hoch, 1977). A third procedure involved post-section-staining with periodic acid-Schiff's reagent (PAS) following the procedure of Martino and Zamboni (1967). All sectioned material was viewed with a Hitachi H-300 TEM.

Observations using light microscopy were made of material mounted in water or in dilute basic fuchsin. Photomicrographs of this material were taken with an American Optical Expostar differential interference contrast microscope (DIC) with an American Optical automatic shutter control, or with an American Optical brightfield microscope (BF). Kodak Technical Pan film 2415 was used. Photomacrographs were taken with an Orthophot camera or with a 4" X 5" camera.

Necrosis/Needle length study. It was noted that symptoms of H. pinicola commonly occur at the distal portion and midsection of a lodgepole pine needle, while the base of the needle remains green. To determine the relationship between the location of the initial infection site on the needle and the amount of necrotic tissue (mm) on the needle, one hundred of the previous year's needles were collected at Laird and BMC on May 20, 1984 and analyzed.

The association of Hendersonia pinicola - Lophodermella concolor. Fifty LPP needles with symptoms of H. pinicola (Hp) and L. concolor (Lc) were obtained at BMC, Mont, and Laird on June 8, 1984, July 15, 1984, and August 4, 1984, respectively. The epidermis on the abaxial and adaxial surfaces was severed and lifted with a razor blade, and by using a stereomicroscope the occurrence of fruiting bodies of these two fungi was recorded. The needles were categorized as possessing: Hp only, Lc only, Lc and Hp, or neither fungus.

RESULTS

Field observations. The disease caused by Hendersonia pinicola seems to spread from the lower portion of the crown upwards. In 20-yr-old LPP trees, foliage may be sparse and discolored at the base of the crown, while foliage higher in the crown appears healthy. In younger trees ca. 10-yr-old, symptoms may occur on all of the foliage, although the lower portion of the crown is usually most heavily damaged. On distal portions of branches, diseased foliage takes on a tufted appearance, often said to resemble a lion's tail, and occurs when 2-yr-old and 1-yr-old needles are prematurely cast. Necrosis begins at the distal end or midsection of the needle, rarely at the base. Often the base remains green when the fungus fruits more distally. In the necrotic zones black bands form which extend into the leaf mesophyll. On both the adaxial and abaxial sides of the needle, between the black bands, a grayish-brown zone appears. It is within this gray zone that pycnidia and conidia are produced.

In late May at BMC black bands occurred occasionally in the epidermis of 1-yr-old needles; however, they were most commonly located in the mesophyll. Small globoid pycnidia were present within the necrotic needle tissue between these bands. Even though pycnidial ostioles had not yet broken through the epidermis, conidia were being produced.

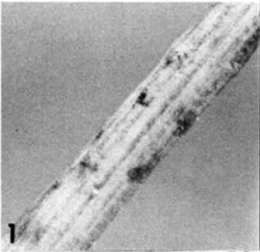
By mid-June new needles were emerging from buds. Within the gray zones of previous yr needles, pycnidial ostioles began to break through the host epidermis (Fig. 1). One month later, conspicuous tendrils (cirri) of conidia had exuded onto the needle surfaces. The spores adhered to the needles, forming soot-like crusts. By this time many of the 1-yr-old needles had fallen and the remaining needles were easily dislodged. By the end of July, the fully expanded new needles, which were adjacent to diseased needles of previous years, showed yellow, spherical spots with red centers that presumably were the first symptoms of the disease. Needles containing the yellow spots were plated on artifical media, but no fungal growth occurred from them.

Inoculation studies. No instance of infection resulting from artificial inoculations was observed.

Cultural studies. *Hendersonia pinicola* conidia begin to germinate within 24 hr after streaking onto agar (Fig. 10). Conidia similar to those produced by the fungus in situ are formed within 10 da on OMA. Fungal colonies are initially hyaline to grayish, later becoming black with a dense, whitish mycelial bloom. Colonies never cover the Petri plate, but tend to become mound-like owing to repeated overgrowing of underlying colonies (Fig. 2). The hyphae are warty, septate and hyaline, becoming olivaceous to brown with age. In old cultures, hyaline, thin-walled, globoid chlamydospores form. These highly guttulate chlamydospores (Fig. 9) may be terminal or intercalary. The ellipsoid to somewhat fusoid, smooth, yellow-brown, occasionally muriform conidia are typically 3-septate, but

Figs. 1-11. *Hendersonia pinicola*. 1. Pycnidia breaking through needle epidermis, X 14. 2. Culture, X 0.5. 3. Section through pycnidium embedded in paraffin showing scattered conidia, X 230. 4. Section through pycnidium embedded in Spurr's resin showing scattered conidia, X 150. 5. Young conidium attached to conidogenous cell with swollen base (arrow), X 875. 6. Conidiogenous cell bearing conidium and showing frills reminiscent of annellations (arrow), X 1850. 7. Conidia, X 600. 8. Conidium, X 1100. 9. Two intercalary chlamydospores, X 1,000. 10. Conidium that has germinated from innermost two cells, X 1,100. 11. Section of conidium, X 5,000.

Figs. 1,2 by photomacrography. Figs. 3,4,7,8,10 by brightfield microscopy. Figs. 5, 9 by differential interference microscopy. Fig. 6 by SEM. Fig. 11 by TEM.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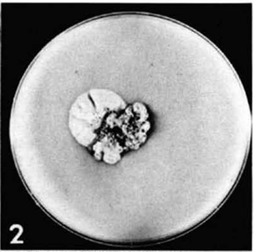
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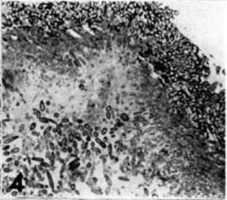
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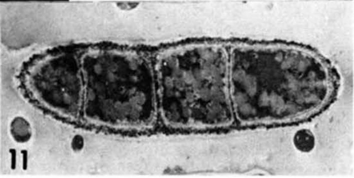
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can be 1-6 septate, (13-)17-21(-29) X (4.5-)5-7.5(-9) µm (Figs. 7,8,11,21,22), and germinate within 24 hr on various media. At first only central conidial cells germinate (Fig. 10), but germ tubes eventually originate from all conidial cells.

Histological studies. Stained and sectioned material of *H. pinicola* within LPP needles shows that branching, septate, rough-walled hyphae ramify inter- and intracellularly throughout host mesophyll tissue. Hyphae do not appear to penetrate the endodermis. Black globoid to irregular-shaped pycnidia containing abundant conidia (Figs. 3 and 4) and possessing papillate ostioles form in the upper mesophyll near the hypodermis. Conidiogenous cells, which commonly have a bulbous bases (Fig. 5), line the pycnidial walls. Pycnidia examined by SEM show that conidiogenous cells are sometimes branched and occasionally show ornaments reminiscent of annellations near the apices (Fig. 6).

Ultrastructural studies. A preliminary study of conidial wall development was made. The newly-formed conidial wall is initially electron-transparent (Fig. 12), but a conspicuous zone of small electron-dense globules soon develops within the innermost portion of the wall (Fig. 13). This zone of globules apparently migrates into the central portion of the wall, becoming more pronounced owing to the increasing size of globules and perhaps their numbers (Figs. 14-16). A homogeneous electron-transparent

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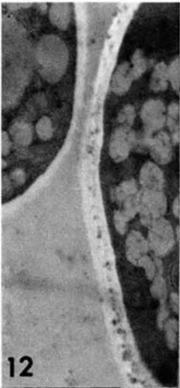
Figs. 12-19. *Hendersonia pinicola*. Sections of conidial wall by TEM. 12. Wall of newly-formed conidium. Unstained after fixation, X 7,000. 13. Wall of newly-formed conidium. Zone of globules (arrow). Unstained after fixation, X 12,000. 14. Wall of young conidium. Note zone of globules in electron-transparent wall. Post-section-stained with BAP, X 20,000. 15. Similar to Fig. 14, but not stained after fixation, X 20,000. 16. Wall of developing conidium showing prevalence of globules within wall. Post-section-stained with BAP, X 20,000. 17. Wall of maturing conidium showing globules (b) near surface embedded in more electron-transparent material (c) and underlain by comparatively electron-transparent inner wall (a). Post-section-stained with UA-RL, X 20,000. 18. Roughened outer layer of mature conidium (b) and underlying layer (a). Post-section-stained with UA-RL, X 13,000. 19. Roughened outer layer of mature conidium. Post-section-stained with BAP, X 9,000.



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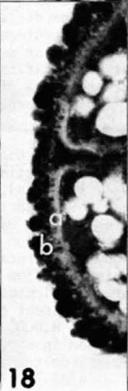

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wall layer develops beneath the globular zone (Figs. 17, 20). The globular zone now comprises a part of the outermost region of the wall, the globules embedded in a matrix of electron-transparent material (Figs. 17,20,23). The surface of the maturing conidium is seen to be highly verrucose (Figs. 18,19,21,22). The verrucae are apparently the surface contours of globules and, presumably, the collapsed and adhering remains of overlying electron-transparent material. The globular layer also forms between individual cells of the conidium and completely encapsulates them (Fig. 22). The outermost globular layer becomes brittle and can be separated and broken away cleanly from the conidium by mechanical means and is fractured during germination by germ tubes. Removal of this layer exposes the more regular innermost wall layer (Fig. 24). Individual cells of a conidium can likewise be separated by coverslip pressure; separation occurs in the globular zone of the wall.

Necrosis/Needle length. Concerning Laird samples, the mean percentage of length of necrotic tissue/total length of needles with the distal portion necrotic was 70.26, while the mean percentage for needles with the midsection of the needle necrotic was 53.26. Concerning BMC samples, the mean percentage for distally necrotic needle tissue was 76.18, and the percentage for midsection necrosis on needles was 58.45. Duncan's multiple range test (P=0.05) showed there was no significant difference between site locations, but there was a significant difference when necrosis at the tip of the needle was compared with

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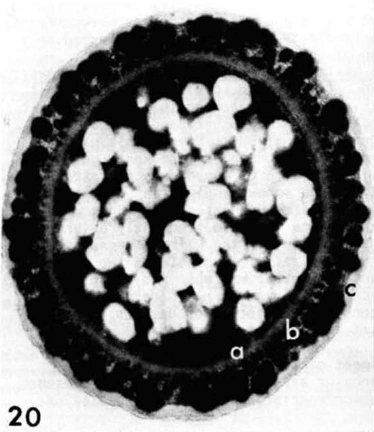
Figs. 20-24. *Hendersonia pinicola*. Details of conidial wall. Fig. 20. Cross-section through maturing conidium showing inner wall layer (a), conspicuous middle zone of globules (b), and thin electron-transparent outermost zone (c). Post-section-stained with UA-RL, X 20,000. 21. Scanning electron micrograph showing conidial surface roughened by globular verrucae, X 4,000. 22. Longitudinal section of maturing conidium showing electron-transparent inner wall layer, conspicuous zone of globules, and traces of the electron-transparent outermost zone. Post-section-stained with UA-RL, X 8,000. 23. Portion of wall showing globules (b) embedded in electron-transparent material (c) and underlying electron-transparent wall (a). Post-section-stained with UA-RL, X 48,000. 24. Portion of conidium where globular layer (b) has been removed from inner layer (a). Post-section-stained with PAS, X 20,000.



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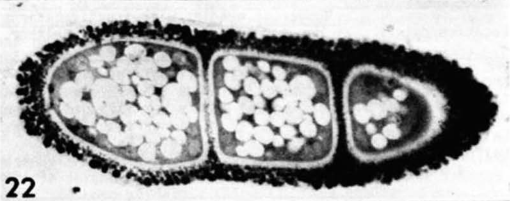

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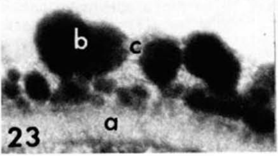

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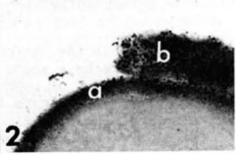

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necrosis at the midsection of the needle. When necrosis occurred at the tip of the needle, there was more necrosis per total needle length than when necrosis occurred only at the midsection of the needle.

Hendersonia pinicola - Lophodermella concolor association. At BMC (Table 1), *H. pinicola* occurred most often in association with *L. concolor* in LPP needles; it rarely occurred alone. On the other hand, *L. concolor* frequently occurred alone at BMC. *Hendersonia pinicola* was never observed alone on needles from Mont, but often appeared in conjunction with *L. concolor*. At Laird and Laird-Strychnine, trends somewhat different from the other sites were noted. At Laird *Hendersonia pinicola* was commonly found alone, and was also frequently observed with *L. concolor*. However, at the Laird-Strychnine site, there appeared to be no association between two fungi. *Lophodermella concolor* rarely was observed alone, whereas *H. pinicola* was commonly found alone. There does not appear to be a consistent association between these two fungi, at least at the locations studied.

Table 1. Assessment of the *Hendersonia pinicola - Lophodermella concolor* association based on the presence of fructifications of one or both fungi on needles of *Pinus contorta*

Location/date	Number of needles with fructifications			
	Hp	Lc	Lc & Hp	neither
BMC # 1: 6/8/84	0	30	5	15
BMC # 4: 6/8/84	5	10	35	0
BMC # 1: 7/15/84	2	20	15	13
Mont # 5: 8/4/84	0	27	23	0
Laird # 6: 6/8/84	23	3	22	2
Laird-Strychnine # 8: 6/8/84	34	8	0	8

DISCUSSION

As noted in the introduction *Hendersonia pinicola* has been assumed to be a secondary fungus associated with pathogenic species of *Lophodermella*. The data from our collection sites indicate that there is no consistent association between *H. pinicola* and *L. concolor* (Table 1). At the study sites there were severely blighted trees on which *H. pinicola* occurred alone. In our opinion, *Hender-*

sonia pinicola is a facultative saprophyte which can be a primary pathogen of lodgepole pine.

It was demonstrated that when necrosis caused by H. pinicola occurs at the distal end of the needle, a greater portion of the needle becomes necrotic than when necrosis occurs only at the midsection of the needle. Because the tip emerges from the bud first, it is exposed to the environment for a longer period of time than the midsection or base of the needle, thus possibly explaining why symptoms are most common at the tips of needles. Also, it is possible that the tips are most susceptible to fungal attack and it is likewise possible that spore availability is greater at the time that the needles are first emerging from the bud.

Results of greenhouse pathogenicity studies were disappointing. In no case did disease symptoms appear. Unknown or poorly understood environmental or host factors may be necessary for infection of lodgepole pine foliage by H. pinicola.

In culture Hendersonia pinicola is slow-growing and grows upon itself, forming mound-like colonies. We also observed this type of growth in cultures of two other needle cast fungi, Dothistroma septospora (Dorog.) Morelet (= Dothistroma pini Hulbary) and Leptomelanconium pinicola (Berk. & Curt.) R. S. Hunt [= Gloeocoryneum cinereum (Dearn.) Weindlmayr]. The localized growth of these fungi in foliage can apparently be predicted from their limited and localized colonies on agar media. Investigators culturing foliage pathogens are frequently frustrated by the slow-growing localized colonies produced by many of these fungi. In our opinion, these fungi may lack the genetic capacity for a more "normal" (rapid and extensive) type of cultural growth.

Pycnidia of H. pinicola are seated in the upper mesophyll near the hypodermis of the needle. The papillate ostiole is the only portion of the pycnidium which reaches above the host epidermis (Fig. 1). The sheltered position of the pycnidium might be of survival value during unfavorable environmental conditions such as cold winter temperatures, intensive solar radiation, high summer temperatures, and desiccation.

A preliminary study of the conidium wall indicates that it is composed of two distinct layers, the outermost of which develops from globules of material embedded in a more homogeneous matrix. It is also possible to interpret the wall as composed of 3 layers if the outermost electron-transparent material is interpreted as distinct from the matrix in which the globules are embedded. In any case, the outer layer is easily removed by exerting pressure on a coverslip. Individual conidial cells can be separated by pressure and the rupture occurs in the globular zone. It might thus be possible to consider the conidium as distoseptate. It is probable that the thick outer layer is advantageous to the fungus in bearing a substantial part of the pigment(s) that protects the conidium from ultraviolet damage while exposed on the needles surface. It is likewise probable that it reduces water loss from the conidium. It undoubtedly has properties that allow the conidium to adhere to pine foliage. The fact that the outer wall layer is easily ruptured by germ tubes and other mechanical means seems advantageous to the fungus in that the conidium can have the advantages of a heavy wall without requiring preformed germination sites such as pores or slits.

At the study locations, LPP is abundant but not considered an economically important species. In other areas where forest fires often occur the species is important because of its serotinous cones which contribute toward rapid reforestation. In some areas in the Pacific Northwest LPP reaches merchantable size. Hendersonia pinicola slows growth of LPP by killing new needles, thereby reducing photosynthetic activity necessary for adequate diameter and height growth. Thus, after several years H. pinicola causes a decline in growth and vigor. Eventually, small trees are killed.

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ANOTHER NEW HYPHOMYCETE FROM LEAF LITTER

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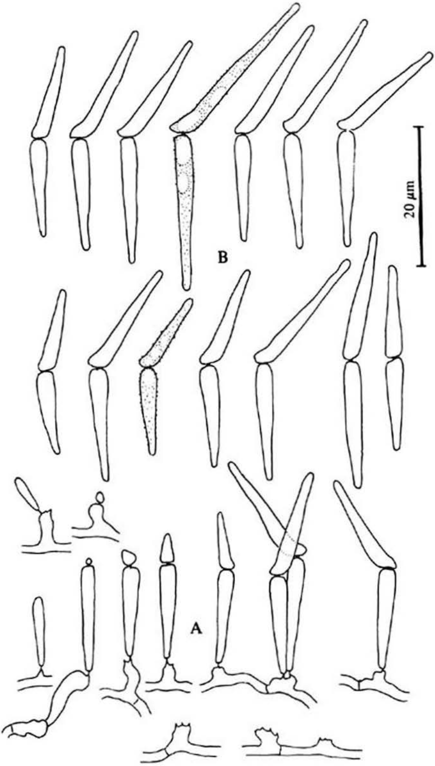
Isthmolongispora geniculata sp.nov., a leaf litter inhabiting hyphomycete with subhyaline, bicellular, constricted, bent conidia is described and illustrated.

Isthmolongispora was established by Matsushima(1971) for two hyphomycetes, **I.intermedia** Matsushima and **I.minima** Matsushima found on decaying leaves from the Solomon Islands and Papua-New Guinea. Seven additional species have been described since then (Matsushima, 1975, 1987, de Hoog & Hennebert, 1983, & Arambarri et al. 1987). The genus is characterised by having short, simple to poorly formed denticulate, sympodially proliferating conidiophores arising from the vegetative hyphae. Conidia arise from denticles in succession and are narrowly clavate to filiform, bicellular to multicellular; the cells making up the conidia are connected by very narrow isthmi. A recent collection of submerged decaying leaves incubated in moist chambers yielded a hyphomycete which fits well into this genus but does not agree with any of the described species and is described below as a new species.

Isthmolongispora geniculata sp.nov. (Figs 1 – 2)

Coloniae in foliis putridis expansae, albidae vel griseolae. Mycelium plerumque superficiale, ex hyphis laevibus, subhyalinis vel pallide fuscis, ramosis, septatis, 1.5 – 2.0 µm latis compositum. Cellulae conidiogenae sparsae, e hyphis lateraliter vel terminaliter in ramis integratae oriundae, saepe modice inflatae; denticuli conidiogeni cylindrici in cellulis conidiogenis terminali aggregati. Conidia subhyalina, pallide brunneo-grisea in massa, laevia vel minute verruculosa, bicellularia, in medio flexa et profunde constricta per isthmum brevem connexa, 30 – 47 µm longa x 2 – 3 µm crassa.

Ex foliis angiospermis putrescentibus in flumine immersi, Pasuh Forest Reserve, Negri Sembilan, 18 Nov. 1986, A. Nawawi, IMI 319609 holotypus.


B
A
20 µm

Colonies on the leaves extensive, whitish to greyish, powdery upon sporulation. Mycelium mostly superficial, often creeping up debris and setae of other fungi present, composed of smooth, subhyaline to pale fuscous, branched, septate 1.5 – 2.0 µm wide hyphae. Conidiogenous cells scattered, arising from undifferentiated hyphae or integrated on short lateral branches, wedge-shaped to ampulliform, sometimes slightly swollen; conidium-bearing denticles short, thread-like, 1 – 5 grouped in the apical regions. Conidia light brownish grey in mass, subhyaline, smooth to minutely verruculose, bicellular, bent at an angle of 130° – 160° at the markedly constricted median septum; the two cells connected by a very narrow isthmus. The basal cell is narrowly clavate with a rounded apex, 15 – 22 µm long x 2 – 3 µm wide. The distal cell is similarly shaped but readily distinguished from the basal cell by the presence of a small protuberance at the base, somewhat resembling a hockey stick. The total length of the mature conidia ranges from 30 – 47 µm, and the distal cell usually exceeds the basal cell by 1 – 3 µm.

Other specimen examined: On submerged decaying leaves incubated in moist chambers, Mimaland, Selangor, 18 Apr. 1987, A. Nawawi.

During conidial development, each conidium starts as a minute, round, hyaline bud growing out from the tip of a denticle. This bud lengthens to become rod-shaped and finally narrowly clavate with a rounded apex. When it reaches 12 – 15 µm long a similar bud grows out from its apex and lengthens to become triangular and finally narrowly clavate. It is connected to the basal cell by a very short, narrow isthmus. The apex of the first cell remains rounded while the base of the second cell develops a notch at one side and as a result it does not grow straight up but bends slightly to one side. The conidiogenous cell proliferates sympodially and up to 5 conidia have been observed growing from one. Conidia secede by a break in the denticle very close to the base, leaving a short, thread-like stump on the conidiogenous cells. The remains of the denticles are not visible in detached conidia.

Conidia germinate readily on agar media by producing germ-tubes from the tips of the cells. On CMA the colony is compact, appressed, initially creamish, but later turning light chocolate brown with sparse, grey aerial mycelium; reverse brown. It is of moderate growth, reaching a diam. of 31 mm in 48 days at

Fig.1. **Isthmolongispora geniculata.** (A) Stages in conidial formation arranged in a developmental series from leaves; (B) Conidia.

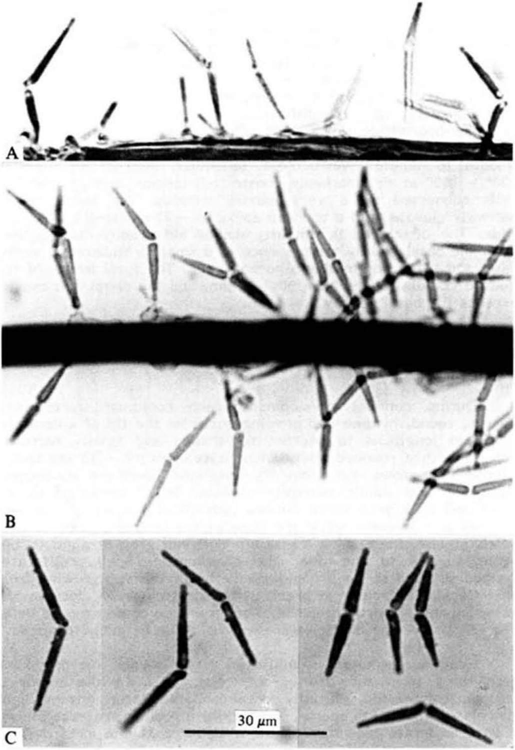


Fig.2. **Isthmolongispora geniculata.** (A – B) The fungus creeping up and sporulating on setae of **Wiesneriomyces laurinus;** (C) Typical conidia.

25 – 28°C. Sporulation is abundant, occurring close to the agar surface or on aerial mycelium. On agar, the conidia tend to be shorter, sparsely punctate and the majority with a slight bend at the septum.

The morphology of the conidiogenous cells and the conidia are the main characteristics which suggest the inclusion of this fungus in the genus **Isthmolongispora.** The distinctly bent conidia of **I.geniculata** are at present unique in the genus and at once distinguish this species from all others. It appears to be most closely related to **I.minima** which also produces bicellular conidia whose cells are connected by narrow isthmi. However, conidia of **I.minima** are straight, fusiform and shorter (16 – 30 µm x 2.5 – 3 µm) and the basal cell is indistinguishable from the distal cell.

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THE BLOXAMIA ANAMORPH OF BISPORELLA DISCEDENS

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ABSTRACT

A *Bloxamia* anamorph is reported for *Bisporella discedens* (Karsten) Carpenter. The anamorph was found on host tissue in association with the teleomorph, on the sides of the apothecia, and was produced in culture from single ascospores.

INTRODUCTION

There have been four reports of anamorphs associated with the genus *Bisporella* Saccardo (= *Calycella* Quélet), a member of the Helotiales. Berthet (1964) reported a *Bloxamia* anamorph in culture from single ascospore isolations of *Calycella sulphurina* (Quélet) Boudier (= *Bisporella sulphurina* (Quélet) Carpenter). Carpenter (1975) reported the anamorph of *Bisporella discedens* (Karsten) Carpenter as *Cystodendron* sp., although he was uncertain of the genus to which the anamorph should be assigned and considered that affinities with *Chalara* were possible. Carpenter (1981) reported a *Cystodendron* anamorph for *Bisporella polygoni* (Velenovsky) Carpenter. Carpenter (1975, 1981) found the anamorphs developing on the receptacle of the teleomorph apothecia, and the links were not proven experimentally. The anamorph of *Bisporella resinicola* (Baranyay & Funk) Seifert & Carpenter was placed in the genus *Eustilbum* Rabenhorst by Seifert & Carpenter (1987). This anamorph-teleomorph link was proven by single ascospore isolations by Baranyay & Funk (1969). *Bisporella pallescens* (Persoon : Fries) Carpenter & Korf is usually found growing in association with the conidial fungus *Bispora monilioides* Corda, but this probably represents a mycoparasitic rather than an anamorph- teleomorph relationship (Korf & Carpenter 1974).

This paper reports the anamorph of *Bisporella discedens* from New Zealand, both from the host and from culture following single ascospore isolations. Single ascospore isolations were also made from *B. citrina* (Batsch : Fries) Korf & Carpenter, another species of *Bisporella* commonly found in New Zealand, but no anamorph was found.

RESULTS

Bisporella discedens was reported from New Zealand by Dennis (1961) (as *Calycella discedens* (Karsten) Dennis), and is common on bark, old pyrenomycete fruiting bodies, and palm fronds, mainly in the north and west of the North Island. The New Zealand collections are typical of *B. discedens* as re-described by Carpenter (1975).

Single ascospores were isolated from two collections (PDD 45590, 45599), and colonies derived from these were grown on Difco cornmeal dextrose agar (CMD) for 21 days at 18°C under near-ultraviolet and cool-white fluorescent light, with a cycle of 12 hour light/12 hour dark. Ascospores germinated within 24 hours and cultures on CMD were 15-20 mm diam. after 21 days. Aerial mycelium was lacking, agar was not discoloured, the colony surface was white except for the black, flat, up to 0.5 mm diam. sporodochia which developed in a ring near the centre of the colony. The sporodochia became greyish in colour following the production of conidia. The sporodochia comprised a 30-50 μm wide base of pseudoparenchymatous tissue on which a tightly packed palisade of pale brown, cylindrical, 50-80 x 2-2.5 μm conidiogenous cells was held. The conidiogenous cells were septate in the lower half, and at the apex were tube-like and contained several conidia. The conidia were hyaline, nonseptate, rectangular in outline, 2.5-4.5 x 1.5-2 μm, held in readily disarticulating chains. No apothecia formed.

In several herbarium collections (PDD 19385, 19387, 19390, 19048, 25678, 29816, 45592) sporodochia were found on the host in association with the *Bisporella* apothecia (Fig 1). These sporodochia were initially black, discoid, more or less circular, 0.3-1.0 mm diam. Following the production of conidia the upper

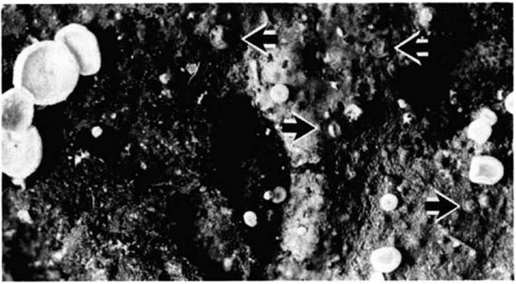
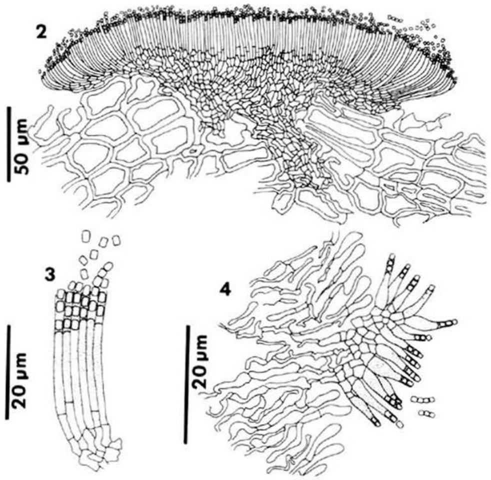


Fig 1 Macroscopic appearance of *Bisporella discedens* and *Bloxamia* anamorph, sporodochia of anamorph indicated by arrows (PDD 29816).



Figs 2-4 *Bloxamia* anamorph of *Bisporella discedens*. **Fig 2** Vertical section of sporodochia on host tissue (PDD 29816); **Fig 3** Detail of conidiogenous cells and conidia from sporodochia on host tissue (PDD 29816); **Fig 4** Anamorph conidiogenous cells and conidia on outside of gelatinous excipulum of teleomorph apothecium (PDD 19385)

surface of the sporodochia became silver-grey in colour. The sporodochia were erumpent from the host tissue, in vertical section were up to 70 m deep, with the basal part, on which the conidiogenous cells are held, comprising hyaline, thin walled, pseudoparenchymatous cells (Fig 2). The conidiogenous cells were pale brown, thin walled, cylindric, 20-28 x 2-2.2 μm, forming a densely-packed palisade (Fig 3). The apex of the conidiogenous cells were tube-like and contained 3-5 conidia. The conidia were hyaline, non-septate, rectangular to more or less square in outline, 1.8-2 x 2- 2.5 μm, released singly or held in readily disarticulating chains.

In the collections listed previously, as well as PDD 19381, 19383, 19389, and 46157, conidiogenous cells and conidia were found attached to the outer excipular layer of the teleomorph apothecia (Fig 4). The apex of the conidiogenous cells and the conidia were similar to those described above from sporodochia, but the conidiogenous cells were shorter (16-19 μm) and slightly swollen near their bases. In some collections there were chains of up to 15 conidia. The conidiogenous cells were in loose groups of up to about 20, and at their base was a narrow layer of thin-walled, angular cells.

The second species, *Bisporella citrina*, is found in New Zealand in the South Island and lower half of the North Island, mostly on decorticated wood of various hosts and on bark of *Nothofagus* spp. Cultures were grown from single ascospores isolated from several collections, including PDD 43162, 45873, 49449, and 49499. The cultures were similar in growth rate and appearance to those described for *B. discedens* but sporodochia did not develop, and they remained sterile. No anamorph was seen in association with the apothecia.

DISCUSSION

I have followed Dennis (1961) in referring the New Zealand collections to *Bisporella discedens*. However, it is uncertain whether *B. discedens* can be distinguished from *B. sulphurina* (Dumont 1981). If the two names are found to represent the same species then *B. sulphurina* would have nomenclatural priorty.

The anamorph described above for *B. discedens* is *Chalara*-like in the structure of its conidiogenous cells and conidia. Because the conidiogenous cells may develop in sporodochia the anamorph should be assigned to the closely related genus *Bloxamia* Berkeley & Broome (Nag Raj & Kendrick 1975). The anamorph closely resembles *Bloxamia truncata* Berkeley & Broome, the type species of the genus (Pirozynski & Morgan-Jones 1968, Nag Raj & Kendrick 1975). The morphology of the *Bisporella discedens* anamorph in culture agrees with the description and illustrations of Berthet (1964) for the anamorph of *B. sulphurina*.

The way in which the conidiogenous cells of the anamorph of *Bisporella discedens* are arranged varies according to substrate. On host tissue and in culture discoid sporodochia form, while on the apothecia loose aggregations of small numbers of conidiogenous cells are found. Carpenter (1975) referred the anamorph found on apothecia to the genus *Cystodendron*. The arrangement of the conidiogenous cells is similar to that illustrated for *Cystodendron* (Ellis 1971, Carmichael et al. 1980), however the structure of the conidiogenous cells and conidia indicates a relationship with *Chalara* rather than with *Cystodendron*. This relationship is supported by the structure of the anamorph in culture and from host tissue.

The *Eustilbum* anamorph described by Baranyay & Funk (1969) (as *Stilbella*) and Seifert & Carpenter (1987) for *Bisporella resinicola* is morphologically very different from the *Chalara*-like anamorphs of *B. discedens* and *B. sulphurina*. This may simply reflect the unusual substrate of conifer resin on which *B. resinicola* develops, or may indicate that *Bisporella* as currently delimited is heterogeneous.

SPECIMENS EXAMINED

New Zealand: AUCKLAND, Waitakere Ra., Kauri Knoll Tr., on *Rhopalostylis sapida*, coll. Johnston, 29 Apr 1987 (PDD 45590); Hunua Ra., on *Hedycarya arborea*, coll. Dingley, 28 Mar 1954 (PDD 19390); Mt. Albert, on *Leptospermum scoparium*, coll. McKenzie, Sep 1948 (PDD 19385); Titirangi, on *Dysoxylon spectabilis*, coll. Dingley, 6 Jun 1949 (PDD 19383); Titirangi, on *Coprosma robusta*, coll. Dingley, 20 Jun 1950 (PDD 19389). COROMANDEL, Thames, on *Muehlenbachia australis*, coll. Dingley, 10 Jun 1950 (PDD 19048). GISBORNE, Urewera Nat. Park, Black Beech Tr., on decort. wood, coll. Samuels et al., 22 May 1981 (PDD 49449); Urewera Nat. Park, Ngamoko Tr., on decort. wood, coll. Samuels et al., 21 May 1981 (PDD 49499). WANGANUI, vic. Kai Iwi, Bushy Park Res., on *Ripogonum scandens*, coll. Johnston, 15 May 1987 (PDD 45599); vic. Kai Iwi, Bushy Park Res., on *Rhopalostylis sapida*, coll. Johnston, 16 May 1987 (PDD 45592); vic. Wanganui, on *Beilschmiedia tawa*, coll. Dingley, 6 Mar 1946 (PDD 19381); vic. Kai Iwi, Bushy Park Res., coll. Johnston, 16 May 1987 (PDD 46157). WELLINGTON, Kandallah Reserve, on *Brachyglottis repanda*, coll. Dingley, Dec 1948 (PDD 19387); Hutt, Days Bay, on ?*Hypoxylon* sp., coll. Dingley, 22 Feb 1972 (PDD 29816). NELSON, Waimea, on *Nothofagus* sp., coll. Dingley, 2 Mar 1967 (PDD 25678); Mt. Arthur, on decort. wood, coll. Samuels et al., 18 May 1983 (PDD 45873). BULLER, vic. Murchison, along road toward Maruia Saddle, on *Nothofagus* sp., coll. Samuels et al., 11 May 1982 (PDD 43162).

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Rust fungi (Uredinales) on Poaceae, mainly from Africa

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ABSTRACT

Fiftythree rust taxa on hosts belonging to Poaceae are reported. Fifteen species are described as new, viz. Puccinia apochitonis on Apochiton burtii, P. trachypogonicola on Trachypogon chevalieri, P. trichopterygicola and P. trichopterygiphila on Trichopteryx fruticulosa, P. triraphidis on Triraphis schinzii, Uredo elymandrae on Elymandra androphila, U. eragrostidiphila on Eragrostis kiwuensis, U. eragrostidis-capensis on Eragrostis capensis, U. leersiae on Leersia hexandra, U. trichopterygis-dregeanae on Trichopteryx dregeana, Uromyces chaetobromi on Chaetobromus schraderi, U. clignyioides on Monocymbium ceresiforme, U. eragrostidicola on Eragrostis rigidior, U. habrochloae on Habrochloa bullockii, and U. pentaschistidis on Pentaschistis aizoides, all from Africa. Species new to Africa are P. chrysopogi on Heteropogon contortus, P. faceta on Olyra latifolia, P. lepturi on Lepturus radicans, P. sessilis on Phalaris arundinacea, Uromyces obesus on Heteropogon contortus and U. turcomanicum on Hordeum bulbosum and H. marinum ssp. gussoneanum. New hosts are recorded.

Keywords: Uredinales, Rusts, Poaceae.

Most of the material presented in this paper belongs to the Herbarium of the Royal Botanic Gardens Kew (Herb. K). A few specimens belong to the Botanical Museum in Copenhagen (Herb. C) and to the Norwegian Plant Protection Institute (NPPI). The rust names and species concept follow that used by Cummins (1971) in his monograph. For synonyms of the rusts see the same publication.

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PHAKOPSORA INCOMPLETA (Syd.) Cumm. in Mycologia 42: 786 (1950).
On Andropogon distachyos L.
Ethiopia. W of Harar, 2500-3000 m, 29.09.1961, W. Burger (1014), II; Addis Ababa, 2800 m, 29.11.1935, H.F. Mooney (5026), II.
On Andropogon eucomus Nees
Malawi. Zomba, 28.04.1950, P.O. Wiehe (N/498), II.
On Themeda triandra Forssk.
Zimbabwe. Bikita distr., 1000 m, 10.05.1969, H.M. Biegel (3096), II.

A. distachyos is a new host for this rust which occurs on several genera in Africa and Asia.

PHAKOPSORA LOUDETIAE Cumm. in Bull. Torrey Bot. Club 83: 223, 1956.
On Loudetia kagerensis (K. Schum.) Hutch.
Uganda. Entebbe road, mile 13, 03.1930, C.G. Hansford (1130), II.

This specimen was published by Wakefield & Hansford (1949) as Puccinia loudetiae Wakef. & Hansf. However, the curved, dorsally thickened paraphyses, the pale wall of the urediniospores and obscure pores indicate it should be placed within the genus Phakopsora.

PHYSOPELLA AFRICANA (Cumm.) Cumm. & Ramachar in Mycologia 50: 742 (1958).
On Brachiaria decumbens Stapf
Kenya. Kitale, 04.09.1956, A. Bogdan (4254), II + III.

This rust species is known only from Kenya and Uganda, occurring on Brachiaria spp.

PUCCINIA AGROPYRI-CILIARIS Tai & Wei in Sinensia 4: 110, 1933.
On Agropyron semicostatum Nees
China. Shantung, Tsingtao, 07.06.1930, C.Y. Chiao (2414), II + III.

The host is new to this rust in China, but it has been reported from Japan.

PUCCINIA ANDROPOGONICOLA Har. & Pat. in Bull. Mus. Hist. Nat. Paris 1909: 199 (1909).
On Cymbopogon caesius (Hook. & Arn.) Stapf

Sudan. Kelling, Jebel Marra, 1900 m, 17.04.1964, G.E. Wickens (1472), II + III.
On *Cymbopogon commutatus* (Steud.) Stapf
Ethiopia. Eritrea, Merriam, below Mei Mapales, 31.04.1894, G. Schweinfurth (45), III; Tigré, Adeneato, 10.12.1909, Chiovenda (1243), III.
Sudan. Darfur Prov., E of Kebkabiya-Zalingei road, about 65 km from Kebkabiya, 1000-1100 m, 01.01.1934, J.E. Dandy (739), III; Darfur, 09.1921, H. Lynes (528), III; Jebel Sirmi in Jebel Marra, 01.10.1964, G.E. Wickens (2763), III.
On *Cymbopogon giganteus* Chiov.
Uganda. Mt Elgon, Simii valley to Siroke valley, 1250 m, 12.12.1927, J.D. Snowden (1246), II.
Central African Republic. E Chari, Snoussi Co., Dar Banda, Ndélé, 1902-04, A. Chevalier (6832), II + III.
On *Cymbopogon martinii* (Roxb.) Wats.
Zimbabwe. Umoukweo, 04.10.1953, R. Pollett, II.

P. andropogonicola is widespread in Africa, occurring on many host genera. *C. commutatus* and *C. martinii* are new hosts for this rust, while *C. giganteus* has been reported from Ghana. Yadav (1963) mentioned a rust as *P.* sp. on *C. caesius* from India, indicating it might be *P. andropogonicola*. If so it is the only record outside Africa.

PUCCINIA ANDROPOGONIS-HIRTI Beltrán in Mem. R. Soc. Espan. Hist. Nat. 50: 252 (1921).
On *Andropogon chinensis* (Nees) Merr. (syn. *A. schinzii* Hack.)
S. Afrika. Transvaal, Pretoria distr., Wonderboom reserve, 05.04.1945, J.E. Repton (2070), II + III.

A. chinensis is a new host for this rust not previously reported outside the Mediterranean area (Corsica, Tunis and Turkey) on *Hyparrhenia hirta* (L.) Stapf (syn. *A. hirti* L.). The teliospores are not or very little thickened at the apex and the pedicels relatively thick-walled, not collapsing and mostly short, but occasionally measuring up to 55 µm. The related *P. eritraeensis* Paz. has teliospores distinctly thickened at the apex and longer, usually collapsing pedicels.

PUCCINIA APOCHITONIS sp.nov. (Fig. 1)

Aecidia et uredinia ignota. Telia amphigena, exposita, pulvinata, fusca. Teliosporae 27-35 x 20-23 µm, late ellipsoideae, raro diorchidioideae, pariete laterali 2.5-3 µm crasso, ad apicem usque 5.5 µm incrassato, cinnamomeo, laevi, pedicello prope sporam pallide brunneo, aliter hyalino, collabente, usque 85 µm longo.
Holotype: H.J. van Rensburg 495 (K), 28.06.1951, Tanzania, Southern Highlands, Chimala on *Apochiton burtii* C.E. Hubbard.

No rust has previously been reported for *Apochiton*.

PUCCINIA ARTHRAXONIS H. & P. Sydow & Butl. in Annls mycol. 5: 499 (1907).

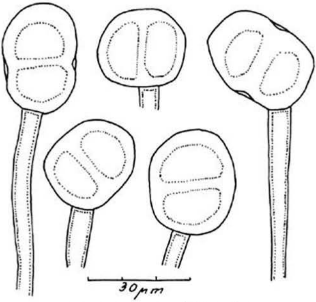

Fig. 1. Puccinia apochitonis sp.nov.
Teliospores from type.

On Arthraxon prionodes (Steud.) Dandy (syn. A. serrulatus Hochst.)
Ethiopia. Eritrea, Haichello Kokob, N of Acrour, 1600 m, 19.03.1892, G. Schweinfurth & D. Riva (1091), II.

This rust is previously reported from Eritrea on the same host (Cummins 1953), but not from other places in Africa. In Asia it is known from Pakistan to China and Taiwan.

PUCCINIA ARTHRAXONIS-CILIARIS Cumm. in Uredineana 4: 16 (1953).
On Arthraxon antisiralensis A. Camus
Madagascar. Betafo, 05.1962, J. Bosser (223), II.
On Arthraxon hispidus (Thunb.) Makino (syn. A. mauritianus Stapf ex C. E. Hubbard)
Mauritius. Mount Pouce, 30.04.1976, M.J.E. Coode (5110), II.
On Arthraxon micans (Nees) Hochst. (syn. A. quartinianus (A. Rich.) Nash)
Ethiopia. Kaffa, Bonga, 1750 m, 13.01.1973, I. Friis et al. (2262), II.
Uganda. Toro, Bwamba Pass, 1800 m, 16.11.1935, A.S. Thomas (1424), II.
Malawi. Between Kondowe and Karonga, 1896, A. Whyte, II + III; Misuku, 28.06.1951, G. Jackson (563), II.
Burundi. Bururi Prov., 06.1977, M. Reekmans (6300), II.
Zaire. Albert National Park, 08.1937, Louis (4815), II; Lumumbashi, Kakanga, 29.04.1963, S. Lisowski (645), II; between Kahungo and Thsibinda, 1928, Scaetta (1215), II.
Cameroon. Dschang near Bambouto, 10.11.1965, A. Meurillon (71), II; 10 miles from Ndop on Bamenda road, 20.12.1932,

A.H. Borghey (10479), II.

In Africa P. arthraxonis-ciliaris is previously reported from Ethiopia, Uganda, and Mauritius. In Asia it is known from India and Nepal to China, Japan and the Far East of Siberia, and it is also reported from New Guinea. A. antisiralensis is a new host for this rust species.

PUCCINIA BRACHYPODII Otth var. POAE-NEMORALIS (Otth) Cumm. & H.C. Greene in Mycologia 58: 705, 1966.
On Festuca griffithiana (St.-Yves) Krivot.
Afghanistan. Baghlan Prov., Salang Pass, Khinjan Tal, 2500 m, 27.06.1965, D. Podlech (11563), II, (det. R.W.G. Dennis).

This host seems to be new to this rust. It is previously reported from Afghanistan on Alopecurus sp. and Poa sp.

PUCCINIA CACAO McAlp. in Rusts of Australia p. 117 (1906).
On Hemarthria altissima (Poir.) Stapf & C.E. Hubbard (syn. H. fasciculata (Lam.) Kunth)
Mozambique. Sul do Save, Maputo, 13.04.1946, M. Myre & A. Balsanhas (577), II; Niassa distr., 18.03.1964, A.R. Torres & J. Palva (10065), II.
Tanzania. Rusuende, 09.02.1966, B.D. Nicholson (89), II.
Zambia. Luzaka Prov., 1130 m, 04.01.1973, J. Kornas (2939), II.
Malawi. Karonga, 26.06.1951, J. Jackson (549), II.
Zimbabwe. Shangani distr., Gurampa forest reserve, 01.1956, B. Goldsmith (13), II.

H. altissima has previously been reported as a host for P. cacao in the Canary Islands and Argentina. Another African host is Rottboellia cochinchinensis (Lour.) W.D. Clayton (syn. R. exaltata L.f.). The rust is also known from Pakistan, China, Japan, Taiwan and Australia. Its aecidial stage (Aecidium manilense Arth.& Cumm.) occurs on Hygrophila spp. (Acanthaceae) and is reported from India, Bangladesh and the Philippines. Angus (1966) reported it from Zambia on an unidentified host, probably belonging to Lamiaceae.

PUCCINIA CHASEANA Arth. & Fromme in Torreya 15: 264 (1915).
On Anthephora cristata (Doell) Hack. ex De Wild. & Dur.
Togo. Cacaveli, 06.09.1976, H. Ern et al. (294), II + III.
On Anthephora pubescens Nees
Botswana. 228 miles NW of Molopolole, 19.06.1955, Story (4935), II (+ III).
On Anthephora schinzii Hack.
Namibia. Grootfontain distr., 11.9 miles SE of Namutoni, 28.03.1955, B. de Winter (2958), II + III.
On Anthephora truncata Robyns
Zaire. Katanga, 19.03.1971, M. Lukuesa (1017), III.

P. chaseana has previously been reported twice from Africa, viz. on A. truncata from Tanzania (Gjærum 1983) and on A. ampullacea from Nigeria (Eboh 1985). Elsewhere it is reported scattered from the Caribbean to Guatemala and Colombia. Except for *A. truncata* the hosts mentioned above are new to this rust species.

PUCCINIA CHLORIDIS Speg. in Rev. Argent. Hist. Nat. Buenos Aires 1: 172 (1891).
On *Chloris gayana* Kunth
Tanzania. On the Dodoma road, 42 miles from Iringa, 1500 m, 25.07.1933, P.J. Greenway (3387), (II +) III.
Nigeria. N Kalkala, SW of Lake Chad, 1933, F. Golding (76), (II +) III.
On *Chloris pycnothrix* Swartz
Nigeria. Tiba plateau, Adamawa, 10.12.1965, K. Peters & P. Tuley (70), (II +) III.
On *Chloris virgata* Swartz
Mozambique. Lower Shiré River, 05.1861, C.S. Meller, III.

This rust has previously been reported from Tanzania and Kenya on the two first mentioned hosts, respectively. *C. virgata* is a new host for this rust in Africa, but it has been reported as such from the Dominican Republic and Mexico. In U.S.A. the aecial stage (*Aecidium brandagei* Peck) occurs on *Asclepias* spp. (Asclepiadaceae) and related genera.

PUCCINIA CHRYSOPOGI Barcl. in Asiatic Soc. Bengal J. 58: 247, 1889.
On *Heteropogon contortus* (L.) Roem. & Schult.
Uganda. Karamoja, Mile 6 on Moroto-Kitale road, 05.10.1952, Verdcourt (762), II + III.

H. contortus represents a new host genus for this rust, previously reported only from Pakistan, India and Burma. Other host genera are *Andropogon*, *Chrysopogon*, and *Themeda*. The aecial stage occurs on hosts belonging to Asclepiadaceae and Oleaceae.

PUCCINIA CORONATA Corda in Icon. Fung. 1: 6 (1837), var. CORONATA.
On *Agropyron cristatum* (L.) Gaertn. ssp. *pectinatum* (Bieb.) Tzvelev (syn. *A. pectiniforme* Roem. & Schult.)
Iran. W side of Lake Rezaiyeh, 15.06.1963, M. Jacobs (6912), II.
On *Agrostis lachnantha* Nees
Ethiopia. Asella, 2300 m, 01.11.1965, W. de Wilde (9005), II (+ III).
On *Avena fatua* L.
Kenya. Five miles N of Eldoret, 2100 m, A. Bogdan, II.
On *Helictotrichon elongatum* (A. Rich.) C.E. Hubbard
Sudan. Gilo, Imatong mts, 1850, 08.11.1980, I. Friis & K. Vollesen (4), II.
Tanzania. Ufipa distr., Malonge plateau, 1800 m, 13.03.1959, M. McCallum Webster (92), II; S. Mbulu distr., 2450 m, 02.08.1946, P.J. Greenway (7672), II.
Malawi. Kasaramba, Nyika plateau, 14.04.1951, G. Jackson (508), II.
Cameroon. Bafut-Ngembe forest reserve, Bamenda division, 2150 m, 27.03.1958, F.N. Hepper (2243), II.
On *Helictotrichon milanjianum* (Rendle) C.E. Hubbard

Kenya. Mt Kenya National Park, 2740 m, 05.03.1974, G. Davidse (7022), II.
Uganda. Lake Bunyonyi, Kashenji, 2100 m, 27.11.1935, H.B. Johnston (1356A), II.
Zaire. Upper Ruamoli river, Kivu, 3700 m, 03.08.1952, R. Ross (770), II.
On *H. turgidulum* (Stapf) Schweick
S. Africa. Orange Free State, 33 km SW of Witsieshoek, 25.02.1974, G. Davidse (6967), II.
On *Lolium multiflorum* Lam. x *perenne* L.
S. Africa. Eastern Cape Prov., Grahamstown, 700 m, 08.11.1981, A. Jordt Guillarmod (8911), II.
On *Polypogon monspeliensis* (L.) Desf.
Cyprus. Morphou, 14.05.1972, W.R. Price (1050), II.
Kenya. Northern Frontier Prov., Marsabit distr., Mt Kulal, 1900 m, 09.10.1947, P. Bally (5547), II.
Tanzania. Northern Prov., Lohondo, 1600 m, 09.11.1953, R. Tanner, II; Musoma distr., Klein's Camp, 1650 m, 23.05.1962, P.J. Greenway (10657), II.
On *Polypogon viridis* (Gouan) Breistr. (syn. *P. semiverticillatus* (Forssk.) Hyl.)
Egypt. Bahr el Shibirm, Bilbeis, 28.10.1928, N.D. Simpson (5927), II.
Ethiopia. Eritrea, Saganeiti, Marakhat valley 08.03.1892, G. Schweinfurth & D. Riva (838), II.

The circumglobal crown rust occurs in Africa on many host genera from the Mediterranean area to S. Africa. *A. lachnantha* and *A. turgidulum* are new hosts for this rust, and *P. elongatus* is a new host for the continent, previously reported only from the Canary Islands. *A. cristatum* is a new host for this rust in Iran. The aecial stage on *Rhamnus* spp. (Rhamnaceae) has been reported from Morocco and Ethiopia.

PUCCINIA DIETELII Sacc. & Sydow in Saccardo Syll. Fung. 14: 358 (1899).
On *Chloris amethystea* Hochst.
Kenya. Athi river station, 24.08.1947, A. Bogdan (1119), II + III.
On *Chloris gayana* Kunth
Kenya. Kitale, 14.04.1964, A. Bogdan (5678), II.
Tanzania. Dodoma road, 42 miles from Iringa, 1500 m, 25.07.1933, P.J. Greenway (3387), (II +) III.
Zambia. Kafue flats, W of Masabuka, 13.05.1957, A. Angus (1586), (II +) III.
Zimbabwe. Matopos, 06.04.1951, D. West (3217), (II +) III.
On *Chloris pilosa* Schumach. (syn. *C. breviseta* Benth.)
Sudan. Nuba mts, Abu Kershola, Tiera, 10.11.1981, G.E. Wickens (818), (II +) III; Darfur, Kulme, 1100 m, 09.1921, H. Lynes (521), III.
Zaire. Wombali (Kasai), 10.1913, Vanderyst (2285), II.
On *Chloris pycnothrix* Trin.
Ethiopia. Lake Tana, Bahadur Gorges, 01.01.1921, G.W. Graham (6), (II +) III.
Nigeria. Vom, 09.-10.1960, M.E. Gambles (8), III.

On *Chloris virgata* Swartz

Uganda. Busoga distr., Jinja, 18.09.1929, Hitchcock (24954), (II +) III.

Tanzania. Iringa distr., Ruaha National Park, Mpululu 22.05.1968, S.A. Renvoize & R.A. Abdallah (2338), (II +) III; Sigi, 370 m, 12.07.19?, P.J. Greenway (762), II; Monik plateau W wall of Rift valley, above Lake Natron, 900 m, 23.07.1962, J.B. Newbould (6206), (II +) III.

Mozambique. Lesiria do Limpopo, Sul do Save, Maniquenque, Guija, 08.07.1948, M. Myre (52), (II +) III.

Malawi. Lilongwe, 23.04.1951, G. Jackson (468), (II +) III.

P. dietelii is widespread in the Americas and in Africa, and it has also been reported from Nepal. *C. amethystea* is a new host species for this rust which has been found on several *Chloris* species. In Tchad it has also been found on *Dactyloctenium aegypticum* (L) Beauv. A record from Zambia on *Andropogon gayanus* Kunth might be doubtful (cf. Gjærum 1983). Cummins (1963) proved its aecial stage to be on *Acalypha* spp. (Euphorbiaceae).

PUCCINIA DIGITARIAE-VELUTINAE Vien.-Bourg. in Bull. Soc. Mycol. Fr. 67: 431 (1951).

On *Digitaria perrottetii* (Kunth) Stapf

Tanzania. Mbula mts, 1 1/2 miles NE of Magugu, 15.04.1964, J.R. Welch, II + III.

P. digitariae-velutinae has been found on several *Digitaria* spp. in Ethiopia, Kenya, Uganda, Tanzania, Nigeria and Ivory Coast, in Uganda also on *Rhynchelytrum repens* (Willd.) C.E. Hubbard. *D. perrottetii* is a new host for this rust.

PUCCINIA DUTHIAE Ell. & Tracy in Ellis & Everhart, Bull. Torrey Bot. Club 24: 283, 1987.

On *Andropogon gayanus* Kunth var. *polycladus* (Hack.) W.D. Clayton (syn. var. *squamulatus* (Hochst.) Stapf)

Zambia. S of Kafue, 22.04.1956, A. Angus (1240), II.

On *Andropogon macrolepis* Hook.

Angola. Between Kutere and Sobi near Knito, 1200 m, 12.03.1900, Kunene-Sambesi Expedition, II.

On *Hyperthelia dissoluta* (Steud.) W.D. Clayton

Ethiopia. Aghere mariam (Alghe), 1900 m, 30.11.1952, J.B. Gillett (14521), II + III.

Tanzania. Kigoma distr., Kibwesa, Mahali mts, 760 m, 11.08.1958, J. Newbould & I.G. Jefford (1639), II (+ III).

Zambia. Lusaka 06.1964, C.A. Smith, II + III.

Zimbabwe. Gwelo, 30.03.1967, H.M. Biegel (1988), II.

S. Africa. Transvaal, Pietermaritzburg distr., Pusela, 25.05.1945, B. Jewaskiewitz, II + III.

In Africa *P. duthiae* has been reported on *Bothriochloa* spp. and *Chrysopogon serrulatus* Trin. The hosts mentioned above are all new to this rust, *Hyperthelia* represents a new host genus. The aecial stage (*Aecidium barleriae* Doidge) occurs on *Barleria* spp. (Acanthaceae), reported from Zambia and Zimbabwe, and also from India.

PUCCINIA ERITRAEENSIS Paz. in Bot. Jahrb. 17: 14 (1893).
On Andropogon gayanus Kunth var. polycladus (Hack.) W.D. Clayton (syn. var. squamulatus (Hochst.) Stapf)
Nigeria. Jos plateau, Gindiri, 24.10.1957, F.N. Hepper (1142), II.
On Andropogon chinensis (Nees) Merr. (syn. A. ascinodis C.B.Cl.)
Kenya. Machahos distr., near Simba, 07.04.1978, Verdcourt (5239), II.
Tanzania. Masai distr., 07.07.1965, Leippert (5988), II + III; Iringa College, 18.04.1972, C. Pedersen (946), (II +) III.
On Diheteropogon amplectens (Nees) W.D. Clayton (syn. Andropogon amplectens Nees)
Malawi. Nehisi mt, 1400, 24.07.1946, L.S. Brass (16917), II.

P. eritraeensis is widespread in Africa, and it is also known from China, Spain (Mallorca), Australia and Honduras occurring on several host genera of which Andropogon, Cymbopogon and Hyparrhenia are the main ones. The three hosts mentioned have been reported only once from Sudan, Kenya and Zambia, respectively.

PUCCINIA FACETA H. Syd. in Annls mycol. 32: 289, 1934.
On Olyra latifolia L.
Mozambique. Lusite valley, Mossovizi, 24.02.1907, coll. not given, II (det. G.B. Cummins).

Up to now P. faceta has been reported only from Brazil, occurring on O. heliconia Lindm.

PUCCINIA GRAMINIS Pers. subsp. GRAMINICOLA Urban in Česka Mycol. 21: 14 (1967).
On Poa leptoclada A. Rich.
Uganda. Mt Moroto, 05.1963, J. Wilson, II + III (det. R.W.G. Dennis).
On Polypogon tenuis Brongn.
S. Africa. Shore between Lourens and Erste rivers, Stellenbosch, 21.05.1946, R.N. Parker (4060) (II +) III.

Polypogon tenuis represents a new host genus for this circumglobal stem rust in Africa, and both hosts mentioned are new for this rust. The aecial stage of P. graminis s.lat. (Aecidium berberidis Pers.) has been reported on Berberis hispanica Boiss. & Reut. (Berberidaceae) from Algeria and Morocco.

PUCCINIA HORDEI Otth in Mitt. Naturf. Ges. Bern 1870: 114 (1871).
On Avena parviflora Desf. (syn. Trisetaria parviflorum (Desf.) Maire)
Algeria. Bou Hamra near Bone, 21.05.1865, Dukesley (550), III (det. R.W.G. Dennis); Constantine Prov., Beni Bou-Jousef, 27.06.1880, E. Cosson, II + III.
On Bromus pectinatus Thunb. (syn. B. japonicus Thunb.)
S. Africa. Cape Prov., Graaff Reinet distr., Blue Gum farm, 14.10.1983, Retief & Reid (563), II + III.
On Holcus lanatus L.

Turkey. Soganli Pass, Trabson, 1500 m, 16.08.1986, P. Jarse (3935), II (+ III).
On *Hordeum marinum* Huds. subsp. *marinum*
Iraq. Baguba, 15.05.1961, Hadač et al. (1953), II + III.
On *Puccinellia anisoclada* V. Krecz.
Afghanistan. Ghorat Prov., 17.3 miles W of Chagcharan, on banks of Hari Reed, 2150 m, 20.06.1971, C. Gray Wilson and T.F. Hewer (1174), II + III.
On *Trisetaria canariense* (Parl.) Pign. (syn. *T. neglecta* *Trisetum canariense*)
Canary Islands. Gran Canaria, Monte, 05.1894, R.M. Murray, III.
On *Trisetum flavescens* (L.) Beauv.
U.S.S.R. Turkmenia, Yugo-zapadni Bakhardensk rayon, Kesse Iola, Kopetdag, 1000 m, 04.06.1974, V.V. Nikitin & A. Ivanov, (II +) III.
Iran. Gorgan, 21.05.1948, Scharif (8055E) (II +) III.
Turkey. Bitlis Prov., Tatvan, 1750 m, 27.06.1954, Davis (22187), II.

In his monograph Cummins (1971) listed numerous synonyms and recognized *P. hordei* as a "complex" species. *Puccinellia anisoclada* represents a new host genus and *A. parviflora*, *B. pectinatus* and *H. marinum* are new hosts for this rust. *H. lanatus* and *T. canariense* are new hosts for the rust in Turkey and the Canary Islands, respectively.

The aecial stage occurs on *Allium* and *Ornithogalum* (Liliaceae) and on *Sedum* (Crassulaceae), and it is reported from Morocco on *Ornithogalum umbellatum* L.

PUCCINIA LEPTURI Hirats.f. in Trans. Sapporo Nat. Hist. Soc. 17: 28 (1941).
On *Lepturus radicans* (Steud.) A. Camus
Kenya. Diana Beach, 06.07.1960, D. Napper (1665), II.
On *Lepturus repens* (G. Forster) R. Br.
Phoenix Islands. Enderbury Island, 31.05.1973, F.R. Fosberg & D.R. Stoddard (54730), II.

P. lepturi is previously reported only on *L. repens* from Ryukyu Islands.

PUCCINIA MAGNUSIANA Koern. in Hedwigia 15: 179 (1876).
On *Phragmites australis* (Cav.) Steud. (syn. *P. communis* Trin.)
U.S.S.R. W Siberia, near Tjumen, 07.1915, S. Mameev (70), (II +) III.
Turkey. Antalya distr., Karagol, Elmali, 07.08.1947, P.H. Davis (13908), III.
Cyprus. Nicosia 03.10.1955, M. Pallis, II.
Oman. Dhofar, Taquah, E of Salalah, 25.11.1981, J.R. Maconochie (2977), II.
Tunisia. Ishkeul National Park, 1978-79, J.M. Fay (830), II.
S. Africa. Orange Free State, Bloemfontein, 06.06.1917, G. Potts (2390), (II +) III; Idas valley, Stellenbosch, 11.04.1920, S. Garside (1378), (II +) III; Western Reg., Genadendal, 05.04.1897, M. Schlechter 10330, II + III.
On *Phragmites mauritianus* Kunth

S. Africa. Transvaal, 28.08.1928, M.E. Blankman (436), II.

This circumglobal rust species has been reported from many countries in Africa, mainly on *P. australis* but also on *P. mauritianus*. It is new to the rust flora of Turkey and Oman. The aecial stage which occur on species of *Anemone*, *Clematis* and *Ranunculus* (Ranunculaceae) has not been reported from Africa.

PUCCINIA NAKANISHIKII Diet. in Bot. Jahrb. 34: 585, 1905.
On *Cymbopogon giganteus* (Hochst.) Chiov.
Mozambique. Mozambique distr., Malema, 28.04.1961, A. Balsenhas & L. Marrime (467), II.

P. nakanishikii, occurring on several graminicolous genera and species, especially on *Cymbopogon* spp., is widespread in Asia from Pakistan to Japan, and on islands in the Pacific Ocean. In Africa it has been reported from Libya, Uganda, Zaire and Madagascar. *C. giganteus* is a new host for this rust species.

PUCCINIA POLYPOGONIS Speg. in An. Mus. Nac. B. Aires 19: 300 (1909).
On *Polypogon monspeliensis* (L.) Desf.
S. Africa. Cape Town, Melkbosstrand, 19.10.1980, A.O. Crook, II; Cape Prov., shore at the mouth of R. Unjab, Kakaoveld, 13.11.1961, D. Giess (3923), II + III, and Vredenberg distr., Paternoster, 14.10.1959, H.J. van Rensburg (124), II + III; near Saron, 10.1896, M. Schlechter (10032), II + III.

Jørstad (1956) also reported this rust on the same host from Saron in the Cape Prov., the only African record up to now. It has been published from Argentina, Brazil and Uruguay and also from Iraq. *P. monspeliensis* is the type host.

PUCCINIA RECONDITA Rob. ex Desm. in Bull. Soc. Bot. Fr. 4: 798 (1857).
On *Agrostis gigantea* Roth
Iran. Kalardasht, 1500 m, 20.08.1960, F.W. Sheard (E 4), II.
On *Agrostis lachnantha* Nees
Malawi. Northern Prov., Nyika plateau, Chelinda Camp, 2200 m, 26.10.1958, N.K.B. Robson (378) II (+ III)
On *Bromus diandrus* Roth
S. Africa. Cape Prov., Barenskop between Malmesbury and Hopefield, 24.09.1969, M.P. Fourie, II.
On *Bromus hordeaceus* L. (syn. *B. molliformis* Lloyd)
S. Africa. Cape Prov., Malgas, Potberg, 12.10.1981, L. Smook (3732), II.
On *Bromus leptocladus* Nees
Kenya. Aberdare forest, 10 miles NE of Kijabe, 2500 m, 16.10.1949, A. Bogdan (2646), II (+ III).
Tanzania. Mbeya mts, 2380 m, 13.05.1956, E. Milne-Redhead & P. Taylor (10334), II + III.

P. recondita includes several specialized forms, often recognized as species, occurring on many genera in Poaceae. To my knowledge this rust has not previously been reported from the African continent on Agrostis, but it has been reported from Madeira on A. castellanea Boiss. & Reut. (Torrend 1912, as P. agrostidis Plowr.). A. lachnantha is a new host for this rust. The aecial stage on Aquilegia (Ranunculaceae) has not been recorded in Africa. A. gigantea is a new host for this rust in Iran.

P. recondita (often as P. bromina Eriks.) has been reported on a large number of Bromus spp. from Morocco, Algeria, Egypt, Ethiopia, Kenya, Uganda and Malawi, and also from S. Africa. B. diandrus is a new host in the African continent, previously recorded only from the Azores (Gjærum & Hansen 1986) while B. hordeaceus has been reported from Tanzania and the Canary Islands and B. leptocladus from Uganda only (Gjærum 1983).

The aecial stage on boraginaceous hosts has been reported from Morocco.

PUCCINIA SESSILIS W.G. Schneider in Schroeter, Abh. Schles. Nat. Abth. 1869-72: 19, 1870, var. SESSILIS.
On Phalaris arundinacea L.
Kenya. Thika distr., Chania river, 21.03.1959, P.J. Greenway (9564), II; 10 miles N of Gilgil, 2400 m, 08.12.1948, A. Bogdan (2159), II.

This rust is widespread in Europe, in U.S.S.R., China and Japan, and also in U.S.A. and Canada. Hitherto it has not been reported from Africa. Phalaris is the main host genus, but it occurs also on Festuca. The aecial stage (Aecidium majanthae Schum.) occurs on numerous species belonging to Araceae, Iridaceae, Liliaceae and Orchidaceae.

PUCCINIA STRIIFORMIS Westend. in Bull. Roy. Acad. Belg., Cl. Sci. 21: 235 (1854) var. STRIIFORMIS.
On Bromus pectinatus Thunb. (syn. B. adoensis Steud.)
S. Africa. Cape Prov., Greifswald, 1913, no coll. given, II.

The stripe rust in Africa is common especially on cereals, but also on grasses from Morocco, Algeria, Libya and Egypt south to Tanzania and Zambia. On Bromus it is reported on B. lanceolatus Roth (syn. B. macrostachys Desf.), B. rigidus Roth and B. squarrosus L. from Morocco, on B. rigidus also from the Canary Islands. B. pectinatus is a new host for this rust.

PUCCINIA TRACHYPOGONICOLA sp.nov. (Fig. 2)

Aecidia et uredinia ignoti. Urediniosporae in teliis intermixtae, paraphyses geniculatae. Urediniosporae 24-38 x 20-33 µm, ellipsoideae, subgloboideae vel irregulares, pariete basi 3 µm crasso, laterali 1.5-2.5 µm crasso, ad apicem usque 3 µm incrassato, castaneo, echinulato, 3-5 poris dispersis instructis. Telia linearia in vagina et in pagina abaxiali foliorum, exposita, pulvinata, fusca. Teliosporae 30-62 x 13-22(-27) µm, fusiformes vel ellipsoideae, irregulares vel geniculatae, ad septum constrictae, pariete 1 µm crasso, ad apicem usque 11 µm incrassato, pallide cinnamomeo vel cinnamomeo, laevi, poro supe-

riore apicali, poro inferiore obscuro, pedicello hyalino, minus quam 15 um longo.
Holotype: M. Reekmans 9196 (K), Burundi, Bururi Prov., Gihofi, 1300 m, 20.05.1980 on *Trachypogon chevalieri* (Stapf) Jac.-Fél. Isotype in NPPI.

Cummins (1971) listed two species on *Trachypogon*, viz. *Puccinia eritraeensis* Paz. and *P. versicolor* Diet. & Holw. This new species differs from the former in having a less number of pores in the urediniospores and longer teliospores with a thinner wall and a more thickened apex. From the latter species it differs in having paraphyses in the uredinia and urediniospores with an evenly thick wall, not stellate as in the latter one.

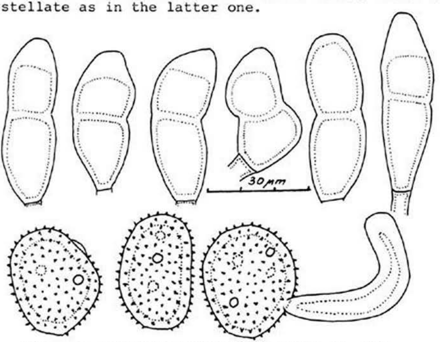

Fig. 2. *Puccinia trachypogonicola* sp. nov. Telio- and urediniospores and paraphysis from type.

PUCCINIA TRICHOPTERYGICOLA sp.nov. (Fig. 3)

Aecidia ignota. Uredinia in pagina abaxiali foliorum, brunnea, cum paraphysibus capitatis vel capitatis-clavatis, usque 70 µm longis, capitulis 14-16 µm lateralis, pariete ad apicem usque 5.5 µm crasso, hyalino. Urediniosporae 20-23 x 19-23 µm, subgloboideae vel globoideae, pariete 1 µm crasso, castaneo, dense echinulato, 3-4 poris equatorialibus instructis. Telia amphigena, exposita, pulvinata, fusca. Teliosporae 33-42 x 22-30(-33) µm, ellipsoideae, ad septum non vel leniter constrictae, pariete 2-4 µm crasso, ad apicem usque 5.5 µm incrassato, cinnamomeo vel castaneo, laevi, poro superiore apicali, poro inferiore obscuro, pedicello hyalino, usque 150 µm longo.
Holotype: M. McCallum Webster A 349 (K), Zambia, Abercorn

distr., Kalumbo falls, 1200 m, 21.04.1959, on *Trichopteryx fruticulosa* Chiov. Isotype in NPPI.

Cummins (1971) listed no rust on *Trichopteryx*. However, Wakefield & Hansford (in Hansford 1938) described *Puccinia trichopterygis* on *T. afroflammida* (an unpublished name for *Loudetia phragmitoides*) and *T. arundinacea* (A. Rich.) Engl. (= *Loudetia arundinacea* (A. Rich.) Steud.) but as this was a nomen nudum they (Wakefield & Hansford 1949) described the same specimen as *P. loudetiae* now on *Loudetia phragmitoides* (Peter) C.E. Hubbard (= *L. flammida* (Triv.) C.E. Hubbard).

P. trichopterygicola differs from *P. trichopterygiphila* Gjærum having wider teliospores with thicker wall and longer pedicel.

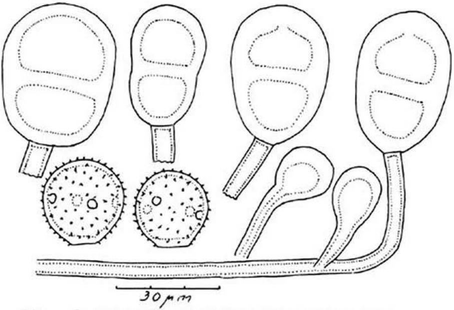

Fig. 3. *Puccinia trichopterygicola* sp.nov. Telio- and urediniospores and paraphyses from type.

PUCCINIA TRICOPTERYGIPHILA sp.nov. (Fig. 4)

Aecidia et uredinia ignota. Telia amphigena, pro maxima parte in pagina abaxiali, lineares, exposita, pulvinata, fusca. Teliosporae 25-36 x 14-21 µm, obovoideae, clavatae vel irregulares, saepe ad apicem truncatae, ad septum constrictae, pariete 1 µm crasso, ad apicem usque 2.5 µm incrassato, apice castaneo, ad basem pallidiore, laevi, pedicello hyalino, usque 15 µm longo. Holotype: G. Jackson 1869 (K), Malawi, Mlanje distr., Tuchila river valley 12.07.1956 on *Trichopteryx fruticulosa* Chiov. Isotype in NPPI.

Teliospores not unlike the two-celled spores in *P. hordei* Otth, but they occur in long streaks without paraphyses. One-celled teliospores are not seen. *P. trichopterygiphila* differs from *P. trichopterygicola* Gjærum in having more narrow teliospores with thinner wall.

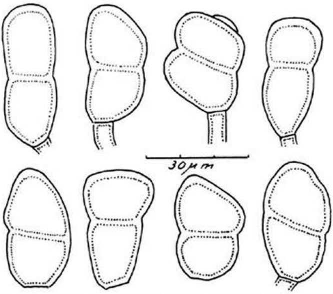

Fig. 4. Puccinia trichopterygiphila sp.nov.
Teliospores from type.

PUCCINIA TRIRAPHIDIS sp. nov. (Fig. 5)

Aecidia et uredinia ignota. Telia in pagina abaxiali foliorum, exposita, pulvinata, fusca. Teliosporae 33-45 x 23-29 µm, ellipsoideae, basi raro contractae, pariete luteo-brunneo, in laterali cellulae inferioris 3-4 µm crasso, cellulae superioris 4-4.5 µm, ad apicem usque 8.5 µm incrassato, laevi, pedicello luteolo, persistente, collabente, usque 125 µm longo.

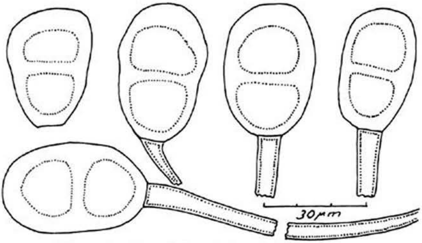

Fig. 5. Puccinia triraphidis sp.nov.
Teliospores from type.

Holotype: B.K. Simon 2166 (K). Zimbabwe, Wankie distr., Kazuma range, 1000 m, 09.05.1972, on Triraphis schinzii Hack. Isotype in NPPI.

No rust has previously been described on Triraphis.

PUCCINIA UNICA Holw. var. BOTTOMLEYAE (Doidge) Cumm. & Husain in Bull. Torrey Bot. Club 93: 60, 1966.
On Aristida adscensionis L.
Saudi Arabia. Near head of Grandi Lavori road, 5 km S of Baljarshi, 2100 m, 17.09.1982, J.S. Collenette (3875), II + III.

This rust is new to Saudi Arabia, but it has been reported on the same host from the Canary Islands, Uganda and S. Africa.

PUCCINIA VERSICOLOR Diet. & Holw. in Holway Bot. Gaz. 24: 28 (1897).
On Andropogon gayanus Kunth
Ivory Coast. At Comoe river between Bouna and Ferkenedougou, 04.08.1967, C. Gerling and J. Bokdan (438), II.
On Andropogon gayanus Kunth var. polycladus (Hack.) W.D. Clayton (syn. var. squamulatus (Hochst.) Stapf)
Sudan. N. Kaloki Hiro, Jebel Marra, 1150 m, 15.09.1964, G.E. Wilkens (2569), (II +) III.
Zambia. Lusaka, 09.08.1952, A. Angus (33), II + III.
Nigeria. Toro, 20 miles E of Jos, 1050 m, 11.1949, A.T. Semple (166), II + III; 69 miles from Yola on road to Bia, 10.11.1969, P. Tuley (1842), II + III.
On Cymbopogon giganteus Chiov.
Zaire. Orientale Prov., Bunia, 1300 m, 01.1960, D. Froment (643), II.
On Cymbopogon martinii (Roxb.) Wats.
Comoro Islands. Mayotte, Kombani, 200 m, 13.12.1968, H.J. Schlieben (11317), II.
On Cymbopogon stypticus (Rendle) Fritsch (syn. C. densiflorus (Steud.) Stapf)
Angola. Malange, prior to 1905, J. Gossweiler (808), II.
On Heteropogon contortus (L.) Roem. & Schult.
Tanzania. Songia distr., 2.5 km E of Johannsbruck, 18.04.1956, E. Milne-Redhead & P. Taylor (9761), II.
Zambia. Mumbwa, 1911, Mrs. Mocanlay, II + III.
Ghana. Accra plains, 02.10.1949, J.T. Baldwin (13440), II + III.
São Thomé. Gulf of Guinea, S. Antonio, 06.1885, A. Moller (151), II.
Zimbabwe. Beatrice distr., 15.02.1947, J.M. Rattray (20620), II.
On Heteropogon melanocarpus (Ell.) Benth.
Kenya. Kwale distr., Buda Mafisini forest, 8 miles W of Gazi, 80 m, 21.08.1953, R.B. Drummond & J.H. Hemsley (3949), II + III.
Tanzania. Ulanza distr., Luhombero junc., 450 m, 09.06.1967, A.F. Rees (98), (II +) III.
Mozambique. Sofala e Manica, Beira, 04.06.1956, M. Myre & A. Balsinhas (2354), III, and 20 km N of Dombe, 150 m, 04.06.1971, H.M. Biegel & G.V. Pape (3546), III; Zambesia,

Metalola, Mbobo, 20.04.1943, A.R. Torre (5209), (II +) III.

Zambia. Southern Prov., near Livingstone, 21.03.1963, W.L. Astle (2283), III; Kafue Game Park, Ngoma forest, 11.06.1960, A. Angus (2403), III, Southern Prov., Namwala, 1150 m, 18.04.1963, H.J. van Rensburg (2050), III.

Zimbabwe. Lomagundi distr., 10 miles E of Banket, 24.03.1969, H.M. Biegel (2891), (II +) III; Wankie distr., Matetsi Safari unit, 1000 m, 19.03.1974, P. Gonde (71/74), (II +) III; Nyamandhlova distr., 13.04.1953, D.C.H. Plowes (1099), III.

Botswana. Tsodilo, 02.05.1975, P.A. Smith (1371), III.

On *Ischaemum afrum* (J.F. Gmel.) Dandy

Kenya. 18 miles SSW of Embu 1100 m, 20.02.1957, A. Bogdan (4432), II (+ III).

Tanzania. Mbulu distr., Mbulumbul, 1530 m, 28.06.1945, P.J. Greenway (7497), II.

Zimbabwe. Beitbridge distr., Lindi valley, 26.04.1972, W.B. Cleghorn (2623), II.

On *Schizachyrium sanguineum* (Retz.) Alston

S. Africa. Natal, Nkandla forest, 1200 m, 14.10.1964, D. Edwards (3310), and Mtungini distr., Ngoye forest reserve, 02.02.1963, B.J. Huntley (901), both only II.

On *Sehima ischaemoides* Forssk.

Zimbabwe. Sabung C distr., 04.1953, R.W. Davis (43445), III.

On *Sehima nervosum* (Bottl.) Stapf

Kenya. Nairobi 27.09.1915, W.J. Dawson (226), II.

In Africa *P. versicolor* has been reported on several host genera and species in many countries from Sudan to S. Africa. *C. giganteus*, *C. stypticus*, *I. afrum*, *S. sanguineum* and *S. ischaemoides* are all new host species. Outside *Africa* it is known from Pakistan, India, China, Japan, Australia, Papua and New Guinea, and from Texas and Arizona in U.S.A. southward to Argentina. In Africa its aecial stage on *Canthium* spp. (Rubiaceae) has been reported from the *Ivory* Coast, Guinea, Nigeria and S. Africa.

UREDO ELYMANDRAE sp. nov. (Fig. 6)

Uredinia in pagina abaxiali foliorum, castanea, cum paraphysibus capitatis vel clavatis, usque ad 55 µm longis, geniculatis, pallide luteolis vel atroluteolis, pariete ad apicem usque 5 µm crasso. Urediniosporae 26-33 x 21-27 µm, ellipsoideae vel lato ellipsoideae, pariete 1-2.5 µm crasso, ad apicem leniter incrassato, cinnamomeo vel atrocinnamomeo, echinulato, (4-)5 poris papillis humilibus tectis equatorialibus instructis.

Holotype: J.M. Fay 5994 (K), Central African Republic, no locality given, 595 m, 21.10.1983 on *Elymandra androphila* Stapf. Isotype in NPPI.

Other material:

On *Elymandra androphila* Stapf

Ghana. On Dokrupe road, 6.8 miles from Seripe, 13.10.1959, J.O. Aukrah (20435), II.

To my knowledge no rust has been described on *Elyman-*

dra. The present rust differs from most other rusts in this group (paraphysate and with equatorial pores) on hosts belonging to Andropogonoideae mainly by the geniculate paraphyses. The only exception is Uredo geniculata Cumm., known from the Philippines and New Guinea on Sorghum nitidum (Vahl) Pers., which differs in having spores with more pores, 6-8 versus (4-)5.

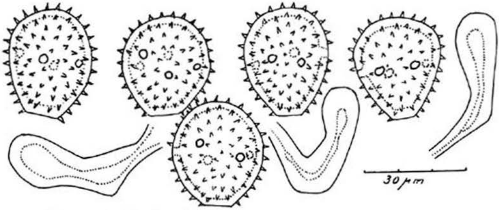

Fig. 6. Uredo elymandrae sp.nov.
Urediniospores and paraphyses from type.

UREDO ERAGROSTIDIPHILA sp. nov. (Fig. 7)

Uredinia amphigena, pro maxima parte in pagina abaxiali, cinnamomea. Urediniosporae 19-24 x 14-18(-20) µm, ellipsoideae vel obovoideae, pariete cinnamomeo, 1-1.5(-2) µm crasso, (3-)4(-5) poris papillis humilibus tectis plus minusve equatorialibus instructis.

Holotype: Liben 425 (K), Zaire, Orientale Prov., Mahagy territory, Gote, 05.11.1952 on Eragrostis kiwuensis Jedw. Isotype in NPPI.

Other material:

On Eragrostis ciliaris (L.) R.Br.

Burundi. Rusizi plain, Bujumbura, 800 m, 05.02.1968 and 13.02.1972, J. Lewalle (2785, 6543), II; Bubanza Prov., S of Kagunuzi river, 1050 m, 14.12.1986, K.A. Lye (12403, NPPI).

Zaire. Stanley Pool, 06.1899, R. Schlechter (12523).

On Eragrostis kiwuensis Jedw.

Ethiopia. Gara Mulata mts, 2650 m, 04.03.1933, J.B. Gillett (5344).

Uganda. Kigezi, near Lake Bunyonyi, 1950 m, 13.10.1929, J.D. Snowden (1447), and Maziba, 2100 m, 12.1944, J.W. Purseglove (1621); Kudan mt 2850 m, 04.1959, J. Wilson (756).

Tanzania. Arusha distr., Mt Meru, 1800 m, 28.05.1968, S.A. Renvoize (2427) and Tue crater, Mt. Meru, E side, 2500 m, 23.04.1968, P.J. Greenway & Kanusi (13516).

Zaire. N. Kivu, Kikomero, Virunga vulcano, 1770 m, 20.09.1954, H.U. Stauffer (439; Matumbe terr., Lubero, 2200 m, 03.09.1959, A. Leonard (5386, C.).

On Eragrostis racemosa (Thunb.) Steud.

Zaire. Mutahapa road, 1800 m, 20.05.1947, Eaton (480).
On Eragrostis schweinfurthii Chiov.
Sudan. Imatong mts, Gilo, 1850, 08.11.1980, I. Friis & K. Vollesen (38, C).

Two specimens on E. kiwiensis from Kigezi in Uganda published as Uromyces eragrostidis Tracy by Wakefield & Hansford (1949) and as Uredo sp. by Gjærum (1983) belong here.

This species differs from Uromyces eragrostidis Tracy and Puccinia eragrostidis Petch having smaller spores with a lower number of pores.

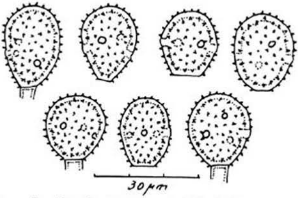

Fig. 7. Uredo eragrostidiphila sp.nov.
Urediniospores from type.

UREDO ERAGROSTIDIS-CAPENSIS sp. nov. (Fig. 8)

Uredinia amphigena, cinnamomea. Urediniosporae 25-35 x 25-34 µm, subgloboideae, pariete 2.5-3 µm crasso, aureo vel cinnamomeo, echinulato, (5-)6-7(-8) poris papillis humilibus tectis dispersis instructis.
Holotype: H.P. van der Schijff 5988 (K), S. Africa, E. Transvaal, Mariepskop, 08.01.1962 on Eragrostis capensis

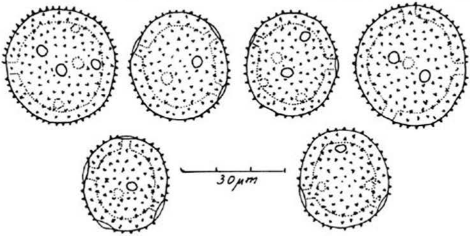

Fig. 8. Uredo eragrostidis-capensis sp.nov.
Urediniospores from type.

(Thunb.) Trin. Isotype in NPPI.

The urediniospores are more globoid and have a thicker and more closely and finely echinulate wall than other species occurring in Eragrostis.

UREDO LEERSIAE sp.nov. (Fig. 9)

Uredinia amphigena, pro maxima parte in pagina abaxiali foliorum, cinnamomea. Urediniosporae (20-)25-43 x 24-35 µm, ellipsoideae, obovoideae vel irregularissimae, pariete 1.5-2.5 µm crasso, cinnamomeo, echinulato (2-)3(-4) poris equatorialibus instructis.

Holotype: J.D. Kennedy 8050 (K), Nigeria, Jos dist., Novaguta 09.10.1944 on Leersia hexandra Sw. Isotype in NPPI.

Cummins (1971) listed 6 rust species on Leersia, three of them with equatorial pores, but none of them has so irregular spores as this, many of them triangular.

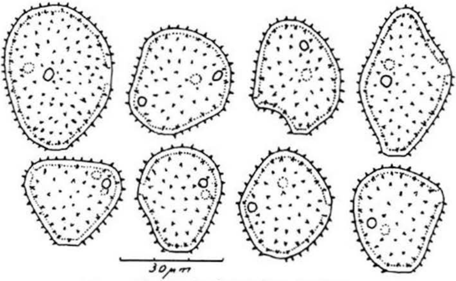

Fig. 9. Uredo leersiae sp.nov.
Urediniospores from type.

UREDO TRICHOPTERYGIS-DREGEANAE sp.nov (Fig. 10).

Uredinia in pagina abaxiali foliorum, atrocinnamomea. Urediniosporae 23-32 x 18-26(-29) µm, subgloboideae, ellipsoideae vel obovoideae, interdum latiores quam longae, pariete 1-1.5 µm crasso, cinnamomeo, echinulato praeter circum duos poros equatorios.

Holotype: I.B. Pole Evans 3430 or 3438 (K), Swaziland, Mbabane, 21.05.1932, on Trichopteryx dregeana Nees. Isotype in NPPI.

This species has no paraphyses and the urediniospores have only two pores while the uredinia of Puccinia trichopterygicola Gjærum have paraphyses and spores with 3-4 pores. It cannot be said whether this uredinial stage belongs to Puccinia trichopterygiphila Gjærum or not as no uredinial stage is known for this species.

In the grass rusts uredinia with 2 equatorial pores are rare. Cummins (1971) listed the following species: Puccinia kiusiana Hirats. f., P. erianthicola Cumm. and three varieties of P. levis (Sacc. & Bizz.) Magn., viz. var. levis, var. goyazensis (P. Henn.) Ramachar & Cumm., and var. tricholaenae (H. & P. Syd.) T. & K. Ramakr. The two species P. advena H. Syd. and P. orientalis (H. & P. Syd. & Butl.) Arth. & Cumm. have basal pores. Several species have urediniospores with 2 or 3 equatorial pores.

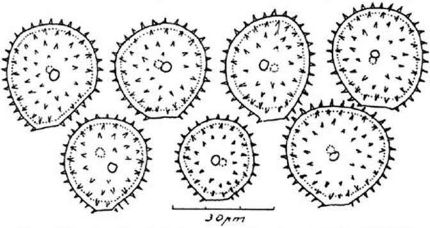

Fig. 10. Uredo trichopterygis-dregeanae sp.nov.
Urediniospores from type.

UROMYCES ARCHERIANUS Arth. & Fromme in Torreya 15: 261 (1915).
On Chloris virgata Swartz
Malawi. Zomba, 900 m, 1936, A.B. Cormack (340), III (det. R.W.G. Dennis).

This rust is reported on Chloris spp. from Uganda, S. Africa, Australia, Mexico and USA, and on Enteroporon monostachya (Vahl) K. Schum. from Tanzania. C. virgata is the type host.

UROMYCES CHAETOBROMI sp.nov. (Fig. 11)

Aecidia et uredinia ignota. Urediniosporae in teliis intermixtae, 28-31 x 23-30 μm, ellipsoideae vel subgloboideae, pariete 2.5-3 μm crasso, echinulato aureo, 7-8 poris dispersis obscuris instructis. Telia amphigena, pulvinata, laxe epidermide tectu. Teliosporae 24-35 x 16-27 μm, irregulares, ellipsoideae, angulatae, saepe apicali truncatae, pariete laterali, 1-1.5 μm crasso, ad apicem 8 μm incrassato, castaneo, ad apicem extus pallidior, pedicello collabente, pallide cinnamomeo, usque 45 μm longo.
Holotype: van Breda 4302 (K), S. Africa, Cape Prov., Chanwilliam distr., 07.11.1974 on Chaetobromus schraderi Stapf. Isotype in NPPI.

No rust has previously been reported on Chaetobromus.

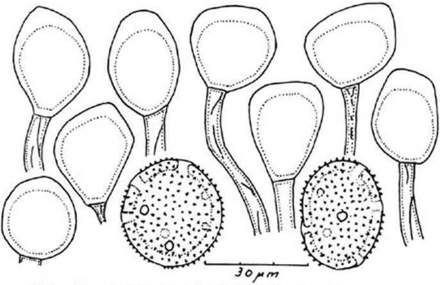

Fig. 11. *Uromyces chaetobromi* sp.nov.
Telio- and urediniospores from type.

UROMYCES CLIGNYI Pat. & Har. in J. Bot. 14: 237 (1900).
On *Andropogon amethystinus* Steud. (syn. *A. pratensis* Hack.)
Kenya. West Kenya, 2200 m, 1923, D.K.S. Grant (1238), II + III; Molo 2700 m, 09.01.1934. no leg., II + III.
Cameroon. Bafat-Ngemba forest reserve, Bamenda, 2100 m, 22.02.1958, F.N. Hepper (2123), II.
S. Africa. Natal, Estcourt distr., 2000 m, 18.02.1969, F.B. Wright 831, II.
On *Andropogon schirensis* A. Rich.
Zambia. Central Prov., Kundalila Falls, 53 km ENE of Serenje, 1450 m, 04.02.1973, A. Strid (2909), II.
Burundi. Kigwena, Bururi, 800 m, 02.04.1981, M. Reekmans (9917), II (+ III).
On *Diheteropogon amplectens* (Nees) W.D. Clayton var. *catangensis* (Chiov.) W.D. Clayton
Malawi. Meno Hills, 1050 m, 02.07.1949, P.O. Wiehe (161), II + III; Mzimba distr., 1350 m, 30.05.1971, Pawek (4677), II.
On *Heteropogon contortus* (L.) Roem. & Schult.
Uganda. Mt Elgon, Buwalasi, 1500 m, 13.12.1927, J.D. Snowden (1247), II.
On *Monocymbium ceresiiforme* (Nees) Stapf
Malawi. Zomba plateau, 1800 m, 25.04.1949, P.O. Wiehe (190), II
(+ III).
On *Schizachyrium urceolatum* (Hack.) Stapf
Ghana. Mole reserve 05.02.1966, Hall & Ente (Gold Coast Herb. No. 35923), III.

Uromyces clignyi has been reported from many countries in Africa and Asia, from some islands in the Pacific Ocean, Australia, Central America, Mexico and from the British West Indies, living on about 15 host genera. *Diheteropogon* is a new host genus for this rust, *A.*

amethystinus and *S. urceolatum* are new hosts and *H. contortus* is a new host for it in Africa. Species of *Chlorophytum* (Liliaceae) and *Crinum* and *Cyrthanthus* (Amaryllidaceae) have been reported as aecial hosts in Africa.

UROMYCES *CLIGNYIOIDES* sp. nov. (Fig. 12)

Aecidia ignota. Uredinia in pagina abaxiali foliorum, cinnamomea. Urediniosporae 19-20 x 19-20 µm, globoideae, pariete 1-1.5 µm crasso, hyalino vel pallide luteo, echinulato, 5-6 poris dispersis instructis. Telia in pagina abaxiali foliorum, exposita, pulvinata, atrocinnamomea. Teliosporae 39-43 x 39-44 µm, globoideae, raro complanatis apicalis, pariete base 2.5-3 µm, aliter 4-5.5(-7) µm crasso, flavobrunneo, laevi, pedicello hyalino vel pallide luteo, persistente, collabente, longitudine 30 µm excedente.

Holotype: G. Davidson et al. 6577 (K), Zimbabwe, Inyanga National Park, 2100 m, 12.02.1974 on *Monocymbium ceresiforme* (Nees) Stapf. Isotype in NPPI.

This rust is similar to *U. clignyi* Pat. & Har., but differs from this in having smaller urediniospores with less pores and having larger teliospores.

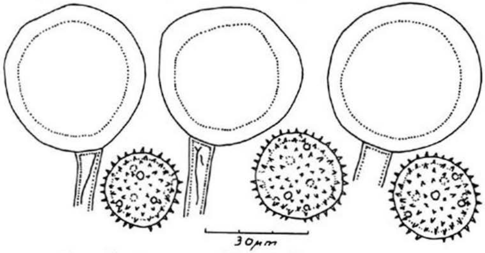

Fig. 12. *Uromyces clignyioides* sp.nov. Telio- and urediniospores from type.

UROMYCES DACTYLIDIS Otth var. POAE (Rbh.) Cumm. The rust fungi of cereals, grasses and bamboos p. 474 (1971).
On *Trisetum flavescens* (L.) Beauv.
Turkey. Giresun Prov., below Tamdere, 1600 m, 09.08.1952, Davis (20638), (II +) III.

T. flavescens was reported from Switzerland by Fischer (1904) as a host for *U. ranunculi-distichophylli* Semad., later described as *U. volkartii* by Gäumann & Terrier (1952), under the former name was also reported from Caucasus (Voronikhin 1927). Cummins (1971) made both names synonymous with *U. dactylidis* var. *poae*. *T. flave-*

scens seems to be a new host for this rust in Turkey.

UROMYCES ERAGROSTIDICOLA sp.nov. (Fig. 13)

Aecidia ignota. Uredinia in pagina abaxiali foliorum, cinnamomea. Urediniosporae 20-28 x 19-25 µm, ellipsoideae vel subgloboideae, pariete 1-2.5 µm crasso, aureo, echinulato, 5-6 poris papillis humilibus tectis dispersis instructis. Telia in pagina abaxiali foliorum, castanea, pulverulenta. Teliosporae 21-28 x 19-23 µm, ellipsoideae vel obovoideae, interdum apice complanatae vel angulares, pariete 1.5-2.5 µm crasso, ad apicem interdum usque 3.5 µm incrassato, cinnamomeo, ad apicem extus pallidior, laevi, pedicello hyalino, usque 60 µm longo, saepe brevius fracto.

Holotype: D.C. Rhodes 1437 (K), Zimbabwe, Matopo Hills, 21.04.1952 on *Eragrostis rigidior* Pilg. Isotype in NPPI.

Other specimens examined:

On *Eragrostis rigidior* Pilg.

Kenya. S of river Tana, 35 miles SE of Embu, 11.07.1953, A. Bogdan (3768), II + III.

Tanzania. Central Prov., Mpawapwa, 26.06.1948, II + III and 31.05.1951, II, both H.J. van Rensburg (445, 611).

Zimbabwe. Salisbury, 1500 m, 03.02.1971, R.M. Davies (3059), II + III.

On *Eragrostis tef* (Zucc.) Trotter (syn. *E. abyssinica* (Jacq.) Link)

Ethiopia. Wambar mariam, 2100 m, 28.10.1926, H. Scott & J.O. Cooper, II + III; Harrihoa 29.-30.10.1862, Schimper (975 d,e), III.

This species differs from *U. eragrostidis* Tracy especially in having teliospores not or only slightly thickened at apex and with hyaline pedicels.

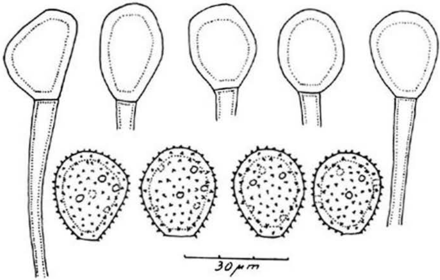

Fig. 13. *Uromyces eragrostidicola* sp.nov. Telio- and urediniospores from type.

UROMYCES ERAGROSTIDIS Tracy in J. Mycol. 7: 281 (1893).
On Cypholepis yemenica (Schweinf.) Chiov.
Botswana. Mpathalwa Pass, 13.03.1976, R.P. Ellis, II (det. R.W.G. Dennis).
On Eragrostis ciliaris (L.) R.Br.
Ghana. Legon Hill, 06.10.1955, C.D. Adams (3361, C), II.
On Eragrostis kiwuensis Jedw.
Uganda. Mt Moroto, 2700 m, 02.1959, J. Wilson (693), II + III; Kigezi, Kashenji, 28.11.1935, H.B. Johnston (1371), II.
On Eragrostis superba Peyr.
Uganda. Eastern Prov., Sukulu stock farm, 1935, H.E.L. Lloyd (11), II, (det. R.W.G. Dennis).
On Eragrostis tef (Zucc.) Trotter
Ethiopia. Eritrea, Asmara, 04.10.1964, J.R. Blair, II; Eritrea, Saganeiti, Degena valley, 2200 m, 26.03.1892, G. Schweinfurth & D. Riva (1261), II + III; Kaffa Prov., 23 km E of Bonga along road to Jimma, 1500 m, 14.01.1973, I. Friis et al. (2278, C), II.

U. eragrostidis is widespread in the Americas and in Africa, especially on Eragrostis spp., and it is also known from Israel, Pakistan, India, Turkmenia in USSR and in Australia. Its aecial stage which occurs on Anthericum (Liliaceae), is known from U.S.A.

UROMYCES HABROCHLOAE sp.nov. (Fig. 14)

Aecidia et uredinia ignota. Telia amphigena, exposita, pulvinata, fusca. Teliosporae 16-23 x 13-19 µm, obovoideae vel angulares, saepe apice truncatae, pariete laterali 1 µm crasso, ad apicem usque 8 µm incrassato, castaneo, laevi, pedicello hyalino, minus quam 20 µm longo.
Holotype: G. Jackson 2242 (K), Malawi, Karonga distr., Mweri Misuki, 06.1958 on Habrochloa bullockii C.E. Hubbard. Isotype in NPPI.

Hitherto no rust has been described on Habrochloa.

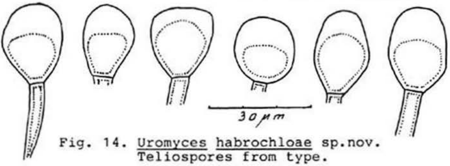

Fig. 14. Uromyces habrochloae sp.nov.
Teliospores from type.

UROMYCES KENYENSIS Hennen in Hennen & Cumm., Mycologia 48: 158 (1956).
On Chloris roxburghiana Schult.
Zimbabwe. Shangani distr., Gurampa forest reserve, 06.1955, Herb. Salisbury (50398), (II +) III.

U. kenyensis has previously been known only from Kenya and Uganda. Another host species is C. gayana Kunth.

UROMYCES OBESUS Durrieu in Mycologia 79: 96, 1987.
On *Heteropogon contortus* (L.) Roem. & Schult.
Uganda. Mt. Elgon, Bulawasi, 1500 m, 13.12.1927, J.D. Snowden (1247), II + III.

This rust species is new to the African rust flora, described on the same host from Nepal. In the African specimen the urediniospores are somewhat larger, (27-)34-37 x (20-)33-37 µm, and with up to 14 pores, but as the teliospores match fairly well with the spores in the type specimen, I prefer to place it within this species.

UROMYCES PENTASCHISTIDIS sp.nov. (Fig. 15)

Aecidia et uredinia ignota. Telia amphigena, pro maxima parte in pagina abaxiali, exposita, pulvinata, fusca. Teliosporae (19-)22-24 x 19-22 µm, ellipsoideae, pariete lamelloso, laterali 3-4 µm crasso, ad apicem usque 8 µm incrassato, luteolo-brunneo, ad apicem extus pallidior, laevi, pedicello brunneolo, saepe collabente, usque 70 µm longo.
Holotype: R. Schlecther 1740 (K), S. Africa, Cape Prov., Riversdale 11.1892 on *Pentaschistis airoides* (Nees) Stapf. Isotype in NPPI.

To my knowledge no rust has previously been described on this host genus.

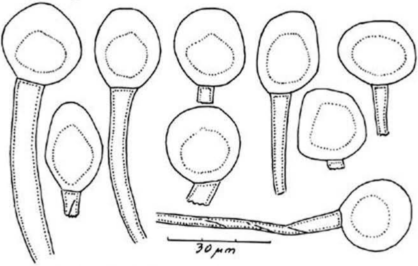

Fig. 15. *Uromyces pentaschistidis* sp.nov. Teliospores from type.

UROMYCES SETARIAE-ITALICAE Yosh. in Bot. Mag. Tokyo 20: 247 (1906).
On *Brachiaria comata* (A. Rich.) Stapf
Sudan. Torit distr., Equatoria, 620 m, 29.10.1949, J. Jackson (868), (II +) III.
On *Melinis minutiflora* P. Beauv.
Burundi. Bubanga Prov., near conflux of Kagunuzi and Karonge rivers, 1080 m, 28.11.1986, K.A. Lye (12204, NPPI), II.

In Africa this species, which occurs circumglobal, has been found on several host genera from the Mediterranean area southward to S. Africa. Both species mentioned above have been reported with this rust from Uganda, on the latter also from Malawi and Sierra Leone.

UROMYCES TENUICUTIS McAlp. in Rusts of Australia p. 87, 1906.
On *Sporobolus jacquemontii* Kunth
Kenya. Nairobi, 13.04.1947, A. Bogdan (503), II + III.
On *Sporobolus kentrophyllus* (K. Schum.) W.D. Clayton.
Somalia. Tugdheer reg., Tiyo plain, 18.06.1979, Hansen & Heernstig (6193), II + III.
On *Sporobolus natalensis* (Steud.) Th. Dur. & Schinz (syn. *S. capensis* (P. Beauv.) Kunth var. *laxus* Nees)
Ethiopia. Bahadur gorge, Lake Tana, 1920, G.W. Grabham, II.
Zaire. Kiwu Prov., Rubshuni, Bishusho, 1810 m, 28.08.1959, A. Leonard (5261), III; Kasai Prov., Mukamba road, 10.1956, Liben (1961), II.
On *Sporobolus pyramidalis* P. Beauv.
Ethiopia. Odde, 2600 m, 23.03.1958, H. Smeeds (1184 A), II + III.

This rust is widespread in warmer regions in Africa, Asia, Australia and the Americas, occurring on a large number of *Sporobolus* species. To my knowledge the rust has been recorded on *S. capensis* from S. Africa, Tristan da Cunha and New Zealand, but as the variety is not given it cannot be said whether *S. natalensis* is a new host for this rust.

UROMYCES TURCOMANICUM Katajev in Akad. Nauk Bot. Odt. Sporov. Rast. Bot. Mater. 8: 111, 1952.
On *Hordeum bulbosum* L.
Jordan. Gabel Amans (Moab), 600--700 m, 25.04.1945, P.G. Davies (8718), II + III.
On *Hordeum marinum* Huds ssp. *gussoneanum* (Farl.) (syn. *H. geniculatum* All.)
Libya. Cirenaica, Sirene-es Safsat, 18.04.1933, R. Pampanini (733); Cirenaica 650 m, 11.04.1939, N.Y. Sandwith (2245), both II + III.

Urom. turcomanicum has hitherto been known only from Iraq, Iran and Turcmenistan. *H. bulbosum* is the type host while *H. marinum* ssp. *gussoneanum* is new to this rust. Some teliospores on the latter host are somewhat longer than stated in the diagnosis, up to 28 µm.

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MYCOTAXON

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SOME FORGOTTEN DISCOMYCETE COMBINATIONS

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ABSTRACT

Thirteen combinations for discomycete names have been found in early volumes of the *Bulletin de la Société Mycologique de France* which have apparently been overlooked by all subsequent authors. Several common species names now require different author citations and/or different literature citations than ever have been adopted. A new name is proposed for the fungus illustrated by Boudier in his *Icones Mycologicae* as *Cyathipodia villosa: Helvella dissingii* Korf.

Perhaps because no complete indices to the volumes of the *Bulletin de la Société Mycologique de France* exist, thirteen apparent new combinations for discomycetes made in papers by L. Arnauld (**1893**), E. Boudier (**1897, 1898, 1899**), and N. Patouillard (**1906**) have not, to my knowledge, ever been noted by later authors. I call them to attention here, for amongst them are eight new combinations which I have cited incorrectly (Korf, **1986**) in my compendium on the names possibly applicable to the plates in Boudier's *Icones Mycologicae,* either as accepted names or as synonyms. These are indicated with an asterisk (*) below; since the compendium is arranged by the final plate number assigned by Boudier, the *Icones Mycologicae* plate number is also listed for ease of entry of these errata in volume 5 of the reprint edition. Names which I consider "generally acceptable modern" names are given in boldface.

In addition to the names I list here, there are many other apparent new combinations made in the *Bulletin* within articles or in lists of species collected on forays or brought to meetings. These are not validly published combinations when they lack author citation for the epithet and thus do not fulfill the requirements for a "reference (direct or indirect) to a previously and effectively published description or diagnosis ..." demanded by Art. 32.1*(c)* of the *International Code of Botanical Nomenclature.* Mere citation of the name(s) of or abbreviation(s) of the author(s) of an epithet is sufficient indirect reference for papers published prior to 1953 (Art. 33.2). No attempt was made to cover combinations in genera other than those of discomycetes, and post-1910 volumes of the *Bulletin* were not checked.

THIRTEEN REVISED AUTHOR AND/OR LITERATURE CITATIONS

ALEURIA BUXEA (Quél.) Arnauld (*'busxea'*), *Bull. Soc. Mycol. France* **9:** 111. 1893.
≡ ***Peziza buxea*** Quél., *C. R. Ass. franç. Av. Sci.* (Rouen, 1883) **12:** 509. 1884.
*__ANTHRACOBIA MELALOMA__ (Alb. & Schw. : Fr.) Arnauld, *Bull. Soc. Mycol. France* **9:** 112. 1893. [Icon. Mycol. pl. 387.]
≡ *Peziza melaloma* Alb. & Schw., *Consp. fung. lusat.* 336. 1805.
ASCOPHANUS HEPATICUS (Batsch) Boud., *Bull. Soc. Mycol. France* **13:** 15. 1897.
≡ *Peziza hepatica* Batsch, *Elench. fung. Continuatio* **1:** 199. 1786.
≡ ***Fimaria hepatica*** (Batsch) Brumm., *Persoonia* **2:** 322. 1962.
CILIARIA HIRTA (Schum. : Fr.) Arnauld, *Bull. Soc. Mycol. France* **9:** 112. 1893.
≡ *Peziza hirta* Schum., *Enum. pl.* **2:** 422. 1803.
≡ ***Scutellinia hirta*** (Schum. : Fr.) Kuntze, *Revis. gen. pl.* **2:** 869. 1891.
CILIARIA LIVIDA (Schum. : Fr.) Pat., *Bull. Soc. Mycol. France* **22:** 53. 1906.
≡ *Peziza livida* Schum., *Enum. Pl. Saell.* **2:** 422. 1803.
≡ *Trichophaea livida* (Schum. : Fr.) Boud., *Icon. mycol. Liste prélim.* p. [3]. 1904. [Doubtful species: *cfr.* Yang and Korf, **1985**, p. 523.]
*__DISCIOTIS VENOSA__ (Pers. : Fr.) Arnauld, *Bull. Soc. Mycol. France* **9:** 111. 1893. [Icon. Mycol. pl. 254.]
≡ *Peziza venosa* Pers., *Syn. meth. fung.* 618. 1801.
*__DISCIOTIS VENOSA__ (Pers. : Fr.) Arnauld var. **RETICULATA** (Grev.) Boud., *Bull. Soc. Mycol. France* **15:** 53. 1899. [Icon. Mycol. pl. 255.]
≡ *Peziza reticulata* Grev., *Scott. crypt. fl.* pl. 156. 1825.
*GALACTINIA BADIA (Pers. : Fr.) Arnauld, *Bull. Soc. Mycol. France* **9:** 111. 1893. [Icon. Mycol. pl. 283.]
≡ ***Peziza badia*** Pers. : Fr., *Observ. mycol.* **2:** 78. 1800.
*GALACTINIA CASTANEA (Quél.) Boud. (ut 'Q.'), *Bull. Soc. Mycol. France* **14:** 20. 1898. [Icon. Mycol. pl. 287.]
≡ *Peziza castanea* Quél., *Mém. Soc. Emul. Montbéliard*, sér. 2, **5:** 399. 1873.
= ***Peziza applanata*** (Hedw. : Fr.) Alb. & Schw., *Consp. fung. lusat.* 312. 1805.
GALACTINIA BOLTONII (Quél.) Boud. (ut '*Boltoni* Q.'), *Bull. Soc. Mycol. France* **14:** 20. 1898.
≡ ***Peziza boltonii*** Quél. (*'Boltonii'*), *Bull. Soc. Bot. France* **25:** 290. 1879 (1878).

*LEPTOPODIA VILLOSA (Schaeff.) Boud. *in* Arnauld, *Bull. Soc. Mycol. France* **9:** 111. 1893. [Icon. Mycol. pl. 240, as *Cyathipodia villosa.*]

≡ *Elvela villosa* Schaeff., *Fung. Bavar. Palat. nasc.* **4:** 114. 1774.

≠ *Helvella villosa* (Hedw.) Dissing & Nannf., *Svensk Bot. Tidskr.* **60:** 330. 1966 *(later homonym),* ≡ ***Helvella dissingii*** Korf.[1]

*OTIDEA GRANDIS (Pers.) Arnauld, *Bull. Soc. Mycol. France* **9:** 111. 1893. [Icon. Mycol. pl. 328.]

≡ *Peziza grandis* Pers., *Syn. meth. fung.* 639. 1801.

*TRICHOPHAEA WOOLHOPEIA (Cooke & Phill. *in* Cooke) Arnauld (*'Woolhopeïa'*), *Bull. Soc. Mycol. France* **9:** 112. 1893. [Icon. Mycol. pl. 365.]

≡ *Peziza woolhopeia* Cooke & Phill. *in* Cooke (*'Woolhopei'*), *Grevillea* **6:** 75. 1877.

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Professor Donald H. Pfister, Farlow Herbarium, Harvard University, kindly acted as pre-submission reviewer of this note. Dr. Wen-ying Zhuang, formerly of this Department, also carefully checked the text.

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DISSING, H. AND J. A. NANNFELDT. **1966.** *Helvella cupuliformis* sp. nov., *H. villosa* (Hedw. ex O. Kuntze) comb. nov., *H. macropus* (Pers. ex Fr.) Karst., and their allies. *Svensk Bot. Tidskr.* **60:** 325-337, pl. 1-3.

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[1] Dissing (**1966a, 1966b**) and Dissing and Nannfeldt (**1966**) treat *Helvella (Elvela) villosa* Schaeff. as a questionable synonym of *Thelephora hirsuta* (Relh. : Fr.) Willd. and of *Auricularia reflexa* Bull. Though Boudier's plate is clearly the fungus they call *Helvella villosa* (Hedw.) Dissing & Nannf., that name cannot be applied to the species because it is a later homonym of Schaeffer's name. A new name for the Hedwig's species, which was not sanctioned by Fries, is required, and is provided here, using the same iconotype ('lectotype') designated by Dissing and Nannfeldt. A European neotype specimen, preferably a topotype, should be carefully chosen to replace the iconotype. The new name, which applies to the species illustrated by Boudier, is **Helvella dissingii** Korf, *nom. nov.* (basionym: *Octospora villosa* Hedw., *Descr. micr.-anal. musc. frond.* **2:** 54., pl. 19, f. B. 1789, non *H. villosa* Schaeff. 1774; typus Hedwig, *loc. cit.*, pl. 19, f. B.).

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MYCOTAXON

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AN UNDESCRIBED PATTERN OF ASCOCARP DEVELOPMENT IN SOME NON-CONIFEROUS LOPHODERMIUM SPECIES

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SUMMARY

Ascocarp development of *Lophodermium multimatricum* sp. nov., a species common on many angiosperms in New Zealand and South America, is described and illustrated. The pattern of development differs from that previously described for other *Lophodermium* species because the ascocarp primordium consists of vertically oriented rows of cylindrical cells, and a layer of vertically oriented cells remains present between the ascocarp walls and the hymenium at all stages of ascocarp development. Several other *Lophodermium* species from non-coniferous plants have the same pattern of development. It is suggested that the combination of developmental characters correlated with macroscopic features of the ascomata, could be used to segregate this group of species from *Lophodermium* s.l.

INTRODUCTION

There have been several studies on ascocarp development in conifer-inhabiting species of *Lophodermium* Chevallier and other closely related genera, including *Hypodermella* Tubeuf and *Lophodermella* Höhnel. Although there is disagreement regarding the nature of the sterile elements present amongst the asci, and the exact site of ascus development (see discussions in Uecker & Staley 1973, Campbell & Syrop 1975, Morgan-Jones & Hulton 1979) there is general agreement regarding the pattern of development of sterile tissues of the ascocarps (Jones 1935, Gordon 1966, Thyr & Shaw 1966, Uecker & Staley 1973, Campbell & Syrop 1975, Morgan-Jones & Hulton 1979). The ascocarp primordium consists of a mass of undifferentiated, interwoven hyphae (= "plectenchyma" as defined in Hawksworth et al. 1983) within which the hymenium develops (see, for example, illustrations in Campbell & Syrop 1975, figs 2, 3; Uecker & Staley 1973, figs 4, 5, 6). The part of the plectenchyma above the hymenium forms the upper ascomatal wall (often termed the clypeus) and that below the hymenium either forms a layer of undifferentiated, pseudoparenchymatous tissue or becomes darkened to form a differentiated lower wall. One exception to this general pattern has been reported by Gordon (1968) for *Lophodermium nitens* Darker. Morgan-Jones & Hulton (1977), however, disagreed with Gordon's interpretation of ascocarp development in this species.

The present paper describes a new species from New Zealand and South America, and reports the pattern of development seen in sterile tissues of the ascomata. Development in this species is compared with that previously described for other species of *Lophodermium*, and its taxonomic significance is discussed.

MATERIALS AND METHODS

Dried herbarium material was rehydrated in 3% KOH, and 8-10 µm thick sections of ascocarps and pycnidia were cut using a freezing microtome. Asci, ascospores, and paraphyses were examined from squash mounts made in 3% KOH and Melzer's solution. Cultural characteristics were determined from single ascospore isolates grown on 'Difco' oatmeal agar. Colonies were incubated at 20°C under near ultraviolet and cool white fluorescent light, with a cycle of 12 hour light/12 hour dark.

RESULTS

Lophodermium multimatricum sp. nov. (Figs 1, 2, 7)

Ascocarpi elliptici, atri; margine induti duobus cum stratis quorum, stratum intorsum cellulas habet verticales; paraphyses ramosae; asci 95-130(-150) x 6-8 µm, cylindrici, apices versus decrescentes; ascosporae 75-100 x 1.5-2 µm, in muco involutae.

HOLOTYPE: New Zealand, Buller, vic. Murchison, Maruia Saddle, Warbeck Scenic Res., on *Rubus cissoides*, coll. Johnston (R161) et al., 16 Apr 1983 (PDD 46125).

ETYMOLOGY: *multi-* = many, *-matricum* = matrix, host; refers to large number of plant species on which this fungus is found.

Ascocarps forming on fallen leaves, in discrete groups within pale yellowish areas, or in some collections in undifferentiated areas. Not associated with zone lines or with anamorph pycnidia.

In surface view immature, unopened ascocarps appear macroscopically as two blackened areas separated by a broad, pale longitudinal zone. In some collections the paler zone is less defined, and immature ascocarps appear as a single blackened area more or less elliptical in outline, with a narrow paler zone extending longitudinally along the ascocarp. Mature, opened ascocarps 0.3-0.8 (-

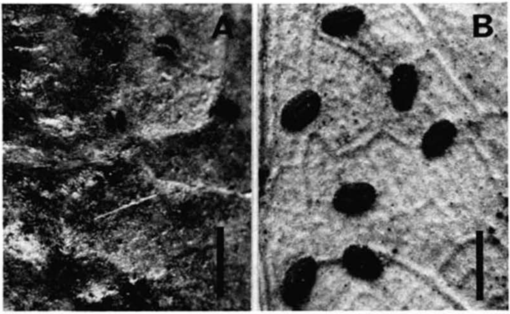

Fig 1 *Lophodermium multimatricum* . Macroscopic appearance of ascocarps. A. Immature ascocarps. B. Mature ascocarps. (bar scale = 1mm).

2.0) x 0.2-0.3 mm, walls black, the ascocarp raising the host surface so that the wall becomes steeply angled to the surrounding leaf surface. Ascocarps developing a distinctive, black, flattened area adjacent to both sides of the elongate, slit-like opening. Lip cells absent.

Ascocarps subepidermal to intraepidermal. In vertical section in immature ascocarps there are three distinct layers of tissue surrounding the developing hymenium, termed here an upper wall layer, a lower wall layer, and an inner layer. The separate upper and lower wall layers both comprising dark brown, thick-walled cells. The upper wall 10-15 µm wide, the lower wall up to about 5 µm. Between the upper and lower walls is the third, inner layer, comprising hyaline, thin-walled, cylindrical cells arranged in vertical rows. The hymenium develops within the inner layer following a breakdown of some of the vertically arranged cells near the centre of the ascocarp. In mature ascocarps the upper wall is up to 20 µm wide. There is a narrow extension to the upper wall bordering the ascocarp opening, and this covers the top of the hymenium. It consists of very dark tissue, and is oriented at right angles to the rest of the upper wall.

Paraphyses 1-2 µm diam., unswollen, branching 2-3 times near apex, extending 20-30 µm beyond asci. Asci

95-130(-150) x 6-8 µm, cylindric, tapering to rounded apex, wall not thickened at apex, 8-spored. Ascospores 75-100 x 1.5-2 µm, tapering slightly to both ends, 0-1 septate, surrounded by a narrow gelatinous sheath.

CHARACTERISTICS IN CULTURE: Ascospores from seven collections germinated on agar within 2-4 days. The appearance in culture was variable. In most isolates on oatmeal agar, colonies were 50-70 mm diam. after 3 weeks, aerial mycelium was cottony, white to pale grey, agar surface was not discoloured. Black-walled, more or less globose bodies developed near centre of colonies, mostly remaining sterile but in one collection (PDD 43259) containing immature asci.

In isolates from two collections (PDD 43038 and PDD 43036) aerial mycelium was sparse, white, stringy, agar surface was brown to vinaceous-brown, with globose, black-walled pycnidia with yellowish conidial ooze present on agar surface. Pycnidia were up to 250 µm diam., walls up to 30 µm wide, pseudoparenchymatous, outermost 2-3 layers of cells with dark brown, thickened walls, otherwise of thin-walled, hyaline cells. Conidiogenous

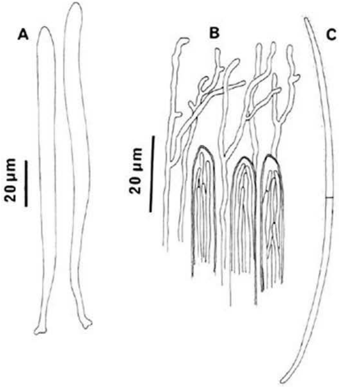

Fig 2 *Lophodermium multimatricum* (PDD 46125). A. Asci. B. Apex of asci and paraphyses. C. Released ascospore.

layer lined whole of the single, convoluted locule. Conidiogenous cells 10-22 x 2.5-4 µm, discrete, more or less flask-shaped, sympodial, often with two conidia held at apex. Conidia 3-7 x 0.8-1.2 µm, cylindric with rounded ends, nonseptate, hyaline.

HABITAT: Fallen leaves of *Beilschmiedia tawa*, *Cordyline* spp., *Clusia* sp., *Dendrobium* sp., *Dracophyllum pyrimidale*, *Elaeocarpus hookerianus*, *Freycinetia baueriana* ssp. *banksii*, *Gahnia* sp., *Gaultheria* spp., *Hoheria* sp., *Knightia excelsa*, *Leptospermum* sp., *Metrosideros fulgens*, *Nestegis lanceolata*, *Nothofagus dombeyi*, *N. fusca*, *N. menziesii*, *N. truncata*, *Phormium* sp., *Pseudopanax* spp., *Rhopalostylis sapida*, *Ripogonum scandens*, *Rubus cissoides*, *Weinmannia racemosa*.

DISTRIBUTION: All parts of New Zealand, also from Chile, Venezuela.

SPECIMENS EXAMINED: Over 60 collections have been examined including: New Zealand, BULLER, E. of Murchison, between 6-Mile and Matakitaki, on *Pseudopanax* sp., coll. Johnston (R190) et al., 16 Apr 1983 (PDD 43972). NELSON, Lake Rotoiti, on *Pseudopanax* sp., coll. Johnston (R43), 13 May 1982 (PDD 43246). WAIKATO, vic. Waitomo, on *Beilschmiedia tawa*, coll. Kendrick (KNZ167), 14 Jan 1974 (PDD 40553). TAUPO, Kaimanawa State Forest Park, Cascade Hut Tr., on *Nothofagus menziesii*, coll. Johnston (R428) & McKenzie, 26 Mar 1984 (PDD 46125).
South America, CHILE, Valdivia, on *Nothofagus dombeyi*, coll. Butin, 22 Sep 1968 (ZT - as *L. hysterioides*). VENEZUELA, border Dpto. Federal and Edo. Miranda, La Silla, on *Clusia* sp., coll. Dumont (VE-106) et al., 18 Jun 1971 (NY - filed under *Propolis emarginata*, which is also present on this collection).

NOTES: Two features distinguish *L. multimatricum* from other *Lophodermium* species found in New Zealand:

1. a layer of cylindrical cells arranged in vertical rows between the wall layers and the hymenium; and
2. ascomata which lack lip cells but which at maturity have a black, flattened area adjacent to both sides of the ascocarp opening. In vertical section this flattened area is seen as a distinct, narrow extension to the upper wall, stretching across the top of the hymenium.

Several other *Lophodermium* species, described from other parts of the world on various angiosperm hosts, also have these two distinctive features (see below). *L. multimatricum* is distinguished from these species by the shape of the paraphysis apex, by the width and shape of the ascus apex, and by the presence or absence of anamorph pycnidia.

Pattern of ascocarp development in *Lophodermium multimatricum*

Both mature and immature ascomata are found at all times of the year, and all stages of ascocarp development may be present in individual collections. The less mature ascocarps are near the edge of the usually discrete groups of ascocarps.

Ascocarps are first visible macroscopically as small round to elliptic, greyish areas. In vertical section they consist of a series of vertically oriented rows of hyaline, thin-walled, cylindrical cells embedded beneath the host epidermis. The bottom cell of each row is pale brown and its outermost wall is slightly thickened (Fig 3).

A horizontal split develops across some of these rows of vertically arranged cells (arrowed in Fig 3). A layer of "true" paraphyses (i.e. growing upwards from the base of the locule and never attached at their apices) arise from disorganised, hyphal cells which develop near the base of the cavity formed by this split. The remains of the broken rows of vertically oriented cells can be seen above and below the developing paraphyses, and unbroken rows of these cells are present to both sides of the space into which the paraphyses are growing (Fig 4). With further development the ascocarp becomes wider and deeper as the unbroken rows of vertically oriented cells grow longer. At this stage the lowermost cells of the vertical rows become darker brown and thicker walled and start to differentiate into a distinct lower ascocarp wall. A few dark brown, thick walled fungal cells are now present within the previously empty epidermal cells of the host (Fig 4), and as the paraphyses continue to lengthen these cells almost fill the epidermal cells, so forming a differentiated upper wall layer. Two or three of the epidermal cells near the centre of the ascocarp remain empty (Fig 5). At this stage, in surface view, the ascocarps appear macroscopically as two separate blackened areas. The paraphyses now become closely septate in their lower half, and hyphal bridges develop between adjacent paraphyses (Fig 5).

The ascocarp starts to open with the breakdown of epidermal cells which do not contain the dark brown fungal cells of the upper ascocarp wall. Simultaneously the

Figs 3-7 *Lophodermium multimatricum* (PDD 46125). Vertical median transverse sections of ascocarps at different stages of development. All at same scale. See text pp. 388-390 for details.

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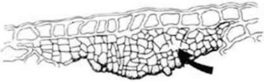

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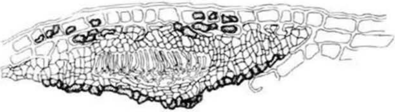

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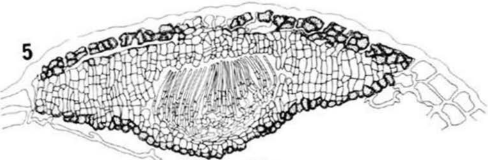

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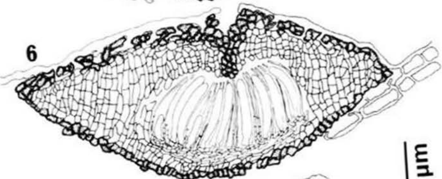

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upper wall becomes more extensive near the centre of the ascocarp, developing a narrow group of dark brown cells which extend at right angles to the rest of the wall, down through the remains of the vertical rows of hyaline cells which are still present above the hymenium (Fig 6). Asci start to develop at this stage. The exact site of ascus development was not observed.

As ascospores develop, the hymenium expands and the top of the ascocarp is raised above the level of the surrounding leaf tissue. The upper ascocarp wall becomes almost vertical in orientation, with the top of the hymenium covered by the narrow extension to the upper wall which first develops as the ascocarp starts to break open (Fig 7). By this time the extension is very dark without a distinct cellular structure. The hyaline, vertically oriented cells which surrounded the developing hymenium are still present, although, except at the outer edge of the base of the ascocarp, they are crushed and misshapen because of the pressure exerted by the developing hymenium.

When wet the hymenium further expands and the sides of the ascocarp are forced apart so that the top of the hymenium is exposed. When dry the hymenium is completely enclosed, covered by the narrow extensions to the upper wall which developed adjacent to the ascocarp opening. It is the development of these extensions to the upper wall which give the ascocarps their characteristic macroscopic appearance.

Other *Lophodermium* species with the same pattern of ascocarp development as described for *L. multimatricum*.

This list has been compiled following examination of the specimens and/or illustrations cited. It is probable that other *Lophodermium* species also belong in this group.

L. aleuritis Rehm (Philippines, Los Baños, on dead leaves, coll. S. A. Reyes, 27 May 1914 - S; C. F. Baker Fungi Malayana #154 - S).
L. breve (Berkeley) de Notaris (Campbell Is., on *Uncinia hookeri* - Holotype, K).
L. camelliicola Minter (India, Assam, on *Camellia sinesii*, coll. Tunstall, 9 Aug 1922 - Holotype, IMI 23122). Illustration, Cannon & Minter 1986, page 59.
L. dracaenae Phillips & Harkness (USA, California, May 1881, Harkness collection of fungi #2514 - Holotype, BPI).
L. "hawaiense" Petrak (Hawaii, Pogues Ditch Trail, on *Polypodium* sp., coll. Shear, 30 Dec 1927 - Type, W).
L. hederae Dennis & Spooner (Azores, Sao Miguel, Ponta Delgada, on *Hedera* sp., 21 Mar 1975 - Holotype, K).
L. hedericola Ahmad (Pakistan, Ghora Gali, on *Hedera nepalensis*, coll. Ahmad, 14 Apr 1962 - Holotype, IMI 292063). Illustration, Cannon & Minter 1986, page 71.

L. javanicum Penzig & Saccardo (Java, Tjibodas, on *Elettaria* sp., coll. O. Penzig, 1897 - ? Type, W).

L. mangiferae Koorders. Type material not examined but several collections identified as this species in IMI (IMI 297389 on *Hydnocarpus*, Malaysia; IMI 207753 on *Mangifera*, India; IMI 956459 on *Mangifera*, Guinea; IMI 285291 on *Spatholobus*, India) fit into this group. Not all IMI collections labelled as *L. mangiferae* belong in this group. Illustration, Cannon & Minter 1986, page 73.

L. passiflorae Rehm (Philippines, Los Baños, on *Passiflora quadrangularis*, coll. C. F. Baker #406, Dec 1912 - ? Holotype, S; Philippines, Los Baños, on *P. quadrangularis*, coll. C. F. Baker, 5 Sep 1913 - S).

L. planchoniae Rehm (Philippines, Los Baños, on *Planchonia spectabilis*, coll. C. F. Baker #3080, 4 Apr 1914 - S; C. F. Baker Fungi Malayana #156 - S, W).

L. reyesianum Rehm (Philippines, Los Baños, on fallen leaves, coll. S. A. Reyes, 15 Aug 1913 - S).

L. rotundatum Sydow (Philippines, Prov. Laguna, near Los Baños, Mt. Maquiling, on *Dillenia* sp., coll. C. F. Baker, Dec 1913, Fungi Malayana #39 - Type, W; also present on same leaves as *L. reyesianum* in collection cited above - S).

L. smilacinum Petrak (USA, Hawaii, Olinda Pipe Line, on *Smilax* sp., Shear & Stevens, 29 Dec 1928 - Holotype, W).

Lophodermium **sp.** (Chile, Valdivia, on *Gevuina avellana*, coll. Butin, 22 Sept 1968 - ZT, as *L. hysterioides*).

Lophodermium **sp.** (USA, California, Humboldt Co., coll Parks (4650), 6 Feb 1931 - IMI 23082, as *L. exaridium*).

Lophodermium **sp.** (USA, Hawaii, Oahu, on *Metrosideros* sp., coll. Loring (2853), 11 May 1947 - BPI).

Lophodermium **sp.** on various hosts from South America, (numerous collections examined including, Venezuela, Edo. Aragua, Parq. Nac. Henry Pettier, Maracay-Choroni Rd., on *Clusia* sp., coll. Dumont (CO-5961) et al, 12 Jun 1971 - NY. Nova Granata, 186m, Herb. Lindig 2891, Herb. J.J.Triana (1829-1890), on *Clusia* sp. - K, as *L. hysterioides*. There are two other *Lophodermium* species also present on this collection).

Clithris pandani Tehon. Illustration, Tehon 1918, plate IX, fig 6.

DISCUSSION

The ascocarp primordium of *L.multimatricum* is similar to that described by Gordon (1968) for *L. nitens*, with both consisting of a series of vertically oriented rows of cylindrical cells. However, the pattern of development described by Gordon (1968) differs from that of *L. multimatricum* in two respects. In *L. nitens* at an early stage of development the vertically arranged cells became dark brown, and the vertical arrangement was lost before the ascocarps matured. Morgan-Jones & Hulton (1977) examined other collections of *L. nitens*, disagreed with Gordon's interpretation, and found the pattern of development to be the same as that previously described for other *Lophodermium* species. They claimed the vertically arranged cells illustrated by Gordon (1968) were an artifact caused by sectioning close to the edges of the ascocarps. Assuming that the collections examined in these two studies represent the same species, then Gordon's observations must be considered suspect, although Gordon included collections with subepidermal as well as subcuticular ascocarps in his concept of *L. nitens*. Darker (1932) in the original description of this species, and Minter (1981), both described *L. nitens* as having subcuticular ascocarps, and regarded this feature as diagnostically useful. It is possible that Gordon's material represented another *Lophodermium* species. Whatever the case, the ascocarp primordium consisting of vertical rows of cylindrical cells described in this study for *L. multimatricum* is not an artifact caused by the position at which the vertical sections were cut, the same structure is seen in serial sections down the entire length of an ascoma. It remains uncertain if any *Lophodermium* species on Pinaceae have this kind of ascocarp development.

Most non-coniferous *Lophodermium* species examined, including *L. arundinaceum* (Schrader)Chevallier, the type species of *Lophodermium*, have an ascocarp primordium comprising plectenchymous tissue as previously described for *Lophodermium* by Morgan-Jones & Hulton (1977, 1979) and others (unpublished observations). However, the species listed above in the results section form a distinctive and easily recognisable second group, with a primordium comprising rows of vertically oriented, cylindrical cells. *Lophodermium* as at present circumscribed includes any member of the Rhytismataceae with filiform ascospores, and an ascocarp opening by a single longitudinal slit. The group of species sharing these two characters is large and heterogeneous. The heterogeneous nature of *Lophodermium* has long been recognised (e.g. Darker 1932, Tehon 1935). However the only attempt to reorganise *Lophodermium* (Tehon 1935) was rejected by later authors (e.g. Terrier 1942, Darker 1967, Cannon & Minter 1986) in spite of these authors acknowledging the unsatisfactory nature of the genus.

The Rhytismataceae vary considerably in the way the sterile ascocarp tissues develop, in the way the ascocarp opening develops, and in the development and nature of the structures which line the openings of mature ascocarps (unpublished observations). These characters may be useful in redefining generic limits within the Rhytismataceae. The developmental characters shared by *L. multimatricum* and the other *Lophodermium* species listed, could usefully and conveniently be used to segregate out these taxa from *Lophodermium* into a new, clearly definable genus. The feature of having a layer of tissue comprising vertically oriented cells between the ascocarp wall and the developing hymenium is seen at all stages of ascocarp maturity. The macroscopic characteristic of a black, flattened area adjacent to the ascocarp opening means that this group can also be distinguished in the field.

Many of the species in this group also have a second distinctive, macroscopic character. In surface view the immature ascocarps appear as two parallel dark patches separated by a paler zone (Fig 1A). This feature was noted by Cannon & Minter (1986) for *L. mangiferae*, and is seen in most collections of *L. multimatricum*, however, its presence is variable, and in some species is not seen at all. Some other species, which do not have the mode of ascocarp development characteristic of this group, for example *Lophodermium agathidis* Minter & Hettige, may also have a well developed paler zone down the centre of immature ascomata. Thus, this feature, although distinctive, must be used with caution.

The segregation of the present group from *Lophodermium* s.l., although not formally proposed here, would be a start to the long overdue rearrangement of this heterogeneous genus. Before doing this there is a need for a monographic revision of all species which possess the developmental characters discussed here.

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PLASMOPARA LACTUCAE-RADICIS, A NEW SPECIES ON ROOTS OF HYDROPONICALLY GROWN LETTUCE [1]

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SUMMARY

Plasmopara lactucae-radicis is described as a new species of downy mildew from roots of hydroponically grown *Lactuca sativa* L. in Virginia. It differs from *P. helianthi* Novotelnova f. *helianthi*, the only other downy mildew known to sporulate on roots, in having shorter sporangiophores that lack a swollen base, non-verticillate ultimate branches, and unipapillate sporangia. *Plasmopara lactucae-radicis* has been found only on roots.

In August, 1987, lettuce plants (*Lactuca sativa* L. cv. Ostinata and Salina) exhibiting root-rot symptoms were obtained from a commercial greenhouse in Rapidan, Virginia. Microscopic examination revealed the presence of a downy mildew-like fungus on the roots. Profuse aerial development of sporangia occurred on the roots, but not on leaves, following incubation in humidity chambers. Oospores were also observed in decayed root tissues. An "on site" visit of the greenhouse in September, 1987 by the senior author revealed that the fungus was sporulating on roots of lettuce plants of all ages and was uniformly distributed throughout the 2.4 ha facility which employs the nutrient film technique of cultivation. Repeated attempts to isolate the fungus on agar medium were not successful. Since the morphological characteristics of this fungus, in addition to its occurrence on roots of cultivated lettuce, could not be matched or found in a survey of the literature, it is here described as a new species. Details on the ecology and pathology of the fungus will be published elsewhere.

PLASMOPARA LACTUCAE-RADICIS Stanghellini and Gilbertson, sp. nov.

Sporangiophoris in radices, hyalinis, singulis vel fasciculatis, a vesiculus exorientibus, 5-10 µm late, 150-520 µm altitudinae; 3-5 pinnatis; ramos ultimis fusoideus, rectis ad flexis, 10-40 µm longis; sporangia ovata vel ellipsoidea, unipapillatae, crassitunicatae, 40-91 x 29-52 µm, germinationis a zoosporis; zoosporis 40-160 per sporangium, circa 10-12 µm in diam; sporangiophoris secundarius saepe exorientibus ramos ultimis; oosporis apleroticus, crassitunicatae, laeves, 28-32 µm in diam. Hab. in radices *Lactucae sativae*, Rapidan, Virginia; Holotypus: AZ 16100, in herb. National Fungus Collections, Beltsville, Maryland.

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[1] Univ. of Ariz. Agricultural Exp. Station Journal Paper 4442.

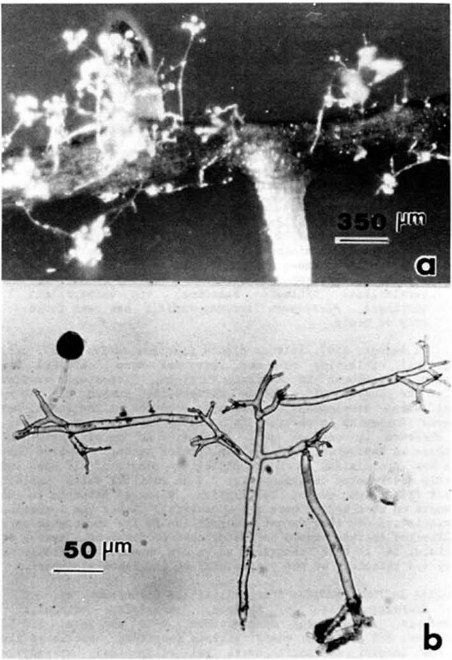

Fig. 1. *Plasmopara lactucae-radicis*. a, sporangiophores and sporangia on root; b, sporangiophore showing development of secondary sporangiophores from sterigmata.

Sporangiophores hyaline, developing on roots, singly or in clusters, arising from swollen vesicles in host tissue; main axis of sporangiophore 5-10 µm in diam, 150-520 µm in height, monopodially branched with 3-5 primary branches; primary branches 5-10 µm in diam,

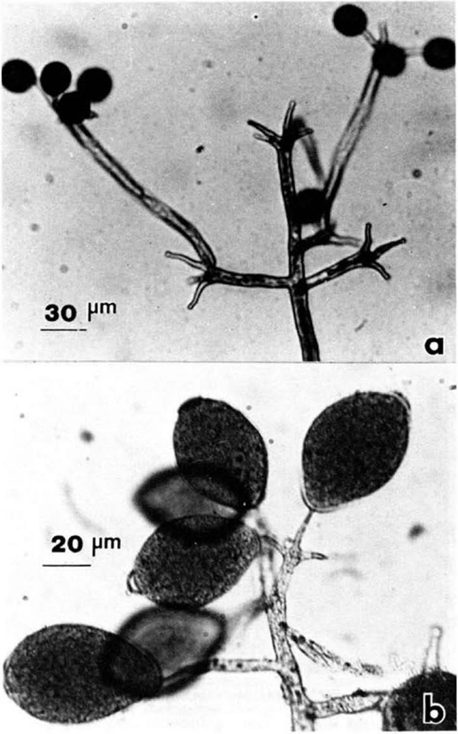

Fig. 2. *Plasmopara lactucae-radicis*. a, sterigmata on primary sporangiophore and development of secondary sporangiophores from sterigmata; b, sporangia showing single apical papilla.

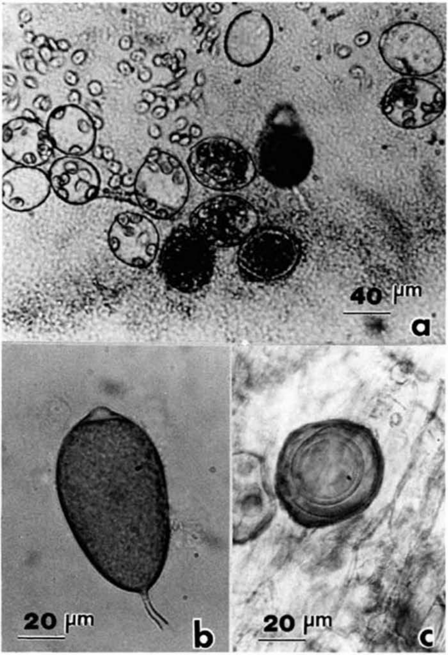

Fig. 3. *Plasmopara lactucae-radicis.* a, sporangia liberating zoospores; b, sporangium showing apical papilla and basal septum; c, oogonium and oospore in root tissue.

arising at acute to right angles, secondary branches 3-5, not verticillate, arising at acute to right angles, producing sporangia or sporangium producing tertiary branches, ultimate sporangium producing

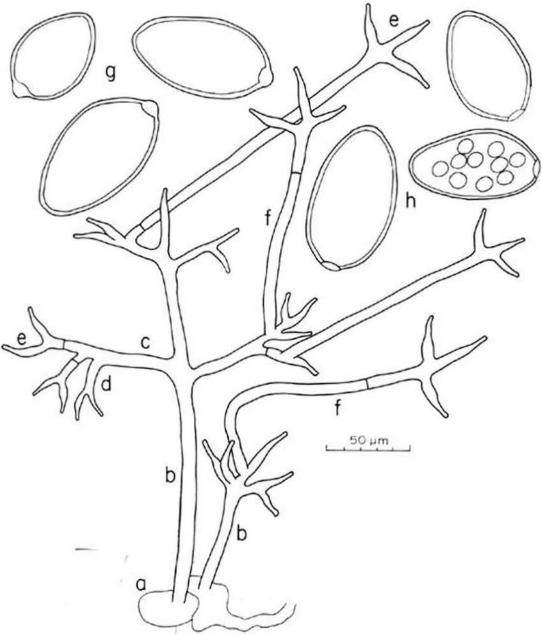

Fig. 4. *Plasmopara lactucae-radicis.* a, vesicular hyphal structures imbedded in root tissue; b, primary sporangiophores arising from vesicles; c, primary branches; d, secondary branches; e, ultimate branches (sterigmata); f, secondary sporangiophores arising from sterigmata; g, sporangia showing apical papillae; h, sporangia after zoospore discharge showing apical pore.

branches or sterigmata tapered to the tip, occasionally septate near the base, 4-6 µm in diam at the base, 1-3 µm in diam at the tip, 10-40 µm long, straight or curved, truncate at the tip, some giving rise to long, straight, stout secondary sporangiophores 100-220 µm long and 6-9 µm in diam that produce branches and sporangia as do the primary sporangiophores; sporangia cut off by a septum below the base of the sporangium, hyaline, ovate to ellipsoid, with a single apical papilla, 40-91 x 29-52 µm (mean 70 x 45 µm), wall up to 2 µm thick, germinating by dissolution of the apical papilla and release of zoospores; zoospores approximately 40-160 per sporangium, about 10-12 µm in length, leaving the sporangium singly or in a compact mass and separating after exiting; encysting to form spherical microcysts about 10 µm in diam; oogonia developing in cortical tissue of host roots, irregularly ellipsoid, 45-50 µm in diam; oospores aplerotic, 28-32 µm in diam, spherical, smooth-walled at maturity, wall 2.5-3 µm thick, germination not observed; sporangia on roots placed on water agar occasionally observed to germinate directly by germ tube, those in water observed to germinate by zoospores only.

The only downy mildew previously known to produce sporangiophores on roots of its host is *Plasmopara helianthi* f. *helianthi* (Nishimura 1926; Novotelnova 1966; Spencer 1981). According to Novotelnova (1966) and Zimmer (1974) this fungus is restricted to annual sunflower (*Helianthus annuus* L.). *Plasmopara halstedii*, a species with a wide host range in the Compositae, has been reported on wild lettuce (*Lactuca canadensis* L.) in Maryland (Anonymous 1960). However, no specimens of *P. halstedii* on wild lettuce could be found, and this record could not be confirmed. Additionally, no reports of any downy mildews sporulating on roots of lettuce were found in the literature.

Plasmopara lactucae-radicis is morphologically similar to *P. helianthi* f. *helianthi* on annual sunflower roots in size of sporangia and in proliferation of terminal branches to produce secondary sporangiophores. However, *P. lactucae-radicis* is clearly distinguished from *P. helianthi* f. *helianthi* by the absence of a swollen base on its sporangiophores, its non-verticillate branching habit, and its strictly unipapillate sporangia. In addition to these morphological distinctions, *P. lactucae-radicis* sporulates only on roots of cultivated lettuce whereas *P. helianthi* f. *helianthi* sporulates on leaves as well as on roots of annual sunflower.

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TAXONOMICAL STUDIES ON USTILAGINALES. I.

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ABSTRACT

The name *Ustilago turcomanica* Tranzschel (on *Eremopyrum* spp.) is validated. The following new combinations are proposed: *Sporisorium consanguineum* (Ell. & Ev.) Vánky, based on *Sorosporium consanguineum* (on *Aristida* spp.), and *Sporisorium bursum* (Berk.) Vánky, based on *Ustilago bursa* (on *Anthistiria arundinacea*). The following names are considered synonyms: *Doassansia borealis* Liro, and *D. alpina* Lavrov (both on *Sagittaria natans*) are synonyms of *D. sagittariae* (Fuck.) C. Fisch. *Entyloma schweinfurthii* P. Henn. (on *Polypogon monspeliensis*) is *E. dactylidis* (Pass.) Cif. *Thecaphora orobi* Ziling (type on *Orobus luteus*) is identical with *Thecaphora deformans* Dur. & Mont. ex L.-R. & C. Tul. *Tilletia transiliensis* Kuzn. & Schwarz. and *T. sabaudae* Zogg (both on *Poa nemoralis*) are synonyms of *T. paradoxa* Jacz. *Ustilago grossheimii* Ul'yan. (neotype on *Zerna gussonei*) is *U. bullata* Berk. *Ustilago jaczevskyana* Lavrov var. *sibirica* Lavrov (syntype on *Hierochloa odorata*) is *U. striiformis* (Westend.) Niessl. *Ustilago michnoana* Lavrov (syntype on *Elymus dasystachys*) is *U. serpens* (Karst.) B. Lindeb. *Ustilago sinkiangensis* Wang (type on *Polygonum* sp.) is a synonym of *U. piperii* G.P. Clint. *Ustilago kazachstanica* Gutner & Sergeeva (type on *Aneurolepidium angustum*) is *U. trebouxii* H. & P. Sydow. *Lygeum spartum* is parasitised at least by two species of *Ustilago*: on the stems by the plurivorous *U. hypodytes* (Schlecht.) Fries, and in the inflorescence by *U. sparti* Massenot. The name *Ustilago lygei* (nom. nud.) refers to *U. hypodytes*. *Entyloma echinopsis* Schwarzman (on *Echinops sphaerocephalus*) is excluded from the Ustilaginales since it is a bacteriosis. Lectotypes are selected for *Doassansia alpina* and *Ustilago jaczevskyana* var. *sibirica*, and neotype for *Ustilago grossheimii*.

In the course of my studies of smut fungi (Ustilaginales) from Europe and elsewhere, I have seen a great number of types and other specimens. Many interesting facts came to light. Several taxonomical and nomenclatorial problems appeared. I have found inexactnesses, nomina nuda and contradictions in the literature. I have also confirmed earlier assumptions. Some specimens showed to be undescribed species. The study of some types revealed that they are in fact not smut fungi. Others turned out to be nomenclatorial or taxonomic synonyms. I have selected some of these problems to present in a series of papers.

To elucidate the taxonomical position of the three known *Doassansia* species on *Sagittaria* spp. in Europe and Siberia, I studied the types of *D. sagittariae* (Fuckel) C. Fisch (including the type of *Protomyces bizzozerianus* Saccardo, 1876, in Sacc. Mycoth. Veneta 889), *D. borealis* Liro, and *D. alpina* Lavrov. I compared the spore ball structure and the measurements of the spores and sterile cells. These studies revealed no essential differences, except for a rather great variability in the form and size of the cortical sterile cells. The characteristics of the cortical cells served for the description of D. borealis. In some of the spore balls of D. borealis and D. alpina, the sterile cells are smaller and longer than those in D. sagittariae. These may vary not only from one specimen to another, but also from spore ball to spore ball within the same sorus and, moreover, within the same spore ball, measuring between 15–25 µm in length. Other spore balls of these species do not differ in any way. In spite of the rather large variability in the form and size of the sterile cells, I consider these species conspecific as follows: Doassansia sagittariae (Fuckel) C. Fisch – Physoderma sagittariae Fuckel, 1865. Type on Sagittaria sagittifolia L., Germany "bei Hattenheim im Altrhein", automn, L. Fuckel, in Fuckel, Fgi. rhenani exs. 1549, 1865 (HUV 514!). – Doassansia borealis Liro, 1934. Type on Sagittaria natans Pallas, Finland, Savonia bor., Kuopio, 10.VIII.1933, M.J. Kotilainen, in Mycoth. fenn. 210, 1934 (HUV 474!). – Doassansia alpina Lavrov, 1937:4. Type on Sagittaria natans, USSR, Siberia, (sel. here) Yakutskaya ASSR, Verhoyanskij reg., lake Myuryu between Yakutsk and Aldan river, 20.VIII.1925, K. Benua (LEP!).

Entyloma schweinfurthii P. Hennings, 1902:(210), has been described from Egypt on Polypogon monspeliensis (L.) Desf. (Gramineae). Several authors mistakenly reported it from Polygonum monspeliense Guss. (Polygonaceae). The description of this fungus agrees with the plurivorous, graminicolous Entyloma dactylidis (Passerini) Ciferri, with characteristic small, lead-coloured sori and dark, smooth spores. Consequently, I consider E. schweinfurthii a synonym of E. dactylidis. I have not seen its type, but I have seen two specimens on Polypogon monspeliensis, under the name of "Tolyposporella semenoviana" Lavrov (including the type), which are also typical E. dactylidis (Vánky, 1985:61).

Sorosporium consanguineum Ellis & Everhart, in ovaries of different species of Aristida (Gramineae), forms at first persistent, later decomposing spore balls. I propose to transfer it into the genus Sporisorium as Sporisorium consanguineum (Ellis & Everhart) Vánky, comb. nov. Basionym: Sorosporium consanguineum Ellis & Everhart, Journal of Mycology 3:56, 1887. Type on Aristida rusbyi Scribner (= A. arizonica Vasey), USA, N. Arizona, coll. Rusby. Germination of the spores originating recently from Australia, resulted in long, septate promycelia giving rise laterally and terminally to basidiospores (A. Nagler, pers. comm.).

The study of the type of Thecaphora orobi Ziling, in Murashkinskij & Ziling, 1927:25, on Orobus luteus L. (= Lathyrus gmelini Fritsch), Asia, N. Altai, Chamir valley, near Kozlushka, 16.VIII.1926, M.K. Ziling (LEP!) confirmed my earlier conclusion (Vánky 1985:124), based only on the description of this species, that it is a synonym of Thecaphora deformans Durieu & Montagne ex L.-R. & C. Tulasne.

There is a group of Tilletia species which has unusual large spores and a very characteristic ornamentation. These species are: T. paradoxa Jaczewski, Tilletia transiliensis Kuznetzova & Schwarzman, and T. sabaudiae Zogg. The spores are globose or subglobose and measure 37–52 x 37–58 µm. In LM the surface of the spores are obscurely reticulate with 6–10 meshes per spore diameter and finely verruculose muri; in median view a 4–6 µm wide corona surrounds the spores with erect ridges or ridges curved in one direction (optical phenomenon?). In SEM the surface of the spores appear densely and narrowly tuberculate. Sterile cells between the spores are smaller (10–30 µm long), hyaline, with a 3–7 µm thick, smooth wall. A study of the types of these species did not reveal any essential differences. Their taxonomical position is considered as follows: T. paradoxa

Jaczewski, 1926:169, type on Phleum sp., USSR, Transcaucasia, between Ipchreuli and Dioban, 19.VIII.1910, H. Popov (AA!, originating from Tiflis). – Syn. Tilletia transiliensis Kuznetzova & Schwarzman, in Schwarzman, 1960:240, type on Poa nemoralis L., USSR, Kazakhstan, reg. Alma-Ata, Mt. Zilinskij Alatau, in valley Kazachki, 8.X.1957, S.R. Schwarzman (AA!), – T. sabaudiae Zogg, 1983:91, type on Poa nemoralis L., Frace, "in Alpibus Sabaudiae" (= prov. Savoie), 1851, J. Müller-Argoviensis (NEU!).

A specimen in Alma Ata (AA!), labelled as T. poae Nagornyj, collected by Nagornyj in or near the type locality of this species but one year later, contains typical T. paradoxa. T. poae is, however, a quite different species, having inter alia spores of 30–35 µm in diameter. An additional specimen, seen by me, collected on Poa nemoralis in France, reg. Alpes-Maritimes, near the village St. Martin-Vésubie, Mt. Argentera, "Madone de Fenestre", 2200 m, 25.VII.1965 (GZU!) belongs also to T. paradoxa.

The type of Ustilago bursa Berkeley, in scattered ovaries of Anthistiria arundinacea shows the characters of the genus Sporisorium. Sori in ovaries, surrounded by a peridium, the spores are formed in many-spored balls (40–100 µm long) which are easily decomposed in spores (7–10 x 8–11 µm). I propose to transfer it into this genus as Sporisorium bursum (Berkeley) Vánky, comb. nov. Basionym: Ustilago bursa Berkeley, in Hooker's J. Bot. Kew Gard. Misc. 6:206, 1854. Type on Anthistiria arundinacea Roxb. (= Themeda gigantea (Cav.) Hock var. arundinacea (Retz.) Hock), India, Sikkim (Herb. Berk. 4733, 1879; K!). – Syn. Sphacelotheca bursa (Berk.) Mundkur & Thirumalachar, 1946:6.

Ustilago grossheimii Ul'yanishchev, 1950:74, was described on Zerna gussonei Parl. (= Bromus rigidus L. subsp. gussonei (Parl.) Cout., = Bromus diandrus Roth) from USSR, Azerbajdzhan, peninsula Apsheron, near the village Pirshagi, not far from Baku, collected on 27.V.1938 by V.I. Ul'yanishchev. The holotype was lost by fire in the herbarium of Baku (BAK) c. 20 years ago (Prof. Ul'yanishchev, pers. comm.). However, I got a sample from Prof. Ul'yanishchev, collected on the same host, in the same locality some years earlier (on 21.VI.1936) which I propose for neotype. The study of the neotype, and of additional specimens collected by me in and around Baku recently, could not reveal any essential differences between this species and Ustilago bullata Berkeley. Consequently, U. grossheimii is considered a synonym of U. bullata.

The syntype of Ustilago michnoana Lavrov, 1936:17, on Elymus dasystachys Trin., USSR, Yakutskaya ASSR, lower reach of the Amga river, near the village Uryunchaj, 26.VII.1925, I. Benua (LEP!) is Ustilago serpens (Karsten) B. Lindeberg, similarly to the lectotype (Vánky 1985:234).

The type of Ustilago sinkiangensis Wang, 1962:134, with sori as anastomosing pustules on the leaves of a Polygonum sp., China, Sinkiang, Ta-cheng, Ha-mu-sze-tai, 26.VIII.1959, Liu Hen-ying (731; in "HMAS" 31560, Beijing, copy in HUV 7992!) is indistinguishable from Ustilago piperii G.P. Clinton, 1904:382, presenting 6–11 µm long, pale brownish-violet spores with the typical spore surface ornamentation resembling fingerprint markings. Consequently, U. sinkiangensis is considered a synonym of U. piperii, alike to Sphacelotheca polygoni-alpini P. Cruchet, 1908:247 (Vánky 1985:228).

Ustilago turcomanica was named and distributed by W. Tranzschel, apparently without any description. This smut is somewhat similar to U. bullata but differs from it by larger spores and by the characteristics of the spore germination.

Ustilago turcomanica Tranzschel ex Vánky sp. nov. – Ustilago turcomanica Tranzschel, in Tranzschel & Serebrianikow, Mycotheca rossica 302, 1912 (nomen nudum). – Typus in matrice Triticum squarrosum Roth. (= Eremopyrum bounapartis (Spreng.) Nevsky), USSR, Turkmenya, Austro-Occid. versus ad Komsomol'sk (Chardzhou), pr. pag. Repetek, 4.V.1911, leg. Androssow, in Tranzschel & Sereb., Mycoth. ross. 302 (Holotypus in herbario HUV 4892!, isotypi in Tranzschel & Sereb., Mycoth. ross. 302).

Sori tumefacti, in ovariis ad basim palearum et glumarum formati, cooperti per membranam tenuem, in statu lacerato multitudinem sporarum atrobrunneam, semi-pulverulentam exponentem. Sporae globosae, subglobosae, ellipsoideae usque parum irregulares, episporio 1–1,5 µm crasso, fere leves usque plerumque dense et leniter verrucosae, 9–11 x 9,5–14(–15) µm, mediocriter olivaceo-brunneae, in polis parum pallidiores. Germinatio: promycelium 2- vel 3-septatum, plerumque a basi 2–4-ramosum, e quo in aqua mycelium, in mediis nutrientibus basidiosporae laterales et terminales.

Sori as in Ustilago bullata Berkeley. The spores measure 9–11 x 9.5–14(–15) µm. Germination (Brefeld 1895:114; Fischer & Meiners 1952:209) by a 2–3-septate, usually from the base 2–4-branched promycelium, in water giving rise to mycelium, in nutrient media developing lateral and terminal basidiospores. In nature, U. turcomanica seems to be confined to Eremopyrum species, but it may artificially infect even Elymus s. lat. species (Fischer & Meiners 1952:208). It is known from E. Europe, Asia and North America (USA, probably introduced from Asia).

A study of the types of Ustilago trebouxii and U. kazachstanica revealed that they are conspecific. Consequently the correct name of this fungus should be Ustilago trebouxii H. & P. Sydow, 1912:214, type on Triticum cristatum (L.) Schreber (= Agropyron cristatum (L.) Gaertner, USSR, Novotscherkassk, 17.IV.1911, O. Treboux (LE!). – Syn. Ustilago kazachstanica Gutner & Sergeeva, 1941:75 (n.v.), type on Aneurolepidium angustum (Trin.) Nevski (= Leymus karelinii (Turcz.) Tzvelev, USSR, Kazakhstan, Dzhezkazgan raion, 15 km from Dzhezkazgan to Karabulak, 26.VII.1936, K.S. Sergeeva (AA!, LE!, HUV 12136!); on Elymus giganteus Vahl (= Leymus racemosus (Lam.) Tzvelov), USSR, Kazakhstan, Akmolinskij rajon, between the lakes Bozgum and Karakul, 18.VI.1913, V.F. Semenov (LEP!).

I found one of the syntypes of Ustilago jaczevskyana Lavrov var. sibirica Lavrov in Leningrad–Pushkin (LEP), namely that on Hierochloe odorata (L.) Beauv, from USSR, Far East, distr. Vladivostok, near the river Lyanchin, 29.VII.1927, I.N. Abramov (lectotype, sel. here). This variety belongs to Ustilago striiformis (Westendorp) Niessl, as does the main variety (Vánky 1985:238) on the same host plant. The differences in the spore measurements lie within the range of the normal variability of this species.

On Lygeum spartum L. (Gramineae) were reported four Ustilago species: 1) U. hypodytes (Schlecht.) Fries, 2) U. spegazzini Hirschh. var. agrestis (H. Sydow) Fischer & Holton, 3) U. lygei Rbh., and 4) U. sparti Massenot. Inter alia Angus (1956:118) and Vánky (1985:214-217) showed, that U. spegazzini and its var. agrestis are synonyms of U. hypodytes. "Ustilago lygey Rabenh." was distributed in the exsiccata "Un. itin. crypt. 1866. Dr Marcucci" under No. IV, without any description. Apparently Rabenhorst never compiled a description for this name. Moreover, in his exsiccata Fungi europaei No. 1800, in 1874, he distributed a similar smut fungus on this host plant under the name Ustilago hypodytes var. lygei. (One notices, that in Rabenhorst's usage the variety means a connection to a special host plant rather than a morphological deviation from the species). A study of "Rabenhorst's species" in Un. itin. crypt. 1866, No. IV (HUV 9301!), showed that it is typical U. hypodytes. This species develops its sori on the stems and rarely also on the floral axis of the more or less aborted inflorescence of different grasses belonging to a great number of genera. The spores measure 4–6(–7) µm in lenght. The sori of U. sparti are restricted only to the floral parts of Lygeum spartum, the spores are larger measuring 6.5–8 µm in lenght, usually with a lighter area. Consequently, the four species of Ustilago reported on Lygeum spartum belong to two species: the common U. hypodytes, and the more rare collected U. sparti.

EXCLUDED SPECIES

A study of the type of Entyloma echinopsis Schwarzman, 1960:288 (on Echinops sphaerocephalus L., USSR, Kazakhstan, Western Tyan'-Shan', at the Koksu river, 19.VII.1949, S.R. Schwarzman; AA!) did not reveal any spores of Entyloma type but rather abundant masses of bacteria (= bacteriosis) and spherical cells of host plant origin.

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TWO NEW POLYPORES FROM BURUNDI IN AFRICA

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SUMMARY

Oligoporus africanus Ryv. and **Perenniporia dendrohyphidia** Ryv. are described as new. The former is characterized by small, allantoid and amyloid spores, the latter by cystidioles, dendrohyphidia and skeletal hyphae, which are dextrinoid and become olivaceous green in KOH.

Dr. J. Rammeloo has in the recent years collected extensively in Central Africa and has over years sent me many polypores for identification. In a collection from Burundi there were two polypores which seem to be undescribed, both typified by rather remarkable characters. I would like here to express my thanks to Dr. J. Rammeloo for his generosity in sending specimens.

Oligoporus africanus Ryv. nov. sp.
Fructificatio sessilia; pileus glaber, ochraceus ad pallide brunneus, Pori facies labus ubi vivus, pallide brunneus ubi siccus, contextus albus, pori angulatis, 4-5 per mm, systema hypharum monomiticum, hyphae generatoriae fibulatae, sporae allantoidae, hyalinae, leviter amyloideae, 3.5-4.5 x 1-1.2 µm. Holotype Burundi, Muramyya, Teza, 20 Dec. 1978. Leg.J. Rammeloo 6155. (Herb. B, isotype in Herb. O).

Basidiocarp pileate, annual, spathulate to dimidiate, 5 x 3 cm, up to 8 mm thick at the base, fragile when dry, probably soft when fresh, upper surface glabrous, wrinkled and folded radially when dry, probably smooth when fresh; white at the margin, becoming darker towards the base, sordid pale brown and black with a distinct cartilaginous and very dense crust at the base; pore surface pale ochraceous to pale grey, pores angular, thin-walled, 4-5 per mm, more irregular of outline when dry, but entire and partly shrunken, tubes concolorous with pore surface, fragile, partly translucent and difficult to tear apart in microscopical preparations, up to 2 mm deep, context white and loose contrasting with the tubes, 2-6 mm thick.
Hyphal system monomitic, generative hyphae with clamps, hyaline, moderately branched, agglutinated in the trama, 2-4 µm wide, more irregular in the context with large clamps,

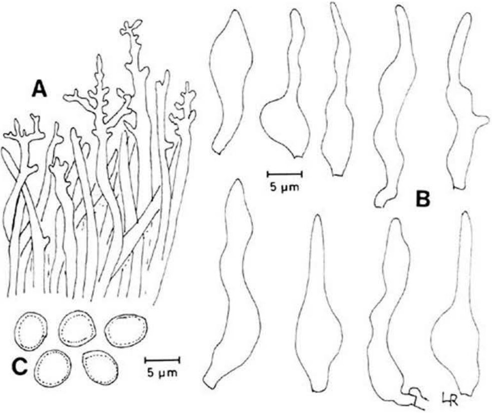

Fig. 1. **Perenniporia dendrohyphidia** a) Dendrohyphidia from the dissepiments, b) Cystidoles from the hymenium, c) Spores. From the holotype.

moderately branched, but also with some stout side-branches, 4-8 µm wide. Basidia clavate, 4-sterigmate, 8-10 x 4-5 µm, cystidia not seen, spores allantoid, smooth, hyaline and amyloid, 3.5-4.5 x 1-1.2 µm. From the substrate apparently associated with a brown rot of an angiosperm. This new species is related to the group of species around **O. caesius** (Fr.) Gilb. & Ryv., sharing the same type of basidiocarp, hyphal system and allantoid, slightly amyloid spores. However, **O. africanus** has much smaller spores than either **O. caesius** (Fr.) Gilb. & Ryv., **O. subcaesius** (David) Ryv. or **O. luteocaesius** (David) Ryv.For a description of the three latter species, see David (1980).

Perenniporia dendrohyphidia Ryv. nov. sp.
Fructificatio resupinata, pori ochracei, 6-7 per mm, contextus pallide griseus, systema hypharum dimiticum, hyphae generatoriae fibulatae, 2-3 µm in diametro, hyphae skeletales crassitunicatae, 2-5 µm in diametro, dextrinoideae, pallide olivaceus in KOH, cystidioles hyalinae, papillatae, 20-25 x 3-7 µm, dendrohyphidia ad marginem poris adsunt, sporae globosae, crassitunicatae, dextrinoideae, 5-6 µm in diametro.
Holotype: Burundi: T. Rutana, Mosso, Bekemba, 12. Jan.

1979. J. Rammeloo no. 6286, herb. B, isotype in herb. O. Basidiocarp resupinate, adnate, tough and hard, widely effused, up to 15 x 5 cm in the paratype and to 5 mm thick, pore surface wood-coloured to pale isabelline, margin absent to very narrow, pores round, 6-7 per mm, tubes concolorous, up to 5 mm deep, context cottony and fibrous, grey becoming darker towards the substrate, 1-2 mm thick. Hyphal system dimitic. Generative hyphae with clamps, hyaline, moderately branched, 2-4 µm wide, skeletal hyphae dominant, thick-walled, flexuous, moderately branched, towards the apex with a tendency to arboriform branching, dextrinoid, distinctly olivaceous in 3% KOH, especially in older parts of basidiocarp, the colour reaction is very distinct in hyphal masses, cystidioles present, hyaline, ventricose to clavate, with elongated neck, a few with a protuberance, 20-25 x 3-7 µm wide, arising from a clamp, basidia not seen with sterigmata, but bulbous organs, 6-12 µm in diameter may represent immature basidia, dendrohyphidia abundant along the pore-ridges, branched in the apex, hyaline and up to 55 µm long, arising from a clamp, spores globose, slightly thick-walled, dextrinoid and 5-6 µm in diameter.

This is a very remarkable species in **Perenniporia** to which it belongs owing to the dextrinoid skeletal hyphae and thick-walled, dextrinoid spores. The deviating and unique characters are the olivaceous reaction of the skeletal hyphae in KOH, the presence of dendrohyphidia in the pore mouths and the strange mammillate to bottle-shaped cystidioles. None of the three latter characters has so far been reported for the genus. The dendrohyphidia are not easy to observe as they collapse easily, apparently during the drying, and several sections have to be made to obtain a proper observation. An olivaceous reaction in the skeletal hyphae seems to be completely unknown in the Polyporaceae, but it is known from several species in **Collybia**. (Halling 1979, 1981)

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NOTES ON LACHNELLULA THEIODEA

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Peziza theiodea Cke. & Ell. was published based on an Ellis collection from New Jersey (Cooke & Ellis, 1878) and was later transferred to the genus *Lachnellula* by Saccardo (1889). Since then, the taxonomic situation of this interesting fungus has been discussed twice (Korf, 1962; Dennis, 1963), but the generic name has not been changed, even though both authors expressed doubt on the assignment of this species to *Lachnellula.*

Almost all known specimens collected in North America were examined carefully by Korf (1962), and the morphology of this species was described and illustrated in detail. He stated that "the ectal excipular layer of this discomycete is unlike that known to me in any other of the 'hairy inoperculate discomycetes,' and I suspect that the fungus may represent an as yet undescribed genus. ... The question of its placement in the classification on a natural basis remains doubtful." He indicated also that "For the time being, the fungus can be left to slumber in the genus *Lachnellula,* as natural classification of the Discomycetes progresses, it will surely need another generic name." (Korf, 1962). It is clear that Saccardo's transfer of the fungus to *Lachnellula* was based on the presence of granulate hairs and spherical ascospores. Little can be found in common in the anatomical structure of this discomycete and that of other *Lachnellula* species. The highly gelatinized, elongated, very thick-walled, interwoven excipular hyphae are not *Lachnellula*-like, and the shape of hairs is wrong for *Lachnellula.* This fungus is found associated with other fungi on decorticated wood of angiosperms while species of *Lachnellula* are typically found on the bark of conifers.

When Dennis studied the type specimen of this species, he noted "these are not the hairs of a typical *Lachnellula.* It may possibly be a *Pithyella*, but I have not studied the type species, *P. hypnorum* (Quél.) Boud., and prefer not to propose a transfer here" (Dennis, 1963). [He meant to write "*P. hypnina* (Quél.) Boud."] The type of the genus *Pithyella* has marked ascospores, smooth hyphal protrusions if any, and is moss-inhabiting (Korf & Zhuang, 1987). *Lachnellula theiodea* is neither a species of *Pithyella* nor of *Lachnellula.*

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neither a species of *Pithyella* nor of *Lachnellula*.

The specific epithet *theiodea* means sulphur-like and is a summary of part of the original description: "the sulphury powder which covers the cups is sprinkled over the matrix" (Cooke & Ellis, 1878). All the authors who studied this fungus were interested in the yellow powder covering the cups. I have seen it in some of the collections. They are crystals which dissolve in aqueous KOH and very possibly are secreted by the fungus.

When a photograph of the holotype of *Hyphodiscus gregarius* Kirschst., type species of the genus *Hyphodiscus* Kirschst. (1907), was found by me attached to a 1984 letter from Dr. Wolf-Rüdiger Arendholz to Prof. Korf came to my attention, the excipular structure and short, apically granulate hairs of this species attracted my interest. The photograph shows many characters of *Lachnellula theiodea*. The holotype of *H. gregarius* was therefore borrowed. My type examinations proved that *L. theiodea* and *H. gregarius* are synonyms. *Hyphodiscus* is the correct generic name for *L. theiodea*. The correct specific epithet for the fungus should be *theiodea*, and a transfer to *Hyphodiscus* is required.

Examination of type specimens also revealed that *Mollisiella austriaca* Höhnel is another later synonym of *Lachnellula theiodea* (Cke. & Ell.) Sacc. *Mollisiella austriaca* was erected by Höhnel (1903) based on a tiny discomycete which grew on an old thallus of *Peniophora cinerea* on decaying wood of *Fagus* sp. Only one collection was found under *M. austriaca* in the Höhnel Herbarium of FH and the species appears to have been ignored by mycologists other than Saccardo (1906), who accepted the name and copied Höhnel's original description in the Sylloge Fungorum. Three of the five known North American collections of *L. theiodea* are also on the fruit bodies of *Peniophora* sp., but the host fungus is too inconspicuous to have been noticed by any of the collectors. Korf (1962) illustrated a brown *Calycellina*-like basal ring of the apothecium of this fungus. My observation reveals that the brown cells do not belong to the discomycete, but to the host fungus instead. I checked each plant substrate of these collections very carefully and came to the conclusion that *L. theiodea* is a fungicolous or fungus-associated fungus, and its apothecia are often found on fruit bodies of *Peniophora* sp. or other fungi on the same substrate. This discomycete occurs mainly in the early spring, but it has been collected once in September.

One thing which needs to be clarified is the type of *Mollisiella austriaca*. The type specimen was sent from the Höhnel Herbarium at FH. The label on the packet is full of information. The measurements of microscopic characters on the label match those in the original description well. The generic name was first put down as *Pulparia*, followed by the specific epithet *austriaca*. Then *Pulparia* was crossed out, and *Mollisiella* was substituted at the top. In his discussion, Höhnel (1903) stated that "Die beschriebene Art steht der *Pulparia australis* Speg. (Sacc. Syll. X, p. 38) aus Brasilien nahe, ist aber von ihr gut zu unterscheiden." Later, *Mollisiella* was also crossed out and *Niesslella* was written down at margin of the label, but the combination in *Niesslella* was never published by Höhnel. No questions can be raised on the locality and substrates when

FIG. 1. Apothecia of *Hyphodiscus theiodeus* on substrate, from R.P.K. 3277, x 17.5.

comparing the information given on the label with that in the original description. The only problem is the collection date, which appears on the label as "27. 2. 1903" but was published as "March, 1902." Prof. Korf has suggested to me that this is merely a inversion of month and year. Prof. Pfister of FH indicates that this is the only specimen in FH under any of these names. I checked Höhnel's paper and found that the latest collection included in that paper was dated June, 1903. The collecting date, 27. 2. 1903, is not too late for publication in the paper. My conclusion is that this specimen is the type of *M. austriaca*.

Generic and specific descriptions are provided as follows:

Hyphodiscus Kirschst., Verh. Bot. Vereins Prov. Brandenburg 48: 44, 1907 (1906).

Apothecia solitary to gregarious, turbinate, discoid, or applanate, sessile; hymenium yellowish brown, receptacle concolorous, surface downy. Hairs short, nonseptate to 1-septate, with rod-like granules mostly on the apical cell, subhyaline to pigmented, more or less thick-walled. Ectal excipulum of textura intricata, with hyphae gelatinized, thick- and glassy-walled. Medullary excipulum of textura intricata, less gelatinized. Asci inoperculate, 8-spored, J+ in Melzer's reagent with or without aqueous KOH pretreatment. Ascospores unicellular, hyaline, smooth-walled, guttulate. Paraphyses filiform, septate.

On woody substrates, often associated with other fungi.

Type: *Hyphodiscus gregarius* Kirschst.

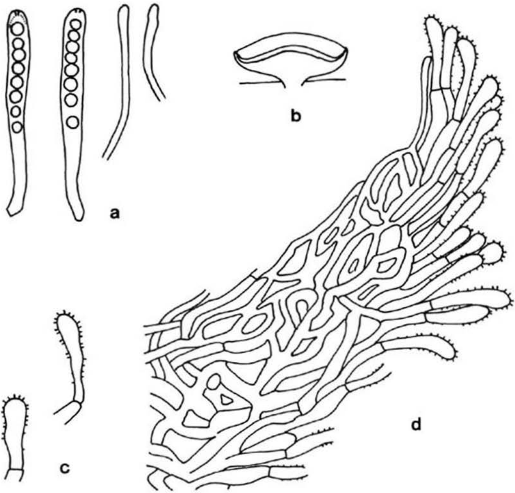

FIG. 2. *Hyphodiscus theiodeus:* **a**. paraphysis apices and asci with ascospores (R.P.K. 3277), **b**. shape of apothecium, from top to bottom showing hymenium, medullary excipulum and ectal excipulum (R.P.K. 2943), **c**. granulate hairs (R.P.K. 3277), **d**. structure of excipulum (R.P.K. 2943); **a** x 50, **b**-**d** x 1000.

Hyphodiscus theiodeus (Cooke & Ellis) Zhuang, **comb. nov.** (Figs. 1, 2)

≡ *Peziza theiodea* Cke. & Ell., Grevillea 7: 7, 1878.

≡ *Lachnellula theiodea* (Cke. & Ell.) Sacc. ('*theioidea*'), Syll. Fung. 8: 391, 1889.

≡ *Lachnella theiodea* (Cke. & Ell.) Sacc. in Seymour ('*theioidea*'), Host Index Fungi N. Am. p. 469, 1929 .

= *Mollisiella austriaca* Höhn., Ann. Mycol. 1: 396, 1903.

≡ *Pithyella austriaca* (Höhn.) Boud., Hist. Classif. Discom. Europe p. 125, 1907.

= *Hyphodiscus gregarius* Kirschst., Verh. Bot. Vereins Prov. Brandenburg 48: 44, 1907 (1906).

Apothecia turbinate to discoid when young, discoid to applanate at maturity, sessile, solitary to gregarious, 150-550 µm in diam; hymenium yellowish brown, warm brown to dark brown when dry; receptacle concolorous with hymenium, surface downy; with yellow powder covering receptacle surface and part of hymenium in some collections. Hairs present mostly at margin and flanks; light brown, cylindrical, often slightly inflated at apex, non-gelatinized, with granules mostly on the apical cell of hairs or less commonly covering the entire length, more or less thick-walled, 0-1 septate, 8-25 µm long, 2.7-4.0(-5.0) µm wide. Ectal excipulum of textura intricata, mixed with textura angularis at the base, 15-55(-75) µm thick; hyphae gelatinized, elongated, thick- and glassy-walled, subhyaline, slightly brownish towards the outside, 4.5-5.0 µm wide; hyphal walls 1-2 µm thick; many yellow crystals seen covering the receptacle surface when mounted in cotton blue-lactic acid or in water, crystals dissolved by 10% KOH. Medullary excipulum of textura intricata, less gelatinized, 13-20(-40) µm thick; hyphae slender, subhyaline to light brown. Subhymenium indistinguishable. Asci 8-spored, cylindrical with a tapered base, J+ in Melzer's reagent with or without 10% KOH pretreatment, walls somewhat thick at apex, 40-45 x 3.0-4.8 µm, with crozier at base. Ascospores uniseriate, spherical to subspherical, unicellular, hyaline, smooth-walled, uniguttulate, 2.2-3.3 µm in diam. Paraphyses filiform, septate, unbranched or branched only at base, 1.5 (-2.0) µm wide, not exceeding asci.

HABITAT: On fruit bodies of, or associated with, *Peniophora* sp. and other fungi on decorticated branches.

ILLUSTRATIONS: Kirschstein, W., Verh. Bot. Vereins Prov. Brandenburg 48: 45, Fig. 1907 (1906). Korf, R.P., Trans. Mycol. Soc. Japan 3: 49, Fig. 1, 1962. Dennis, R.W.G., Kew Bull. 17: 370, Fig. 68, 1963. This paper Figs. 1, 2.

SPECIMENS EXAMINED: **Austria**: On fruit bodies of *Peniophora cinerea* on decaying wood of *Fagus*, Georgenberg b. Purkersdorf, v. Höhnel, 27. II. 1903, FH-Herb. Höhnel #d. 5056 (holotype of *Mollisiella austriaca*).

United States: On decorticated *Rhus venenata* [associated with other fungi], New Jersey, Ellis 2956, (no date), K (holotype of *Peziza theiodea*), CUP-D 3820 (90-133) (isotype); on *Rhus venenata* [associated with another fungus], Vineland, New Jersey, Ellis, 6. III. 1878, CUP-D 8757 (90-134); on beech (?) stick [or on fruit bodies of *Peniophora* sp. on the same substrate], Sylvan, Washtenaw Co., Michigan, A.H. Smith, 9. IV. 1929, MICH, NY-Cummins 69, R. P. Korf Personal Herbarium (R.P.K.) 3100; [on fruit bodies of *Peniophora* sp.] on *Platanus occidentalis* L., Rte. 261 near Ohio-Breckinridge city line, Kentucky, R.T. Pennoyer 2707, 2. IV. 1961, R.P.K. 2943; on wood [and associated with another fungus], High Bridge, Indiana, R.T.

Pennoyer 2852, 26. VIII. 1961, R.P.K. 3277.

West Germany: On rotten wood of *Rhamnus frangula*, Stadtforst Rathenow a/H, W. Kirschstein, 19. III. 1905, B (holotype of *Hyphodiscus gregarius*).

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A NEW SPECIES OF HETEROTHALLIC TALAROMYCES

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SUMMARY

A new heterothallic fungus, *Talaromyces derxii* (anamorph: *Penicillium derxii*), was isolated from cultivated soil in Kurashiki City, western Japan. The species is characterized by the rapid growth at 37°C, deep greenish to pale orange colony reverse, grayish green ascomata, ellipsoidal and spinulose ascospores, bi- or terverticillate penicilli, and cylindroidal-fusiform conidia. Besides morphological differences, it clearly differs from the other *Talaromyces* species by its heterothallic sexual reproduction.

Cleistothecial Ascomycetes with *Aspergillus, Penicillium* and *Paecilomyces* anamorphs have been classified in the Trichocomaceae by most recent authors (Malloch and Cain, 1972, 1973; Benny and Kimbrough, 1980). As recently summarized by Eriksson and Hawksworth (1986), the family contains more than 18 genera due to the discovery of the teleomorphs of more and more *Aspergillus* and *Penicillium* species. In spite of this taxonomic diversity, the Trichocomaceae have proved to be almost uniformly homothallic, although individual isolates may vary widely in sexual potency. Only three exceptions were encountered; viz. *Emericella heterothallica* (Kwon, Fennell et Raper) Malloch et Cain (Raper and Fennell, 1965; Kwon and Raper, 1967), *Neosartorya fennelliae* Kwon-Chung et Kim (Kwon-Chung and Kim, 1974) and *N. spathulata* Takada et Udagawa (Takada and Udagawa, 1985). Their anamorphs are obviously assignable to *Aspergillus*. In 1925 and 1926, Derx published two preliminary reports, in which he presented strong evidence of heterothallism in an isolate designated, "*Penicillium luteum* (Zukal?) Wehmer *certissime*!" Because this was not confirmed by subsequent workers (Emmons, 1935; Raper and Fennell, 1952), the discovery of heterothallism in *Penicillium* has received very little attention (Raper and Thom, 1949; Pitt, 1979).

During our continuous survey of soil-borne ascomycetous fungi in Japan, an unusual species of *Talaromyces* resembling *T. bacillosporus* C.R. Benjamin (Stolk and Samson, 1972), but having ellipsoidal ascospores, was isolated in 1976. Recent experiments with 10 single germinating ascospore-isolates of this fungus that had only the anamorph (*Penicillium*) showed that there were two groups of self-sterile but cross-fertile isolates. Production of fertile ascomata in malt agar or oatmeal agar cultures by adequate crosses between the single-ascospore isolates clearly showed this fungus to be heterothallic. Although there are some minor morphological differences between the two groups (vide the description), all single-ascospore isolates in the same group resemble each other in growth characteristics and colony morphology, indicating a relatively high degree of stability. Thus, nearly 50 years after Derx's work, we have encountered evidence of heterothallism in ascosporic Penicillia. Unfortunately, questions have not yet been resolved concerning the correct identification of Derx's culture as representing "*Penicillium luteum* (Zukal?) Wehmer *certissime*." Derx (1926) stated that "This is the species in which I discovered heterothallism." For subcultures of *Penicillium luteum* NRRL 2102 and NRRL 2103 which were forwarded to him by Raper and Fennell in 1950, however, he had subsequently answered them that neither of these strains conformed with that which he investigated, and then Raper and Fennell (1952) concluded that "Derx may thus have worked with some strain possessing unusual and possibly unique cultural characteristics." No type specimen of Derx's fungus is also known to be preserved. Since the taxonomic treatment of the first heterothallic *Talaromyces* (Derx, 1925, 1926) is not entirely adequate by modern standards, and since Derx never distributed cultures of his fungus, our isolate is described here as a first heterothallic species of *Talaromyces* with a *Penicillium* anamorph.

Talaromyces derxii Takada et Udagawa, sp.nov. (Figs.1-9)

Stat. Anam. *Penicillium derxii* Takada et Udagawa, anam. sp.nov.

Fungus heterothallicus. Ascomata superficialia, discreta vel confluentia, celeriter maturescentia, sine ostiolo, mycelio laxo intertexto obtecta, alba vel griseo-

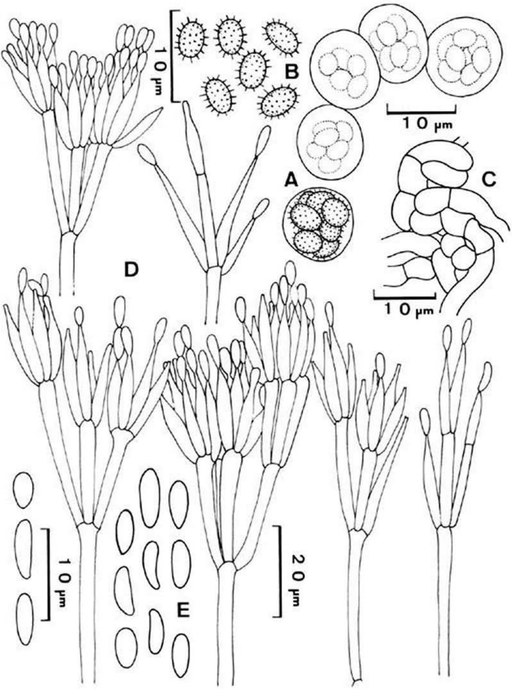


Figure 1. *Talaromyces derxii* , NHL 2980-2982.
A. Asci. B. Ascospores. C. Coiled ascogonium.
D. Penicilli. E. Conidia.

viridia vel valde aeruginosa, globosa vel subglobosa, 160-320 µm; peridium laxum, 'textura intricata', ex hyphis hyalinis vel pigmentiferis, ramosis, septatis, saepe granulatis, 1.5-4 µm diam compositum. Asci catenulati breviter, 8-spori, globosi vel subglobosi,10-13 x 9-12 µm, postremo evanescentes. Ascosporae hyalinae vel pallide flavae, ellipsoideae, 3.5-5 x 2.5-3 µm, spinulosae.

Mycelium ex hyphis hyalinis vel flavo-brunneis, ramosis, septatis, ad septum saepe constrictis, levibus vel asperatis, 1.5-5 µm diam compositum, interdum aggregatum in funiculo. Conidiophora ex hyphis subsuperficialibus, hyphis aeriis vel fasciculis hypharum oriunda, hyalina, septata, levia, stipites 16-125 x 2.5-3.5 µm. Penicilli variabiles, vulgo biverticillati vel terverticillati, sed interdum monoverticillati. Rami 12-45 x 2-3 µm, leves. Metulae 2-4 verticillatae, 15-24(-30) x 2-4 µm, leves, appressae. Phialides 3-7 verticillatae, acerosae vel cylindricae, 10-20(-25) x 2-3.5 µm, leves. Conidia hyalina, fusiformia, cylindrica vel ellipsoidea, 4-8 x 1.5-3 µm, levia, in catenis implicatis connexa.

Coloniae in agaro Czapekii restrictae, floccosae, constantes ex mycelio basali coacto tenuiter et conidiis moderate vel copiose formantibus, albae vel obscure virides vel pistaceae; reversum atrovirens vel flavo-brunneum vel nigrum.

Coloniae in agaro 'Czapek-Yeast Autolysate' effusae, floccosae vel aliquantum velutinae, planae vel radiatim sulcatae, constantes ex mycelio basali coacto tenuiter et conidiis moderate formantibus, albae vel griseo-virides vel pallide aurantiacae; reversum griseo-viride vel pallide aurantiacum.

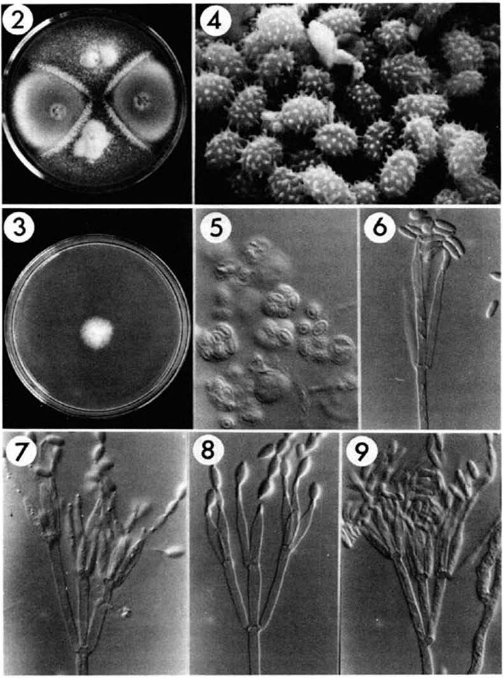
Coloniae in agaro maltoso effusae, floccosae, funiculosae vel gossypinae, planae, constantes ex mycelio basali coacto tenuiter cum conidiis moderate vel copiose formantibus et ex mycelio aerio sterili, albae vel griseo-virides; reversum atrovirens vel pistaceum.

Temperatura optima 30-37°C, crescere potest inter 16 et 40°C.

Holotypus NHL 2980, colonia exsiccata ex crusi NHL 2981 x NHL 2982, uterque ex solo sativo, Okayama, in Japonia, 1.v.1976,a M. Takada, isolata. In herb. NHL.

Etymology: After H.G. Derx.

Heterothallic. Ascomata superficial, discrete but often confluent, maturing within 7-10 days at 37°C, non-ostiolate, bounded by loosely interwoven mycelial overgrowth, white to grayish green or dark bluish green, globose to subglobose, 160-320 µm in diam; ascoma wall soft,



Figs. 2-9. *Talaromyces derxii* , NHL 2980-2982.
2. Paired culture of 'A' x 'a' on malt agar at 37°C, 7 days. (Top and bottom: 'A', NHL 2981; left and right: 'a', NHL 2982). x 1/2. 3. Colony of NHL 2981 on Czapek's agar at 37°C, 7 days. x 1/2. 4. Ascospores (SEM photograph). x 2500. 5. Asci. x 1200. 6-9. Conidial structures. 7 and 8: NHL 2981; 6 and 9: NHL 2982. x 750.

composed of hyaline or pigmented, branched, septate, often incrusted with granules, 1.5-4 µm diam hyphae, forming a 'textura intricata'; ascoma initials composed of ascogonial coils on swollen hypha. Asci borne in short chains, 8-spored, globose to subglobose, 10-13 x 9-12 µm, evanescent at maturity. Ascospores hyaline to pale yellow, ellipsoidal, 3.5-5 x 2.5-3 µm, spinulose with spines about 0.5 µm long.

Mycelium composed of hyaline or yellow to brown, branched, septate, often constricted at the septa, with smooth or roughened walls, more or less guttulate, 1.5-5 µm diam hyphae, sometimes forming a funicle. Conidiophores borne from subsurface hyphae, aerial hyphae or bundles of hyphae, stipes variable in length, 16-125 x 2.5-3.5 µm, hyaline, septate, with walls smooth, bearing terminal penicilli. Penicilli varying with strain, in NHL 2981 producing commonly biverticillate or terverticillate, rarely quaterverticillate or monoverticillate, in NHL 2982 rather simple, monoverticillate to biverticillate, sometimes terverticillate. Rami, when present, 12-45 x 2-3 µm, with walls smooth. Metulae 2-4 in the verticil, 15-24(-30) x 2-4 µm, with walls smooth, closely appressed, often with enlarged apices. Phialides 3-7 per metula, acerose to cylindroidal, 10-20(-25) x 2-3.5 µm, with walls smooth, closely appressed, often tapering abruptly to cylindroidal collula. Conidia hyaline, grayish green in mass, cylindroidal, fusiform, or ellipsoidal, sometimes curved, 4-8 x 1.5-3 µm, with walls smooth, borne in tangled chains up to 200-250 µm in length.

Colonies on Czapek's agar growing restrictedly, attaining a diameter of 15-20 mm in NHL 2981 or 10-13 mm in NHL 2982 within 7 days at 37°C, floccose, composed of a thin basal felt bearing moderate or abundant conidia, white to dull green (M.26D4, after Kornerup and Wanscher, 1978) or 'Pistachio Green'(Rayner, 1970); reverse deep green (M.25E8) or 'Dark Bluish Green'(Rayner) in NHL 2981, and yellowish brown (M.5E4), 'Greyish Sepia'(Rayner) or black in NHL 2982.

Colonies on Czapek Yeast Autolysate agar (CYA) growing rapidly, 65-69 mm in NHL 2981 or 42-46 mm in NHL 2982 within 7 days at 37°C, floccose or somewhat velvety, composed of a thin basal felt bearing moderate conidia, plain or radially furrowed, white to grayish green (M. 25C5) or 'Pistachio Green'(Rayner) in NHL 2981 and to grayish green (M.26B3), pale orange (M.5A3), 'Greenish Glaucous' or 'Salmon'(Rayner) in NHL 2982; exudate clear in small droplets; odor moldy; reverse grayish green

(M.25C5), pale orange (M.5A3), 'Pistachio Green' or 'Salmon'(Rayner) in NHL 2981, and light orange (M.5A5) or 'Ochreous'(Rayner) in NHL 2982.

Colonies on malt agar spreading broadly, 67-80 mm in NHL 2981 or 60-64 mm in NHL 2982 within 7 days at 37°C, floccose, funiculose or cottony, composed of a thin basal felt with a limited growth of sterile aerial mycelium and moderate or abundant conidia, plain, with color as on CYA, developing numerous ascomata in a layer at the contacted zone only after appropriate pairings; ascomata white at first, then overgrown by a loose network of pigmented hyphae, grayish green (M.25C6) or 'Bluish Green'(Rayner); reverse deep green (M.25E8) or 'Pistachio Green'(Rayner).

Colonies on oatmeal agar spreading broadly, up to 85 mm or more in 12 days at 37°C, floccose in NHL 2981 or velvety in NHL 2982, composed of a thin basal felt with abundant conidia, dull green (M.28D3-4, 27D4), 'Smoke Grey' or 'Pistachio Green'(Rayner), producing numerous ascomata in a layer at the contacted zone after pairings as on malt agar; reverse deep green (M.25E1) to pale orange (M.5A3), or 'Dark Bluish Green' to 'Rosy Buff' (Rayner).

Colonies on cornmeal agar growing rapidly, very thin, with vegetative mycelium submerged, producing scattered conidia.

Optimum temperature for growth is 30-37°C with a temperature range between 16 and 40°C.

Isolation: cultivated soil, Higashitomii, Kurashiki City, Okayama Prefecture, Japan, May 1, 1976, coll. M. Takada.

Holotype: The type of *Talaromyces derxii* is a dried culture of NHL 2981 x 2982 preserved in NHL 2980. Subcultures of the 'A'(NHL 2981) and 'a'(NHL 2982) mating types are deposited in the American Type Culture Collection.

This fungus is easily distinguished from all described species of *Talaromyces* (Stolk and Samson, 1972; Samson and Abdel-Fattah, 1978; Pitt, 1979) by its heterothallic sexual reproduction. The greenish colony appearance and the slender penicilli with cylindroidal conidia of this fungus, resembles *T. bacillosporus* (anamorph: *Geosmithia swiftii* Pitt), but differs by ellipsoidal ascospores, rather complex penicilli with all elements smooth-walled, and larger conidia (4-8 x 1.5-3 µm vs. 4-5 x 1-1.2(-1.5) µm in *G. swiftii*). Although the *Penicillium* anamorph of this fungus resembles *Geosmithia* (Pitt, 1979) in the production of appressed penicilli with cylindroidal phialides and conidia, the phialides are always smooth-walled.

This appears to be the first report of heterothallism in the Trichocomoideae (the subfamily lacking bivalvate ascospores (Malloch, 1985)).

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STUDIES IN THE GENUS PHOMA. X. CONCERNING PHOMA EUPYRENA, AN UBIQUITOUS, SOIL-BORNE SPECIES.

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ABSTRACT

Phoma eupyrena Sacc., an ubiquitous, chlamydospore-forming, soil-inhabiting species is described and illustrated. Its characteristics when grown on agar media are documented, as is the anatomy of its pycnidial wall. Distinctions between it and species of *Phoma* Sacc. with which it can be confused are noted.

INTRODUCTION

Ten species currently classified in the genus *Phoma* are known to produce chlamydospores. Of these, only three bear unicellular chlamydospores; namely *P. eupyrena*, *P. medicaginis* Malbr. & Roum., and *P. pinodella* (L.K. Jones) Morgan-Jones & Burch. The latter two, in addition to five dictyochlamydospore-bearing species, *P. americana* Morgan-Jones & White, *P. glomerata* (Cda) Wollenw. & Hochapf., *P. jolyana* Pirozynski & Morgan-Jones, *P. pomorum* Thümen, and *P. sorghina* (Sacc.) Boerema, Dorenbosch & van Kesteren, have been previously treated in this series of papers (Morgan-Jones and White, 1983; White and Morgan-Jones, 1983, 1986, 1987a, 1987b, Morgan-Jones and Burch, 1987a, 1987b). The present paper describes *P. eupyrena*.

The binomial *Phoma eupyrena* has, historically, been applied predominantly to isolates found in association with potato tubers. It is now known, however, to occur commonly in soil (Domsch and Gams, 1970; Domsch, Gams and Anderson, 1980), to have a wide host range, and a cosmopolitan distribution. The fungus was originally described by Saccardo (1879) from stems of potato. Although he did not note the presence of chlamydospores, their production has been accepted as an important differentiating criterion for it in subsequent work. It was isolated from potato tubers by Wollenweber (1920) and noted to be the causal organism of blackish pimples on skins. He reported his strain to induce rotting of apple and cucumber, as well as potato, and to produce typical chlamydospores. Wollenweber and Hochapfel (1936) did not, however, list *P. eupyrena* among *Phoma* species causing minor fruit rots. In subsequent use of the name *Phoma eupyrena*, the qualifications "as interpreted by Wollenweber" or "sensu Wollenweber" were added (Dennis, 1946; Malcolmson,

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1958; Boerema and van Kesteren, 1962; Kranz, 1963), indicating uncertainty as to whether or not the fungus studied by Wollenweber was identical to that of Saccardo (1879). Dennis (1946) described two closely similar strains (designated 17 and 18 and constituting his Group VII among *Phoma* isolates) isolated from tissue of potato tubers showing superficial necrosis. Both produced abundant and characteristic chlamydospores. Strain 18, received from A.R. Wilson, had been identified as *P. eupyrena* by G.R. Bisby. Dennis, however, doubted that Wollenweber's fungus (conidia 4-6 X 1.7-2.3 um) was identical with Saccardo's (conidia 4 X 1.5 um). Uncertainty about Wollenweber's application of the name *P. eupyrena* was further increased when Malcolmson (1958) failed to find chlamydospores in a specimen, labelled "*P. eupyrena* f. *dulcamarae*" (collected on *Solanum dulcamara* L. in the U.S.A. in 1889 by C.E. Fairman), in Saccardo's herbarium. This was not, however, the type material. The fungus on *S. dulcamara*, also issued by C. Roumeguêre in his *Fungi gallici exsiccati* no. 2116 as *P. eupyrena*, and isolated from this host by Kranz (1963), is now thought to be *Phoma exigua* Desm. var. *exigua* (Boerema, 1976). It occurs commonly on this host but is also known from potato where it is associated with a dry rot or gangrene disorder [the names *Phoma solanicola* Prill. & Del. and *Phoma tuberosa* Melhus, Rosenbaum & Schultz have also been applied to it; both now accepted as synonyms of *P. exigua*]. Examination of the holotype of *P. eupyrena*, which is extant [on stems of *Solanum tuberosum* L., collected near Saintes (Charente-Inférieur), P. Brunaud (without date), Herb Sacc. "39", PAD], reveals characteristics that agree closely with Wollenweber's interpretation, including possession of chlamydospores and conidia measuring 3.4-5.1 X 1.7-2.6 um (Dorenbosch, 1970). The binomial *P. eupyrena* has, therefore, for the most part, been correctly applied in the past but the qualification "sensu Wollenweber" is superfluous.

Phoma eupyrena is sometimes associated with superficial necroses of potato tubers (Boyd, 1972) and it may be implicated as a causal organism of seedling damping-off in various plants (Hampel, 1972). It is, however, considered to be predominantly a secondary invader of plant tissues (Domsch and Gams, 1970; Boerema, 1976). In addition to *P. eupyrena*, as noted in part above, a number of binomials in the genus *Phoma* have, in the past, been applied to fungi associated with potato. These include *P. destructiva* Plowright, *P. exigua*, *P. foveata* Foister, *P. solanicola*, and *P. tuberosa*. *Phoma foveata* was considered by Boerema (1967) to be a pigment-producing variety of *P. exigua* and reclassified in that species as *P. exigua* var. *foveata* (Foister) Boerema. To facilitate correct identification of *P. eupyrena*, a new comprehensive description of it is offered here. The characteristics by which it can be distinguished from *Phoma exigua* vars. *exigua* and *foveata*, both of which cause gangrene of potatoes, and *P. pomorum*, with which it might be confused when the latter fails to form dictyochlamydospores, are documented.

In this series of papers the reader is reminded that many *Phoma* form-species are variable in their *in vitro* cultural characteristics. Differences are often found between strains from various sources and between single conidial isolates of individual strains. An attempt is made to determine the range of variation but caution must be exercised in applying some of the information since descriptions are prepared from limited number of isolates.

We are using the term "chlamydospores" *sensu amplo* for convenience, perpetuating the practice of previous authors of *Phoma* descriptions, to designate swollen, thick-walled, darkly pigmented elements formed by modification of

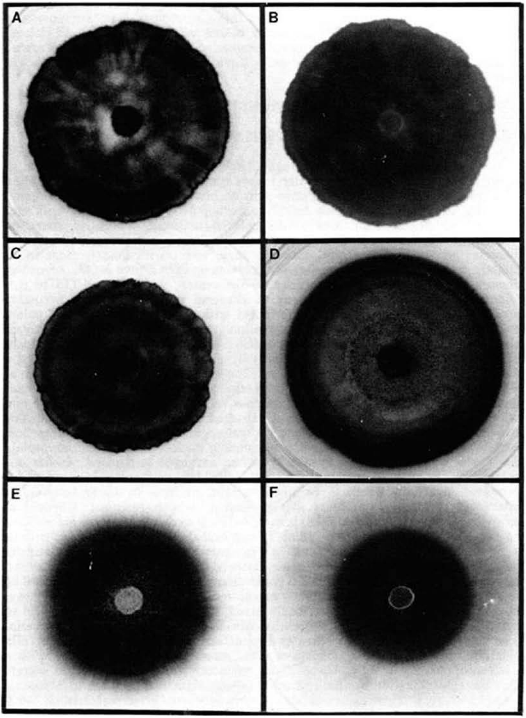


PLATE 1. *Phoma eupyrena*. A, 14-day-old colony on PDA at 25C; B, reverse of same; C, 14-day-old colony on PDA at 25C [A and C, single-conidial isolates of same strain: ATCC 22238]; D, 14-day-old colony on PDA at 20C; E, 14-day-old colony on MEA at 25C; F, 14-day-old colony on MEA at 20C.

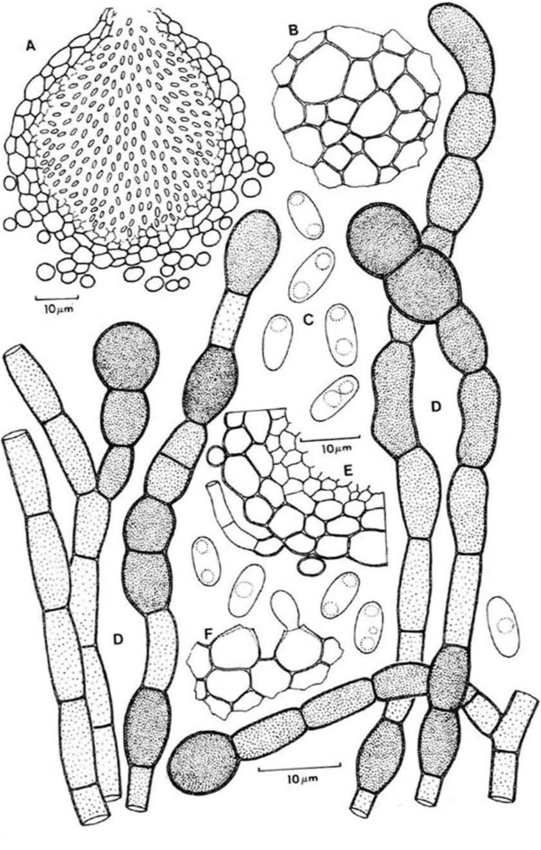
terminal or intercalary hyphal cells by internal deposition of additional wall material. We are, of course, aware that these structures do not correspond to those for which the term was originally coined by de Bary (1859). As Hughes (1985) noted, true chlamydospores, *sensu* de Bary, which are formed endogenously within preexisting cells, are not known to occur in the Ascomycotina or Deuteromycotina.

TAXONOMIC PART

Phoma eupyrena Sacc., Michelia 1: 525, 1879 (Plates 1 and 2, figure 1).

Colonies on potato dextrose agar (PDA) [Difco] somewhat variable in appearance and coloration, generally lanose but usually becoming densely felted after two to three weeks, pale dove gray to olivaceous gray to charcoal gray, becoming brownish to blackish and irregularly pulvinate at the center with age. Colonies either more or less evenly colored in broad concentric zones or irregularly mottled or with indistinct and variously-sized sectors, attaining a diameter of 44-48 mm at 25C after 10 days, with an irregularly indented or slightly scalloped margin. Ten-day-old colonies on PDA grown at 20C, 65 mm in diameter, lanose, grayish olivaceous in the center, with a broad (15-16 mm wide), somewhat felted, dove gray to charcoal gray outer zone, becoming progressively darker towards the periphery with a narrow (2 mm wide), paler, even margin of mostly immersed mycelium; reverse uniformly dark gray to black. Colonies on malt extract agar (MEA) [Difco] densely striate in the form of olivaceous, mostly immersed, radially-arranged mycelial strands, attaining a diameter of 43 mm at 25C after 10 days. Ten-day-old colonies on MEA grown at 20C, 60 mm in diameter, olivaceous green, with very little aerial mycelium, immersed mycelium organized as numerous radial strands, with a broad (5 mm wide), pale margin. Colonies on cellulose agar sparse. Mycelium composed of two main types of hyphae: hyaline to subhyaline, smooth, thin-walled, branched, septate, 2-2.5 um wide; and pale brown, smooth, thick-walled, branched, septate 2.5-4 um wide. The latter hyphae are often arranged in parallel strands and sometimes become irregularly inflated in older cultures. Chlamydospores produced abundantly on all three media, arising singly or in chains, terminal or intercalary, where intercalary barrel-shaped, where terminal ellipsoid to subglobose, smooth, thick-walled, brown, 4-12 um in diameter. Pycnidia solitary or sometimes confluent, often initiated from hyphal strands, subglobose, without a pronounced neck, pale to dark brown, pseudoparenchymatous, indistinctly uniostiolate, glabrous or, more often, loosely covered with wide, pale brown hyphae and chlamydospores, 165-225 um in diameter. Pycnidial wall composed of more or less isodiametric or slightly elongate cells of two types; an outer layer, two to three cells thick, of variously sized, thick-walled, brown cells and an inner layer, two to three cells thick, of thin-walled, subhyaline to hyaline cells. The inner layer of cells disintegrates soon after conidiation. Conidiogenous cells phialidic, hyaline, simple, smooth-walled, ampulliform to doliiform, with a thickened periclinal wall, borne from pycnidial wall cells lining the venter. Conidia enteroblastic, hyaline, smooth, oblong with obtuse ends to ellipsoid, straight or very slightly curved, unicellular, guttulate (often biguttulate), 3-6 X 1.5-3 um. Exuding conidial masses whitish to pale gray.

FIGURE 1. *Phoma eupyrena*. A, vertical section of pycnidium; B, surface view of pycnidial wall; C, conidia; D, chlamydospores; E, portion of pycnidial wall in section; F, conidiogenous cells.


A
B
10 μm
C
D
10μm
E
D
F
10 μm

Plurivorous, particularly on plant roots and decaying organic matter, soil-inhabiting; probably cosmopolitan.

Collections examined: isolated from soil, The Netherlands, CBS 527.66, IMI 45944, ATCC 22238; isolated from *Phaseolus vulgaris* L., Martinesse, Noordoostpolder, The Netherlands, 1978, PD 78/745.

DISCUSSION

Sutton (1980) reports that approximately a hundred collections of this taxon from thirty different host genera are housed in the herbarium at the CAB International Mycological Institute. Although originally described from potato, Gams *et al.* (1969) isolated it frequently from soils in which potatoes had never been grown.

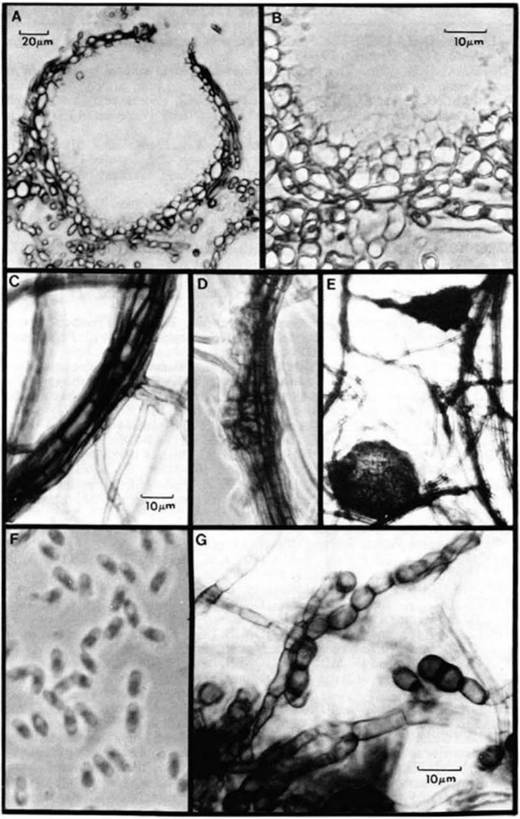
Isolates of *Phoma eupyrena* grow faster at 20C than at 25C and, on PDA, colonies grown at the former temperature have a more even and consistent appearance (cf. Plate 1A, 1D). Single-conidial subisolates of a given strain vary somewhat in their growth rates (cf. Plate 1A, 1C). Colonies grown on MEA at 25C tend to be more prominently striate than those grown at 20C, particularly at their margin (cf. Plate 1E, 1F). One of the isolates studied (ATCC 22238) does not produce pycnidia as readily as the other, possibly because of *in vitro* deterioration. Intensity of chlamydospore production varies among individual isolates and is affected by the sugar content of the medium (Malcolmson, 1958). The chlamydospores, which are not dissimilar in appearance to those of the soil-borne fungus *Verticillium nigrescens* Pethybr., when mature sometimes disarticulate rather readily in the manner of species of *Scytalidium* Pesante. Conidia of *P. eupyrena* are predominantly biguttulate as in alpha-conidia of *Phomopsis* (Sacc.) Sacc.

Phoma eupyrena and another soil-borne fungus, *P. pomorum*, though similar in that they possess chlamydospores and anatomically somewhat similar pycnidia, can be distinguished by a number of characteristics. Although *P. pomorum* does not invariably form dictyochlamydospores and frequently only in old cultures, the shape of its individual non-septate chlamydospores is different from those of *P. eupyrena*, being subglobose or globose. The appearance of the two species in culture is also quite different, particularly on MEA (cf. White and Morgan-Jones, 1986). Lack of chlamydospores in *P. exigua*, which is also soil-borne, colony characteristics and possession of somewhat larger, occasionally septate, conidia serve to easily differentiate that species from *P. eupyrena*.

ACKNOWLEDGMENTS

We thank Dr. M.E. Noordeloos, Plantenziektenkundige Dienst, Wageningen, The Netherlands, for providing us with the isolate of *P. eupyrena* from *Phaseolus vulgaris*. Dr. J. Leland Crane, State History Survey Division, Illinois Department of Energy and Natural Resources, reviewed the manuscript.

PLATE 2. *Phoma eupyrena*. A, vertical section of pycnidium; B, portion of pycnidial wall in section; C, hyphal rope; D, pycnidial initial originating from hyphal rope; E, hyphae, hyphal ropes and developing pycnidia; F, conidia; G, chlamydospores.


A
20µm
B
10µm
C
10µm
D
E
F
G
10µm

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CONSIDERATIONS ABOUT THE VALIDITY OF THE GENUS CYLINDROTRICHUM Bonorden.

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ABSTRACT

The validity of the genus Cylindrotrichum is discussed. In order to make clear certain generic concept the genus is redefined. A complete list of 11 accepted species of the genus is provided.

During the last years the genus Cylindrotrichum Bonorden has been revised and analysed by different authors (Gams and Holubová-Jechová, 1976; Morgan-Jones, 1980; DiCosmo, Berch and Kendrick, 1983). At the same time new species were described being their number enlarged. This fact caused the limits of the genus to be confounded and lead DiCosmo et al. (op. cit.) to rearrange the disposition of all the species of Cylindrotrichum in three genera: Kylindria DiCosmo, Berch et Kendrick and Xenokylindria DiCosmo, Berch et Kendrick, two new genera, and a third one Chaetopsis Greville whose concept was extended in order to include the remaining species. Difficulties in delimitating these genera and the allied genera arise from this new disposition.

Because of what has been stated above, we consider it necessary to make clear certain generic concepts, this been the purpose of the present paper.

The genus Cylindrotrichum was erected by Bonorden in 1851 and of Bonorden's four original species only one, C. oligospermum (Corda) Bonorden, chosen by Hughes (1958) as lectotype for the genus, was included. The remaining three names were excluded for different reasons (Morgan-Jones, 1980).

DiCosmo et al. (op. cit.) transferred C. oligospermum to the genus Chaetopsis, whose concept was extended. Chaetopsis was erected by Greville in 1825, being C. grisea (Ehrenberg) Saccardo the type species. This species has setiform conidiophore branched near the base, each branch bearing polyphialidic conidiogenous cells. The change in the sense of the genus carried out by DiCosmo et al. (op. cit.) means such an enlargement that this genus can superpose itself with other genera such as Chloridium and Dictyochaeta. This is so because DiCosmo et al. (op.

cit.) included forms with or without setas and unbranched conidiophore, so that the conidiogenous cells are borne at the top of the sparse conidiophores.

According to the type species *C. oligospermum* (Corda) Bonorden, the genus *Cylindrotrichum* is defined as follows: unbranched conidiophore with terminal polyphialidic sympodial conidiogenous cells.

The article 52 of the International Code of Botanical Nomenclature (1983) states: "When a genus is divided in two or more genera, the generic name, if correct, must be retained for one of them...". For that reason we consider as incorrect the proposal of DiCosmo et al. because the type species can be included in the genus *Cylindrotrichum* with species such as *C. fasciculatum* Mercado Sierra, *C. hennebertii* Gams et Holubová-Jechová, and *C. prosbosciophorum* (DiCosmo, Berch et Kendrick) Arambarri et Cabello. On the other hand, *C. clavatum* Gams, *C. ellisii* Morgan-Jones, *C. triseptatum* Matsushima and *C. zygnöellae* (Höhnel) Gams et Holubová-Jechová can also be considerer as species of the genus *Cylindrotrichum*, since the presence of multiple and single conidiogenous loci in the phialide can occur within one genus (Gams et al., 1985).

According to the considerations mentioned before, the genus *Cylindrotrichum* can be defined as follows: conidiophore erect and unbranched; conidiogenous cells terminal with single or multiple conidiogenous loci produced by sympodial or percurrent proliferation. *C. proliferum* Matsushima should also be included in this definition of the genus.

We are introducing now a complete list of 11 accepted species of the genus *Cylindrotrichum*:

1. *C. oligospermum (Corda) Bonorden, Handb. allyem. Mykol. 98, 1851.*
   Menispora oligosperma Corda, Icon. Fung. 2: 12, 1838.
   Chaetopsis oligosperma (Corda) DiCosmo, Berch et Kendrick, Mycologia 75(6): 962, 1983.

2. *C. proliferum Matsushima, Icones Microfungorum a Matsushima Lectorum: 47-48, 1975.*
   Xenokylindria prolifera (Matsushima) DiCosmo, Berch et Kendrick, Mycologia 75(6): 971, 1983.

3. *C. triseptatum Matsushima, Icones Microfungorum a Matsushima Lectorum: 48, 1975; non C. triseptatum Ellis, More Dematiaceous Hyphomycetes: 470, 1976.*
   Kylindria triseptata (Matsushima) DiCosmo, Berch et Kendrick, Mycologia 75(6): 971, 1983.

4. *C. clavatum Gams in Gams & Holubová-Jechová, Stud. Mycol. 13: 54, 1976.*
   Kylindria clavata (Gams in Gams & Holubová-Jechová) DiCosmo, Berch et Kendrick, Mycologia 75(6): 970, 1983.

5. *C. hennebertii Gams et Holubová-Jechová, Stud. Mycol.*

13: 50, 1976.
Chaetopsis hennebertii (Gams et Holubová-Jechová) DiCosmo, Berch et Kendrick, Mycologia 75(6): 970, 1983.

6. *C. zygnöellae* (Höhnel) Gams et Holubová-Jechová, Stud. Mycol. 13: 53, 1976.
Acrotheca zygnöellae Höhnel, Sber. K. Akad. Wiss. Wien, Math.-nat. Kl. 118:332, 1909.
Kylindria zygnöellae (Höhnel) DiCosmo, Berch et Kendrick, Mycologia 75(6): 971, 1983.

7. *C. ellisii* Morgan-Jones, Mycotaxon 5: 490, 1977.
C. triseptatum Ellis, More Dematiaceous Hyphomycetes: 470, 1976, non *C. triseptatum* Matsushima, Icones Microfungorum a Matsushima Lectorum: 48, 1975.
Kylindria ellisii (Morgan-Jones) DiCosmo Berch et Kendrick, Mycologia 75(6): 970, 1983.

8. *C. oblongisporum* Morgan-Jones, Mycotaxon 5 (2): 487, 1977.
Kylindria oblongispora (Morgan-Jones) DiCosmo, Berch et Kendrick, Mycologia 75(6): 971, 1983.

9. *C. fasciculatum* Mercado Sierra, Acta Botánica Cubana 16: 5, 1985.

10. *C. excentricum* (Bhat et Sutton) Cabello et Arambarri, comb. nov.
Kylindria excentrica Bhat et Sutton, Trans. Br. Mycol. Soc. 84(4): 728, 1985.

11. *C. probosciophorum* (DiCosmo, Berch et Kendrick) Arambarri et Cabello, comb. nov.
Chaetopsis probosciophora DiCosmo, Berch et Kendrick, Mycologia 75(6): 962, 1983.

C. curvatum Morgan-Jones (Morgan-Jones, 1980) and *C. helisciforme* Marvanová (Marvanová, 1979) are two species that would need a quite detailed review; the first one could be a species of *Dictyochaeta* as DiCosmo et al. propose (although they use *Codinaea* as generic name) while the second one could be one species of the genus *Heliscus*; nevertheless, the conidia do not coincide with those of the genus.

We conclude that *Cylindrotrichum* is a valid genus with 11 species; we are not taking into account the genera *Kylindria* and *Xenokylindria* limitating *Chaetopsis* to the original concept. Nevertheless assuming the similarities and difficulties the allied genera present we consider it necessary to carry out a much deeper taxonomy work.

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STUDIES IN CORTICIACEAE (BASIDIOMYCETES) NEW SPECIES AND NEW COMBINATIONS

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Abstract. Phlebia ryvardenii Hallenb. & Hjortst. and Sistotrema quadrisporum Hallenb. & Hjortst. are described as new species on material from N. Europe and Spain. The combinations Steccherinum albo-fibrillosum (Hjortst.& Ryv.)Hallenb.& Hjortst. and S. queletii (Bourd.& Galz.) Hallenb.& Hjortst. are proposed.

PHLEBIA RYVARDENII Hallenb. & Hjortst. spec. nov.

Basidioma resupinatum, plus minus stramineum, distincte odontioides; aculeis fimbriatis, circiter 0.5 mm longis, 3-4/mm, aggregatis; margo gracilis, pallescens, interdum abruptus. Systema hyphale monomiticum, hyphae basales crassitunicatae, 3.5-4 µm latae, plus minus tumescentes, tum 8(-10) µm latae, hyphae ceterae tenuitunicatae, 2.5-3.5 µm, omnes fibulatae. Cystidia sparsa, projecta, tenuitunicata, levia, hyalina, 40-60 x 4 µm. Basidia anguste clavata, leviter sinuosa, 15-20 x 4.5(-5) µm, 4 sterigmatibus; sporis ellipsoidibus, tenuitunicatis, hyalinis, levibus, 4.5-5 x 2.5(-3) µm, neque amyloidibus, neque dextrinoidibus et cyanophilis.

Holotypus: Sweden. Medelpad, Haverö par., Björntjärnås Forest Reserve, on Picea abies. 17.IX.1986, leg. Leif Ryvarden 24081 (GB). Isotypus: (O). Paratypi: Spain. Huesca Prov., Ordesa Nat. Park, 1500 m.s.m., on Pinus, 9.XI.1977, leg. Leif Ryvarden 15009, 15031 (GB and O).

Etymology: In honour of our friend, Leif Ryvarden, who has collected all hitherto known specimens of this new species.

Basidiome resupinate, closely adnate, crustose, cracking conspicuously when dried, straw-coloured or pale ochraceous, densely odontioid, with the aculei about 0.5 mm long and 3-4/mm, crowded, apically fimbriate; subiculum whitish, thin (0.1-0.2 mm); margin indeterminate, thinning out, sometimes abrupt.
Hyphal system monomitic, basal hyphae thick-walled, partly encrusted, irregularly branched, 3.5-4(-5) µm wide, sometimes swelling considerably in KOH and then up to

8(-10) um wide, next to the substratum parallely arranged, elsewhere more or less vertical and intermingled with thin-walled hyphae; subhymenial tissue dense, consisting of thin-walled hyphae with shorter cells, about 2.5-3.5 µm wide, all hyphae with clamps.

Cystidia few and mainly in the upper part of the aculei, 40-60 x 4 µm, smooth and hyaline, projecting as much as 20-30 µm above the basidia, apically obtuse and with a basal clamp.

Basidia short-clavate, slightly sinuous, 15-20 x 4-4.5 (-5) µm, with 4 sterigmata and a basal clamp.

Spores ellipsoid to narrowly ellipsoid, 4.5-5 x 2.5(-3) µm, thin-walled, smooth, adaxial side often slightly concave, inamyloid, indextrinoid, and acyanophilous.

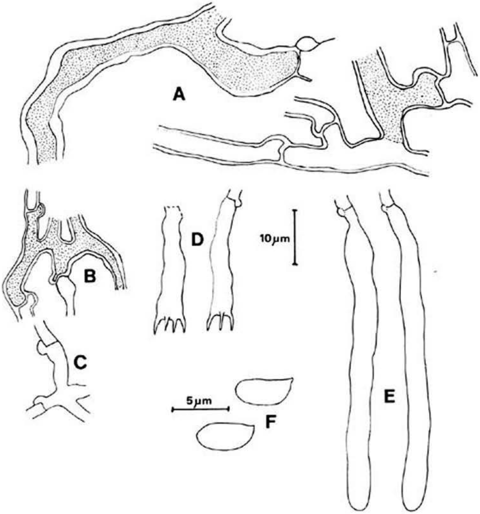

Fig. 1. Phlebia ryvardenii. A) subicular hyphae, swelling in KOH, B) context hyphae, swelling in KOH, C) subhymenial hyphae, D) basidia, E) cystidia, F) spores. - Holotypus.

Remarks. Macromorphologically this species shows affinity with some species of Hyphodontia (especially in the section Ellipsosporae Parm.) or Odonticium due to the odontioid fruitbody. However, the species resembles Phlebia s.l. in certain microfeatures, especially the narrow basidia and relatively small spores fit the modern, though wide, interpretation of this genus.

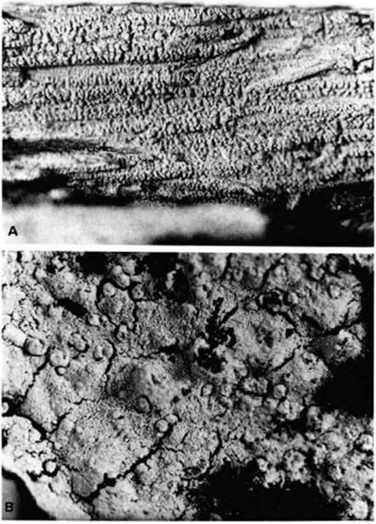

Fig. 2. Basidiocarps of A) Phlebia ryvardenii (X 4). - Coll. L. Ryvarden 24081. B) Sistotrema quadrisporum (X 4,7). - Coll. N. Hallenberg 10506. Photo Ellen Hansson.

SISTOTREMA QUADRISPORUM Hallenb. & Hjortst. spec. nov.

Basidioma resupinatum, dense adnatum, tenue, hymenio albescenti, grandinioide; aculeis circiter 0,2 mm longis, usque ad 7/mm; margine indeterminato. Systema hyphale monomiticum; hyphae tenuitunicatae, 2-3.5 µm latae, fibulatae. Cystidia nulla. Basidia urniformia, 10-20 x 5.5-7 µm, 4 sterigmatibus; sporae ellipsoideae, subreniformes, 5.5-7 x 3.3-4 µm, tenuitunicatae, leves, non-amyloides, binucleatae.

Holotypus: Spain. Santander Prov., ca 5 km S of Cavadonga, on Alnus incana. 14.XI.1977, leg. Leif Ryvarden 15372 (GB). Paratypus: Denmark. Jutland, Djursland Prov. Mols Bjerge, near Lake Bogens, on Salix. 3.IX.1987, leg. Nils Hallenberg 10506 (GB).

Basidiome resupinate, closely adnate, thin, white to slightly yellowish, hymenium continuous - porulose, grandinioid, aculei minute (ca 0,2 mm), rounded, rather scattered to crowded (up to 7/mm) in well developed parts, margin indeterminate, thinning out.
Hyphal system monomitic, hyphae 2-3.5 µm wide, constantly with clamps, with thin but distinct walls, intermingled with lots of crystalline material, densely branched and tightly packed in the thin subiculum.
Cystidia none.
Basidia urniform, 15-20 x 5.5-7 µm, apical part 3.5-4 µm wide, with 4 sterigmata and a basal clamp.
Spores ellipsoid - subreniform, adaxial side usually straight but may be slightly concave, 5.5-7 x 3.3-4 µm, thin-walled, smooth, inamyloid, binucleate.

Remarks. This species was first noticed in Eriksson et al (1984) as Sistotrema sp. Ryvarden 15372. Later, it was collected by Hallenberg in Denmark, where it covered the underside of a lying log of Salix in a swamp.
Under the lens S. quadrisporum is very similar to S. brinkmannii (Bres.)John Erikss. and the two species are certainly very closely related. Under the microscope S. quadrisporum is easily distinguished by its 4 sterigmate basidia and larger spores, which are also binucleate.

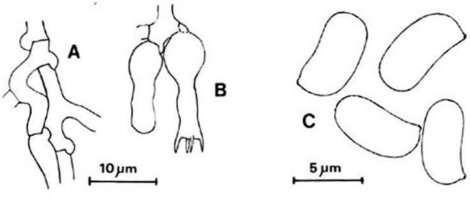

Fig. 3. Sistotrema quadrisporum. A) Context hyphae, B) basidia, C) spores. - Holotypus.

Sistotrema intermedium Hjortst. and S. sernanderi (Litsch.)Donk also have 4 sterigmate basidia. None of these is, however, grandinioid, which make them easily separated from S. quadrisporum. Moreover, S. intermedium differs by having navicular spores and S. sernanderi has gloeocystidia. Sistotrema eximum (Jacks.)Ryv. & Solh. has spores of similar size and shape as S. quadrisporum, but the fruitbodies are smooth and basidia usually bisterigmate.

STECCHERINUM QUELETII (Bourd.& Galz.)Hallenb.& Hjortst. comb. nov. Basionym: Odontia queletii Bourd. & Galz., Bull.. Soc. Mycol. France 30:270, 1914 sub nom. nov. Odontia farinacea Quel., Fl. Mycol. France p. 435, 1888; nec Odontia farinacea (Pers.:Fr.) Cooke & Quel. 1878.

Although this species is monomitic, or rather lacking skeletal hyphae in the subiculum, it fits the generic description of Steccherinum (type species: Hydnum ochraceum Pers.:Fr.) in several respects. At first, the micromorphology is very similar, particularly the strongly encrusted cystidia which sometimes have a prolonged hyphal part (pseudocystidia). Also the shape and size of the basidia and spores indicate a close relationship to Steccherinum. Moreover, Phlebia, where it has been placed by Christiansen (1960), is known to contain species which are bipolar and with a astatocoenocytic nuclear behaviour whereas Odontia queletii is proved to be tetrapolar and with a normal nuclear behaviour (Boidin & Lanquetin, 1984). The latter character is shared with species of Steccherinum.

STECCHERINUM ALBO-FIBRILLOSUM (Hjortst. & Ryv.) Hallenb. & Hjortst. comb. nov. Basionym: Phlebia albo-fibrillosa Hjortst. & Ryv., Mycotaxon 20:139, 1984.

This species is similar to S. queletii, but may be readily distinguished by shorter and more subglobose spores that are 4-4.5(-5) x 3.5-4 µm (in S. queletii 5-6 x 3-3.5 µm) and a whiter fruitbody with fibrous margin.

ACKNOWLEDGEMENTS. We are indebted to D. Pegler, London, for his critical review and for correcting the English, to E. Hansson, Göteborg for making the photos.

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SPECIES DELIMITATION IN CORTICIACEAE (BASIDIOMYCETES)

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Abstract. Compatibility tests were used to study species delimitation in 25 species of Corticiaceae. Interincompatible siblings were detected in seven species. An additional incompatibility system, restricting dikaryotization between homokaryotic mycelia were found in Peniophora limitata and Bulbillomyces farinosus.

Introduction. The study of basidiocarp morphology has been the basis for taxonomic species delimitation in Corticiaceae. In heterothallic species, compatibility tests have been used as an additional method to find out the limits between closely related species. Basidiocarps from which compatible cultures originate, have been compared with each other and with the actual taxonomic definition of the species concerned. In this way it is possible to give a more precise description of the morphological variation as well as ecological amplitude and geographical distribution. This is also one of the main purposes with this paper.

In Boidin (1977) and Hallenberg (1984) a number of earlier records from compatibility studies are summarized. Later results are given in publications by Boidin and Lanquetin, Ginns, Hallenberg, and others.

Culture data exist now for a great number of species. However, our knowledge from compatibility studies, on species variation, habitat preference and distribution is still fragmentary. Moreover, an increasing number of sibling species have been detected as a result of such tests. These siblings are very similar or apparently identical in their basidiocarp morphology but constitute genetically isolated groups (biological species). In this paper, sibling species are reported from seven taxonomical species.
As shown below, separating characters between different siblings seem to be their preferences for different substrates or habitats. This has also been indicated in earlier reports (Hallenberg 1986 a, b). A hypothesis is discussed in Hallenberg (1987), on differences in substrate or habitat preference as possible first steps in speciation processes for some species in Corticiaceae.

Intercompatibility has been accepted as a condition for "biological" conspecificity. Nevertheless, there are several explanations to negative results in mating tests between specimens which belong to the same biological species (see Boidin, 1986). From the results presented below there exist factors which restrict the mating ability in Peniophora limitata and Bulbillomyces farinosus, and which are additional to mating type system.

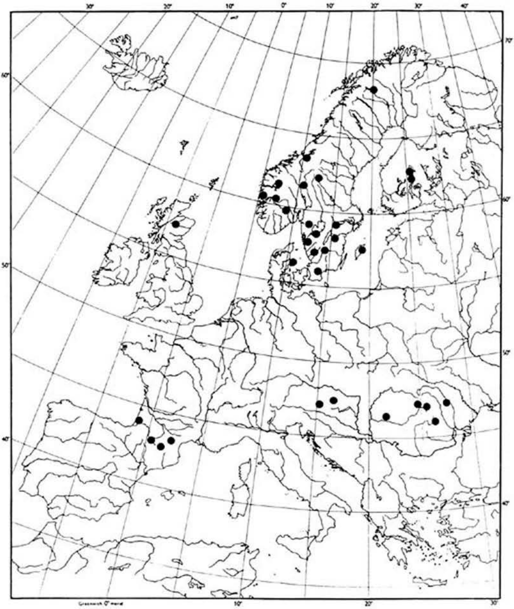

Fig. 1. Collecting localities in Europe, from where the investigated specimens originate.

METHODS. The specimens originate in Austria, Canada, Denmark, Finland, France, Norway, Romania, Scotland, Spain, and Sweden. Main collecting localities are marked in fig. 1. The studied specimens have been carefully compared with types or other representative material. When spore measurements are given these have been made from spore prints. Single-spore (SS)-cultures and polyspore (PS-)cultures were isolated after dispersal on common malt agar. To determine the breeding ability (i.e., the ability to form clamps in matings) of the individual SS-cultures, matings between SS-cultures of each specimen were first made. Compatible mating types from one specimen were mated with compatible mating types from the other specimens. In some cultures it was impossible to obtain compatible mating types. However, such SS-cultures have been accepted if they were compatible in matings with cultures from other specimens. Formation of clamps in matings was looked for after that the mycelia had been in contact for 6 weeks.
Doubtful and unexpected results were repeated. To check the occurrence of dikaryons in some cases, mycelia from the confrontation line were subcultured in malt liquid and stained in giemsa (staining method according to Boidin, 1958).

In the lists of "material" (below, under each species) information concerning the studied specimens are given. Such data are cathegorized by slanted lines: Culture number/ substrate/ locality/ SS-numbers of compatible mating types, separated by a slant line ("/"). When no compatible mating types have been found, the total number of available cultures is given.

Cultures are stored in the culture-collection at the Department of Systematic Botany, Gothenburg University. The GB-numbers refer to the culture-collection. The original specimen together with spore-print can be identified by the same number and are kept in the herbarium (GB). Descriptions of basidiocarps are referred to "Corticiaceae of North Europe" (Eriksson and Ryvarden, Eriksson et al, 1973-1987).

RESULTS

Athelia decipiens (Höhn & Litsch.)John Erikss.

Material:
GB 0291/ Picea/ Sweden, Småland/ 1,2,5/4,6,7,8,9,10.
GB 0388/ Castanea/ Austria, Steiermark/ 1/2.
GB 1494/ coniferous wood/ Romania, Suceava/ 2,4,7/3,5,6,8.
GB 1687/ Picea/ Finland, South Häme/ 1,5,7,9/2,3,6,8,10.
GB 1691/ Picea/ Finland, North Häme/ 3,8/1,2,4,5,6,7,9.
GB 1762/ Acer/ Sweden, Dalsland/ 1,4,8,9/2,5,7,6,10.

All the above mentioned cultures are intercompatible. No morphological differences between the basidiocarps have been noticed.

	GB 932-1	GB 932-2	GB 932-3	GB 932-4	GB 932-5	GB 932-6	GB 1033-1	GB 1033-2	GB 1033-3	GB 1033-5	GB 1034-1	GB 1034-3	GB 1034-5	GB 1034-2	GB 1034-4	GB 1270-1	GB 1270-3	GB 1270-4	GB 1270-2	GB 1270-5	GB 1510-1	GB 1510-3	GB 1510-2	GB 1510-4	GB 1510-6	GB 1510-8	GB 1529-1	GB 1529-2	GB 1529-3	GB 1726-1	GB 1726-2	GB 1726-3	GB 1726-4	GB 1726-5	GB 1726-6	GB 1758-1	GB 1758-3	GB 1758-8	GB 1760-1	GB 1760-2	GB 1760-3	GB 1830-5	GB 1830-7	GB 1830-8
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GB 1034-3	+	+						+	+							+			+		+		+	+	+		+	+	+	−	+	+	−	+	+	+	+		+	+	+	+	+	+
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GB 1034-4																														−	−	−	−	+	+	+	−		+	+	+	+	+	+
GB 1270-1	+	+	+	+				−	−		+	+		+							+		+	+	+		+	+		−	−	−	−	−	−	−	−	−	−	−	−	+	+	+
GB 1270-3	+	+	−	−				−	−																		+	+		+[3]	−	+[3]	+[3]	−	−	−	−	−	+	+	+	+	+	+
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GB 1270-5	−	−						+	+																																	+	+	+
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GB 1510-2	−	+	−	−			+[1]			−	+	+				+			−								+	+		−	−	−	−	−	−	−	−	+	−	+	+	+	+	+
GB 1510-4	−	+	−	−			+[2]			−	+	+				+			−[4]								−	+	−	−	+	−	−	−	−	−	−	+	−	+	+	+	+	+
GB 1510-6	−	+	−	−			−			−	+	+				+			−								+	+		+	−	−	−	+	−	−	−	+	+	+	+	+	+	+
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GB 1529-2	+	+						−	−		+	+				+	+				+		+	+	+					+	−	−	+	−	−	−	−	+	+	+	+	+	+	+
GB 1529-3											−	+									−			−						+	−	−	+	−	−	−	−	+	+	+	+	+	+	+

	GB 932-1	GB 932-2	GB 932-3	GB 932-4	GB 932-5	GB 932-6	GB 1033-1	GB 1033-2	GB 1033-3	GB 1033-5	GB 1034-1	GB 1034-3	GB 1034-5	GB 1034-2	GB 1034-4	GB 1270-1	GB 1270-3	GB 1270-4	GB 1270-2	GB 1270-5	GB 1510-1	GB 1510-3	GB 1510-2	GB 1510-4	GB 1510-6	GB 1510-8	GB 1529-1	GB 1529-2	GB 1529-3	GB 1726-1	GB 1726-2	GB 1726-3	GB 1726-4	GB 1726-5	GB 1726-6	GB 1758-1	GB 1758-3	GB 1758-8	GB 1760-1	GB 1760-2	GB 1760-3	GB 1830-5	GB 1830-7	GB 1830-8
GB 1726-1	+		+	+	+	+			+		+	-	-	-	-	-	$+^3$	-	+		-	+	-	-	+	-	+	+	+							-	-	-	+	+	+	+	+	+
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Fig. 2. Crossings in Bulbillomyces farinosus. 1 = negative result on MA dish, constant clamps when subcultured in malt liquid and grown under a collodion film. 2 = as above, but only a few clamps detected when subcultured in malt liquid. 3 = distinct barrier formed between the SS-cultures, only a few clamps formed on confrontation line. 4 = a few false clamps formed on confrontation line.

One character in this species is the lack of clamps in all parts of the basidiocarps. In cultured secondary mycelia, however, clamps are present at many septa (inconstant clamps - Boidin and Lanquetin, 1984 a). Bipolarity is indicated and the nuclear behaviour is normal.

Athelia decipiens is reported to be frequent in the conifer region in N. Europe, occurring in both drier forests and more humid ones (Corticiaceae of North Europe). The investigated specimens were collected on decayed wood and trunks (both white- and brown-rotted) of Picea, Acer, Castanea, both on lignum and on bark.

Basidioradulum radula (Fr.)Nobles

Material:
GB 0246/ Salix/ Sweden, Torne Lappmark/ 2,4/5.
GB 0374/ Abies/ Austria, Steiermark/ 1/2,4.
GB 0381/ Abies/ Austria, Steiermark/ 1,2/3,4,5.
GB 0386/ Prunus/ Austria, Steiermark/ 1/2,3,4.
GB 0463/ Alnus/ Norway, South Tröndelag/ 7 SS.
GB 0582/ Populus/ Canada, Quebec/ 2 SS.
GB 0783/ deciduous wood/ Canada, Quebec/ 1,3/2,4.
GB 1016/ Abies/ Romania, Suceava/ 5 SS.
GB 1706/ Alnus/ Finland, North Häme/ 5 SS.
GB 1805/ Abies/ Spain, Lerida/ 2,3,7,8/4,5,9,10.
GB 1844/ Abies/ Spain, Lerida/ 2 SS.

Complete compatibility between the above mentioned cultures. No morphological differences between the basidiocarps noticed in the microscope, but macroscopically the species is obviously variable. The hymenophore may be almost smooth to raduloid with teeth up to 5 mm long. Recorded on both bark and wood, in N. Europe frequently on deciduous wood, in C. and S. Europe often found on Abies.

Bulbillomyces farinosus (Bres.)Jül.

Material:
GB 0932/ deciduous wood/ Scotland, Perthshire/ 6 SS.
GB 1033/ deciduous wood/ Romania, Iasi/ 2/3,4.
GB 1034/ deciduous wood/ Romania, Suceava/ 1/3,5.
GB 1270/ Fagus/ Sweden, Skåne/ 1,3,4/2,5.
GB 1510/ deciduous wood/ Romania, Iasi/ 2/1,3,5,7; 4/6,8.
GB 1529/ Carpinus/ Romania, Iasi/ 3 SS.
GB 1726/ deciduous wood/ Sweden, Västergötland/ 1/2,3,7; 4/5,6,8,9.
GB 1758/ deciduous wood/ Sweden, Västergötland/ 1,3,6/8.
GB 1760/ deciduous wood/ Sweden, Västergötland/ 5 SS.
GB 1830/ deciduous wood/ Spain, Lerida/ 5/7,8.

No noticeable morphological differences between the basidiocarps have been seen, with the exception for the frequency of encrusted cystidia, which is variable. Moreover, the size of the basidiocarp varies. Mostly they are very small and the specimens are recognized in the field because of abundant Aegerita-state. However, sometimes the basidiocarps are bigger (GB 1760) and in Lundell & Nannfeldt (1953) a specimen is reported where the basidiocarp covers several dm^3. The latter specimen, as well as GB 1760 were compatible with other specimens with small basidiocarps.

The compatibility tests performed here gave a number of unexpected results (fig. 2). In some matings a narrow but distinct barrier was formed and no clamps or dikaryons were recorded. This incompatibility is not of homogenic nature (identical mating type alleles) because different SS-cultures, representing the same mating type in a specimen, behaved differently in matings with certain other cultures. The same kind of behaviour was reported by Boidin and Lanquetin (1984 c) in matings between Amylostereum ferreum (Berk. & Curt.)Boid. & Lanq. and A. laevigatum (Fr.)Boid. In two matings, however, no clamps were formed in matings on the malt agar dish (GB 1033/1 x GB 1510/2 and 4). After the confrontation line had been subcultured in malt liquid and then grown under a collodion film on a slide, constant clamps were seen. However, this change of behaviour was not found in other "negative" matings.

This incompatibility seems to be of heterogenic nature and the responsible genes are not linked to the mating type system, but superimposed on it. The genetical structure of this incompatibility system is not further analyzed here, however, the biological consequences must be that an additional mating barrier exist.

Ceraceomerulius serpens (Fr.)Erikss. & Ryv.

Material:
GB 262/ Salix/ Sweden, Torne Lappmark/ 1 SS, 1 PS.
GB 536/ Picea/ Canada, Quebec/ 1/2; 3/4.
GB 816/ Fagus/ Canada, Quebec/ 1 PS.
GB 915/ Juniperus/ Norway, North Tröndelag/ 1 haploid SS used; 8 other isolated SS were clamped.
GB 1452/ Fagus/ Sweden, Västergötland/ 1,3,4/5,8; 2,6/7.
GB 1731/ Corylus/ Sweden, Västergötland/ 2/6.
LY 10020/ Picea/ Austria, Nieder Österreich/ 2 SS.

GB 1209/ Populus/ Norway, Telemark/ 1/2,3,4.
GB 1246/ deciduous wood/ Norway, Opland/ 1,2/3.

GB 1711/ Pinus/ Finland, North Häme/ 1,7/2,5,6; 3/4,8.
GB 1811/ Pinus/ Spain, Huesca/ 1/3.

C. serpens has been regarded as a species with rather variable macroscopic basidiocarp features, but morphologically uniform in the microscope. Further, it is a widely distributed species over the N. hemisphere and it has a wide substrate spectrum. The hymenium may be smooth in very young specimens and in distal parts of the basidiocarps, or distinctly meruloid in well developed basidiocarps. Its margin varies from rather narrow to wide and byssoid, frequently whitish. Rhizomorphic strands may be present or absent in association to the basidiocarp. The colour is frequently greyish ochraceous but with reddish, greenish, or yellowish tints. C. serpens has been reported from a number of deciduous and coniferous trees. The basidiocarps have been found in association with booth white- and brown-rotted wood.

	GB 536-1	GB 536-2	GB 536-3	GB 536-4	GB 816-PS	GB 915-7	LY 10020-1	LY 10020-2	GB 1452-1	GB 1452-5	GB 1452-2	GB 1452-7	GB 1731-1	GB 1731-2	GB 1731-3	GB 1209-1	GB 1209-2	GB 1209-3	GB 1246-1	GB 1246-2	GB 1246-3	GB 1711-1	GB 1711-2	GB 1711-3	GB 1711-4	GB 1811-1	GB 1811-3
GB 262-1	+	+	+	+			+	+	+		+					-	-		-								
GB 262-PS	+	+																									
GB 536-1					-											-	-		-		-						
GB 536-2					+		+	+								-	-		-		-						
GB 536-3							+	+					+	$-^{1}$					-		-	-	-	-	-	-	-
GB 536-4													+	+					-		-	-	-	-	-	-	-
GB 816-PS	-	+														-	-										
GB 915-7									+	+						-	-			-	-						
LY 10020-1		+	+						+		+					-	-					$-^{3}$	$-^{3}$				
LY 10020-2		+	+						+		+					-	-					$-^{3}$	$-^{3}$				
GB 1452-1						+	+	+					+	+		-	-			-	-	$-^{3}$	$-^{3}$	-	-	-	-
GB 1452-5						+							+	+								$-^{3}$	$-^{3}$	-	-	-	-
GB 1452-2							+	+					+	+		-	-			-	-	-	-	-	-	-	-
GB 1452-7													+	+								-	-	-	-	-	-
GB 1731-1			+	+					+	+	+	+				-	-		-		-	-	-	-	-	-	-
GB 1731-2			$-^{1}$	+					+	+	+	+				-	-		-		-					-	-
GB 1731-3																						-	-	-	-		
GB 1209-1	-	-			-	-	-	-	-		-		-	-					+		+	$-^{2}$	$-^{2}$	-	-	-	-
GB 1209-2	-	-			-	-	-	-	-		-		-	-					+		+	$-^{2}$	$-^{2}$	-	-	-	-
GB 1209-3																						-	-	-	-		
GB 1246-1	-	-	-	-									-	-		+	+					-	-	-	-	-	-
GB 1246-2						-			-		-													-	-		
GB 1246-3	-	-	-	-		-			-		-		-	-		+	+					-	-	-	-	-	-
GB 1711-1			-	-			$-^{3}$	$-^{3}$	$-^{3}$	$-^{3}$	-	-	-		-	$-^{2}$	$-^{2}$	-	-		-					+	+
GB 1711-2			-	-			$-^{3}$	$-^{3}$	$-^{3}$	$-^{3}$	-	-	-		-	$-^{2}$	$-^{2}$	-	-		-					+	+
GB 1711-3			-	-					-	-	-	-	-		-	-	-	-	-	-	-					+	+
GB 1711-4			-	-					-	-	-	-	-		-	-	-	-	-	-	-					+	+
GB 1811-1			-	-					-	-	-	-	-	-		-	-		-		-	+	+	+	+		
GB 1811-3			-	-					-	-	-	-	-	-		-	-		-		-	+	+	+	+		

Fig. 3. Confrontations in Ceraceomerulius serpens. 1 = Distinct barrier between the two mycelia. GB 536-3 forms lots of cordons. 2 = A weak, but distinct barrier formed. 3 = A strong barrier formed, which is reddish brown.

From intercompatibility tests follows that three incompatibility groups have been distinguished (fig. 3):
Group 1: GB 262, GB 536, GB 915, GB 1452, GB 1731, LY 10020.
Group 2: GB 1209, GB 1246.
Group 3: 1711, GB 1811.
Group 1. These specimens have been found on a variety of deciduous trees and on Picea, Juniperus (and Pinus in Canada). They are associated with rather hard or distinctly brown-rotted wood. Tetrapolarity is indicated.

Group 2. These specimens were collected in S. Norway on deciduous wood (Alnus and Populus) in mixed forests. The basidiocarps were associated with loose, white-rotted wood. Bipolarity is indicated but only few SS-cultures available.

Group 3. These specimens were collected on Pinus in old virgin forests with mixed coniferous and deciduous trees. The basidiocarps were associated with rather hard wood. Tetrapolarity is indicated. Both specimens had a greenish tint but in other respects the basidiocarp morphology was in accordance with group 1 and 2. In our herbarium (GB) there are several findings of C. serpens on Pinus and most of them have a greenish tint.

Drop tests for extracellular oxidases were negative for all three groups (Syringaldazine, 1-Naphthol, Gum Guaiac, Guaiacol, p-Cresol, L-Tyrosine - Marr, 1979).

The polarity pattern for C. serpens has been differently interpreted. According to Ginns (1976) it is bipolar, while Boidin and Lanquetin (1984 b) report tetrapolarity. The existence of three (or more) siblings within this complex may explain the different results.

Cystostereum murraii (Berk. & Curt.)Pouz.

Material:
GB 0129/ Picea/ Sweden, Dalarna/ 2,3/4.
GB 0588/ Acer/ Canada, Quebec/ 1,2/4.
GB 0738/ Betula/ Canada, Ontario/ 2 SS.
GB 1051/ Abies/ Romania, Suceava/ 5 SS.
GB 1826/ Abies/ Spain, Huesca/ 5 SS.

All investigated specimens are fully intercompatible. Eriksson & Ryvarden (1975) noticed that there are some differences in basidiocarp morphology and substrate preference between European and N. American specimens. Kotlaba (1987) reports that C. murraii is widely distributed over the earth and that the species in Europe has been found on both Picea and Abies, rarely also on deciduous trees. Hallenberg (1984) reported compatibility between the above mentioned cultures from Canada and GB 129 (on Picea). Now, two specimens on Abies from S. Europe have been added to this compatibility group.

Gloeocystidiellum clavuligerum(Höhn. & Litsch.)Nakas.

Material:
GB 0554/ deciduous wood/ Canada, Quebec/ 1/2.
GB 0656/ Pseudotsuga/ Canada, B.C./ 4 SS.
GB 0670/ Alnus/ Canada, B.C./ 1,3/4.
GB 0676/ Alnus/ Canada, B.C./ 1,3/4.
GB 0677/ Alnus/ Canada, B.C./ neohaploidized PS-culture used in mating tests.
GB 1039/ deciduous wood/ Romania, Bihor/ 5 SS.

Intercompatibility between the N. American specimens (above) have earlier been verified (Hallenberg, 1984). There, I argued that the type collection was not conspecific with the N. American material used in my tests. A repeated study of the type collection showed that one piece of it contained a small basidiocarp which was in accordance with the N. American specimens used by me as well as those used by Nakasone (1982). In 1983 I collected a specimen of *G. clavuligerum* from Romania which proved to be compatible with those of N. America.

Gloeocystidiellum porosum (Berk. & Curt.)Donk

Material:
GB 0038/ Ulmus/ Sweden, Västergötland/ 3 SS.
GB 0061/ Fagus/ Denmark, Jutland/ 1,6,8/5,10: 3,4/7,9.
GB 0072/ Fraxinus/ Denmark, Jutland/ 3/5.
GB 0324/ Ulmus/ Sweden, Närke/ 3 SS.
GB 0587/ Alnus/ Canada, Quebec/ 1/2.
GB 0690/ Alnus/ Canada, B.C./ 2/3.
GB 0898/ deciduous wood/ Denmark, Jutland/ 5 SS.
GB 0937/ Ulmus/ Sweden, Västergötland/ 9 SS.
GB 1018/ Fagus/ Romania, Suceava/ 5 SS.
GB 1168/ Corylus/ Sweden, Bohuslän/ 5 SS.
GB 1183/ Alnus/ Norway, Sogn and Fjordane/ 5 SS.
GB 1184/ Alnus/ Norway, Sogn and Fjordane/ 5 SS.
GB 1271/ Quercus/ Sweden, Skåne/ 5 SS.

The incompatibility group from Hallenberg (1984) has been enlarged with 5 additional specimens. No morphological differences between the basidiocarps and fully intercompatibility recorded.

Hyphodontia alutacea (Fr.)John Erikss.

Material:
GB 0328/ Ulmus/ Sweden, Närke/ 1,2/3.
GB 0405/ deciduous wood/ Austria, Steiermark/ 4/3,5.
GB 1683/ Picea/ Sweden, Halland/ 1,2/3,4,5,6.

GB 1721/ Pinus/ Sweden, Småland/ 1,4,5,7,8,10/2,3,6,9.

Complete intercompatibility between GB 328, GB 405, and GB 1683. GB 1721 was incompatible with the other cultures.

According to Eriksson & Ryvarden (1976), H. alutacea occurs on decayed coniferous wood, and almost all herbarium material available in GB has been collected on such substrates.
The basidiocarp morphology in 1721 is very similar to the other specimens macroscopically. However, in the microscope there are some minor differences: In the main group the hyphae in the centre of the aculei are more thick-walled, contrasting rather distictly to the slightly more thin-walled subhymenial hyphae. In GB 1721 there is no distinct differentiation between the central hyphae and the subhymenial ones.

Hyphodontia alutaria (Burt)John Erikss.

Material:
GB 0181/ Picea/ Sweden, Östergötland/ 3 SS.
GB 0207/ deciduous wood/ Sweden, Västergötland/ 1/6; 2/5.
GB 1339/ Juniperus/ Sweden, Gotland/ 1,3,6/2,4,5.
GB 1558/ Picea/ Romania, Suceava/ neohaploidized PS-culture used in mating tests.
GB 1836/ Abies/ Spain, Huesca/ 1,3/2,4,5.

Complete compatibility between investigated specimens. The specimens are very similar in basidiocarp morphology, differing only slightly in the size of projecting cystidia.

Hyphodontia arguta (Fr.)John Erikss.

Material:
GB 0062/ Fagus/ Denmark, Jutland/ 8 SS.
GB 0344/ deciduous wood/ Sweden, Västmanland/ 1/3,4.
GB 0798/ deciduous wood/ Canada, B.C./ 4 SS.
GB 1083/ Picea/ Romania, Suceava/ 1 PS.
GB 1298/ Ulmus/ Sweden, Skåne/ 6/2,3,4,5.
GB 1347/ Ulmus/ Sweden, Västergötland/ 6 SS.
GB 1355/ Ulmus/ Sweden, Västergötland/ 6 SS.
GB 1541/ Fagus/ Austria, Steiermark/ 1,2,3,5,7/4,6.

Complete compatibility between the specimens above. No morphological differences between the basidiocarps, with exception for the length of the aculei (0,5 - 1,5 mm).

Hyphodontia aspera (Fr.)John Erikss.

Material:
GB 1093/ Picea/ Romania, Suceava/ 1,6,9/8,13; 4,5,10/12.
GB 1094/ Picea/ Romania, Alba/ 2/4,5.
GB 1278/ Picea/ Norway, Opland/ 1/2.
GB 1313/ Picea/ Norway, Opland/ 3 SS.
GB 1333/ Populus/ Norway, Opland/ 4 SS.
GB 1409/ Juniperus/ France, Savoie/ 2 SS.
GB 1543/ Alnus/ Austria, Steiermark/ 2,3/6.
GB 1562/ Picea/ Romania, Suceava/ 1 PS.

In Hallenberg (1984) a number of interincompatible specimens were reported from *Hyphodontia aspera-breviseta* complex. Two Romanian cultures (GB 1093 and GB 1094) were then found to be compatible and this group has now been enlarged to 8 specimens (above). These specimens are fully interincompatible and very uniform in their basidiocarp morphology.

Fructification starts with a white, cottony mycelium covering the substrate surface and later a smooth, continuous hymenium with scattered aculei appears. Then it is no longer pure white but has a light creamish tint. The aculei in mature basidiocarps are scattered and there is always continuous hymenium in between. The aculei are initially small and conical but will soon be longer and with penicillate apices. The context in basidiocarps is rather loose.

This description is clearly embraced by the taxonomic definition for *H. aspera* given in Eriksson & Ryvarden (1976). However, there is no doubt that this definition covers several sibling species, which in basidiocarp morphology are very similar. A few are mentioned under *H. aspera* in Hallenberg (1984). An additional incompatible specimen has been found in Norway (GB 1309), differing minutely in micromorphology (more dense tissue, more frequent capitate cystidioles).

Hyphodontia crustosa (Fr.)John Erikss.

Material:
GB 1163/ deciduous wood/ Sweden, Bohuslän/ 4 SS.
GB 1345/ Corylus/ Sweden, Gotland/ 2,3/4.
GB 1364/ Juniperus/ Sweden, Gotland/ 1,3,4,6/5.
GB 1548/ Picea/ Romania, Brasov/ 1,8/4; 9/5,7.
GB 1559/ Fagus/ Romania, Suceava/ 1 PS.
GB 1824/ deciduous wood/ Spain, Lerida/ 1/2.
LY 3614/ coniferous wood/ France, Tarn/ 1/2.

GB 1779/ deciduous wood/ Finland, South Häme/ 5 SS.

Intercompatibility between above mentioned cultures, except for GB 1779. The specimens in the main group are very similar in their basidiocarp morphology, while GB 1779 deviates by minutely longer and narrower spores.

Hyphodontia pallidula (Bres.)John Erikss.

Material:
GB 0802/ coniferous wood/ Canada, B.C./ 3 SS.
GB 1296/ Picea/ Sweden, Halland/ 1,3,6/2,4,7.
GB 1365/ Fagus/ Sweden, Dalsland/ 1/5.

Many attempts have been made to get SS-cultures from spore prints of this species, without success. Gradually, however, a few cultures have been obtained which have been shown to be fully compatible. No morphological differences between their basidiocarps noticed.

Hyphodontia pruni (Lasch)Svrcek

Material:
GB 0346/ Corylus/ Sweden, Närke/ 1/4; 2/3.
GB 0829/ Ulmus/ Sweden, Västergötland/ 3/4.
GB 1343/ deciduous wood/ Sweden, Västergötland/ 2,3/4.
GB 1346/ Fraxinus/ Sweden, Gotland/ 1,3,5/2.
GB 1348/ Corylus/ Sweden, Gotland/ 1/5.

Intercompatibility between the cultures above. No morphological differences between the basidiocarps noticed.

Hyphodontia rimosissima (Peck)Gilb.

Material:
GB 0085/ Fraxinus/ Denmark, Jutland/ 1,3/2.
GB 0273/ Fraxinus/ Denmark, Jutland/ 1 PS.
GB 0345/ deciduous wood/ Sweden, Västergötland/ 1 PS.
GB 1228/ Fagus/ Norway, Rogaland/ 2 SS.
GB 1301/ Acer/ Sweden, Skåne/ 1,3,4/2,5.
GB 1314/ Fagus/ Sweden, Skåne/ 3 SS.
GB 1460/ Ulmus/ Sweden, Västergötland/ 6 SS.

These specimens were fully intercompatible and no morphological differences between the basidiocarps were seen. All specimens were collected on white-rotted wood. In Hallenberg (1984) it was shown that specimens from Europe were partially compatible with specimens from N. America.

Hyphodontia subalutacea (Karst.)John Erikss.

Material:
GB 0096/ Pinus/ Sweden, Dalarna/ 6 SS.
GB 0286/ Pinus/ Denmark, Jutland/ 4 SS.
GB 1433/ coniferous wood/ Norway, Oslo/ 1/5,7.

GB 0299/ Quercus/ Sweden, Småland/ 5 SS.
GB 0335/ Ulmus/ Sweden, Närke/ 1 SS, 1 PS.
GB 0349/ Quercus/ Sweden, Västmanland/ 3 SS.
GB 1095/ deciduous wood/ Sweden, Västergötland/ 5 SS.
GB 1205/ Fagus/ Norway, Rogaland/ 1,3,5/2,4.
GB 1208/ Betula/ Norway, Hordaland/ 2/5.
GB 1522/ Fagus/ Romania, Brasov/ 1/3.

GB 0961/ Betula/ Scotland, Perthshire/ 7 SS.

GB 1318/ Pinus/ Sweden, Gotland/ 1/6.

GB 1834/ Pinus/ France, Pyrenees Orientales/ 1,3/5; 2/4.

GB 1838/ Pinus/ Spain, Huesca/ 2/3.

Incompatibility has been shown between the following groups and specimens. Within each group fully intercompatibility has been recorded.

Group 1. GB 96, GB 286, GB 1433. This group seems to be confined to coniferous wood in Europe.

Group 2. GB 299, GB 335, GB 349, GB 1095, GB 1205, GB 1208, GB 1522. The specimens in this group were all collected on wood from deciduous trees.

Group 3. GB 961. This specimens deviates from the other groups morphologically by an almost smooth and continuous hymenium. Moreover, the basidiocarp was associated with strongly decayed, white-rotted wood, while all other groups in H. subalutacea were associated with rather hard wood when dried, frequently with a typical brown-rot.

Group 4. GB 1318. The basidiocarp of this specimen is more adnate than other representatives, and more ceraceous in its consistency.

Group 5. GB 1834. The basidiocarp is cream-coloured and rather thick.

Group 6. GB 1838. The basidiocarp is thin and whitish.

Two specimens from Canada also belong to group 1, but one of these was also compatible with representatives of group 2 (Hallenberg, 1984).
With exception of the differences mentioned above, the tested specimens are very similar in basidiocarp morphology. Even if some species in the close vicinity of H. subalutacea have been described (H. altaica Parm, H. cineracea (Bourd. & Galz.)Erikss. & Hjortst., H. floccosa (Bourd & Galz.)John Erikss.) it seems obvious that some more (biological) species exist in this complex.

Hypochnicium eichleri (Bres.)Erikss. & Ryv.

Material:
GB 0936/ Picea/ Scotland, Perthshire/ 2 SS.
GB 0938/ Betula/ Scotland, Perthshire/ 3 SS.
GB 1065/ Betula/ Romania, Suceava/ 6 SS.
GB 1203/ Alnus/ Norway, Hordaland/ 2 SS.
GB 1362/ Fagus/ Sweden, Dalsland/ 2/1,3.
GB 1794/ Pinus/ France, Landes/ 1,3,5,6/4,9,10; 2,8/7.

GB 1772/ Pinus/ Sweden, Dalsland/ 1,5,6/2,3,7,8.
GB 1865/ Pinus/ Spain, Lerida/ 1/2.

GB 1709/ Pinus/ Finland, South Häme/ 3 SS.

The Hypochnicium eichleri complex was discussed in Hallenberg (1985). The compatibility group detected there (H. eichleri s.str.) has now been enlargened with one more specimen (GB 1794). Still, however, 20 % of the matings within this group are negative. Moreover, three other specimens have been shown to be completely incompatible with the main group (fig. 4):

- GB 1709. This specimen is incompatible with all other avialable cultures in this complex.
- GB 1772 is partial compatible with GB 1865, both of them are incompatible with all other representatives in this complex.

All specimens tested here are very similar in their basidiocarp morphology with exception for GB 1865, where the spores are more ellipsoid - ovoid, and slightly larger than in *H. eichleri* (8,5-9 x 6-6,5 µm versus 7-8 x 5,5-7 µm). GB 1865 is thus morphologically very close to *H. albostramineum* (Bres.)Hallenb., while the spores in GB 1772 are slightly smaller and more rounded (7,5-8 x 6,5 µm), and consequently will be placed within the limits for *H. eichleri*. The spore ornamentation is very similar for all representatives (see fig. 5).

Chlamydospores have been found in culture in the main compatibility group but are absent in the other siblings.

	GB 938-1	GB 938-3	GB 1065-1	GB 1065-2	GB 1203-1	GB 1203-2	GB 1203-5	GB 1203-3	GB 1203-4	GB 1362-1	GB 1362-2	GB 1362-3	GB 1794-1	GB 1794-4	GB 1794-2	GB 1794-7	GB 1709-1	GB 1772-1	GB 1772-2	GB 1772-3	GB 1772-9	GB 1865-1	GB 1865-2
GB 936-1	-	+	+	+						+	+	+	+	+	+	+	-	-		-		-	-
GB 936-3	-	+	+	+						+	+	+	+	+	+	+	-	-		-		-	-
GB 938-1			-	-	-	-		-		+	+	+						-		-			
GB 938-3			+	+		+	+			+	+	+						-		-			
GB 1065-1	-	+			+	+		+		-	+	-[1]	+	+	+	+	-	-		-			
GB 1065-2	-	+			+	+		+		-	+	+	+	+	+	+	-	-		-			
GB 1203-1	-		+	+						+	+	+											
GB 1203-2	-	+	+	+						+	+	+											
GB 1203-5		+								+	+	+											
GB 1203-3	-		+	+						+	+	+					-						
GB 1203-4																	-						
GB 1362-1	+	+	-	-	+	+	+	+					+	+	+	+	-	-		-		-	-
GB 1362-2	+	+	+	+[1]	+	+	+	+					-	-	-	-	-	-		-		-	-
GB 1362-3	+	+	-	+	+	+	+	+															
GB 1794-1			+	+						+	-						-	-		-			
GB 1794-4			+	+						+	-						-	-		-			
GB 1794-2			+	+						+	-						-	-		-			
GB 1794-7			+	+						+	-						-	-		-			
GB 1709-1			-	-				-	-	-	-		-	-	-	-		-		-		-	-
GB 1772-1	-	-	-	-						-	-		-	-	-	-	-					-	-
GB 1772-2																						-	-
GB 1772-3	-	-	-	-						-	-		-	-	-	-	-						
GB 1772-9																						+	+
GB 1865-1										-	-		-	-	-	-	-	-	-		+		
GB 1865-2										-	-		-	-	-	-	-	-	-		+		

Fig. 4. Confrontations in *Hypochnicium eichleri*. 1 = Only a few clamps formed on confrontation line.

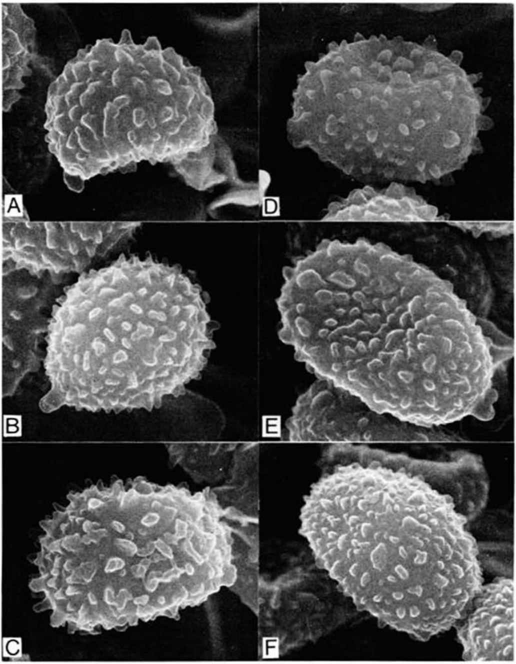

Fig. 5. SEM pictures of spores in Hypochnicium eichleri. A) GB 938, B) GB 1794, C) GB 1203, D) GB 1772, E) GB 1865, F) GB 1709. Magnification: 1 µm = 9 mm. - Photo T. Bergquist.

Leptosporomyces galzinii (Bourd.)Jül.

Material:
GB 0255/ Pinus/ Denmark, Jutland/ 2,4,5/1,3,6,7,8,9.
GB 0270/ Pinus/ Sweden, Torne Lappmark/ 1,5/4,7.
GB 0276/ Picea/ Denmark, Jutland/ 3 SS.

Compatibility between these three specimens. No morphological differences recorded.

Merulius tremellosus Fr.

Material:
GB 0519/ Fraxinus/ Sweden, Västergötland/ 1,3,6,7,8,9/2,4,5.
GB 0617/ Betula/ Canada, Ontario/ 1 PS.
GB 1261/ Fagus/ Sweden, Skåne/ 4 SS.
GB 1447/ Fagus/ Sweden, Västergötland/ 2,5/3.
GB 1787/ Quercus/ France, Les Landes/ 1,4,6,7,10/2,3,5,8,9.
GB 1813/ Betula/ France Pyrenees Orientales/ 1,2/3.

Complete compatibility between the tested specimens. No morphological differences between the basidiocarps noticed.

Peniophora incarnata (Fr.)Karst.

Material:
GB 0043/ Quercus/ Sweden, Skåne/ 1/7; 3/9.
GB 0712/ Alnus/ Canada, B.C./ 2/3.
GB 0728/ Alnus/ Canada, B.C./ 2 SS.
GB 0924/ coniferous wood/ Scotland, Perthshire/ 1/2.
GB 1020/ deciduous wood/ Romania, Iasi/ 5 SS.
GB 1174/ deciduous wood/ Sweden, Bohuslän/ 5 SS.
GB 1502/ deciduous wood/ Romania, Brasov/ 1,2,7/5,6.
GB 1689/ Populus/ Finland, North Häme/ 6,7,9/1,2,3,4,5,8.
GB 1837/ deciduous wood/ Spain, Lerida/ 3 SS.

Complete compatibility between these specimens. There is a small variation in basidiocarp colour between the tested specimens. Normally, the colour is reddish but it may also be slightly brownish (GB 712, GB 1502) or whitish with only a reddish or brownish tint (GB 1689). The sulfocystidia are numerous in all specimens while the number of metuloids varies. In no other respects have any morphological differences been recorded between the specimens.

Peniophora limitata (Fr.)Cooke

Material:
GB 0231/ Fraxinus/ Denmark, Jutland/ 2 SS.
GB 1011/ Fraxinus/ Romania, Suceava/ 4 SS.
GB 1012/ Fraxinus/ Romania, Suceava/ 5 SS.
GB 1167/ Fraxinus/ Sweden, Bohuslän/ 1,2,3,4/5.
GB 1481/ Fraxinus/ Romania, Iasi/ 9 SS.

When the first matings were made in this species, very few combinations with clamp formation were recorded. This was astonishing, as P. limitata was regarded as a well defined species with little delimitation problems. Later, mycelium from the confrontation line in all matings were subcultured in malt liquid, then grown under a collodion film on slides and finally stained in Giemsa. This was done in order to check if there were any dikaryons present in spite of the lack of clamps. It was then realized that both clamps and dikaryons were present in abundance (fig. 6).

Initially, when the SS-mycelia were confronted on a malt-agar dish, a strong barrier was developed between the mycelia. This must be a superimposed incompatibility system which is effective when great amounts of mycelia from two compatible SS-cultures meet, but which is not effective when only single hyphae get in contact with each other. After a prolonged growth (more than 2 months) of the confrontation lines on common malt agar dishes, clamps began to appear, but not in all combinations and only at a low frequency.

	GB 231-1	GB 231-2	GB 231-3	GB 1011-1	GB 1011-2	GB 1012-1	GB 1012-2	GB 1167-1	GB 1167-2	GB 1167-5	GB 1481-1	GB 1481-2
GB 1011-1						-*	-*	+		-*		
GB 1011-2						-*	-*	-*		+		
GB 1012-1	-	-*		-*	-*			-*	-		-*	-*
GB 1012-2	-	-*		-*	-*			-*	-		-*	-*
GB 1167-1	-	-*		+	-*	-*	-*				-*	-*
GB 1167-2	-	-*				-	-					
GB 1167-5				-*	+						+	+
GB 1481-1		-*	-*			-*	-*	-*		+		
GB 1481-2		-*	-*			-*	-*	-*		+		

Fig. 6. Confrontations in Peniophora limitata. -* = Mycelium from confrontation line were subcultured in malt liquid and grown on slides under a collodion film. Clamps absent on MA dishes but present in subcultures.

Phlebia livida (Fr.)Bres.

Material:
GB 0395/ Abies/ Austria, Steiermark/ 1 PS.
GB 1283/ deciduous wood/ Sweden, Skåne/ 2 SS.
GB 1455/ Fagus/ Sweden, Västergötland/ 1,2,3,5,6,/4.
GB 1509/ deciduous wood/ Romania, Brasov/ 6 SS.
GB 1518/ Fagus/ Romania, Neamt/ neohaploidized PS-culture used in mating tests.
GB 1798/ Fagus/ Spain, Huesca/ 1/2,3.
GB 1812/ Fagus/ Spain, Huesca/ 1,4/2,3,5.
GB 1814/ Abies/ Spain, Lerida/ 1,2,6,7,8,10/3,4,5,9.

GB 0301/ Picea/ Sweden, Östergötland/ 1,3/2,4.
GB 1290/ Picea/ Sweden, Halland/ 1,2,3,4/5.

Two compatibility groups have been distinguished:

Group 1. GB 301, GB 1290. Both specimens were collected on Picea.
Group 2. GB 395, GB 1283, GB 1455, GB 1509, GB 1518, GB 1798, GB 1812, GB 1814.

	GB 395-PS	GB 1283-1	GB 1283-2	GB 1455-1	GB 1455-2	GB 1455-4	GB 1509-1	GB 1509-2	GB 1518-PS	GB 1659-1	GB 1659-2	GB 1798-1	GB 1798-2	GB 1812-1	GB 1812-2	GB 1814-1	GB 1814-3	GB 301-1	GB 301-2	GB 301-3	GB 301-4	GB 1290-1	GB 1290-5
GB 1283-1	+			+	+															-	-	-	-
GB 1283-2	+			+	+															-	-	-	-
GB 1455-1		+	+				+	+	+			+	+	+	+	+	+					-	-
GB 1455-2		+	+																			-	-
GB 1455-4							+	+	+			+	+	+	+	+	+						
GB 1509-1				+		+			+													-	-
GB 1509-2				+		+			+													-	-
GB 1518-PS				+		+	+	+														-	-
GB 1659-1												+	+	+	+	+	+						
GB 1659-2												+	+	+	+	+	+						
GB 1798-1				+		+				+	+			+	+	+	+	-	-			-	
GB 1798-2				+		+				+	+			+	+	+	+	-	-			-	
GB 1812-1				+		+				+	+	+	+			+	+	-	-			-	
GB 1812-2				+		+				+	+	+	+			+	+	-	-			-	
GB 1814-1				+		+				+	+	+	+	+	+			-	-			-	
GB 1814-2				+		+				+	+	+	+	+	+			-	-			-	
GB 301-1												-	-	-	-	-	-						
GB 301-2												-	-	-	-	-	-						
GB 301-3		-	-																			+	+
GB 301-4		-	-																			+	+
GB 1290-1		-	-	-	-		-	-	-			-	-	-	-	-	-			+	+		
GB 1290-5		-	-	-	-		-	-	-											+	+		

Fig. 7. Confrontations i Phlebia livida.

Complete intercompatibility within respective group, incompatibility between them (fig. 7). In basidiocarp morphology the representatives of the two groups are almost identical. Only, the number of tubercles on the hymenial surface is somewhat higher in group 2 than in group 1. Like in Hyphodontia subalutacea, there seem to be a distinction between a "coniferous type" and a "broad-leaved type", here also including Abies.

Radulomyces confluens (Fr.)M.P. Christ.

Material:
GB 0074/ Sambucus/ Denmark, Jutland/ 1,7,9,10/3,8.
GB 0733/ Alnus/ Canada, Ontario/ 1/2.
GB 1062/ Rosa/ Romania, Harghita/ 1 PS.
GB 1071/ deciduous wood/ Romania, Bistrita-Nasaud/ 6 SS.
GB 1705/ deciduous wood/ Finland, North Häme/ 3,5/4,6.
GB 1818/ Fagus/ Spain, Navarra/ 1/3,4.
GB 1875/ deciduous wood/ Spain, Lerida/ 2 SS.

Intercompatibility between above mentioned specimens. No morphological differences noticed.

Resinicium bicolor (Fr.)Parm.

Material:
GB 0046/ coniferous wood/ Sweden, Skåne/ 1,3,4/2.
GB 0391/ Abies/ Austria, Steiermark/ 1,2/3.
GB 0927/ coniferous wood/ Scotland, Perthshire/ 1/2.
GB 1026/ Picea/ Romania, Bistrita-Nasaud/ 5 SS.
GB 1195/ Norway, Hordaland/ 1,2,3,5/4.
GB 1308/ Picea/ Sweden, Gotland/ 1,2,4,6/3,5.
GB 1821/ Abies/ Spain, Lerida/ 1,5,6,7,8,9/2,3,4.
GB 1827/ Abies/ France, Pyrenees Orientales/ 1,4,5/2,3.

Compatibility has been shown between these specimens, and no morphological differences noticed between the corresponding basidiocarps. A specimen from Canada is partially compatible with the European ones and differs morphologically by somewhat smaller spores (Hallenberg, 1984).

Sistotremastrum suecicum Litsch. in John Erikss.

Material:
GB 0745/ Pinus/ Canada, Ontario/ 1,3/2.
GB 0934/ Pinus/ Scotland, Perthshire/ 1,2,6/3,4,7.
GB 1741/ Pinus/ Finland, South Häme/ 3 SS.

GB 1512/ Picea/ Romania, Suceava/ 1,5/2,3,4,6.

Compatibility between GB 745, GB 934, GB 1741. These specimens are morphologically uniform in their basidiocarps and conform well with the description in Eriksson et al (1984). GB 1512 is incompatible with these specimens. It also differs in morphology by having a very thin basidiocarp and slightly wider spores (2,8 µm versus 2-2,5 µm).

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MATERIALS FOR A LICHEN FLORA OF THE ANDAMAN ISLANDS - IV PYRENOCARPOUS LICHENS

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ABSTRACT

Data on thirteen corticolous species of the lichen genera Astrothelium, Ditremis, Lithothelium, Melanotheca, Parmentaria and Trypethelium are presented. Ditremis corticata, D. verrucosa, Parmentaria albidopora and P. nilamburensis are described as new. All of these species represent additions to the lichen flora of the Andaman Islands.

INTRODUCTION

The present paper, the fourth in a series on the linchens of the Andaman Islands, India, includes thirteen corticolous species in six pyrenocarpous lichen genera, Astrothelium, Ditremis, Lithothelium, Melanotheca, Parmentaria and Trypethelium, none of them previously known from the area.

Sixteen species of foliicolous pyrenolichens in the genera Phylloblastia (1), Porina (7), Raciborskiella (1), Strigula (5) and Tricothelium (2) and thirty three species in the corticolous pyrenolichen genera Anthracothecium (4), Arthopyrenia (4), Clathroporina (1), Microthelia (2), Parmentaria (2), Pertusaria (1), Porina (14) and Pyrenula (5) have so far been described from the Andaman Islands by Nylander (1873), Jatta (1905), Santesson (1952) and Singh A. (1970 a, b, 1971, 1985).

Pyrenocarpous lichens, characterised by flask shaped (perithecia) ascomata, comprise one of the major groups of lichens in the tropical rain forest ecosystem. The generic and family delimitations of this group of lichens, however, are still in flux as the nature of the ascospores (colour, shape of the cells) and the ascomata are considered in various ways by different lichenologists.

However, for the present, until the variations in ascocarps, ascus and ascospores are understood through morphological research on pyrenolichens, we will use artificial genera based on ascocarp type (Zahlbruckner, A. 1926, Müll. Arg., 1885, 1888). Eriksson and Hawksworth

(1985), actually, accepted many of these genera in their recent treatment of the Ascomycetes.

1. Astrothelium fallax Müll. Arg. in Engler Botan. Jahrbuch., 6 : 383, 1885. Zahlbruckner, A. Cat. Lich. Univ. 1 : 515, 1922. Figs : 9, 22

Type : Cuba, C. WRIGHT, s.n. Syntype - G (!)

Thallus corticolous, yellowish green, distinctly verrucose, cracked, glossy, K + yellow, P -ve; warts large, rounded or elongated, convex or almost globose; cortex 30-50 µm thick; algal layer 17-30 µm thick; ascomata black, carbonized, completely embedded in large thalline warts, externally visible by black or blackish brown ostiolar region, 2-4 opening into common ostiole; ascospores 8/ascus, hyaline, 4-locular, 16.5-27.5 x 6-8 µm in size.

Specimens Examined : Andaman Islands, South Andaman, Alexandria Island, Wandoor, 85.1037, 85.1043, 85.1068; Baratang Island, Bishnu Nala, 85.658, 85.659.

Remarks : Astrothelium Eschw., with 40 species (Hawksworth et al, 1983) on the world level is represented by only one species A. fallax Müll. Arg. in India.

Apparently, A. fallax reminds one very much of Campylothelium superbum (Fr.) Müll. Arg. on account of the similar morphology of the thallus and the pseudostroma but microscopic examination soon reveals fundamental differences.

2. Astrothelium subfuscum Krempelh. in Nuov. Giorn. Botan. Ital., 7 : 64, 1875. Zahlbruckner, A. Cat. Lich. Univ. 1 : 517, 1922. Figs : 1, 10, 23

Type : Singapore, O. BECCARI, 236-M (!), Holotype.

Thallus corticolous, olivaceous green, distinctly warty, K + orange, P -ve, corticated; cortex 33-82.50 µm thick; algal layer 30-86 µm thick; ascomata black, carbonized embedded in concolorous pseudostromata, externally visible as black ostioles surrounded by black, flattended periostiolar region; pseudostromata irregular in shape, 0.5-2.5 mm long, 0.5-1.2 mm broad, with white tops (due to the exposed medullary layer of the pseudostromata); ascospores 8/ascus, hyaline, ovate, 4-locular, with lenticular lumen, 23.1-26.4 x 7-8 µm in size.

Specimens Examined : South Andaman, Alexandria Island, Wandoor, 85.1101, 85.1121, 85.1126.

Remarks : Astrothelium subfuscum, is closely related to A. variolosum (Ach.) Müll. Arg. with regard to structure of the pseudostroma where the cortex of the pseudostroma bends back towards the bottom, skirting the ascoma, from which it can easily be distinguished by smaller pseudostromata and larger ascospores.

3. Ditremis corticata sp. nov. Figs : 4, 18, 31

Typus : Little Andaman, Netaji Nagar, Krishana Nala, 28.2.1985, P.G. PATWARDHAN & M.B. NAGARKAR, 85.865 (Holotype AMH, Isotype- BM).

Thallus olivaceo viridis, rimosus, verrucosus, endophloeodes; stratum corticale 16.5-66 µm crassum; ascomata in verruca thallina, 0.5-1.5 mm crassa, hemispherica inclusa, subhorizontalia, vel horizontalia, ostiolo laterali in papilla prominula ; asci 8-spori; ascosporae incolores, ellipsoideae, 1- septatae, in medio constrictae, 66-120 µm longae et 16.5-23 µm latae.

Thallus corticolous, olivaceous green, distinctly cracked and verruculose, corticated; cortex hyaline, 16.5-66 um thick; ascomata mostly completely immersed in concolorous, 0.5-1.5 mm thalline warts, sometimes appear as flattened, minute, black spots on the warts or by their ostioles; wall of the ascomata dark blackish brown, entire; ostioles blackish brown, obliquily oriented; ascospores 8/ascus, hyaline, 1-septate, broadly ellipsoidal, ends blunt, constricted at the septum, thick walled, 66-120 x 16.5-23 µm in size.

Remarks: None of the species of the known genus has a corticated thallus and large ascosores reaching a length of 120 um.

4. Ditremis verrucosa sp. nov. Figs : 19, 32

Typus: Middle Andaman, Long Island, on the way to Lalaji in evergreen forest, 22.2.1985, P. G. PATWARDHAN & M. B. NAGARKAR, 85.2096(Holotype- AMH, Isotype-BM).

Thallus, viridis, verrucosus, endophloeodes, stratum corticale 13.0-49.5 µm crassum; ascomata toto immersa in verruca thallina, solitaria, externe visa ut pallidum punctum ostiolum, subhorizontalia vel horizontalia; ascosporae hyalinae, ellipsoideae 1-septatae, medio constrictae, 33-88.5 µm longae et 13-18 µm latae.

Thallus corticolous, olivaceous green; verrucose, corticated; cortex 13-49.5 µm thick, hyaline; ascomata deeply embedded in large (2-3 mm in diameter), highly elevated concolorous thalline warts, externally visible as white or very light brown ostioles; ascospores hyaline ellipsoidal, 1-septate, 33-88.5 x 13-8 µm in size.

Remarks : The present species differs from Ditremis corticata in having distinctly warty thallus, white to pale brown ostioles and much smaller ascospores.

5. Lithothelium paraguaense Müll. Arg. in Reveue Mycolog. 10 : 27, 1888. Zahlbruckner, A. Cat. Lich. Univ. 1 : 513, 1922. Figs : 2, 11, 24.

Type : Paraguay, BALANSA 215, Lectotype - G (!)

Thallus corticolous, green, thin, smooth; algal layer situated deep in the thallus; ascomata 2-5 grouped together, opening into common, black, punctate ostiole, semi-emergent to emergent, black, horizontal, elongated, 0.4- 0.8 mm in diameter, totally carbonized; ascospores 8/ascus, hyaline, ellipsoidal to ovate, tranversely 1-3 septate, cells cubical, 8.4-16.5 x 3-4.5 µm in size.

Specimens Examined : North Andaman, Mayabander Range, Kaichi Nala, 85.2773, Interview Island, 85.2850, on way to Lamia Bay to Kalipur, S.E. of Aerial Bay, in mixed forest, 86.492; South Andaman, Baratang Island, 85.513, 85.525, 85.638; Little Andaman, Netaji Nagar, Krishana Nala, 85.917; Buttler Bay, 85.919, 85.935; Vivekanandpur, 85.988.

Remarks : The genus *Lithothelium* Müll. Arg. is known from only five species, *L. Cubanum* Müll. Arg. , *L. violascens* Malme, *L. indicum* Patwardhan, Makhija et Rane(1980) and *L. neoindicum* A. Singh (1986 a, b).

Lithothelium paraguaense is reported for the first time from India.

6. *Melanotheca anomala* (Ach.) Malme in Ark. Bot. 19(1) :30, 1924.*Trypethelium anomalum* Ach. in Syn. Lich. 105, 1814 (p.p. maj. acc. to Malme). Zahlbruckner, A. Cat. Lich. Univ.1 :487, 1922. Figs. 12 , 25.

Thallus corticolous, yellow to yellowish brown, smooth, delimeted by a black hypothalloidal region at the periphery, totally endophloedal, K-ve, P-ve; ascomata black, carbonized, minute, conical, flattened at the base; ostioles black, punctate, centrally situated; pseudostromata black, carbonized, 2-20 carpic, irregular, flattend, 0.5-3.5 mm long and 0.5-2.5 mm broad ; structure of the pseudostromata of the *M. aggregata* type with tissues of the pseudostromata together with the substratum cells carbonized; ascospores 8/ascus , brown, ovate, 4-locular, with lenticular lumen, 14-20 x 6-8.5 µm in size.

Specimens Examined : South Andaman, Pongibalu, Rutland, Kala Pahad, 85.585, 85.1177, 85.1199.

Other Specimens Examined : Africa ; Golungo, Sovado de Quilambo, ad Corticaticem Euphorbiacearum, C. WELWITSCH, 187, TUR- VAINIO 31225; Cuba, C. WRIGHT, Verru. Cub. 132, 169, 172 d, 174, 229 a, c, d, Ser. II, 599, 600- G.

Remarks : This species is reported for the first time from India.

7. *Melanotheca arthonioides* (Eschw.) Müll. Arg. in Flora, 67 : 128, 1884 . *Verrucaria arthonioides* Eschw. in Martius, Icon. Plant. Cryptog. , 1 : 15, 1828-1834. Zahlbruckner, Cat. Lich. Univ. 1 : 480, 1922., in Mart., Icon. Plant. Cryptog. 2 : 15, 1827 (with description). Figs : 13, 26.

Type : Brazil, Cresit and corticem tenuem arborum prope para, Cayete Martius (not seen).

Thallus corticolous, crustose, brown, cracked, delimited by a thick, black hypothallodial region at the periphery, completely endophloeodal, K -ve, P -ve; ascomata black, carbonized, minute, aggregated in ± rounded or irregularly shaped, black pseudostromata; ostioles black, punctate, indistinct; pseudostromata poly carpic, 1.8-8 mm long and 1-3 mm broad, flattened; structure of the psendostroma as in M. aggregata; ascospores 8/ascus, brown, 4-locular, with lenticular or sub-globose lumen, ovate, 10-17 x 5-8 µm in size.

Specimens Examined : South Andaman, Pongibalu, Rutland, Kala Pahad, 85.1169.

Other Specimens Examined : Cuba, C. WRIGHT, Verr. Cub. 171, 172, 601, Ser. II 601-G., Colombia, LINDIG, 2794 - H. NYL. 7569, Cuba, C. WRIGHT, Verr. Cub. 172, TUR - Vainio, 31223.

Remarks : Melanotheca arthonioides can easily be distinguished from other species by its pseudostromata which resemble the ascocarps of Arthonia and Arthothelium (Arthoniaceae).

8. Melanotheca arthonioides var. grisea Müll. Arg. in Engler, Botan. Jahrbuch, 6 : 396, 1885. Zahlbruckner, A. Cat. Lich. Univ. 1 : 481, 1922. Figs. : 14,27

Type : Cuba, C. WRIGHT Verr. Cuba, 173 b, Lectotype - G (!)

Thallus corticolous, yellow, smooth, cracked, delimited by a black hypothalloidal region at the periphery, K -ve, P -ve; algal layer situated deep in the thallus, ascomata black, carbonized, aggregated; ostioles black, punctate, centrally situated, surrounded by thin, white, annular rim; pseudostromata black, carbonized, irregularly spreading, polycarpic, 1-7.5 mm long and 1-6 mm broad; ascospores 8/ascus, brown, 4-locular, lumen lenticular, 13-20 x 6-8 µm in size.

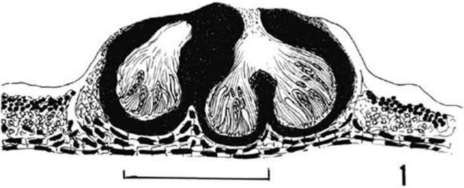
Specimens Examined : South Andaman, Wimberliganj, Kalatang, 85.86, 85.191, 85.192; Middle Andaman, Long Island, on the way to Lalaji, 85.2040.

Other Specimens Examined : Cuba, C. WRIGHT, Verr. Cuba, 173 a, Ser. II, 604-G.

Remarks : The present variety differs from M. arthonioides in having ostioles surrounded by a white annular rim.

9. Melanotheca leucotrypa (Nyl.) Müll. Arg. in Flora, 68 : 253, 1885. Trypethelium leucotrypum Nyl. in Flora, 50 : 9, 1867. Zahlbruckner, A. Cat. Lich, Univ. 1 : 482, 1922. Figs : 3, 15, 28

Figs : 1-8 - V.S. of pseudostroma. 1. Astrothelium subfuscum, 85.1126-AMH; 2. Lithothelium paraguaense, 85.919-AMH; 3. Melanotheca leucotrypa, 85.789-AMH; 4. Ditremis corticata, 85.865, Holotype-AMH; 5. Parmentaria albidopora, 85.500, Holotype-AMH; 6. Parmentaria nilamburensis, 85.320, Holotype-AMH; 7. Trypethelium eluteriae, 85.487-AMH; 8. Trypethelium ubianense, 85.2137-AMH. Scale = 500 µm.



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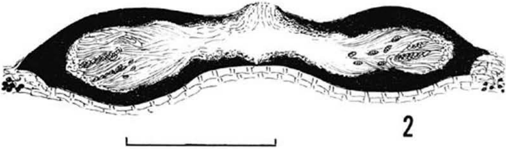

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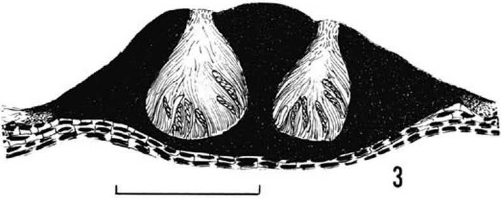

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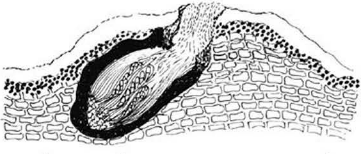

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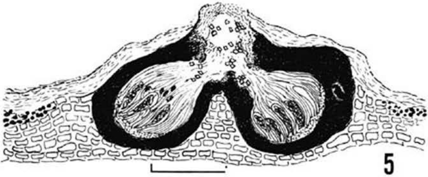

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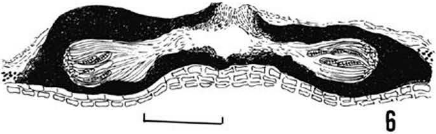

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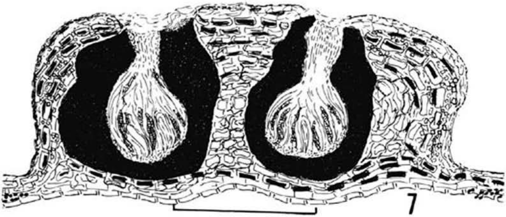

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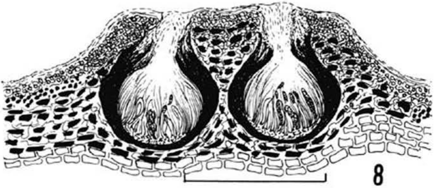

8

Type : Calcutta, Botanical Gardens, S. KURZ, 12 Lectotype H-NYL. 285 (!).

Thallus corticolous, yellowish brown to brown, more or less smooth, cracked, corticate, K + red, P -ve; cortex hyaline, 33-120 µm thick; ascomata black, carbonized, hemispherical, embedded in pseudostromata; ostioles black, punctate, centrally situated, surrounded by a white periostiolar region; pseudostromata black, carbonized, elevated, 1-12 carpic, 1.0-4.5 mm long and 1-3 mm broad; structure of the pseudostromata similar to *M. aggregata*, the cortical layer and the algal layer breaking at the level of the thallus and the substratum cells mixed with some hyphae and becoming carbonized; ascospores 8/ascus, brown, 4-locular, with lenticular lumen, ellipsoidal, 13-23 x 6-10 µm in size.

Specimens Examined : South Andaman, Baratang Island, Baludera, Mangrove forest, 85.758, 85.785, 85.789.

Other Specimens Examined : Calcutta, S. KURZ. 222 G, H-NYL. 286, S. KURZ. 12, H-NYL. 284.

Remarks : *M. leucotrypa* closely resembles *M. arthonioides* var. *grisea* in having more or less the same pseudostromata and ascospores. Variety *grisea*, however differs in having rather smaller ascomata, larger pseudostromata, and a thin, white ostiolar rim. In *M. leucotrypa* the white annular rim surrounding the ostioles is prominent.

10. *Parmentaria albidopora* sp. nov. Figs : 5, 16, 29.

Typus : South Andaman, Baratang, Nilambur, 22.2.1985, P.G. PATWARDHAN, M.B. NAGARKAR, & P.K. SETHY, 85.500 (Holotype-AMH, Isotype-BM.

Thallus uniformis, cinereus vel brunneus, endophloeodes, hypothallo nigricante limitatus; ascomata convexa, rotundata vel oblonga, nigra, 2-5, obliqua in ostiolum commune rectum, confluentia, ostiola albida vel ebureno, conspicuo; asci 8-spori; ascosporae fuscae, oblongo - ellipsoideae, muriformia, 8 loculares, loculi 3-5 locellati, 30-50 µm longae et 13-23 µm latae.

Thallus corticolous, grayish brown to brown, smooth, endophleodal, studded with crystals delimited by a black hypothalloidal region at the periphery; ascomata black, carbonized, in groups of 2-5, strongly emergent, opening

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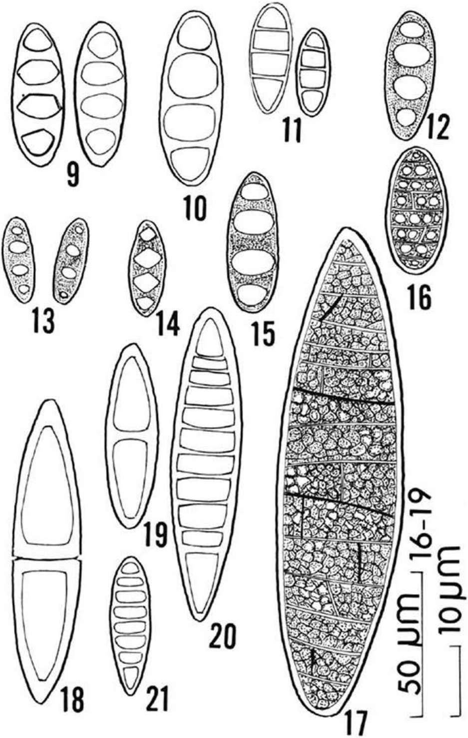
Figs : 9-21 - Ascospores. 9. *Astrothelium fallax*, 85.1068-AMH; 10. *Astrothelium subfuscum*, 85.1126-AMH; 11. *Lithothelium paraguaense*, 85.919-AMH; 12. *Malanotheca anomala*, 85.1199-AMH; 13. *Malanotheca arthonioides*, 85.1169-AMH; 14. *Melanotheca arthonioides*, var. *grisea* 85.191-AMH; 15. *Melanotheca leucotrya*, 85.789-AMH; 16. *Parmentaria albidopora*, 85.500, Holotype-AMH; 17. *Parmentaria nilamburensis*, 85.320, Holotype-AMH; 18. *Ditremis corticata* 85.865, Holotype-AMH; 19. *Ditremis verrucosa*, 85.2096, Holotype-AMH; 20. *Trypethelium eluteriae*, 85.487-AMH; 21. *Trypethelium ubianense*, 85.2137-AMH;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20
21
16-19
50 µm
10µm

into prominent, white, widely open, common ostiole; ostioles with long, white, protruding neck, studded with crystals; ascomata hemispherical, 0.5 to 1.2 mm in diameter, sometimes appear to be elongated due to long protruding neck; ascospores 8 /ascus, olivaceous brown to dark brown, ovate, muriform, mostly 7 septate, 1-5 lacuneate per tier, 30-50 x 13-23 µm in size.

Specimens Examined : South Andaman, Baratang, Nilambur, 85.457 , 85.496, 85.505.

Remarks : P.albidopora is readily distinguished from closely related p. baileyi Müll. Arg. by the ascocarps having a long, white, prominent protruding neck and concolorous, prominent, ostioles.

11. Parmentaria nilamburensis sp. nov. Figs : 6, 17, 30. Typus : South Andaman, Baratang, Nilambur, 22.2.1985, P.G. PATWARDHAN, M. B. NAGARKAR & P. K. SETHY, 85.320 (Holotype- AMH, Isotype- BM).

Thallus ochraceous, distincte rimosus, endophloeodes; ascomata ut plurimum 2-5 apprpximata et collo obliquo ostiolo communi praedito confluentia, horizontalia emergentia convexa , usque 1.0 mm lata; ascosporeae 2-nae, parenchymatosae, fuscae, circa 82-218 µm longae et 30-46 µm latae.

Thallus corticolous, buff to ochraceous, distinctly cracked, endophloeodal, algal layer situated deep in the bark; ascomata strongly emergent, black, carbonized, hemispherical to elongated, 2-5 in a group, opening into black, common ostiole, 0.8-1.1 mm long; ascospores 2/ascus, brown, elongate-ovate or ellipsoidal, muriform, transversly and vertically multiseptate, parenchymatous, 82-218 x 30-46 µm in size.

Specimens Examined : South Andaman, Baratang, Nilambur, 85.320, 85.375, 85.376, Baludera, 85.789.

Remarks : The ochraceous, cracked thallus; strongly emergent, horizontal, ascomata with a black, wide, prominent ostiole and large ascospores reaching a length of 220 µm distinguish P. nilamburensis from the closely related P. subastroidea Müll. Arg. [Queensland, SHIRLEY, 1863 Lectotype- G.] which, however, has more or less similar external morphology but a glaucous, glossy thallus, semi-emergent ascomata having brown punctate ostioles surrounded

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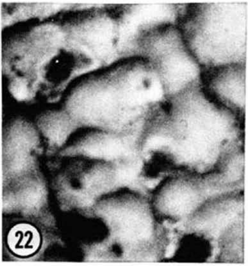
Figs : 22-34. 22. Astrothelium fallax, 85.1068-AMH; 23. Astrothelium subfuscum, 85.1126-AMH; 24. Lithothelium paraguaense, 85.919-AMH; 25. Melanotheca anomala, 85.1199-AMH; 26. Malanotheca arthonioides, 85.1169-AMH; 27. Melanotheca arthonioides, var. grisea, 85.191-AMH; 28. Melanotheca leucotrypa, 85.789-AMH; 29. Parmentaria albidopora, 85.500, Holotype-AMH; 30. Parmentaria nilamburensis, 85.320, Holotype-AMH; 31. Ditremis corticata, 85.865, Holotype-AMH; 32. Ditremis verrucosa, 85.487-AMH; 33. Trypethelium eluteriae, 85.2096, Holotype-AMH; 34. Trypethelium ubianense, 85.2137-AMH. scale = 1 mm.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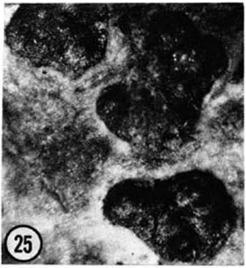
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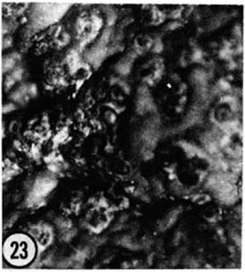
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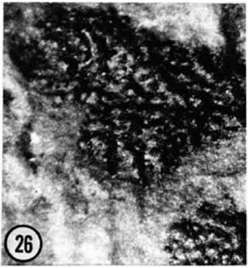
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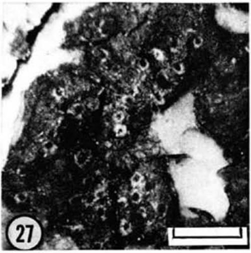
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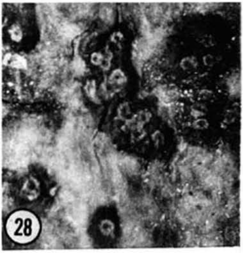

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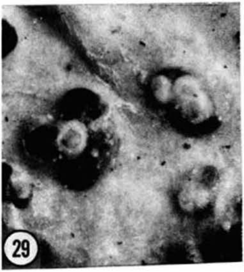

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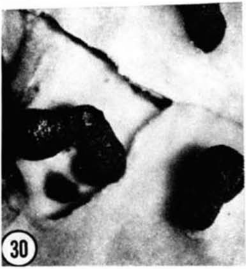

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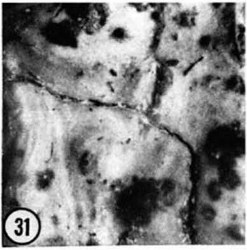

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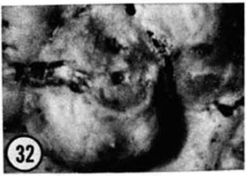

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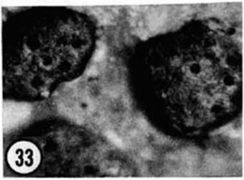

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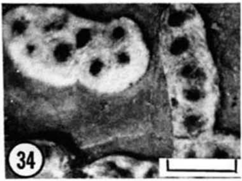

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by pale brown to white rim and much smaller ascospores (99-165 x 39- 45 um).

12. Trypethelium eluteriae Sprengel in Einleitung in das Studium der Kryptog. Gewachse, p. 351, 1804. Zahlbruckner, A., Cat. Lich. Univ. 1:490, 1922.
Figs : 7, 20, 33

Thallus corticolous, pale brown, smooth, glossy, totally endophloeodal; algal layer situated deep in the thallus, 10-35 µm thick; ascomata black, carbonized, vertically elongated, embedded in yellow to yellowish brown rounded to orbicular or elongated, highly elevated pseudostromata; pseudostromata 1-12 carpic, 1-4 mm long and 1-3 mm broad, cortical layer totally endophloeodal, divided into two with a thin layer extending to the ostiolar region and most of it below the ascomata, the medullary layer highly studded with crystals, K + purple and mixed with the bark cells forming tissue of the pseudostromata; ascospores 8/ascus, hyaline, fusiform, transversely 5-13 septate, with cells lenticular to cubical, some times 30-50 x 8-11 µm in size.

Specimens Examined : South Andaman, Baratang, Nilambur, 85.402, 85.487; Middle Andaman, Long Island, on the way to Lalaji, 85.2024.

Other Specimens Examined : India, Calcutta, S. KURZ 9 H-NYL. 229, 6, H-NYL. 232. Colombia, LINDING 2893-H-NYL Indo China, Annam, Nha-trang and vicinity, C.B. ROBINSON, 1409. TUR-Vainio 30726, 1410, TUR-Vainio 30727.

Remarks : The genus Trypethelium Sprengel, with 100 species (Hawksworth et al, 1983) on the world level distributed mainly in tropical regions, is reported for the first time from the Andaman Islands.

T. eluteriae Sprengel can be distinguished easily by the yellow to yellowish brown coloured, rounded, orbicular, highly elevated, constricted, polycarpic pseudostromata with the medullary region K + purple.

13. Trypethelium ubianense (Vainio) A. Zahlbr. in Cat. Lich. Univ. 8:129, 1932. Pseudopyrenula ubianensis Vainio in Ann. Acad. Sci. Fenn., Ser. A, 15(6):353, 1921.
Figs : 8, 21, 34

Type : The Philippines, Ubian Island. Ad corticem arboris, E.D. MERRILL, 5403 - Lectotype, TUR-Vainio - 30798 (!)

Thallus corticolous, grayish green, thin, totally endophloeodal, evanescent, K -ve, P -ve; algal layer situated deep in the thallus; ascomata black, carbonized, globose, completely embedded in pseudostromata; ostioles black, punctate to disc like, flattened; wall of the ascomata striate at the ostiolar region; pseudostromata white, rounded, orbicular, linear, constricted at the base, flattened to moderately elevated above the thallus, 1-20 carpic, 1-3.5 mm long and 0.8-1.5 mm broad; tissue of the pseudostromata consisting of the brown filaments mixed with a large number of crystals surrounding the ascomata together with bark cells; ascosores 8/ascus, hyaline, fusiform, ellipsoidal, transversely 5-10 septate, lumen of the cells lenticular, 30-36.3 x 6.6-9.9 µm in size.

Specimens Examined : Middle Andaman, Guitar Island, 85.2135, 85.2136, 85.2138, 85.2137, 85.2149.

Remarks : Trypethelium ubianense, seems close to Trypethelium duplex but the structure of the pseudostromata is much different. T. duplex invariably has 4-locular ascospores.

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CHEILYMENIA FRAUDANS AND REMARKS ON THE GENERA CHEILYMENIA AND COPROBIA

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ABSTRACT: Cheilymenia fraudans (Karst.)Boud. is described and illustrated by line drawings according to the author's examination of the type of Peziza fraudans (Karst.) Karsten. C. fraudans is a well founded species clearly distinguished from Cheilymenia raripila (Phill.)Dennis and related species by its rooting hairs and much smaller subglobose ascospores with different ornamentation of perisporium. The ascospore size, shape and ornamentation differentiate C. fraudans from other species of the genus Cheilymenia too.
C. fraudans sensu Gamundí (1960) is quite a different fungus considered here to be a species of Coprobia Boud. emend. J. Moravec (1984,1986), the new emendation is formally made in this present paper. The importance of the perisporial ascospore ornamentation and striation for generic deliminat-ion between Cheilymenia (Boud.) and Coprobia Boud.emend.nov. is discussed.

Peziza fraudans (Karst.) Karsten (1871) (= P. subhirsuta Schum. *fraudans Karsten (1870), transferred to the genus Cheilymenia Boud. by Boudier (1907) was insufficiently known species. The reexamination of the type has revealed that individual authors have treated this taxon in different conceptions.

CHEILYMENIA FRAUDANS (Karsten)Boudier, Hist.Class.Disc.Eur. p.63, (1907).
Peziza subhirsuta Schum. *fraudans Karsten, Not.Sällsk. pro Fauna et Fl. fennica XI, p. 229. (1870).
Peziza fraudans (Karst.)Karsten, Mycologia fennica p.65,(1871).
Neottiella fraudans(Karst.)Saccardo,Syll.Fung.8:191,(1889).

1. The original Karsten's description (latin diagnose), described originally in an infraspecific value as Peziza subhirsuta *P. fraudans Karsten (1870), later in the specific rank- Peziza fraudans Karsten (1871):

"Supra terram argillaceam, materia viridi obductam, in Mustiala mense ineunte Julio semel inventa.- Apothecia gregaria, planiuscula, aurantia-co-lutea, pilis raris, sordidis, articulatis, subaequalibus, brevibus (longit. 150-200 µm) adspersa, latit. 1.5-2 mm; sporae ellipsoideae, eguttulatae, monostichae, longit. 18-21 µm, crassit 13-14 µm (immixtis aliis minoribus = junioribus longit. 12-15 µm, crassit 10 µm), thecae cylindraceae, apice iodo non tinctae, longit. 240-280 µm, crassit. 16-25 µm; paraphyses filiformes, articulatae, in vivo statu granulosae et aurantiaco-fulvae, crassit. 4 µm, apice incrassato crassit. 8-10 µm." (Karsten 1870, p. 229).

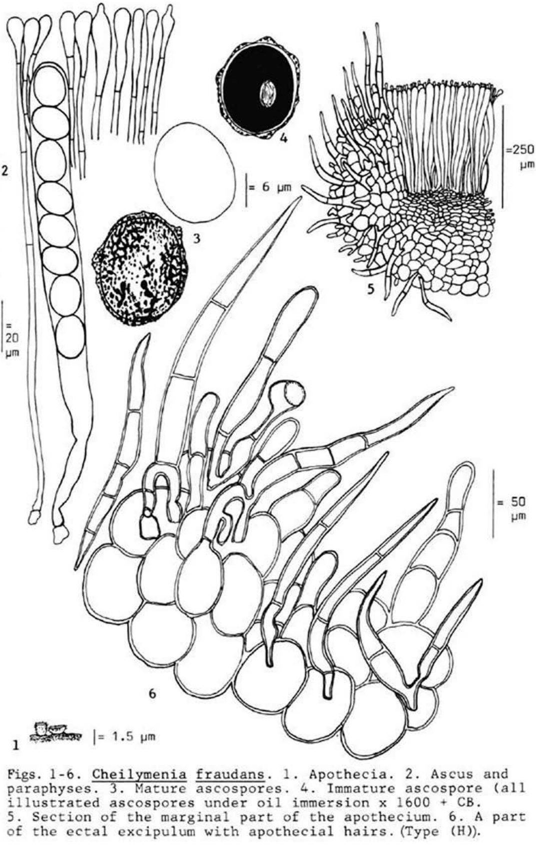
2. Description according to the examination of the type (five dried apothecia densely crowded on a substrate; only one of the three apothecia examined was found fully mature:

One apothecium turbinate with a flat thecium (immature), the other apothecia cupulate with a flattened thecium, sessile, 0.8-1.5 mm diam., dark orange brownish (when dried), outer surface and margin covered with inconspicuous pale hairs. Excipulum in the inner (medullare) layer comprising of angular to ellongated almost hypha-like cells 4-10 µm thick, forming an atypical textura angularis to textura subintricata to subepidermoidea under the hypothecium and in the hypothecium, the cells are with thin walls; ectal excipulum comprising of globose to ellipsoid or angular cells (15-75 µm diam.) with thin (0.5-0.8 µm) hyaline walls, forming a textura globulosa-angularis, the cells are elongated towards the ectal surface in the marginal part of apothecia, the marginal cells are with thickenned (up to 1.5 µm) yellow-brown walls (of the same colour as the excipular hairs). Hairs 68-270 x 8-19 µm, arrising from the ectal excipulum, septate, pale yellow-brownish, often with hyaline tops, mostly irregularly curved or straight, with pointed or blunt apex, rooting at their base; the roots ocassionally inflated, originating from the ectal excipular cells, but terminated roots also occur, often the base of hairs is simple and attenuated and truncate (in one hair even pointed), so it is evident that these hairs originate within the excipular tissue. Asci 230-255 x 13.5-17 µm, cylindrical, with a blunt apex and attenuated base, eight-spored. Paraphyses filiform, 2.7-3.5 µm thick, sparcely septate, straight, apex slightly to conspicuously enlarged (4.5-8-10.5 µm), clavate or pyriform to ampullaceous, containing an yellowish pigment. Ascospores 16,5 - 19.5 - (19.8) x 12 - 13.5 - (13.8) µm, broadly ellipsoid or subglobose, hyaline at maturity, with a pealable perisporium; the perisporium covered with irregular cyanophylic warts and short anastomosing ribs forming occasionally an irregular and very incomplete reticulum. Immature ascospores with a thick cyanophilic plasma.

Material examined: Only the type collection (H 2226) cited above in the Karsten's original diagnose.

Cheilymenia fraudans is well distinguished from other species of the genus *Cheilymenia* Boud. and also from species of the genus *Coprobia* Boud. emend J.Moravec (1984,1986). The genus *Coprobia*, with the type species *Coprobia granulata* (Bull.)Boud. which includes in this sense also a group of species having superficial hairs originating from the excipular cells (represented by *Coprobia theleboloides* (Alb. et Schw.) J.Mor. and related species), differs from the genus *Cheilymenia* not only by the mentioned shape of hairs, but also by the perisporium of ascospores covered with rib-like longitudinal cyanophilic striation (J.Moravec 1984, 1986), which I consider an important feature for the generic delimination between *Cheilymenia* and *Coprobia* too.

Brummelen (1986), without any note or explanation, treated *Peziza fraudans* Karst. as a synonym of *Cheilymenia raripila* (Phill.) Dennis. However, C. *raripila* differs distinctly in



Figs. 1-6. Cheilymenia fraudans. 1. Apothecia. 2. Ascus and paraphyses. 3. Mature ascospores. 4. Immature ascospore (all illustrated ascospores under oil immersion x 1600 + CB. 5. Section of the marginal part of the apothecium. 6. A part of the ectal excipulum with apothecial hairs. (Type (H)).

many important features, e.g. much larger ascospores, different ascospore ornamentation, and a different shape of hairs which are superficial, not broadly rooting at their base. Moreover, C. fraudans sensu Gamundí (1960) is not identical with the original Karsten's taxon. Gamundí (1960) noted that she did not examine the type. I have not examined the Argentinian material described and illustrated by Gamundí (1960) under this name, but according to the description and illustration, it clearly differs from the Karsten's type specimen. The ascospores of the Argentinian collection are described much more ellipsoid and of a different size (15.6 - 18.9 x 10.8-11 μm, and with a longitudinal perisporial striation, the hairs are of a different type, conspicuously superficial with a bulbous base as originating from excipular cells, and, the paraphyses are slender above. This seems to be a species of Coprobia related to C. theleboloides, but, of course, this cannot be stated with certainty without examining of the Argentinian collections. Coprobia hyphopila J.Moravec (1984) differs from the Argentinian fungus by much longer (up to 1000 μm) hypha-like, flexuous to subspiral hairs (though the base of these superficial hairs is similar in both species), which distinctly differs from the rooting hairs of Cheilymenia fraudans, too.

In my opinion, C. fraudans is a species which is congeneric with Cheilymenia ciliata (Bull.) Maas Geesteranus, although I have not found the yellow refractive colour in mature ascospores of the type when stained by Cotton blue in lactic acid, which is one of the features of the genus Cheilymenia. However, it maight be caused by the fact that I cut only a very little section of one mature apothecium possessing several mature ascospores only, as the other two apothecia examined were immature. In my experience, also a certain number of mature ascospores in other species of Cheilymenia is hyaline.

The habitat, according to the Karsten's diagnose, remains uncertain (terestrial?) whilst in the type specimen the apothecia seems to grow on an excrement. I suppose that it is a coprophilous species.

As it has been noted in the description, I have found one apothecial hair having a pointed base of a shape resembling hairs in species of the genus Trichophaeopsis Korf et Erb (1972), whilst other hairs were rooting or with a simple, attenuated and truncate base (hairs with attenuated truncate base also occurs in Trichophaeopsis). However, this genus is distinguished especially by its excipular structure, which consists of smaller angular cells regularly arranged in vertical raws towards the margin of apothecia, and, by much thiner paraphyses (1.5 - 3 μm thick at their apex).

Reexaminations of the type of Trichophaeopsis latispora J. Moravec (1979) and of collections of Trichophaeopsis bicuspis (Boud,) Korf et Erb has confirmed the basic differences. Moreover, no species of Trichophaeopsis , Trichophaea Boud., Tricharina Boud. and Wilcoxina Yang et Korf (1985) have such rooting hairs as those which are present in C. fraudans. Also the genus Neottiella (Cooke) Sacc. emend Boud.,including its broader sense in which Neottiella is merging with Leucoscypha Boud., distintly differs.

In my opinion, the most closely related species to *C. fraudans* is *Cheilymenia humarioides*(Rehm) Gamundí sensu Gamundí (1972). According to the description and illustration (Gamundi 1972, 1975), *C. humarioides* differs by larger ascospores (19 -25.9 x 10.6 -14µm) with a smooth perisporium. The other features, especially the hairs are very similar in both taxa. I have not examined the neotype of *C. humarioides* based on one of the Argentinian collections and stated by Gamundí (1972). However, I have examined two collections from Greenland kindly send to me by Dr. Henri Dissing, Kobenhaven: East Greenland, Mestersving near Nyhavn, on dung of Barnacle goose, 5.VIII. 1983, and on the same locality on summer dung of Muskox, 2.VIII. 1983 leg. H. Dissing. I have found the ascospores of these two collections, which I have determined as *C. humarioides*, smooth or with a finely punctate perisporium. In other features, they well correspond with the Gamundí's description and illustration of the neotype of *C. humarioides*, and differ in ascospore size and ornamentation from *C. fraudans*.

The ascospore ornamentation in *C. fraudans* is of the perisporial origin, and, the perisporium is pealable and can be easily deformed after the sections, stained in Cotton blue in lactic acid , were heated. Unfortunately, I cannot prepare a specimen to take SEM photomicrographs as the type material is very scanty, but the ornamentation is clearly seen by light microscope.

On this occasion, I wish to emphasize again the existence of the original perisporial ascospore ornamentation in *Cheilymenia* and *Coprobia*, which can be observed before the deformation of the perisporium, and, represents an important feature discussed in J.Moravec (1984). The rib-like character of the original perisporial striation in ascospores of *Coprobia* has been also proved by SEM photomicrographs taken from dried specimens (J.Moravec 1986). Recently, I have examined ascospores of *Cheilymenia raripila*, *Cheilymenia hyalochaeta*(Speg.) Gamundí (1960) and *Cheilymenia notabilispora* J.Moravec (1968, 1984), and found an outstanding original perisporial ornamentation. This ornamentation, already described and illustrated by Gamundí (1960) in ascospores of *C. hyalochaeta*, is well seen by light microscope, and, we have it now proved by SEM too (yet unpublished results). In spite of the fact, Brummelen (1986) has illustrated and described a deformed and wrinkled perisporium of one ascospore in *C. raripila*, and, has considered it merely a secondary wrinkling caused by the heating in lactic acid. However, as it was already discussed (J.Moravec 1984), in light microscopy, it is necessary to recognize the original perisporial ornamentation, clearly seen before the heating, as distinct from the secondary deformation of perisporium caused by the heating or longer action of lactic acid. Therefore, it is necessary to use such Cotton blue in lactic acid, which stains promptly without heating (CB Geigy s.123).The ornamentation is strongly cyanophilic and clearly observable, in a case of *C. raripila* even by a dried objective, and seen also in the optical section of ascospores. Provided that the sections are stained without heating, the perisporium in majority of ascospores of *C. raripila* is very resistant and the ornamentation is clearly seen after ten and more years on stored slides prepared by such simple method, even when the CB was dried up and the sections had to be revived again. The cyanophilic ornamentation is clearly seen on ascospores with perfectly regular and tense perisporium without any deformation, and can be seen on the deformed or separated perisporium too.

In its features, e.g. the shape and type of hairs and the pealable ascospore sheat (perisporium), *C. fraudans* agrees with those species,which,after the new emendation of *Coprobia*, remains in the genus *Cheilymenia* Boud.
The new emendation of the genus *Coprobia* follows:

COPROBIA Boudier, Bull.Soc.Mycol.Fr.1:107,(1885), **emend nov.**
Apothecia turbinata, doliiformia,convexa vel moliter patelliaria, sessilia, usque explanata, thecio plano vel usque pulvinato, luteo, luteo-ochraceo, aurantiaco-luteo vel aurantiaco, raro etiam sordide albido-subochraceo; pars exterior apothecii minute vel crasse granulata, glabra sed parte basali cum hyphis sparsis superficialibus, hyalinis, septatis, vel etiam pars exterior apothecii pilis sparsis tota obsita. Pili superficiales, parte basali simplices, e cellulis globosis excipuli excrescentes, (raro etiam ramosae sed ramis brevibus, superficiales, obtusi, e cellulis excrescentes), hyphoidei et flexuosi vel recti, septati, tenuiter tunicati, hyalini vel lutei, usque laete luteo-fusci. Excipulum externum e textura globulosa usque globuloso-angularis, excipulum parte inferiore sub hypothecio e textura globuloso-angularis vel usque textura angularis-subintricata. Paraphyses filiformes, apice sensim vel valde incrassatae, clavatae, vel usque capitatae et lobato-furcatae, pigmento luteo vel luteo-aurantiaco, carotenoideo donatae. Asci cylindracei, octospori, non amylloidei. Ascosporae ellipsoideae, eguttulatae, hyalinae, perisporio separabili,longitudinaliter striato cum costis cyanophilis anastomosantibus.
Habitat: Ad excrementa.
Typus: *Peziza granulata* Bulliard, Herb.Fr.t.438,fig.3,1970;
ex Fries, Syst.mycol. 2/1:67,1822.
Species: *Coprobia granulata* (Bull.)Boud.,*C. sordida* J.Mor. *C. flava* (Karst.)Thind et Kaushal, *C. striata* (Thind,Cash et Singh) Waraith, *C. theleboloides* (Alb. et Schw.) J.Mor., *C. crassistriata* J.Mor., *C. humana* (Velen.) Svr.

The basic features which distinguishe *Coprobia* from *Cheilymenia* are: the absence of hairs of the external surface of apothecia which are with only rare hyphal outgrowths near the base, or, presence of only superficial hairs or hyphae, which originate from the excipular cells of the ectal layer, and, the perisporial cyanophilic rib-like longitudinal striation of ascospores.
The differences in excipular structure, considered not important features by me, were discussed earlier (J.Moravec 1984). In *Coprobia*, the differences are slight in fact. Medullary excipulum is not differentiated, or is only purely differentiated from the ectal layer, and, in no species is formed of typical textura intricata, though the cells may be gradding to some hyphal elements (even in species commonly regarded as species with "homogenous" excipulum).
In my opinion, *Cheilymenia lemuriensis* Heim ex Le Gal (1953) is a species of *Coprobia* too, but I have not yet examined the type.

The genus *Cheilymenia* is distinguished by the presence of rooting apothecial hairs originating deeply within the excipular tissue, and, by the ascospores which are without the longitudinal rib-like striation of the perisporium. This genus is very close to *Scutellinia* (Cooke)Lamb.emend Le Gal and deserves further study.
Cheilymenia raripila and related species are not congeneric, in this sense, with *Cheilymenia* nor *Coprobia*. A paper on their taxonomy, including results of reexaminations of the type collections of *C. hyalochaeta* and *C. notabilispora* will be published in near future.

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NEW SPECIES IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTINA) FROM THE SOUTHERN HEMISPHERE

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ABSTRACT : The species, *Canoparmelia macrospora* Elix & Johnston, *Canoparmelia norpruinata* Elix & Johnston, *Parmelia protosignifera* Elix & Johnston, *Parmeliopsis evernica* Elix & Johnston, *Parmotrema austrocetratum* Elix & Johnston, *Parmotrema convolutum* Elix & Johnston, *Parmotrema judithae* Elix & Johnston, *Parmotrema ochrocrinitum* Elix & Johnston, *Punctelia nebulata* Elix & Johnston, *Punctelia novozelandica* Elix & Johnston, *Relicina subnigra* Elix & Johnston, *Relicina terricrocodila* Elix & Johnston, *Relicinopsis stevensii* Elix & Johnston, *Xanthoparmelia callifolioides* Adler, Elix & Johnston, *Xanthoparmelia nigraoleosa* Elix & Johnston, and *Xanthoparmelia prodomokosii* Hale, Elix & Johnston are described as new. Apart from the Argentinian species *X. callifolioides* and the New Zealand endemic, *P. novozelandica*, the remaining species occur in Australia. *Parmotrema austrocetratum* and *P. protosignifera* also occur in New Zealand and *Parmotrema austrocetratum* on Norfolk Island. The new combination *Punctelia subflava* (Taylor) Elix & Johnston is made and *X. brunnthaleri* (Stein. & Zahlbr.) Hale and *X. subpigmentosa* Hale are reported for the first time from Australia.

Introduction

As a result of further study of the lichen family Parmeliaceae in the Southern Hemisphere, and particularly in Australasia (Adler & Elix 1987; Elix & Adler 1987; Elix & Johnston 1986, 1987a, 1987b, 1987c; Elix, Johnston & Armstrong 1986; Nash & Elix 1987; Nash, Elix & Johnston 1987a, 1987b), we are describing 18 new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson, Culberson & Johnson 1981; Culberson & Johnson 1982), high performance liquid chromatography (Lumbsch & Elix 1985) and comparison with authentic samples.

Canoparmelia macrospora Elix & Johnston, sp. nov. Figure 1

Species cum thallo ut in *Canoparmelia pruinata* sed ab hac specie subtus pallida , sporis majoribus et scabrosinum 4,4'-diacetatum continente differt.

Type. Australia. Western Australia. On bark, near Kalgoorlie, *M. F. Day*, viii.1982; CBG-holotype.

Thallus foliose, corticolous, closely adnate, mineral to lead-grey, to 5 cm in diameter; *lobes* subirregular, crowded and imbricate, 1.0-2.0 mm wide, eciliate. *Upper surface* smooth and shiny at the apices, plane or weakly foveolate at first, becoming

wrinkled and rugose with age, ± weakly maculate around the submarginal foveolae, lacking soredia and isidia but usually with granular white pruina towards the apices; medulla buff. *Lower surface* ivory to pale brown, moderately to densely rhizinate, rhizines concolorous with the lower surface, simple or tufted at the tips. *Apothecia* common, sessile, to 2 mm in diameter, disc concave at first but becoming flattened with age, dark brown, epruinose; margin thin, entire, smooth, thalline exciple densely pruinose; asci 8-spored, spores simple, colourless, oblong, straight or commonly curved, 16-20 x 5-6 µm. *Pycnidia* numerous, punctiform or slightly emergent, black; conidia commonly curved, cylindrical to weakly fusiform, 9-11 x 1 µm.
Chemistry. Thallus K+ yellow, medulla K-, C-, KC-, P- ; containing atranorin, chloroatranorin, scabrosin 4,4'-diacetate.

This rare species closely resembles smaller specimens of *Canoparmelia pruinata* (Müll. Arg.) Elix & Johnston; both species have weakly foveolate, ± maculate apical lobes which are densely pruinose, pruinose amphithecia, and conidia which are commonly curved and cylindrical to weakly fusiform. However *C. macrospora* has a pale ivory lower surface and large (16-20 x 5-6 µm), oblong (± curved) spores whereas *C. pruinata* has a black lower surface and small (8-9 x 5-5.5 µm), ellipsoid spores. Moreover these two species can readily be distinguished chemically since *C. pruinata* contains medullary lecanoric acid (C+ red) while *C. macrospora* contains scabrosin 4,4'-diacetate. At present this new species is only known from the southern inland of Western Australia.

Specimen Examined
WESTERN AUSTRALIA. On base of *Acacia* in open scrubland with *Acacia* and *Eucalyptus* dominant, 4 km east of Bulla Bulling, 31°01'S, 120°53'E, *J. A. Elix 21728 & M. V. Sargent*, 20.viii.1987 (ANUC).

Canoparmelia norpruinata Elix & Johnston, sp.nov. Figure 2

Thallus adnatus vel appressus, corticola, pallide cinereus, 5-10 cm latus; lobis subirregularibus, 2-5 mm latis, marginibus eciliatis; superne nitidus, rugulosus, pruinosus ad apices; subtus niger, modice rhizinosus, rhizinis nigris, simplicibus. Apothecia numerosa, sessilia vel substipitata, disco concavo demum undulato et distorto, 3-7(-17) mm diametro; sporae 8, 9-11 x 6-8 µm. Atranorinum, chloroatranorinum et acidum lecanoricum continens.

Type. Australia. New South Wales. On trunk of old *Banksia* in pasture, along the Steeple Flat road, 4 km east of Nimmitabel, 1095 m, J. A. Elix *1626*, 20.i.1976; CBG-holotype, MEL-isotype.

Thallus foliose, corticolous, closely appressed to the substrate, pale grey to grey-green, 5-10 cm in diameter; *lobes* subirregular, crowded and imbricate, 2.0-5.0(-7.0) mm wide, ± subascending, apices rotund. *Upper surface* shiny at first, becoming dull and markedly rugose with age, emaculate, lacking soredia and isidia but usually with granular white pruina towards the apices; medulla white. *Lower surface* black to brown-black, with a pale brown to ivory marginal zone, moderately to sparsely rhizinate, rhizines often more prominent subapically, simple to tufted or fasciculate, concolorous with the lower surface. *Apothecia* common, sessile to substipitate, to 3-7(-17) mm in diameter, disc concave at first but becoming undulate-distorted with age and developing elevated, concentric zones from the centre, red-brown to dark brown-black, epruinose; margin thick, entire, inrolled, thalline exciple smooth, shining, often pruinose, asci 8-spored, spores colourless, ellipsoid, 9-11 x 6-8 µm. *Pycnidia* numerous, commonly elevated, crateriform, black, conidia straight, weakly fusiform to bifusiform, 7-8 x 1 µm.
Chemistry. Thallus K+ yellow, medulla K-, C+ red, P- ; containing atranorin, chloroatranorin, lecanoric acid and rarely traces of orsellinic acid.

Previously this species has been confused with *Parmelina stevensiana* Elix & Johnston (Elix & Johnston 1986), as these two species have a similar growth habit and contain lecanoric acid. However *Canoparmelia norpruinata* has a more robust thallus, with broader (2-5 mm), irregular, thicker lobes, larger (to 17 mm), gyrose-contorted apothecia, and lacks cilia even in the lobe axils. This new species has a restricted distibution in the mountainous areas of south-eastern Australia and Tasmania. *P. stevensiana* occurs in a much wider area of southern Australia, Tasmania and New Zealand and is distinguished by the smaller thalli (2-4 mm), with thinner, narrower (1-2 mm), sublinear-elongate lobes, smaller (to 4 mm) concave apothecia, and the presence of cilia (albeit often sparse) in the lobe axils. This new species also resembles *Canoparmelia pruinata* (Müll.Arg.) Elix & Johnston, from South Australia and Western Australia. The latter species differs from *C. norpruinata* in having concave to flat apothecia with a densely granular-pruinose disc and curved conidia. By contrast the apothecia of *C. norpruinata* become gyrose-contorted, with an epruinose disc and straight conidia.

C. norpruinata is a scattered species on the branches of trees and shrubs (and rarely on rocks) in the cooler, higher rainfall, upland areas of southern Australia (NSW, ACT, Vic, Tas.).

Specimens Examined

NEW SOUTH WALES. On dead twigs of *Acacia* in pasture, 46 km south of Cooma along the Snowy Mountains Hwy., 1150 m, *J. A. Elix 5443*, 23.xi.1978 (ANUC); on shrubs in open *Eucalyptus* forest, Morton National Park, 8 km NE of Nerriga, 35°07'S, 150°08'E, 750 m, *J. A. Elix 11426 & J. Johnston*, 6.x.1983 (ANUC).

AUSTRALIAN CAPITAL TERRITORY. On bark of *Pinus radiata*, on dry ridge, Mulligans Flat, 670 m, *J. A. Elix 1435*, 10.xii.1975 (ANUC); on granite rocks in dry sclerophyll forest, along Kangaroo Creek near Corin Dam, 1000 m, *J. A. Elix 2925*, 10.iii.1977 (ANUC); on *Leptospermum* shrubs, summit of Mt. Aggie, Brindabella Range, 43 km WSW of Canberra, 1490 m, *J. A. Elix 5824*, 28.iii.1979, *J. A. Elix 10256*, 29.v.1982 (ANUC); at base of *Eucalyptus* in open woodland, Long Flat, Clear Range, 65 km S of Canberra, 1350 m, *J. A. Elix 9020*, 1.x.1980 (ANUC).

VICTORIA. On *Leptospermum* in coastal scrub, 0.5 km E of Marlo, 6 m, *J. A. Elix 5203*, 20.xi.1978 (ANUC).

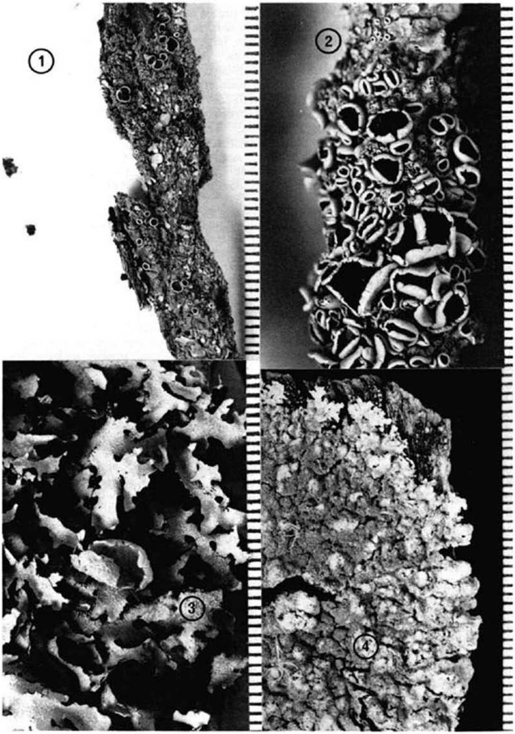
TASMANIA. On *Pinus radiata* in park, Ouse, 88 km NW of Hobart, *J. A. Elix 5621*, 18.i.1979 (ANUC); on *Kunzea ambigua*, Myrmidon Bay, 800 m SW of Squashway, Dover Island, Kents Group, Bass Strait, 40 m, *J. S. Whinray*, 13.xii.1970 (MEL 1012678).

Parmelia protosignifera Elix & Johnston, sp.nov. Figure 3

Species cum thallo ut in *Parmelia signifera* sed ab hac specie acidum protocetraricum continente differt.

Type. Australia. New South Wales. On sheltered granite rock ledges in *Eucalyptus* woodland, eastern slopes of Tinderry Pic, 12 km E of Michelago, 1340 m, *J. A. Elix 4051*, 8.xii.1977; CBG-holotype; MEL-isotype.

Thallus foliose, saxicolous, loosely adnate, pale mineral grey or becoming brownish and blackening with age, to 15 cm in diameter; *lobes* sublinear, crowded and imbricate, 2.0-6.0(-10.0) mm wide, apices rotund, secondary lobes often building the thallus into a thick, pulvinate mat, ± lobulate with age in the centre of the thallus, lobules marginal, suberect. *Upper surface* shiny at the apices, becoming dull, plane to rugose or foveolate, becoming extensively cracked with age, with pseudocyphellae but lacking soredia and isidia, *pseudocyphellae* effigurate, dense, often forming a reticulate pattern, appearing raised; medulla white. *Lower surface* jet black but brown at the margins, densely rhizinate to the margins, rhizines simple, dichotomous or sparingly squarrosely branched, black. *Apothecia* common, sessile to substipitate, to 8 mm in diameter, disc



Figures 1-4. New species of Parmeliaceae: 1, *Canoparmelia macrospora* (holotype in CBG); 2, *Canoparmelia norpruinata* (*J. A. Elix 5443* in ANUC); 3, *Parmelia protosignifera* (holotype in CBG); 4, *Parmeliopsis evernica* (holotype in CBG). Scale in mm.

rugulose, concave at first but becoming undulate-distorted with age, pale brown to dark brown; margin thin, crenulate, deeply incised and lacerate, amphithecium pseudocyphellate; asci 8-spored, spores colourless, ellipsoid to broad ellipsoid, 11-15 x 8-9 µm. *Pycnidia* minute, punctiform, conidia bifusiform, 6-7 x 1 µm.
Chemistry. Thallus K+ yellow; medulla K+ pale yellow-brown, C-, P+ red-orange; containing atranorin, chloroatranorin, protocetraric acid.

Previously this new species has been incorporated with *Parmelia signifera* Nyl. since these two species have comparable morphology and can only reliably be distinguished by chemical means. Thus *P. signifera* contains medullary salazinic acid (K+ yellow-dark red) while *P. protosignifera* contains protocetraric acid (K+ pale yellow-brown). However since these two species have markedly different distribution patterns (*P. protosignifera* is much rarer and has a more southerly distribution in both Australia and New Zealand) they are considered distinct species (Elix 1982). *P. protosignifera* is a scattered species on rocks in subalpine areas of south-eastern Australia and the south island of New Zealand.

Specimens Examined
VICTORIA. On exposed sandstone, 1 km from summit of Mt. William, Grampian Mts., *M. E. Hale 58,374*, 13.i.1982 (US).
NEW ZEALAND. South Island. On rock, Cave Hill, near Dunedin, *J. S. Thomson* (Z. A. 241) (CHR).

Parmeliopsis evernica Elix & Johnston, sp. nov. Figure 4

Species cum thallo ut in *Parmeliopsis aleurites* sed ab hac specie acidum evernicum continente differt.
Type. Australia. New South Wales. On dead stump in open *Eucalyptus* woodland, Goorooyarroo Reserve, 15 km north of Queanbeyan along the Sutton road, 35°14'S, 149°15'E, 740 m, *J. A. Elix 11405*, 11.x.1983; CBG-holotype.

Thallus foliose, corticolous, orbicular, adnate, pale ash-grey, to 5 cm in diameter; *lobes* sublinear, narrow, 0.8-1.5 mm wide, irregularly branched. *Upper surface* dull, plane or weakly foveolate, slightly arachnoid under strong magnification (x 50), emaculate, with short granulose *isidia*, coalescing with age to form to form a dense mass of *soredia* in the centre of the thallus; medulla white. *Lower surface* ivory to pale brown, moderately to densely rhizinate, rhizines concolorous with the lower surface, simple or tufted at the tips. Apothecia not seen. *Pycnidia* small, black, globose, emergent at or near the margins, to 0.1 mm in diameter; conidia immature.
Chemistry. Thallus K+ yellow; medulla K-, C-, KC+ red, P- ; containing atranorin, chloroatranorin, evernic acid.

Morphologically this new species resembles some specimens of *Parmeliopsis aleurites* (Ach.) Nyl. em. Lettau where the initial short, cylindrical isidia degenerate with age to form a dense, coarsely-granular sorediate mass in the centre of the thallus. However the development of granulose sorediate-isidia is much more extensive in *P. evernica* than it is in Australian specimens of *P. aleurites*, which often exhibits corticate, cylindrical isidia even when aged. Furthermore these two species can be readily distinguished chemically since *P. aleurites* contains medullary thamnolic acid (K+ yellow) while *P. evernica* contains evernic acid. This new species is known only from the type location.

Parmotrema austrocetratum Elix & Johnston, sp. nov. Figure 5

Species cum thallo ut in *Parmotrema cetratum* sed ab hac specie superne dactylata, aetate areolas magnas formans, areolis demum valde concavis plus minusve conferruminatis et porcas formantibus vel disruptis et areis erosis albidis differt.

Type. New Zealand. North Island. On tree trunk in remnant forest, Burgess Park, New Plymouth, 60 m, *J. A. Elix 4645*, 7.v.1980; CHR-holotype, CBG-isotype.

Thallus corticolous or saxicolous, loosely attached, light mineral-grey, 6-12 cm in diameter. *Lobes* rotund, imbricate or not, 10-20(-30) mm wide, apices often laciniate, the lacinae flat or convex, 0.5-1.5 mm wide, 1-5(-8) mm long, lobes moderately ciliate, the cilia 0.2-1.0(-1.5) mm long, simple or sparingly branched. *Upper surface* white-reticulate at first but becoming conspicuously cracked to the margin, developing raised closed dactyls, dactyls ± curved, laminal, ultimately becoming fused with the formation of laminal ridges, the older parts of the thallus eventually becoming cracked-areolate and the areolae flaking off and exposing the white medulla in eroded areas; lacking soredia and isidia. *Lower surface* black with a bare, brown marginal zone 1-2 mm wide, moderately to densely rhizinate, rhizines simple or sparsely branched, slender, black. *Apothecia* rare, stipitate, to 10 mm in diameter, disc perforate, pale tan, concave at first then concave-distorted, margin eciliate, thin, ± stellate-cracked, asci 8-spored, spores colourless, ellipsoid, 12-16 x 8-9 µm. *Pycnidia* scattered, punctiform, black, conidia filiform, 9-16 x 1 µm.
Chemistry. Cortex K+ yellow, medulla K+ yellow becoming deep red, C-, P+ red-orange; containing atranorin, chloroatranorin, salazinic acid (major), consalazinic acid (minor), protocetraric acid (± trace).

This new species seems to be related to *Parmotrema cetratum* (Ach.) Choisy, which also contains salazinic acid and has a reticulate-cracked upper cortex and perforate apothecia. However *P. austrocetratum* is distinguished by the development of laminal dactyls, by the upper cortex becoming much more extensively and deeply cracked and areolate, in being rarely fertile, more loosely adnate, and by having a distinct bare brown marginal zone on the underside of the lobes. By comparison *P. cetratum* is usually copiously fertile, adnate to the substrate, edactylate, is only weakly reticulate and never cracked-areolate, while the lower surface is black and rhizinate to the margins. In particular, *P. cetratum* does not exhibit distinct laminal dactyls (ridges), nor the flaking off of the areolae, which are very characteristic features of *P. austrocetratum*. *Parmelia (Parmotrema) hawaiiensis* H. Magnusson and *P. (Parmotrema) ruminata* Zahlbr. also appear to be related to *P. austrocetratum*. However *P. hawaiiensis* lacks apical laciniae and although the upper cortex becomes cracked and areolate with the areolae ultimately peeling off and exposing the lower cortex, they do not develop from raised dactyls. *P. ruminata* on the other hand lacks cilia and could well be the eciliate counterpart of *P. austrocetratum*. *P. austrocetratum* is a widespread species on rocks and trees in coastal and hinterland areas along the subtropical and tropical east coast of Australia and the north island of New Zealand.

Specimens Examined
QUEENSLAND. On rain forest trees, Lake Eacham National Park, 750 m, *J. A. Elix 2628*, 27.viii.1976 (ANUC); on felled tree in rainforest, Kirrima State Forest, Cardwell Range, 24 km WNW of Cardwell, 18°12'S, 145°48'E, 750 m, *J. A. Elix 15714 & H. Streimann*, 20.vi.1984 (ANUC); on sapling along margin of regrowth rainforest, Great Dividing Range, Mt. Baldy, 4 km SW of Atherton, 17°17'S, 145°27'E, 1080 m, *J. A. Elix 16307 & H. Streimann*, 25.vi.1984 (ANUC); on rocks in *Eucalyptus grandis* woodland, Hugh Nelson Range, along Plath Road, 15 km S of Atherton, 17°25'S, 145°26'E, 1080 m, *J. A. Elix 16328 & H. Streimann*, 25.vi.1984 (ANUC); on *Flindersia* in open rainforest, Mt. Windsor Tableland, 45 km NW of Mossman, 16°15'S, 145°01'E, 1200 m, *J. A. Elix 16440 & H. Streimann*, 26.vi.1984 (ANUC); on remnant trees, along the Tully Falls Road, 8 km SE of Ravenshoe, 17°40'S, 145°31'E, 940 m, *J. A. Elix 16803 & H. Streimann*, 29.vi.1984 (ANUC); on trunk of roadside tree, 1 km S of Maalan, 11 km E of Ravenshoe, 17°36'S, 145°38'E, 980 m, *J. A. Elix 17104 & H. Streimann*, 2.vii.1984 (ANUC); on canopy of *Argyrodendron* in rainforest,

Crediton State Forest, 20 km SSW of Finch Hatton, 21°19'S, 148°33'E, 840 m, *J. A. Elix 21021 & H. Streimann*, 1.vii.1986 (ANUC).
NEW SOUTH WALES. On mossy rocks in rainforest, Jamison Valley below Katoomba Falls, 850m, *J. A. Elix 3244*, 25.iv.1977 (MEL, ANUC); on sandstone rocks in dry sclerophyll forest, near Mt. Bouddi, Bouddi National Park, *J. A. Elix 4645*, *J. A. Elix 4676*, 7.v.1978 (ANUC); on sandstone rocks, Tianjara Falls, 33 km NNW of Ulladulla, *J. A. Elix 5945a*, *J. A. Elix 5963*, 21.vi.1979 (ANUC); on remnant rainforest trees, 4 km E of Robertson, 730 m, *J. A. Elix 8892*, 17.ix.1980 (ANUC).
SOUTH AUSTRALIA. On rocks in ravine, Alligator Gorge, 9 km S of Wilmington, Mt. Remarkable National Park, Flinders Ranges, 32°45'S, 138°03'E, 400 m, *J. A. Elix 17779 & L. H. Elix*, 27.x.1984 (ANUC).
NEW ZEALAND. North Island. North Auckland: on fallen twigs in remnant forest, Whangarei Falls, Whangarei, 60 m, *J. A. Elix 8029*, 11.v.1980 (ANUC). South Auckland: on *Avicennia resinifera* in tidal swamp, Kauaeranga River estuary, Thames, *J. A. Elix 9946*, 9.i.1982 (ANUC); on rocks in open scrubland, trail to Cathedral Cove, Hahei, Coromandel Peninsula, 15 m, *J. A. Elix 9990*, 9.i.1982 (ANUC); on pohutukawa along foreshore, Orakawa Bay, Waihi Beach, *J. A. Elix 10008*, 11.i.1982 (ANUC); on pohutukawa along foreshore, Ohope Beach, Bay of Plenty, *J. A. Elix 10020*, 11.i.1982 (ANUC). Gisbourne: on rocks along the foreshore, Hicks Bay, East Cape, *J. A. Elix 10069*, 12.i.1982 (ANUC). Taranaki: on forest trees in park, Pukekura Park, New Plymouth, 30 m, *J. A. Elix 7967*, 7.v.1980 (ANUC).
NORFOLK ISLAND. On *Elaeodendron* in open woodland, Mt. Pitt Reserve, track at end of Selwyn Pine Road, 29°01'S, 167°56'30"E, 215 m, *J. A. Elix 18742 & H. Streimann*, 8.xii.1984 (ANUC).

Parmotrema convolutum Elix & Johnston, sp. nov. Figure 6

Thallus corticola ad ramos, laxe adnatus, rigidulus, albo-cinereus, 3-5 cm latus; lobis sublinearibus, convolutis, separatis, apicibus rotundatis, subdichotome lobatis, 3-5 mm latis, ciliatis; superne nitidus, convexus, emaculatus, ± lobulatus; sorediis isidiisque destitutis; subtus centrum versus niger, sparse rhizinosus, ambitu nudus, castaneus.
Type. Australia. New South Wales. Growing on *Prostanthera* sp. in wet sclerophyll forest, Great Dividing Range, 6 km east of Captains Flat, 2 km north of Parkers Gap, 35°37'S, 149°30'E, 1260 m, *J. A. Elix 10894 & J. Johnston*, 3.iii.1983; CBG-holotype.

Thallus corticolous on twigs, loosely attached, pale grey, relatively rigid, 3-5 cm in diameter. Lobes linear-elongate, markedly convolute, separate, not at all imbricate, subdichotomously divided, 3-5 mm wide, the apices rotund, ciliate, cilia simple, minute, 0.5-1.0 mm long. *Upper surface* shiny, smooth, convex, emaculate, lacking soredia and isidia but occasionally developing rotund marginal lobulae, lobules 0.5-2.0 mm wide; medulla white. *Lower surface* black with a broad, nude, chestnut brown marginal zone, moderately to sparsely rhizinate, rhizines grouped subapically, simple, short, slender, 0.5-1.0 mm long. Apothecia and pycnidia not seen.
Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, P+ orange; containing atranorin, chloroatranorin, stictic acid (major), constictic acid (major), cryptostictic acid (trace), norstictic acid (trace), menegazziaic acid (trace).

This new species is distinguished by the unique morphology, with the characteristic elongated, markedly convolute, lobes, and rotund lobules. *Parmotrema lobulatum* Marcelli & Hale also is characterised by the presence of medullary stictic acid, lobules and short cilia, but this species has an entirely different growth form, with flat, crowded lobes and linear-elongate, marginal lobules. This new species appears to be very rare and at present is known only from the type locality.

Parmotrema judithae Elix & Johnston, sp. nov. Figure 7

Species cum thallo ut in *Parmotrema flaccidifolium* sed ab hac specie tenuiore et eciliata differt.
Type. Australia. Queensland. On *Callitris columellaris* in open woodland, Coochiemudlo Island, Moreton Bay, sea level, *J. A. Elix 10433*, 5.ix.1982; CBG-holotype.

Thallus corticolous, adnate to loosely adnate, coriaceous, pale mineral grey, 4-6 cm in diameter; *lobes* irregular, 4-10 mm wide, rotund at the apices, imbricate or subascending at the margins, eciliate. *Upper surface* dull, emaculate, becoming markedly rugose with age, continuous or ± cracked, sorediate; *soralia* marginal, linear along the margins to subcapitate on somewhat revolute lobes or short marginal laciniae, sometimes spreading submarginally; medulla white. *Lower surface* wrinkled, black, with a broad, brown, naked marginal zone, sparsely to moderately rhizinate, rhizines simple, short, *ca*.0.1-0.2 mm long, slender. *Apothecia* rare, adnate, concave, to 3 mm in diameter, disc dark brown, imperforate, margin thick, eciliate, margin and amphithecium sorediate; spores ellipsoid to reniform, 17-21 x 8-10 μm. *Pycnidia* rare, punctiform, no mature conidia seen.
Chemistry: Cortex K+ yellow; medulla K-, C-, P+ brick-red; containing atranorin, chloroatranorin, fumarprotocetraric acid (minor), succinprotocetraric acid (major), protocetraric acid (trace), protolichesterinic acid (± minor), unknown fatty acids (± trace).

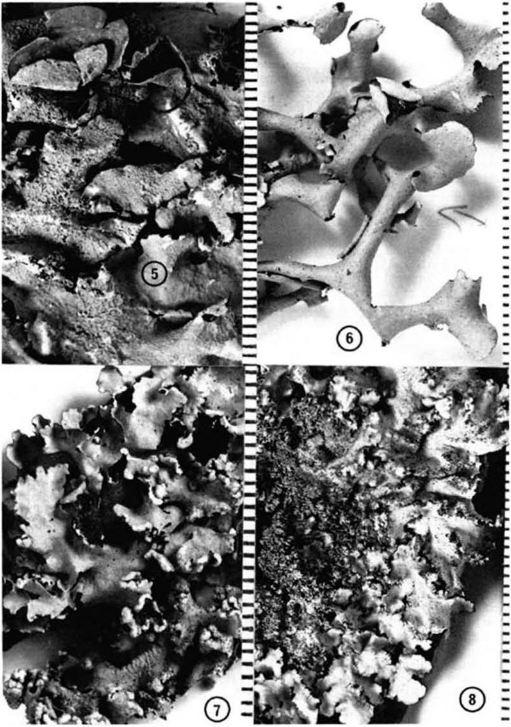
The presence of the marginal soralia and the medullary succinprotocetraric acid and fumarprotocetraric acid in this new species immediately bring the Papua New Guinean species, *P. flaccidifolium* (Kurok.) Streim., to mind. However the latter has dense, long and conspicuous cilia and a thin, papery thallus, whereas *P. judithae* is eciliate and has a coriaceous thallus. Morphologically this new species resembles some sparingly ciliate forms of the common species, *Parmotrema dilatatum* (Vain.) Hale, but the latter can be distinguished by the scattered cilia, the yellow tinge of the upper surface (due to traces of usnic acid present) and the medullary chemistry (protocetraric acid and echinocarpic acid). At present this species is known from several coastal and hinterland localities in Queensland. This species is named in honour of the Australian bryologist, Judith A. Curnow of the Herbarium, Australian National Botanic Gardens (CBG), who brought this species to our attention.

Specimens Examined
QUEENSLAND. On *Araucaria cunninghamii* in rainforest, Pine Circle Track, Noosa Heads National Park, 20 m, *J. A. Elix 10376*, 31.viii.1982 (ANUC); on Euphorbiaceae in dry sclerophyll forest, 19°26'S, 146°24'E, 350 m, *J. A. Elix 20442 & H. Streimann, J. A. Elix 20443 & J. A. Curnow*, 20.vi.1986 (ANUC); on volcanic rocks in disturbed *Eucalyptus* woodland, Mt. Stuart, 10 km SSW of Townsville, 19°21'S, 146°47'E, *J. A. Elix 21232 & H. Streimann*, 3.vii.1986 (ANUC); type locality, *J. Johnston 1349*, 30.viii.1984 (ANUC).

Parmotrema ochrocrinitum Elix and Johnston, sp. nov. Figure 8

Species cum thallo ut in *Parmotrema crinitum* sed ab hac specie medulla inferiore pigmentum ochraceum et euplectinum continente differt.
Typus. Australia. Victoria. On *Banksia integrifolia*, Cape Conran, 18 km east of Marlo, East Gippsland, sea level, *J. A. Elix 5293*, 21.xi.1978; CBG-holotype.

Thallus corticolous or saxicolous, coriaceous, adnate, pale mineral grey to grey-green, 5-6 cm in diameter. *Lobes* subirregular, crenate or irregularly incised, imbricate, 2-5 mm wide, the margin ciliate, cilia simple or branched, 0.5-3.0 mm long. *Upper surface* plane, emaculate, smooth to rugose with age, cortex fragile, isidiate; *isidia* laminal and marginal, short-cylindrical at first, ± becoming coralloid, granulose or



Figures 5-8. New species of Parmeliaceae: 5, *Parmotrema austrocetratum* (holotype in CHR); 6, *Parmotrema convolutum* (holotype in CBG); 7, *Parmotrema judithae* (holotype in CBG); 8, *Parmotrema ochrocrinitum* (holotype in CBG). Scale in mm

occasionally dissolving into soredia, often ciliate at the apices; medulla white in the upper part but pigmented yellow-orange towards the lower cortex. *Lower surface* black, with a narrow brown, naked marginal zone, densely rhizinate, rhizines slender, to 1.0 mm long. Apothecia and pycnidia not seen.
Chemistry: Cortex K+ yellow; upper medulla K+ yellow, C-, P+ orange, lower medulla K+ violet. Containing atranorin, chloroatranorin, stictic acid (major), constictic acid (minor), euplectin (minor), cryptostictic acid (trace), norstictic acid (trace), menegazziaic acid (±trace), connorstictic acid (± trace).

Morphologically and chemically this new species closely resembles the common *Parmotrema crinitum* (Ach.) Choisy, but can be readily distinguished by the heavily yellow-orange pigmented lower medulla. This region contains the anthraquinone pigment euplectin, first recognised in *Flavoparmelia euplecta* (Stirt.) Hale, but of indeterminate structure. *P. ochrocrinitum* has a much more restricted distribution than the cosmopolitan *P. crinitum*, at present being known only from southern and eastern Australia and possibly Taiwan (M. E. Hale, in litt.).

Specimens Examined
QUEENSLAND. On dead wood, trail through rainforest, Python Rock Track, Lamington National Park, S of Brisbane, *M. E. Hale 68883*, 8.viii.1983 (US); over mosses, debris and stones, large road cutting with a southerly aspect in wet sclerophyll forest, junction of Mt. Nebo and Samford PEI roads, Mt. Glorious, 27°21'S, 152°46'E, 520 m, *J. Johnston 1412*, 28.viii.1984 (ANUC).
VICTORIA. On coastal granite rocks, type locality, *J. A. Elix 5283*; on shrub in coastal scrub, type locality, *J. A. Elix 5309*, 21.xi.1978 (ANUC).

Punctelia nebulata Elix & Johnston, sp.nov. Figure 9

Species cum thallo ut in *Punctelia subalbicans* sed ab hac specie acidum lecanoricum deficiente differt.
Type. Australia. New South Wales. On roadside *Callitris columellaris*, 10 km north of Gilgandra along Highway 39, 280 m, *J. A. Elix-2320*, 16.viii.1976; CBG-holotype, MEL-isotype.

Thallus foliose, corticolous, adnate, pale grey to mineral grey or blackening with age, to 8 cm in diameter; *lobes* subirregular, crowded and imbricate, 2.0-4.0 mm wide, apices rotund, crenulate. *Upper surface* shiny at first, becoming dull, rugose towards the centre, pseudocyphellate; *pseudocyphellae* punctiform, confined to the lobe margins and the receptacle, lacking soredia and isidia but usually with granular white pruina towards the apices; medulla white. *Lower surface* ivory to pale brown, moderately rhizinate, rhizines simple to fasciculate or agglutinated, concolorous with the lower surface. *Apothecia* common, pedicellate, crowded in the central part of the thallus, to 10 mm in diameter, disc concave at first but becoming undulate and more or less flat with age, ± irregularly cracked, pale brown to dark brown; margin thin, crenulate, persistent, margin and amphithecium rugose-areolate, pseudocyphellate; asci 8-spored, spores colourless, subspherical to ellipsoid, 10-13 x 7-9 µm. *Pycnidia* numerous, subspherical, immersed in the thallus, conidia elongated, filiform, 9-11 x 1 µm.
Chemistry. Thallus K+ yellow; medulla K-, C-, KC-, P-; containing atranorin, chloroatranorin.

Previously this new species has been confused with *Punctelia subalbicans* (Stirt.) Galloway & Elix as these two species have comparable morphology and can only reliably be distinguished by chemical means. Thus *P. subalbicans* contains medullary lecanoric acid (C+ red) while *P. nebulata* lacks medullary substances.

P. nebulata is a scattered species growing on *Callitris* trees in the semi-arid, inland areas of southern Australia (NSW, SA).

Specimens Examined
NEW SOUTH WALES. On *Callitris columellaris* in *Callitris* woodland, along the Sturt Highway, 30 km west of Narrandera, *J. A. Elix 3655*, 27.viii.1977 (ANUC).
SOUTH AUSTRALIA. on *Callitris columellaris* in *Callitris* woodland, Flinders Ranges, Wilpena Chalet, 31°32'S, 138°36'E, 400 m, *J. A. Elix 17866 & L. H. Elix*, 29.x.1984 (ANUC); on *Callitris columellaris* in *Callitris* woodland, 4 km N of Bunyeroo Gorge, Flinders Ranges, 17 km NW of Wilpena, 31°24'S, 138°34'E, 400 m, *J. A. Elix 17908 & L. H. Elix*, 29.x.1984 (ANUC).

Punctelia novozelandica Elix & Johnston, sp.nov. Figure 10

Species cum thallo ut in *Punctelia subflava* sed ab hac specie subtus nigricante differt. *Type*. New Zealand. South Island. Canterbury; on moist rock ledges in remnant forest, Mitchells Track, Port Hills, Banks Peninsula, 420 m, *J. A. Elix 7809*, 17.iv.1980; CHR-holotype.

Thallus foliose, corticolous or saxicolous, adnate to loosely adnate, pale ash grey to brownish grey, to 10 cm in diameter; *lobes* irregular, crowded and imbricate, 2.0-4.0 mm wide, rotund at the apices, margins crenulate. *Upper surface* shiny, ± becoming white-maculate, slightly ridged, rugulose or weakly foveolate, pseudocyphellate; *pseudocyphellae* punctiform, confined to the receptacle, very rarely laminal, lacking soredia but with lobulae and isidia, *lobulae* marginal at first, developing terete isidia from the margins, *isidia*, cylindrical to slightly flattened, simple or becoming coralloid, isidia and lobulae becoming dense and spreading laminally over older lobes; medulla white. *Lower surface* black in the centre but with a paler, brown marginal zone, sparsely to moderately rhizinate, rhizines simple to fasciculate or tufted, concolorous with the lower surface. *Apothecia* rare, subpedicellate, crowded in the central part of the thallus, to 12 mm in diameter, disc irregularly concave at first but becoming undulate-distorted and ± stellate-cracked with age, red-brown to dark brown; margin thin, persistent, isidiate; amphithecium rugulose, pseudocyphellate, densely isidiate; asci 8-spored, spores colourless, ellipsoid, 11-14 x 7-8 µm. *Pycnidia* scattered, subapical, immersed in the thallus, conidia, filiform, 9-10 x 1.5 µm.
Chemistry. Thallus K-; medulla K-, C+ red, P- ; containing atranorin (trace), chloroatranorin (trace), lecanoric acid (major), orsellinic acid (± trace).

This new species closely resembles *Punctelia subflava* (Taylor) Elix & Johnston since these two species have comparable thalli, produce cylindrical to sublobulate isidia on the upper surface and have identical chemistry. However these two species are readily distinguished by the colour of the lower surface: it being black in *P. novozelandica* but ivory to pale tan in *P. subflava*. *P. novozelandica* is a scattered species on tree branches and rocks in the cool temperate Podocarp forests of both islands of New Zealand.

Specimens Examined
NEW ZEALAND. North Island. Wellington: on fallen branches in mixed Podocarp forest, Tongariro National Park, Mangawhero Forest Walk, Ohakune, 39°20'S, 175°31'E, 650 m, *J. A. Elix 18917, 18925*, 14.i.1985 (ANUC).

Punctelia subflava (Taylor) Elix & Johnston, comb.nov.

Basionym: *Parmelia subflava* Taylor, *Hook. Lond. J. Bot.*, **6** : 147 (1847).

Holotype: Van Diemen's Land (Tasmania). *Mr. Borrer*'s Herb. FH!

Previously this species has been synonymized with *Punctelia rudecta* (Ach.) Krog

(Filson 1982, Galloway & Elix 1983, Galloway 1985, Krog 1982), a species not found in Australasia. These two species have identical chemistry and bear laminal isidia on the upper surface of the lobes, but differ in a number of important morphological characters. *P. rudecta* has a thick, coriaceous thallus and more or less smooth marginal lobes while *P. subflava* has a much thinner, fragile thallus and the marginal lobes are usually foveolate. These species also differ in the nature and distribution of the pseudocyphellae. The pseudocyphellae are prominent and laminal in *P. rudecta* (dense on the marginal lobes) and often become elongated, while in *P. subflava* they are relatively sparse, occur on the margins and the amphithecium (and only rarely become laminal), and are punctiform. The nature of the isidia can also be used to distiguish these species. The isidia of *P. rudecta* are predominantly cylindrical, occasionaly interspersed with squamiform isidia, while those of *P. subflava* are always dorsiventral (rarely subterete as in the type) and usually phyllidiate-lobulate.

Relicina subnigra Elix & Johnston, sp. nov. Figure 11

Species cum thallo ut in *Relicina sydneyensis* sed ab hac specie colore nigro subtus differt.

Type. Australia. Australian Capital Territory. On sheltered granite rocks on cliff, along Paddys River, 1 km south of Murrays Corner, 35°23'S, 148°58'E, 550 m, *J. A. Elix 670*, 3.iii.1975 ; CBG-holotype, MEL-isotype.

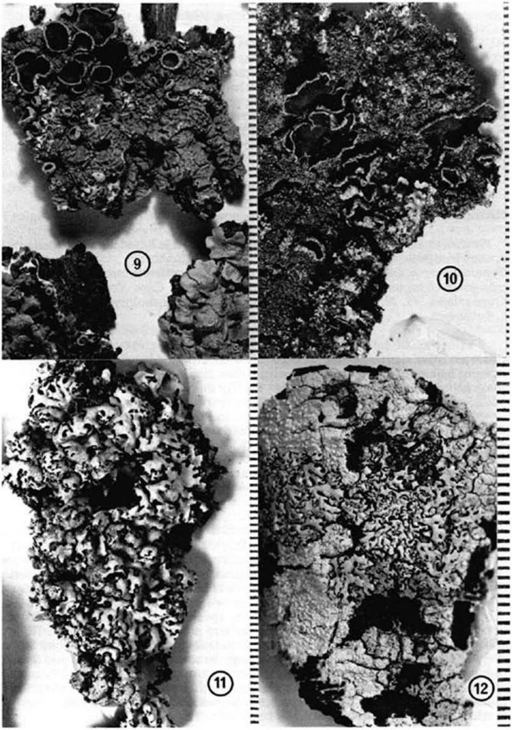
Thallus foliose, saxicolous, adnate on rocks or growing over other lichens, yellow-green to yellow-brown on storage, to 8 cm in diameter; *lobes* linear-elongate, contiguous centrally to separate at the periphery, 1.0-3.0 mm wide, ± imbricate, dichotomously divided, the margins bulbate-ciliate; *cilia* dense and conspicuous, black, to 1.0 mm long, tapering to markedly inflated. *Upper surface* plane to convex, continuous, apices shiny, isidiate, *isidia* cylindrical, sparingly branched but rarely becoming coralloid; *medulla* white. *Lower surface* black to brown-black, rhizines dense, black, elongated, furcate or dichotomously branched. *Apothecia* rare, adnate, to 2 mm in diameter, disc shallowly concave then ± flat, dark brown; the exciple ecoronate, amphithecium isidiate, ± retrorsely rhizinate; asci 8-spored, spores simple, colourless, ellipsoid, 6-8 x 4-5 µm.

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

Morphologically this new species closely resembles *Relicina sydneyensis* (Gyelnik) Hale. Both species are characterised by linear-elongate lobes with cylindrical isidia, ecoronate apothecia and the presence of the stictic acid complex in the medulla. However these two species are distinguished readily by the colour of the lower surface, the morphology of the thallus and rhizines, and their ecological requirements. *R. subnigra* has a black to brown-black lower surface, with dense, elongated, branched and entangled rhizines whereas *R. sydneyensis* has a pale tan lower surface centrally (it becomes dark brown towards the apices and the margins) and moderate, short, and predominantly simple, rhizines. Moreover the thallus of *R. subnigra* is usually considerably larger (6-8 cm *cf.* 3-6 cm) and the lobes broader (1-3 cm *cf.* 0.8-1.5 cm) than that of *R. sydneyensis*. *R. subnigra* is a saxicolous species and has a restricted distribution in the mountain and tableland areas of southern New South Wales and Victoria while *R. sydneyensis* is both corticolous and saxicolous, with a more extensive distribution, being known from temperate coastal areas in southern New South Wales to north Queensland. The latter species is known also from Japan, Taiwan, Indonesia and Papua New Guinea.

Specimens Examined

NEW SOUTH WALES. On sandstone rocks in dry sclerophyll forest, Morton National



Figures 9-12. New species of Parmeliaceae: 9, *Punctelia nebulata* (holotype in CBG); 10, *Punctelia novozelandica* (holotype in CHR); 11, *Relicina subnigra* (holotype in CBG); 12, *Relicina terricrocodila*.(holotype in MEL). Scale in mm.

Park, 8 km north-east of Nerriga, 760 m, *J. A. Elix 3082*, 30.iii.1977 (ANUC); on sandstone rocks, Peckmans Plateau, Katoomba, 980 m, *J. A. Elix 3226*, 24.iv.1977 (ANUC).
AUSTRALIAN CAPITAL TERRITORY. On rocks, Molonglo River Gorge, 15 km east of Canberra, 700 m, *J. Burmeister 139*, 27.v.1975 (CBG 058784); on sandstone rocks in moist, sheltered gully, west of summit, Black Mountain, Canberra, 730 m, *J. A. Elix 3644*, 14.viii.1977 (ANUC); on mossy granite rocks in subalpine woodland, along trail to Booroomba Rocks, 11 km south of Tharwa, 1065 m, *J. A. Elix 4034*, 16.xi.1977 (ANUC); over *Hypogymnia* and *Parmelia* lichens on mossy granite rocks, Gudgenby River Gorge, 4.5 km south of Tharwa, 35°34'S, 149°04'E, 620 m, *J. A. Elix 10907*, 10.iv.1983 (J. A. Elix: Lichenes Australasici Exsiccati, No. 50 as *Relicina sydneyensis* (Gyelnik) Hale; ANUC, CBG, MEL).
VICTORIA. On rocks, Mt. Arapiles, *R. W. Rogers 2435*, 16.viii.1981 (BRIU).

Relicina terricrocodila Elix & Johnston, sp. nov. Figure 12

Species thallo ut in *Relicina samoensis* sed ab hac specie lobis latioribus, contiguis et acidum incognitum continente differt.
Type. Australia. Queensland. On bark of *Ceriops* towards the landward fringe, large mangrove community with crocodiles, Portland Roads, Cape York Peninsula, north Queensland, *G. N. Stevens 5009*, 29.vi.1983 ; MEL-holotype; ANUC, CBG, US-isotypes.

Thallus small foliose, corticolous, tightly adnate, yellow-green, to 1.5 cm in diameter; *lobes* short, sublinear, 0.6-1.0 mm wide, crowded but sparingly imbricate, the margins bulbate-ciliate; *cilia* conspicuous, bulbae globose to tapering, cilia up to 0.4 mm long, unbranched. *Upper surface* plane, slightly shiny, emaculate, lacking soredia and isidia; medulla white. *Lower surface* jet black, sparsely rhizinate, rhizines black, simple or sparingly branched. *Apothecia* rare, adnate, to 1.0 mm in diameter, disc more or less flat, pale brown to brown, exciple apparently ecoronate (but may be immature), amphithecium retrorsely rhizinate; asci 8-spored, spores simple, colourless, broad-ellipsoid, 5.5-7 x 3.5-4.5 µm.
Chemistry. Thallus K-; medulla K+ pale yellow, C+ faint orange, KC-, P+ yellow-orange; containing usnic acid, echinocarpic acid (major), conechinocarpic acid (minor) and hirtifructic acid (trace).

This new species would appear to be closely related to *Relicina samoensis* (Zahlbr.) Hale as they have comparable thalli, narrow lobes, a black lower surface and lack isidia. However the thalli of *R. terricrocodila* are compact, with contiguous, sublinear lobes with acute axils (to *ca.* 30°), dense cilia, and dense retrorse apothecial rhizines, whereas *R. samoensis* has separate, more markedly linear lobes with broader lobe-axils (*ca.* > 50°), moderate cilia and retrorse rhizines. The two species also differ chemically. Thus the major medullary substances in both species are echinocarpic acid and conechinocarpic acid, but *R. terricrocodila* also produces hirtifructic acid (Elix & Johnston 1986). The latter substance also occurs in *Relicina hirtifructa* (Kurok.) Streim. and *Relicina fijiensis* Elix & Johnston, although the structure of this compound remains unknown. This new species is morphologically similar to *R. fijiensis* but the latter species has larger, more robust thalli, coronate apothecia and lacks echinocarpic acid and conechinocarpic acid. This new species is known only in collections from the type locality.

Relicinopsis stevensii Elix & Johnston, sp. nov. Figure 13

Species cum thallo ut in *Relicinopsis rahengensis* sed ab hac specie nonisidiato differt.

Type. Australia. Queensland. On isolated tree growing on a ridge of conglomerate in dry open country, Broken River, 230 km north-west of Charters Towers, *G. N. Stevens 3435*, 1975 ; MEL-holotype.

Thallus small foliose, corticolous, adnate to tightly adnate, yellow-green, *ca*. 1.5 cm in diameter; *lobes* subirregular, contiguous, 0.8-1.0 mm wide, ± imbricate, dichotomously to subirregularly divided, margins eciliate. *Upper surface* convex, continuous, shiny, lacking soredia and isidia; medulla white. *Lower surface* pale tan, moderately rhizinate, rhizines concolorous with the lower surface, simple. *Apothecia* common, adnate, to 1 mm in diameter, disc shallowly concave, dark brown; asci 8-spored, spores simple, colourless, ellipsoid, 6-8 x 4-5 µm.
Chemistry. Thallus K-; medulla K-, C-, KC+ yellow, P-; containing usnic acid, barbatic acid (major), 4-O-demethylbarbatic acid (minor), obtusatic acid (trace), norobtusatic acid (trace), 3-α-hydroxybarbatic acid (trace), atranorin (trace).

In some aspects this new species resembles *Relicinopsis rahengensis* (Vainio) Elix & Verdon. Both species are characterised by narrow, eciliate lobes with a pale lower surface, and the presence of the barbatic acid complex in the medulla. However *R. rahengensis* is clearly distinguished by the production of cylindrical isidia, and can be considered the isidiate counterpart of *R. stevensii*. *R. stevensii* is known only from the type locality.

Xanthoparmelia callifolioides Adler, Elix & Johnston, sp.nov. Figure 14

Species cum thallo ut in *Xanthoparmelia versicolor* sed ab hac specie subtus pallido differt.
Type. Argentina. Salta Province. On soil and pebbles, 50 m above the road, Las Pailas, 2280 m, *M. T. Adler*, ii.1986; BAFC-holotype; ANUC, US-isotypes.

Thallus foliose, loosely attached to soil or debris, pale yellow-green, forming irregular patches or rosettes to 10 cm in diameter; *lobes* variable, subirregular to linear-elongate, often forming a dense, imbricate mat, with broad primary lobes with subrotund apices, 2-4 mm wide, with narrower (0.7-1.2 mm wide); elongated, subdichotomously divided, revolute to weakly convolute secondary lobes or lobules developing from the centre. *Upper surface* shiny at the apices, dull within, smooth, emaculate, lacking soredia and isidia; medulla white. *Lower surface* pale tan to light brown, apices darker, sparsely to moderately rhizinate, rhizines grouped subapically, darker brown, simple, tufted, or rarely dichotomously divided, slender, 1-2 mm long. *Apothecia* not seen. Pycnidia common, minute, punctiform, immersed in the thallus.
Chemistry. Cortex K-; medulla K+ yellow-dark red, C-, KC-, P+ red-orange; containing usnic acid, salazinic acid (major), consalazinic acid (minor), norstictic acid (± trace), protocetraric acid (± trace).

This species is characterised by the terricolous substrate, the revolute secondary lobes and the production of salazinic acid and consalazinic acid in the medulla. Morphologically this species resembles *X. versicolor* Hale as both species form extended thalli on soil, produce revolute to subterete lobulae and contain salazinic acid. However *X. callifolioides* is readily distinguished by the pale brown lower surface, this being jet black in *X. versicolor*. In many respects this new species also resembles *X. taractica* (Krempelh.) Hale but is distinguished by the revolute secondary lobes (these are more or less flat in *X. taractica*). Another related species, *X. alternata* Elix & Johnston, differs in having narrower lobes and developing terete, coralloid, isidia-like lobules in the centre of the thallus. At present this new species is known only from the type locality.

Specimen Examined
ARGENTINA. Salta Province. On rock, spreading on to soil, type locality, *M. T. Adler*, ii. 1986 (ANUC).

Xanthoparmelia nigraoleosa Elix & Johnston, sp.nov. Figure 15

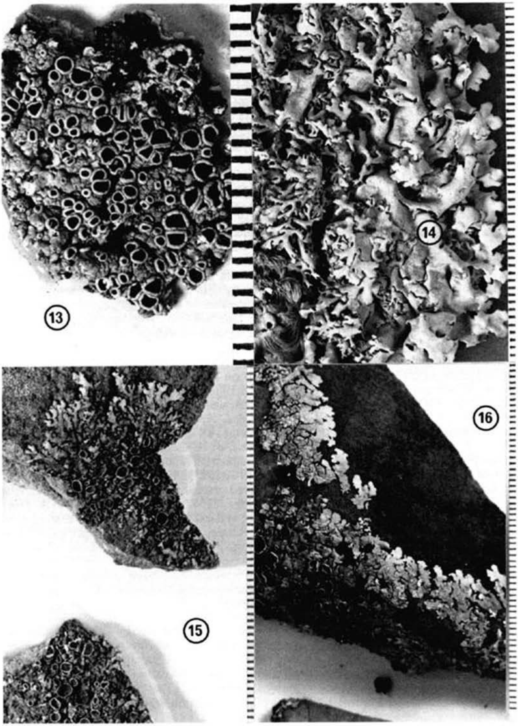
Species cum thallo ut in *Xanthoparmelia oleosa* sed ab hac specie colore nigro subtus differt.
Type. Australia. South Australia. On sandstone rocks in open *Eucalyptus* woodland, Flinders Ranges, lower slopes of Mt. Remarkable, Melrose, 32°35'S, 138°11'E, 500m, *J.A.Elix 17748* & *L.H.Elix*, 26.x.1984; CBG-holotype.
Thallus small foliose to subcrustose, saxicolous, tightly adnate, yellow-green but darkening with age and becoming greyish-black, 3-6 cm in diameter; *lobes* irregular to sublinear-elongate, 0.8-1.5 mm wide, irregularly branched, barely imbricate but contiguous, becoming cracked and areolate in the older central portion of the thallus, areolae *ca.* 1.0 mm in diameter. *Upper surface* opaque, emaculate, shiny and black-marginate near the apices, older lobes becoming cracked and areolate, lacking soredia and isidia; medulla white. *Lower surface* black, often brown at the lobe apices, moderately rhizinate, rhizines black, simple, slender. *Apothecia* common, adnate to substipitate, 1.0-2.5 mm in diameter, the disc concave, dark brown, margin thin, continuous, amphithecium smooth; spores (8), ellipsoid, 7-8 x 4-5 µm.
Chemistry. Cortex K+ yellow; medulla K-, C-, KC-, P- ; containing usnic acid, constipatic acid (major), protoconstipatic acid (major), dehydroconstipatic acid (± minor), atranorin (minor).

This distinctive new species is characterised by the black lower surface, the small foliose to subcrustose growth habit and the production of the fatty acids, dehydroconstipatic acid, constipatic acid and protoconstipatic acid, in the medulla. Morphologically and chemically *X. nigraoleosa* closely resembles *X. oleosa* (Elix & Armstrong) Elix & Nash as both have similarly adnate thalli which become ± areolate in the older portions, lack soredia and isidia and contain the same medullary fatty acids. However *X.nigraoleosa* is clearly distinguished by the black lower surface. *X.oleosa* has a tan to dark brown lower surface. This species has been previously confused with the South African species, *X. subnigra* Hale (Elix & Johnston 1987c), a morphologically similar species but with larger thalli, broader lobes and containing a different constellation of aliphatic acids [*X. subnigra* contains constipatic acid (minor), protoconstipatic acid (minor), pertusaric acid (trace), unknown fatty acids R_F(15% acetic acid/toluene) 0.34 (major), 0.38 (major), 0.36 (minor), 0.32 (trace), 0.18 (trace), 0.40 (trace) - the latter acids also occur in *X. subdecipiens* (Vainio) Hale]. At the present time this new species is known only from rock outcrops in South Australia.

Specimens Examined
SOUTH AUSTRALIA. On sandstone rocks in open *Eucalyptus* woodland, type locality, *J. A. Elix 17758* & *L. H. Elix*, 26.x.1984 (ANUC); on quartzite rocks in pasture, Kangaroo Island, just E of Wisanger Park Homestead, 35°37'S, 137°28'E, 80 m, *J. A. Elix 19628* & *L. H. Elix* (ANUC).

Xanthoparmelia prodomokosii Hale, Elix & Johnston, sp.nov. Figure 16

Species cum thallo ut in *Xanthoparmelia subdomokosii* sed ab hac specie deminuta, arcte adnata et skyrino deficiente differt.
Type. Australia. Northern Territory. On sandstone rocks with a southerly aspect in *Acacia-Callitris* woodland, Macdonnell Range, 1 km east of Pine Gap, 23°49'S, 133°45'E, 600 m, *J. A. Elix 11309* & *L. A. Craven*, 17.ix.1983; CBG-holotype.



Figures 13-16. New species of Parmeliaceae. 13, *Relicinopsis stevensii* (holotype in MEL); 14, *Xanthoparmelia callifolioides* (holotype in BAFC); 15, *Xanthoparmelia nigraoleosa* (holotype in CBG); 16, *Xanthoparmelia prodomokosii* (holotype in CBG). Scale in mm.

Thallus foliose, saxicolous, adnate, pale yellow-green, 5-7 cm in diameter; *lobes* sublinear-elongate to subirregular, contiguous or slightly imbricate, apices ± rotund, 1.0-2.5 mm wide. *Upper surface* flat, shiny, emaculate, often tangentially or irregularly cracked, older lobes becoming rugulose and ± areolate, often with black margins, lacking soredia and isidia; medulla white. *Lower surface* pale brown to brown, moderately to sparsely rhizinate, rhizines simple, concolorous with the lower surface or dark brown, slender. *Apothecia* common, 1-2(-8) mm in diameter, disc dark brown to black, margin inrolled at first, then thin, entire, exciple smooth; spores colourless,ellipsoid, 6-8 x 4-5 µm.
Chemistry. Cortex K-; medulla K-, C-, P-; containing usnic acid, hypoprotocetraric acid (major), 4-O-demethylnotatic acid (± trace), scabrosin 4,4'-dibutyrate (±), scabrosin 4-acetate 4'-butyrate (±), scabrosin 4-acetate 4'-hexanoate (±), scabrosin 4,4'-diacetate (± trace), unknown scabrosins (± traces).

Previously this new species has been confused with the South African lichen *Xanthoparmelia subdomokosii* (Hale) Hale (which apparently does not occur in Australia), since both have a pale lower surface, lack soredia and isidia and contain medullary hypoprotocetraric acid. However whereas *X. subdomokosii* has larger thalli (to 12 cm), with broader (2-4 mm wide), adnate to loosely adnate, continuous lobes, *X. prodomokosii* has smaller thalli (to 7 cm), with narrower (1-2.5 mm wide), tightly adnate lobes which often become areolate with age. In addition the lower medulla of *X. subdomokosii* normally contains significant quantities of the orange pigment skyrin (K+ purple), but this compound is absent in *X. prodomokosii*. This new species is quite common in arid Central Australia and also occurs in South Africa.

Specimens Examined
WESTERN AUSTRALIA. On rock outcrop on south-facing slope, *ca*. 11 km W of Yeelirrie Station, *D. H. S. Richardson 69*, 2.iii.1980 (PERTH 000745).
NORTHERN TERRITORY. On sandstone rock, west face of Ayers Rock, 630 m, *J. A. Elix 11072 & L. A. Craven*, *J. A. Elix 11073 & L. A. Craven*, 10.ix.1983 (ANUC); on sandstone rock, exposed arid ridge, James Range, 88 km S of Alice Springs along the Stuart Highway, 24°19'S, 133°28'E, 470 m, *J. A. Elix 11132 & L. A. Craven*, 11.ix.1983 (ANUC); on exposed sandstone rock with a southerly aspect, Macdonnell Range, Serpentine Gorge National Park, 23°45'S, 132°58'E, 670 m, *J. A. Elix 11256 & L. A. Craven*, 15.ix.1983 (ANUC); on weathered granite in arid scrubland, Carmichaels Tourist Camp, Macdonnell Range, Alice Springs, 23°42'S, 133°52'E, 600 m, *J. A. Elix 11285 & L. A. Craven*, 17.ix.1983 (ANUC); on sandstone ledges with a southerly aspect in open mulga woodland, Macdonnell Range, 10 km N of Alice Springs, 1.5 km W of Stuart Hwy., 23°37'S, 133°52', 680 m, *J. A. Elix 11366 & L. A. Craven*, 18.ix.1983 (ANUC).
REPUBLIC OF SOUTH AFRICA. Cape Province. On large granite domes and boulders in karoo, Nieuwoudtville Nature Reserve outside Nieuwoudtville off Hwy. 27, Grid 3119 AC., 800 m, *M. E. Hale 72, 138*, 29.i.1986 (US).

New Records of Parmeliaceae for Australia

Xanthoparmelia brunnthaleri (Stein. & Zahlbr.) Hale
This species was known previously from South Africa.
Chemistry. Cortex K-; medulla K-, C-, P-; containing usnic acid, scabrosin 4,4'-diacetate, unknown scabrosins (± traces).
Specimen Examined
NORTHERN TERRITORY. On granite rocks in mulga scrub, Macdonnell Range, 10 km north of Alice Springs along Stuart Hwy., 23°37'S, 133°53'E, 680 m, *J. A. Elix 11334 & L. A. Craven*, 18.ix.1983 (ANUC).

Xanthoparmelia subpigmentosa Hale
This species has previously been reported from South Africa (Hale 1984).
Chemistry. Cortex K-; upper medulla K+ yellow-dark red, C-, P+ red-orange; lower medulla K+ violet; containing usnic acid, salazinic acid (major), consalazinic acid (minor), skyrin (minor).

Specimen Examined
NEW SOUTH WALES. On exposed rocks in subalpine grassland, Kosciusko National Park, New Chums Hill, above the old Kiandra cemetery, 1460 m, 35°52'S, 148°30'E, *J. A. Elix 19123 & H. Streimann*, 10.vi.1985 (ANUC).

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NOTES ON HYPHOMYCETES. LVII. CORYNESPORA BISEPTATA, RECLASSIFIED IN CORYNESPOROPSIS

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ABSTRACT

Corynespora biseptata M.B. Ellis is reclassified in the genus *Corynesporopsis* Kirk, as *C. biseptata* (M.B. Ellis) Morgan-Jones. It is described and illustrated.

INTRODUCTION

The segregate genus *Corynesporopsis* Kirk was established to accommodate *Corynespora quercicola* Borowska, which was not considered to be congeneric with *Corynespora cassiicola* (Berk. & Curt.) Wei [= *Corynespora mazei* Güssow], the type species of *Corynespora* Güssow (Kirk, 1981a). *Corynesporopsis* differs from *Corynespora* in having typically catenate, short-cylindrical to ellipsoid, euseptate conidia. Although the two genera have similar conidiophores and both show monotretic conidiogenesis, conidia of *Corynespora* are mostly solitary, long-cylindrical or obclavate, often rostrate and euseptate.

A second species, *Corynesporopsis uniseptata* Kirk, was added to the genus later in the same year (Kirk, 1981b). This differs from *C. quercicola* in having smaller conidiophores, one-septate conidia, with dark pigmentation at the septum, and occurring on leaves rather than wood. Conidiophores of *C. quercicola* were noted to rarely proliferate percurrently, a common occurrence in species of *Corynespora* (Ellis, 1957; 1960; 1971). No such proliferation was noted in *C. uniseptata*. Kirk (1981a) experienced difficulty in determining precisely how percurrent proliferation occurred. He stated that it was not clear whether proliferation occurs from a conidiogenous cell that remains active following secession of conidia, whether it results from conidiophore regeneration following a dormant period or damage, or from a conidiogenous cell that fails to produce a conidium.

Corynesporopsis indica Kirk, a third species described two years later (Kirk, 1983) was compared with the two known species of *Hemicorynespora* M.B. Ellis, *H. deightonii* M.B. Ellis, the type, and *H. mitrata* (Penz. & Sacc.) M.B. Ellis. *Hemicorynespora* has morphologically similar conidiophores to *Corynespora* and *Corynesporopsis* but its conidia are produced solitarily on successive percurrent proliferations, are mitre-shaped or limoniform, and have

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a distinctly truncate base. Kirk (1983) noted the base of the conidia in *C. indica*, whether produced terminally on the conidiophore or from a subtending conidium in an acropetal chain, to be similarly truncate. Conidia in an intermediate position, or at the base of a chain of three, are truncate at both ends. Taking into account this similarity, Kirk suggested that conidiogenesis in *C. indica* and *Hemicorynespora* may be identical. By scanning electron microscopy it was shown that, although abrupt truncation suggests a flat conidial base, the base is, in fact, concave with a central pore defining the precise conidiogenous locus. The concave surface of the conidial base in effect closely abuts onto the convex apex of the conidiogenous cell. Conidia of *C. indica* are distinctive in having a median septum obscured by a dark brown band, reminiscent of septa seen in species of *Bispora* Corda. Other than the septa, the conidial shape and the fact that the conidia catenate, there is little difference between *Corynesporopsis* and *Hemicorynespora*.

Holubovā-Jechovā and Mercado (1986) redescribed and illustrated *C. quercicola* from a collection made in Cuba and named a further species, *C. rionensis* Hol.-Jech., bringing the total number to four. The Cuban collection of *C. quercicola* differed from those made in Europe by having slightly longer conidiophores and conidia. Although no mention of percurrent proliferation was made in the description, such proliferation was shown in one of the four conidiophores illustrated. *Corynesporopsis rionensis* has conidia that are similarly shaped to those of *C. indica*, being somewhat doliiform and distinctly truncate at the base, or at both ends where intermediate in position in a chain. Each conidium bears three to five thick, dark septa. The conidiogenous cells of *C. quercicola* were described as being percurrent although only one out of three conidiophores illustrated shows any proliferation. Those of *C. rionensis* were also noted to be percurrent and illustrated as such.

During the course of determining an appropriate classification for *Monotretomyces uniseptatum* Morgan-Jones, Sinclair & Eicker, a number of morphologically similar genera and species were considered (Morgan-Jones *et al.*, 1987). These included *Bispora*, *Corynespora*, *Corynesporopsis*, *Diplococcium* Grove and *Spadicoides* Hughes. It was noted that *Bispora betulina* (Corda) Hughes, *B. novae-zelandiae* Matsushima and *Corynespora biseptata* each bears some resemblance to *Monotretomyces*. A suggestion was made that *C. biseptata* might be better classified in *Corynesporopsis*. Since that time, I have had opportunity to examine the type material of *C. biseptata* and have determined the suggestion to be a valid one. A transfer is therefore made herein.

TAXONOMIC PART

Corynesporopsis biseptata (M.B. Ellis) comb. nov. (Figure 1).

≡ *Corynespora biseptata* M.B. Ellis, *Mycol. Pap.* 76: 27, 1960.

Colonies dense, hairy, black, effuse. Mycelium mostly immersed in the substratum, composed of pale to mid-brown, smooth, branched, septate, 1.5-3.5 um wide hyphae. Swollen, brown, hyphal cells up to 10 um in diameter frequently present at the base of conidiophores. Stromata partly superficial, partly immersed in the substratum, brown, irregular in shape, sometimes rudimentary or extending laterally as a loosely-organized, linearly arranged group of cells or compact and pseudoparenchymatous in texture. Conidiophores

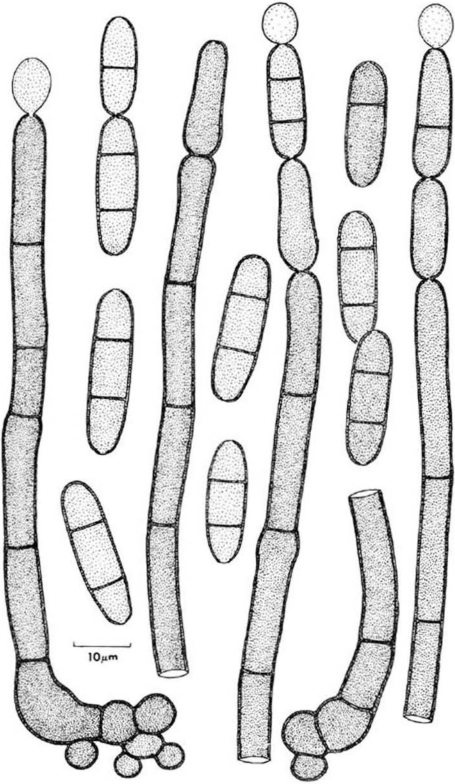

FIGURE 1. *Corynesporopsis biseptata*. Conidiophores and conidia.

borne from cells of the stromata or from hyphae, solitary or, when borne from stromata, loosely caespitose, mononematous, macronematous,erect, more or less straight or slightly curved, septate, brown, often slightly paler toward the apex, smooth, usually with several apical, percurrent, cylindrical or often obclavate proliferations, up to 160 um long, 4.5-7 um wide. Conidiogenous cells monotretic, integrated, determinate. Conidia acrogenous dry, catenate, arising through a single pore at the apex of each conidophore, percurrent proliferations thereof, or successive conidia, cylindrical, more or less straight, obtuse at each end, smooth, pale to mid-brown, mostly 2-septate, with the central cell usually slightly longer than end cells, 18-33 X 7-9 um.

On dead, decorticated wood; United Kingdom.

Collection examined: on dead wood, Dunford House, Midhurst, Sussex, England, M.B. and E.M. Ellis, May 22, 1979, IMI 76701, holotype.

DISCUSSION

Corynesporopsis biseptata fits perfectly in the genus as defined by Kirk (1981a). It quite closely resembles the type species, *C. quercicola*, and *C. uniseptata*, differing only in the detailed morphology and size of its conidia and in the frequent percurrent proliferation of its conidiophores. The two other species, *C. indica* and *C. rionensis*, differ appreciably in the shape of their conidia and in possessing dark pigmented bands obscuring their conidial septa. *C uniseptata*, which has conidia more like those of *C. biseptata* and *C. quercicola* has also, interestingly, darker pigmentation at the septa.

The phenomenon of having dark bands at conidial septa is a feature shared in common with a number of other dematiaceous hyphomycete genera. Among these, *Bispora* bears some morphological resemblance, except for the fact that it has semi-macronematous conidiophores. *Didymobotryum* Sacc., a monotretic, catenate genus, has broadly similar conidia but very different, branched, synnematous conidiophores. When grown *in vitro*, *B. betulina*, however, produces chains of conidia lacking dark bands (Morgan-Jones *et al.*, 1987), indicating that this may not be a totally stable characteristic. As discussed previously (Morgan-Jones *et al.*, 1987), a species such as *B. betulina*, although usually described as being monoblastic in its conidiogenesis (Hughes, 1953; Ellis, 1971), is very similar in many respects, and in conidial morphology in particular, to such genera as *Corynesporopsis* and *Monotretomyces*. The same is true of *B. novae-zelandiae*. The type species of *Bispora*, *B. antennata* (Pers.) Mason, although much smaller, has a somewhat similar appearance to *Taeniolella exilis* (Karst.) Hughes, the type species of *Taeniolella* Hughes, and is more clearly monoblastic. The discontinuities that are employed to separate genera, especially with regard to cell wall relationships may, in some instances, be more imagined than real. The use of the terms monoblastic and monotretic is often quite problematic and the use of conidial truncation as a hallmark for the former is far from being reliable. Genera such as *Corynesporella* Munjal and Gill and *Podosporium* Schw., for example, whose conidiogenesis is considered to be tretic (Ellis, 1971), bear conidia with a truncate base. Kirk (1983), in his scanning electron microscope study of the conidial base of *C. indica*, noted the presence of a central pore bounded by a somewhat irregular, ring-like border beyond which a wider, relatively smooth wall area occurs. It would appear that during the process of conidial enlargement and maturation, when the conidial wall is still relatively thin, the peripheral smooth area partly invaginates into the body of the conidium over the convex apex of the conidiophore, becoming concave as a result. The increasing weight of the developing conidium may be at least partly responsible for this. The final effect is that when the conidial base is viewed from the side it appears flat. It may well be that as a conidium matures, its exposed wall becomes increasingly thicker, particularly at the juncture with the concave portion, whereas the latter remains comparatively thin. Deposition of wall material at this juncture creates a ring-like thickening that appears as a dark, truncate hilum at the conidial base when viewed laterally. Such a hilum is a feature commonly occurring in conidia of *Corynespora* and *Corynesporella*.

Ellis (1960) described the conidiophore of *C. biseptata* as proliferating through its apical pore after the first conidium or chain of conidia has fallen. It is, however, as Kirk (1981a) pointed out in connection with *C. quercicola*, often difficult to determine the sequence of events vis-ã-vis proliferation. With isolation and growth of such fungi *in vitro* the process could be followed more precisely. In the case of *C. biseptata* it appears, at least in some instances, that the first conidium initial produced at the apex of a conidiogenous cell fails to mature into a septate conidium but such an entity gives rise to a conidium distally. In shape and morphology, except for septation, the initial has the characteristics of a conidium, but could easily be incorrectly interpreted as having been produced following secession of a preceding conidium and referred to as a proliferation. It seems possible that true conidiophore proliferations, in addition to aborted conidial elements, might be present, but it is impossible to be certain by examination of a dried herbarium specimen.

ACKNOWLEDGMENTS

Dr. B.C. Sutton, CAB International Mycological Institute, Kew, Surrey, United Kingdom, afforded me the opportunity to examine the type material of *C. biseptata* and Dr. Roger D. Goos, Department of Botany, University of Rhode Island, reviewed the manuscript.

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ONTOGENY AND MORPHOLOGY OF TELIOSPORES (PROBASIDIA) IN UREDINALES AND THEIR SIGNIFICANCE IN TAXONOMY AND PHYLOGENY

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Abstract

At least four types of spore ontogeny and numerous morphological variations, such as cell arrangement, surface ornamentation, and pigmentation exist in teliospores (probasidia) of Uredinales (rust fungi). The diverse morphology found in probasidia of rust fungi is unique in Basidiomycetes. Taxonomic and phylogenetic significance of spore ontogeny and morphological characteristics of teliospores are discussed within Uredinales and in comparison with other groups of fungi in the Heterobasidiomycetes.

This paper describes four types of teliospore ontogeny exist in the rust fungi (Uredinales) and discusses their significance in taxonomy and phylogeny.

Rust fungi are a unique group of Heterobasidiomycetes with about 5000-6000 recognized species and about 105 'good' genera (Cummins and Hiratsuka 1984). They are parasites of many gymnosperm and angiosperm families. Rust fungi are unique among Basidiomycetes because (1) they possess spermogonia, (2) up to six morphological and functional spore states exist in one species, and (3) they are obligate parasites of the higher plants. Many species need only one kind of plant to complete their life cycles (autoecious), but others require two unrelated groups of host plants to do so (heteroecious).

A part of this study was presented in a symposium entitled "Structure and systematics of Heterobasidiomycetes" at the 14th International Botanical Congress, Berlin, W.Germany, 1987. Figs. 1,3,5-7,9,and 11-16 are adopted from Cummins (1959) with the permission of Dr. G. B. Cummins.

The name teliospore has been used traditionally for one spore state of rust and smut rust fungi. But in a more universal terminology for Basidiomycetes proposed by Donk (1954) and Talbot (1973) and used in most of the recent taxonomic work in Basidiomycetes, these structures are called PROBASIDIA, since karyogamy occurs in them. Structures commonly called basidia in rusts are METABASIDIA, according to the Donk-Talbot system of terminology, because meiosis occurs in them.

In many other groups of Basidiomycetes, probasidia are replaced by metabasidia internally and no distinct structures called probasidia exist. Therefore, clear distinction between pro- and meta-basidia is a somewhat unique characteristic of rust fungi. Some of the rust genera such as *Coleosporium*, *Chrysopsora*, *Chrysella*, *Ochropsora*, and *Goplana* also lack distinct separation of pro- and meta-basidia. It is noteworthy that all known genera of rust fungi with this type of basidia are colorless and germinate without dormancy. Genera of rusts having this type of telial germination may provide some clues to phylogenetic links with other groups of Basidiomycetes. Uredinologists often call this internal basidia formation, but the term is not appropriate, as pointed out by Oberwinkler (1982). On the other hand, some genera of Heterobasidiomycetes, such as *Uredinella*, *Septobasidium*, *Eocronartium*, *Cystobasidium*, and *Jola*, are considered to be closely related to rust fungi (Julich 1982; Bandoni 1984) and some authors even suggest that they be included in the rust fungi (Hennen & Buritica 1980, Leppik 1972). They have distinctly separate probasidia or cysts, which are equivalent to teliospores of rusts, but they are morphologically simple and without much variation. On the other hand, tremendous morphological variation exists among teliospores (probasidia) of the rust fungi (Fig. 1), such as variations in spore arrangement, number of cells in a spore, and spore surface ornamentation.

The presence of gelatinous basidiocarps is a common and important feature of most of the groups of Heterobasidiomycetes, but they are absent in rust fungi. Some of the telia of rusts have a gelatinous or waxy appearance; for example, many species of *Gymnosporangium* have gelatinous telia, but they are composed of spores and hygroscopic pedicels of spores, and are not equivalent to gelatinous basidiocarps of other Heterobasidiomycetes. This wide morphological variability of teliospores or probasidia

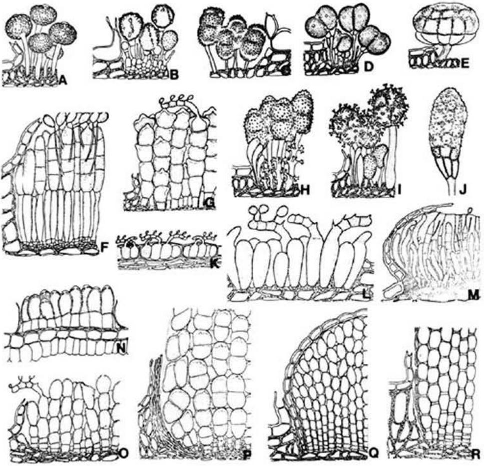

Fig. 1. Morphological variations of teliospores of rust fungi.

is one of the unique morphological features of rust fungi. The only other group of fungi that may have some degree of morphological variations in probasidia is the Ustilaginales or smut fungi, but the morphological and ontogenical variability in smuts is far less than in the rust fungi.

Since teliospores are considered to be the teleomorph or perfect state of the rust fungi under the International Code of Botanical Nomenclature, morphology of teliospores is important in the taxonomy of rust fungi, especially in defining families and genera. It has been traditional to divide teliospores into two major families: Melampsoraceae, including genera with sessile teliospores, or teliospores without stalks or pedicels, and

Pucciniaceae, for those genera with teliospores having stalks or pedicels. However, it has become obvious that this simple division of Uredinales creates an unnatural classification, especially since more genera and species occurring in tropical regions have been described. With added information on morphological types of spermogonia (Hiratsuka & Cummins 1963, Hiratsuka & Hiratsuka 1980) and other criteria, several additional families have been proposed by Savile (1976, 1980), Leppik (1972), and Azbukina (1974). Cummins & Hiratsuka (1983, 1984) proposed the division of the rust fungi into 14 families, as shown below.

1. Pucciniastraceae (Arthur) Gaeumann
2. Coleosporiaceae Dietel
3. Cronartiaceae Dietel
4. Melampsoraceae Schroeter
5. Phakopsoraceae (Arthur) Cummins and Y. Hiratsuka
6. Mikronegeriaceae Cummins and Y. Hiratsuka
7. Chaconiaceae Cummins and Y. Hiratsuka
8. Uropyxidaceae (Arthur) Cummins and Y. Hiratsuka
9. Pileolariaceae (Arthur) Cummins and Y. Hiratsuka
10. Raveneliaceae (Arthur) Leppik
11. Phragmidiaceae Corda
12. Sphaerophragmiaceae Cummins and Y. Hiratsuka
13. Pucciniaceae Chevalier
14. Pucciniosiraceae (Dietel) Cummins and Y. Hiratsuka

Hughes (1970) surveyed the spore ontogeny of various spore states of rust fungi including teliospores and suggested the occurrence of three different types of teliospore ontogeny. I agree with his basic categorization and want to expand what he suggested. I categorize them into four types.

Type I:

Teliospores are produced mostly within host tissue and result from simple proliferation of terminal cells of the hyphae (Fig. 2). Spores are produced randomly in intercellular spaces of mesophyll of host leaf tissue, as in the genera Uredinopsis and Melampsoridium, or are produced within epidermal cells,as in Milesina, Hyalopsora, and Melampsorella. Teliospores of Uredinopsis are least organized, having spore balls of one to several cells scattered in the mesophyll tissue of fern hosts. This type of teliospore ontogeny has been documented by S. M. Pady in 1933. All genera belonging to the family Pucciniastraceae

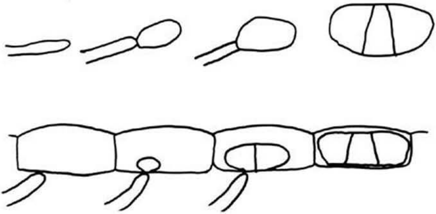

Fig. 2. Type I teliospore ontogeny

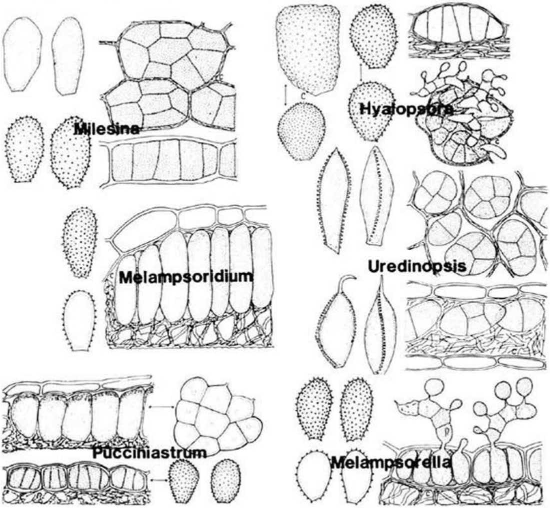

Fig. 3. Representative genera of Pucciniastraceae.

(Fig. 3) have this type of teliospores, and conifers are their aecial hosts. Telial hosts of Uredinopsis, Milesina, and Hyalopsora are ferns. All genera of this family have spermogonia of Group I. All teliospores have simple morphology, that is, smooth lightly pigmented or hyaline spore walls.

Type II:

Sori are more organized than those of Type I. Spores are laterally adherent and produce crusts of spores that often appear as cushions of indeterminate growth or tall column-like structures (Fig. 5). They are one spore deep (Melampsora), a few spores deep (Coleosporium, Phakopsora), or many spores deep (Chrysomyxa, Cronartium) and are produced on a sporogenous basal cell layer. Rust genera belonging to families Coleosporiaceae (Fig.6), Cronartiaceae, Melampsoraceae (Fig. 7), Phakopsoraceae (Fig. 8), and Raveneliaceae can be assigned to this type. Some genera in Phakopsoraceae, such as Nothoravenelia and Uredopeltis, and genera in Raveneliaceae such as Ravenelia and Kernkampella (Fig. 9) may well be placed in the pedicellate spore type, which I will discuss later as Type IV. However, I think they belong to Type II. Teliospore heads of these rusts can be considered as spore clusters produced on sporogenous basal cells and raised up with single or multicellular stalks. Therefore, stalked spore balls of this type always have sporogenous basal cells below the spore clusters and they are ontogenically different from Type IV teliospores.

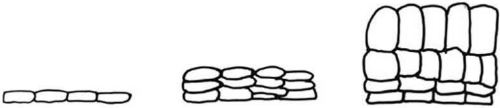

Fig. 4. Type II teliospore ontogeny.

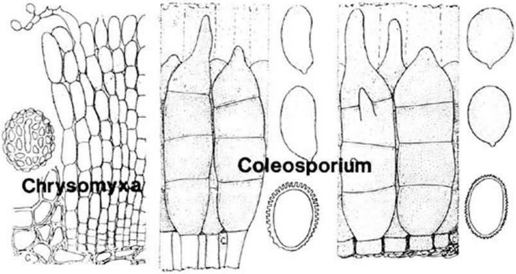

Fig. 5. Representative genera of Coleosporiaceae.

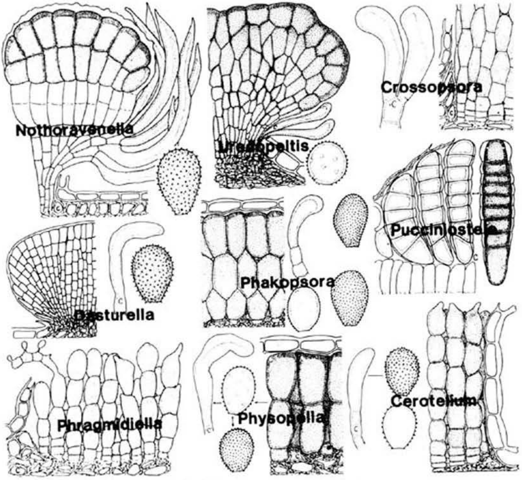

Fig. 6. Representative genera of Phakopsoraceae.

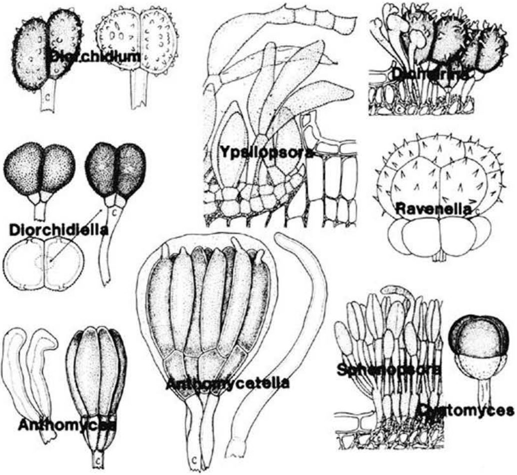

Fig. 7. Representative genera of Raveneliaceae.

Type III:

Teliospores are laterally separated and produced in a chain as meristem arthrospores (Fig. 8). Most of the genera of the family Pucciniosiraceae can be included here. In this type, a basal sporogenous cell divides to produce a spore initial and by successive elongation and division of the basal cell a basipetal succession of teliospore initials is formed and pushes up the column of spores. This results in the oldest spore at the tip and the youngest at the bottom. In the case of spores with intercalary cells, each spore initial divides to form two unequal cells, a small proximal intercalary cell and a large distal spore. Basically they have the same spore ontogeny of catenulate aeciospores. Genera of the family Puccinosiraceae have this type of teliospores (Fig. 9). It is speculated that most of the genera belonging to this family are derived from aecial states of certain rusts by shortening of the life cycles. For this reason, this family is phylogenetically rather heterogeneous.

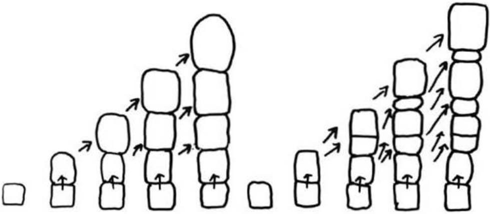

Fig. 8. Type III teliospore ontogeny.

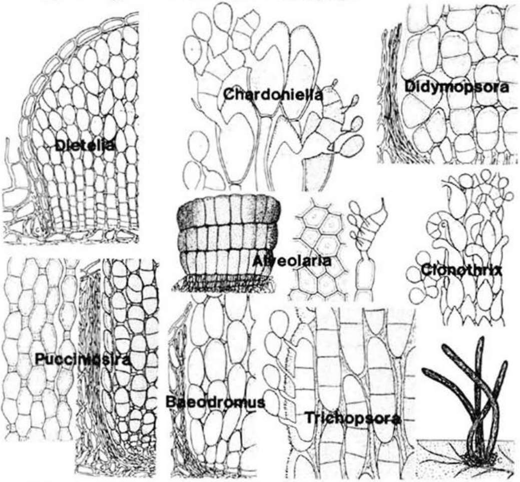

Fig. 9. Representative genera of Pucciniosiraceae.

Type IV:

Teliospores are produced mostly on pedicels as sympodioconidia (Fig. 12). In this case teliospores are produced on sporogenous cells. Sporogenous basal cells produce spore initials and the spore initials divide in two; the proximal cell becomes a pedicel and the other becomes the spore. Spore parts may divide one or more times to produce teliospores that are two-celled to multi-celled. Spore initials are produced by successive budding of sporogenous cells one beside the other. The main difference between this and the previous type is that the young new spore initial is produced below the previous one in Type III but occurs separately in Type IV. Teliospores of the largest family of rusts, Pucciniaceae (Fig. 13), as well as Phragmidiaceae (Fig. 14), Uropyxidaceae (Fig. 15), Shaerophragmiaceae (Fig. 16), Pileolariaceae (Fig. 17), Micronegeriaceae, and Chaconiaceae belong to Type IV. Morphological types of spermogonia of this group of rusts are Group V (Pucciniaceae), Group VI (Uropyxidaceae, Sphaerophragmiaceae, Pileolariaceae, Chaconiaceae), Group IV (Phragmidiaceae), and Group III (Micronegeriaceae). Spermogonia of these groups have well-developed bounding structures (periphyses and peridia) and are considered to be phylogenetically advanced. Great variations in spore cell arrangement and surface ornamentation exist in the teliospores of Type IV. Teliospore walls are predominantly heavily pigmented. Some of the stomatosporous genera such as Hemileia, Desmella, and Edythea (Fig. 18) have enlarged sporogenous cells which produce spores in great numbers as blastospores. This may be considered as one of the variations of this type. However, examination of these genera may reveal significantly different ontogeny.

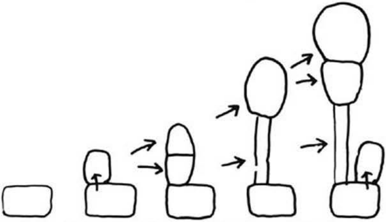

Fig. 10. Type IV teliospore ontogeny.

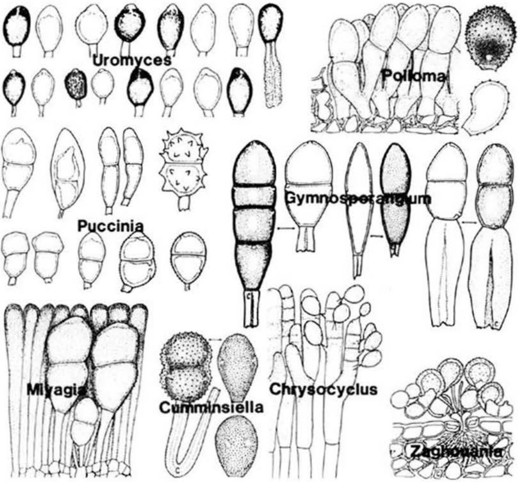

Fig. 11. Representative genera of Pucciniaceae.

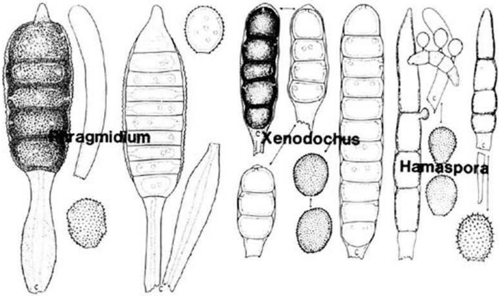

Fig. 12. Representative genera of Phragmidiaceae.

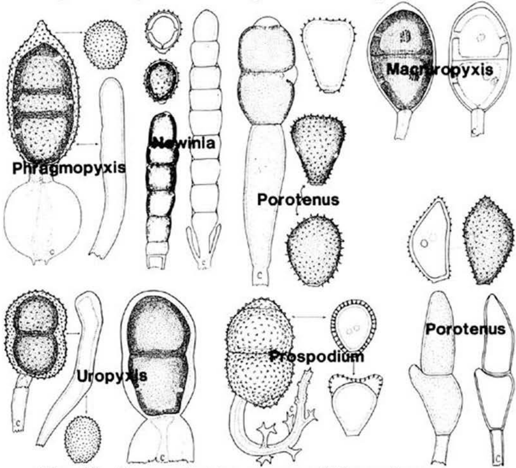

Fig. 13. Representative genera of Uropyxiaceae.

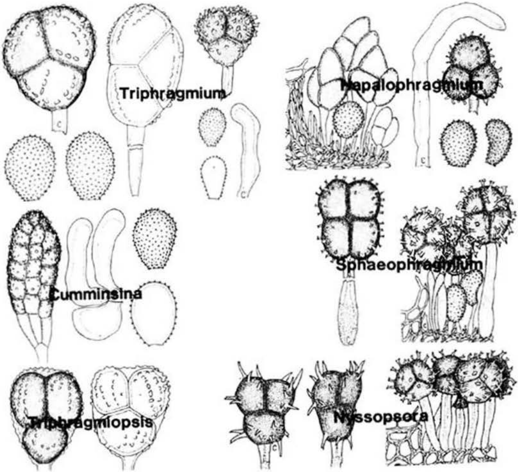

Fig. 14. Representative genera of Sphaerophragmiaceae.

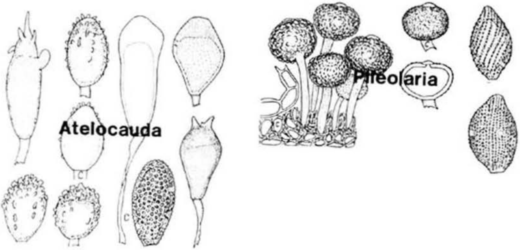

Fig. 15. Representative genera of Pileolariaceae.

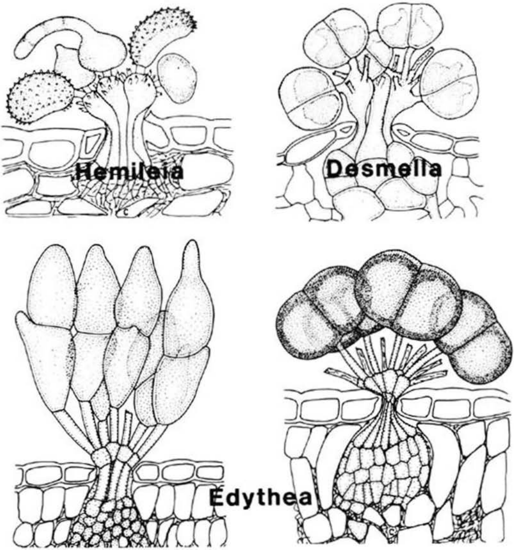

Fig. 16. Genera with stomatosporus telia.

Teliospore ontogeny definitely reflects phylogenetic relationships among rust fungi. Also, well developed teliospores (probasidia) with wide morphological and ontogenical variations demonstrate the unique taxonomic position of Uredinales among Basidiomycetes. The ontogenic types of teliospores discussed here seem to relate to the degree of spore wall pigmentation, variations and complexities of spore wall ornamentation, and variations in teliospore organization. Teliospores range from those of Type I, which are simple, with smooth, colorless or lightly pigmented walls, and embedded within host tissue, to those of Type IV, which are usually highly pigmented and typically pedicellate, and have highly variable organization. Types

II and III are somewhere between Types I and IV. Furthermore, these teliospore groupings seem to correspond to morphological types of spermogonia and support the division of rust fungi into 14 families.

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FIVE NEW SPECIES OF PARMELIA (PARMELIACEAE, LICHENIZED ASCOMYCETES) FROM SOUTHERN AFRICA, WITH NEW COMBINATIONS AND NOTES, AND NEW LICHEN RECORDS

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ABSTRACT

Five new species of *Parmelia* (Parmeliaceae, Lichenized Ascomycetes) are described from southern Africa. They are: *Parmelia adligans* Brusse, *P. arquata* Brusse, *P. ganymedea* Brusse, *P. sigillata* Brusse and *P. verecunda* Brusse. One new name is proposed, *Parmelia capicola* Brusse. Thirteen new combinations are made: *Parmelia ceresensis* (Hale) Brusse, *P. diacida* (Hale) Brusse, *P. endochromatica* (Hale) Brusse, *P. gyrophorica* (Hale) Brusse, *P. lesothoensis* (Hale) Brusse, *P. ochropulchra* (Hale) Brusse, *P. rogersii* (Elix & Jen Johnston) Brusse, *P. stenosporonica* (Hale) Brusse, *P. thamnolica* (Hale) Brusse, *P. transvaalensis* (Hale) Brusse, *P. xanthomelanoides* (Elix & Nash) Brusse, *Porpidia corralensis* (Raes.) Brusse and *Thelotrema berkeleyanum* (Mont.) Brusse. Sixty eight new lichen records are reported for South Africa. Notes on eighteen *Parmelia* species are given.

NEW SPECIES

PARMELIA ADLIGANS Brusse, *sp. nov.*

Thallus crustosus et effiguratus, saxicola, ad 5 cm diametro, 80–160 μm crassus. *Lobi* elongati, 1–6 mm longi, 0,2–1,0 mm lati. *Thallus superne* flavo-viridis, opacus vel ad apices loborum grosse pruinosus, emaculatus, isidiis sorediisque destitutus. *Cortex superior* 10–15 μm crassus. *Stratum gonidiale* 30–50 μm crassum, algis *Trebouxiis*, 4,5–15 μm diametris. *Medulla* albida, 10–70 μm crassa. *Cortex inferior* 10–15 μm crassus. *Thallus inferne* pallide brunneus vel ad apices loborum ater. *Rhizinae* non bene evolutae. *Apothecia* immersa vel sessilia, ad 0,8 mm diametris. *Hypothecium* hyalinum, 25–35 μm crassum, J-. *Subhymenium* hyalinum, 20–80 μm crassum. J+ caeruleum. *Hymenium* hyalinum, 45–55 μm altum, J+ caeruleum. *Asci* clavati, cum tholis J+ caeruleis (figura 1). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 8–10 × 4,5–6 μm. *Pycnidia* globosa, circa 100 μm profunda et 75–100 μm lata. *Pycnidiosporae* bacillares, hyalinae, 5,5–8,5 × 0,8 μm. *Thallus* atranorinum, acidum usnicum, acidum sticticum et acidum consticticum continens.

TYPUS: SOUTH AFRICA, Transvaal, **2430** (Pilgrim's Rest): Clearwater Falls on the Treur River a few kilometers upstream from Bourke's Luck Potholes, on rocky NE slope of sandstone and quartzite, in full sun, alt. 1240 m (–DB). *F. Brusse 4452*, 14.i.1986 (PRE, holo-; BM, COLO, LD, iso-). Figure 4.

Thallus crustose and effigurate, saxicolous, to 5 cm across, 80–160 μm thick. *Lobes* elongate, 1–6 mm long, 0,2–1,0 mm wide. *Upper surface* yellow-green, matt to coarse-pruinose at the lobe tips, emaculate, without isidia or soredia. *Upper cortex* 10–15 μm thick. *Algal layer* 30–50 μm thick, algae *Trebouxia*, 4,5–15 μm diam. *Medulla* whitish, 10–70 μm thick. *Lower cortex* 10–15 μm thick. *Lower surface* pale brown, becoming black at the lobe tips. *Rhizines* not well developed. *Apothecia* immersed to sessile, to 0,8 mm across. *Hypothecium* hyaline, 25–35 μm thick, J-. *Subhymenium* hyaline, 20–80 μm thick, J+ blue. *Hymenium* hyaline, 45–55 μm high, J+ blue. *Asci* clavate, eight-spored, tholus J+ blue (figure 1). *Ascospores* hyaline, monolocular, ellipsoid, 8–10 × 4,5–6 μm. *Pycnidia* globose, about 100 μm deep, 75–100 μm wide. *Pycnidiospores* hyaline rods, 5,5–8,5 × 0,8 μm. *Chemistry*: Atranorin, usnic, stictic and constictic acids present.

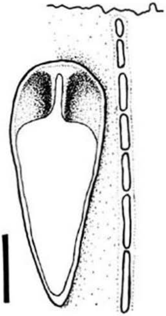

FIGURE 1.—*Parmelia adligans* Brusse, ascus and paraphysis. *F. Brusse 4452*, holotype. Bar = 10 μm.

This new species is related to the salacinic acid containing *Parmelia leptoplaca* (Zahlbr.) Brusse, but contains stictic acid and is distributed in more humid areas than the typical karooid localities of *P. leptoplaca*.

Parmelia adligans may also be related to *P. adhaerens* Nyl. with a similar chemistry, but *P. adhaerens* is more robust and the centre of the thallus is not truely areolate as in *P. adligans*. *P. adligans* also consistently contains atranorin in addition to usnic acid, the overlap areas of which give a peculiar purple colour on TLC plates after acid and heat treatment. This purple colour is similar to that given by some terpenes, but the purple colour is only produced in the overlap zones of atranorin and usnic acid, which seems to indicate that a terpene is not present. *Parmelia adligans* also lacks hypostictic acid and unknown PQ-4, present in *P. adhaerens*, and contains an additional unidentified substance, not present in *P. adhaerens*. Krog & Swinscow (1987) have confirmed the presence of hypostictic acid and unknown PQ-4 in *P. adhaerens*. Both *P. adhaerens* Nyl. and *P. adligans* Brusse sometimes contain another unidentified substance related to stictic acid, which is present in large amounts in the holotype specimen of *Parmelia steineri* Gyeln. (P.A. v.d. Bijl 1141, W) which is a synonym of *P. molliuscula* Ach. This substance may be methylstictic acid (Shimada *et al*. 1980).

The apothecia of *P. adhaerens* are adnate, whereas those of *P. adligans* are usually immersed in the central areoles.

Parmelia adligans is a common species in southern Africa on the eastern side, and also extends along the mountains into the south-western Cape.

Additional specimens examined. SOUTH AFRICA, TRANSVAAL—**2527** (Rustenburg): Div. Krugersdorp, Magaliesberg, Retiefskloof, S. of Rustenburg, on quartz rocks near waterfall, exposed ± 1 500 m alt. (–CD). *R.A. Maas Geesteranus*, 7.11.1949 (Almborn, Lichenes Africani 6497; LD, PRE). **2528** (Pretoria): Pretoria Botanical Garden, Silverton Ridge, on quartzite on ridge top, common on all aspects, alt. 1 350 m (–CB). *F. Brusse 2001*, 20.viii.1980 (BM, COLO, LD, PRE); Pretoria, Constantia Park water tower, on rocks on NE slope, alt. 1 560 m (–CD). *F. Brusse 4956*, 26.ii.1986 (BM, COLO, PRE); Pretoria, Donkerpoort, on sandstone (–DC). *E.M. Doidge CH4583*, iii.1943. **2529** (Witbank): Middelburg, koppie just W of the town (1 km NW of town centre, on road to township; 25°46'S; 29°26,5'E), on E sides of Waterberg sandstone exposures on gentle NE slope, alt. 1 500 m (–CD). *F. Brusse 1304*, 27.iii.1981 (COLO, PRE). **2530** (Lydenburg): Summit of Long Tom Pass between Sabie and Lydenburg, on gentle NW slope with small sandstone boulders, on sandstone, alt. 2 150 m (–BA). *F. Brusse 4479*, 16.i.1986 (BM, COLO, LD, PRE); Mac Mac Falls on Sabie River, SW of Sabie, on W top of gorge just downstream from falls, on top of low sandstone outcrop, in full sun, alt. 1 300 m (–BB). *F. Brusse 4492*, 16.i.1986 (LD, PRE).

CAPE PROVINCE—**3320** (Montagu): 7 km S of Winery at Barrydale, Tradouw Pass, Langeberg range, on TMS on steep S slope, alt. 350 m (–DC). *F. Brusse 3667*, 11.v.1981 (COLO, PRE). **3321** (Ladismith): 8,6 km NW of Amalienstein, near Ladismith, Seven Weeks Poort, on bouldered W slope, on TMS boulders, alt. 670 m (–AD). *F. Brusse 4934*, 10.ii.1986 (COLO, LD, PRE).

PARMELIA ARQUATA Brusse, *sp. nov.*

Thallus crustosus et effiguratus, saxicola, ad 4 cm diametro. *Lobi* elongati, 1–4,5 mm longi, 0,2–1,0 mm lati, 100–270 μm crassi. *Thallus superne* viridis, opacus vel ad apices loborum grosse pruinosus, emaculatus, isidiis sorediisque destitutus. *Cortex superior* 10–15 μm crassus. *Stratum gonidiale* 20–80 μm crassum, algis *Trebouxiis*, 4–20 μm diametris. *Medulla* alba, 30–160 μm crassa. *Cortex inferior* 10–15 μm crassus. *Thallus inferne* ad apices loborum ater. *Rhizinae* non bene evolutae. *Apothecia* immersa, ad 0,8 mm diametris. *Hypothecium* hyalinum, 10–40 μm crassum. *Subhymenium* hyalinum, 10–70 μm profundum, J+ caeruleum. *Hymenium* hyalinum, 35–45 μm altum, J+ caeruleum. *Asci* clavati, cum tholis J+ caeruleis (figura 2). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 8–10,5 × 4–6,5 μm. *Pycnidia* globosa, circa 95 μm profunda et circa 85 μm lata. *Pycnidiosporae* hyalinae, bacillares, 5–8,5 × 0,8 μm. *Thallus* atranorinum, acidum usnicum et acidum psoromicum continens.

TYPUS: SOUTH AFRICA, Transvaal, **2628** (Johannesburg): Johannesburg, Linksfield Ridge, on W face of sandstone rock, on steep N slope, rare, alt. 1 780 m (–AA). *F. Brusse 1126*, 15.v.1976 (PRE, holo-; ANUC, BM, COLO, LD, MEL, US, iso-). Figure 5.

Thallus crustose and effigurate, saxicolous, to 4 cm across. *Lobes* elongate, 1–4,5 mm long, 0,2–1,0 mm wide, 100–270 μm thick. *Upper surface* green, matt to coarse pruinose at lobe tips, emaculate, isidia and soredia absent. *Upper cortex* 10–15 μm thick. *Algal layer* 20–80 μm thick; algae *Trebouxia*, 4–20 μm diam. *Medulla* white, 30–160 μm thick. *Lower cortex* 10–15 μm thick. *Lower surface* black at lobe tips. *Rhizines* not well developed. *Apothecia* immersed, to 0,8 mm across. *Hypothecium* hyaline, 10–40 μm thick. *Subhymenium* hyaline, 10–70 μm deep, J+ blue. *Hymenium* hyaline, 35–45 μm high, J+ blue. *Asci* clavate, eight-spored, tholus J+ blue (figure 2).

Ascospores hyaline, monolocular, ellipsoid, 8–10,5 × 4–6,5 µm. *Pycnidia* globose, about 95 µm deep and about 85 µm wide. *Pycnidiospores* hyaline, rods, 5–8,5 × 0,8 µm. *Chemistry*: Atranorin, usnic acid and psoromic acid present.

Etymology: *arquata* (L) = sufferer of jaundice, in allusion to the colour of the medulla in *para*-phenylenediamine solution, due to the presence of psoromic acid.

Parmelia arquata is similar to *P. adligans* in thallus morphology, but is clearly distinct, because of the presence of psoromic acid, rather than stictic acid. Other members of this group have different distributions: *P. insipida* Brusse (evernic acid) occurs from the Sneeuwberg near Graaff-Reinet, to the southern Drakensberg, at Qacha's Nek near Matatiele; *Parmelia leptoplaca* (Zahlbr.) Brusse (salacinic acid) is widespread and common in the central Cape Province and the Little Karoo in Karooid areas; *Parmelia ralla* Brusse (norlobaridone) is present in the Cape fold mountains (Cape floral area) with definite records as far as Uniondale; *Parmelia squamatica* Brusse (squamatic acid) is only known from the Cedarberg near Clanwilliam in the western Cape Province, and *Parmelia adhaerens* Nyl. (hypostictic plus stictic acids), so far only known from the south-western Cape.

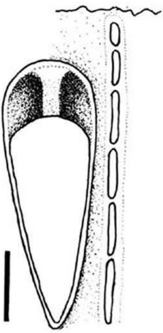

FIGURE 2. — *Parmelia arquata* Brusse, ascus and paraphysis. *F. Brusse 1126*, holotype. Bar = 10 µm.

Other *Xanthoparmeliae* containing psoromic acid are clearly foliose and lack atranorin.

Parmelia arquata is presently only known from the type collection, from Johannesburg in the southern Transvaal.

PARMELIA GANYMEDEA Brusse, *sp. nov.*

Thallus crustosus et effiguratus, saxicola, ad 4 cm diametro. *Lobi* elongati, 0,2–0,8 mm lati, 100–170 µm crassi. *Thallus superne* viridis, opacus vel ad apices loborum grosse pruinosus, emaculatus, pustuli-soraliatus. *Soralia* alba, 0,1–0,3 mm diametris. *Soredia* granularia, 35–80 µm diametris. *Cortex superior* 12–15 µm crassus. *Stratum gonidiale* 20–80 µm crassum, algis *Trebouxiis*, 5–18 µm diametris. *Medulla* alba, 40–100 µm crassa. *Cortex inferior* circa 10 µm crassus. *Thallus inferne* brunneus. *Rhizinae* non bene evolutae. *Apothecia* et *pycnidia* non visa. *Thallus* acidum usnicum et acidum evernicum continens.

TYPUS: SOUTH AFRICA, Transvaal, **2628** (Johannesburg): Johannesburg, Linksfield Ridge, on W face of quartzite rock, on steep N slope, alt. 1 780 m (–AA). *F. Brusse 5089*, 8.xi.1987 (PRE, holo-; BM, COLO, LD, US, iso-). Figure 6.

Thallus crustose and effigurate, saxicolous, to 4 cm across. *Lobes* elongate, 0,2–0,8 mm wide, 100–170 µm thick. *Upper surface* green, matt to coarse pruinose at the lobe tips, emaculate, pustular-soraliate. *Soralia* white, 0,1–0,3 mm across. *Soredia* granular, 35–80 µm diam. *Upper cortex* 12–15 µm thick. *Algal layer* 20–80 µm thick, algae

Trebouxia, 5–18 µm diam. *Medulla* white, 40–100 µm thick. *Lower cortex* around 10 µm thick. *Lower surface* brown. *Rhizines* not well developed. *Apothecia* and *pycnidia* not seen. *Chemistry*: Usnic acid in the upper cortex and evernic acid in the medulla.

Etymology: *ganymedea* (G) = belonging to ganymedes, the cup-bearer of Jove in Greek mythology, in allusion to the cup-shaped scars of spent soralia. Ganymede is also the name of the largest moon of Jupiter, and is visible with small telescopes.

This new species is quite unique amongst the crustose *Xanthoparmeliae*, in having small pustular soralia, which are granular sorediate. The only close species is the Cape lichen, *Parmelia (Xanthoparmelia eruptens* Hale), which although small itself, is a foliose lichen with a shiny upper surface, with dactyls up to 0,5 mm wide. The dactyls do not become sorediate, but are warty, fragile and subpustular. The lichen is reported to contain lecanoric acid in addition to evernic acid in the medulla (Hale 1987), whereas *P. ganymedea* contains only evernic acid in this region.

Thus far, *Parmelia ganymedea*, is known only from the type gathering, from Johannesburg in the southern Transvaal.

PARMELIA SIGILLATA Brusse, *sp. nov.*

Thallus foliosus, saxicola, sat adnatus, ad 4 cm diametro. *Lobi* elongati, 1–3 mm lati, 85–200 µm crassi. *Thallus superne* viridis, nitidus, reticulate maculatus, isidiis sorediisque destitutus. *Cortex superior* 7–11 µm crassus, paraplectenchymatus. *Stratum gonidiale* 20–60 µm crassum, algis *Trebouxiis*, 4,5–16 µm diametris. *Medulla* alba, 30–140 µm crassa. *Cortex inferior* 6–8 µm crassus. *Thallus inferne* pallide brunneus. *Rhizinae* sat numerosae, 25–80 µm crassae, simplices. *Apothecia* adnata, ad 2,5 mm diametris. *Hypothecium* hyalinum, 15–40 µm crassum. *Subhymenium* hyalinum, 10–15 µm crassum, J+ pallide caeruleum. *Hymenium* hyalinum, 35–45 µm altum, J+ caeruleum. *Asci* clavati, cum tholis J+ caeruleum (figure 3). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 8–11,5 × 5–6,5 µm. *Pycnidia* 100–120 µm profunda, 70–110 µm lata. *Pycnidiosporae* hyalinae, bacillares, 4,5–8,5 × 0,8 µm.

TYPUS: SOUTH AFRICA, CAPE PROVINCE—**3322** (Oudtshoorn): 9 km N of De Rust, Meiringspoort, on TMS outcrops on steep SW slope, alt. 550 m (–BC). *F. Brusse 4827*, 5.ii.1986 (PRE, holo-; BM, iso-). Figure 7.

Thallus foliose, saxicolous, moderately adnate, to 4 cm across. *Lobes* elongate, 1–3 mm wide, 85–200 µm thick. *Upper surface* green, nitid, reticulately maculate, isidia and soredia absent. *Upper cortex* 7–11 µm thick, paraplectenchymatous. *Algal layer* 20–60 µm thick, algae *Trebouxia*, 4,5–16 µm diam. *Medulla* white, 30–140 µm thick. *Lower cortex* 6–8 µm thick. *Lower surface* pale brown. *Rhizines* moderately numerous, simple, 25–80 µm thick. *Apothecia* adnate, to 2,5 mm across. *Hypothecium* hyaline, 15–40 µm thick. *Subhymenium* hyaline, 10–15 µm thick, J+ pale blue. *Hymenium* hyaline, 35–45 µm high, J+ blue. *Asci* clavate, eight-spored, tholus J+ blue (figure 3). *Ascospores* hyaline, monolocular, ellipsoid, 8–11,5 × 5–6,5 µm. *Pycnidia* globose, 100–120 µm deep, 70–110 µm wide. *Pycnidiospores* hyaline, rods, 4,5–8,5 × 0,8 µm.

Etymology: *sigillata* (L) = spotted or blotched like a seal, in allusion to the reticulately maculate upper surface.

Parmelia sigillata is an unusual *Xanthoparmelia* in that the upper surface is reticulately maculate, and the upper cortex is more paraplectenchymatous than is usual for this section. These characteristics are indicative of the *Parmelia saxatilis* group, but this is probably a distinct genus because of the presence of a syncortex (i.e. a mucopolysaccharide matrix embedding the upper cortex which is soluble in hyaluronidase (Modenesi & Vanzo 1986)). *P. sigillata* is epicorticate (i.e. has a polysaccharide layer on top of the upper cortex, which although not tested, would probably be insoluble in hyaluronidase, like that of *P. caperata*, tested by Modenesi & Vanzo (1986)).

Other maculate species in *Xanthoparmelia*, are effigurately maculate, and species containing closely related substances, such as *Parmelia dysprosa* (Brusse & Knox) Brusse (1984) and *Parmelia (Xanthoparmelia protodysprosa* Hale (1987)) are black below, not pale brown as in *P. sigillata.*

Parmelia sigillata may also be related to *P. worcesteri* Stnr. & Zahlbr. (Zahlbruckner 1926), but the latter is emaculate and contains lecanoric acid only, without any evernic acid.

At present this species is known only from the type locality, Meiringspoort, in the Great Swartberg mountains just north of the village of De Rust.

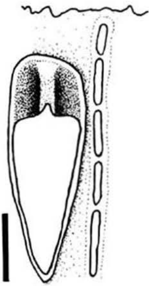

FIGURE 3.—*Parmelia sigillata* Brusse, ascus and paraphysis. *F. Brusse 4827*, holotype. Bar = 10 µm.

PARMELIA VERECUNDA Brusse, *sp. nov.*

Thallus foliosus, saxicola, sat adnatus, ad 3 cm diametro. *Lobi* elongati, imbricati, 0,1–1,2 mm lati, 90–260 µm crassi. *Thallus superne* viridis, nitidus, emaculatus, reticulate-foveatus, isidiis sorediisque destitutus. *Cortex superior* 10–15 µm crassus, paraplectenchymatus. *Stratum gonidiale* 20–40 µm crassum, algis *Trebouxiis*, 6–15 µm diametris. *Medulla* crocea, 30–180 µm crassa. *Cortex inferior* 8–10 µm crassus. *Thallus inferne* piceus. *Rhizinae* simplices, 45–65 µm crassae. *Apothecia* et *pycnidia* non visa. *Thallus* acidum usnicum, acidum secalonicum A et materiam ignotam continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE.—**3322** (Oudtshoorn): 10 km from George to Oudtshoorn, Outeniqua Pass, Outeniqua mountains, on TMS outcrop on steep S slope, in semi-shade of trees, alt. 790 m (–CD). *F. Brusse 4790*, 3.ii.1986 (PRE, holo-; BM, COLO, iso-). Figure 8.

Thallus foliose, saxicolous, moderately adnate, to 3 cm across. *Lobes* elongate, imbricate 0,1–1,2 mm wide, 90–260 µm thick. *Upper surface* green, nitid, emaculate, reticulately foveate, isidia and soredia absent. *Upper cortex* 10–15 µm thick, paraplectenchymatous. *Algal layer* 20–40 µm thick, algae *Trebouxia*, 6–15 µm diam. *Medulla* dirty orange, 30–180 µm thick. *Lower cortex* 8–10 µm thick. *Lower surface* black. *Rhizines* simple, 45–65 µm thick. *Apothecia* and *pycnidia* not seen. *Chemistry*: Usnic acid in the upper cortex, secalonic acid A and an unknown substance (possibly the same unknown as in *Parmelia brunnthaleri* Stnr. & Zahlbr.) in the medulla.

Etymology: *verecunda* (L) = modest, indicating the modest size of this lichen.

This new species has no close relatives, but should the unknown substance by the same unknown as in *Parmelia brunnthaleri* Stnr. & Zahlbr. (Zahlbruckner 1926), then it may be a relative of that species. However, *P. brunnthaleri* lacks the pigment, is pale brown below and is a typical karoo lichen, occurring in the central areas of the Cape Province and in the Little Karoo, in short arid open shrubland, which typifies Karooid vegetation. *P. verecunda* occurs on the seaward slopes of the Outeniqua mountains, in mediterranean sclerophyllous vegetation, locally known as fynbos. These slopes receive much rain and mist all the year round and the two habitats are very different.

At present this new species is known only from the type locality, in the Outeniqua mountains near George, in the southern Cape Province.

NEW COMBINATIONS

Parmelia capicola Brusse, *nom. nov.*

Basionym: *Xanthoparmelia capensis* Hale, Mycotaxon **27**: 567. 1986. (non *Parmelia capensis* Ach. Method. Lich.: 269. 1803).

Parmelia ceresensis (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia ceresensis* Hale, Mycotaxon **27**: 568. 1986.

Parmelia diacida (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia diacida* Hale, Mycotaxon **27**: 572. 1986.

Parmelia endochromatica (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia endochromatica* Hale, Mycotaxon **27**: 574. 1986.

Parmelia gyrophorica (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia gyrophorica* Hale, Mycotaxon **27**: 578. 1986.

Parmelia lesothoensis (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia lesothoensis* Hale, Mycotaxon **27**: 582. 1986.

Parmelia ochropulchra (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia ochropulchra* Hale, Mycotaxon **27**: 590. 1986.

Synonym: *Xanthoparmelia duplicata* Hale, Mycotaxon **27**: 572 (non *Parmelia duplicata* Ach. Method. Lich.: 252. 1803).

Parmelia rogersii (Elix & Jen Johnston) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia rogersii* Elix & Jen Johnston, Bull. Br. Mus. nat. Hist. (Bot.) **15**(3): 317. 1986.

Synonym: *Xanthoparmelia viridis* Hale, Mycotaxon **27**: 609. 1986. (non *Parmelia viridis* Spreng., Syst. Veget. **4**(1): 294. 1827; nec *Parmelia viridis* Mont., Sylloge Gen. Sp. Crypt.: 329. 1856).

Parmelia stenosporonica (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia stenosporonica* Hale, Mycotaxon **27**: 598. 1986.

Parmelia thamnolica (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia thamnolica* Hale, Mycotaxon **27**: 604. 1986.

Parmelia transvaalensis (Hale, Nash & Elix) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia transvaalensis* Hale, Nash & Elix in Hale, Mycotaxon **27**: 606. 1986.

Parmelia xanthomelanoides (Elix & Nash) Brusse, *comb. nov.*

Basionym: *Paraparmelia xanthomelanoides* Elix & Nash in Nash & Elix, Mycotaxon **29**: 469. 1987.

Porpidia corralensis (Raes.) Brusse, *comb. nov.*

Basionym: *Lecidea corralensis* Raes., Revista Univ. (Santiago) **22**: 211. 1937. Hertel, Herzogia **2**: 40. 1970.

Synonym: *Poeltiaria corralensis* (Raes.) Hertel, Beih. Nova Hedwigia **79**: 431. 1984.

NEW RECORDS

Acarospora bella (Nyl.) Jatta

SOUTH WEST AFRICA/NAMIBIA.—**2615** (Luderitz): Haalenberg summit, east of Luderitz, on rock (–CB). *G. Williamson 2852*, 1980 (PRE).

Arthonia mira R. Sant.

SOUTH AFRICA, CAPE PROVINCE.—**3423** (Knysna): Knysna, C.P., on *Cassine crocea* leaves (–AA). *A.M. Bottomley 1631*, 23.iv.1939, det. R. Santesson (COLO, LD, PRE).

Arthonia trilocularis Müll. Arg.

SOUTH AFRICA, NATAL.—**2930** (Pietermaritzburg): Buccleugh near Cramond (–AD). *E.M. Doidge 269* (on *Podocarpus falcatus* leaves) & *272* (on *Behnia reticulata* leaves), 17.vii.1918, det. R. Santesson 1954 (PRE).

CAPE PROVINCE.—**3423** (Knysna): Knysna, C.P., on *Cassine crocea* leaves (–AA). *A.M. Bottomley 1631a*, 23.iv.1939, det. R. Santesson (PRE).

Arthrorhaphis citrinella (Ach.) Poelt

SOUTH AFRICA, NATAL.—**2828** (Bethlehem): 31 km S of Phuthaditjhaba (Witsieshoek), Mont-aux-Sources, summit of Western Buttress, summit plateau, on small soil bank with SE aspect, on gentle S slope, on blue-green algal pellicles on soil, with mosses, alt. 3080 m (–DB). *F. Brusse 4515*, 21.i.1986 (BM, LD, PRE). Lit. Galloway & Bartlett (1986).

Asterothyrium rotuliforme (Müll. Arg.) Serusiaux

SOUTH AFRICA, NATAL.—**3030** (Port Shepstone): Umtentwini, on *Lichi chinensis* leaves (–CB). *H. Porter 1709*, 30.xii.1940, det. R. Santesson 1954 (PRE).

TRANSKEI.—**3228** (Butterworth): Xoposa, on *Citrus aurantium* leaves (–AC). *J. Mac Muir 265*, 12.iii.1915, det. R. Santesson 1954 (PRE).

Aulaxina dictyospora R. Sant.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Pietersburg district, Serala Wilderness Area, forest on E slope of Mt. Serala, on leaves of *Chionanthes foveolata* in deep shade of tall forest (–AA). *F. Venter 10494a*, 19.i.1985 (PRE).

Aulaxina quadrangula (Stirt.) R. Sant.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Pietersburg district, Serala Wilderness Area, forest on E slope of Mt. Serala, on leaves of *Chionanthes foveolata* in deep shade of tall forest (–AA). *F. Venter 10494b*, 29.i.1985 (PRE); Pilgrim's Rest, on leaves of *Syzygium guineense* (–DD). *F. Venter 10577b*, 20.ii.1985 (PRE).

NATAL.—**3030** (Port Shepstone): Umtentweni, on *Lichi sinensis* leaves (–CB). *H. Porter 1708*, 30.xii.1940, det. R. Santesson 1954 (PRE).

Byssoloma subdiscordans (Nyl.) P. James

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): Louis Trichardt, on leaves of *Syncarpia laurifolia* (–BB). *District Forest Officer 2150a, 2151*, 6.ix.1938 (PRE). **2430** (Pilgrim's Rest): Pietersburg district, Serala Wilderness Area, near Serala Peak, on leaves of *Carissa bispinosa*, in deep shade (–AA). *F. Venter 10496*, 30.i.1985 (PRE); Pilgrim's Rest, alt. 1570 m (–DD). *F. Venter 10573c* (on *Maytenus undata* leaves), *10576b* (on leaves of *Peddiea africana*), 20.ii.1985 (PRE).

Calopadia fusca (Müll. Arg.) Vezda

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Pilgrim's Rest, alt. 1 570 m (–DD). *F. Venter 10573a* (on *Maytenus undata* leaves), *10576a* (on leaves of *Peddiea africana*), 20.ii.1985 (PRE).

NATAL.—**2831** (Nkandla): Eshowe, on *Cola natalensis* leaves (–CD). *J. Gerstner 1966*, det. R. Santesson 1954 (PRE).

Calopadia puiggarii (Müll. Arg.) Vezda

SOUTH AFRICA, NATAL.—**2832** (Mtubatuba): Hlabisa, Dukuduku Farm no. 175, on *Dracaena* leaves in forest (–AD). *R.G. Strey 4711* (5608b), 23.xi.1964 (PRE). **2930** (Pietermaritzburg): Inanda, on leaves of tea plant (*Thea viridis*) (–DB). *J.M. Wood 4*, 1877–78, det. R. Santesson 1954 (PRE).

Candelariella coralliza (Nyl.) H. Magn.

SOUTH AFRICA, CAPE PROVINCE.—**3219** (Wuppertal): Pakhuisberg in the Clanwilliam area, top of Pakhuis Pass, on S TMS faces on moderate bouldered slope, 850–1 000 m (–AA). *F. Brusse 3132*, 3.v.1981 (PRE). **3220** (Sutherland): 34 km N of Matjiesfontein, Turck's Pass, on S side of prominent dolerite rock, on W kranz, rare, alt. 1 200–1 235 m (–DC). *F. Brusse 1072*, 4.ii.1977 (PRE).

Cladonia fuscocinerea Ahti

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Mount Sheba near Pilgrim's Rest, scattered boulders on S slope near mountain top (–DC). *Nancy Slack s.n.*, 15.i.1986 (PRE); Mount Sheba near Pilgrim's Rest, sandstone outcrops and boulders called 'The Lost City', S slope, on soil at S bases of boulders in semi-shade of *Erica* shrubs. Clumps grow up to 30 cm in diameter. Alt. 1 850 m (–DC). *F. Brusse 5003*, 17.iv.1987 (B, BM, CBG, COLO, E, LD, LG, MEL, PRE, S, UC, UPS, US).

Cladonia hedbergii Ahti

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Mount Sheba near Pilgrim's Rest, sandstone outcrops and boulders called 'The Lost City', S slope, on soil at S bases of boulders, in more exposed positions than *Cladonia fuscocinerea*, and thallus shorter and browner. Thallus clumps up to one meter across. Alt. 1 850 m (–DC). *F. Brusse 5004*, 17.iv.1987 (BM, COLO, LD, PRE, UC, UPS).

CAPE PROVINCE.—**3321** (Ladismith): Garcia's Pass (–CC). *J. Muir 3767*, 4.ix.1925 (PRE); 17 km N of Riversdale, Garcia's Pass, SW side of Kareekop, on the Langeberg, on soil near rock on steep S slope, alt. 500–600 m (–CC). *F. Brusse 3603*, 10.v.1981 (COLO, PRE). **3322** (Oudtshoorn): 10 km from George to Oudtshoorn, Outeniqua mountains, Outeniqua Pass, on soil between rocks in semi-shade, on steep S slope, alt. 790 m (–CD). *F. Brusse 4788*, 3.ii.1986 (BM, COLO, PRE).

Coccocarpia palmicola (Spreng.) Arvidss. & D. Gallow.

SOUTH AFRICA, TRANSVAAL.—**2530** (Lydenburg) Mac Mac Falls, W of Sabi, on W top gorge just downstream from the falls, on level sandstone over mosses, in shade of shrubs and trees, alt. 1 300 m (–BB). *F. Brusse 4495*, 16.i.1986 (PRE). Lit. Arvidsson (1982).

Coenogonium moniliforme Tuck.

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): District Soutpansberg, 13 km NE of Soekmekaar, on *Dombeya rotundifolia*, alt. 1 100 m (–BD). *F. Brusse 1659*, 23–29.i.1981 (PRE).

Dimerella zonata (Müll. Arg.) R. Sant.

SOUTH AFRICA, NATAL.—**2831** (Nkandla): Eshowe on *Cola natalensis* leaves (–CD). *J. Gerstner 1963*, det. R. Santesson 1954 (PRE).

Dirinaria flava (Müll. Arg.) Dodge

SOUTH AFRICA, TRANSVAAL.—**2231** (Pafuri): Kruger National Park, Punda Maria ridge, on bark of *Holarrhena febrifuga* (–CA). *A.M. Brynard 4059*, 11.viii.1959 (COLO, LD, PRE).

NATAL.—**3030** (Port Shepstone): Oribi Gorge near Port Shepstone, on branches of a dead *Tarchonanthus trilobus* tree, in shade of a TMS overhang (–CA). *F. Brusse 1482*, 27.xii.1978 (PRE). Lit. Awasthi (1975).

Echinoplaca epiphylla Fée

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Pietersburg district, Serala Wilderness area, near Serala Peak, on leaves of *Scolopia mundii* in deep shade (–AA). *F. Venter 10497*, 30.i.1985 (PRE); Pilgrim's Rest, on *Maytenus undata* leaves alt. 1570 m (–DD). *F. Venter 10573e*, 20.ii.1985 (PRE).

Echinoplaca pellicula (Müll. Arg.) R. Sant.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Pilgrim's Rest, on leaves of *Oxyanthus gerrardii*, alt. 1 570 m (–DD). *F. Venter 10575*, 20.ii.1985 (PRE).

Heterodermia comosa (Eschw.) Follm. & Redon

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): 4 km NNE of Soekmekaar, farm Excelsior 521, on *Dombeya rotundifolia*, alt. 1 200 m (–BD). *F. Brusse 1670*, 23–29.i.1981 (PRE).

Heterodermia dactyliza (Nyl.) Swinsc. & Krog

SOUTH AFRICA, TRANSVAAL.—**2530** (Lydenburg): Mac Mac Falls, W of Sabi, on W top of gorge just downstream from the falls, on S and E faces of sandstone outcrops, in semi-shade, loosely attached, alt. 1 300 m (–BB). *F. Brusse 4493*, 16.i.1986 (COLO, PRE).

Heterodermia erinacea (Ach.) W. Weber

SOUTH AFRICA, CAPE PROVINCE.—**2917** (Springbok): 1,5 km towards Kleinsee from t.o. from Port Nolloth–Steinkopf road, on various dead and dying shrubs, alt. c. 100 m (–AC). *H. Glen 1438*, 29.viii.1985 (COLO, LD, PRE). This lichen was previously only known from western North America, from a similar submediterranean coastal desert.

Heterodermia flabellata (Fée) Awast.

SOUTH AFRICA, NATAL.—**2832** (Mtubatuba): Hlabisa, Palm Ridge Farm, coastal sandflats, scrub with scattered trees, occurs on bark of trees, alt. 60 m (–AC). *E.R. Harrison 470*, 30.iv.1968 (COLO, LD, PRE). **3030** (Port Shepstone): Umtamvuna Nature Reserve, Devil's Backbone, on rock in short forest, alt. 300 m (–CC). *A. Abbott 1768*, 23.02.1984 (PRE).

CAPE PROVINCE.—**3227** (Stutterheim): Pirie Forest, on bark (–CB). *E. Schaefer 2047*, iii.1944, det. S. Kurokawa 1962 (PRE).

Heterodermia lepidota Swinsc. & Krog

SOUTH AFRICA, NATAL.—**3029** (Kokstad): Mount Currie district, Dassiekop (Trig. beacon 135; 30°28'S, 29°20,5'E), on coarse grained dolerite, in partial shade, alt. 1 880 m (–AD). *F. Brusse 1167*, 30.xii.1977 (PRE).

Heterodermia lutescens (Kurok.) Follm.

SOUTH AFRICA, NATAL.—**3030** (Port Shepstone): Oribi Gorge near Port Shepstone, on TMS (–CA). *F. Brusse 1488*, 27.xii.1978 (PRE). **3130** (Port Edward): Port Edward, Ka-inSizizi location, on rocks (–AA). *C.H. Stirton 5697*, 25.x.1975 (PRE).

Heterodermia microphylla (Kurok.) Swinsc. & Krog

SOUTH AFRICA, NATAL.—**2930** (Pietermaritzburg): Pietermaritzburg, Everton, on tree in natural forest (–DD). *C.H. Stirton 5500*, 23.x.1975 (PRE).

Heterodermia obscurata (Nyl.) Trev.

SOUTH AFRICA, CAPE PROVINCE.—**3323** (Willowmore): Knysna district, Blauwkrantz, on oaks (*Q. pedunculata*) in open situation at the forester's house (–DC). *O.A. Hoeg s.n.*, 21.vi.1929, det. S. Kurokawa 1969 (PRE, TRH). No specimens have been cited for South Africa previously, and therefore this species has not been validly recorded for this area up until now.

Heterodermia pseudospeciosa (Kurok.) Culb.

SWAZILAND.—**2631** (Mbabane): Ezulwini Valley, S of Mbabane, Mantenga Falls, on the Little Usutu River, on bark, alt. 770 m (–AC). *F. Brusse 1131*, 1.v.1976 PRE).

Lecanora epibryon (Ach.) Ach.

SOUTH AFRICA, CAPE PROVINCE.—**3319** (Calvinia): Ceres District, Gydo Pass, on vertical low mossy soil bank, in shade of bushes, on steep SW slope, alt. 1 000 m (–AB). *F. Brusse 2612*, 27.iv.1981 (PRE).

Lecanora gangaleoides Nyl.

SOUTH AFRICA, NATAL.—**2829** (Harrismith): Cathederal Peak Nature Reserve, Doreen Falls on the mLambonja River, tree cluster around boulder cluster near lower falls, on rock in tree shade, alt. 1 680 m (–CC). *F. Brusse 4532*, 22.i.1986 (LD, PRE).

Lepraria incana (L.) Ach.

SOUTH AFRICA, TRANSVAAL.—**2628** (Johannesburg): Johannesburg, Linksfield Ridge, on soil under rock, in rock shade, on N facing slopes (–AA). *F. Brusse 1142*, 16.iv.1978 (PRE).

ORANGE FREE STATE.—**2827** (Senekal): 18 km E of Marquard, De Hoek farm on Clarens sandstone (–CB). *D. Venter 4505*, 18.iv.1979 (PRE).

Parmelia (Bulbothrix) sensibilis Stnr. & Zahlbr.

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): Soutpansberg district, 10 km from Louis Trichardt to Vivo, on *Sclerocarya caffra* bark, alt. 1 000 m (–BB). *F. Brusse 1589*, 23–29.i.1981 (PRE).

Parmelia (Flavopunctelia) flaventior Stirt.

SOUTH AFRICA, ORANGE FREE STATE.—**2828** (Bethlehem): Clarens, on bark of *Prunus persica* (–CB). *J.E. v.d. Plank 4442*, vii.1943, det. M.E. Hale (COLO, LD, NU, PRE). **2829** (Harrismith): Farm Rensburgskop near Swinburne, on bark (–DC). *M.L. Jacobsz 5006*, xi.1978 (PRE). No specimens have been cited for this species from South Africa, and therefore no valid record exists.

Parmelia (Flavopunctelia) soredica Nyl.

SOUTH WEST AFRICA/NAMIBIA.—**2217** (Windhoek): Windhoek, Administrasie tuine, op bas van *Jacaranda* (–CA). *A.J. Gous 4552*, vii. 1968 (PRE).

SOUTH AFRICA, TRANSVAAL.—**2528** (Pretoria): Pretoria Botanical Gardens, Silverton Ridge, on *Ochna pulchra* bark (–CB). *F. Brusse 2037*, 4.xi.1980 (LD, PRE).

2628 (Johannesburg): Johannesburg, Linksfield Ridge, common on tree bark (–AA). *F. Brusse 1136*, 26.vi.1976 (LD, PRE). This species is common on the highveld, growing on both indigenous and introduced trees. There is no effectively published citation of a specimen available, although Hale (1980) published distribution maps with dot records for South Africa.

Parmelia (Hypotrachyna) degelii Hale

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Mount Sheba near Pilgrim's Rest, scattered sandstone boulders on S slope, near top of mountain, on S side of boulder in full sun, alt. 1 850 m (–DC). *F. Brusse 4464*, 15.i.1986 (LD, PRE).

Parmelia (Hypotrachyna) densirhizinata Kurok.

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): Soutpansberg approximately 50 km W of Louis Trichardt, summit of mountain range on farm Ottosdal, rocky quartzite and sandstone terrain on S edge of summit, on *Bequaertiodendron magaliesmontanum* bark, alt. 1 430 m (–AB). *F. Brusse 4433*, 13.i.1986 (PRE).

Parmelia (Hypotrachyna) erythrodes (Zahlbr.) Hale & Kurok.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Mount Sheba near Pilgrim's Rest, scattered sandstone boulders on S slope, near top of mountain, on S rock face in semi-shade (–DC). *F. Brusse 4468*, 15.i.1986 (PRE).

Parmelia (Hypotrachyna) imbricatula Zahlbr.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Mount Sheba near Pilgrim's Rest, scattered sandstone boulders on S slope, near top of mountain, on SE boulder face, alt. 1 850 m (–DC). *F. Brusse 4477*, 15.i.1986 (LD, PRE).

Parmelia (Neofuscelia) parviloba Essl.

SOUTH AFRICA, CAPE PROVINCE.—**3322** (Oudtshoorn): 19 km S of Prince Albert, summit of Swartberg Pass, windblown SE gulley on S faces of TMS rock, alt. 1 650 m (–AC). *F. Brusse 4892*, 7.ii.1986 (BM, COLO, LD, PRE) & *F. Brusse 4879*, 6.ii.1986 (PRE).

Parmelia (Parmelia) kerguelensis F. Wils.

SOUTH AFRICA, CAPE PROVINCE.—**3319** (Worcester): 15 km E of Wellington, Bains Kloof, White river valley, on the lower S slopes of Limietkop, on SW faces of large TMS outcrop near road, alt. 600 m (–CA). *F. Brusse 2590*, 26.iv.1981 (LD, PRE).

Parmelia (Parmotrema) mellissii Dodge

SOUTH AFRICA, NATAL.—**3029** (Kokstad): Weza Forest, on horizontal branch, shaded (–DC). *C.H. Stirton 10410*, 17.12.1981 (PRE).

Parmelia (Parmotrema) usambarensis Stnr. & Zahlbr.

SOUTH AFRICA, NATAL.—**2929** (Underberg): 65 km SW of Estcourt, Giant's Castle Game Reserve, about half-way along Giant's Hut trail, along umChezi (Bushman's) river, boulder cluster near river, on E Clarens (Cave) sandstone boulder face in full sun, alt. 1 950 m (–BC). *F. Brusse 4552*, 23.i.1986 (BM, COLO, LD, PRE).

Parmelia (Xanthoparmelia) burmeisteri Elix

SOUTH AFRICA, CAPE PROVINCE.—**3321** (Ladismith): Seven Weeks Poort, about 16½ km from the main Calitzdorp–Ladismith road, on large TMS boulders in the cove of a high water trickle (waterfall), alt. 950 m (–AD). *F. Brusse 3566*, 9.v.1981 (BM, LD, PRE). **3322** (Oudtshoorn): 19 km S of Prince Albert, top of Swartberg Pass, on TMS, on steep S slope, alt. 1 600 m (–AC). *F. Brusse 3461*, 7.v.1981 (BM, COLO, LD, PRE).

Parmelia (Xanthoparmelia) conspersa Ach.

SOUTH AFRICA, CAPE PROVINCE.—**3218** (Clanwilliam): 3 km W of Olyvenboskraal, Witelskloof, on large TMS boulder outcrop, alt. 500 m (–BD). *F. Brusse 3088*, 2.v.1981 (PRE); Half-way up Versveld Pass near Piketberg, on TMS rocks on ledges of E facing cliffs, semishaded, alt. 500 m (–DC). *F. Brusse 2950*, 1.v.1981 (PRE). This species has previously not been correctly reported for South Africa.

Parmelia (Xanthoparmelia) filarszkyana Gyeln.

SOUTH AFRICA, CAPE PROVINCE.—**3220** (Sutherland): Roggeveld Mountains, Ouberg Pass, low Kranz on steep SW slope, on mudstone, alt. 1 400 m (–AD). *F. Brusse 3290*, 5.v.1981 (PRE).

Parmelia (Xanthoparmelia) nigropsoromifera Nash

SOUTH WEST AFRICA/NAMIBIA.—**2017** (Waterberg): Waterberg plateau, rock outcrops or low rocky hills, on sandstone (–AD). *F. Brusse 4248*, 23.iii.1984 (COLO, LD, PRE).

SOUTH AFRICA, CAPE PROVINCE.—**3220** (Sutherland): Roggeveld Mountains, about 30 km SW of Middelpos, near bottom of Gannaga Pass, on large dolerite boulder-outcrop on steep S slope, alt. 800 m (–AA). *F. Brusse 3267*, 5.v.1981 (CBG, COLO, LD, PRE).

Parmelia (Xanthoparmelia) psoromifera Kurok.

SOUTH AFRICA, CAPE PROVINCE.—**2917** (Springbok): On top of Spektakelberg, Springbok, on rock (–AD). *J.J.M. v.d. Merwe 247*, 9.ix.1970 (PRE). **3219** (Wuppertal): Clanwilliam district, upper Biedouw valley, 1 km S of Mertenhof, on low TMS kranzes on a gentle N facing slope (–AA). *F. Brusse 3166*, 3.v.1981 (PRE). **3221** (Merweville): 40 km E of Sutherland, Die Poort se Nek, on a low S to SE mudstone kranz on a low ridge in gentle terrain, alt. 1 400 m (–AC). *F. Brusse 3371*, 6.v.1981 (PRE).

Parmelia (Xanthoparmelia) scabrosa Tayl.

SOUTH WEST AFRICA/NAMIBIA.—**2017** (Waterberg): Südwesafrika, Wasserberg bei Windhoek, auf Schiefer (–AC), *Fincke* (W 3787, on holotype of *Lecanora placodina* Zahlbr.).

SOUTH AFRICA, CAPE PROVINCE.—**2820** (Kakamas): 86 km WNW of Upington, on granitic rock, alt. 760–920 m (–AD). *F. Brusse 772 1-3-1* (J). **2821** (Upington): 10 km SSE of Keimoes, on granite, alt. 760–920 m (–CC). *F. Brusse 768 8-6-3* (J).

Phyllopsora haemophaea (Nyl.) Müll. Arg.

SOUTH AFRICA, NATAL.—**3029** (Kokstad): inGeli forest near Harding, on tree trunk in permanent shade (–DA). *F. Brusse 1846*, 9.i.1982 (LD, PRE). Lit. Swinscow & Krog (1981).

Physcia dubia (Hoffm.) Lett.

SOUTH AFRICA, CAPE PROVINCE.—**3218** (Clanwilliam): Top of Versveld Pass near Piketberg, on TMS boulders on W aspect, alt. 600 m (–DC). *F. Brusse 2999*, 1.v.1981, (BM, LD, PRE). **3318** (Cape Town): Bothmaskloof Pass near Riebeeks Kasteel, Porseleinberg, on TMS outcrops on a NW slope, alt. 350 m (–BD). *F. Brusse 2774*, 28.iv.1981 (PRE).

Physcia tribacia (Ach.) Nyl.

SOUTH AFRICA, NATAL.—**2929** (Underberg): 30 km NE of Underberg, about 2 km from RSA border post at Sani Pass, umKomanazana river valley, hill with boulders and trees. On rock on N slope in semi-shade of trees (–CB). *F. Brusse 4570*, 24.i.1986

(PRE). **3029** (Kokstad): Mount Currie district, 18 km NW of Kokstad, farm Weltevrede, S kranz near the Droewig river (20°28.8'S; 29°18.1'E), on light blue-grey mudstone, alt. 1 480 m (–AD). *F. Brusse 1166*, 1.i.1978 (PRE).

CAPE PROVINCE.—**3218** (Clanwilliam): 3 km W of Olyvenboskraal, Witelskloof, on large TMS boulder outcrop, alt. 500 m (–BD). *F. Brusse 3105*, 2.v.1981 (LD, PRE). **3219** (Wuppertal): 17 km W of Citrusdale, top of Middelberg Pass, on W facing TMS, alt. 1 100 m (–CA). *F. Brusse 3058*, 2.v.1981 (COLO, LD, PRE). Lit. Moberg (1986).

Physconia grisea (Lam.) Poelt

SOUTH AFRICA, TRANSVAAL.—**2628** (Johannesburg): Johannesburg, Linksfield Ridge, corticole on a wide range of tree species, also on rock in shade or with a fair amount of debris, alt. 1 780 m (–AA). *F. Brusse 1129*, 27.vi.1976 (PRE).

Polychidium dendriscum (Nyl.) Henss.

SOUTH AFRICA, CAPE PROVINCE.—**3318** (Cape Town): Cape, Kirstenbosch, on mossy rocks (–CD). *S. Garside 5087* (NU); Large sandstone ledge and ridges in dense fynbos, trail from Platteklip Gorge to Woodhead Resevoir, Table Mountain, elev. 950 m (–CD). *M.E. Hale 72,084*, 23.i.1986 (PRE, on isotype of *Xanthoparmelia surrogata* Hale).

Porina nitidula Müll. Arg.

SOUTH AFRICA, NATAL.—**2931** (Stanger): Stella Bush, Durban, Natal, on leaves (–CC). *A.M. Bottomley 263b*, 15.x.1919, det. R. Santesson 1954 (PRE).

Porpidia corralensis (Räs) Brusse

SOUTH AFRICA, CAPE PROVINCE.—**3423** (Knysna): Tsitsikamma National Park, on TMS rock outcrop on W bank of Storms River mouth, on top face of rock, alt. 5 m (–BB). *F. Brusse 4749*, 1.ii.1986 (BM, COLO, PRE, UC). Lit. Hertel (1984).

Pyxine reticulata (Vain.) Vain.

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): District Vuvani, 18 km NNE of Soekmekaar, on *Ficus burkei* on an E slope, alt. 1 100 m (–BD). *F. Brusse 1650*, 23–29.i.1981 (LD, PRE).

Ramalina peruviana Ach.

SOUTH AFRICA, NATAL.—**2732** (Ubombo): Makhathini flats, a few km from Jozini on road to Sodwana Bay, on twigs, alt. c.100 m (–AC). *L. Henderson 4460*, 8.xi.1980 (PRE); 45 km from Mkuze to Sodwana Bay (–AD). *C.H. Stirton 8866*, 13.v.1981 (BM, LD, PRE). **2832** (Mtubatuba): Hlabisa, Palm Ridge Farm, coastal sandflats, scrub with scattered trees, occurs on small trees and shrubs (–AC). *E.R. Harrison 473*, 30.iv.1968 (BM, LD, PRE).

CAPE PROVINCE.—**3325** (Port Elizabeth): Alexandria district, 5 km from Paterson to Addo, farm Vista, on bark (–BD). *E. Retief 487*, 22.vii.1980 (PRE). **3326** (Grahamstown): Bathurst area, view and picnic site overlooking horseshoe bend of Kowie River, on twigs of tree on edge of cliff, mist affected, alt. c.200 m (–DB). *S.J. Smithies 106*, i.1981 (PRE).

Ramalina tenella Müll. Arg.

SOUTH AFRICA, NATAL.—**2832** (Mtubatuba): Hlabisa, Palm Ridge Farm, coastal sand flats, on small trees and shrubs (–AC). *E.R. Harrison 4298*, 30.iv.1968 (LD, PRE). **2930** (Pietermaritzburg): Pinetown, on *Citrus* branches (–DD). *E.M. Doidge 1549*, 24.xi.1933 (PRE).

CAPE PROVINCE.—**3325** (Port Elizabeth): Addo National Park, on trees (–BD). *L.C.C. Liebenberg 4110*, vii.1962 (PRE).

Strigula maculata (Cooke & Massee) R. Sant.

SOUTH AFRICA, NATAL.—**2930** (Pietermaritzburg): Buccleugh near Cramond, on *Chrysophyllum* leaves (–AD). *E.M. Doidge 270*, 17.viii.1917, det. R. Santesson (PRE). **3030** (Port Shepstone): Amanzimtoti, on leaves (–BB). *E.M. Doidge 268*, 10.vii.1911, det. R. Santesson (PRE).

Strigula subtilissima (Fée). Müll. Arg.

SOUTH AFRICA, CAPE PROVINCE.—**3423** (Knysna): Knysna, C.P., on *Cassine croceum* leaves (–AA). *A.M. Bottomley 1631b*, 23.iv.1939, det. R. Santesson 1954 (PRE).

Thelotrema berkeleyanum (Mont.) Brusse, *comb. nov.*

Basionym: *Stegobolus berkeleyanus* Mont. Hook., Lond J. Bot. **4**: 4. 1845.

Synonym: *Ocellularia berkeleyana* (Mont.) Zahlbr. Engler-Prantl, Naturl. Pflanzenfam., teil **1**(1): 118. 1905.

SOUTH AFRICA, CAPE PROVINCE.—**3323** (Willowmore): Distr. Knysna, Gouna Forest, on bark of *Faurea macnaughtonii* (–CC). *Ove Almborn 3296*, 19.viii.1953, det. M. Hale as *Ocellularia b.* (LD, PRE).

Thelotrema subtile Tuck.

SOUTH AFRICA, CAPE PROVINCE.—**3323** (Willowmore): Distr. Knysna, Deepwalls, on bark of indig. tree (–CC). *Ove Almborn 3534*, 21.viii.1953, det. M. Hale 1973 as *Ocellularia s.* (LD, PRE); Distr. Humansdorp, Stormsrivier, on *Ocotea* near 'the big tree' (–DD). *Ove Almborn 3799*, 24.viii.1953, det. M. Hale as *Ocellularia s.* (LD, PRE).

Tricharia albostrigosa R. Sant.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Pilgrim's Rest, on leaves of *Cassine sp.*, alt. 1 750 m (–DD). *F. Venter 10583b*, 20.ii.1985 (PRE). Lit. Serusiaux (1984).

Usnea (Eumitria) baileyi (Stirt.) Zahlbr.

SOUTH AFRICA, NATAL.—**2831** (Nkandla): 5 km from Eshowe to Nkwaleni, farm 'Eyrie', on bark (–CC). *C.H. Stirton CH4536*, 12.x.1975 (PRE). **3030** (Port Shepstone): Umtamvuna Nature Reserve, South Ridge, on bark in short dry forest (–CC). *A. Abbott 1873*, 22.iii.1984 (PRE).

Usnea complanata (Müll. Arg.) Mot.

SOUTH AFRICA, TRANSVAAL.—**2231** (Pafuri): Kruger National Park, Punda Maria, on twigs (–CA). *A.M. Brynard 4054*, 11.viii.1959 (PRE). **2330** (Tzaneen): Magoebaskloof Hotel, tree in car park, on erect trunk (–CC). *C.H. Stirton 10605*, ii.1982 (PRE). **2530** (Lydenburg): Barberton, Cythna Letty nature reserve, on tree branches in forest (–DD). *H. Glen 1320*, 1984 (PRE).

Usnea (Eumitria) liechtensteinii Stnr.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Distrik Pelgrimsrus: Hebronberg, noordelike berghang, teen oosliggende sandsteenkrans, ook bo-op, in volle sonlig, alt. 1 700 m (–DB). *P. Vorster 1876b*, 19.iv.1970 (PRE). **2527** (Rustenburg): Magaliesberg, Breedtsnek, on S facing quartzite cliffs, alt. 1 750 m (–CD). *F. Brusse 1116*, 19.iv.1976 (PRE).

Usnea perplexans Stirt

SOUTH AFRICA, TRANSVAAL.—**2329** (Pietersburg): Soutpansberg District, 2 km from Soekmekaar to Tzaneen, on *Acacia sieberana* var. *woodii*, on gentle slope, alt. 1 100 m (–DB). *F. Brusse 1724*, 23–29.i.1981 (PRE); 5½ km from Haenertsburg to Annies Fortune, on trees in small forest patch on a steep slope, terrain mountainous, alt. 1 600 m (–DD). *F. Brusse 1842*, 23–29.i.1981 (PRE). **2430** (Pilgrim's Rest): Mariepskop, bosboustasie, epifieties teen vertikale stam van aangeplante *Cussonia*, alt. 1 300 m (–DB). *P. Vorster 174b*, 16.i.1969 (PRE).

Usnea (Eumitria) welwitschiana Mot.

SOUTH AFRICA, TRANSVAAL.—**2430** (Pilgrim's Rest): Blyderiviervallei, op westelike rand, op sandsteen in volle sonlig, alt. c.1 500 m (–DB). *M. v.d. Merwe 55*, 18.iv.1970 (PRE).

NATAL.—**3030** (Port Shepstone): Oribi Gorge near Port Shepstone, on TMS (–CA). *F. Brusse 1490*, 27.xii.1978 (LD, PRE).

NOTES ON SOME PARMELIACEAE SPECIES

Parmelia astricta Brusse, *Bothalia* **15**: 315. 1984

Synonym: *Paraparmelia astricta* (Brusse) Elix & Jen Johnston, *Mycotaxon* **27**: 279. 1986.

The paratype specimen (*F. Brusse 3444*) from the top of Swartberg Pass between the Cango Caves and Prince Albert, was originally stated to contain gyrophoric acid. This has proven to be erroneous and it contains olivetoric acid in addition to alectoronic acid. Olivetoric acid is therefore best not regarded as an accessory, as originally stated, but as a major constituent of this species.

Additional material of this species was collected in early 1986 and distributed as follows:

SOUTH AFRICA, CAPE PROVINCE.—**3321** (Ladismith): 15 km N of Riversdale, Garcia's Pass, SW side of Kareekop, on low lying TMS outcrops on S slope, partially shaded by shrubs, alt. 550 m (–CC). *F. Brusse 4911*, 8.ii.1986 (BM, LD, US). **3322** (Oudtshoorn): 19 km S of Prince Albert, summit of Swartberg Pass, collected on W side of road, on steep SE rocky slope, on TMS near crevices, on low lying rock, alt. 1 650 m (–AC). *F. Brusse 4878*, 6.ii.1986 (BM, LD, PRE, US); Robinson's Pass between Mossel Bay and Oudtshoorn, SW slopes of Ruitersberg, on N sides of TMS boulders, in partial shade of shrubs, near ground level, alt. 790 m (–CC). *F. Brusse 4808*, 4.ii.1986 (BM, LD).

Paraparmelia olivetorica Nash & Elix (1987), reported to contain olivetoric and 4-0-demethylmicrophyllinic acids, is obviously a closely related species, if not part of a chemosyndromic series of *Parmelia astricta*.

Parmelia cedrus-montana (Brusse) Brusse, *Bothalia* **15**: 320. 1984.

Synonym: *Xanthoparmelia cedrus-montana* Brusse *Jl. S. Afr. Bot.* **49**: 145. 1983.

A further collection of the type strain of this species has been made at Gwarrie Poort near Willowmore.

SOUTH AFRICA, CAPE PROVINCE.—**3323** (Willowmore): 16 km from Willowmore to Uniondale, Gwarriepoort, Suurberg se Loop valley, SE slopes of Rebosrand, on quartzite cliff, alt. 910 m (–AD). *F. Brusse 4859*, 6.ii.1986 (BM, COLO, LD, PRE, UC, UPS, US).

Parmelia eximia Brusse, *Mycotaxon* **27**: 183. 1986.

Synonyms: *Xanthoparmelia calvinia* Hale, *Mycotaxon* **27**: 567. 1986.

Xanthoparmelia competita Hale, *Mycotaxon* **27**: 568. 1986.

These names appeared simultaneously, so the epithet '*eximia*' has priority in *Parmelia*, and one of two synonyms listed above in *Xanthoparmelia*. Although Hale (1986) regarded *X. calvinia* as distinct due to the presence of 'isidia', these are no more than high bullae, which can easily be decapitated mechanically. Very many species from arid areas are bullate in the centre of the thallus. These collections increase the range of this species considerably, and the distribution is not as restricted as previously thought (Brusse 1986). The acetone extracts of the holotype of this species and the isotypes of *X. calvinia* and *X. competita* were run together on the same TLC plate, and compared with some lichens containing 4-O-methylhypoprotocetraric acid, particularly *P. hypoprotocetrarica* Kurok., which often contains this substance in minor quantities. This confirmed the suspicion that unknown FB-6 (Brusse 1986) is probably 4-O-methylhypoprotocetraric acid, as indicated by Brusse (1980). Jen Johnston of the Australian National University in Canberra has also indicated that this is 4-O-methylhypoprotocetraric acid (determination slips in the paratype of *P. eximia*). A trace of hypoprotocetraric acid was also stated to be present. FB-1 and FB-2 are the two other major substances present and these appear to be new unknown substances, not treated by Culberson & Hale (1973). The types of *P. eximia* and *X. calvinia* are identical in chemistry containing 4-O-methylhypoprotocetraric acid, FB-1 and FB-2 and a low substance related to FB-1. However *P. eximia* also contains low aliphatic acids, clearly visible on plate B, but obscured on plates A and C. The isotype of *X. competita* lacks unknown FB-1 and the lower running related substance, and the aliphatic acids. However all three types are clearly united by the presence of 4-O-methylhypoprotocetraric acid (FB-6) and unknown FB-2, and the variation is of a chemosyndromic nature with the aliphatic acids as accessories.

An isotype specimen has been lodged at ANUC, in addition to the herbaria originally indicated. A paratype specimen has been lodged at US, in addition to the herbaria originally cited.

Parmelia fausta Brusse, *Mycotaxon* **27**: 185. 1986.

An isotype specimen has been lodged at ANUC, in addition to the herbaria originally indicated.

Xanthoparmelia hybrida Hale, *Mycotaxon* **27**: 580. 1986.

An examination of the isotype specimen revealed the presence of usnic and protocetraric acids and unknown Th-1. The original publication stated the presence of stictic and constictic acids in addition to protocetraric and usnic acids, but this could not be confirmed. The unknown Th-1 seems to be a very pale yellow pigment, which reacts with a 2 molar solution of potassium hydroxide, rapidly giving a bright orange-red colour. Stictic and constictic acids slowly become yellow with the same reagent. Deeper colours are due to the co-occurrence of norstictic acid, but again, these develop slowly, and are duller reds or red-oranges.

This substance (Th-1) is common in *Parmelia cedrus-montana*, and has been found in *P. endomiltodes* Nyl. (the type of *Xanthoparmelia ianthina* Brusse contains this substance and Th-2, with the 'endomiltodes anthraquinone pigments') and also in *P. hypoleia* Nyl. with protocetraric acid. For this reason it is regarded as an accessory substance, and *X. hybrida* is regarded as a synonym of *P. mutabilis* Tayl. (see below).

Parmelia insignis Brusse, *Mycotaxon* **27**: 186. 1986.

A further isotype specimen has been deposited at ANUC.

Dr. J.A. Elix has suggested that this species contains stenosporonic acid as the major substance and colensoic acid as the minor substance (Elix *in litt*), and also that it is a synonym of *Parmelia mongaensis* Elix. While I have not been able to examine the type of *P. mongaensis*, I have been able to compare it to *Xanthoparmelia shebaiensis* Nash & Elix (1987) and *P. stenosporonica* (Hale) Brusse. On TLC plates the substances move identically, although insig-1 is more pale yellow-brown than stenosporonic acid, which is a more pale olive-green colour, on the same plate. Although *P. mongaensis* was originally described as containing grayanic and colensoic acids (Elix 1981), this has recently been corrected to stenosporonic and colensoic acids (Culberson *et al.* 1985). The difference in spot colour on the same plate gives me some reservation as to what insig-1 is, in the absence of a confirmatory test.

In the original description of *P. mongaensis* Elix (1981) the ascospores were reported as 11–13 × 7–10 µm, which is quite large for a *Paraparmelia*, which are supposed to fall within the range 7–10 × 4–6 µm (Elix *et al.* 1986). While the type material of *P. insignis* is sparsely apotheciate, the hymenia have been partly damaged by mite grazing, and the remainders contain only few ascospores, a concerted effort to find ascospores, revealed that they are within the range normal for a *Paraparmelia*. This requires confirmation with better fertile material.

For the present, therefore, the decision to synonomize *P. insignis* with *P. mongaensis* is delayed until more data becomes available.

Parmelia insipida Brusse, *Mycotaxon* **27**: 238. 1986.

An isotype specimen has been deposited in ANUC, in addition to those originally cited.

Originally this species was known from the Sneeuwberg at Lootsberg Pass (type locality) and the south-western end of the Drakensberg at Barkly Pass (originally misspelt 'Barkleys Pass') near Elliot. Recently the range has been extended further north-east to Qacha's Nek near Matatiele, by the following specimen:

SOUTH AFRICA, TRANSKEI.—**3028** (Matatiele): 32 km NNE of Matatiele, Qacha's Nek, near Transkei/Lesotho border on Transkei side, on Clarens (cave) sandstone on E slope in mountainous terrain, alt. 1 950 m (–BA). *F. Brusse 4579*, 25.i.1986 (BM, COLO, LD, PRE).

Parmelia lesothoensis (Hale) Brusse

Synonym: *Xanthoparmelia lesothoensis* Hale, *Mycotaxon* **27**: 582. 1986.

An examination of the isotype specimen of this species, revealed all the originally reported substances (usnic, salacinic and diffracteic acids), as well as the 'chalybaeizans unknown'.

Xanthoparmelia lividica Hale, *Mycotaxon* **27**: 584. 1986.

The reported cortical chemistry of this species (usnic acid), could not be confirmed in a thin-layer chromatographic study of the isotype specimen. Instead atranorin was the only cortical substance found, and no trace of usnic acid could be detected. The medulla contains colensoic and lividic acids as reported. More collections are needed to eliminate the possibility that this species does not intergrade chemosyndromically with *Parmelia mongaensis* Elix.

Parmelia marroninipuncta Brusse, *Bothalia* **15**: 315. 1984.

An additional isotype specimen has been deposited at COLO.

Recently a large collection of this lichen was made:

SOUTH AFRICA, CAPE PROVINCE.—**3225** (Somerset East): Mountain Zebra National Park near Cradock, Bankberg mountains, Wilgeboom River Valley, just beyond poplar grove from dam, dolerite ridge on W side of road, on siltstone and dolerite on steep E slope, alt. 1 280 m (–AB). *F. Brusse 4685*, 29.i.1986 (BM, COLO, LD, MEL, PRE, S, UC, UPS, US).

Parmelia mutabilis Tayl., *Lond. J. Bot.* **6**: 171. 1847.

There is type material of this species both in BM and FH, but FH is the only herbarium with material labelled with the words '5' and 'Uitenhage' as cited in the original description. This material, which must be regarded as the holotype, consists of two specimens, both of which contain usnic, fumarprotocetraric and succinoprotocetraric acids, and which are morphologically essentially the same. This lichen has previously been variously referred to as *P. subconspersa* Nyl. and *P. phaeophana* Stirt., although the list of synonyms is now very long.

The latin description fits the holotype material fairly well, except for the word 'cinereus' (= grey), which was used to describe the colour of the thallus. In the postamble the author compared the lichen to *P. conspersa* Ach. in its mode of branching, and to *P. herbacea* (Huds.) Ach. (= *Lobaria laetevirens* (Lightf.) Zahlbr.) in colour and general habit. This latter lichen is a tan colour when dry, and resembles a *Xanthoparmelia* rather than a *Paraparmelia*.

Since the lower surface was stated to be brown in the original description ('subtus fuscentibus'), the material with a brown lower surface must be selected. This excludes most of the rest of the syntype material, labelled as from Uitenhage, which is *P. hypoleia* Nyl., a maculate lichen with a black lower surface.

Xanthoparmelia olivetorica Hale, *Mycotaxon* **27**: 591. 1986.

The description of this species is based on a mixture of two species. One species is grey and contains atranorin and olivetoric acid, and the other is yellow and contains usnic and gyrophoric acids. The grey species is probably *Parmelia astricta* Brusse with the alectoronic acid obscured on the TLC plates, and other species is probably *Parmelia endochromatica* (Hale) Brusse, the type of which comes from very close-by or even from the same spot on Table Mountain. Neither of the 'schenkiana pigments' were found in *X. olivetorica*, but pigments are produced in older parts of the lobes, and are sometimes not detectable, as in *P. schenckiana* itself.

Parmelia patula Brusse, *Bothalia* **15**: 317. 1984.

An additional isotype specimen has been deposited at US.

Although the type of this species is quite tightly adnate, I include in the range of variation such looser forms as *Xanthoparmelia oribensis* Hale.

Parmelia ralla Brusse, *Mycotaxon* **27**: 240. 1986.

An additional isotype specimen has been deposited at ANUC.

The range of this species is now known to cover the whole of the Cape fold mountain area up to Uniondale, by the following additional specimens:

SOUTH AFRICA, CAPE PROVINCE.—**3219** (Wuppertal): Clanwilliam district, Biedouw Valley, 1 km S of Mertenhof, on low TMS kranzes on gentle N facing slope, alt. 500 m (–AA). *F. Brusse 3168*, 3.v.1981 (BM, LD, PRE). **3318** (Cape Town):

Bothmaskloof Pass near Riebeeks Kasteel, Porseleinberg, on TMS outcrops on NW slope, alt. 350 m (–BD). *F. Brusse 2777*, 28.iv.1981 (PRE).

Parmelia scitula Brusse, *Bothalia* **15**: 317. 1984.

An isotype specimen has been deposited at COLO, in addition to the LD & PRE of the original publication.

Parmelia spargens Brusse, *Bothalia* **15**: 318. 1984.

The range of this species has been extended by the following specimens:

SOUTH WEST AFRICA/NAMIBIA.—**2016** (Otjiwarongo): 7 km S of Otjiwarongo, tall boulder strewn koppie, on granite on S slope (–DA). *F. Brusse 4207*, 21.iii.1984 (PRE).

SOUTH AFRICA, CAPE PROVINCE.—**3322** (Oudtshoorn): 10 km S of Prince Albert, Dorps River valley, at picnic site, on vertical S TMS cliff, at N base of large mountain range (Swartberg range), alt. 790 m (–AC). *F. Brusse 4885*, 7.ii.1986 (BM, COLO, LD, PRE); 9 km N of De Rust, Meiringspoort, on SW TMS outcrop with 30° slope, alt. 550 m (–BC). *F. Brusse 4826*, 5.ii.1986 (BM, COLO, LD, PRE, UPS, US).

Parmelia thamnolica (Hale) Brusse

Synonym: *Xanthoparmelia thamnolica* Hale, *Mycotaxon* **27**: 604. 1986.

An examination of the isotype specimen, showed that no thamnolic acid was present as originally reported. This was immediately clear, because the medulla did not react with K. However, the chemistry is new for a *Xanthoparmelia* containing squamatic acid and two unidentified substances in the medulla. Garbarino *et al.* (1987) have identified 2-O-methylsquamatic acid in *Protousnea magellanica* (Mont.) Krog, which may be the same as one of these unidentified substances.

Parmelia unctula Brusse, *Bothalia* **15**: 319. 1984.

An isotype specimen has been deposited at LD.

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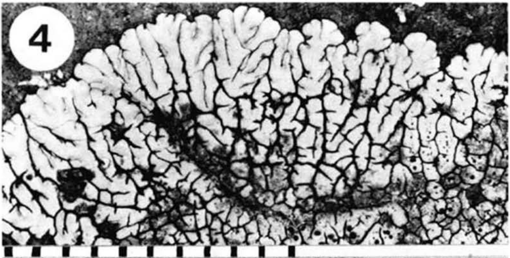
FIGURE 4.—*Parmelia adligans* Brusse, habit. *F. Brusse 4452*, holotype. Scale in mm.

FIGURE 5.—*Parmelia arquata* Brusse, habit *F. Brusse 1126*, holotype. Scale in mm.

FIGURE 6.—*Parmelia ganymedea* Brusse, habit. *F. Brusse 5089*, holotype. Scale in mm.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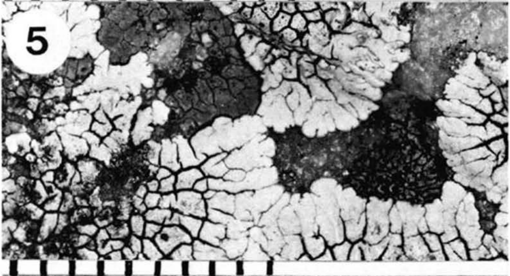
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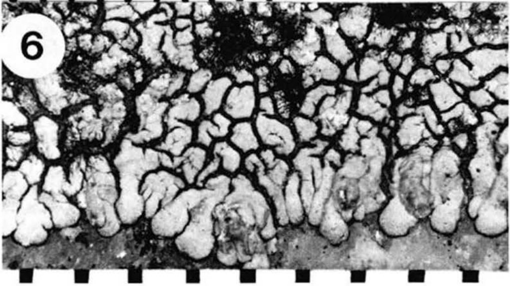
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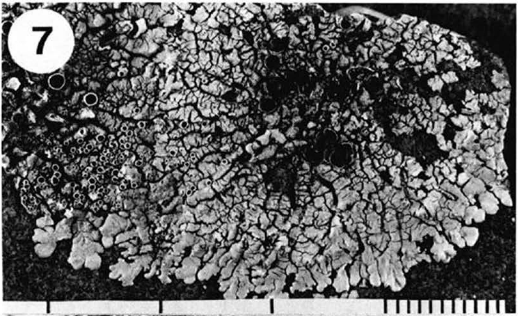

FIGURE 7.—*Parmelia sigillata* Brusse, habit. *F. Brusse 4827*, holotype. Scale in mm and cm.

FIGURE 8.—*Parmelia verecunda* Brusse, habit. *F. Brusse 4790*, holotype. Scale in mm and cm.

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RUTSTROEMIA ALLANTOSPORA : AN UNDESCRIBED SPECIES OF THE SCLEROTINIACEAE FROM SPAIN.[1]

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SUMMARY

Rutstroemia allantospora Galán, Honrubia & Palmer is described as a new species for science. Its peculiar habitat (little decomposed bark of *Pinus* spp. branches) together with the hymenial characters and the microanatomy of the apothecia are used to separate it from *Rutstroemia firma* (Pers.: Fr.) Karst. Photomicrographs show the more important characters, using an optical microscope.

RESUMEN

Se describe *Rutstroemia allantospora* Galán, Honrubia & Palmer como especie nueva para la Ciencia. Su peculiar hábitat (corteza de ramas poco descompuestas de *Pinus* sps.), unido a las características de los constituyentes del himenio y a la microanatomía de los apotecios, son usadas como elementos de separación con *Rutstroemia firma* (Pers.: Fr.) Karst. Se aportan microfotografías al microscopico óptico de los caracteres más sobresalientes de la especie.

METHODS

Microscopic studies have been made using 5% KOH, 2% KOH-Phloxine, Melzer's Reagent and Lactophenol-Methyl Blue. Photomicrographs, including phase contrast, were made with a Nikon microscope, Optiphot model, with an incorporated automatic system. Line drawings were prepared using a camera lucida. Mass ascospore cultures were grown in test tubes at room temperature on P.D.A.

Specimens of the type collection are preserved in the private herbaria of the three authors: RG (R. Gálan), MHG (M. Honrubia) and JTP (J. T. Palmer) with duplicates in various Spanish universities and research centres as part of the *Mycotheca Hispanica* and Cornell University (CUP) whilst the other three collections are in herbaria RG and MHG.

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[1] *This paper was presented in a slightly different form at the Simposio de Botánica Criptogámica VIII on 23-26 September, 1987, in Madrid.*

INTRODUCTION

Following the appearance of a recent publication (HONRUBIA, BERTAULT & LLIMONA, 1983), one of us (R. G.) became interested in the study of certain collections identified by these authors as *Rutstroemia firma* (Pers.) Karst.

The more important characters of these collections, judging from the description and illustrations, are the bicellular, incurved ascospores and, above all, the very characteristic habitat: corticated branches of *Pinus halepensis* Miller.

WHITE (1941) studied not only the type of *Peziza firma* but also additional specimens from various Central European countries and, in accordance with his excellent description, this species, also known as *Poculum firmum* (Pers. : Fr.) Dumont, is characterized by its weakly inequilateral ascospores, at first unicellular, with 3-5 septa at maturity and erumpent from the stromatized wood beneath or through fissures in the bark of deciduous trees, especially *Quercus*. He included a translation of *Rutstroemia firma* var. *acuum* Feltgen, apparently only known from the original collection on *Pinus* needles in Luxembourg and commented: "No morphological characters are indicated which would separate this variety from the species and it is here maintained only because of its rather distinctive habitat."

Therefore, motivated by these contradictions and in collaboration, the collections in Herb. Murcia and those to which we have previously referred, have been restudied. In addition, fresh material on *Pinus halepensis* as well as *Pinus* sp. (*P. pinaster* Aiton and *P. nigra* Arnold subsp. *salzmannii* (Dunal) Franco growing together in a mixed wood) have also been investigated.

The results indicate a distinct taxon and a species new to science is therefore proposed.

DESCRIPTION

Rutstroemia allantospora Galán, Honrubia & Palmer sp. nov.

MISAPPLICATION: *Rutstroemia firma* (Pers.) Karst. by Honrubia, Bertault & LLimona in Bull. Soc. Mycol. France **99**: 299 (1983).

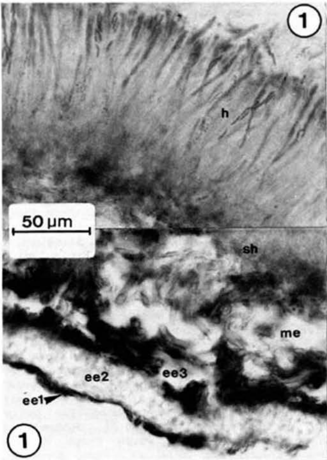
Stroma praesens, parte externa dubium, sed patens obscura zona super externam corticis faciem. **Apothecia** gregaria, cupulata, stipitata et rufofusca. **Receptaculum** pruinosum. **Discus** 0.3-0.8 mm. diam. **Stipes** semper manifestus, variable incrementum habet. **Excipulum Ectale** tribus tegumentis formatum. Externum tegumentum raris hyphae, fuscis, ramosis, flexilibus, laxisque formatum, dispositis paribus intervallis superficiei, tenuibus parietibus, cumque pictus fulcimentis est incrustans. Tegumentum medium hyphae hyalinis formatum, quoque paribus intervallis superficiei dispositus, angustis luminibus et valde glutinosis parietibus. Tegumentum interius indefinita magnitude, formatum hyphae simillimis componentium internus stratum. **Medullare Excipulum** intricata textura. **Subhymenium** densum, (textura intricata aunt textura epidermoidea). **Asci** octosporici, subcylindrati, J+, (70)-85-115 x 6.8-8 μm. **Ascosporae** allantoides, sigmoideo aspectum, (0-)1(-2) septatis, hyalini 10.5-15.5 x 2.4-3.5 μm, quae microconidia in uno vel duobus extremis generant. **Microconidia** subglobosa (x 2-2.5 μm) uniguttulata. **Paraphyses** subclavatae (x 2.4-4.3 μm), pluriseptatae; summum culmen colore fusco.

Habitat: in cortice ramorum mortuorum *Pini halepensis*; in Aceniche, Bullas, in provincia Murcia, in Hispania; Legit M. Honrubia et J. T. Palmer (8-xii-1984); Holotypus: RG 348 et isotypi in CUP 61858, JTP 4130 and MHG 426-2.

Stroma externally indeterminate but appearing as a darkened area on the underside of the bark with no stromatization of the phloem. **Apothecia** gregarious, cupulate, stipitate, reddish brown. **Receptacle** pruinose. **Disc** 0.3-0.8 mm in diameter. **Stipe** always present, although from well developed to variable (equal in length to the diameter of the disc), often very slightly villose at the base. **Ectal Excipulum** in three layers: outer zone formed of some sparse rows of loosely branched, flexuous, brown hyphae (x 3-6.5 μm in diam.) arranged parallel to the surface, with thin walls encrusted with pigment giving a typically banded aspect *(Figs. 3 & 5c)*. The medial layer (30-38 μm thick) is formed of hyaline hyphae, similarly parallel to the surface, with very small lumina and strongly gelatinized walls ***(Figs. 1 & 3)***. The inner zone, of imprecise thickness and not well delimited from the Medullary Excipulum, is formed of very similar hyphae to the outer zone, (i.e. encrusted walls, loose and parallel with coloured contents) but lighter in colour and up to 10 μm in diameter ***(Fig. 1)***. **Medullary Excipulum** well developed, of *textura intricata* and subhyaline cells with thin, smooth walls (3-6.5 μm in diam.) ***(Figs. 1 & 2)***. **Subhymenium** compact, sparsely developed, formed of densely woven brown hyphae: *textura intricata* or *textura epidermoidea* ***(Fig. 1)***. **Asci** 8-spored, subcylindrical (tapering below to form a pedicel of imperceptible limits) with a broad, ± rounded apex and a broad plug, J+, (70-)85-115 x 6.8-8 μm ***(Figs. 1, 4 & 5)***. **Ascospores** allantoid, inequilateral, sometimes slightly sigmoid with (0-)1(-2) septa, hyaline and producing microconidia at one or both apices (present even in the asci), (10.5)-11.5-15.5 x 2.4-3.1(-3.5) μm ***(Figs. 1, 4 & 5)***. **Microconidia** subglobose (x 2-2.5 μm), uniguttulate ***(Figs. 1, 4 & 5)***. **Paraphyses** subclavate, branched at the base (x 2.4-4.3 μm), pluriseptate, brown at the apex and appearing hyaline below with length similar to and not protruding above the asci ***(Fig. 5)***.

ETYMOLOGY: From Latin: **allantoideus** (sausage-shaped) and **sporae** (spores), referring to the shape of the ascospores.

ADDITIONAL SPECIMENS EXAMINED: On bark-covered twigs and branchlets of fallen branches of *Pinus halepensis* Miller (1) or *Pinus* sp. (2): El Carrascalejo, Bullas, prov. Murcia, (1), 27-x-1979, X. LLimona, MHG 2343; Valle de Leiva, Sierra de Espuña, prov. Murcia, 3-xii-77 (1), X. LLimona, MHG 426, *Mycotheca Hispanica 187*; Los Reales, Estepona, prov. Málaga, Spain, 13-vi-1984, (2), M. Honrubia, R. Galán & J. Larios, RG 328.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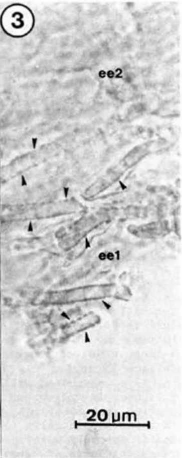
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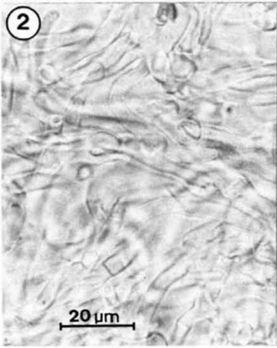
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Rutstroemia allantospora

FIG. 1: Longitudinal section of apothecium to show the Hymenium **(h)**, Subhymenium **(sh)**, Medullary Excipulum **(me)** and the external **(ee¹)**, medial **(ee²)** and internal **(ee³)** of the Ectal Excipulum.

FIG. 2: Intermixed hyphae in the Medullary Excipulum.

FIG. 3: Gelatinized medial layer **(ee²)** and external layer **(ee¹)** of the Ectal Excipulum showing the encrustation of the hyphae **(arrows)**.

FIG. 4: Hymenium **(h)** with 8-spored Asci and 1-septate Ascospores.

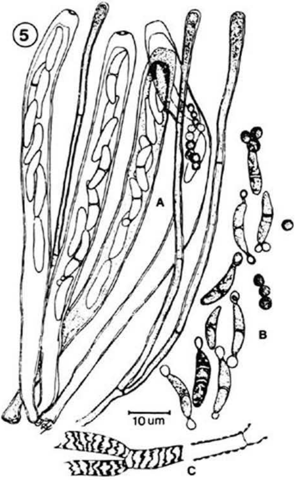
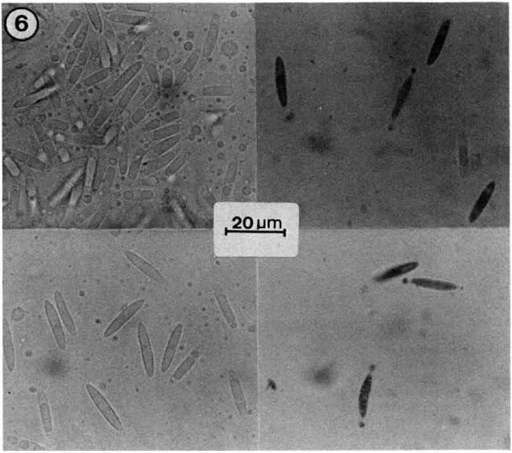


FIG. 5: 8-spored Asci and Paraphyses *(a)*, Mature Ascospores and Microconidia *(b)* and Hyphae from the exterior of the Ectal Excipulum showing the banded reinforcement of the walls *(c)*.

DISCUSSION

This species is distinguished by its mainly 1-septate, narrowly allantoid ascospores and the banded roughening on the tomentum emerging from the gelatinized excipular zone, as similarly stated to occur in *Elliottinia kerneri* (Wettst.) Kohn (L. M. KOHN in litt.) and development from the bark of *Pinus* spp. The species belongs in the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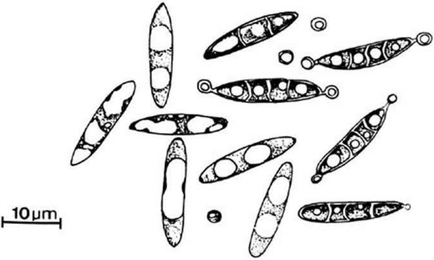
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genus *Poculum* Velen., as typified by DUMONT (1972), which is characterized by a stratum of ± prismatic, gelatinized cells in the ectal excipulum constructed in a complicated manner and formed of prosenchymatous cells. However, in view of the recent vote of the Committee for Fungi and Lichens of the International Association for Plant Taxonomy to conserve the generic name *Rutstroemia* Karst. with *R. firma* (Pers.: Fr.) Karst. as its type, we are now required to adopt *Rutstroemia*. Therefore *Poculum* Vel. is a taxonomic synonym.

It undoubtedly has affinities with *Rutstroemia firma*, not only macroscopically but also in the microanatomy of the apothecium. Despite this, *R. firma* has no "banded" hyphae in the excipulum and the asci are longer, 130-153 x 9-10.5 µm with the ascospores nearly straight or slightly inequilateral, larger, 15.5-21 x 4-5.5 µm in Spanish specimens. WHITE (1941) gave the asci as 125-150 x 9.5-13 µm and ascospores as 14-19 x 4.7-6.5 µm, becoming 3-5 septate at maturity ***(Fig. 6)***. PALMER & TRUSZKOWSKA (1969) reported on two collections on *Quercus robur* twigs in Poland with asci 118-157 x 6.1-10.8 µm and ascospores 12-17.7 x 3.7-6.4 µm, narrowly ellipsoid with pointed ends, 2-multiguttullate and becoming septate. DENNIS (1978) gives the asci as 150 x 12 µm and ascospores as 14-19 x 4.0-6.5 µm, becoming 3-5 septate at maturity. The characteristic short-stipitate apothecia may very well have been due to the typically aerial habitat as stipes of apothecia subsequently developed in natural culture were up to 7 mm long and may similarly occur on twigs immersed in the soil or leaf litter.

This new taxon has been reported by HONRUBIA & al. (1983) with asci 120-140 µm and ascospores 15-19 x 3-4 µm; these dimensions have not been encountered in the present revision.

ACKNOWLEDGEMENTS

The authors wish to express their profound gratitude to Professor R. P. Korf, as well as Drs. L. Holm and L. M. Kohn, for their valued comments on this taxon and Mr. H. G. Ward (Bath, England) for advice on the Latin diagnosis.

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Rutstroemia firma:

FIG. 6. Typical Ascospores with 0-2-3 septa and Microconidia.

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THE LICHEN GENUS LAURERA (FAMILY TRYPETHELIACEAE) IN INDIA

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ABSTRACT

Seventeen species of Laurera Reichenb. are described in detail together with a key to species. Laurera cumingii, L. megasperma, L. phaeomelodes, L. sphaerioides and L. varia are new to India and L. alboverruca, L. aurantiaca, L. columellata, L. fusispora, L. indica, L. sikkimensis, L. subsphaerioides, L. tuberculosa, L. verrucoaggregata and L. vezdae are new species.

INTRODUCTION

The genus Laurera Riechenb. characterized by the ascomata embedded in pseudostroma, fissitunicate asci, interthecial hyphae branched and anastomosed, forming a loose and regular reticulum and hyaline, muriform ascospores, is placed in the family Trypetheliaceae, based on the inclusion of the ascomata in pseudostroma, together with the four other genera - Bottaria, Melanotheca, Tomasellia and Trypethelium (Zahlbruckener, 1926; Letrouit - Galinou, 1957, 1958 and Harris, 1975.)

Recently, however, Harris placed the genera Bottaria (= Mycoporum Flot. ex. Nyl.) and Melanotheca in the family Pyrenulaceae and Tomasellia in the family Mycoporaceae (Bryologist and Evansia, in press).

Vezda (1968), who found the asci of both Laurera and Trypethelium to be bitunicate, removed Laurera to a separate group along with some species of Polyblastiopsis, while Poelt (1974), preferred to place the genus in the provisional family Laureraceae but referred Phyllobathelium also to the same family. Eriksson (1981), however, is of the openion that if the family Trypetheliaceae is split up and Laurera is segregated into a family of its own, the name of this family should not be Laureraceae (sensu Poelt, 1974) but Crypototheliaceae.

In the revisionary study of Laurera, Letrouit-Galinou (1957, 1958) distinguished six different groups, in the genus based on the resemblences of the species particularly in the type of the structure of the pseudostroma, namely : *L. octospora* (Fig. 1), *L. megasperma* (Fig. 2), *L. sphaerioides* (Fig. 3), *L. phaeomelodes* (Fig. 4), *L. cumingii* (Fig. 5) and *L. madreporiformis* (Fig. 6).

Thus, the structure of the pseudostroma, morphology of the thallus and the ascospores provide good taxonomic criteria for the speciation in *Laurera*.

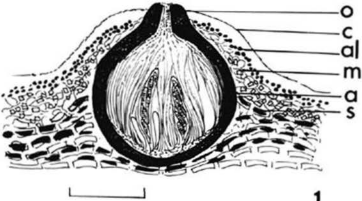
Laurera includes 31 corticolous species and 4 varieties distributed mainly in tropical regions of the world (Letrouit - Galinou, 1957, 1958). Recently, Harris (1984) described one species of the genus, *L. aurata* Harris from Brazil and recognized *L. subdisjuncta* (Müll. Arg.) Harris (synonym *L. dodgei* Letr. G.) from Cuba and Galloway (1985), recorded *L. elatior* (Stirton) Galloway, from New Zealand.

In India the first records of the genus were made by Nylander (1869), who reported two species : *L. benguelensis* (Mull. Arg.) A. Zahlbr. (as *Trypethelium madreporiformis* Eschw.) and *L. subdiscreta* (Nyl.) A. Zahlbr. (as *Trypethelium subdiscretum* Nyl.) from Bengal, based on the S. Kurz collections.

Although a number of studies on the lichen flora of India have been carried out in recent years and several species of pyrenolichens have been reported, only two species, *Laurera* sp. from Chunabhatti of the Darjeeling district (LWU-66.104) by Awasthi and Agarwal (1970) and *L. madreporiformis* (Eschw.) Riddle, from 24-Parganas (n.675) by Roychowdhury (1985), have been recorded.

Seventeen corticolous species of this genus have so far been determined from lichen specimens collected in the Western Ghats, North East India and the Andaman Islands.

Figs. 1-6 : Structure of Pseudostromata 1. type *L. octospora* (Letrouit - Galinou, 1957, pl. I, fig. A), 2. type *L. megasperma* (73.2325), 3. type *L. sphaerioides* (85.869). 4. type *L. phaeomelodes*, eg. *L. verrucoaggregata* (86.550, Holotype - AMH); 5. type *L. cumingii* (85.1019), 6. type *L. madreporiformis*, *L. tuberculosa* (74.2689, Holotype - AMH). Explanation for the abbreviations used in figures. a, ascoma; al, algal layer; b, supplementary brown layer; c, an amorphous cortical zone; cx, zone of Ca-oxalate crystals; e, external zone (K + red); eb, external zone of brown hyphae; ib, inner zone of light brown hyphae; ic, inner amorphous zone; m, medullary zone (crystals studded); O, ostiole; ps.a; tissue of pseudostroma and ascomata; s, substratum cells; rs, red substance (K + purple). Scale = 500 µm.



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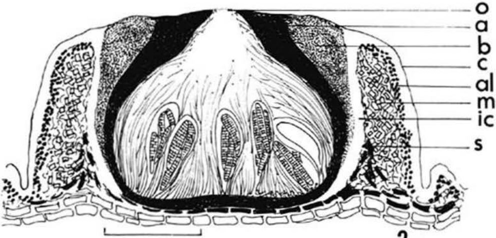

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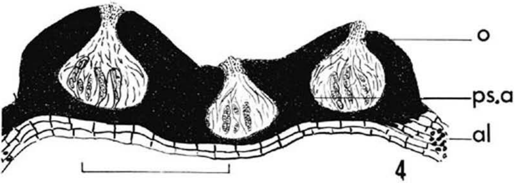

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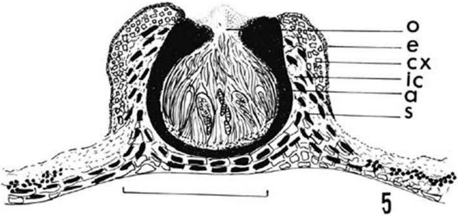

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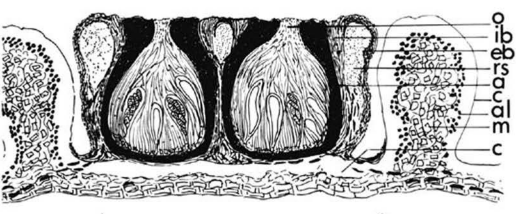

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KEY TO THE SPECIES

1a. Cortical zone present up to the ostioles of ascomata 2

1b. Cortical zone broken at the level of the thallus at the base of pseudostroma 11

(1a)2a. Cortical zone bending towards the bottom, skirting the wall of ascoma; algal layer present up to the ostiole; type L. megasperma 3

(1a)2b. Cortical zone not bending towards the bottom, algal layer broken at the level of thallus; type L. sphaerioides 9

(2a)3a. Ascospores 4/ascus, large, 200-300 µm in length (ascomata in concolorous pseudostromata); .... **L. megasperma**

(2a)3b. Ascospores 8/ascus, always less than 225 um in length 4

(3b)4a. Ascomata with columella or vertical walls (Multiloculate) 5

(3b)4b. Ascomata without columella or vertical walls (uniloculate) 6

(4a)5a. Ascomata with strong columella; pseudostromata concolorous with the thallus, with white, flattened top; ascospores 160-200 x 23-33 µm in size .... **L. columellata**

(4a)5b. Ascomata with strong, vertical walls, multiloculate; pseudostromata conical, dialated at the base; ascospores 66-150 x 23-36 µm in size .... **L. sikkimensis**

(4a)6a. Ascoma having hymenium saturated with orange globules; ascospores 115-135 x 26-32 µm in size .... **L. aurantiaca**

(4b)6b. Ascomata with clear hymenium, without orange globules 7

(6b)7a. Pseudostromata brownish black to black, immersed; ascospores fusiform, 33-53 µm in size .... **L. fusispora**

(6b)7b. Pseudostromata concolorous with the thallus; ascospores never fusiform, more than 60 µm 8

(7b)8a. Ascomata immersed; periostiolar region black, disc like, separated from the tissue of pseudostromata by deep cleavage; ascospores 66-

100 x 16.5-28 µm; cortex K + red .... *L. varia*

(7b)8b. Ascomata semi-emergent; periostiolar region brownish black not separated by cleavage; ostioles papillate; ascospores 95-160 x 30-50 µm in size; cortex K + orange .... *L. indica*

(2b)9a. Pseudostromata white, polycarpic; ascospores 2/ascus, 99-132 x 26.4-36.30 µm in size .... *L. sphaerioides*

(2b)9b. Pseudostromata other than white; ascospores 2-4/ascus 10

(9b)10a. Pseudostromata concolorous with the thallus; ascospores 2/ascus, 99-118 x 30-37 µm in size; thallus farinaceous, cracked .... *L. subsphaerioides*

(9b)10b. Pseudostromata concolorous or brown; ascospores 2-4/ascus, 100-178 x 33-43 µm; thallus not farinaceous, smooth .... *L. vezdae*

(1b)11a. Tissue of the pseudostromata totally carbonized; type *L. phaeomelodes* 12

(1b)11b. Tissue of the pseudostromata not carbonized 14

(11a)12a. Pseudostromata monocarpic ..... *L. subdiscreta*

(11a)12b. Pseudostromata polycarpic 13

(12b)13a. Pseudostromata 1-5 carpic; ascomata surrounded by scale like structure at the base; ascospores oblong, 23-46 x 7-13 µm in size .... *L. phaeomelodes*

(12b)13b. Pseudostromata 1-polycarpic (large number); ascomata not surrounded by scale like structure, glossy; ascospores 34-46 x 12-15 µm in size .... *L. verrucoaggregata*

(11b)14a. Outer most zone of the pseudostromata consisting of brown hyphae followed by medullary zone and the inner most zone of light brown hyphae; type *L. madreporiformis* 15

(11b)14b. Outer most zone of the pseudostromata is brown, K + red, followed by zone of Ca-oxalate crystals and internal amorphous zone; type *L. cumingii* 16

(14a)15a. Ascomata strongly columellate; pseudostromata white; ascospores 85-169 x 30-33 µm in size .... *L. alboverruca*

(14a)15b. Ascomata ecolumellate; pseudostromata brownish black to black; ascospores 70-132 x 40-50 µm in size .... *L. tuberculosa*

(14b)16a. Pseudostromata orange, medulla yellowish orange, ascospores 36-66 x 10-12 µm in size .... *L. cumingii*

(14b)16b. Pseudostromata greenish yellow to yellow; ascospores 60-76 x 13-19 µm in size .... *L. benguelensis*

1. *Laurera alboverruca* sp. nov. (Figs : 7, 11, 28)

Typus : Andaman Islands, South Andaman, Port Mout, 14.2.1985, P.G. PATWARDHAN, M.B. NAGARKAR & P.K. SETHY, 85.36 (Holotype-AMH, Isotype-BM).

Thallus olivaceus, endophloeodes; stratum corticale amorphum, 26-43 µm crassum; stratum gonidiale 16.5-33 µm crassum; stratum medullare albidum; pseudostromata thallo fere concolores vel albida, prominentes, oligocarpica, 1-3 ascomata continentes, circa 1-2 mm lata, ostiolo fusco vel nigro periostiolo nigro; structura pseudostroma ejusdem modi ac groupe *L. madreporiformis*, columella centrali basi dilatata, apice acuto instructa, ascosporae 6-8 nae, oblongae, medio constrictae, parenchymaticae, 85-169 µm longae at 30-33 µm latae.

Thallus corticolous, crustose, grayish-green to olive green, endophloeodal; cortex 26-43 µm thick; ascomata strongly erumpent, 1-2 mm in diameter, columellate, embedded in monocarpic to tri-carpic pseudostromata; ostioles black, centrally situated, surrounded by black annular rim, wide open; structure of the pseudostroma differentiated into three different zones as in *L. madreporiformis*; ascospores 6-8/ascus, oblong, parenchymatous, constricted at the middle, transversely and vertically multiseptate, 85-169 x 23-33 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostroma K-, P-.

Specimen Examined : South Andaman, Port Mout, 85.38.

Remarks : *L. linearis* (Dodge) Letr. G. and *L. sphaerica* (Dodge) Letr. G., the only two species of the group *L. madreporiformis* (Letrouit-Galinou, 1957) having large ascospores (more than 100 µm in length), are comparable with *L. alboverruca* which, however, has white mono-tricarpic, highly elevated pseudostromata, medulla K-, strongly columellate ascomata and much larger ascospores (85-169 µm long) with middle septum distinctly thickened and constricted.

2. *Laurera aurantiaca* sp. nov. (Figs : 12, 29)

Typus : Karnataka, Agumbe - Shringeri Road, 28.2.77, P.G. PATWARDHAN & M.B. NAGARKAR, 77.461 (Holotype-AMH).

Thallus sordide glaucescens, subolivaceus vel olivaceus, verrucosus, hypothallo nigricante limitatus; stratum corticale 23-66 µm crassum; stratum medullare albidum, ascomata nigra, hemisphaerica, immersa in pseudostroma ostiolo nigro, punctato, papillato; periostiola punctata vel complanata; pseudostromata thallo fere concolores, elevata, globosa, 1-5 carpica, circa 1-3.5 mm longa et 1-3 mm lata;structura pseudostroma, ejusdem modi ac groupe *L. megasperma*, gelatina hymenialis sed numerosas guttulas aurantiacas continens; ascosporae octonae, naeviculatae, extremitatibus obtusis vel leviter attenuatis, 116-135 µm longae et 26-33 µm latae, septis transeversis multi, septis verticalibus 1-6, medio constrictae.

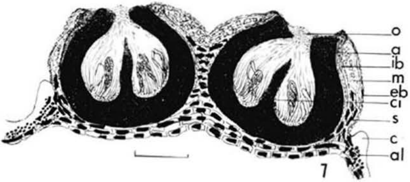
Thallus corticolous, crustose, grayish green to olivaceous green, distinctly warty; warts rounded to vertically elongated, determinated by black hypothalloidal region at the periphery; cortex 23-66 µm thick, hyaline; medulla white; ascomata black, carbonized, hemisphaerical, thin at the base; ostioles black, punctate, centrally situated, surrounded by black periostiolar region; pseudostromata concolorous with the thallus, rounded to orbicular, elevated, 1-5 carpic, 1-3.5 mm long and 1-3 mm broad, structure of the pseudostroma of the *L. megasperma* type, hymenium hyaline but completely saturated with orange coloured globules, ascospores 8/ascus, often constricted at the middle, transversely many septate, vertically 1-6 septate, 115.5-135 x 26-33 µm in size.

Chemistry : Thallus K + Yellow. Medulla of the pseudostroma K-, P-.

Remarks : *L. aurantiaca* holds an isolated position among the species of the group *L. megasperma* by the unusual presence of orange coloured globules in the hymenial tissue. Perhaps in this respect it is nearest to *L. santessoni* Letr. G. which has the hymenium saturated with a red coloured substance. *L. santessoni* is, in fact, not comparable with the present species in regard to other characters.

Another species, *L. sanguinaria* Malme, also contains a red coloured substance, but only in the medullary region of the pseudostroma and not in the hymenial tissue.

Figs 7-10 : Structure of the pseudostromata 7.*L. alboverruca* (85.36, Holotype-AMH); 8. *L. columellata* (78.59, Holotype-AMH); 9.*L. indica* (85.656, Holotype-AMH); 10. *L. sikkimensis* (77.1970, Holotype-AMH). Explanation for the abbreviations used in figures. a, ascoma; al, algal layer; b, supplementary brown layer; c, an amorphous cortical zone; cl, columella; eb, external zone of brown hyphae; hl, hyaline supplementary layer resembling medullary zone; ib, inner zone of brown hyphae; ic, inner amorphous zone; m. medullary zone (crystals studded); s, substratum cells; w, vertical walls of ascoma. Scale = 500 µm.



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3. *Laurera benguelensis* (Müll. Arg.) A. Zahlbr. in Cat Lich. Univ., 1 : 503, 1922. *Bathelium benguelense* Müll. Arg. in Flora, **68** : 256, 1885. (Figs : 13, 30)

Type : Bengal, leg. S. KURZ, 1883, n. 852, Ex Herb. Mull. Arg. G. (designated by Letrouit-Galinou, 1957).

Thallus corticolous, crustose, yellow, smooth, cracked; cortex 50-70 µm thick, light green to hyaline; medulla white, studded with crystals; ascomata black, carbonized, embedded in greenish yellow to yellow, highly elevated pseudostromata; pseudostromata 2.5-5 mm long and 1-1.5 mm broad, with flattened tops, covered with yellow coloured pruina, consist of 1-6(10) ascomata; structure of the pseudostromata of the *L. cumingii* group, but here without a particular zone containing Ca-oxalate crystals exclusively. These crystals are mixed in the external, orange-brown coloured layer, forming a pruina on the thallus. A secondary cortex becomes organised from the superficial hyphae of the external zone of the pseudostroma, ascospores 8/ascus, ovate-oblong, ends obtuse, transversely 15-20 septate, vertically 1-5 septate, 60-76 x 13-19 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostroma K-, P-. Pruina (forming the outer layer of pseudostroma) K + red, P-.

Specimens Examined : Karnataka, near Mangalore, Manjeshwar, 76.1012, 76.1015, 76.1016; Bengal, S. KURZ no. 2o2, H.Nyl. No. 122, S. KURZ, sn, H.Nyl. No. 125, S. KURZ. no. 173, H. Nyl. No. 128, 173 (H).

Remarks : *L. benguelensis* can easily be distinguished from the allied *L. cumingii* (Mont.) A. Zahlbr., especially by its greenish yellow to yellow pseudostromata covered by yellow pruina. *L. cumingii*, however, is characterised by bright orange coloured pseudostromata having a distinct zone containing Ca-oxalate crystals but in *L. benguelensis* there is no comparable zone of Ca-oxalate crystals and these are mixed in the external orange-brown coloured layer which resembles pruina frequently covering the thallus.

This species was previously known only from Bengal (type locality), India.

4. *Laurera columellata* sp. nov. (Figs : 8, 14, 31).

Typus : Karnataka, S. Kanara, Hiriyadaka, Udupi-Hebri Road, in moist rain forest, elevation 150 ft., 22.2.1978, P.G. PATWARDHAN, 78.59 (Holotype-AMH, Isotype-BM).

Thallus viridis, olivaceus-viridis, vel flavo-viridis, laevigatus vel verrucosus, limitatus; stratum corticale 16.5-66 µm crassum; stratum medullare albidum, ascomata subglobosa vel globosa, columello centrali basi dilatato, immersa in pseudostroma, ostiolo punctato, nigro, periostiolo complanato, nigro; pseudostromata thallo concolores, valde elevata, prominentes, maximum partem monocarpica, raro bi-tricarpica, constricta, rotundata, circa 0.8-2.5 mm diametro; structura pseudostroma ejusdem modi ac groupe *L. megasperma*; ascosporae octonae, rectae vel curvulae, 160-200 µm longae et 23-33 µm latae, medio constrictae.

Thallus corticolous, crustose, green, olivaceous green to yellowish green, smooth to distinctly verrucose, determinate; cortex 16.5-66 µm thick, hyaline; medulla white, crystals studded, ascomata black, carbonized, globose to subglobose, embedded in strongly elevated pseudostromata, invaribly columellate, ostioles black, punctate, centrally oriented, surrounded by black periostiolar region often covered with tissue of the pseudostroma, pseudostromata, concolorous with the thallus, highly elevated, constricted at the base, with white, flattened tops, mostly monocarpic, rarely 2-3 carpic, structure of the pseudostroma of the *L. megasperma* type, but a supplementary brown coloured, woody layer present between the inner amorphous zone and the wall of the ascomata, ascospores 8/ascus, with ends obtuse to slightly acute, straight to slightly curved, constricted at the middle, transversely and vertically many septate, 160-200 x 23-33 µm in size.

Chemistry : Thallus K + Yellow, P-. Medulla of the pseudostroma K-, P-.

Specimens Examined : Karnataka, Sringeri, 2 km from Sringeri, Sringeri - Balehonur Rd -74.3129, 74.3130, 74.3131, 74.3134, 74.3135, 74.3147, 74.3209; 6 km from Sringeri, on the Sringeri - Balehonur Road - 74.3173, 74.3229, 74,3259, 31 km from Sringeri - Balehonur Road - 74.3161, 74.3162, Bettigeri - 74.3412; Agumbe - Sringeri Road, 77.448; Sirsi - Siddhapur Road, -77.184; Hiriyadaka, Udupi - Hebri Road, moist rain forest approx. 150 ft. elev. -78.32, 78.36, 78.37, 78.54, 78.55, 78.56, 78.57, 78.58; Mercara - Bagmandala - 74.3413; Kerala, Anamalai hills, Vazachal, 76.361, Maryoor -76.448; Andaman Islands, North Andaman, Diglipur Range, Moist forest Sitapur - 86.76, 86.77, 86.79; Tugapur Range, Pathar Thikri - 85.2424.

Remarks : This new species is well characterized by the highly elevated, large, rounded, mostly monocarpic, constricted pseudostromata concolorous with the thallus and with white flattened tops; invariably with strongly columellate ascomata and ascospores 8/ascus, constricted at the middle septum, 160-200 x 23-33 µm in size.

L. columellata seems to be very closely related to *L. megasperma* (Mont.) Riddle and *L. meristospora* (Mont.) A. Zahlbr. and in many respects it seems to be intermediate between these two species.

It agrees well with the *L. megasperma* in regard to the structure of the pseudostromata but the ascospores are much larger (200-330 µm in length), 4/ascus in *L. megasperma*.

L. columellata resembles to *L. meristospora* in having mostly monocarpic, elevated, concolorous pseudostromata and in having similar type of ascospore morphology and size. However, the structure of the pseudostroma is different from *L. meristospora* in having a supplementary brown woody layer between the inner amorphous zone and the wall of the ascomata. In addition, the ascomata of *L. columellata* are always columellate.

5. *Laurera cumingii* (Mont.) Zahlbr., in Cat. Lich. Univ. 2 : 503, 1922. *Trypethelium cumingii* Mont., in Hook, London

J. Bot. 4 : 5, 1845. (Figs : 5, 15, 32)

Type : Philippines, CUMING, 2170, P., BM (!) (designated by Letrouit-Galinou, 1957).

Thallus corticolous, crustose, pale greenish brown to yellowish brown, smooth; cortex 16.5-66 µm thick, often studded with hyaline crystals; algal layer 13-40 µm thick; medulla orange-yellow, studded with hyaline crystals; ascomata 1-20 aggregated, yellowish orange to orange, hemispherical, 0.4-1.0 mm in diameter, with black tops, the structure of the pseudostroma of the L. cumingii type, ascospores 8/ascus, parenchymatous, ovate, oblong, ends obtuse, 36.33-66 x 10-22 µm in size.

Chemistry : Thallus K + red, P-. Medulla of the pseudostroma K + red.

Specimens Examined : North Andaman, Pathar Thikri, Tugapur Range, 85.2402; Middle Andaman, Betapur Range, Pitcher Nala, 85.2387; Dhaninala, 85.2481; South Andaman, Little Andaman, South Bay, 85.1019. Philippines, CUMING 2169, BM.

Remarks : The species is reported for the first time from India.

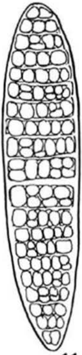
6. Laurera fusispora sp. nov. (Figs : 16, 33)

Typus : Karnataka, Anamod ghat, 5 km from Anamod check post, Anamod-Goa Road, 10.12.1974, P.G. PATWARDHAN and A.V. PRABHU, 74.2499 (Holotype-AMH, Isotype-BM).

Thallus subviride-flavescens, verrucosus, rimosus, hypothallo nigricante limitatus; stratum corticale 30-60 µm crassum; stratum medullare album; pseudostromata fusco-nigra vel nigra, polycarpica, immersa, irregulares; structura pseudostroma ejusdem modi ac groupe L. megasperma; ascosporae octonae, fusiformae, extremitatibus, acutis, 33-53 µm longae et 8-10 µm latae, septis transversis 10-15, septis verticalibus 1-3.

Thallus corticolous, crustose, greenish yellow, distinctly verrucose, cracked, determinate; cortex 30-60 µm thick; medulla white, studded with crystals; ascomata black, carbonized, sphaerical, externally not visible, totally embedded in pseudostromata; ostioles black, punctate, often indistinct; pseudostromata blackish brown to totally black, large, irregularly spread all over the thallus, immersed between thalline warts, polycarpic; structure of the pseudostroma of the L. megasperma type, a supplementary brown tissue observed between the internal amorphous zone and the wall of the ascomata towards the ostiolar region;

Figs 11-18 : Ascospores. 11. L. alboverruca (85.36, Holotype-AMH); 12. L. aurantiaca (77.461, Holotype-AMH); 13. L. benguelensis (76.1015); 14. L. columellata (78.59, Holotype-AMH); 15. L. cumingii (85.1019); 16. L. fusispora (74.2499, Holotype-AMH); 17. L. indica (85.656, Holotype-AMH); 18. L. megasperma (73.2325).



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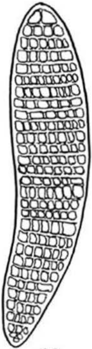

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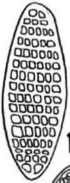

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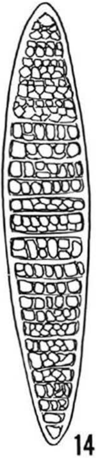

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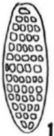

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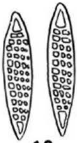

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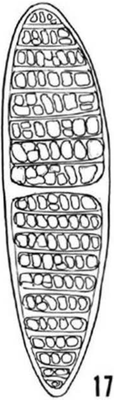

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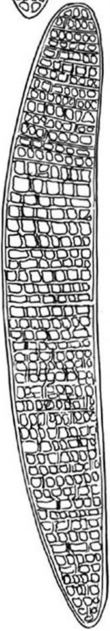

18

ascospores 8/ascus, hyaline, muriform, fusiform, ends acute, transversely 10-15 septate, vertically 1-3 septate, 33-53 x 8-10 µm in size.

Chemistry : Thallus and medulla of the pseudostroma K-, P-.

Specimens Examined : Karnataka, Anamod Ghat, 1 km from Anamod check post, Anamod-Goa Road, 74.2477; Devimane Ghat, Sirsi Kumtha Road, 74.2607, 74.2608.

Remarks : The thin fusiform ascospores characteristic of the present species are rather rare among *Laurera* species. This type of ascospore is found in *L. pyriformis* (Dodge) Letr. G.

The new species, with the structure of the pseudostroma of the *L. megasperma* group type, is distinct from all other species of *Laurera* by its highly verrucose thallus; large, blackish brown to black irregularly spreading, polycarpic, flattened, immersed pseudostromata and thin, fusiform ascospores.

7. *Laurera indica* sp. nov. (Figs : 9, 17, 34).

Typus : Andaman Islands, South Andaman, Baratang Islands, Bishnu Nala, 22.2.1985, P.G. PATWARDHAN and P.K. SETHY - 85.656 (Holotype-AMH, Isotype-BM).

Thallus sordid glaucescens vel flavoalbus continuus inaequalis; stratum corticale 16.5-33 µm crassum; stratum medullare albidum; ascomata integra, nigra, subsphaerica, ostiolo punctato, nigro; periostolum nigrum; pseudostromata thallo fere concolores, prominentes, oligocarpica, 1-8 ascomata contentes, rotundata, elongata, circa. 0.5-5 mm diam; parum evoluta vel evoluta; structura pseudostroma ejusdem modi ac *L. megasperma*; ascosporae octanae, extremitatibus obtusis, vel leviter attenuatis, 95-160 µm longae et 30-50 µm latae, septis transversis multi, septis verticalibus 1-8, medio constrictis.

Thallus corticolous, crustose, glaucous to yellowish white, more or less uneven; cortex hyaline, 16.5-33 µm in elevated pseudostromata; ostioles black, punctate, centrally situated, surrounded by black periostiolar region; pseudostromata concolorous with the thallus, 1-8 carpic, ± rounded, 0.5-5 mm in diameter; structure of the pseudostroma of the *L. megasperma* group, ascospores 6-8/ascus, transversely many septate, vertically 1-8 septate, 95-160 x 30-50 µm in size.

Chemistry : Thallus K + orange. Medulla of the pseudostroma K-, P-.

Remarks : *L. indica* holds an isolated position in having pseudostromata with two supplementary layers between the inner amorphous zone and the ascoma wall. The one towards the inner amorphous zone is more or less medulla like and is saturated with numerous hyaline crystals and the second one, lining the wall of ascoma, is brownish red in colour and very thick towards the ostiolar region.

8. *Laurera megasperma* (Mont.). Riddle, in Bull. Torrey Bot. Club, **44** : 323, 1917. *Trypethelium megaspermum* Mont. in Ann. Sci. Nat. Bot., ser. 2, 19 : 68, 1843. Zahlbruckener, A., 1922, Cat. Lich. Univ., 1 : 505. (Figs : 2, 18, 35).

Type : Guyana, Francaise, leg. LEPRIEUR - P (designated by Letrouit-Galinou, 1957).

Thallus corticolous, crustose, whitish green, yellowish green or greenish brown, uneven but not distinctly verrucose, determinate by thick black hypothalloidal region at the periphery; cortex 20-40 µm thick, hyaline; medulla white, studded with crystals; ascomata black, carbonized, more or less sphaerial with black, punctate, centrally oriented ostioles surrounded by white rim which is formed by the exposed white medulla of pseudostroma, embedded in pseudostromata; pseudostromata concolorous with the thallus, elevated, 1-3-carpic, rarely 4-carpic, 1-4 mm long and 1-2.5 mm broad; structure of the pseudostroma of the *L. megasperma* type, ascospores 4-6/ascus, cylindrical with obtuse ends, transversely and vertically many septate, 230-298 x 26-36 µm in size.

Chemistry : Thallus and Medulla of the pseudostroma K-, P-.

Specimens Examined : Kerala, cardamom hills, Kumali Road, 73.2325, 73.2329, 73.2351, Darugiri, Darugiri reserved forest, Baghmara Road, 10 km from Ronjengh, 78.410; Ceylon, South of the Island, G.H.K. THAWAITES-BM; Amazonia, C. WRIGHT, verr. Cub. 184-BM; Brazil, DR. BURCHELR. n. 339b-BM.

Remarks : *Laurera megasperma* (Mont.) Riddle is very well distinguished from all known species of *Laurera* by its very large (200-300 (330) µm long), mostly 4/ascus ascospores.

This species is reported for the first time from India.

9. *Laurera phaeomelodes* (Müll. Arg.) A. Zahlbr. in Engler-Prantl, Natürl. Pfhlanzenfamil., I Teil, Abt. 1 : 71, 1903. *Bathelium phaeomelodes* Müll. Arg. in Engler, Bot. Jahrbuch 6 : 394, 1885. Zahlbruckner, A., Cat. Lich. Univ. 1 : 506, 1922. (Figs : 19, 36)

Type : Cuba, leg. WRIGHT, 1883, n. 170 - Herb. Müller - G. (designated by Letrouit-Galinou, 1957), Isolectotype-H(!).

Thallus corticolous, crustose, smooth, olivaceous brown, determinate by a black hypothalloidal region at the periphery, completely endophloeodal; cortex 20-66 µm thick; algal layer 13-33, µm thick, ascomata black, carbonized, hemispherical, 0.4-0.6 mm in diameter, 1-5 aggregated in black, irregularly shaped pseudostromata, united at the level of the thalline region and appearing like scales, ostioles black, punctate, ascospores 8/ascus, ovate to oblong, 23-46 x 7-13 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostrom K-, P-.

Specimen Examined : Little Andaman, South Bay, 85.1015.

Remarks : *L. phaeomelodes*, earlier known from Cuba, is reported for the first time from India.

10. *Laurera sikkimensis* sp. nov. (Figs : 10, 20, 37)

Typus : Sikkim, Gangtok, Near Tangshi View Point, 17.11.77, P.G. PATWARDHAN and M.B. NAGARKAR, 77.1970 (Holotype-AMH, Isotype-BM).

Thallus crassus, continuus, verrucosus, olivaceus vel fuscus, stratum corticale circa 66-100 µm crassum; stratum medullare album; pseudostromata thallo fere concolores, oligocarpica, 1-5 ascomata continentes, circa 1-5 mm longa et 1-6.5 mm lata; ascomata multiloculata, periostiola nigra, albida annulata, ostiolo nigro; structura pseudostroma ejusdem modi ac groupe *L. megasperma*, scilicet verrucae hyphis intermixtis cum cellulis substrati; ascosporae octonae, murales, hyalinae, extremitatibus obtusis vel attenuatis, 60-150 µm longae et 23-26 µm latae, septis transversis 10-18, septis verticalibus 1-5.

Thallus corticolous, crustose, dark greenish brown to brown, verrucose, determinate by black hypothalloidal region at the periphery; cortex 66-100 um thick; medulla white; ascomata large, woody, black carbonized, embedded in large pseudostromata, hymenium divided into more than one chambers by thick, carbonized walls, ostioles black, punctate, centrally oriented, surrounded by black periostiolar region with white annular rim; pseudostromata slightly to highly elevated, concolorous with the thallus, horizontally elongated, 1-5 carpic, 1-7 mm long and 1-6.5 mm broad; structure of the pseudostroma of the *L. megasperma* type, but most of the part covered with the bark cells up to the ostiolar region, ascospores 8/ascus, transversely 10-18 septate, vertically 1-5 septate, 66-150 x 23-26 µm in size.

Chemistry : Thallus K + yellow, P-. Medulla of the pseudostroma K-, P-.

Remarks : The present new species is very well distinguished from the allied species of the *L. megasperma* group by its dark brown, verrucose thallus, concolorous pseudostromata with columellate or multioculate ascomata and smaller ascospores of the size 66-150 x 23-26 µm with a constriction at the middle septum. In addition, most tissue of the pseudostroma is covered with bark cells.

On account of the ascospore size and morphology it can be compared with the *L. chrysocarpa* (Müll. Arg.) A. Zahlbr. which, however, has different morphology of the pseudostroma

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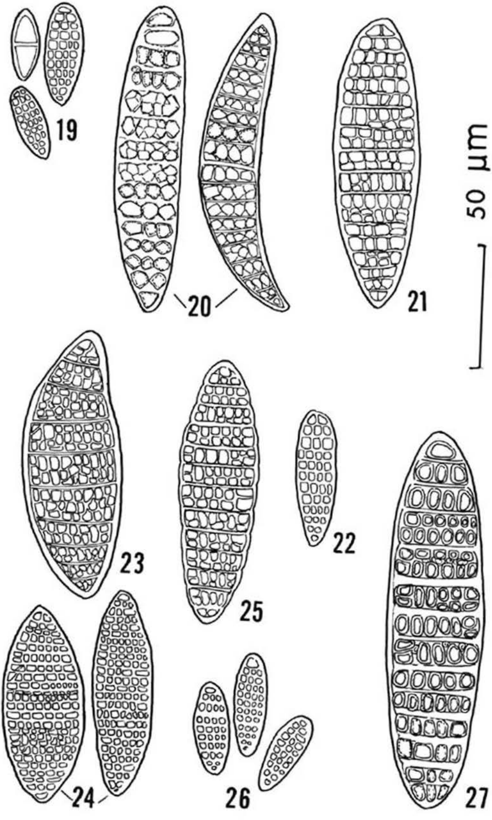
Figs 19-27 : Ascospores. 19. *L. phaeomelodes* (85.1015); 20. *L. sikkimensis* (77.1970, Holotype-AMH); 21. *L. sphaerioides* (85.869); 22. *L. subdiscreta* (H.Nyl. No. 322, Lectotype-H); 23. *L. subsphaerioides* (85.168, Holotype-AMH); 24. *L. tuberculosa* (74.2689, Holotype-AMH); 25. *L. varia* (85.1096); 26. *L. verrucoaggregata* (86.550, Holotype-AMH); 27. *L. vezdae* (74.2183, Holotype-AMH).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intermediate between the L. megasperma and L. madreporiformis types.

11. Laurera sphaerioides (Mont.) A. Zahlbr. in Cat. Lich. Univ. 1 : 506, 1922. Trypethelium sphaerioides Mont. in Ann. Sci. Nat. Bot., Ser. 2 19 : 73,1843. (Figs : 3, 21, 38)

Type : Guyana, LEPERIEUR, 80, syntype-BM (!).

Thallus corticolous, crustose, brown, smooth, totally endophloeodal; algal layer deeply situated in the thallus; ascomata aggregated in white slightly elevated, monocarpic to polycarpic (2-13), 1-9 mm long and 2-3 mm broad, rounded, linear or irregular, white pseudostromata, black, carbonized emergent; ostioles black, punctate to wide open, ascospores 2/ascus, ovate, parenchymatous, 99-132 x 26.4-36.30 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostroma K-, P-.

Specimens Examined : South Andaman, Baratang, Nilambur, Forest Guest house, 85.348, 85.869.

12. Laurera subdiscreta (Nyl.) A. Zahlbr. in Cat. Lich. Univ. 1 : 506, 1922. Trypethelium subdiscretum Nyl. in Flora, 52 : 73, 1869. (Fig : 22)

Type : Bengal, S. KURZ. H. Nyl. No. 322-Lectotype-H (!).

Thallus corticolous, crustose, completely endophoeodal, olivaceous green to brown; cortex yellow, totally endophloedal; ascomata black, carbonized, subglobose; ostioles black, punctate, centrally situated, not very distinct; pseudostromata blackish green, more or less rounded, 0.5-0.8 mm in diameter, monocarpic; structure of the pseudostromata of L. phaeomelodes type, ascospores 8/ascus, hyaline, ellipsoidal, 29.7-50 x 9.9-19.8 µm in size.

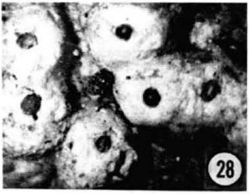
Chemistry : Thallus and medulla of the pseudostroma K-, P-.

Remarks : L. subdiscreta (Nyl.) A. Zahlbr. is characterised by the small, greenish black, monocarpic pseudostromata which distinguish the species from the other known species of the group L. phaeomelodes, namely L. phaeomelodes (Müll. Arg.) A. Zahlbr. and L. dodgei Letr. G. In addition L. dodgei has very large ascospores (120-150 x 28-40 µm).

13. Laurera subsphaerioides sp. nov. (Figs : 23, 39)

Typus : Andaman Islands, South Andaman, Wimberliganj,

Figs : 28-35 : 28. L. alboverruca (85.36, Holotype-AMH); 29. L. aurantiaca (77.461, Holotype-AMH); 30. L. benguelensis (76.1015); 31. L. columellata (78.59, Holotype-AMH); 32. L. cumingii (85.1019); 33. L. fusispora (74.2499, Holotype-AMH); 34. L. indica (85.656, Holotype-AMH); 35. L. megasperma (73.2325, Holotype-AMH). Scale in mm.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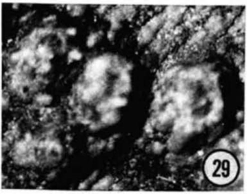
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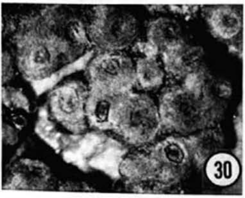
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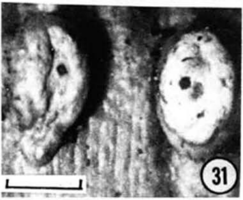
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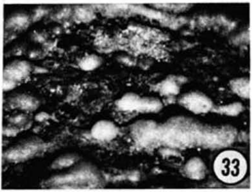
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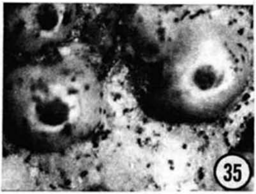
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Kalatang, 16.2.1985, P.G. PATWARDHAN, M.B. NAGARKAR and P.K. SETHY, 85.168 (Holotype-AMH, Isotype-BM).

Thallus crustaceus, fuscus, tenuis, farinaceus laevis, ramosus, endophloeodes; stratum gonidiale penitum; pseudostromata thallo concolores, 1-oligocarpica, 1-2.5 mm diametro; ostiola nigra, punctiformia, structura pseudostroma ejusdem modi ac groupe L. sphaerioides, ascosporae binae, 1-seriales, hyalinae, oblongato-ellipsoideae, parenchymaticae, 99-118 µm longae et 30-37 µm latae.

Thallus corticolous, crustose, distinctly cracked, brown, totally endophloeodal, farinaceous; algal layer deeply situated in the thallus; ascomata 1-5, embedded in concolorous, 1-2.5 mm in diameter thalline verrucae, externally visible by their black, punctate, centrally situated ostioles; the structure of the pseudostroma of the L. sphaerioides group, ascospores 2/ascus, ovate, oblong, ellipsoidal, parenchymatous, 99-118.80 x 30-37 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostroma K-, P-.

Specimen Examined : South Andaman, Wimberlinganj, Kalatang 85.171.

Remarks : Only two species of the group L. sphaerioides (Letrouit Galinou, 1957) - L. sphaerioides (Mont.) A. Zahlbr. and L. chrysoglypha (Vainio) A. Zahlbr. have two spored asci. Both of these species, however, have much larger, polycarpic pseudostromata. L. sphaerioides has 1 cm long, white pseudostromata with a white, medulla (K-), while L. chrysoglypha has large (2-15 x 1.5-3 mm), polycarpic (up to 25 ascomata) pseudostromata with orange medulla (K + red).

The present new species, thus, can be distinguished from L. chrysoglypha and L. sphaerioides in having a distinctly farinaceous and cracked thallus, concolorous pseudostromata with only 1-5 ascomata and a white medulla (K-).

14. Laurera tuberculosa sp. nov. (Figs : 6, 24, 40)

Typus : Karnataka, Sirsi-Kumtha Road, 48 km from Sirsi, 12.12.1974, C.R. KULKARNI, 74.2689 (Holotype-AMH, Isotype-BM).

Thallus epiphloeodes, ochraceo-olivaceus, tuberculosoverrucosus; stratum corticale 30-100 µm crassum; stratum medullare album; ascomata fusco-nigra, ovoidia, basi tenuiora, ostiolo punctato, papillato nigro, periostolo fusco-nigro; pseudostromata fusco-nigra vel nigra, monocarpica, raro 2-3 carpica, sphaerica, basi-constrictica, circa 1-1.5 (-2) mm diametro; structura pseudostroma ejusdem modi ac groupe L. madreporiformis; stratum medullare des pseudostromata saturatum sanguineum; ascosporae 4-8:nae, hyalinae, ellipsoideo-ovate, murales, parenchymaticae, 70-132 µm longae et 40-50 µm latae.

Thallus corticolous, crustose, yellowish green to yellowish olivaceous, distinctly verrucose, verruceae globose to tuberculoid, sometimes completely separating from the main thallus; cortex 30-100 µm thick; medulla white, studded with crystals; ascomata blackish brown, completely embedded in pseudostromata ovoid, thinly carbonized at the base; pseudostromata, blackish brown to brown, sphaerical, constricted at the base, mostly monocarpic, rarely 2-3 carpic, about 1-1.5(2) mm in diameter, structure of the pseudostroma of the *L. madreporiformis* group; ascospores 4-8/ascus, hyaline, ellipsoidal, elliptical or ovate, parenchymatous, 70-132 x 40-50 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostroma red, K + purple.

Specimens Examined : Karnataka, Ammanthali, 74.2702, Manipal 77.561.

Remarks : *L. tuberculosa*, is very well distinguished by its distinctly tuberculoid verrucose thallus and mostly monocarpic to rarely 2-3 carpic, blackish brown pseudostromata with a red coloured substance (K + purple) in the medullary layer.

The presence of a red coloured substance in the medullary layer of the pseudostromata distinguishes it from *L. sphaerica* (Dodge) Letr. G., which resembles it closely in regard to morphology of the thallus, ascocarps and ascospores.

On account of the red coloured substance the new species comes close to the *L. sanguinaria* Malme, which has much larger (1-4 mm) polycarpic (often 5-15 carpic) pseudostromata.

L. tuberculosa was found associated with the *L. fusispora* and it can be mistaken for it if not examined carefully.

15. *Laurera varia* (Fée emend. Roum. et Müll. Arg.) A. Zahlbr. Engler-Prantl, Natürl. Pflanzenfamil., I. Teil, Abt. I, p. 71, 1903. *Meissneria varia* Fee in Suppl. Essai Cryptog. Ecorc., Officin., p. 66, tab. XL, fig 1, 1837. Zahlbruckner, A. 1922, Cat. Lich. Univ. 1 : 507.
(Figs : 25, 41).

Type : Moluccas, Ambon, LAURIER - Ex. Herb. Müll, Arg., - Lectotype - G (designated by Letrouit-Galinou, 1957).

Thallus corticolous, crustose, yellowish green to olivaceous, cracked, unevenly thickened; cortex yellow, 45-132 µm thick; medulla white, studded with crystals; ascomata black, carbonized completely immersed in pseudostromata and externally visible by their indistinct, black, punctate, centrally situated ostioles surrounded by blackish brown to black disc like periostiolar region, which often separates from the surrounding tissue by a distinct cleavage, pseudostromata concolorous with the thallus, slightly elevated, rounded, orbicular, elongated, 1-7 carpic, 0.5-9 mm long and 0.5-5 mm broad; structure of the pseudostroma of the *L. megasperma* group, ascospores 8/ascus, straight to curved, ovate, oblong, transversely upto 20 septate, vertically 1-6 septate, 66-100 x 16.5-28 µm in size.

Chemistry : Thallus K + red, P-. Medulla of the pseudostroma K-, P-.

Specimen Examined : Andaman Islands, South Andaman, Alexander Island, 85.1096.

Remarks : L. varia is well distinguished by the pseudostromata 1-7 carpic and concolorous with the thallus, ascomata with externally indistinct ostioles surrounded by rounded to irregular, black coloured, flattened, disc like periostiolar region separating from the surrounding tissue of the pseudostroma by the cleavage and the orange coloured zone of pseudostroma reacting K + red.

The specimen examined, however, varies from the lectotype specimen (Letrouit-Galinou, 1957) of L. varia in having the tissue of the pseudostroma surrounding the ascomata covered by the bark cells except the cortical region up to the ostioles. Thus, the structue apparently reminds one very much of the L. sphaerioides group but, if examined carefully the structure of the pseudostroma is of the L. megasperma group.

The species is reported for the first time from India.

16. Laurera verrucoaggregata sp. nov. (Figs : 4, 26, 42)

Typus : Andaman Islands, North Andaman, on the way to Lamia Bay, in mixed forest, S.E. of Aerial Bay, 5.1.1986, M.B. NAGARKAR and P.K. SETHY, 86.550 (Holotype-AMH, Isotype-BM).

Thallus stramineus, laevigatus, omnino endophloeodes; stratum corticale indistinctcum; stratum medullare albidum. crebre intermixtum in substratum penetrans; ascomata integra, nigra, hemispheaerica vel sphaerica, valde emergentia, nitida, confluentia in pseudostroma, ostiolo punctatato, papillato nigro; pseudostromata prominentes, subnitida et nigra, polycarpica, irregulariter angulosa, varie multiformi elongata et anastomosanta, ascomata in pseudostroma pluriserialae; structura pseudostromata ejusdem modi ac groupe L. phaeomelodis, scilicet pseudostromata hyphis carbonaceis cum cellulis suberosis nigrescentibus substrati immixtis constitutae, ascosporae octonae, murales, hyalinae, ovatae, extremitatibus obtusis vel rotundatis, 34-46 µm longae et 12-15 µm latae, septis transversis 9-11, septis verticalibus 1-4.

Thallus corticolous, crustose, straw coloured, more or less smooth, totally endophloeodal; algal layer deeply situated in the bark cells; medulla white, ascomata black, carbonized, totally emergent, glossy, hemisphaerical to sphaerical, aggregated in black pseudostromata; ostioles black, punctate, centrally situated, papillate; pseudostromata black, carbonized, polycarpic, irregularly spreading over the thallus leaving very little of the vegetative thallus uncovered forming a network on the thallus; structure of the pseudostroma of the L. phaeomelodes group, ascospores 8/ascus, hyaline, transversely 9-11 septate, vertically 1-4 septate, 34-46 x 12-15 µm in size.

Chemistry : Thallus K-, P-. Medulla of the pseudostroma K-, P-.

Specimens Examined : Andaman Islands, North Andaman, Kalipur to Lamia Bay, S.E. of Aerial Bay, 86.535, 86.537, 86.538, 86.594.

Remarks : The present new species, with the structure of pseudostroma of the *L. phaeomelodes* group, is distinguished by its straw coloured thallus; very large, irregularly shaped, polycarpic, black, irregularly spreading pseudostromata leaving a very little of vegetative thallus uncovered.

It resembles *L. phaeomelodes* (Müll. Arg.) A. Zahlbr. and *L. subdiscreta* (Nyl.) A. Zahlbr. in regard to structure of the pseudostroma, ascospore size and morphology. However, *L. phaeomelodes* is especially distinct in having mono-oligocarpic pseudostromata with a scaly structure at the base, and *L. subdiscreta* differs in having monocarpic pseudostromata.

17. *Laurera vezdae* sp. nov. (Figs : 27, 43).

Typus : Maharashtra, Vishalgarh, Amba-Gajapur Road, 6.12.1974, M.B. NAGARKAR and A.V. PRABHU, 74.2183 (Holotype-AMH, Isotype-BM).

Thallus viridi-flavus, nitidus, laevigatus; stratum corticale 33-100 µm crassum; stratum medullare albidum; ascomata integra, nigra, endophloedal, ostiolo punctato, nigro, pseudostromata thallo fere concoleores vel bruneo-flava, 1-15 carpica, rotundata vel irregulara, 1-6.5 mm longa et 1-5.5 mm lata; structura pseudostroma ejusdem modi ac *L. sphaerioidis*, stratum gonidiale thalli in pseudostroma non penetrans, stratum gonidiale thalli in pseudostroma non penetrans, pseudostroma hyphis cum cellulis substrati immixitis constitutae; ascosporae binae, tetranae, murales, ovatoelongatae, oblongae, extremitatibus obtusis vel rotundatis, 100-178 µm longae et 33-43 µm latae, septis transversis 15-20, septis verticaliibus 1-10.

Thallus corticolous, crustose, greenish-yellow, glossy, smooth; cortex 33-100 µm thick, hyaline to very light yellow; medulla white, studded with crystals; ascomata black, carbonized, pyriform, with punctate, internally reddish brown, papillate, black ostioles; pseudostromata concolorous with the thallus or brownish yellow to brown coloured, rounded to irregular, slightly elevated, 1-15 carpic, 1-16.5 mm long and 1-5.5 mm broad; structure of the pseudostroma of the *L. sphaerioides* type; ascospores 2-4/ascus, transversely 15-20 septate, vertically 1-10 septate, 100-178 x 33-43 µm in size.

Chemistry : Thallus K + orange, P-. Medulla of the pseudostroma K-, P-.

Specimens Examined ,: Maharashtra, Vishalgarh, Amba-Gajapur Road, 74.2175, 74.2180.

Remarks : The present new species is distinguished from the known species of the *L. sphaerioides* group by its brownish yellow to brown coloured, rounded to irregular elevated pseudostromata, 2-4 spored asci with much larger ascospores reaching 100-178 x 33-43 µm.

The other species of this group, *L. sphaerioides* (Mont.) A. Zahlbr. has distinctly white, polycarpic,


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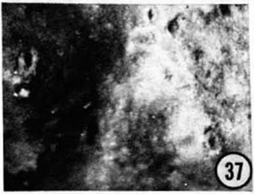
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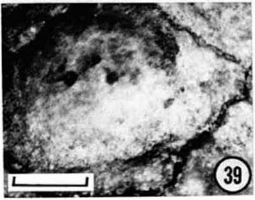
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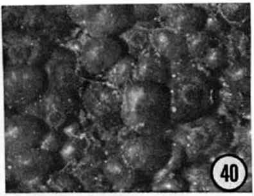
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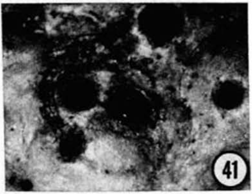
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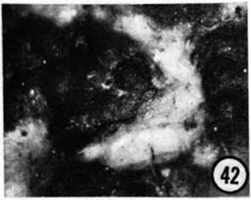
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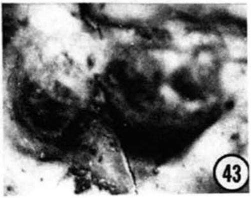
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irregularly shaped pseudostromata and L. chrysoglypha (Vainio) A. Zahlbr. has yellow coloured elevated, polycarpic pseudostromata with orange coloured medulla. Both these species are characterized by 80-150 µm long ascospores and 2-spored asci.

The species has been named after Dr. A. Vezda.

ACKNOWLEDGEMENTS

We are grateful to the Directors/Keepers of the Herbaria of BM, H and TUR for the loan of many specimens, including types, preserved in their herbaria. We are also grateful to Dr. M.E. Hale, Smithsonian Institution, Washington D.C. and to Dr. R.C. Harris, New York Botanical Garden, Bronx, New York, U.S.A. for critical review and valuable suggestions.

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Figs 36-43 : 36. L. phaeomelodes (85.1015); 37. L. sikkimensis (77.1970, Holotype-AMH); 38. L. sphaerioides (85.869); 39. L. subsphaerioides (85.168, Holotype-AMH); 40. L. tuberculosa (74.2689, Holotype-AMH); 41. L. varia (85.1096); 42. L. verrucoaggregata (86.550, Holotype-AMH); 43. L. vezdae (74.2183, Holotype-AMH). Scale in mm.

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MYCOTAXON

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NEOTYPIFICATION OF SPARASSIS CRISPA

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Fungal taxonomy and nomenclature are constantly plagued by the lack of type specimens for purportedly well-known species described by starting point or prestarting point authors. The genus Sparassis Fries is a case in point. According to Burdsall and Miller (1988) it is composed of two species, S. spathulata Schw. and S. crispa Wülf.:Fr. A lectotype was recently designated for S. spathulata by Burdsall and Miller (1988). However, no nomenclatural type exists for S. crispa, the generic-type species. Even though the concept of S. crispa is well understood, it is not possible to relate the presently used biosystematic characteristics of micromorphology, chemotaxonomy, and other taxonomic methods yet to be developed to the words and pictures that now serve as its nomenclatural type. Thus, the purpose of our study was to designate a tangible and appropriate specimen as neotype. This removes the final elements of doubt as to what the name S. crispa represents.

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[1] Maintained in Madison, WI, in cooperation with the University of Wisconsin.

Elvella ramosa Schaeffer (Schaeffer 1772; p. 106, t. 163; typified by description and illustration) is apparently the earliest name for the taxon called *S. crispa*. Wülfen described it as *Clavaria crispa* Wülf. in Jacquin (Jacquin 1781, p. 100, t. 14, f. 1), and this was the name sanctioned by Fries (1821, p. 465). Unfortunately, there is no known extant material from either of these mycologists. Because Fries (1821) sanctioned the name proposed by Wülfen, a specimen from Carinthia would be the most appropriate to serve as neotype. However, because both Jacquin's and Schaeffer's concepts were included by citation in Fries' work, it is reasonable and allowable to designate a specimen from the locality where Schaeffer collected to serve as a neotype.

Dr. Andreas Bresinsky has made two such specimens available for this purpose. They were collected near Regensburg, Germany, and conform to what we believe was the concept of all three authors and what represents the present concept of *C. crispa*. We have chosen the specimen with the more well-developed radicating base to be neotype.

DESCRIPTION OF NEOTYPE

Sparassis crispa Wülfen: Fr., Syst. Mycol. 1:465. 1821.
≡ *Clavaria crispa* Wülfen in Jacquin. Misc. Austriaca 2: p. 100. 1781.
≡ *Elvella ramosa* Schaeffer, Fung. Bavaria et Palatinatu. p. 106. 1772.

Neotype: [GERMANY], Etterzhausen, am Fusse von *Pinus silv*., 20.9.76., leg. Besl, Nr. 23 (REG).

Macroscopic Characters: Basidiocarp 6-10 cm broad, 6-10 cm tall, composed of several broad flattened layers of tissue extending from just above ground level and forming broad flabellae that are much dissected and contorted, the ends of the flabellae becoming even more dissected, undulating, and contorted, the apices being 0.5-1 cm wide, abhymenial surface pale creamy yellow, hymenial surface brownish yellow, both surfaces with irregularly oriented veins and ridges; epigeous portion borne on a hypogeus radicating base, composed of soil particles and interwoven hyphae.

Microscopic Characters: Flabellae approximately 1-1.25 mm thick; cutis approximately 20 μm thick with hyphae hyaline, thin-walled, interwoven, 2-4 μm diam, with clamp connections, tips protruding just above the surface; context 800-1,000 μm thick with hyphae extremely variable in shape, (1) hypha-like cells 4-10 μm diam, possessing clamp connections, (2) pseudoparenchymatous cells up to 40 μm diam, both more or less thick-walled; refractive hyphae interspersed among these cells, staining strongly in phloxine and in Melzer's reagent, hyaline, thin-walled, with clamp connections; subhymenium up to 20 μm thick, hyphae densely interwoven, 3-6 μm diam, hyaline, thin-walled, with clamp connections; basidia 50-70 x 5-7 μm, clavate, hyaline, thin-walled, four-sterigmate, with a clamp connection at the base; hyphidia 30-60 x 2-4 μm, apex cylindrical or swollen up to 4 μm diam, hyaline, thin-walled, smooth, clamped at the base; basidiospores broadly ovoid, 5-6(-6.5) x 4-5 μm, hyaline, thin-walled, smooth, not reacting with Melzer's reagent, with a small apiculum.

As indicated by Martin and Gilbertson (1976, p. 637), the fungus called S. radicata in the United States is actually S. crispa. What was known as S. crispa in the southeastern United States is now known to be S. spathulata. Both species cause a brown rot of roots and heartwood of living trees.

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Drs. R. L. Gilbertson and M. J. Larsen are thanked for their comments on this manuscript.

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MYCOTAXON

Vol. XXXI, No. 2, p. 595 April-June 1988

NOTICE:

ROYAL BOTANIC GARDENS, KEW

Regulations governing loan of mycological specimens

Many requests for the loan of mycological collections are received each year. Processing of these places a heavy burden on the limited staff available for this work and, in addition, postal costs are an increasing strain on the annual budget. All demands for loans therefore cannot be met, and some restriction on the amount of material sent out is necessary.

All requests should be made to the Director by the head of a recognized mycological establishment, who will be expected to accept responsibility for the safe custody and return of the specimens. Loans must not be removed from the establishment to which they are assigned.

Names of the researchers and scope of work should be stated. Loans to postgraduate students will only be sent as the student approaches the final stage of the work.

Loans are normally for three months from receipt, and prompt return is requested. An extension may be granted in exceptional circumstances following a written request.

Full data as to locality, collector and number, author and place of publication is requested. Further, 'Saccardo numbers' are requested where possible for all taxa described prior to 1889, and synonyms or alternative names under which material may be filed are helpful.

Blanket requests for all material of a taxon cannot be met. Loans will normally be limited to 20 specimens. Larger requests will be divided, with the second consignment sent on return of the first. Required specimens should be listed individually.

Requests for types should relate to specimens known to be preserved at Kew. We cannot deal with long lists circulated in duplicate to many herbaria.

Portions of specimens for applied research e.g. biochemistry, electron microscopy, will be supplied only if material is adequate for the purpose. Resulting SEM/TEM photographs are requested in exchange for any material provided.

All microscope slide preparations must be returned. *Determinavit* labels, written legibly in permanent ink and signed, should accompany each returned collection. Any information which might prove of value to future researchers should be provided. Labels must not be glued to the sheet but inserted in the packet.

Reprints resulting from the study of Kew material should be sent to the Kew Library.

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ERRATA, VOLUME TWENTY

Page 330	line	3	for	*Echinopora*	read	*Echinoporia*
		19	for	*Echinopora*	read	*Echinoporia*
		21	for	*E. hydnophorus*	read	*E. hydnophora*
343	line	36	for	*Echinopora hydnophorus*	read	*Echinoporia hydnophora*

ERRATA, VOLUME TWENTY-EIGHT

Page 539	line	10	for	**biokensis**	read	**biokoensis**
		12	for	**biokensis**	read	**biokoensis**

ERRATA, VOLUME TWENTY-NINE

Page 467	line	13	for	*xanthomelaenoides*	read	*xanthomelanoides*

ERRATA, VOLUME THIRTY

Page 313	line	14	*for*	Knudsen,	*read*	Knudsen ut Hebeloma truncatum (Fr.) Kumm. ss. Lange,
316	line	14	*for*	Knudsen,	*read*	Knudsen ut Hebeloma truncatum (Fr.) Kumm. ss. Lange,

ERRATA, VOLUME THIRTY-ONE

Page 54	line	47	for	**phlebiaformis**	read	**phlebiaeformis**
		48	for	**phlebiaformis**	read	**phlebiaeformis**
192	line	12	for	*A. osmophila*	read	*Ascosphaera osmophila*
437	line	31	for	C.	read	Cylindrotrichum
467	line	23	for	Tricothelium	read	Trichothelium
489	line	10	for	C. hyalochaeta	read	Cheilymenia hyalochaeta
496	line	36	for	*P.*	read	*Parmotrema*
514	line	45	for	*C.*	read	*Corynesporopsis*
515	line	10	for	*C.*	read	*Corynesporopsis*
524	fig.	7	for	**Dicheirina**	read	**Dicheirinia**
		7	for	**Ypsilopsora**	read	**Ypsilospora**
		7	for	**Sphenopsora**	read	**Sphenospora**
529	fig.	14	for	**Sphaeophragmium**	read	**Sphaerophragmium**
551	line	25	for	*P. hypo-*	read	*Parmelia hypo-*

INDEX TO FUNGOUS AND LICHEN TAXA, VOLUME THIRTY-ONE

This index contains the names of genera, infrageneric taxa, species, and infraspecific taxa. New names are in **boldface,** as are the page numbers on which such new taxa are proposed.

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